BUKTI KORESPONDENSI

ARTIKEL PROSIDING SEMINAR INTERNASIONAL

Judul artikel : Chemical Use in Tidal Lowland Agriculture

Seminar : Internasional Conference on Food Safety and Security under Changing Climate

Penulis : Muhammad Yazid, Mad Nasir Shamsudin, Khalid Abdul Rahim, Alias Radam, Azizi Muda

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Abstract dan Poster Submission

CHEMICAL USE IN TIDAL LOWLAND AGRICULTURE

Muhammad Yazid, Mad Nasir Shamsudin, Khalid Abdul Rahim, Alias Radam and Azizi Muda
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Abstract

Despite continuing debates over the use of chemicals in agriculture, the use of pesticides in food crop production in tidal lowlands has been unavoidable partly due to the uncertainty caused by climate change. The reason behind this is to maintain current productivity and to prevent loss due to pest and disease threats caused by a shift in planting season.

A survey has been conducted to compare the benefit and cost (including environmental cost) of chemical use in food crop production in tidal lowland. A random sampling of 500 farms has been drawn to prove whether the use of chemicals has an economic support.

The result indicates that the use of chemical has significant effect on rice production, but only slightly increased the productivity of rice. When the environmental cost of chemical used is considered, the benefit of using it is mostly absorbed by the cost.

Keywords: chemicals, agriculture, tidal lowland

Chemical Use in Tidal Lowland Agriculture

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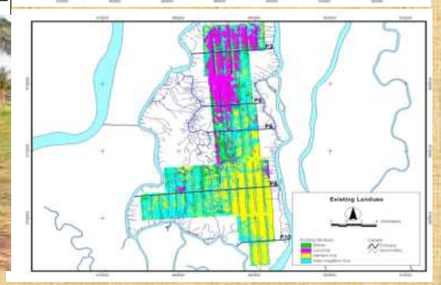
INTRODUCTION

Tidal lowland development in Indonesia aimed at supporting transmigration program and increasing rice production to compensate the conversion of irrigated farm land in Java (Suprianto et al., 2009; Schultz et al., 2005; Suriadikarta et al., 2001). After severe droughts in 1991, 1994, and 1997 which resulted in import of rice up to 4.5 million tons in each of these years, the objective of tidal lowland development has shifted from previously focused on transmigration to pushing up the productivity of rice in tidal lowlands. As a result, about 30 percent of the area suitable for rice has reached the productivity above 5 tons per ha. In addition, 10 percent of the area can be cultivated twice to three times a year. However, the negative impact of modern input use has emerged. As a consequence of chemical use, canal water which was previously used for various domestic needs is no longer safe, raising externality among farmers themselves. In addition, recent climate change that shifts planting season has increased the risk of pest and disease threats and confirmed the use of chemicals. This study aimed to investigate the use of chemicals and to consider its cost (including environmental cost) in rice production in tidal lowlands.



METHODOLOGY

- This study was carried out in Telang, a rice production center in tidal lowland area of South Sumatra, through a survey.
- Research sample of 500 farm households were randomly drawn from some 10,000 farm households, covering 12 secondary blocks (approximately 3,072 ha).
- Data were collected through field observation and structured interview.
- The effect of chemical use on rice production was analyzed using linear regression based on a Cobb-Douglas production function (Hair et al., 2010; Coelli, 1995) as the following:

$$\ln Y_i = \beta_0 + \beta_1 \ln SEED + \beta_2 \ln CHEM + \beta_3 \ln FERT + \beta_4 \ln LABOR + \beta_5 D_{WS} + \varepsilon_i$$

where *Yi* = total rice production in tons
SEED = seed used in kg
CHEM = chemical used in Rupiah
FERT = fertilizers used in Rupiah
LABOR = labor used in man days
Dws = dummy variable for 0 = without and 1 = with water service

RESULTS AND DISCUSSION

- The costs of rice cultivation were estimated based on per hectare rice cultivation in the first planting season (Table 1). The cost of pesticides accounts for 10.57 percent of the total cost. Among three types of pesticide, the cost of herbicide was the highest and accounted for 65.76 percent of total pesticide cost.

Table 1. Costs of rice cultivation per hectare in the study area

Inputs	Types of Inputs	Unit	Volume	Unit Cost (Rp)	Total Cost (Rp)
Seed	Rice seed	Kg	63.5	6,000	381,000
Pesticides	Herbicides[1]	n.a	n.a	n.a	344,770
	Insecticides[1]	n.a	n.a	n.a	72,480
	Fungicides[1]	n.a	n.a	n.a	107,000
Fertilizers	Nitrogen	Kg	220	1,300	286,000
	Phosphorus	Kg	121	2,300	278,300
	Potassium[2]	Kg	n.a	n.a	13,910
Labor	Land preparation	Man day	10	50,000	500,000
	Planting	Man day	4.5	50,000	225,000
	Fertilizing	Man day	2	50,000	100,000
	Controlling	Man day	2	50,000	100,000
	Harvesting[3]	Man day	51	50,000	2,550,000
Total					4,958,460

Notes:
1Various types with various unit (L, ml, Kg, gram, etc) such that only total cost is applied.
2Only few samples used this type of fertilizer such that average volume is not relevant.
3Consists of harvesting and threshing. Harvesting cost is in shared product with the ratio 1:7 (12.5% for labor, 87.5% for owner). Threshing cost is Rp 50 per Kg output. All of these expenses are made equivalent to man day.
n.a not applicable

- Herbicides were used during land preparation as pre-planting weeding and during growth stage as post-planting weeding. Insecticides were used incidentally according to the existence and intensity of insect attacks. Fungicides were used to control fungus and to enhance growth.
- Rice production varied from as low as 1.5 tons to as high as 79.2 tons of on-farm dried paddy due to the variation in area cultivated from as low as 0.25 hectare to as high as 12 hectares.
- The average production was 9.75 tons (standard deviation = 5.70 tons) and the average cultivation area was 1.84 hectares (standard deviation = 0.99 hectare).
- The average productivity was 5.35 tons per hectare on-farm dried paddy (standard deviation = 0.88 ton).

- Results of multiple regression analyses were presented in Table 2. The Cobb-Douglas model was robust based on the R2 statistics (Gujarati, 2003) and the overall model was statistically significant at 95 percent confidence interval.

Table 2. Regression coefficients and the value of t-test statistics

Variables	Coefficients	Std. Error	t	Sig.
(Constant)	-3.910	.212	-18.449	.000
Seed	.023	.026	.901	.368
Chemicals	.034	.018	1.828	.068*
Fertilizer	.128	.026	5.030	.000***
Labor	.782	.028	28.374	.000***
Water service (dummy variable: 0 = without; 1 = with)	.040	.013	3.026	.003***

Note:
Dependent variable is total rice production
All variables are in logarithmic, except water service.
R Square .936; F-test 57.083; Sig. of F-test .000
*Significant at 10% **Significant at 5%; ***Significant at 1%

- All coefficients are positive as expected. The coefficient of chemicals is positive and significant.
- As indicated by its coefficient, one unit increase in chemical used associated with 0.034 unit increase in rice production.
- Environmental cost of chemical use was estimated using avoidance cost (the cost of bottled water purchased to avoid contaminated canal water) which was Rp 11,520,000 per secondary block or Rp 45,000 per ha.
- This cost was expected to be recovered through the increase in production of 20 kg on-farm dried paddy per ha, assuming the price of Rp 2,250 per kg.
- This was equivalent to 0.37 percent increase in productivity, considering the average productivity was 5.35 tons per ha.
- Based on the value of elasticity, 0.37 percent change in production was associated with 10.88 percent change in chemical use. Since the average cost of chemical use was Rp 524,250 per ha, the required change in chemical cost was Rp 57,038.
- Therefore, to recover the external cost of Rp 45,000 per ha requires Rp 57,000 additional cost of chemical per ha. This meant that the cost to recover the external cost of chemical use was higher than the externality itself.

CONCLUSION

- The use of chemical was currently unavoidable in tidal lowland rice cultivation due to present threat of pests and diseases and the increasing risk of pest and disease attacks due to the shift in planting season caused by climate change.
- Despite undervaluing the economic cost of chemical contamination in canal water, the use of avoidance cost is considered the most tangible since majority of farm households experienced this impact in tidal lowlands.
- The use of chemicals, especially herbicide, should be reduced and replaced by mechanical practice to control weed during pre and post planting.

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Acceptance Letter for Paper

October 25, 2010

LETTER OF ACCEPTANCE

INTERNATIONAL CONFERENCE ON FOOD SAFETY AND SECURITY UNDER CHANGING CLIMATE

http://www.fcc2010.upm.edu.my
http://www.selamat.net

DECEMBER 6 - 7, 2010

Please review this information carefully

Abstract Code	:	126
Corresponding Author	:	Muhammad Yazid
Co-Author	:	Mad Nasir Shamsudin, Khalid Abdul Rahim, Alias Radam and Azizi Muda
Title	:	*Chemical Use In Tidal Lowland Agriculture*
Mode of Presentation	:	Poster

Dear Muhammad Yazid
I am pleased to inform that your above referenced abstract has been accepted for presentation at the International Conference on Food Safety and Security under Changing Climate, 6-7 December 2010, Penang, Malaysia.

1. Please submit your final full paper via mail to *foodclimatechange@gmail.com* and *chonggh@food.upm.edu.my* before **15 November 2010**. Please refer to http://www.fcc2010.upm.edu.my/guidelines.html for full paper guidelines. The paper must be camera ready for proceeding. Final manuscripts received after the deadline may not be included in the proceedings.
2. One of the authors or the presenter registers online and pays the registration fee by **15 November 2010**. Please make the payment to the **BENDAHARI UPM** via instructions posted on our website: http://www.fcc2010.upm.edu.my/registration.html or *http://www.selamat.net*. The registration and payment done after 15 November 2010 may not be included in the proceedings.
3. If you want to have any other conference related information, please visit our homepage: *http://www.fcc2010.upm.edu.my*

Please arrange for your hotel accommodation as soon as possible as December is a peak season for vacation and room availability at the conference venue is limited. You may visit our homepage for other hotels nearby the conference venue.

Congratulations for being selected to take part in this highly exciting and challenging international program. We are excited to have you as a participant in our Conference. Should you have any questions regarding the Conference, please do not hesitate to contact us at *foodclimatechange@gmail.com*

I look forward to meeting you in Penang, Malaysia.

Thank you.

Sincerely,

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Chemical Use in Tidal Lowland Agriculture

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[4]Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak, Malaysia

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Despite continuing debates over the use of chemicals in agriculture, the use of pesticides in food crop production in tidal lowlands has been unavoidable partly due to the uncertainty caused by climate change. The reason behind this is to maintain current productivity and to prevent loss due to pest and disease threats caused by a shift in planting season. A survey has been conducted to study the cost (including environmental cost) of chemical use in rice production in tidal lowland. A random sample of 500 farm-households was drawn to prove whether the use of chemicals has an economic support. The result indicates that the use of chemical has significant effect on rice production. However, chemical use has caused externality and the cost required to recover this externality is higher than the external cost itself. Therefore, reducing the use of chemicals would possibly be a choice for rational farmers.

Keywords: chemicals, agriculture, tidal lowland

INTRODUCTION

Tidal lowland development in Indonesia aimed at supporting transmigration program and increasing rice production to compensate the conversion of irrigated farm land in Java (Suprianto et al., 2009; Schultz et al., 2005; Suriadikarta et al., 2001). Farm land conversion to non-agriculture was estimated 40,000 to 50,000 ha per year. In order to maintain current level of rice production, each ha lost of irrigated farm land must be replaced by more than 3 ha upland or rain-fed lowland.

Tidal lowland development was carried out through reclamation. Reclamation of lowlands in Sumatra has reached 692,000 ha, of which 373,000 ha is located in South Sumatra Province (Directorate of Lowland and Coasts, 2007). In spite of this large reclaimed area, its utilization for agriculture production is considered low. In addition, its productivity is yet considered lower than that of irrigated areas (Simatupang and Rusastra, 2003). This is due to the limited knowledge and information regarding agro-physical and chemical characteristics of tidal soil as well as the implementation of water management strategy on tidal lowlands.

The objective to increase rice production in tidal lowlands was restated after severe droughts in 1991, 1994, and 1997 which resulted in import of rice up to 4.5 million tons in each of these years. The objective to increase rice production by pushing up the productivity of rice in tidal lowlands was adopted as the objective of tidal lowland development which previously was focused on transmigration. Further development in tidal lowlands is aimed at increasing productive capacity of tidal lowlands to accommodate recent development in agriculture

technology, including the introduction of new varieties, use of equipments, fertilizers, and pesticides, and improvement of water management. Recent climate change that shifts planting season has increased the risk of pest and disease threats and confirmed the use of chemicals.

As a result, about 30 percent of the area suitable for rice has reached the productivity above 5 tons per ha. In addition, 10 percent of the area can be cultivated twice to three times a year. However, the negative impact of modern input use has emerged. As a consequence of chemical use, canal water which was previously used for various domestic needs is no longer safe, raising externality among farmers themselves.

The objective of this study was to examine the chemical use in food crop production in tidal lowlands and to consider the cost (including environmental cost) of chemical use in rice cultivation. This study is expected to provide inputs for reconsidering chemical use in tidal lowland rice production.

METHODS

This study was carried out in Telang, a rice production center in tidal lowland area of South Sumatra, through a survey. This deltaic area is administratively located in Sub-district Muara Telang, District Banyuasin, South Sumatra Province. This area was selected as research area since it was among the most productive reclaimed tidal lowland areas due to the use of modern inputs (high-yielding varieties, chemicals) and supported by relatively better water management system.

Research sample of 500 farm households were randomly drawn from some 10,000 farm households, covering 12 secondary blocks of approximately 3,072 ha. Data were collected through field observation and structured interview with the farmers.

Data were mostly quantitative in nature. Therefore, data analysis was carried out using some statistical tools. The effect of chemical use on rice production was analyzed using linear regression based on a Cobb-Douglas production function (Hair et al., 2010; Coelli, 1995) as the following:

$$\ln Y_i = \beta_0 + \beta_1 \ln SEED + \beta_2 \ln CHEM + \beta_3 \ln FERT + \beta_4 \ln LABOR + \beta_5 D_{ws} + \varepsilon_i \qquad (1)$$

where Y_i = total rice production in tons
SEED = seed used in kg
CHEM = chemical used in Rupiah
FERT = fertilizers used in Rupiah
LABOR = labor used in man days
D_{ws} = dummy variable water service for 1 = with water service 0 = without

RESULTS AND DISCUSSION

As a primary process, rice cultivation employs primary inputs such as seed, fertilizers of several kinds, some types of pesticides, labor and some basic equipments. Three kinds of fertilizers are used, namely Nitrogen, Phosphorous, and Potassium fertilizer. The first two were recommended, whereas the third was used according to particular need. Pesticide consisted of three types, namely herbicides, insecticides, and fungicides. The following result described the cost of rice cultivation (including chemical cost), production, and productivity of rice.

The costs of rice cultivation were presented in Table 1. These costs were estimated based on per hectare rice cultivation in the first planting season. The cost of each input was derived from the whole research sample based on its average value (mean). The cost of pesticides accounts for 10.57 percent of the total cost, excluding the labor cost of pesticide application. Among three types of pesticide, the cost of herbicide was the highest and accounted for 65.76 percent of total pesticide cost. Herbicides were used during pre and post planting to control weed.

Table 1. Cost of rice cultivation per hectare in the study area

Inputs	Types of Inputs	Unit	Volume	Unit Cost (Rp)	Total Cost (Rp)
Seed	Rice seed	Kg	63.5	6,000	381,000
Pesticides	Herbicides[1]	n.a	n.a	n.a	344,770
	Insecticides[1]	n.a	n.a	n.a	72,480
	Fungicides[1]	n.a	n.a	n.a	107,000
Fertilizers	Nitrogen	Kg	220	1,300	286,000
	Phosphorus	Kg	121	2,300	278,300
	Potassium[2]	Kg	n.a	n.a	13,910
Labor	Land preparation	Man day	10	50,000	500,000
	Planting	Man day	4.5	50,000	225,000
	Fertilizing	Man day	2	50,000	100,000
	Controlling	Man day	2	50,000	100,000
	Harvesting[3]	Man day	51	50,000	2,550,000
Total					4,958,460

[1]Various types with various unit (l, ml, kg, gram) such that only total cost was applied.
[2]Only few samples used this type of fertilizer such that average volume was not relevant.
[3] Consists of harvesting and threshing. Harvesting cost was in shared product with the ratio 1:7 (12.5% for labor, 87.5% for owner). Threshing cost was Rp 50 per Kg output. All of these expenses were made equivalent to man day.
n.a not applicable

Production is the output of farming activities as the result of employing several inputs such as seed, pesticides, fertilizers and labor. The amount of production depends on the acreage of the cultivation such that it varies among farmers with different land holding. In order to measure a standard output of farming activities, a measure of productivity is employed. Besides its independency on the use of inputs, measure of productivity uses cultivation acreage as a reference. Therefore, productivity refers to the output per unit land cultivated. In the study area, reference for the acreage of cultivation is hectare.

Analysis on the data on rice production among respondents of this research indicated that rice production varied from as low as 1.5 tons to as high as 79.2 tons of on-farm dried paddy due to the variation in area cultivated from as low as 0.25 hectare to as high as 12 hectares. The average production was 9.75 tons (standard deviation = 5.70 tons) and the average cultivation area was 1.84 hectares (standard deviation = 0.99 hectare). Whilst, the average productivity was 5.35 tons per hectare on-farm dried paddy (standard deviation = 0.88 ton).

Rice production is a function of several input factors such as seed, chemicals (herbicides, insecticides, and fungicides), fertilizers (Nitrogen, Phosphorous and Potassium fertilizers), and labor for various activities during the whole process of rice cultivation starting from land preparation, planting, fertilizer application, pests and diseases control until harvesting. In order to estimate the effect of these variables including the effect of chemical used, a

regression analysis was performed with all of the independent variables considered in the model.

Cobb-Douglas production function was estimated using multiple regression analysis. This model was robust based on the R^2 statistics. Model fit analysis for the Cobb-Douglas production function indicated that the overall model was statistically significant at 95 percent confidence interval.

Analysis on the effect of each of the independent variable was performed using t-test and the results of the analysis were presented in Table 2. Among all of the independent variables assumed to affect rice production, all but seed have significant effect on the dependent variable.

All coefficients were positive as expected. The coefficient of chemicals was positive and significant. Chemicals consist of herbicides, insecticides, and fungicides. Herbicides were used during land preparation as pre-planting weeding and during growth stage as post-planting weeding. Insecticides were used incidentally according to the existence and intensity of insect attacks. Fungicides were used to control fungus and to enhance growth. These three types of chemicals have been consistently used by farmers in the study area and became part of farming practices regardless their effects on the environment. As indicated by its coefficient, one unit increase in chemical used associated with 0.034 unit increase in rice production. The effect of chemicals on rice production was proved to be statistically significant.

Table 2. Regression coefficients and the value of t-test statistics

Variables	Coefficients	Std. Error	t	Sig.
(Constant)	-3.910	.212	-18.449	.000
Seed	.023	.026	.901	.368
Chemicals	.034	.018	1.828	.068*
Fertilizer	.128	.026	5.030	.000***
Labor	.782	.028	28.374	.000***
Water service (dummy variable: 0 = without; 1 = with)	.040	.013	3.026	.003***

Dependent variable was total rice production.
All variables were in logarithmic, except water service.
R Square = 0.936; F-test = 57.083; Sig. of F-test = 0.000
*Significant at 10% **Significant at 5%; ***Significant at 1%

The environmental impact of chemical use in rice production was observed through its impact on canal water. Being the main domestic water source, visible change in canal water has shifted household need for drinking water to bottled water. Therefore, environmental cost of chemical use was estimated using avoidance cost. In this case, avoidance cost was the cost of bottled water purchased to avoid contaminated canal water during cultivation period which was Rp 11,520,000 per secondary block of 256 ha (one water management unit).

Based on the above calculation, the external cost of chemical use was estimated to be Rp 45,000 per ha. Assuming farmers were responsible for this external cost according to polluters pay principle, this cost was expected to be recovered through the increase in production. Taking the local price of Rp 2,250 per kg on-farm dried paddy, the required increase in production was equivalent with 20 kg on-farm dried paddy per ha. This was also

equivalent to 0.37 percent increase in productivity, considering the average productivity was 5.35 tons per ha.

Based on the value of elasticity, 0.37 percent change in production was associated with 10.88 percent change in chemical use. Since the average cost of chemical use was Rp 524,250 per ha, the required change in chemical cost was Rp 57,038. Therefore, to recover the external cost of Rp 45,000 per ha requires Rp 57,000 additional cost of chemical per ha. This meant that the cost to recover the external cost of chemical use was higher than the externality itself. As such, reducing the use of chemical would possibly be a choice of rational farmers.

CONCLUSION

It can be concluded from the study that

1. The use of chemical was currently unavoidable in tidal lowland rice cultivation due to present threat of pests and diseases and the increasing risk of pest and disease attacks due to the shift in planting season caused by climate change.

2. Despite undervaluing the economic cost of chemical contamination in canal water, the use of avoidance cost is considered the most tangible since majority of farm households experienced this impact in tidal lowlands.

3. The use of chemicals, especially herbicide, should be reduced and replaced by mechanical practice to control weed during pre and post planting.

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Proceeding

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FCC2010

International Conference on Food Safety and Security under Changing Climate

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ISBN: 978-967-960-275-3

http://www.fcc2010.upm.edu.my

Proceedings International Conference on Food Safety and Security under Changing Climate 2010 (FCC2010): December 6-7, 2010, Parkroyal Hotel, Penang, Malaysia

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PREFACE

Proceedings of the International Conference on Food Safety and Security under Changing Climate 2010 (FCC2010) are the compilation of papers presented at FCC2010 on December 6 – 7, 2010, at Parkroyal Hotel, Penang, Malaysia. The keynote speaker and invited speakers have enriched us with the latest issue and development in global climate change. There are 64 local and oversea presenters from various universities, institutions and industry players, they came to FCC2010 to share their findings and experience.

Objectives of this conference are to provide a platform for learning and discussion among local and foreign researchers on policies, issues, prospects, strategies and other relevant activities, to create awareness among the citizens of the Earth about the global climate change and also to enhance efforts in reducing the impact of destruction to the Earth especially those affecting the food safety and security.

We would like to thank all presenters who have contributed their papers in these proceedings. It is hoped these proceedings will benefit the food industry stakeholders from all around the world.

We would like to inform that all the papers are camera ready from the authors.

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FCC2010

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INVITED SPEAKERS

THE ECONOMIC IMPACTS OF CLIMATE CHANGE ON THE MALAYSIAN RICE PRODUCTION

Negin Vaghefi, Mad Nasir Shamsudin*, Ahmad Makmom and Milad Bagheri
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Universiti Putra Malaysia
43400 UPM Serdang, Selangor
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ABSTRACT

This study attempts to estimate the potential impacts of climate change on the rice production in Malaysia. The crop model ORYZA 2000 was used to simulate rice yield of MR 219 variety in eight granary areas of Malaysia from 1999-2007. The model predicted a reduction in rice yield of 0.36 tonnes per hectare under the scenario of an increase in temperature of 2°C and at the current CO_2 level of 383 ppm. With the reduction in yield, the economic loss to the Malaysian rice industry was estimated at RM162.531 million per year. Under the scenario of increase of CO_2 concentration from 383 to 574 ppm and with 2°C rise in temperature, there would also be a decline in yield of 0.69 tonne per hectare and hence production. This can be translated to the economic loss of RM299.145 million per year for the industry. With the above potential impacts, some adaptation and mitigation strategies to overcome the adverse effects of climate change on the rice production were recommended.

Keywords: Economic impacts, climate change, temperature change, rice production

INTRODUCTION

One of the most serious long-term challenges facing the world today is climate change. A sector that is most affected is agriculture since climate is a primary determinant of agricultural productivity (Adams et al., 1998). This will consequently affected food supply as future supply may be directly threatened by climate change and its capacity may be changed by efforts to reduce Green House Gas (GHG) emission as society attempts to mitigate future implications of the climate change (McCarl et al., 2001).

The climatic variability and the predicted climatic changes are of major concern to rice producers because of their potential threat to rice productivity (Krishnan et al., 2007). Aggarwal (2003) noted that among the global atmospheric changes, the increasing concentrations of greenhouse gases such as CO_2 may have significant effect on rice productivity due to increase in both the average surface temperature and the amount of CO_2 available for photosynthesis (cited in Krishnan et al., 2007, p. 233).

Simulation analyses by different models and field experiments have shown the potential impacts of climatic change on the variability of rice productivity (Baker et al., 1990; Peng et al., 2004; Kim et al., 2003). In the absence of temperature increase, studies have shown that the net effect of doubling of CO_2 was increase in the yield of rice (Kim et al., 2003). Sheehy et al., (2006) found that increasing CO_2 concentration in the atmosphere has a positive effect on crop biomass production, but its net effect on rice yield depends on possible yield reductions associated with increasing temperature. For every 75 ppm increase in CO_2 concentration, rice yields will increase by 0.5 tonne ha^{-1}, but yield will decrease by 0.6 tonne ha^{-1} for every $1^{\circ C}$ increase in temperature. Thus an assessment of the potential impacts of interactive changes of CO_2 and temperature in order to

determine the future of agricultural strategies that would maintain higher rice productivity is crucial.

Rice (*Oryza Sativa* L), the staple food of Malaysian, is the most important source of employment and income of the rural population. Presently, the self-sufficiency level of rice is about 75 percent. Thus there is growing concern that global warming would decrease the productivity of rice crop (Tao et al., 2008), and hence the rural income and the self-sufficiency level. This study therefore attempts to determine the potential economic impacts of climate change, namely changes in temperature, on the Malaysian rice yield and economy.

MATERIALS AND METHODS

Study Areas

The study was conducted at eight granary areas in Malaysia, namely, MADA, KADA, Kerian, Barat Laut, Seberang Perak, Ketara and Kemasin in 2008-2009 (Fig. 1). They are designated as permanent rice producing areas, to realize a minimum self-sufficiency level for rice of 75%, and this is one of the major strategies to enhance rice production (Lee et al., 2004). In 2008, these granary areas covered 36 percent of the total physical rice areas, but constituted 57 percent of the total area planted and contributed 72 percent of the total national rice production.

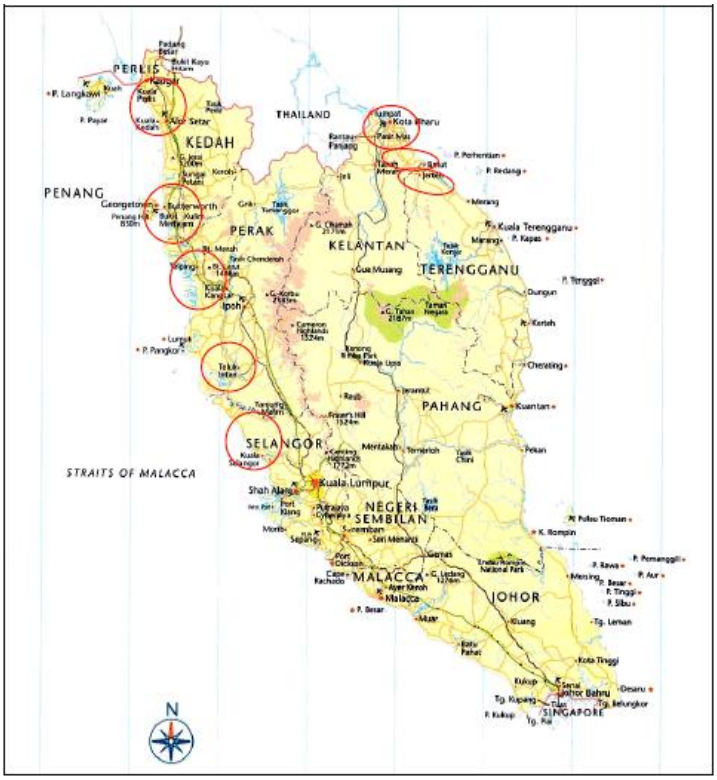

Figure 1: The eight granary areas in Malaysia

Malaysia characteristically experiences heavy rainfall (above 2,540 mm per annum), average daily temperatures of 21-32°C and a humidity averaging about 85%. The seasonal variation in solar radiation is low, resulting in an annual difference in day length of only 2 min along the equator and 49 min in northern regions. In consequence, there is a year round day length of 12.5 h.

ORYZA 2000 Model

The ORYZA 2000 crop growth model was used to simulate the effect of temperature and CO_2 on growth and yield of rice in a situation where nutrient and water were assumed to be non-limiting. In this model we used of MR-219 variety as high yielding rice variety. MR-219 is the most common rice variety planted by Malaysian rice growers (Suswanto et al., 2007).

ORYZA2000 is a crop model to simulate the growth, development and water balance of rice under conditions of potential production, water imitations and nitrogen limitations. It is an updated and integration of the models ORYZA1 for potential production, ORYZA-W for water-limited situations, and ORYZA-N for nitrogen-limited production. In this study ORYZA1 crop growth model was used. The model was validated with experimental data for variety MR-219, with the application of 240 kg N ha^{-1}. This model was used to simulate the potential rice yields under three scenarios. Scenario 1 is the situation at the current level of temperature and CO_2. Scenario 2 is with the changes of temperature only (+2°C above current level), and Scenario 3 is with changes in both CO_2 (1.5 times of the current level) and temperature (+2°C above current temperature).

Input Data

The Input data required to simulate the ORYZA 2000 crop growth model included experimental data, crop data, soil data and weather data. The experimental data contains information on the run modes of ORYZA 2000, the site and experimental conditions of the simulation run, and any observed variables. The crop data file contains all the parameter values that characterize the rice crop. The soil data file contains all data to run the soilwater balance module. The weather data was the daily weather station data at Petaling Jaya for nine years (1999-2007).

RESULTS AND DISCUSSIONS

Scenario 1: Simulation under current level of temperature and CO_2

Simulation results of the potential production of MR-219 variety rice plant under the current temperature (27°C) and CO_2 (383 ppm) by ORYZA 2000 model in 1999-2007 are presented in Table 1. In this study average temperature and atmospheric CO_2 concentration are considered as the major climate factors. The other factors, such as management practice, air pollution, soil, plant that have effect on rice yield, are assumed constant. According to this relationship:

Yield = f (climate, technology, management, land)

Climate factors include temperature and CO_2. Technology and management are considered as systematic factors under the control of producers and land represents soil conditions. Determinant factors are such as light, temperature, and CO_2. Limiter factors are fertilizer and H_2O. Reducer factors are biotic and abiotic. All of them can have effect on the rice yield, but in this model, only temperature and CO_2 are considered and the best management practice and condition are assumed. There is a big gap between simulated yields which we have obtained from ORYZA 2000 model with observed data due to 60% management problem. The correction factor is 0.41 so we can obtain the actual yield, without management problem.

Table 1: Simulated, observed and actual yield with best management practices

Year	Simulated Yield (kg ha^{-1})	Observed* Yield (kg ha^{-1})	Actual Yield (kg ha^{-1})
1999	9658.8	3696	3960.108
2000	9690.6	3749	3973.146
2001	9585.8	3833	3930.178
2002	9297.8	3904	3812.098
2003	9503.6	4106	3896.476
2004	9532.9	4051	3908.489
2005	9077.4	4132	3721.734
2006	9834.9	3771	4032.309
2007	9921.6	4207	4067.856

*Source: Department of Agriculture, Malaysia

Scenario 2: Effect of Increase in Temperature on Potential Yield

The predicted changes in yield under the 2°C increase in temperature and at current CO_2 level (383 ppm) are shown in Table 2. The results indicate that rice yield would decline with increase of temperature at 2°C.

Table 2: Effect of 2°C increase in temperature on rice yield

Average Temperature	Yield (kg ha^{-1})								
	1999	2000	2001	2002	2003	2004	2005	2006	2007
27 °C	9658.8	9690.6	9585.8	9297.8	9503.6	9532.9	9077.4	9834.9	9921.6
29 °C	9376.5	9403.1	8717.8	7847.2	9048	6840.2	8038.9	9369.1	9579.2

Note: CO_2 = 383 ppm

Furuya and Koyama (2005) reported that high temperatures would cause decrease in world rice production. Temperature affects both the photoperiod-sensitive and photoperiod-insensitive cultivars (Alagarswamy et al., 1998). Generally, high temperature accelerates and low temperature delays heading, and also high temperature delays flowering. Increasing in temperature can cause increased plant growth rate and decreased growth duration leading to shorter grain filling period (Streck, 2005).

Scenario 3: Effect of Increase in Temperature and CO_2 on Potential Yield

Table 3 shows the predicted changes in yield with 2°C increase above the current temperature and 1.5 times of the current level of CO_2. Studies found that with increase in atmospheric CO_2 concentration, other factors remain constant, could produce beneficial effects on rice including increases in grain production, increases in photosynthetic rates and decreases in stomata conductance and transpiration rates (Olszyk and Ingram, 1993). However, in this study, increasing both the temperature and CO_2 level would have negative effects on the rice yield.

Table 3: Comparison of yield (kg ha^{-1}) with increase in temperature and CO_2 and base level

Temperature and CO_2	Yield (kg ha^{-1})								
	1999	2000	2001	2002	2003	2004	2005	2006	2007
27 °C & 383 ppm	9658.8	9690.6	9585.8	9297.8	9503.6	9532.9	9077.4	9834.9	9921.6
29 °C & 574 ppm	8543.7	8576.4	7716.7	6946.8	8168.8	6061.5	7247.1	8519.4	8731.3

Matthews et al. (1997) reported that increase in CO_2 level will increase yields and increases in temperature will reduce yields. The result of this study is consistent with the findings of Rosenzweing and Hillel (1995), Singh et al. (1996), Timsina and Humphreys (2006) and Krishnan et al. (2007). Increased CO_2 and higher temperatures have a negative effect on both photosynthesis and growth of crops. Thus, it seems that there is interactive effect of CO_2 and temperature on rice yield.

Economic Impacts of Temperature Change

Increasing the temperature by 2°C would decrease the rice yield by 0.359 tonne per hectare. By multiplying the yield loss by the planted area for each year, the estimated average production loss from 1999 to 2007 would be 147,755 metric tonne (Table 4). With the average price of rice of RM1.10, the average of economic loss for the second scenario is estimated to be RM162.531 million per year. Under third scenario (increasing both temperature 2°C and CO_2 574 ppm), the average of yield loss would be 0.689 tonne per hectare, and the economic loss would be RM299.145 million per year (Table 5).

Table 4: Economic loss in the second scenario

Year	Actual yield (ton/ha)	Predicted yield (ton/ha)	Yield loss (ton/ha)	Planted area (Hectare)	Production loss (metric tone)	Economic loss (RM)
1999	3.960	3.844	0.116	394,076	45,712.8	50,284.09
2000	3.973	3.855	0.118	391,012	46,139.4	50,753.35
2001	3.930	3.573	0.357	375,116	230,321.2	253,353.32
2002	3.812	3.217	0.595	382,355	22,7501.2	350,251.3
2003	3.896	3.709	0.187	381,310	71,304.9	78,435.46
2004	3.908	2.804	1.104	377,794	417,084.5	458,793.03
2005	3.721	3.295	0.426	384,112	16,3631.7	179,994.88
2006	4.032	3.841	0.191	387,312	73,976.5	81,374.25
2007	4.067	3.927	0.140	386,592	54,122.8	59,535.16
						Average= 162,530.53

Table 5: Economic loss in the third scenario

Year	Actual yield (ton/ha)	Predicted yield (ton/ha)	Yield loss (ton/ha)	Planted area (Hectare)	Production loss (metric tone)	Economic loss (RM)
1999	3.960	3.502	0.458	394,076	180,486.8	198,535.48
2000	3.973	3.516	0.457	391,012	178,692.5	196,561.76
2001	3.930	3.163	0.614	375,116	287,713.9	316,485.29
2002	3.812	2.848	0.964	382,355	368,590.9	405,449.99
2003	3.896	3.349	0.547	381,310	208,576.8	229,434.26
2004	3.908	2.485	1.423	377,794	537,600.9	591,360.99
2005	3.721	2.971	0.750	384,112	288,084.0	316,892.40
2006	4.032	3.492	0.504	387,312	209,148.4	230,063.24
2007	4.067	3.579	0.488	386,592	188,656.8	207,522.58
						Average= 299,145.10

Adaptation and Mitigation Strategies

The Malaysian rice industry is highly regulated. Adaptation strategies could help mitigate the impact of climate change on the world's poor. Designating paddy producing areas is one of the major strategies whereby the eight granary areas are designated as permanent paddy producing areas, to realise a minimum self-sufficiency level for rice of 65% (FAO, 2005).

Another strategy is the identification of suitable areas for large-scale commercial paddy production by the private sector. Selection for varieties with a higher tolerance of spikelet fertility to temperature was shown to be capable of restoring yield levels to those predicted for current climates. Breeding for new cultivars Varieties that are tolerant to higher temperatures likely to be encountered under the changed climatic scenario, possibly through genetic engineering (Singh *et al*., 1996). Varieties with improved tolerance to heat or drought, or adapted to take advantage of a longer growing season for increased yield, will be available for some crop species. Changing varieties, like changing planting date, is a first line of defence for farmers to consider (Wolfe *et al*., 2008).

Among farmer adaptation options, changing planting and/or harvest date can be an effective, low-cost option to take advantage of a longer growing season or to avoid crop exposure to adverse climate (e.g., high temperature stress, low rainfall) (Wolfe *et al*., 2008). The use of longer-maturing varieties to take advantage of longer growing seasons at higher latitudes may instead result in lower yields, due to the grain formation and ripening periods being pushed to less favorable conditions later in the season. A better strategy might be to select for shorter-maturing varieties to allow a second crop to be grown in these regions (Matthews *et al*., 1997).

Management practice is one of the important strategies to overcome the adverse effects of climate change on rice production (Matthews *et al*., 1997). Agronomic practices such as fertilizer application, weed control, pest and disease management need to be adjusted under the changed climate (Singh *et al*., 1996). Warmer temperatures, longer growing seasons and increased drought will lead to increase agricultural water use. Water storage facilities should be expanded and managed more efficiently. Controlled supply of irrigation water could avoid oversupply at critical stages.

Controlling emissions and concentration can be one of the most important mitigation strategies, such as controlling emission of greenhouse gases and/or enhancing carbon sinks, alter fertilizer application, lower use of herbicide and pesticide sprays, reduces fuel requirements and use of conservation tillage on herbicide tolerant plants. There are some innovative approaches for reducing emissions which can succeed to capture significant amounts of carbon and other greenhouse gases from the atmosphere; therefore it can mitigate the future climate change.

CONCLUSION

This study attempted to investigate the economic impacts of climate change (changes in temperature and CO_2) on the rice economy of Malaysia. The methodology involved pooling data on crop yields and climate and non-climate related variables which were used to simulate the impact of changes in temperature and CO_2 on rice yield. ORYZA 2000 model was employed to simulate the potential effects on rice yield under various scenarios of changes in temperature and CO_2 levels. The results indicated that there would be negative effects on rice yield and hence production and farm income as well as the future food supply. Thus policies on mitigation need to be formulated and adaptive farm practices need to be adopted to overcome the adverse affects of climate change to ensure sustainable farm income and self-sufficiency level. Policies on rice production are

closely associated with poverty alleviation and priorities for sectoral growth. Some adaptation and mitigation strategies to overcome the adverse effects of climate change on rice production are recommended.

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A PERSPECTIVE OF GLOBAL WARMING IMPACT ON AQUACULTURE FOOD PRODUCTION IN MALAYSIA

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ABSTRACT

With closed to 60kg per capita fish usage, Malaysian is thus ranked among the highest fish consumer in the world. Beside food security, fish production was long time served as major foreign exchange earnings and act to balance agricultural food trading (BOT). Today, domestic fish supply caters only 80% of usage and 85% is still from landings. Foresee thus, aquaculture was enhanced under the Third National Agricultural Development Plan, NAP3 (1998-2010) and was translated into action during the 9MP (2006-2010). A prospective development plan for aquaculture beyond 2010 was projected with a production target of 508,000 mt annually from the level of 200,000 mt or at 21.5% annual growth. Following, action plans and investment incentives were implemented and executed. The highlight is the setting up of Aquaculture Industrial Zone (AIZ) and the development of 39 high impact projects (HIP). However, participation of industry players, its development program and production are yet satisfactory due to factors linked to increasing risk in of operations, cost of production and to implement standard of practice (SOP). Beyond, impact of climate change factor will add to the hazard list. This is already felt but is yet justified by true scientific findings. To mitigate, a task force to climate change impact on aquaculture was recently formed and formulated the plan of actions (POA). The seven objectives underline in the POA are ; development of meteorology database, food security, research and knowledge management, capacity building and institutional strengthening, comprehensive disaster management, infrastructure development, and awareness programmes. Each of the objectives provide strategies to enable aquaculture operation handle at the best.

Keywords: Malaysia, Aquaculture, food security, global warming, perspective.

NATIONAL FISH REQUIREMENT

Fish Consumption Pattern

Naturally, Malaysian is a fish consumer. This relates well to country's demographic and location. It is surrounded by sea and embedded with few large rivers and wet lands. With ready available thus fish continue to become its population main protein source. This is well indicating in household expenditure and daily diet of Malaysian. On average a family spend about twenty percent of their food expenses on fish. Most of the time on every meal there is fish served. Based on this simple fish consuming habit thus make Malaysian ranked equal to Japanese, Korean and population of China mainland or. On average this about 60 kg per capita per annum (Othman, 2008).

Fish as Income Earner

Beside being an important food item, fish and its products for sometimes has turned into a lucrative income to the country. This was well documented by MoA (1999). Indeed, prior to implementation of the third National Agricultural Policy (NAP), fish resources and its product was always indicate positive trading compare to other agricultural food items. For the reason thus, during the implementation of NAP3, government strongly emphasize on fish production. It is a mean to provide food security and a bigger agenda of to achieve balance of trade (BOT) in agricultural food items which for sometimes indicated a deficit.

The production was set at 2.5 million metric tons with the hope of to create an income of about 2 billions, an amount need for the BOT (MoA, 1999). Finally, to produce that quantity the harvest was set up to come from three main sources viz., deep sea catch, coastal zone landing and from aquaculture activities. At each of the respective zone the harvest is forecasted to be 900,000 mt, 500,000 mt and 508,000 mt. Beside, there will another contribution 125,000 from sea weed harvest.

AQUACULTURE IN MALAYSIA

Production System

Having both coastal and inland waters allowed Malaysian to practice both fresh water and marine fish aquaculture. Within the freshwater environment there are six Common production systems employed.

Table 1 : Status of aquaculture production systems in Malaysia (Anon, 2008).

Brackish water/marine	area	culturist (no.)	Fresh water	area	culturist (no.)
Ponds (Ha)	7,309.1	1,346	Ponds	4,760.4	14,004
Cages (m2 x 1000)	1,186.8	1800	Cages (m2 x 1000)	247. 2	1,220
Bottom culture (Ha)	6,797.8	278	Ex-mining pools	1,688.8	234
Raft culture (m2 x 1000)	310.9	433	Tanks (m2 x 1000)	108,5	328
Long line (Ha)	2,368.9	583	Pen culture	92.5	475

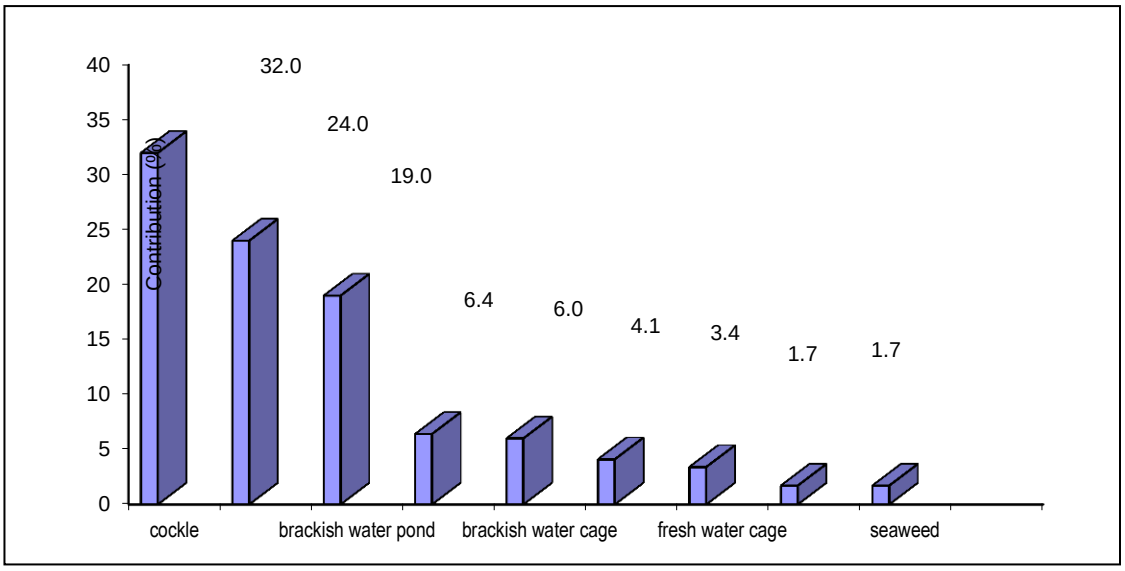

Fig. 1: Breakdown on the contribution of commodity to aquaculture

These are ponds, used-mining pools, tanks, cages and pen culture system (Table 1, Fig.1). Pond is the preferred system used to produce aquaculture commodity in fresh water. The next preferred system is the floating cages. A modern cage of polythene materials is getting popular and is becoming a common view in many of the aquaculture operation sides in lakes environment. The other common production system is tank.

Tanks, mainly cement followed by canvas and poly materials are another common system in fresh water. The production from this sector has gaining impact, mainly is from catfish production.

In the brackish water / marine environment the production systems employed are ponds, cages, raft system for mussel, raft system for oyster, bottom culture for cockle and long line for seaweed (Fig.1). Bottom culture of cockle in natural system caters about 30 percent of marine aquaculture production. Pond system is the most prominent method in marine aquaculture production. Despite contributed to only 19 percent of national aquaculture production pond operation in many cases produced high value commodity such as shrimp and of late, finfish. One good aspect of pond operation in brackish water environment is quick to respond to innovation and changes.

Next common system to pond is floating cages and rafts. Floating cages as well has undergone kind of transformation. Poly cages material is now common view in cages farm area. Floating cages mainly handle fish production. Though not yet highlighted in Department of Fisheries Statistical report (DoF, 2007) tank system is fast getting popular for indoor fish production. Imported modules and system from overseas and varieties of modules introduced by locals are being used extensively now. Raft is another system applied in marine aquaculture production. It caters for mussel and oyster production. Another system employed is seaweed long line. The line assists in seaweed propagation and cultivation.

STATUS OF AQUACULTURE PRODUCTION

General

Aquaculture food production in the country continues to show increase in trend. The trend (Fig.2) highlighted the marine and brackish water segment as major contributor. This is expected following incentives and encouragement by the government towards production for export market and monetary gain as well as food security purposes. The main contributors from this segment of aquaculture are marine shrimp, marine finfish and seaweed. On the marine fish side, production went up to more than 36 percent in the year 2008 compare to the previous year. The increased in marine finfish production was likely to the increased in land based type of production (DoF, 2007). Another push factor was the seaweed production which saw a tremendous increased from the previous years yields (DoF, 2007). Based on the above trend of production and guided by improve in technology and disease management control Malaysia will be able to capture more fish from aquaculture activities within the next few years.

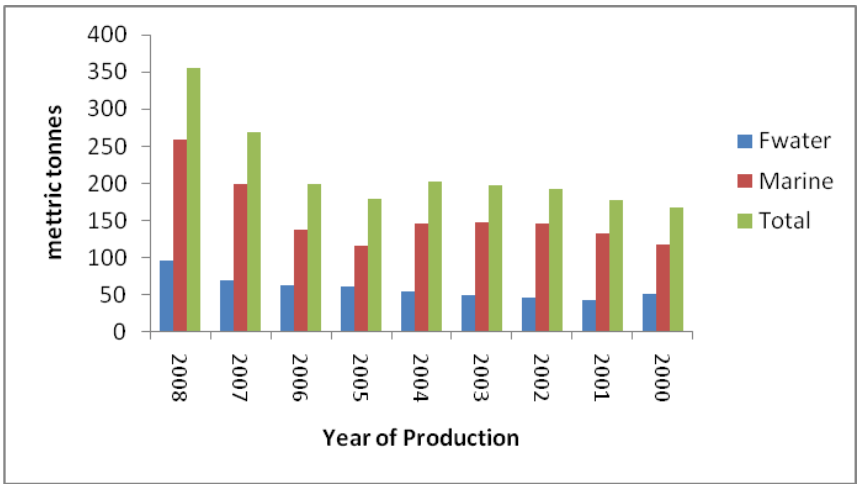

Fig. 2: Production from all aquaculture systems during 2000 to 2008

Inland / Freshwater Aquaculture

Fresh water aquaculture activities currently farmed more than 15 species of fishes. Majority or 30 to 40 percent of the share comprises of keli and tilapias. Among reason for bigger share the two types of fish received was due to easy supply of seed. Supplementary to that is the availability of commercial pellet feed and acceptance of the fish species to many culture systems (Othman, 2008). Majority of the farming are done in floating cages in lakes, excavated ponds, followed by in ex-mining pools and tanks.

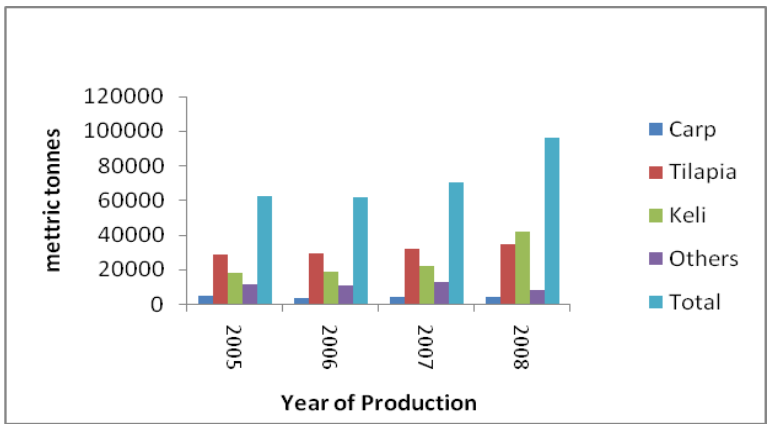

Fig. 3: Fresh water fish production by species during the year of 2004-2008.

During the last four years (Fig.3) the fresh aquaculture contributed to about 56-95,000 mt of fish annually. The increase in production trend is significant. This was a 35 percent increased in 2008 (DoF, in press) compare to a year before.

Coastal and Marine Aquaculture

Coastal and marine aquaculture activities in Malaysia constituted of products from five major commodities. The commodities are finfish, shrimp, cockle, bivalve and seaweed. Following traditional demand and market accessibility at local and international level this sector of aquaculture continues to dominate national aquaculture production. By volume the production is more than 70 percent annually (Fig. 4). While big amount of the production were from cockle and seaweed but value wise shrimp and fish production many times surpassed the income from the later commodities (Fig. 4).

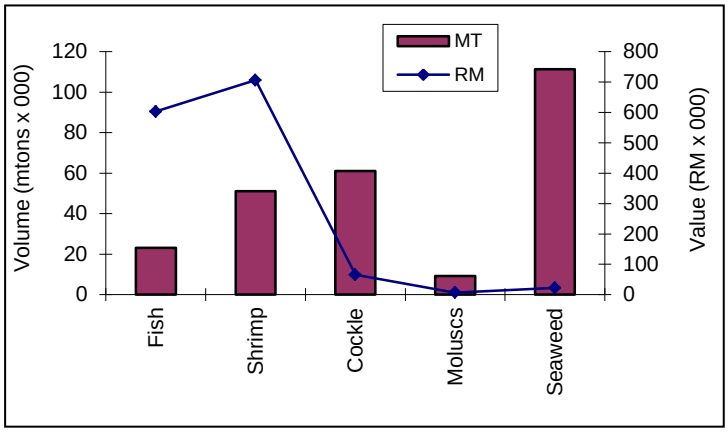

Fig 4: Quantity and value of aquaculture production from coastal and marine side during the year 2008 (DoF, 2008).

Technology wise this sector of aquaculture also is fast moving to catch up especially on disease control, bio-security measure and production protocol in line with international requirements.

ROLE OF AQUACULTURE

Aquaculture under NAP3

As a tool to serve as food supply and income earning, aquaculture activities within the country are centred at food production, aquarium fish and sea weed culture. Under NAP3 each of these commodities has the production target of 508,000 mt, 2 million tails and 125,000 mt, respectively. The harvest figure of 508,000 mt from aquaculture food production was set to come from six main commodities. These are the marine shrimp (120,000 mt), marine fish (100,000 mt), fresh water fish (188,000 mt), and bivalves (100,000mt) (Table 2). Beside the food fish, there is also need to produce sea weed at an amount of 300,000 mt. The prospect and feature it has on the development of pharmaceutical related products make sea weed as an appropriate commodity to single out as a potential aquaculture item. Whereas income from aquarium fish trading always justify to list as an item need to be prioritized.

Table 2: Target aquaculture produce within DPN3 (1998-2010)

Commodity	Production (mt)	(RM ' Mill.)
F.water fish /prawn	188,000	863
Marine shrimp	120,000	4,500
Marine finfish	100,000	860
Bivalves	100,000	102
TOTAL	508,000	6,325

On average the activity create an annual income of RM20 million as from the year 2003-2005.

Aquaculture Master Plan

Following the need to increase fish production by mean of aquaculture, a master plan on its development was set in place during the NAP 3 (1998-2010). One of the highlight in the strategies was the development of Industry Aquaculture Zone (AIZ) and the development of the Corridor Economic Region Plan (Anon., 2009).

AIZ is a zoning programme of identified suitable lands and water bodies to be developed at commercial scales dedicated for aquaculture projects (Table 3, 4). The programme is part and parcel of initiative by government to develop aquaculture per se into a massive industry in line with overall government vision to transplant agriculture sector to become the third engine of economic growth. Supplementary to present traditional areas, operation at AIZ will enable about 217,000 mt of overall 508,000 mt of aquaculture production value at RM2.07 billion compare overall set target of RM 3.3 billion which is to be achieved annually after 2010. Within AIZ there are 39 sites gazetted as high impact

project or HIP. These sites will be cultivated with selected aquatic species (Table 3) or species which are high in demand and high in market value.

Table 3: Area and figures projected within AIZ (Anon., 2009)

Subject	Shrimp pond	Grouper cage	S. bass cage	Snapper cage	Mussel raft	S/ weed ropes
Area (Ha)	5,428	693	693	693	55	5600
Volume (mt)	52,923	92,252	208,000	183,456	1833	153,216
RM' billions	0.95	3.69	2.70	2.75	0.004	0.38

Subject	Tilapia cage	Patin cage	Keli tank	Arowana aquarium	Discus aquarium	Goldfish aquarium
Area (Ha)	1561	1561	1561	135	135	135
Volume (mt)	699,179	1,098,709	126,363	23	27	72,720
RM' millions	3.50	3.85	0.57	0.02	0.00011	0.02

Table 4: Summary of the objectives on the development of AIZ and HIP (Anon., 2008)

Item	Objective	Description
1.	Contribution to GDP	Increase the output of fishes and raw material used in processing of fish products.
2.	Balance of Trade, BOT	Increasing the exports of fishes and high – value fish products; and reducing the import of low-value fish for consumption and raw material used in processing of fish products
3.	Private sector involvement	Increasing investments from both local and foreign companies.
4.	Increasing the income of aquaculture farmers and entrepreneurs	Increasing the aquaculture farmers / entrepreneurs income to a minimum of RM3000 per month at the same time creating a new business opportunities and employments.
5.	Innovation and technology capability	Introducing a new technology suited for aquaculture industry.
6.	Enhancing the value chain	Establishing new hatcheries, livestock field, farm food factory, processing factory and effective marketing systems to support the value chain of aquaculture industry.
7.	Efficient aquaculture development	The certification of farm in accordance with SPLAM / SAAB

THE RISK TO AQUACULTURE PRODUCTION

Abiotic and Biotic Factors

Despite government incentive and strategy to increase fish production by mean of aquaculture all this years, the production as a whole yet reach to the level of expectation (Table 2; Fig.3). Data gathered from Fisheries statistic (DoF, 2009) indicated that the production of key commodities are still much below par despite closed to target due date.

There are few key factors linked to the poor performance. One is the problem relate to land matter. Acquirement of land takes long time to settle and involve several beurocracies. Not least is problem related to slow adaptation of technology in production system. The other main constrain is disease problem which is linked to an increase in intensity of production, environmental pollution and degradation as well as a lack of good aquaculture practice (GaP) observation.

Economic Factor

Beside the above hazards aquaculture operation now is also meeting the challenges in escalating cost of production. The increase in cost of production are due effect to increase in feed cost, regulation on food safety of aquaculture production and the requirement for technology upgrading toward disease control.

The Global Warming Factor

In addition to the above hazards, local aquaculture activities of late are also subjected to climate change factor which is linked to the global warming phenomenon. Looking at one side of the coin the change may produce hazard impact however likely is, this will create opportunities to some area of aquaculture activities.

To begin with, the hazard impact of climate change begun from global warming phenomenon. As portrayed, the later even will result to rise in surface temperature. This will induce melting of ice in the poles, fluctuate earth's surface temperature and change normal rain patterns. The extreme weather change if exist will create sudden strong wind and storm. At least as being observed, some places will experience a heavier rain drop and the other will encounter a longer drought period.

CLIMATE CHANGE

Eventuality

Is there already or is going to be a serious impact of global warming to climate change pattern in this country? While the local public seem to felt the heat, in reality however this is yet. According to a report by the Meteorological Department Malaysia (DOM, 2009) there is no significant changes observed yet. In facts, based on ongoing monitoring and

simulation works covering the 21st century, the authority certain that there will be no alarming impact. Based on the data gatherings (DOM, 2009) this part of the earth will only dictate a temperature rise of between 1-2 ^{0}C. The extreme weather that is encounter now is periodical which are due mainly to phenomenon related to La Nina and Al Nino. These are short term in nature. Thing get worsened with intense physical development and deforestation activities.

While the above statement is good news to aquaculture in the country but it is of advantage to always prepare for the worst. Mainly because aquaculture requires input of water not only as culture media butalso stability for its operation. Hence, climate change at its minimum and even short term will produce an impact to overall operation.

Forecast of Impact on Locations and Activities

In accepting the general understanding, changes that may be encountered due to global warming are on surface temperature and rainfall patterns (MMD, 2009). As water bodies are concerned these eventually will manipulate the physical, chemical and biological quality of water such as on dissolve oxygen, salinity, pH, nutrients and planktons dynamics (Fariduddin et all., 2005) . At this stage the immediate encounter will be those activities in open environment such as in the lakes and estuarine as well as in the open sea (Zuraidah, 2009).

As indicated earlier (Table 1; Fig. 1) there are two main areas which concentrate the activities, the lakes and the mangrove estuarine. While aquaculture in lakes is dominates only by cage operation but there are multi disciplines of activities concentrate in the estuarine environment (Fig. 1). At the river mouth and distance out are fish cages, raft for mollusc, long line for seaweed and cockle at the bottom. Within the vicinity also water is used for various marine related organisms such as shrimp, fish and mollusc. Further down inland mangrove estuarine locate the activity related to pond culture. There are ponds for shrimp and grow out operation and ponds for finfish seed production.

As activities in lakes are concerned, the impact will be lesser compare to those originate in estuarine environment. Beside, only minor operations are concentrated in this location and with only about two to three fish commodities involved. The more devastating impact is for see will be in the estuarine environment. First and foremost the location supported about 80 percent aquaculture produce of Malaysia. There are two commercial shrimp species in pond farming, minimum of 15 fish species in cages and ponds, three commodities of mollusc culture in raft or long line as well as bottom culture and with minimum of three species of seaweed cultivated within the vicinity.

Following the manipulation on water chemistry, there is going to be manipulation of the fauna and flora within. This eventually makes the location unsuitable to already established aquaculture species. Beside that hazard, if there happened to be a raised in water level, possibility is that these traditional aquaculture grounds will disappear.

MITIGATION AND ADAPTATION PLAN

Like others in Malaysia, aquaculture operators realise of the climate change phenomenon of recent. They observed the frequent heavy rain in some places and sudden drought in other places. Apparently however, the phenomenon cannot be tackled individually or may be the least accepted it as a normal change. Being the authority for national aquaculture development, Department of Fisheries (DoF) has recently established a Climate Change Task Force. To address the issues the committee lead by Fisheries Research Institute (FRI) formulated a national plan of action. The action plan covered seven focus areas or objectives to be adopted (Table: 7). These are: a). Development of meteorology database, b). Food security, c). Research and knowledge management, d). Capacity building and institutional strengthening, e). Comprehensive disaster management, f). Infrastructure development, and g). Awareness programmes. Each of the objectives provide strategies to enable aquaculture operation be handled at it best.

Some of the works underline in this POA are not at all new. Programme on domestication for example has been executed for the last five years for two species of marine shrimp. Apparently this was part of a programme towards production of specific pathogen free animal (SPF) in line with the practice of disease management control in aquaculture. The other activity is development of recirculating aquaculture system (RAS). This part of research activity has been rapid and at some level was already being transferred and implemented by the target groups.

Table 7: The seven objectives underlying the Plan of Action on climate change endorsed by DoF Task Force

Objective 1 - Development of Meteorology Database	
Strategy	1. Establish National Fisheries Climate Change Centre (NFCCC).
	2. Acquire aquaculture / meteorology data
	3. Develop Temporal and Spatial Data
	4. Develop aquaculture meteorological stations network.

Objective 2 - Food Security		
Strategy	1.	Increase national fish production
Strategy	2.	Research and monitoring on disease patterns
Objective 3 - Research and Knowledge Management		
Strategy	1.	Appropriate culture systems
	2.	Domestication programme
	3.	Develop new fish strains
	4.	Early warning systems
	5.	Climate change modelling
	6.	Monitor impacts on pond ecosystems
	7.	Outsourcing technology.
	8.	To increase institutional and human capacity on research and knowledge management related to climate change, and to train sector professionals.
Objective 4 - Capacity Building and Institutional Strengthening		
Strategy	1.	Increase number of personnel and expertise on climate change.
	2.	Establish NFCCC
	3.	To integrate climate change issues into development policy and action.
	4.	Development of adequate human capacity to effectively manage climate resilient development programmes and to take part in international negotiations.
	5.	Develop strong organisations to effectively respond to climate change
Objective 5 - Comprehensive Disaster Management		
Strategy	1.	Improvement of the existing flood forecasting and early warning systems by increasing lead times and strengthening dissemination mechanisms.
	2.	Community based disaster preparedness and improved resilience.
Objective 6 - Infrastructure Development		
Strategy	1.	Plan and implement an investment programme to ensure that the coastal area, including all islands, adapts to raining season and storm.
	2.	Put in place effective river training works to control river bank

erosion.

Objective 7 - Awareness Programme		
Strategy	1.	Aims to provide a comprehensive service for school.
	2.	To give knowledge to public about climate change . Raising public awareness across the country by main-streaming climate change issues in the print and electronic media.

DISCUSSION

Similar to any agricultural ventures, aquaculture operation at all means are also subjected to risks and failures. Disease, mainly viruses are one of the risk factor in intensive aquaculture activities of late. Beside the great risk of disease, aquaculture farmers nowadays are also subjected to increase in cost of production in their operations. Mainly are due to increase in feed cost and cost requiring adjusting to food safety regulation amendment. Apart to that, due to the nature of the practice, aquaculture is and always at risk to environmental fluctuation. This apparently may be adjustable when small disturbance occur but not when greater risk is expected such as due to global warming impact. The phenomenon is already being felt and to some extent has indicated an impact at aquaculture scenario in the country. Among some of the example are the rampant of disease occurring, changes on spawning pattern of aquaculture organisms, variation in nutrient dynamic and microbial diversity in the water ecosystem. While these pattern are to certain extent is within control and adaptable but has an impact on production cost and quality of the produce. The much concern to come is the possible collapse of traditional aquaculture areas which is currently located at the river mouth and open coastal areas as well as in the lakes.

While few disruptions to normal aquaculture operation and production are expected, overall climate change will not always bring about disaster but also bring opportunities to aquaculture operation in this region. With the increase in water temperature for example will induce faster growth to many of aquaculture species and shortened the culture period. Not only that aquaculture will be turned into more of indoor type which make it better in turn of husbandry and disease control and finally hygiene of the product.

Whatever the upcoming are global warming and climate change phenomenon should be followed by a well plan of action to mitigate and adapt. At this point, being the authority in aquaculture Department of Fisheries has forms a task force and came out with few plan of actions to apprehend the situation.

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IMPACT OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTIVITY AND FOOD SECURITY

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ABSTRACT

Our planet earth is warming, thus climates are changing, according to research of many world scientists. Global warming is likely to reduce agricultural productivity and hence, food production in the tropics, where many developing countries are located. Despite recent advances in analyzing the economic impacts of global warming, however, information about its threats to food security in developing countries is so limited. The global impact of climate change on agriculture and food security indicates that the overall impacts would be small, taking into account adjustments in agriculture and other sectors of the economy. This could be made possible given the free flow of agricultural products by wide trading opportunities among countries.

INTRODUCTION

The earth's atmosphere, with its various layers, acts as a filter for solar rays. Approximately half of the visible light and ultraviolet (UV) radiation given off by the sun is either absorbed by the various layers or reflected back into space. Most of the 50% of light and UV that get through heat the earth's surface and are eventually reflected back into space as infrared radiation. The atmospheric trapping of that infrared radiation is known as the 'greenhouse effect'.

In our daily activities, the combustion of carbon-based fossil fuels, greenhouse gases (GHGs) such as carbon dioxide, methane and nitrous oxide are released into the atmosphere. These gases add to that atmospheric layer that is permeable to UV, but not infrared radiation. As more fossil fuels are burned, the layer of GHGs thickens; solar radiation continues to pass through unimpeded, while heat reflected from the earth finds it harder to escape into space. This has resulted in the gradual increase over time in the Earth's temperature known as 'global warming' problem.

Over the past century or so the amounts of greenhouse gases within our atmosphere have been increasing rapidly. Consequently, global temperatures have been increasing more rapidly than the historic record shows. Scientists believe this accelerated heating of the atmosphere is because increasing amounts of these greenhouse gases trap more and more heat. The impacts of global warming are too many to mention. With drought affecting some areas and heat intensifying in the tropics, many areas are becoming unsuitable for agriculture. In tropical areas that are already dry and hot, the agricultural production will likely decrease with even small amounts of climate change. Less agricultural output means less food. Scientists predict that by the 2080s, about 80 million people, mostly within Africa, will be hungry as a consequence of climate change.

Initiatives to Mitigate Global Warming

The United Nations Conference on Environment and Development (UNCED), known as the Earth's Summit, was held in Rio de Janeiro in June 1992 attended by over 100 national leaders. The 'Earth Summit' was concerned with a range of environmental issues. Amongst other initiatives, the conference established the United Nations Framework Convention on Climate Change (UNFCCC). In parallel sessions to the conference, NGOs held a significant event in Rio, the Global Forum.

United Nations Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC or the Convention) was the first major initiative for international cooperation in the area of greenhouse gas mitigation. The UNFCCC aims to stabilize atmospheric levels of GHGs to prevent detrimental anthropogenic interference with the climate - this is accomplished through a list of commitments for signatory nations, including:

- annual reporting of national greenhouse gas inventories;
- regular disclosure and review of progress on regional greenhouse gas abatement programs;
- technological assistance to developing countries that are especially vulnerable to climate change;
- participation in the meetings of the Conference of Parties (COP) to the Convention.

The Convention further adopted a list of industrialized nations (Annex I) for which domestic/international GHG reduction measures were recommended and developing nations (non-Annex I) which are exempted from immediate emission reduction measures, but may participate on a voluntary basis. The UNFCCC was adopted at the Rio 'Earth Summit' in June 1992 and entered into force in March 1995.

The first 'Conference of Parties' (COP) was held in Berlin in 1995 which initiated a new round of talks that sought to achieve stronger and more specific emissions reduction commitments. The voluntary commitments made at the 1992 Rio 'Earth Summit' were insufficient to result in concrete GHG emission reductions. The subsequent agreement negotiated at 'COP3', the Kyoto Protocol, is an addendum to the UNFCCC that was adopted in December 1997. The Kyoto Protocol represents a potentially binding international treaty that stipulates actions to be taken by nations to combat global climate change. It bound industrialised nations to reduce greenhouse gas emissions by an average of 5.2% below 1990 levels by the first commitment period of 2008 to 2012. Six specific greenhouse gases are regulated under the Kyoto Protocol. These gases include: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC's), perfluorocarbons (PFC's), and sulphur hexafluoride (SF_6). Subsequent COPs have been held on an annual basis.

Intergovernmental Panel on Climate Change (IPCC)

The leading body for the assessment of climate change is the Intergovernmental Panel on Climate Change (IPCC), established by the **United Nations Environment Programme** (UNEP) and the **World Meteorological Organization** (WMO) in 1988 to provide the world with a clear scientific view on the current state of climate change and its potential environmental and socio-economic consequences. The IPCC represents the collective work of over 2,000 scientists, principally in the atmospheric sciences, and also comprising social, economic and other environmental components potentially impacted by climate change. Between its three Working Groups, the IPCC assesses the scientific and socioeconomic aspects of human-induced climate change, as well as options for greenhouse gas reduction and other forms of climate change mitigation. Its Task Force on National Greenhouse Gas Inventories is responsible for overseeing the National Greenhouse Gas Inventories Programme (NGGIP).

The IPCC neither conducts original research nor monitors climate-related data, but publishes periodic assessment reports and technical papers which play a significant role in the creation of climate change policies. The IPCC was instrumental in establishing the Intergovernmental Negotiating Committee for the UNFCCC in 1992. In 1995, the IPCC concluded in its Second Assessment Report that the global mean surface temperature has increased by between about 0.3 and 0.6º C since the late 19th century, and that there are also changes in geographical, seasonal and vertical patterns of atmospheric temperature, i.e. changes that are inferred to originate from discernible human influence. This conclusion is sometimes credited as being the political impetus that eventually created the Kyoto Protocol in 1997.

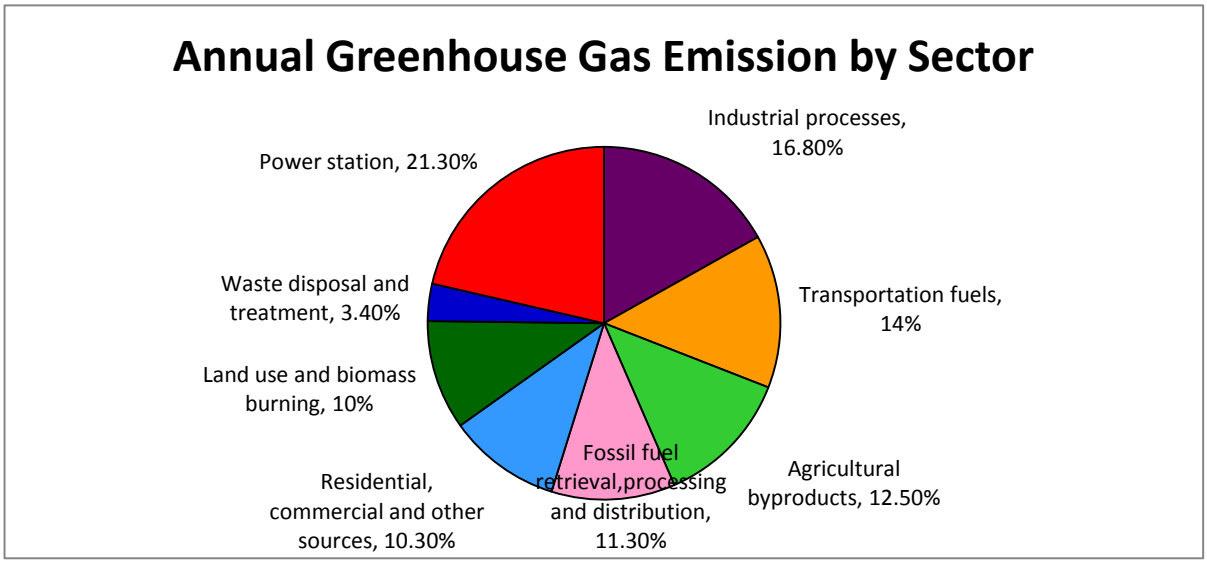
The recently released Fourth Assessment Report 2007 identifies the potential for even more dire consequences arising from human induced climate change. According to the panel's report, "*most of the observed increase in globally averaged temperatures since the mid-20th century is very likely (>90%) due to the observed increase in anthropogenic (human) greenhouse gas concentrations".* An increase in atmospheric concentrations of greenhouse gases equivalent to a doubling of carbon dioxide (CO_2) will force a rise in global average surface temperature of 1.1 to 6.4 degrees Celsius during the 21st Century. Sea levels will probably rise by 18 to 59 cm (7.08 to 23.22 in). With a confidence level of >90%, there will be more frequent warm spells, heat waves, and heavy rainfall. There will also be an increase in droughts, tropical cyclones, and extreme high tides with a confidence level of >66%. The Fifth Assessment Report will be finalized in 2014.

Climate Change and Agriculture

Climate change and agriculture are interrelated. Agriculture is identified to have been producing significant effects on climate change. According to the IPCC, the three main causes of the increase in greenhouse gases observed over the past 250 years have been fossil fuels, land use, and agriculture (Fig. 1). Agriculture contributes to greenhouse gas increases through the production and release of carbon dioxide, methane, and nitrous oxide (Fig. 2a, 2b and 2c), and also by altering the Earth's land cover, which can change its ability to absorb or reflect heat and light, thus contributing to radiation. Land use change such as deforestation and desertification, together with the use of fossil fuels, are the major anthropogenic sources of carbon dioxide; agriculture itself is the

major contributor to increasing methane and nitrous oxide concentrations in the earth's atmosphere (http://en.wikipedia.org/wiki/Greenhouse_gas).

Figure 1: Annual Greenhouse Gas Emission by Sector



Source: http://en.wikipedia.org/wiki/Greenhouse_gas

Figure 2a: Production and Release of Carbon Dioide by Sector

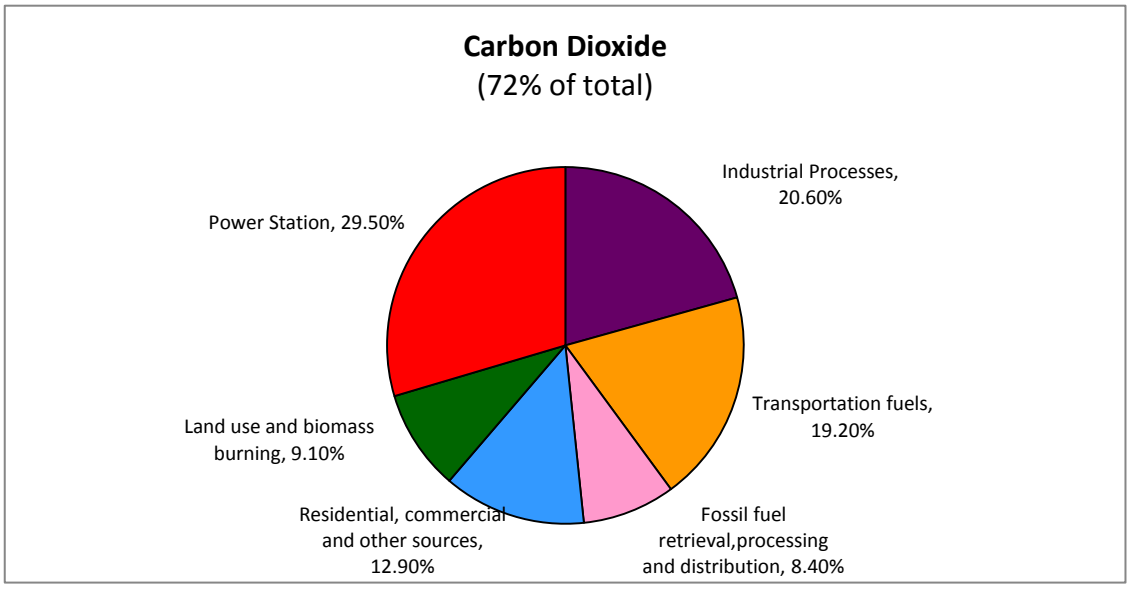


Figure 2b: Production and Release of Methane by Sector

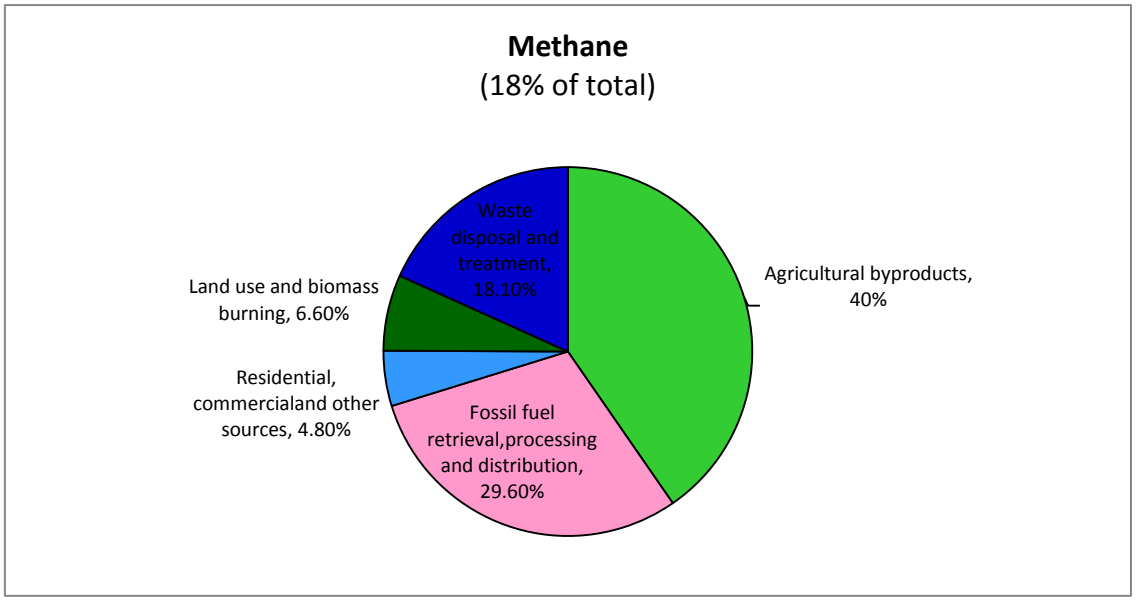
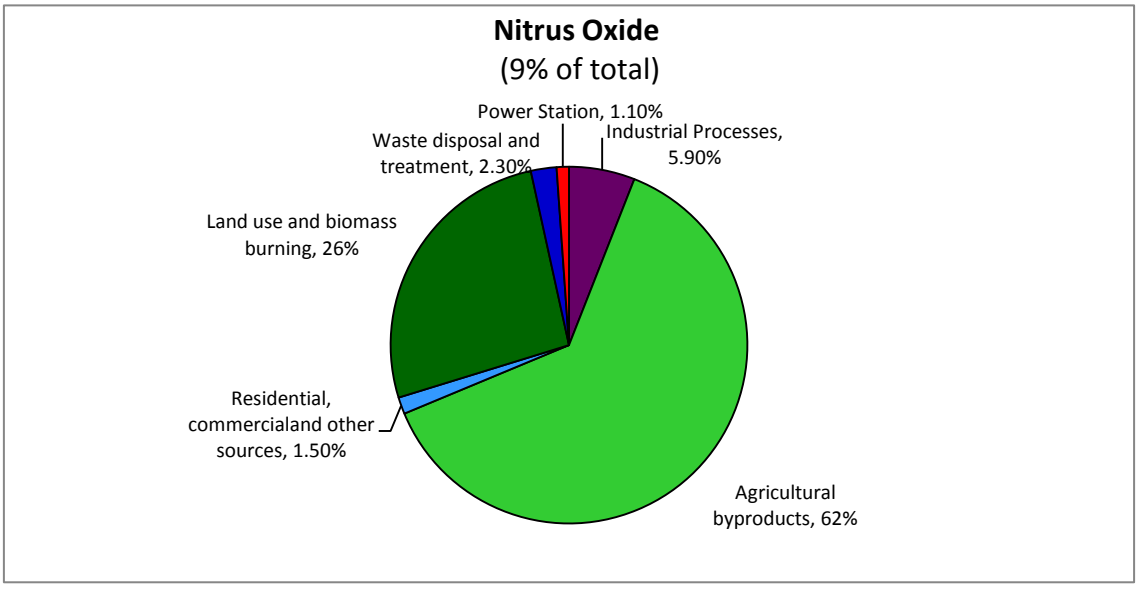


Figure 2c: Production and Release of Nitrous Oxide by Sector



Source: http://en.wikipedia.org/wiki/Greenhouse_gas

On the other hand, agriculture is highly sensitive to climate variability and weather extremes, such as droughts, floods and severe storms. The forces that shape our climate are also critical to agricultural productivity (Fraser, 2008). Human activity has already changed atmospheric characteristics such as temperature, rainfall, levels of carbon dioxide (CO_2) and ground level ozone. These trends are expected to continue. While food production may benefit from a warmer climate, the increased potential for droughts, floods, heat waves and extreme weather will pose challenges for farmers. In some regions, it may be less feasible to continue crop production given the enduring changes in climate, water supply and soil moisture. These factors create large uncertainties as to whether we have the capacity to produce enough food for the human population and domesticated animals. Agriculture is not only a source of the commodity food but also an important source of income. Besides ***productivity***, in the long run the climatic change could affect agriculture through:

- ***agricultural practices***, i.e. changes in water use (such as irrigation) and agricultural inputs (such as herbicides, insecticides and fertilizers)
- ***environmental effects***, i.e. nitrogen leaching, soil erosion, reduction of crop diversity
- ***rural space***, i.e. land use conversion such as from agriculture to housing and from forest to agriculture
- ***adaptation***, i.e. development of more competitive organisms, such as flood resistant or salt resistant varieties of rice.

Factors that directly link climate change and agricultural productivity include:

- Average temperature increase
- Change in rainfall amount and patterns
- Rising atmospheric concentrations of CO_2
- Pollution levels such as tropospheric ozone
- Change in climatic variability and extreme weather

Most agronomists believe that agricultural production will be mostly affected by rapid climate change because there is less time for optimum natural selection and adaptation especially when there are already poor soil and climate conditions. Gradual and marginal trends in climate change may provide enough time to allow for adaptation.

The 1996 and 2001 IPCC Second and Third Assessment Reports respectively concluded that the poorest countries would be hardest hit, with reductions in crop yields in most tropical and sub-tropical regions due to decreased water availability, and new or changed insect pest incidence. In Africa and Latin America many rainfed crops are near their maximum temperature tolerance, so that yields are likely to fall sharply for even small climate changes; falls in agricultural productivity of up to 30% over the 21st century are projected. Marine life and the fishing industry will also be severely affected in some places. Table 1 illustrates the IPCC estimates of the impact of climate change on world grain production.

Table 1: Estimated Percentage of Grain Production Changes from Climate Change

Scenario	World	Developed Countries	Developing Countries (Asia, Africa, Latin America)
No offsetting effects considered	-11 to -20	-4 to -24	-14 to -16
Including CO2 fertilization effect	-1 to -8	-4 to +11	-9 to -11
Including CO2 fertilization and Modest farmer adaptation	0 to -5	+2 to +11	-9 to -13
Including CO2 fertilization and more ambitious farmer adaptation	-2 to +1	+4 to +14	-6 to -7

Source: 1996 IPCC Report.

The 2007 IPCC Assessment Report projected impacts of climate change on several sectors and for different regions. The projected impacts on agriculture, forestry and ecosystems are presented in Table 2 while Table 3 summarizes the impacts on agriculture by selected regions.

Table 2: Impact of Climate Change Scenarios on Agriculture, Forestry and Ecosystems

Phenomenon[a] and direction of trend	**Likelihood of future trends based on projections for 21st century using SRES[b] scenarios**	**Agriculture, forestry and ecosystems**

Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights	Virtually certain[c]	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks
Warm spells/heat waves. Frequency increases over most land areas	Very likely	Reduced yields in warmer regions due to heat stress; increased danger of wildfire
Heavy precipitation events. Frequency increases over most areas	Very likely	Damage to crops; soil erosion, inability to cultivate land due to waterlogging of soils
Area affected by drought increases	Likely	Land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire
Intense tropical cyclone activity increases	Likely	Damage to crops; windthrow (uprooting) of trees; damage to coral reefs
Increased incidence of extreme high sea level (excludes tsunamis)[d]	Likely[e]	Salinisation of irrigation water, estuaries and fresh- water systems

Notes:

a) See Working Group I Table 3.7 for further details regarding definitions.

b) Special Report on Emissions Scenarios (SRES).

c) Warming of the most extreme days and nights each year.

d) Extreme high sea level depends on average sea level and on regional weather systems. It is defined as the highest 1% of hourly values of observed sea level at a station for a given reference period.

e) In all scenarios, the projected global average sea level at 2100 is higher than in the reference period. The effect of changes in regional weather systems on sea level extremes has not been assessed.

Source: 2007 IPCC Assessment Report

Table 3: Projected Impacts of Climate Change on Agriculture, Forestry and Ecosystems by Selected Regions

Africa	• Yields from rain-fed agriculture could be reduced by up to 50% in some countries by 2020. Agricultural production, including access to food, in many African countries is projected to be severely compromised. This would further adversely affect food security and exacerbate malnutrition. • Sea level is projected to rise affecting low-lying coastal areas with large populations towards the end of the 21st century. The cost of adaptation: at least 5 to 10% of Gross Domestic Product (GDP). • Arid and semi-arid land in Africa is projected to increase by 5 to 8% by 2080 under a range of climate
Asia	• Freshwater availability in Central, South,East and South-East Asia, particularly in large river basins is projected to decrease by 2050. • Coastal areas, especially heavily populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers. • Pressures on natural resources and the environment associated with rapid urbanisation, industrialisation and economic development.
Australia and New Zealand	• Production from agriculture and forestry is projected to decline by 2030 over much of southern and eastern Australia, and over parts of eastern New Zealand, due to increased drought and fire.
Europe	• Regional differences in Europe's natural resources and assets are expected to be magnified. Negative impacts will include increased risk of inland flash floods and more frequent coastal flooding and increased erosion (due to storminess and sea level rise). • In southern Europe, climate change is projected to worsen conditions (high temperatures and drought) in a region already vulnerable to climate variability, and to reduce water availability, hydropower potential, summer tourism and, in general, crop productivity.

Latin America	• Gradual replacement of tropical forest by savanna in eastern Amazonia by 2050. Semi-arid vegetation will tend to be replaced by arid-land vegetation. • There is a risk of significant biodiversity loss through species extinction in many areas of tropical Latin America. • Productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase. Overall, the number of people at risk of hunger is projected to increase • Changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation.
North America	• In the early decades of the century, moderate climate change is projected to increase aggregate yields of rain-fed agriculture by 5 to 20%, but with important variability among regions. Major challenges are projected for crops that are near the warm end of their suitable range or which depend on highly utilised water resources. • Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution.

Note:

Unless stated explicitly, all entries are from Working Group II SPM text, and are either very high confidence or high confidence statements, reflecting different sectors (agriculture, ecosystems, water, coasts, health, industry and settlements). The Working Group II SPM refers to the source of the statements, timelines and temperatures. The magnitude and timing of impacts that will ultimately be realised will vary with the amount and rate of climate change, emissions scenarios, development pathways and adaptation.

Source: 2007 IPCC Assessment Report

Implication on Food Security

The Food and Agriculture Organization (FAO) defines food security as a “situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002). This definition comprises four key dimensions of food supplies: ***availability, utilization, accessibility, and stability***. In a world where trade is possible, the availability of food depends on local production and imports. The crucial issue then for food security is not whether food is available, but whether the purchasing power of consumers is sufficient to allow everyone access to adequate quantities of food given the rising food prices. Thus, national self-sufficiency strategy is neither necessary nor sufficient to guarantee food security at the country level. Hong Kong and Singapore, for example, are not self-sufficient but with sufficient purchasing power, their populations are food-secure, whereas India is self-sufficient but a large part of its population is not food-secure.

Climate Change, Agricultural Productivity and Food Security Linkages

The linkage between climate change and food security have, to date, largely been explored using process-based crop production models, i.e. linking climate to crop productivity and hence, food production. The yield can then be modeled for a uniform crop and upscaled to a larger area within some geographic information system (GIS). For instance, Gregory *et al*. (2002) found reductions in wheat and rice yields of about 5% $°C^{-1}$ rise of temperature above 32°C. These reductions in yield due to temperature offset the increase in yield due to increased atmospheric carbon dioxide (CO_2) concentration. Other reviews (e.g. Amthor 2001; Fuhrer 2003; Long *et al*. 2005) have also found that the benefits of CO_2 fertilization on growth and yield of crop plants would be largely offset by nutrient limitations, pollutants and further interactions with climatic factors. Simulations of maize production for food (ignoring the fact that maize is commonly used as fodder as well) in Africa and Latin America (Jones & Thornton 2003) predicted an overall reduction of 10% for 2055 using predicted climate data from the HadCM2 model.

Spatial variation in effects of climate change has been studied using Global Circulation Models (GCMs). Fischer *et al*. (2001) studied on the potential yields of rainfed cereal crops using climate predictions in 2080 obtained from various GCMs. Based on current populations and socio-economic conditions the results demonstrated that cereal producing regions of Canada, and northern Europe and Russia might be expected to increase production as a consequence of the climate changes predicted by GCMs, while many parts of the world would suffer losses including the western edge of the USA prairies, eastern Brazil and western Australia. Overall, the results of this and subsequent work that included assessments of future populations and alternative future socio-economic conditions (Fischer *et al*. 2002*a*,*b*, 2005), demonstrated that climate change would benefit the developed countries more than the developing countries even if cropping practices evolved to allow more than one rainfed crop per year. Moreover, the anticipated demographic growth and socio-economic development in these developing countries would result in substantial increases in food requirements thereby exacerbating the detrimental effects of climate change.

CONCLUSION

Climate change affects food security through a chain of processes. Agricultural productivity and hence, food production is directly affected by changes in temperature, rainfall, atmospheric concentrations of carbon dioxide, pollution levels and climate variability. While some regions benefit from warmer climate, some countries may struggle to adapt to the detrimental effects of the change in the environment. The overall effect of climate change on food security will depend on the balance of these effects. Openness in agricultural trade may ensure that food is available for the world population. However, the critical issue is whether everyone gets economic access to sufficient, safe, and nutritious

food. Assessment of the effects of global climate changes on agriculture might help to properly anticipate and adapt, or even reform farming to maximize agricultural production. Consumer preferences may also change.

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AN EMPIRICAL STUDY OF FARM LEVEL IMPACTS ASSESSMENT OF CLIMATIC CHANGE ON AGRICULTURAL PRODUCTIVITY, CROP CHOICE, AND FOOD SECURITY IN NORTHWEST SELANGOR, MALAYSIA

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ABSTRACT

Climate change is proven to have had impacted the agricultural productivity, crop choice, and food security everywhere in the world. The nature, scale, frequency, and outcome of such impact differ significantly among countries, regions as well as areas within a country. This study is an effort to empirically investigate theses issues for Malaysia using both primary and secondary data collected from and relevant to the Integrated Agriculture Development Areas in the Northwest Selangor. The results reveal that climate change phenomenon such as natural disaster, drought, flood, pest attack, plant disease, and changing the time of crop cycle have adversely been impacting Malaysian agriculture and its productivity as well as profitability. Despite continuous increases of government subsidy as well as permission only for paddy production, the paddy planting area is decreasing as the agricultural farmers often experience adverse impacts of climatic variation. So, climate change phenomenon is also depressingly impacting the state of food security among the farmers. As climate change is universal and its existence is indefinite, the adaptation to and mitigation of damages from climate change will be the best ways to deal with its effects in the short run. Therefore, the farmers need to adapt to and find ways to mitigate the damages of climatic variation in order for them to sustain agricultural productivity and attain food security.

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Key words: Climate Change, Agricultural Productivity, Crop Choice, Food Security, Paddy

Farming, Farm Profitability, Agricultural Sustainability, Malaysia.

INTRODUCTION

Agriculture is primarily and heavily dependent on climate. The uncontrollable natures of climate factors, such as temperature, rainfall, soil moisture, flood, drought, other natural disaster etc., are changing over the time affecting agricultural, economic, social, and environmental sustainability. Due to the climate change, several agricultural factors, such as yield, cultivated area, and value of crops, are changing that influences the sustainability of agriculture. Changes in climate affect the productivity of different crops differently. Therefore, changes in outputs and economic returns from different crops differ significantly affecting the decision of crop selection. Climate change also affects the state of food security at both household and national levels.

In fact, climate change has mixed impacts on agriculture**.** The global impacts of climate change on agricultural production vary from slight to moderate, while the regional impacts are observed to be significant in many areas. Regional variations in gains and losses result in a slight overall changes in world food productivity. Several studies suggest that climate change will slow or reverse the rural poverty increasing the negative impacts on agriculture. Warren et al. (2006) mentioned that some 600 million additional people are at risk of hunger if temperature increases by over 3°C. Climate change may slow the rates of improvement in food security. Projection by a study reveals that in 2080 around 1300 million people could be at risk of hunger under the most extreme scenarios, that is around 600 million more than that in 1999 (Parry et al. 2004). The Food and Agriculture Organization (FAO) (2008) reports that over 860 million people in the world are suffering from severe food insecurity and chronic malnourishment, and about 95 percent of them are in developing countries.

The Intergovernmental Panel on Climate Change (IPCC) mentioned Africa as one of the most vulnerable continents to climate change (Boko et al. 2007). Very few parts of Africa will be benefited from a rising temperature, unlike some parts of the northern hemisphere. The United Nations Framework Convention on Climate Change (UNFCCC) identifies a list of 49 Least Developed Countries (LDCs), which are at high risk from climate change and 33 of these countries are located in Africa. A study revealed that due to climate change, Southern Africa will lose more than 30% of its main crop, maize, by

2030, and Asia, especially South Asia and South East Asia will lose top 10% of many regional staples, such as rice, millet and maize (Lobell et al. 2008).

Studies also have linked the climate change impacts to the yield variation of cash crops, such as rice, wheat, and tobacco, in South and Southeast Asian regions (Matthews et al. 1994a, 1994b). Climatic impacts on agriculture span a wide range of attributes and outcomes depending on the specific climate scenario, geographical location, and nature of study. For example, while major climate changes were predicted for China, to a certain extent warming would be beneficial for yield increasing in the country due to diversification of cropping systems. In case of Japan, the positive effects of CO_2 on rice yields would generally more than offset any negative climatic effects (MOSTE 2001). But in case of Malaysia, under current climate change scenario, temperature above 25^{o}C may decline grain mass of 4.4% per 1^{o}C rise (Tashiro and Wardlaw 1989), and grain yield may decline as much as 9.6%-10.0% per 1^{o}C rise (Baker and Allen 1993), whereas an average temperature in rice growing areas in Malaysia is about 26^{o}C. Singh et al. (1996) revealed that that the actual farm yields of rice in Malaysia vary from 3-5 tons per hectare, where potential yield is 7.2 tons. The study also revealed that there is a decline in rice yield between 4.6%-6.1% per 1^{o}C temperature increase and that doubling of CO_2 concentration (from present level 340ppm to 680ppm) may offset the detrimental effect of 4^{o}C temperature increase on rice production in Malaysia. Overall, based on the analysis of minimum and maximum yield of last 28 years, the macro cases of the national data from 1980 to 2008 of Malaysia shows the yield of paddy would be decreased between 43% and 61% if 1^{o}C temperature and 1 millimeter (mm) rainfall increased (Ali and Ali 2009). In a recent study, based on the micro data on paddy field of Integrated Agricultural Development Area (IADA), North-West Selangor, it has been found that a 1% increase in temperature will lead to 3.44% decrease in current paddy yield and 0.03% decrease in paddy yield in next season. Also a 1% increase in rainfall will lead to 0.12% decrease in current paddy yield and 0.21% decrease of paddy yield in next season (Alam et al. 2010).

However, the climatic factors are changing very rapidly in Malaysia. According to the United Nations Development Report, carbon dioxide (CO_2) emissions in Malaysia increased by 221% during the period from 1990 to 2004 and the country has been placed in the list of 30 biggest greenhouse gas emitters in the world (The Associated Press 2007). Liebman (2007) also revealed that rapid growth in CO_2 emissions has been occurred even though Malaysia ratified the Kyoto Protocol and has taken several initiatives to use renewable energy as well as ways to cut emissions. Currently Malaysia ranks as the 26th largest greenhouse gas emitter in the world with a population of about 27 million, and it appears likely to move up the list quickly due to the growth rate of emissions. Due to high greenhouse gas emissions, the average temperature is projected to rise by 0.3^{o}C to 4.5^{o}C and the warmer temperature will cause a rise in sea level about 95cm over hundred periods. The changes in rainfall may fluctuate from about -30% to +30%. This change will reduce crop yield and is prone to drought in many areas so that

cultivation of some crops such as rubber, oil palm and cocoa will not be possible (MOSTE 2001).

Moreover, the recent projection shows maximum monthly precipitation, which will increase up to 51% over Pahang, Kelantan and Terengganu, while minimum precipitation decreases between 32% and 61% for all over Peninsular Malaysia. Consequently, annual rainfall will increase up to 10% in Kelantan, Terengganu, Pahang and North West Coast, and decrease up to 5% in Selangor and Johor (NAHRIM 2006). Tisdell (1996) found that rainfall variability increases the level of environmental stress that affects the capability of the system to maintain productivity. Projection reveals that any changes, both positive and negative, more than only 0.4% will cause to fall the yield of paddy production in Malaysia (MOSTE 2001). Alam et al. (2009) found that total yearly rainfall in Malaysia is increasing but its monthly variation is too high. In Malaysia, the effect of lower rainfall is almost possible to check through proper irrigation system, but the opposite phenomenon of over rainfall for any particular time, especially at the end of the crop cycle or at the maturity period, causes serious damages of crops, which is absolutely uncontrollable for now.

In order to sustain the self-sufficiency level and food security of the nation through increasing food productivity, income, and the provision of improved irrigation and drainage facilities and other complementary inputs, such as fertilizers, pesticides, and weedicides etc, and other agricultural services such as extension, credit, marketing and subsidies, the Integrated Agricultural Development Projects (IADPs) were adopted since 1971 in Malaysia. When initiated, however, there were eight IADPs in Malaysia and they have then been renamed as IADAs.

Contribution of Agriculture to National Economy and Food Security

In the path of economic development from agriculture to industrial movement, the agricultural sector of Malaysia has been declining its share of GDP since 1975. In 1970, the contribution of agriculture to GDP was 30.8% which is the highest among all sectoral contribution. The contribution of the agriculture to the GDP accounted 22.7% in 1975, 22.9% in 1980 and 20.8% in 1985, but it was still the major contributor in GDP. In 1990, agriculture became the second largest sector contributing 18.7% to the national GDP. In 1995, the contribution of agriculture to the national GDP further declined to 13.6%, but it remained as the second largest sector in the economy. The contribution of the sector continued to decline to 8.9% in 2000 and 8.2% in 2005. While the agriculture sector was loosing its importance to the national economy, services and manufacturing sectors have taken the first and second highest contributing roles respectively, placing the agriculture as the third engine of economic growth in the country (Table 1).

Table 1: Sectoral Contribution to GDP (in %) in Malaysia

Industry	Year							
	1970	1975	1980	1985	1990	1995	2000	2005
Agriculture, livestock, forestry & fishery	30.8	22.7	22.9	20.8	18.7	13.6	8.9	8.2
Mining & quarry	6.3	4.6	10.1	9.7	5.7	7.4	7.3	6.7
Manufacturing	13.4	16.4	19.6	19.7	27.0	33.1	31.9	31.4
Construction	3.9	3.8	4.6	4.8	3.5	4.4	3.3	2.7
Services (total)	41.9	45.1	40.1	43.6	42.3	44.1	53.9	58.1
Electric, gas & water	1.9	2.1	1.4	1.7	1.9	2.3	3.9	4.1
Transportation, storage & communication	4.7	6.2	5.7	6.4	6.9	7.3	8.0	8.8
Wholesale, trade, retail	13.4	12.8	12.8	12.1	11.0	12.1	14.8	14.7
Finance, insurance & properties	8.4	8.5	8.5	8.9	9.7	10.7	12.7	15.1
Government services	11.1	12.7	12.7	12.2	10.7	9.7	6.8	7.6
Other services	2.5	2.8	2.8	2.3	2.1	2.0	7.6	7.8

Source: Government of Malaysia (1986, 1991, 1996, 2000, 2006)

Use of land by Malaysia's agriculture also continues to decrease due to the country's rapid economic development, which occupies more agricultural land mainly for housing, business, and industrial purposes. Since 1960 until 2005, the land use for industrial crops is increasing while it is decreasing for food crops (Table 2). It just means that the major part of agricultural land is being used for growing industrial crops and that importance of growing food crops continues to decrease. In 1960, for example, land use for food crops accounted for 31.5% of the total agricultural land in Malaysia while it has decreased to 16.3% in 2005. Among the industrial crops, palm oil sector accounted for the largest share of the total land utilization in the country. Agricultural land use by the palm oil sector has significantly increased over the last five decades with only 2.1% in

1960 to 63.4% in 2005. This just reveals the facts that palm oil production has been getting more importance and contributing significantly to the national economy.

Table 2: Distribution of Agricultural Land Utilization (in %) in Malaysia

Crop	Year									
	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Industrial crops(Total)	*68.5*	*71.7*	*68.0*	*69.3*	*71.7*	*76.1*	*81.3*	*77*	*80.2*	*83.7*
Rubber	65.7	66.9	58.6	51.2	45.1	39.3	44	30.6	26.1	19.6
Palm Oil	2.1	4.0	8.4	16.5	23	29.9	30.4	37.9	48.8	63.4
Cocoa	0.0	0.1	0.2	0.7	2.8	6.1	6.3	7.9	4.7	0.5
Pineapple	0.6	0.6	0.6	0.5	0.3	0.2	0.1	0.2	0.3	0.1
Tobacco	0.1	0.1	0.1	0.3	0.3	0.3	0.2	0.2	0.2	0.2
Food Crops (Total)	*31.5*	*28.3*	*32.0*	*30.7*	*26.8*	*22.6*	*17.9*	*21.7*	*18.8*	*16.3*
Paddy	17.5	16.8	20.8	19.5	16.5	13.1	10	11.3	7.5	7.1
Coconut	9.2	8.1	8.7	7.4	7.9	6.7	4.7	5.7	4.1	2.8
Vegetables	1.3	0.7	0.5	0.3	0.3	0.3	0.5	0.3	0.8	1
Fruits	1.5	1.6	1.6	1.7	2.1	2.4	2.7	4.3	6.4	5.2
Others	1.9	1.1	0.4	1.9	1.5	1.4	0.9	1.3	1	0.3
Total Land Area (Ha)	2667	3066	3445	3887	4446.6	4952.4	6636.3	5716.3	5368.3	6382

Source: Government of Malaysia (1986, 1991, 1996, 2000, 2006)

In Malaysia, there is no specific policy on food security, but it has been embedded into the theme of self sufficiency level that referred to paddy or rice sector (Fatimah & Mad Nasir, 1997). Since rice is the main staple food in Malaysia, self-sufficiency level has been focused on paddy and rice production. However, the scope has been expanded to other food items including fruits, vegetables, fish products, beef, mutton, pork, chicken, duck, eggs, and dairy products in the First National Agriculture Plan in 1984. To ensure food security in Malaysia, however, government follows two procedures, such as establishing self-sufficiency level and maintaining rice stocks both domestically and internationally. Malaysia has had never met food self-sufficiency level. About 10% to 35% of total required rice imported from neighboring countries, such as Thailand,

Vietnam, Myanmar, India, and Pakistan. The highest food self-sufficiency level for the country was 95% and the lowest one was 65%, which were recorded in 1975 and 1990, respectively. National Paddy and Rice Board (LPN- later been privatized as Padiberas Nasional Berhad - BERNAS) is the authorized body to manage the domestic rice stock.

Table 3: Recent Paddy Statistics in Malaysia

Item	2003	2004	2005	2006	2007	2008[P]
Paddy Parcels Area (Hectare)[2]	459,702	459,044	440,961	429,805	426,224	426,260
Average Yield of Paddy (Kg./Ha.)	3,360	3,434	3,471	3,236	3,514	3,556
Paddy Production ('000 Tones)	2,257	2,291	2,314	2,187	2,375	2,384
Rice Production ('000 Tones)	1,453	1,467	1,490	1,407	1,531	1,535
Production Values (RM'000)	1,241,350	1,260,050	1,272,700	1,421,550	1,543,750	1,788,000
Total Rice Import ('000 Tones)	398.7	558.1	584.7	843.3[P]	798.7[P]	657.9[P(1)]

[1]For Jan –Jun 2008; [2]A paddy parcel is a piece of land which is usually used for paddy planting

Source: Agriculture Statistical Handbook 2008

The current record shows a positive trend of import and a negative trend of land usage for paddy production in Malaysia (Table 3). The objectives of government's policy about paddy and rice sector reflect three issues: ensure sufficient supply and affordable price for the citizens, meet the target of self sufficiency level, and ensure high prices to paddy farmers for better income and reducing higher level of poverty in this sector (Selvadurai, 1972; Chamhuri, 1992; Fatimah & Mad Nasir, 1997 & Fatimah, 2007).

SOURCES OF DATA AND SAMPLE DESIGN

In order to determine and analyze the impacts of climate change on agricultural productivity, crop choice, and food security, primary data have been collected through an in depth survey on farmers in the IADA area of North-West Selangor, Malaysia. The total agricultural land in the above IADA area is 100,000 hectares, where 55,000 hectares are being cultivated for palm oil, 20,000 hectares for coconut, 5,000 hectares for fruits and vegetable, and 20,000 hectares for paddy. The 20,000 hectares allocated for paddy also

consist of river, drain, and road. Within the 20,000 hectares allocated for paddy farming, the total paddy producible area is actually 18,638 hectares, but paddy is currently being planted within 18,355 hectares and the rest 283 hectares of land are currently unused. Moreover, total paddy irrigated area is 18,980 hectares, where an extra 625 hectares are being used for irrigation drainage. The IADA area in Northwest Selangor further consists of eight areas where total reported paddy farmers are about 10,300, other crop producing farmers are about 30,000, and the total size of the agricultural community reported in the area is about 50,000. Among the paddy producing farmers, a total of 198 farmers were interviewed using a structured questionnaire. Trained enumerators were hired to interview the respondents in all IADA areas using a stratified-quota random sampling technique. All the 198 agricultural farmers interviewed in the study were reported to have been cultivating a total 577.53 hectares of land for paddy production. Relevant secondary data have also been collected from several sources, such as IADA publication, Ministry of Science Technology and the Environment (MOSTE) publication, National Hydraulic Research Institute of Malaysia (NAHRIM) publication, Agriculture Statistical Handbook, and Government of Malaysia various fifth-year plans.

RESULTS AND DISCUSSION

Impacts of Climatic Change on Crop Productivity

Available literatures have revealed earlier that climate change has an adverse impact on agriculture in Malaysia. The projection of paddy yield in the country showed that any positive or negative variation of above 0.4% in both rainfall and temperature will decrease the yield of paddy production by 2020 (Table 4). When considering a positive or negative variation of above 0.7% in both rainfall and temperature by 2040, paddy yield tends to decline further and this negative trend of paddy yield is expected to continue by the year 2060, considering the variation (±) of above 1%. These clearly indicate a very high level of vulnerability of paddy productivity to the climatic variation in the next couple of decades.

Table 4: Projection of Paddy Yield (Kg/Ha) with Different Variations of Temperature and Rainfall

Year 2020*				**Year 2040^**				**Year 2060#**			
Variation in Rainfall	Variation in Temperature (^{0}C)			Variation in Rainfall	Variation in Temperature (^{0}C)			Variation in Rainfall	Variation in Temperature (^{0}C)		
	0.3	**0.85**	**1.4**		**0.4**	**1.4**	**2.4**		**0.6**	**2**	**3.4**
14%	6,156	5,806	5,586	**23%**	7,342	6,942	6,542	**32%**	8,619	8,059	7,499
7%	6,646	6,306	6,086	**11%**	8,200	7,800	7,400	**15%**	9,834	9,274	8,714
0.40%	7,202	6,862	6,642	**0.70%**	9,042	8,642	8,242	**1%**	10,962	10,402	9,842

0%	7,202	6,862	6,642	**0%**	9,042	8,642	8,242	**0%**	10,962	10,402	9,642
-0.40%	7,202	6,862	6,642	**-0.70%**	9,042	8,642	8,242	**-1%**	10,962	10,402	9,642
-7%	6,698	6,382	6,177	**-11%**	8,047	7,691	7,335	**-15%**	9,318	8,842	8,366
-14%	6,194	5,901	5,712	**-23%**	6,962	6,654	6,346	**-32%**	7,454	7,073	6,693

* CO_2 is given at 400 ppm; ^ CO_2 is given at 600 ppm; # CO_2 is given at 800 ppm;

Source: MOSTE 2001

But the farmers have different views concerning the impacts of climate change on agricultural output. While they were asked about the possible impacts of climate change on paddy yield, 21.2% indicated that climate change causes productivity to decline (Table 5). There were several reasons that farmers perceived as causing productivity decline in agriculture. For example, 48% farmers indicated that natural disaster, drought, pest attack, and plant disease negatively affect the crop productivity and hence changes the time of crop cycle. On the other hand, 30.8% farmers indicated that increase in agricultural input cost does indirectly affect the crop productivity. These farmers have further indicated that the higher input cost results in lesser amount of input use, which eventually causes crop productivity to decline.

Table 5: Farmers' Perception toward the Effect of the Climate Change on Paddy Production

Response	**No. of Respondent**	**% of Total**
Productivity Decline	42	21.20%
Increase Production Cost	61	30.80%
Natural Disaster	13	6.60%
Drought	10	5.10%
Pest Attack	23	11.60%
Plant Diseases	38	19.20%
Timing of Cultivation	11	5.60%
Total	198	100%

Source: Primary Data from Survey 2009

All the farmers interviewed were also asked whether or not climatic variation in the IADA area affects their paddy production. A total of 64% farmers indicated that they have had experienced reduced amount of paddy production due to climatic variation in the area. When the same farmers were asked if climatic variation does also affect the yield of other crops, a majority of those farmers (65.2%) responded positively by agreeing that yield of other crops also decreases due to climate changes. Given the fact that climate change negatively affects the yield of paddy and other crops, those farmers were then asked which crop they want to select under such adverse situation. Their response, however, was not in favor of paddy crop as only 23.7% farmers have chosen this crop followed by 19.7% farmers who like to produce only short term or seasonal plants, which are not considerably affected by the climatic variation in that particular area. Among those farmers who were asked which crop to select under such adverse climatic situation, as many as 39.4% farmers have responded that they prefer to cultivate long term plants such as mango, palm oil, coconut, and banana in areas which were actually allocated by the IADA authorities for paddy farming.

Impacts of Climatic Change on Farms' Profitability and Relevant Government Subsidy

The farmers are dependent on agriculture for their income. As a result, when the quantity of agricultural production declines the income of the farmers also declines, resulting in a loss of their profitability. The recent projection by the Ministry of Science, Technology, and the Environment (MOSTE), Malaysia reveals that income earnings from paddy cultivation under different variations of temperature and rainfall are different. For example, any positive or negative variation of above 0.4% in rainfall will decrease farmers' income earning as well as profitability from paddy production in the next several decades (Table 6).

Table 6: Projection of Revenue Changes (RM/ Ha) for Paddy Production with Different Variations of Temperature and Rainfall

Year 2020**				**Year 2040^**				**Year 2060#**			
Variation in Rainfall	Variation in Temperature (^{0}C)			Variation in Rainfall	Variation in Temperature (^{0}C)			Variation in Rainfall	Variation in Temperature (^{0}C)		
	0.3	**0.85**	**1.4**		**0.4**	**1.4**	**2.4**		**0.6**	**2**	**3.4**
14%	-554.2	-554.2	-554.2	**23%**	-892.1	-892.1	-892.1	**32%**	-1,229.5	-1,229.5	-1,229.5
7%	-291.8	-291.8	-291.8	**11%**	-441.9	-441.9	-441.9	**15%**	-591.9	-591.9	-591.9
0.40%	0	0	0	**0.70%**	0	0	0	**1%**	0	0	0

0%	0	0	0	**0%**	0	0	0	**0%**	0	0	0
0.40%	0	0	0	**-0.70%**	0	0	0	**-1%**	0	0	0
-7%	-264.5	-251.9	-224.0	**-11%**	-522.1	-499.1	-476.0	**-15%**	-862.7	-818.6	-774.5
-14%	-529.0	-504.3	-488.0	**-23%**	-1091.5	-1043.2	-994.9	**-32%**	-1,840.8	-1,764.9	-1,652.4

* Earning calculates as paddy price per 100kg Super Grade= RM55.00 & Normal Grade= RM51.69

** CO_2 is given at 400 ppm; ^ CO_2 is given at 600 ppm; # CO_2 is given at 800 ppm;

Source: MOSTE 2001

In fact, profitability is an important factor which affects farmers' crop selection. While selecting crops, 37.9% farmers' decision criteria are based on the profit that includes high return, government subsidy, and high turnover (Table 7). Also 38.4% farmers indicated that they consider their skills and less requirement of effort to cultivate and manage the crops. Data also reveal that 6.6% farmers select crops based on their fascination about the crop.

Table 7: Farmers' Crop Selection by Free of Choice and Reasons for Selecting a Particular Crop

Crops Choice	**Reason of Choice**							**Total Respondent**	**% of total Respondent**
	High Return	**Government Subsidy**	**High Turnover**	**Skilled Area**	**Easy to Manage**	**High Passionate**	**NR**		
Paddy	9	3	7	13	5	10		47	23.70%
Seasonal Fruits	4		1		3	1		9	4.50%
Vegetable	1		5		5	1		12	6.10%
Lemon Grass	1		2	1	4			8	4.00%
Maize	2		2		3			7	3.50%
Flower					1			1	0.50%

Fishery						1		1	0.50%
Lemon					1			1	0.50%
Palm Oil	5		20	2	20			47	23.70%
Banana	7		3		9			19	9.60%
Coconut	1				8			9	4.50%
Mango			2					2	1.00%
Wood Tree					1			1	0.50%
NR							34	34	17.20%
Total	30	3	42	16	60	13	34	198	100.00%
% of Total	15.20%	1.50%	21.20%	8.10%	30.30%	6.60%	17.2 %	100.00%	

Source: Primary Data from Survey 2009

Worth noting to mention that government of Malaysia currently provides huge amount of subsidy to the paddy producers to encourage paddy cultivation and to ensure more production for increasing the country's self-sufficiency level. However, the types and contents of these subsidies have been summarized below:

- *Input subsidy*: 12 beg (20 kg each) compound fertilizer and 4 beg (20kg each) urea fertilizer per hectare – worth MYR 400 and pesticide incentive MYR 200 per hectare.
- *Price Subsidy*: Provided at the selling price – MYR 248.1 per ton.
- *Rice Production Incentive*: Land preparation/plowing incentive – MYR 100 per hectare and organic fertilizer 100kg per hectare – worth MYR 140.
- *Yield Increase Incentive*: Provided if producers (farmers) are able to produce 10 tons or more per hectare – MYR 650 per ton.
- *Free Supports*: Free supports for irrigation, infrastructure, and water supply.

Table 8: Government Subsidy (in MYR) for Paddy Sector in Malaysia

Items	2004	2005	2006	2007
Subsidy For Paddy Price	476,628,303	443,218,042	445,749,898	444,000,000
Paddy Fertilizers	186,744,867	178,072,073	396,393,001	261,677,743
Paddy Production Incentive	NA	NA	NA	67,563,904
Yield Increase Incentive	NA	NA	NA	85,434,620

Paddy Seed Help	NA	NA	NA	17,000,000
Diesel Subsidy Scheme	NA	NA	989,727,418	1,099,000,723
Petrol	NA	NA	45,413,959	69,461,384
Total Subsidy and Incentive	663,373,170	621,290,115	1,877,284,276	2,044,138,374

Note: NA for data which were not found available.

Source: Agriculture Statistical Handbook 2008

In order to support the farmers and increase productivity as well as increase income of farmers, government's subsidy for agricultural sector is increasing each year (Table 8). The subsidies for urea and compound fertilizer have been continuing since 1979. The incentive for land preparation and using organic fertilizer has been continuing since 2007. Providing urea and compound fertilizer and pesticide incentive was introduced in 2008 and these supports are still continuing.

Impacts of Climatic Change on Crop Choice and Farmers' Income

The government of Malaysia had allocated the IADA area only for paddy production, but paddy production in the area currently provides 90.3% of agriculture related income to the farmers. About one third of those farmers engaged in IADA area also have income from permanent plant such as, mango, coconut, palm oil, cocoa, banana, etc. This is really alarming because the IADA fields are no more being cultivated only for paddy production. Even though the IADA officials have been checking and trying to remove these permanent plants from the fields, but farmers' tendency and attitude are not favorable. The cultivation of these permanent plants, however, provides 7% of agricultural income to all surveyed farmers as a whole, but a maximum of 63.7% of agricultural income is also found for an individual case.

Besides producing paddy in the IADA fields, farmers also like to produce seasonal crops, seasonal fruits, and seasonal vegetables. A total of 3% farmers produce these crops and a maximum of 7.6% of agricultural income comes from such production of non-paddy crops. Livestock production has also been found as a small source of total agricultural income of paddy producing farmers. Only 6.6% farmers are engaged in livestock production, which provides a maximum of 27.9% of total agricultural income to the IADA farmers (Table 9). Agricultural wages are another important source of agricultural income as 14.6% farmers are earning income by engaging themselves as

labor in the IADA fields. Their wages, however, account for 2.1% of total agricultural income of all the surveyed farmers while an individual farmer's income from wage was found to be a maximum of 35.7% of his or her total agriculture related income.

Table 9: Farmers' Income from Different Agriculture Related Sources

Income Range	Paddy Production	Permanent Plants for Long Term	Seasonal Crops, Fruits and Vegetables	Livestock Production	Agricultural Wage from Labor Selling
.01-10%	0	20	6	10	12
10-20%	0	17	0	2	11
20-30%	1	12	0	1	3
30-40%	1	10	0	0	3
40-50%	3	3	0	0	0
50-60%	4	2	0	0	0
60-70%	13	2	0	0	0
70-80%	17	0	0	0	0
80-90%	26	0	0	0	0
90-100%	133	0	0	0	0
Total	198	66	6	13	29
% of Total	100.0%	33.3%	3.0%	6.6%	14.6%
Maximum	100.0%	63.7%	7.6%	27.9%	35.7%
Minimum	23.5%	0.0%	0.0%	0.0%	0.0%
Proportion of Total Income	90.3%	7.0%	0.1%	0.5%	2.1%

Source: Primary Data from Survey 2009

Impacts of Climate Changes on Food Security

While the target of the IADA authorities is to ensure 7.5 tons of paddy production per hectare, the actual average yield found by the survey is 6.85 tons per hectare. The

survey also found that among the people working in the IADA fields there were actually 67% farmers and that 51.8% areas of the IADA fields are being cultivated for paddy production, which are clearly below the government's target level. As per Agriculture Statistical Handbook (2008), paddy yield in the IADA area of West Selangor reported was 5.042 tons per hectare in 2007 while the yield decreased to 4.819 tons per hectare in 2008. Under such variation in yield due to climatic change, it seems to be very tough for the farmers to meet the yield target and the IADA authorities will also find it hard to attract farmers to produce paddy. In fact, climate change is proven to have a negative impact on food security, which coincides with the actual perception of agricultural farmers as evident in the present study. As many as 64.1% of all the surveyed farmers reported that yield of paddy production decreases due to climate change while a total of 65.2% of those farmers further reported the same impact for the other crops (Table 10). So it appears that continuous decreases in crop yield will negatively affect both the self-sufficiency and long-term food security of the country.

Table 10: Farmers Perception of Yield Changes for Paddy and Other Crops Due to Climate Change

Types of Supports	**Observation Scale***					**Average Value of Scale**	**S.D.**	**Agreed (4 & 5) Observation**	**Disagreed (1 & 2) Observation**
	1	**2**	**3**	**4**	**5**				
Yield of Paddy Production Decreases	10 5.1%	13 6.6%	48 24.2%	42 21.2%	85 42.9%	3.9	1.18	127 64.1%	23 11.6%
Yield of Other Crops Production Decreases	12 6.1%	8 4%	49 24.7%	77 38.9%	52 26.3%	3.75	1.08	129 65.2%	20 10.1%

*Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = No Comment, 4 = Agree, 5 = Strongly Agree.

Source: Primary Data from Survey 2009

The survey conducted by the study further reveals that farmers' selection of crops also depends on historical record of different crops. As a matter of fact, 72.2% of all the

surveyed farmers reported that they consider previous years' price and productivity rate of alternative crops to select one for planting (Table 11). The survey also reveals a remarkable finding that 7.1% of those farmers are not willing to produce paddy in next season. As a result, paddy planting area in the IADA fields tends to decrease over the next seasons. However, the average decrease of paddy land reported by the IADA Authorities for the last three years was 0.34% (Table 12). In spite of government's regulation and constant subsidy in the agriculture sector, every year the IADA's paddy planting area decreases and this trend continues.

Table 11: Crop Selection Decision of Farmers

Types of Supports	Observation Scale*					Average Value of Scale	S.D.	Agreed (4 & 5) Observation	Disagreed (1 & 2) Observation
	1	2	3	4	5				
Consider previous years' price and productivity rate of different crops to select one for planting	3 1.5%	6 3%	46 23.2%	76 38.4%	67 33.8%	4	0.91	143 72.2%	9 4.5%
Wish to produce paddy in next season	2 1%	1 0.5%	11 5.6%	59 29.8%	125 63.1%	4.54	0.72	184 92.9%	3 1.5%

*Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = No Comment, 4 = Agree, 5 = Strongly Agree

Source: Primary Data from Survey 2009

Table 12: Changes in Paddy Planting Area in IADA, West Selangor

Year	Paddy Planting Area (In Hectares)	Changing Rate of Paddy Planting Area
2005	18490	
2006	18399	-0.49%
2007	18355	-0.24%
2008	18301	-0.29%

Source: IADA 2009

POLICY RECOMMENDATION AND CONCLUSIONS

As climate change is a continuous and long term process, its effects and solutions are similarly time and effort consuming process. Most of the warming during the next 30 years will be due to emissions that have already occurred. Over the longer term, the degree and pace of warming mainly depend on current and near future emissions (Stern 2007). To adopt with climate change, conventionally, mitigation has received more attention than adaptation, both from a scientific and policy perspective. Mitigation is the main way to prevent future impacts of climate change, and it will reduce the cost of adaptation. So, any delay in mitigation strategy to reduce emissions will increase the need and cost of adaptation, and increase the risk of global climate change. On the other hand, though adaptation is not a substitute of mitigation, there are arguments for adaptation to consider as a response measure. Mitigation actions never stop a certain degree of climate change due to historical emissions and the inertia of the climate system (IPCC 2001b). Moreover, mitigation effects may take several decades to manifest, where most adaptation activities take immediate effect. Adaptation reduces risks associated with current climate variability as well as addressing the risks associated with future climate changes, where mitigation only focuses on future risks. The measures of adaptation can be applied to a local scale or root level with the involvement of large number of stakeholders, where mitigation works in the decision making level. In the current world, climate factors are exogenous variables that are immitigable in a quick manner and as a consequence adaptation is the most appropriate way to cope the system properly. It is therefore important to balance between measures against the causes of climate change and measures to cope with its adverse effects (Stern 2007; Pielke et al. 2007).

In recent years, adaptation has gained prominence as an essential response measure, especially for vulnerable countries due to the fact that some impacts are now unavoidable in the short to medium term. Mitigation is necessary but adapting to future risk is more important. Immediate and long term actions are essential for various actors including government, development partners, research organizations, and community organizations. In fact, adaptation is too broad to attribute its costs clearly, because it needs to be undertaken at many levels, including at the household and community level, and many of these initiatives are self-funded (Stern 2007). Options for agricultural adaptation can be grouped as technological developments, government programs, farm production practices, and farm financial management (Smit and Skinner 2002). So, it has been suggested to prepare a planned and proactive adaptation strategy to secure sound functioning of the economic, social and environmental system. For the case of this study, however, relevant and specific policy recommendations have been proposed below for appropriate stakeholders for better copping up with the impacts of climate changes in the IADA area of Northwest Selangor, Malaysia. Depending on the degree to which current climate change impacts in the above area are similar to those in other IADA areas, states, regions, and countries the following policy recommendations will have wider applicability.

Government as the policy and law making authority has to play most influential role to ensure climatic mitigation and adaptation at all levels. It is the main responsibility of government to give enough supports in order to enable farmers to adapt to different climatic situations and to make them self sufficient rather than subsidy dependent. Appropriate authorities also need to carefully define government's subsidy supports and incentive programmes to influence farm-level production, practices, and financial management. Hence, agricultural policies and investments need to be more strategic. But the government needs to define and ensure the compensation, minimum income protection, and insurance facility for the affected groups – individual farmer or farm. In the planning processes, policy makers need to account the barriers of adaptation including ecological, financial, institutional, and technological barriers, as well as information and cognitive hurdles. Other few important issues need to be focused, such as stakeholders may not sufficiently inform about the needs and possible strategies of climate change (Eisenack and Kropp 2006; Eisenack, Tekken and Kropp 2007), farm level faces uncertain future and hinder the development process causes to obstacle for implementation of adaptations policy (Behringer et al. 2000; Brown et al. 2007), and the policy deals with different conflicting interest groups. To avoid the negative impacts of climate changes on agriculture and to control pollutions and emissions in the sector, however, proper mitigation policies are urgently required for Malaysia. Further, Malaysian agriculture sector also needs to include mitigation policies due to the emission of commercial farming.

The issues of mitigation and adaptation to climate change concern all sectors as well as all levels of political, administrative, economic and everyday life. To better cope up, cooperation is necessary across countries, sectors and administrative levels.

Relevant actors are needed to be aware of the benefits of cooperation to gain long-term benefits instead of focusing only on short-term and individual interest. The production practices of farm and the knowledge of individual farmer also need to be updated with the changes of climate factors. The agricultural farmers should understand the crop rotation, crop portfolio, and crop substitutions. They should also take all precautions and be aware about the uncertainty of low rainfall and heavy rainfall. The financial management of agricultural farms must be efficient and the farmers must secure for minimum two cropping seasons so that if crops damage in one season they will have the seeds for next season. This will help them bear the cost of another crop production and survive financially up to the time when new crops are collected. But this will require the farmers take initiative for crop sharing, forward rating, hedging, and insurance etc.

On the basis of several requirements of farmers, however, the IADA authorities in Northwest Selangor also need to engage different new groups of stakeholders to ensure necessary facilities for the farmers. They also need to engage financial institutions more inclusively in order to provide supports of loan, insurance, saving schemes, hedging or future option, and so on to the agricultural farmers. Technological adaptation to climate change is also important to deal with the climatic problems in the long run. It is apparent that development of technology is a boundless area, but it is possible in several ways. The highest efficient method of technological advancement is expected to be able to solve the problem. Until gaining such level of technological advancement, there should be some alternative options which are expected to help the agricultural farmers in their effort to adapt to climate changes in the following ways:

- *To solve the problem:* controlling the pattern of rainfall, sunshine, and moisture level.
- *To improve shielding resources:* protecting crops from excessive rainfall or sunshine and solving water login problems.
- *To develop defensive approach:* development of verities of crops, development of rainfall and temperature tolerant plants, and finding alternative crops and hybrids.
- *To find alternative approach:* changing crop cycle and reducing the timing of crop cycle.
- *To provide information:* providing weather forecast and early warning system and ensuring delivery of proper information at the farm level.

The impacts of climate change on agricultural sustainability vary from country to country, region to region and time to time. The yield and productivity of agricultural crops in Malaysia are proven to have been heavily influenced by climatic variations. Malaysia is the 26th largest greenhouse gas emitter which causes the expected rise of temperature by 0.3^{o}C to 4.5^{o}C, and rise in sea level is expected to be about 95cm over a hundred years. The changes in the country's rainfall fluctuate heavily from -30% to +30%. This change reduces crop yield and is prone to drought in many areas so that cultivation of some crops such as rubber, oil palm and cocoa becomes unfeasible. Current crop productivity is also affected by the climatic variations throughout the country as the actual

farm yields of rice in Malaysia vary from 3-5 tons per hectare while the potential yield is 7.2 tons per hectare. The projection of climate change and its impacts on productivity and farmers' profitability are thus considered as very alarming.

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ORAL PRESENTATION

POTENTIAL OF CATTLE INTEGRATION IN OIL PALM PLANTATION FOR SUSTAINABLE PALM OIL-BEEF FARMING

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ABSTRACT
Integration of cattle in oil palm plantation system has potential in enhancing the Beef cattle production. During the year from 1964 to 2009 oil palm cultivation expanded from 0.6 to 4.69 million hectares and out of these 2.2 million hectares of plantation area is considered suitable for integrated cattle-oil palm farming. Based on the stocking rate of 2 steers per hectare of oil palm plantation it is estimated that about 4.4 millions beef cattle may be raised in present oil palm industry. In 2006 beef production in Malaysia was 22.11% and projected to achieve 24.4% in 2010 by the National Agricultural Policy (1998-2010). Under the present oil palm plantation the industry can contribute significantly to become self reliance in beef production and thus fulfilling the national target. The world consumption of red meat was increased from 7.8 to 8.5 kgs during the year from 1995 to 2005 which may have affected demand and supply of red meat in the world market. The paper discussed the potential of beef cattle integration in oil palm plantation for increasing beef cattle farming and become self sufficiency in red meat production, and enhancing economy stability in the farm. Additionally, data on agro-ecosystem, soil stability and biology of palm oil-cattle farming are analyzed, compared and potential of the system is identified.

PALM OIL INDUSTRY AND INTEGRATION SYSTEM

The oil palm industry in Malaysia has expanded rapidly from 60,000 ha in 1964 to 4.48 million hectares in 2007 (MPOB, 2008). The world's palm oil production was 36.85 million metric tones (USDA Report, 2007) and constitutes the main agriculture commodity in Malaysia. It has been the most significant agriculture sector that generates around 30% of the Malaysian economy. Both Malaysia and Indonesia are the two leading palm oil producers in the world with an estimated planted area of 4.48 and 6.07 million hectares, respectively. (USDA Report, 2007). Therefore the oil palm plantation areas have vast potential for the integration of livestock, especially beef for increasing domestic beef production and reducing the frozen meat import. Furthermore, the integration of crop-livestock will produce value added products in palm oil industry, create biodiversity in the plantation areas and will predispose the commodity to biological and economic risk

The year 2000 has witnessed the most difficult and challenging year for the industry when surplus stock had caused the commodity price spiraling down below production cost. Further speculation and the environmental issues of global warming have serious negative impact to the industry for its sustainability. Several measures and initiatives have been taken by Malaysian government to stabilize the situation through Malaysian

Palm Oil Board, Malaysian Palm Oil Council and the plantation sector. Among others is the replanting directive to lower down the stock and to diversify its utilization such as bio-fuel. Alternative approaches are required to minimize the risk of plantation as mono crop that also simultaneously maximize the utilization of plantation areas and maintain agroecology. The cattle integration in oil palm is one of the best options for increasing farm income through quality meat production. The paper evaluates the potential of cattle integration in oil palm plantation for beef production, economic benefits and the environments in oil palm industry.

BEEF SUPPLY IN MALAYSIA

The increasing world population has affected food self sufficiency level including red meat. Figure 1 below shows the world's per capita consumption of beef from 7.8 to 8.5kg during the year 1960 to 2005(USDA, 2007)

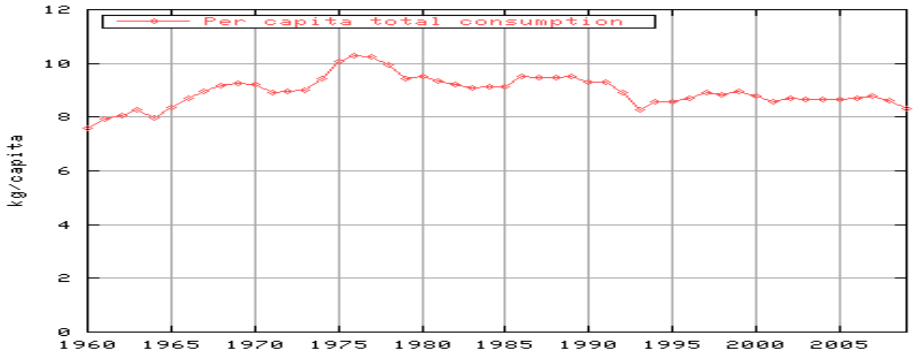

Figure 1: Per capita total consumption of beef

Source: USDA (2007)

Similarly, per capita consumption of beef in Malaysia has increased from 4.3kg in 1995 to 6.7kg in 2005, and projected to further increase to 8.4kg by 2010 (Table 1).

Table 1: Demand and projected and self-sufficiency of beef in Malaysia (1995 – 2010)

	1995	2000	2005	2010	Average annual growth rates (%)			
					1995-2000	2000-2005	2005-2010	1995-2010
Projected total demand ('000 tonnes)	88	122.5	172.3	240	6.8	7.1	6.9	6.9
Per capita consumption (kg)	4.3	5.3	6.7	8.4	4.3	4.8	4.6	4.6
Self-sufficiency level (%)	19.2	20.8	22.5	24.4	1.6	1.6	1.6	1.6
Forecast production ('000 tones)	16.9	20.3	23.9	28	3.7	3.3	3.2	3.4

Source: Department of Veterinary Services Statistic (2008)

Based on the Table 2 the population of cattle in Malaysia, although slightly increased from year 2004 to 2009, is not sufficient to meet local demand for meat. Even though there is a trend for improvement of production from 19.2% to 22.5% during the year 1995 to 2005, importation of beef into Malaysia from Brazil, Australia, India, New Zealand, Thailand and China is also simultaneously increased from 85,277mt to 102,304mt in 2007 (Department of Veterinary Services, 2008).

Table 2: Cattle population in Malaysia (Heads)

Year	2004	2005	2006	2007	2008	2009

Total	787,384	781,316	806,057	863,293	871,892	890,404

Source: Ministry of Agriculture (2009)

POTENTIAL RUMINANT INDUSTRY IN SOUTHEAST ASIA

Large ruminants particularly cattle and buffalo are essential livestock and historically considered as essential component in agricultural farming in South East Asia. They are reared for draught power for crop cultivation, means of transportation, source of meat and milk and maintaining livelihood of the farmers. Increase the demand of meat necessities increase in livestock population together with allocation of land for forage cultivation to meet increased demand of forage for sustaining productivity. Remenyi and Mc William (1986) suggested the naturally grown forage and area under crop plantation are the potential sources for doubling of forage supply for the livestock,. The presence of range of perennial tree crops in many countries of South East Asia provides a common platform for development of integrated crop-livestock production systems. Production system involves integration with perennial tree crops like oil palm, coconut, rubber, and fruit trees and the use of available agro-industry by-product in livestock feeding.

IMPACT OF CATTLE INTEGRATION IN THE OIL PALM PLANTATION ON CROPS AND ENVIRONMENT

The integration of cattle in oil palm plantation is a form of mixed farming where the combinations of the two commodities can be synergized in order to optimally utilize the same piece of land. The two commodities, when properly integrated can contribute towards sustainable means of food production from plant and animal. There are 60 to 70 species of undergrowth herbaceous plants under oil palm plantation consists of planted leguminous crop, naturally occurring grasses, broad leaves and ferns. These are considered as weeds that need to be controlled periodically either by use of chemical spray or cutting manually. These can be potential source of feeds for livestock due to higher biomass yield, palatability and nutritive values for cattle. Under appropriate conditions and systematic management, cattle can be effectively used for control of undergrowth, considered a method of biologically control mechanism of weeds. The system allows the establishment of a harmonious relationship between cattle, undergrowth and oil palm for sustainable farming. The system makes less dependence on costly herbicides, reduce environment pollution and cost of labour. So called ‘nuisance’ of grazing cattle in causing damage to drainage system, oil palm nurseries, chewing fronds of immature palm and fruit bunches can make oil palm plantation biologically sustainable.

Adoption and implementation of appropriate integrated system is required to reduce operational cost such as weeds control, herbicides and extra labour. Reduction in herbicides use alone can significantly reduce operational cost and environment pollution (Azid, 2004). In Malaysia, 3.92 million hectares of the oil palm plantation area are suitable for integration (MPOB, 2009). Samsudin (2002) and Harun (2003), cited by Azid (2004) reported that reduction of use of herbicides by implementing the integrated system the estates managed to save between 30 to 60% of the maintenance cost. Rosli (2000) suggested that the systems effectively improve productivity per unit area of land and contribute positively to local beef production. The studies on soil compaction by using the ‘Proving Ring Penetrometer’ showed no significant difference on soil compaction between the grazing and non grazing area (Yusof and Suboh 1998). In addition grazing of cattle improve soil water storage capacity by biological aeration and increase of organic matter in soil (Lourival Vilrla et al 2003.)Through implementation of

cattle integration also will improve the soil fertility where is the cattle dung can contribute better environment for worms activity which could lead to change the structure of the soil and so indirectly resulting in improved the soil (Abdul Hamid 2008).

An example of the benefit of cattle integration is shown in Table 3. In Kertau Estate usage herbicide of the glyphosate isopropylamine as herbicide was decreased after cattle integration Use of Warfarin for rat control was also decreased due to destruction of their host which resulted minimal damage of fresh fruit bunches by rats. Samsuddin (2000) also observed similar trend in decrease of rat population by integration of cattle in the oil palm plantation.

Table 3: Use of chemicals in LKPP Kertau Estate from 1998 to 2002.

Types of chemical	Active ingredient	1998	1999	2000	2001	2002
Gramoxone (liter)	Paraguat dichloride 25.3%	270	230	180	70	60
Ecomax (liter)	Glyphosate isopropylamine	4222	3650	4052	2152	1315
Ebor baits (kg/box)	Warfarin	400	300	280	30	20

Source: SLLKPP (2003)

TYPES OF RUMINANTS AND THEIR ADVANTAGES IN OIL PALM PLANTATION

There are many benefits were postulated from crop-animal-soil interaction (Devandra and Thomas, 2002). The following interactions are common, almost all of which result in tangible benefit:

i. Beneficial effect of shade and available feeds to livestock.
ii. Draught animal power for land preparations and crop yield.
iii. Beneficial effect of dung and urine on soil fertility and crop growth.
iv. Better utilization of crop residue and tree by product for livestock.
v. Use of under growth vegetation, control of weed, better crops management and growth.
vi. Type of animal production systems (extensive, systems combining arable cropping, and system integrated with tree cropping.), increase income and environment integrity.

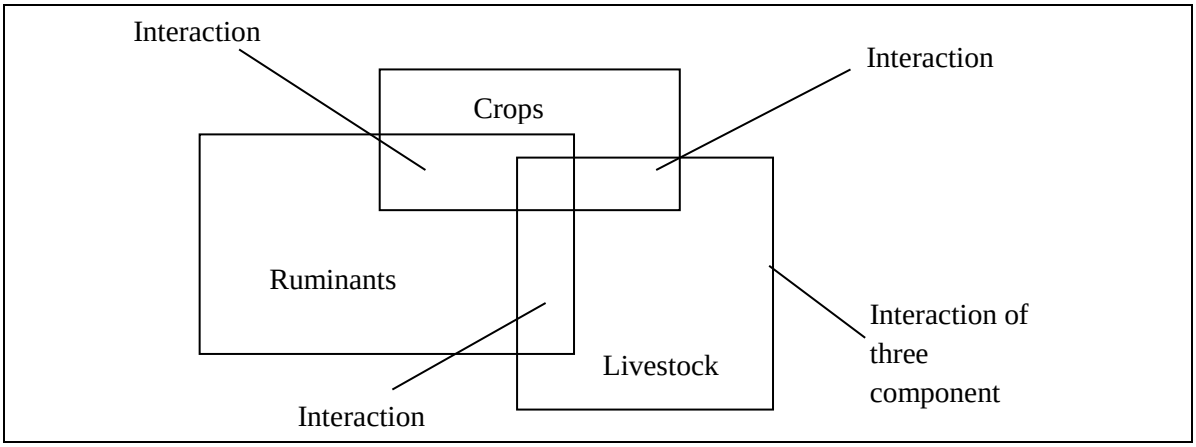

Figure 2: Illustration on concept of crop-livestock integration

Source: Rosli (1998)

The interactions can be positive or negative depending on types of livestock and trees, age of trees and management system. Cattle are well suit to integration with tree crops such as coconut and oil palm. However sheep, cattle and buffaloes are not suitable with rubbers as they cause damage to tree bark and latex collection cups.

FORAGE SUPPLY IN OIL PALM PLANTATION

Under oil palm plantation, light penetration facilitates growth of under storey vegetation of more than 50 species (Wong and Chin, 1980). The common predominant species of vegetation are *Ottochlora nodosa*, *Axonopus compresses*, *Mikania Micranta* and *Asystapia intrusa.* Their nutrient contents are shown in Table 3 below.

Table 3: Composition of naturally grown forages in Malaysia

Location	Species	Nutrient Contain	
		Crude protein	Crude fiber
Rubber plantation	Weed	11.4	33.1
	Fern	13.4	27.2
Oil palm	P. conjugatum	15.8	-
	A. compressus	13.0	-
	O. nodosa	16.8	-
	I. cylindrical	8.7	-
	N. biserrata	18.2	-
Open shade	A. compressus	7.5	30.0
	P. conjugatum (4 weeks)	13.6	26.3
	Guinea (4 weeks)	12.4	33.8
	I. cylindrical	11.7	32.0
	Asystasia intrusa	15.8	35.8
	P. phaseoloides	22.8	33.5
	C. pubescens	25.4	35.7

Source: Mustapa (1983) and Chin (1991)

COST BENEFIT OF WEED CONTROL AND LABOUR

The cattle integration in the oil palm plantation has shown to reduce the cost of weeding and labor. But weeding is still carried out for brushes such as *Clidemia hirta Melastoma malabatricum*, *Pennisetum* grass species as these are not grazed by the cattle. Chong (2001) observed significant (60%) reduction in labour requirement in de-weeding with the introduction of cattle. The same author also observed that labour requirement for de-weeding reduced from 6 to 2 on a 400 ha oil palm plantation area by introduction of 144 head of cattle, reduction of weeding cost varies according to the stages of integration. In the first two years the saving can be as much as 30%, and increased further to more than 70% when the number of cattle is at optimum with palatable undergrowth (Harun, 2003). Samsudin (2002) reported significant saving on labour requirement and weeding cost. The weeding area coverage per labour tremendously increased by almost 600% from 137ha to 956ha, which led to 52.85% saving from cost of weeding (Table 4 and 5). Similar trend of benefit on weeding was also observed in Mensuli Estate (Table 6).

Table 4: Benefit of cattle integration on labour cost in a 1912 ha oil palm plantation area

Parameter	Manual	Grazing	Difference
Total mandays	14	2	-12
Cost/ manday	RM 15.00	RM 30.00	- 15
No. of sprays (*Imperata*, circle spraying and woodies)	1.5	1.5	
Labour: land(ha) ratio per year	1:137	1:956	819

Source: Samsuddin (2002)

Table 5: Comparative economic advantages of cattle integration in plantation project

Types of work	Before cattle integration			After cattle integration			Difference	Saving (%)
	Total expenditure in 1991-95 (RM)	Area (ha)	Cost/ ha	Total expenditure in 1996-02 (RM)	Area (ha)	Cost/ ha		
Weeding	771, 398	9, 537	80.89	512, 420	13, 381	38.29	-42.60	52.66
	168501			109386			-9.50	53.76
Lallang		953	17.67		1338	8.17		
	939900	7		621806	1		-52.08	52.85
Total						46.47		
		953 7	98.55		1338 1			

Source: Samsuddin (2002)

Table 6: Weeding cost at Mensuli Estate

	2001	2002	2003	2004
Weeding cost (RM/ha/year)	79.40	63.30	60.80	63.50

Source: Azid (2008)

It is apparent from the above examples that cattle graze on these properties contributes positively in weed control. Circle and spot spray of herbicides normally cover about 25 per cent of planted area, whereas the weeds under the palm tree can be cleared naturally by rearing of cattle, sheep, goats, or deer (Anon, 2006). Combined with biological pest control, use of herbicides and pesticides in oil palm estate can be reduced.

CATTLE GROWTH PERFORMANCE

Integration of cattle in oil palm plantation has shown to increase in their numbers as evident in Tables 7 and 8. Kertau and Sungai Pejing Estates farm was started March 1999 with 180 heads and until march 2003 the cattle population increased to 378 heads. The increasing was more than 110% within 4 years of the project (Table 7).

Table 7: Cattle population growth in Kertau and Pejing Estate during 1999 to 2003

Estate	1999	2000	2001	2002	2003
Kertau	80	95	121	152	173

Pejing	100	119	142	181	205
Total	180	214	263	333	378
% increase	-	19%	47%	85%	110%

Source: SLLKPP Data (2003)

In two pilot projects belonged to two experimental estates indicated the positive growth of cattle where cattle population increased by 65 per cent within two years with no significant negative impact on overall estate management (Table 8).

Table 8: Cattle Population Growth in Mensuli and Sandau Estates

Estates	**July, 2002**		**July, 2003**	**December, 2003**	**December, 2004**
Mensuli	197		-	348	407
Sandau	-		224	268	287
Total		421		616	694
% increase				46	65

Source: Azid (2002)

FEASIBILITY OF CATTLE INTEGRATION IN SAWIT KINABALU FARM SDN BHD

In a feasibility study, Azid (2004) suggested 20 thousand heads of cattle for integration in 36,028 ha of oil palm plantation. The integration model was then adapted to rear three thousand heads of cows and 97 heads of stud bulls brought in from Australia in 2005 and 2006. The study revealed that the cattle were adapted well in local environment and showed positive growth in numbers (Figure 3). As of September 2009, 8,288 heads of cattle were integrated in oil palm and distributed in 14 estates across the region of Lahad Datu (59%), Tawau (30%) and Sandakan (11%). From Table 10 it is evident that depending on forage availability under the palm and on-going replanting program at the respective estates, the total grazing area in those places increased to 22,224 ha and stocking rate varies between 1.9 and 3.7 per ha.

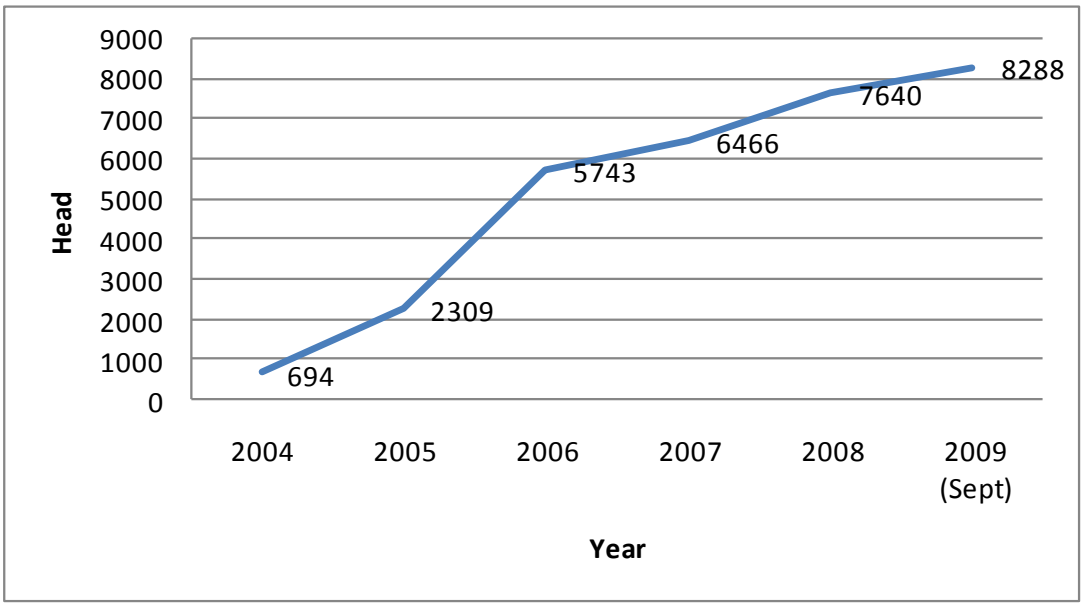

Figure 3: Trend of cattle population growth in Sawit Kinabalu Sdn. Bhd
Source: Sawit Kinabalu Farm Products Sdn. Bhd Data (2009)

Table 9: Cattle distribution and grazing area under oil palm estates.

Region	Estate	Grazing area (ha)	Cattle Population (head)	Stocking rate (ha/head)
Tawau	Sg Balung	1,689	566	3.0
	Madai	2,394	716	3.3
	Sg Kawa	1,077	405	2.7
	Bongalio	2,549	766	3.3
Lahad Datu	Matamba	0	0	0
	Sebrang	1,639	650	2.5
	Mensuli	1,370	373	3.7
	Sandau	2,005	715	2.8
	Boonrich	1,590	661	2.4
	Bagahak 1	1,370	719	1.9
	Bagahak 2	1,919	1027	1.9
	Bagahak 3	2,360	761	3.1
Sandakan	Gomantong/Green	974	379	2.6
	Menanggol	1,288	550	2.3
Total		22,224	8,288	2.68

Source: Azid (2009)

STRATEGY OF INTEGRATION

Strategy of introduction of cattle into the plantation estate need careful planning by studying its existing operation, harvesting pattern, manuring, and overall maintenance operation. These findings are useful for determining the suitability of the estate in terms of individual estate manager's understanding and commitment, types of vegetation and availability, herd size and appropriate time of integration of cattle (Azid, 2007). "Dry-weight-rank' method described by Aminah and Chee (1999) as cited by Azid (2004) can be a very useful estimation tool to determine the population size. Sufficient allocation of fund is required for procurement of livestock and building basic infrastructure (Rosli, 2000). The best time for introduction of cattle is during the minimum operational activity in farm.

Rosli (2000) and Azid (2004) concluded that commitment of estate management is the prerequisite for successful cattle-oil palm integration. Systematic planning, implementation and management system approach can make sustainable cattle-oil palm integration (Ayob,M.A and.Hj Kabul, M.A 2009) The strong commitment and understanding of each of the component of integration along with supportive approache towards implementation, and potential operational matters need to be constructively handled and adjusted to accommodate the 'additional' activity within the farm. The SKSB top management team is the driving force towards the successful adoption of the model as it provides confidence in doing core business of producing palm oil without any compromise with operational activities (Azid, 2007).

It is important that the cattle are acclimatized with new environment and feeds, especially exotic breed to perform well. The cattle should be exposed gradually to new feedstuff comprising of naturally grown vegetation under oil palm and managed in rotational grazing system using electrical fence (Aminah and Chee,1999). Strategic implementation of these factors during initial stress period of integration to people and animals would contribute positively to cattle performance.

GRAZING MANAGEMENT

The application of strategic rotational grazing management through the use of mobile electrical fencing is a dynamic process in which cattle grazing will be adjusted to suit the operational requirement of the estate. Movement of cattle within the estate will be synchronized with common agronomic practices such as harvesting, fertilizer application, weeding and other important activities. Ideally, grazing cattle should be ahead of the other estate operational activities. Occasionally management of grazing cattle and estate activity may need to be accomplished at the same time. The strategic rotational grazing management will require constant adjustment according to prevailing estate operation to minimize work load and to reap the optimum benefit from grazing cattle as 'biological lawn-mower' (Azid, 2007). This explains the different level of saving in weeding cost (15 to 40%) among the participating estates.

The most significant highlight of the model of integration adopted by SKSB is the fact that the primary operation of fresh fruit production is not affected by the introduction of cattle. According to the observation of Kok (2008), cited by Azid (2008) the presence of cattle in the participating estates was never been identified as important factor affecting yield as compared to other important factors such as rainfall, nutritional status and operational efficiency. He further noted that the notion of soil compaction due to grazing cattle was

unfounded as he observed that grass regeneration was unaffected and luxuriant after each grazing period. Similar observations were also reported by Rosli (2000) and Samsudin (2002). Further research is required to validate and quantify the relationship.

CONCLUSION

Integration of cattle in the oil palm plantation can potentially contribute value added products such as beef by utilizing naturally grown herbages and oil palm by-products, maintain agro-ecological for plantation by incorporating manure and control of weeds in farm. The oil palm plantation can be the source of beef cattle farming and make sustainable beef supply in the country. Further research is required on type of plantation and carrying capacity of cattle, feeding systems using under growth herbages, disease control and contribution in plantation to make sustainable oil plam-cattle farming.

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DEVELOPMENT FUMONISIN DETECTION METHOD OF INDONESIAN CORN-BASED FOOD PRODUCTS

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Indonesia has a suitable climate for mold growth and habitat, especially due to its humidity and temperature. For this reason, contamination of mycotoxin become a serious problem for food safety in Indonesia. The climate change and global warming effects are potential to blow up mycotoxin production, hence attention on mycotoxin risk on foods must be increased. Protocol of fumonisin detection, especially for corn-based food products has been developed by Research Center for Drug and Food (RCDF) - National Agency for Drug and Food Control (NADFC).

There were two steps in this research: the first step was HPLC validation method and the second step was fumonisin detection in 7 kinds of corn-based food products. Validation method consisted of linearity test, precision test, and recovery test. Fumonisin detection consisted of sample preparation, sample extraction, sample dilution, clean up with fumonisin immunoaffinity column and analysis using HPLC with fluorescence detector. The linearity test indicated that fumonisin detection using HPLC acquired linear regression equation for fumonisin B1 (FB1), Y=82775x-69801, r = 0.99 and fumonisin B2 (FB2), Y= 22281x-45370, r = 0.99. Relative Standard Deviation (RSD) in precision test for FB1 and FB2 were 0.00002 and 0.00001 while recovery test for FB1 and FB2 were 80.04 and 110.11% respectively. All corn-based food products contaminated by fumonisin B1 in a range of 0.1 – 0.8 ppm. Based on fumonisin standard regulation listed in Indonesian National Standard (SNI 7385 : 2009), that maximum permissible level of fumonisin on corn-based food product was 2 ppm, it can be concluded that all the analyzed products were safe to be consumed.

Keywords: fumonisin, HPLC, Immunoaffinity column, corn-based food product

INTRODUCTION

Tropical climate in Indonesia resulted in foodstuffs susceptible to the mold growth and produce mycotoxins. Mycotoxins are toxic organic compounds derived as secondary metabolites from moulds. Mycotoxins which were regulated in National Standards Indonesia (SNI) concist of deoxynivalenol, fumonisin, aflatoxins, okratoksin A and patulin (SNI 7385, 2009). Fumonisis are mycotoxins produced mainly by the *Fusarium moniliforme (F.verticilioides*), *F.proliferatum*, and several other Fusarium species can grow on agricultural commodities in the field or during storage. These mycotoxins have been found worldwide, primarily in corn. More than ten types of fumonisins have been isolated and characterized. Fumonisin B1 (FB1), fumonisin B2 (FB2), fumonisin B3 (FB3) are the major fumonisins produced. The most prevalent of these mycotoxins in contaminated corn is FB1, which is believed to be the most toxic (Thiel et al., 1992, Musser and Plattner, 1997).

F.verticilioides and *F.proliferatum* are commonly found in corn and corn worldwide products. These fungi have a high level of proliferation in the tropics and subtropics (Bakan et al.,2002). Nevertheless, the amount of the contents of this species on corn has no correlation to the level of fumonisin. Corn with a high number of Fusarium, not necessarily contained fumonisin at a high level. Otherwise the content of

fumonisins have also been detected in samples of good appearance corn, although moldy corn tend to contain the fumonisins in the highest number. The production of mycotoxins in corn under the influence of the factors that cause stress in plants, including damage caused by insects, the amount of water in the soil, high temperature of enviroment and nutritional deficiencies in soil. (Abbas et al., 2002).

Fumonisin analysis selected in this study because this mycotoxin has been regulated in Indonesia by the Indonesian National Standard (SNI 7385: 2009). SNI 7385: 2009 is about permission maximum level of mycotoxins in food. The maximum permissible level of fumonisin on raw materials were 2 ppm and fumonisin on ready to eat of processed corn products was 1 ppm.

OBJECTIVE

The aim of the research was to develop fumonisin detection method using HPLC and to analyzed the fumonisin content of of Indonesian corn-based food products.

MATERIAL AND METHODS

There were two steps in this research: the first step was HPLC validation method and the second step was fumonisin detection of 7 kinds of corn-based food products.

I. Analysis Fumonisin on Food.

The method of Fumonisin analysis consisted of sample preparation, sample extraction, sample dilution, clean up with fumonisin immunoaffinity column and analysis using HPLC with fluorescence detector. Selection of 7 kinds of corn-based food products based on frequency of consumption of Indonesian and ease of getting from traditional markets. They were corn for popcorn from 3 different traditional markets, fresh corn, bulk corn, dried corn and cornstarch.

a. Material

Fumonisin standard B1, B2 50 µg/mL (Sigma aldrich), FumoniTest Immunoaffinity Column (VICAM), sodium dinitrogenphosphate (NaH_2PO_4) (Merck), methanol p.a (Merck), methanol HPLC grade (Merck), phosphorous acid, Phosphate Buffer Saline 1X (VICAM), Developer A and B mixture (derivatization reagen VICAM), acetonitrile (Merck), sodium chloride (VICAM), aquades and nitrogen gas and corn-based food sample from local market.

b. Preparation of fumonisin working standard

Concentration of FB1 and FB2 standard was 50 µg/mL each. Fumonisin working standard in range concentration from 5.0, 2.5, 1.0, 0.5, 0.25 (ppm) in acetonitrile : water (50 : 50 v/v) were prepared.

c. Preparation of Sample

Prepartion of sample consisted of 4 steps. First step was sample extraction, second step was sample dilution, third step was clean up and fourth step was sample derivatization.

- Sample extraction

50 g ground sample and 5 g sodium chloride were out into a blender jar. 100 ml methanol : water (80 : 20 v/v) was added into blender jar. The mixture was blended at high speed for 5 minutes. After filterring, the filtrate was collected in a clean vessel.

Sample dilution

10 ml filtered extract was transferred into clean vessel and diluted with 40 mL PBS. After filterring by microfibre filter, the extract was collected in a clean vessel.

- Clean up

10 mL filtered extract was pipetted and passed completely through FumoniTest™affinity column at a rate of about 1-2 drops/second until air comes through column. 10 mL of PBS was passed through the column at a rate of about 1-2 drops/second until air comes through the column. Glass cuvette was placed under FumoniTest™affinity column and 1.5 mL HPLC grade methanol was added

into glass syringe barrel. FumoniTest™affinity column was eluted at a rate of 1 drop/second or slower (gravity flow rate is acceptable) and all of the sample eluat (1.5 mL) was collected in a glass cuvette. The solvent was evaporated in a speed vaccuum apparatus. Extract was redissolved in 200 µL methanol : purified water (50 : 50, v/v).

- Sample derivatization

25 µL sample was trasferred into dark-srew cap vials. 225 µL developer A and B mixture was added into dark-srew cap vials and vortexed. After 1 minute, 100 µL sample was injected into the HPLC.

d. HPLC condition (VICAM Adopted from AOAC Official Method Analysis, 2005)

Kolom	: reverse phase C18
Mobile phase	: methanol : sodium dinitrogenphosphate (NaH_2PO_4) (77:23 v/v) pH 3.3 with phosphorous acid
Fow rate	: 0.8 mL/min
Fluorescence detector	: excitation 335 nm, emission 440 nm
Retention time	: fumonisin B1 6.0 min, fumonisin B2 12.5 min

II. Validation Method

Validation method consisted of linearity test, precision test, and recovery test.

a. Linearity

According Mulja and Hanwar (2003), data from the linearity requirements for the validation of this method is acceptable if it meets the value of correlation coefficient (r) greater than 0.999 or a coefficient of variation function (Vxo) smaller than 5%.

b. Precision

Assessment of precision of the method of analysis expressed in the Coefficient of Variation (CV). For solution with concentrations less than 0.1%, their precision is good if it has a value of CV ≤ 20% (Anonymous, 2004).

c. Recovery (Accuracy)

Accuracy is a measure of the degree of closeness of the result, with the actual standard sample concentration. Accuracy is expressed as percent recovery (recovery) of the standard sample. The accuracy of results depends on equipment condition that has been calibrated, using the proper reagents and solvents, controlled temperature, skilled analyst and complianced procedure. Accuracy is determined by two methods, the simulation method (recovery-Spiked placebo) or standard addition method (Harmita, 2004).

RESULT AND DISCUSSION

I. Validation method

a. Linearity test

The linearity test indicated that fumonisin detection using HPLC acquired linear regression equation for fumonisin B1 (FB1), Y=82775x-69801, r = 0.99 and fumonisin B2 (FB2), Y= 22281x-45370, r = 0.99.Linear regression equation for fumonisin B1 and B2 were indicated in Figure 1 and 2.

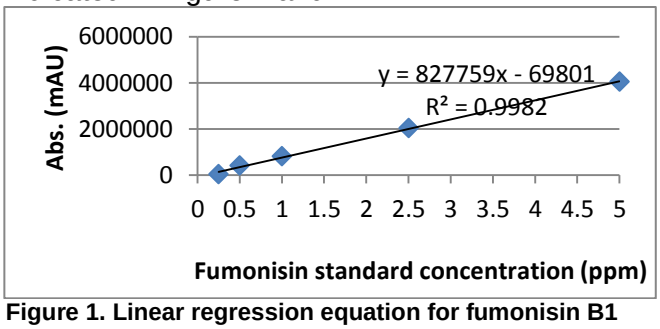

Figure 1. Linear regression equation for fumonisin B1

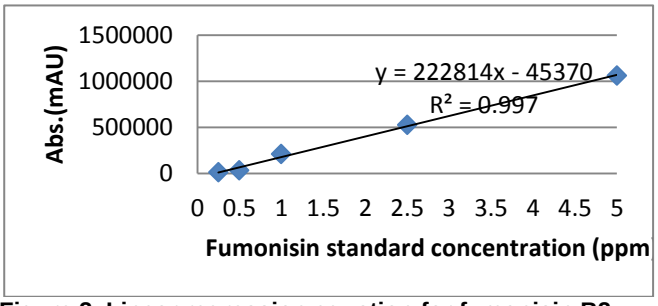

Figure 2. Linear regression equation for fumonisin B2

b. Precision test

Precision is a measure which indicates the level of compatibility between the individual test results. it measured through the dissemination of the results of the average individual, if the procedure is repeatedly applied to the samples drawn from a homogeneous mixture. Precision can be expressed as repeatability or reproducibility and in this study we expressed as repeatability. Repeatability is the precision of the method, if this has been done by the same analyst under the same conditions and within a short period of time. Precision criteria are given if the method provides relative standard deviation (RSD) or coefficient of variation (CV) 0.02 or less (Ibrahim, 2009). Relative Standard Deviation (RSD) in precision test for FB1 and FB2 were 0.00002 and 0.00001. (Table 1).

Table 1. Precision test for FB1 and FB2

B1			B2		
Replication	RT	Area	Replication	RT	Area
1	6.066	2023290	1	12.294	524334
2	6.066	2023291	2	12.294	524334
3	6.066	2023290	3	12.294	524334
4	6.066	2023289	4	12.294	524334
5	6.066	2023290	5	12.294	524334
6	6.066	2023290	6	12.295	524334
7	6.066	2023290	7	12.294	524334
Mean	6.066	2023290	Mean	12.294	524334
SD	0.00113	0.57735	SD	0.00038	0.00001
RSD	0.014792	0.00002	RSD	0.003074	0.00001

c. Recovery test (Accuracy)

The recovery results in this research were between 80.04-102.32 % for Fumonisin B1 and 100.56-110.11 % for Fumonisin B2 (where the standard must 80 – 120%).

II. Analysis Fumonisin on Food.

The Table 2 indicated fumonisin detection in 7 kinds of corn-based food products

Table 2. Corn-based food products contaminated by fumonisin B1

No.	Kinds of corn-based food products	Fumonisin B1 (ppm)	Fumonisin B2 (ppm)
1	Corn for popcorn A	0.1093	-
2	Corn for popcorn B	0.7136	0.2181
3	Corn for popcorn C	0.6830	0.2335
4	Fresh corn	0.7342	-
5	Bulk corn	0.8136	0.4293
6	Dried corn	0.7512	0.3081
7	Cornstarch	0.7912	0.3895

Based on fumonisin standard regulation listed in Indonesian National Standard (SNI 7385: 2009), that maximum permissible level of fumonisin on corn-based food product was 2 ppm, it can be concluded that all the analyzed products were safe to be consumed.

CONCLUSION

As general results, the HPLC method for fumonisins showed good linearity, as well as good precision and accuracy. All corn-based food products contaminated by fumonisin B1 in a range of 0.1 – 0.8 ppm. 5 kinds of corn-based food products contaminated by fumonisin B2 in a range of 0.2 – 0.4 ppm. Based on fumonisin standard regulation listed in Indonesian National Standard (SNI 7385 : 2009), all the test sample contain fumonisin under the permission maximum level.

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SUSTAINABLE LAND USE PLANNING OF RIPARIAN ZONE FOR AGRICULTURE ACTIVITY

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ABSTRACT

Sustainable land use planning is one aspect of sustainable development which determines integrity of ecological aspects of land as well as its socioeconomic characteristics. To do so, at first step the maps of ecological and socioeconomic resources of the Riparian zones of Haffar and Bahmanshir Rivers (RZHB) with an area about 155 square kilometers in south west of Iran were demonstrated. On the second stage digital maps has been prepared by inputting explanatory data in to ArcGIS (version9) software. The land form units were picked out by overlaying digital maps including elevation, direction and slope. Environmental unit's maps were demonstrated by overlapping digital layer maps of soil texture, geology, vegetation canopy, climate, water resource, and wildlife communities on land form unit maps, based on Systematic Analysis named Makhdoum model. The evaluation of our study area indicated that while around 70% of study area has capability for dry farming but because of some parameters like plants density, pH and soil salinity, the actual possibility for this class of land is limited to 40%, and 5% for wet farming. The final result showed some limitation of the ecological capability of RZHB for agriculture activity in most of the area. These limitations should be considered for improvement in land use management.

Key words: Agriculture, geographic information system, land use planning, Riparian zone, systematic analysis,

INTRODUCTION

Due to department of environment of Iran (DOE), quality of human life and natural environment in Iran being degraded in high rates: annually more than two billion tones of the most suitable soil of the watershed is eroded, 1000000 hectares of lands change to desert, and the rate of deforestation is estimated about 360 square meters per second (World Bank, 2004).

Land evaluation as defined by FAO, 1981, is the assessment of land performance for specific uses. It means that while apart of land seems suitable for particular application, practically (even if there is socioeconomic need) impossible to implement because of lack in suitable potential. So before beginning of development it's better to select the most suitable developing site in term of ecological capability, in addition to its socioeconomic ability for any kind of certain use of land. In other word, the lack of proper

information about land capability and rational and irrational use of area bring along more destruction of land resources (Bocco et al., 2001; Prato, 2007).

Sustainable agriculture development and planning requires comprehensive data on land use, water, Climate, economic and human resources available in a given area and synoptic integration and analysis of these resources. Climate change is a issue which has direct affect on agriculture. In addition to the temperature rise, changes in other climatic averages (e.g., rainfall, sunshine) and also more frequent incidence of special events (e.g., frost, deluge, high winds). These will affect the capacity of the land to support different agricultural products and different modes of production (Bishop et al., 2009). In recent years Geographic Information System (GIS) have been widely used as an indispensable tool for analyzing land use and resource management. (Rossiter,1990; Biagi et. all, 2002 and Swanson, 2003). Nowadays using GIS allows combining various ecological and socioeconomic data layers simultaneously, which result in using less time and expense (Saroensong et. all 2006, Bigi et all 2002). This tool enables us to gather very different data types and allows quantitative analysis of different data at the scale of whole region and calculated outputs needed for land uses.

MATERIALS AND METHODS

Riparian zones of Haffar and Bahmanshir Rivers (RZHB) with an area about 155 square kilometers is located in latitude 29º 53´ to 30º 30´north and 48º 10´ to 50º east. This area is located in south west of Iran, southern part of Khuzestan Province expanded from embranchment of Karoon River to Arvand and Bahmanshir River in west , while embracing Abadan , Khoramshahr cities and Minoo Island end to Iran-Iraq border in west and Persian Gulf in south The typical Landscape of study area is totally flat plain with no mountain and average 2.5 meters above sea level. There are no highlands or steep slopes because of sediment deposit by rivers and alluvium made of these sediments. The slope of study area in average is between 2%-10%. The entire study area is located in the arid and semi arid zone of Khuzestan, with long hot summers and short mild winters. The precipitation regime of the area is Mediterranean, occurring during October to April. The average annual precipitation in this area is less than 200 mm. the average precipitation during January, the month with highest average precipitation is 48mm. The average annual temperature varies in the range of 24-26 degree centigrade. The average monthly temperature during June-July the months with highest temperature is around 37-43º C and in January and February, the coldest period of year, this average reaches to 6-12 ºC. Humidity of the area is generally low, particularly during summer months. The average monthly values range from 70% in winter to 30-35% in the summer months. In the whole study area deep alluvial deposits of Quaternary period is main geological feature.

In this research, 13 GIS layers have been used to evaluate the ecological capability of land for agriculture activity, with Systematic method, known as Makhdoum Model (Makhdoum, 2001).

The process of land evaluation is presented in three parts: at first stage collecting information was fulfilled in two ways, by library studying where information resources, libraries, companies, research institutes and ministries were needed for digital information. At first stage all maps were converted from vector form to raster form in ArcGIS software. Then maps of slope, direction and elevation were overlaid in order to produce land form units. At second stage the soil structure, hydrology and flora maps were overlaid on land form unit maps in order to produce environmental units.

In order to identify the areas for each land use form, the encoded stable and unstable resources have been estimated using mathematical equation in ArcGIS. Makhdoum model is linear, multi unknown quantity method to evaluate and recognize the capability of land for different uses based on land potentials. This model would be able to compare the identified and encoded resources with descriptive land use characteristics. In this model 13 parameters related to different factors or related to information of 13 layers were used, while, each information layer were consistent several classes.

RESULTS

With using topographic map of study area in ArcGIS software environment digital elevation map obtained. The elevation factor was used in this study was 4 classes in which first class 0-100 meter was mentioned for our study. The best class of slope was second class from nine class of slope 2-5%.

Considerable parts of the soils in the catchment area and almost all the lands within the study area are to different degrees, affected by salinity. The majority of the lands allocated for irrigation development in Khoramshahr, Abadan and Minoo plains are rather highly saline. Sources of salinity are: particles from parent material (mainly Gachsaran Formation), secondary salinity due to application of low quality irrigation water and evaporation from shallow saline ground water. Inadequate natural drainage capacity associated with low rainfall and high evaporation are other reasons that accelerate the soil salinity process. This is in very close conformity with the ground water status and inadequacy of natural drainage. Almost in all the plains the dominant excess salts of the soils are sodium chloride and sodium sulphate. At the same time adequate calcium sulphate and calcium carbonates are available in the soils.

The typical feature of soils for entire study area are classified as lowland soils with hydromorphic characteristics heavy texture, massive structure, low permeability, poor internal drainage and salt accumulation. In these soils, the sulfate salts are dominant as compared to chloride salts. Moreover, the soil indicates a high content of potash, which is highest at the surface and descends downwards. Based on the available information the structure of soil is including:

- Deep medium to heavy texture (Silty Clay Loam), slight salinity.
- Very deep soils, very heavy texture (Silty Clay), very severe sodic and saline.
- Deep heavy soils (Sandy Clay), sever sodic and saline.

- Deep soils, heavy to very heavy texture (Clay), very severe sodic and saline.

The vegetation mainly comprises are annual and green growth which is visible only for a few months during rainy seasons and because of soil texture and land salinity species are typical of saline areas prevail. Early in summer most of the annul vegetation including grass dries out. The other forms of vegetation are including shrubs and small trees and bushes especially along certain reaches of riverine ecosystem. In general flora of study area were classified in 5 groups: 1- low and medium density of plants including grass and bushes resistant to salinity in uncultivated lands,2- low density of halophytes in uncultivated lands 3- dry farming lands plus low density of plant species resistant to salinity 4- irrigated lands plus low density of saline resistant species 5- date palms and cultivation of summer crops.

According to the exist information most of the fauna species of study area is observable in Minoo Island and marginal part of riverine ecosystem. 20 species of fishes, 2species Amphibians, 2 Reptile species, 32 bird species and 10 mammals species was recognized, between them some like wild boar (Sus scrufa), jackal(Canis aureus), fox(Vulpes vulpes). Squacco heron (Ardeola ralloides), grey heron (Ardea cinerea), buzzard (Buteo buteo) and francolin (Farancolinus francolinus) have more ecological importance. Marsh harrier (Circus aeruginosus) in the IUCN Red book mention as threaten species.

The model we used is as follows:

A4: agriculture class 4

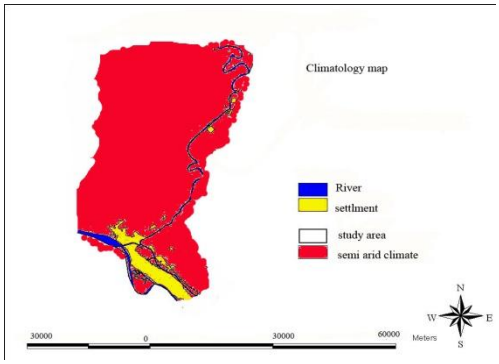
A4=S(1,2,3,4)+A(1,4,5)+pte(3,5,6,10)+pd(1,2,3)+L(4)+cp(2,3,4,5)+ch(2,3,4)+dsm(1,2,3,4)+ Pdr(3,4,5) + H(1,4,5)

A5: Agriculture class 5:

A5=S(1,2,3,4)+A(1,,4,5)+pte(3,5,6,10)+pd(1,2,3,4,5)+L(3,4)+cp(2,3,4,5)+ch(2,3,4)+dsm(1,2,3,4)+ Pdr(4,5) +H(1,4,5)

ct: average temperature as degree centigrade (in 4 classes) .

The overlaid maps were revealed (figures 4 to 11).



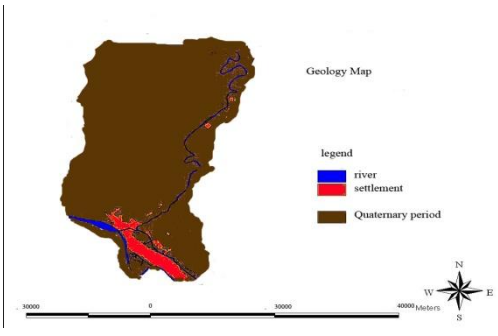
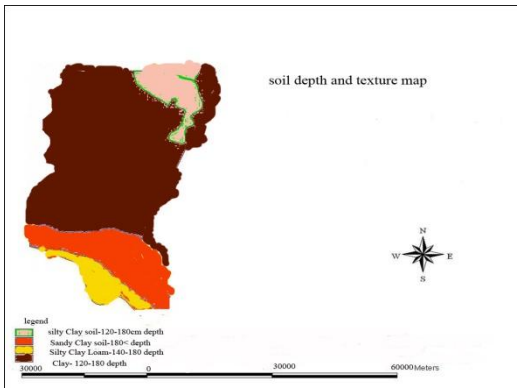


Figure 3: Climatology Map

Figure 4: Geology Map



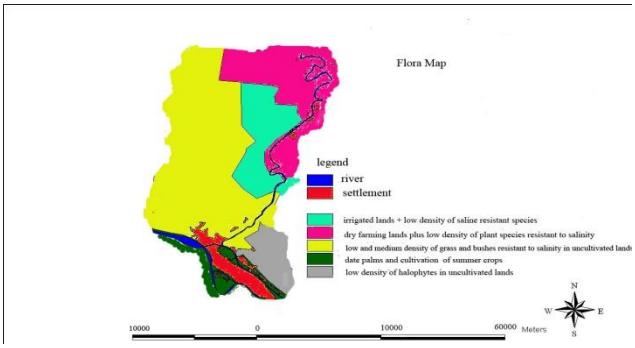
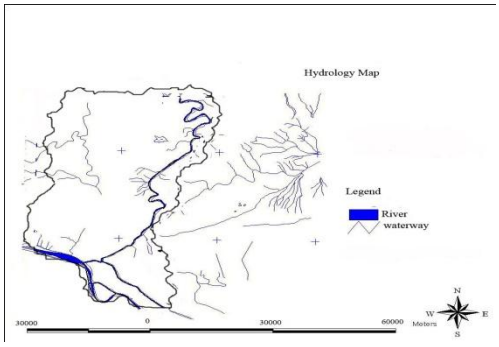


Figure5: soil structure and depth Map

Figure 6: Flora Map



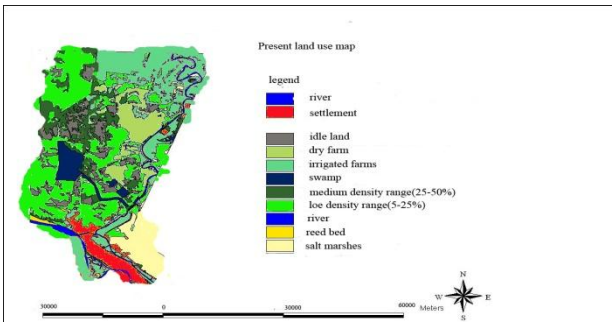
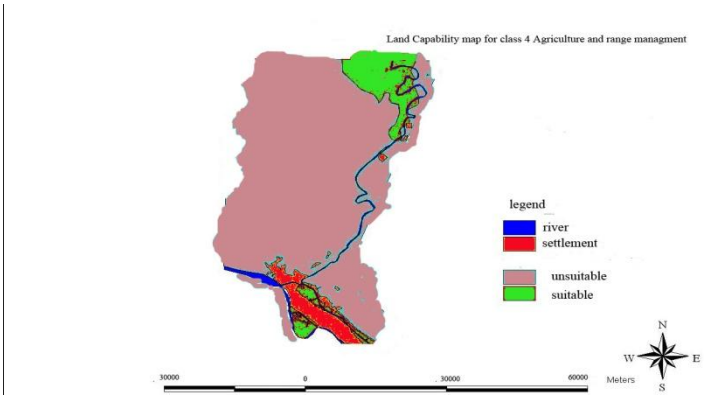


Figure7: Hydrology Map

Figure 8: Present Land Use Map



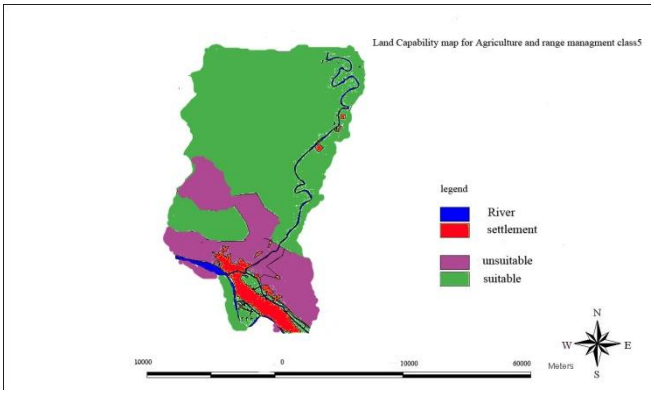


Figure10:Land Capability Map for Agriculture and range management Class 5

Figure9: Land Capability Map for Agriculture and range management, class 4

Finally according to the model and considering information collected from riparian zone of Bahmanshir and Haffar Rivers there are no favorite areas for class's one, two and three dry and wet farming. Also there is no favorite area for class one, two and three

range management. Our result showed that despite some part of the study area have capability for class 3 and 4 range management but because of limitation in parameters such as low density of crops, pH and salinity of soil, the possibility of this activities is such a low that we didn't draw the related map.

According to this model the favorite area for class four, agriculture and range management is just 5% of study area, and the favorite area for class five, agriculture and range management is approximately 70% the study area.

DISCUSSION:

Determination of the appropriate land use showed that RZHB has limitation for agriculture and range management activities. Agriculture plays a small role in the studied area, but according to obtained results, the study area has potential for agriculture activities. Furthermore wet farming areas is limited and basic reason is hot weather and soil condition. As well dry farming in Riparian zone of Haffar and Bahmanshir rivers faces a lot of limitations with accompanies this form of agriculture with a very high risk. This risk is mostly because of low precipitation during menthes April to October, hot climate and soil condition.

The soils of the catchment area and their specification for agricultural uses have certain implications and any kind of management relation to the land development plan must be arranged by considering them. These are:

- Because of soil salinity, high ground water and inadequate natural drainage in most parts of the plains in the study area, subsurface drainage systems have to be installed in all these lands. This would provide a rather fast release of chemical residues from the farms into the river. Application of integrated pest management measures could best help this problem;

- Irrigation development in the study area would inevitably require leaching the excess salts from the soil profile. The salinity of the soils in these plains should be leached out before they are suitable for irrigation and crop production. Sodium chloride and sodium sulphate are easily leachable and would be discharged through the drainage flows.

In other word unless the drainage and irrigation system of study area do not improve we cannot expect to execute these activities.

(1) High accuracy and precious cause to avoid human-inducing errors

(2) High speed of G.I.S-aided method comparing with hand-drown method is cost effective

(3) Capability of transferring attributes tables to spreadsheet software like as Excel cause to the best database management.

(4) High capability of up to date database and maps

Longer term changes in agricultural environments change the range of productive systems. Annual crops can be easily replaced with others year-to-year. If, on the other hand, the environment in 10 years will be (on average) too dry for special kind of product, then that information is required now in the form of land suitability assessment models. Some land uses can adapt by a change in land management practices – for example changes in stock management. In that case a model is required not only of the land and climate conditions but also of the effect of management options on soil conditions and grass growth. Thus, the land manager is informed by a series of models each of which may be quite complex. Land managers need to understand what these changes may be. With this understanding they can better plan their future farm management to be ready and robust in the face of change (Bishop et al., 2009).

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EFFECT OF CLIMATE CHANGE IN POTATO GROWING SEASONS AND HARVEST YEARS ON ACRYLAMIDE FORMATION IN FRENCH FRIES

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The impact of weather conditions during growing and storage, with analytical data for acrylamide and precursor (free amino acids and reducing sugars) contents in two growing seasons (summer and spring) and two harvest years (2008-2009), were studied in frozen, par-fried French fries. Acrylamide and precursor determination was performed using gas chromatography coupled with mass spectrometry (GC–MS) and high-performance liquid chromatography (HPLC). It was observed that final frying generates 76.040-348.554 µg/kg of acrylamide. There was a significant difference between the reducing sugars of the two harvest years (2008-2009). However, there was no significant difference in the acrylamide contents of the two harvest years. Within each harvest year, the highest amount of acrylamide (348.554 µg/kg) was found in samples of stored potatoes. There was a significant difference between summer and spring potatoes in reducing sugar content. The acrylamide content of French fries made from spring potatoes showed higher amount than that of fries made from summer potatoes however, this differentiation in acrylamide content was not significant between spring and summer fries.

INTRODUCTION

Since the industrial revolution in 1750, the concentration of carbon dioxide has risen from 290 to 380 parts per million, and increased greenhouse gas levels are contributing to climate change and increasing the temperature during potato growing season (Haverkort & Verhagen, 2008). The first reason potatoes are not grown in warm areas is because the dry matter concentration is too low (lower than 17%), which leads to poor storability and processing quality (Haverkort & Verhagen, 2008). Sparks (Haverkort & Verhagen, 2008) reported that hot weather and water stress during tuber development can create high concentrations of reducing sugars at the tubers' stem ends. Such tubers usually produce French fries with dark stem ends or sugar ends. Reducing sugars (fructose and glucose) are reported to be key participants in acrylamide formation (Pedreschi et al., 2007) a compound that is neurotoxic for humans (Mestdagh et al., 2008) and was classified as a probable human carcinogen (Tareke et al., 2002 & Lopachin, 2004) by Swedish researchers in 2002. Acrylamide is not present in raw potatoes or formed during boiling; however, high acrylamide levels may be produced when potatoes are fried or oven-baked at high temperatures (Viklund et al., 2008). In addition to the reducing sugars glucose and fructose, the sucrose in potatoes can also undergo enzyme-catalyzed

conversion to glucose and fructose during cold storage at <10 °C. This phenomenon, which is called cold sweetening, contributes to acrylamide formation, particularly for stored potatoes and French fries produced in February and March (Isla et al., 1998). Location and weather conditions during growth also influence the acrylamide precursor composition (Tareke et al., 2002). Potatoes grow best during cool, frost-free weather and do not grow well in heat. It means farmers at latitudes between 40 ° and 60 ° North or South produce potatoes during the summer, the warmest frost-free period of the year (Amrein et al., 2003). Therefore, the aim of this study was to investigate the influence of potatoes crops' origin, growing season and harvest year to determine the effects of climate change on acrylamide formation in frozen, par-fried French fry samples.

MATERIALS AND METHODS

Sample Collection: To study the influence of growing seasons and harvest years, we collected samples from major potato growing areas. According to the crop distribution database of the United Nations Food and Agriculture Organization (Food.F, 2000), Europe has about half of the worldwide potato-producing area and almost 90% of the potato production area is between 22 ° and 59 ° N. The major peaks are between 45 °and 57 °, with summer potato production zones in the temperate climates with harvesting in September and October, and between 23 ° and 34 ° N for the spring crop, with harvesting in April and May. Given the poor storability of spring crop potatoes (Haverkort & Verhagen, 2008), we included only samples from summer-stored potatoes in February-March French fries production to study storage condition effects. Therefore, within each year (2008-2009) samples were categorized to the following three groups: April-May samples (spring crop), September-October samples (summer crop) and February-March samples (stored potatoes). The potato variety used for the par-fried French fry samples was Bintje, which is available in both seasons for French fry production. All frozen, par-fried French fry samples were produced from the same plant. Each sample consisted of a pack (1.5 kg) of 50- to 100-mm long, 7×7 mm French fries. A 150-g portion of each sample was fried in 1.5 L oil at 175 °C for 4 min (Chiou et al., 2009) using an electrical fryer (Model HD 6151, Philips, Amsterdam, The Netherlands). *Acrylamide analysis:* It has been done using gas chromatography coupled with mass spectrometry (GC–MS) with derivatization. *Acrylamide precursor's analysis:* has been determined using methods based on high-performance liquid chromatography (HPLC). *Statistical analysis:* It was performed using Minitab Statistical Software v. 13 (Minitab Inc., State College, PA). The possible significant differences between and within harvest years, growing seasons and stored potatoes were determined with the general linear model, followed by Tukey's multiple-comparisons test. A value of $p \leq 0.05$ was considered to be significant.

RESULTS AND DISCUSSION

The final frying of frozen French fry samples generated 76.040-348.55 µg/kg acrylamide, with widely ranging values for fructose (0.1049-0.8797 mg/g), glucose (0.101-1.274 mg/g) and fifteen free amino acids (0.011-9.172 mg/g) before frying in frozen French fries samples. These results clearly show that the storage of harvested potatoes had a considerable impact on sugar levels and acrylamide formation in both years (2008 and 2009). There was a significant difference in acrylamide content between French fries produced made from stored potatoes in February-March and French fries made from harvested potatoes in September-October (summer crop) or April-May (spring crop) (**Table 1**). The mean acrylamide content in February-March frozen par-fried French fries samples (made from stored potatoes) was 246.19±72.00 µg/kg, which was higher than the acrylamide content in spring crops (April-May; 116.88±31.69 µg/kg) and summer crops (September-October; 99.85±21.37 µg/kg) (**Figure 1**).

Table 1: Glucose (Glc), Fructose (Frc), Reducing sugar (RS), Sucrose (Suc) and Moisture Content (MC%) with Acrylamide content in frozen par fried French fries [a]

Year	Season	Glc	Frc	Suc	RS	MC%	Acrylamide
2008	Stored potato	0.51 ± 0.11 b	0.53 ± 0.21 a	1.02 ± 0.08 bc	1.03 ± 0.33 ab	39.52 ± 0.63 a	188.48 ± 29.55 b
	Spring crop	0.48 ± 0.16 b	0.39 ± 0.17 ab	0.86 ± 0.08 c	0.86 ± 0.32 ab	36.78 ± 6.75 a	116.27 ± 33.93 c
	Summer crop	0.18 ± 0.15 c	0.23 ± 0.20 ab	2.56 ± 0.50 a	0.41 ± 0.36 bc	40.62 ± 2.09 a	95.56 ± 13.83 c
2009	Stored potato	0.89 ± 0.27a	0.57 ± 0.21 a	1.14 ± 0.33 bc	1.46 ± 0.36 a	35.32 ± 2.90 a	303.89 ± 48.40 a
	Spring crop	0.37 ± 0.10 bc	0.46 ± 0.26 ab	1.69 ± 0.24 b	0.83 ± 0.36 ab	42.10 ± 6.31 a	117.48 ± 34.50 c
	Summer crop	0.11 ± 0.01 c	0.13 ± 0.02 b	1.21 ± 0.21 bc	0.24 ± 0.02 c	41.47 ± 3.12 a	104.14 ± 28.73 c

[a] No significant differences between figures sharing the same letters within each column, $p < 0.05$

The amount of reducing sugars in February-March potatoes (stored) was 1.2463±0.3905 µg/kg, which is higher than the levels found in spring crop (0.8488±0.3168 µg/kg) and summer crop (0.3275±0.2532 µg/kg) potatoes (**Figure 2**). Within each investigated year, there was a significant difference between reducing sugars content (**Table 1).** Reducing sugars content in the frozen French fries made from 2009 potatoes (0.6354±0.4712 µg/kg) were higher than in French fries made from 2008 potatoes (0.535±0.450µg/kg) (**Figure 4**); however, the differences were not significant (**Table 1**).

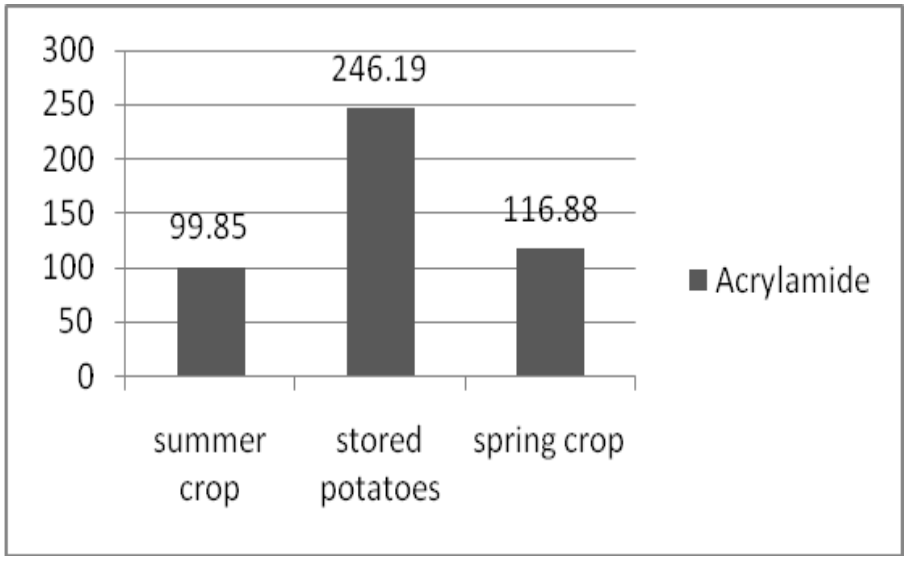

Figure: Mean of acrylamide (µg/kg) content in French fries using two (summer and spring) potato season and stored potatoes.

The mean acrylamide content in frozen, par-fried French fry samples made from potatoes harvested in 2009 (110.81±30.25µg/kg) was higher than the acrylamide content

of potatoes harvested in 2008 (105.91±26.42µg/kg) (**Figure 3)**. The most significant difference was between samples prepared from stored potatoes in February-March (highest acrylamide levels) and samples prepared from summer potatoes in September-October (lowest acrylamide levels).

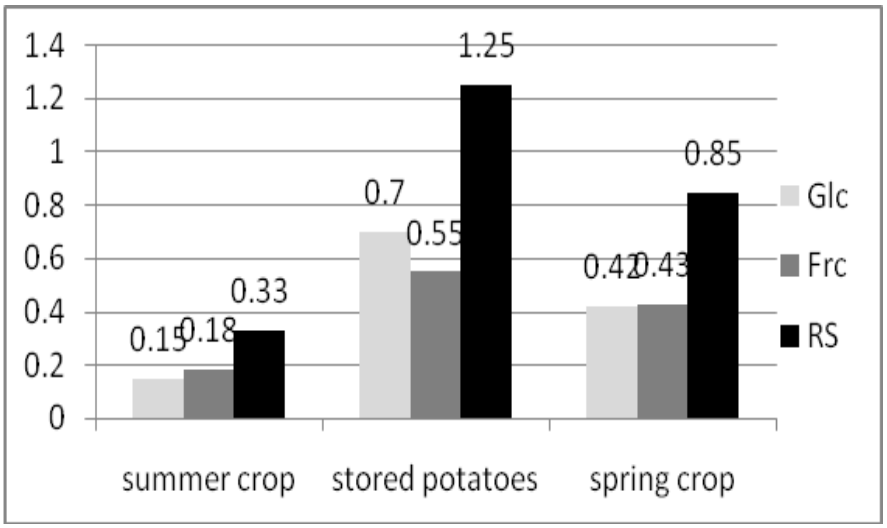

Figure 1: Mean of Glc, Frc and RS (mg/g) content in French fries using two (summer and spring) potato season and stored potatoes.

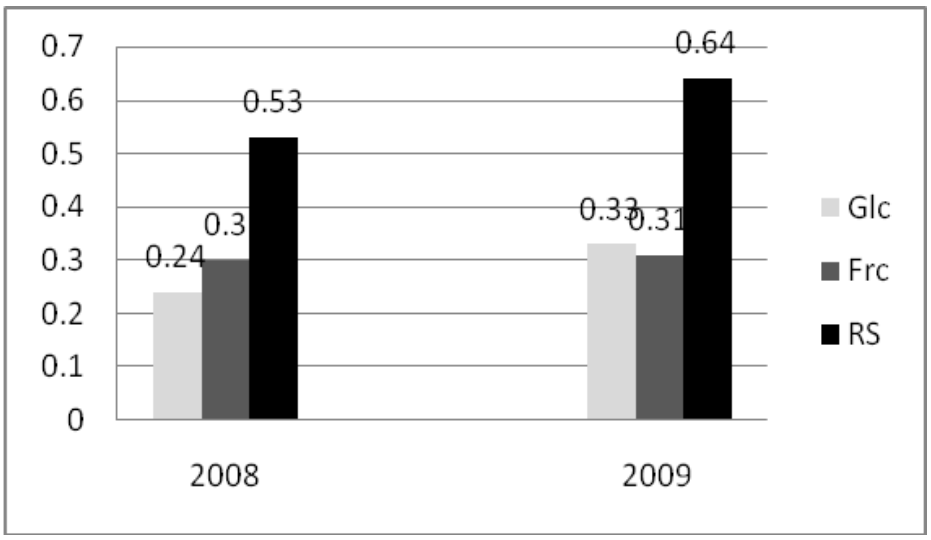

Figure 2: Mean of Glc, Frc and RS (mg/g) content in French fries produced in 2008 and 2009.

CONCLUSION

This trend indicates that potato storage has the greatest effect on the formation of acrylamide and its precursors in frozen, par-fried French fries. Between two investigated years, temperature, total precipitation and global radiation during the two growing seasons (spring and summer) significantly affected reducing sugars; however, there was no significant difference in acrylamide content between 2008 and 2009 produced French fries. French fries produced by summer potatoes in September-October have the lowest acrylamide content.

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OCCURRENCE OF SALMONELLA SPECIES IN PEKIN DUCK INTESTINES AND THEIR ENVIRONMENT

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ABSTRACT: This study was conducted to determine the occurrence of *Salmonella* species in Pekin duck intestines and their environment. Two hundred and twenty (220) samples were analyzed using the conventional method. The overall occurrence of *Salmonella* species was 27.73%. The prevalence of *Salmonella* species were 39.65, 31.67, 28.57, 20.59, 10.00 and 10.00% for duck faeces, intestines, wash water, soil, feed and drinking water, respectively. A total of 61 serovars made up of 9 different *Salmonella* serovars were isolated from the duck intestines and their environment. They are *S*. Typhimirium (12.27%), *S*. Enteritidis (6.82%), *S.* Gallinarum (1.36%), *S.* Braenderup (3.64%), *S*. Albany (1.82%), *S*. Hader (0.45%), *S*. Derby (0.45%), *S*. London (0.45%), and *S*. Newbrunswick (0.45%). This study therefore suggests that ducks are potential sources of *Salmonella* species and consequently salmonellosis, an important food-borne infection of public health concern. Little attention has been paid to the association between ducks and food-borne pathogens thus published data on *Salmonella* species in ducks are limited.

Keywords: Pekin ducks, convectional method, *Salmonella* species and occurrence

INTRODUCTION

Salmonellas are Gram-negative, facultative, non-spore forming bacteria and members of the family *Enterobactericeaec*. They are important food-borne pathogen and a concern for public health in most parts of the world (Herikstad et al., 2002). For instance Meat et al. (1999) showed that non-typhoidal salmonella infection is the second largest of all food-borne illnesses. The symptoms of salmonella infection include fever, diarrhoea, abdominal pain, vomiting and occasionally septicemia (Chiu et al., 2004). Systemic salmonella infections can be life threatening (Zhao et al., 2001).

The alimentary tract of poultry species has been implicated as a primary reservoir for *Salmonella* species (Jacobs-Reitsma et al., 1994). They can also be found in the

poultry rearing (soil, drinking water, feed and faeces) and processing environments (floor, tables, cutting knives and hands of handlers). Cross contamination of *Salmonella* species can occur between the poultry rearing and processing environment under poor handling conditions.

Duck farming for the production of meat and eggs have been practiced for several years, and currently, Malaysia is the third largest producer of duck meat (111,000 tons) after China (2,328,796 tons) and France (234,360 tons), (FAO, 2009). This suggests that Malaysia contributes a reasonable proportion of the total duck meats and eggs consumed worldwide. The methods of producing and processing ducks in Malaysia reveal several critical points that could make the product a potential source of food-borne pathogens such as *Salmonella* species. Studies on the association between ducks and *Salmonella* species are limited. This study was therefore, carried out to determine the prevalence of *Salmonella* species in Pekin ducks raised in Penang, Malaysia in order to ascertain whether ducks are sources of food-borne pathogens.

MATERIALS AND METHOD

Location, duration and data collection

In this study, a total of 220 samples from Pekin duck intestines and their related samples were collected aseptically from various commercial local duck farms, and wet markets during a 5 month period in Penang, Malaysia. Pekin duck intestines and wash water samples (water used for washing duck carcasses) were obtained from the local slaughter house in the wet market while faecal, soil, feed and drinking water samples were taken from duck farms. The samples collected were stored under 4^{o}C, transported to laboratory under aseptic conditions and analyzed immediately for the presence of *Salmonella* species at the Microbiology and Food Safety Laboratory of the Food Technology Division, School of Industry Technology, University Sains Malaysia, Penang.

Isolation, confirmation and identification of Salmonella serovars

The samples collected were pre-enriched in buffered peptone water (Merck, Germany) and incubated at 37^{o}C for 24hours. Approximately 30-50g intestinal contents, faecal and soil samples were thoroughly mixed before transferring 1g portions into 9ml buffered peptone water. For the feed (10g), wash water (10 ml) and drinking water (10ml) were pre-enriched in 90ml buffered peptone water. Following this, 0.1ml and 1ml of pre-enriched aliquots were transferred into 10ml rappaport and vassiliadis broth (Merck, Germany) and 10ml selenite cystine broth (Merck, Germany), respectively for enrichment. Enrichment samples in rappaport and vassiliadis broth were incubated at 42^{o}C for 24hours while that of the selenite cystine broth were incubated at 37^{o}C for 24hours. Enriched aliquots (ca. 10µl) were then streaked onto xylose lysine deoxycholate (Merck, Germany) and rambach agar (Merck, Germany) and incubated at 37^{o}C for 24–48hours. Presumptive *Salmonella* species were purified on MacConkey and nutrient agar all from Merck, Germany and confirmed using Gram staining, biochemical (triple sugar

iron, lysine iron agar, urease, and indole production) and serological (Salmonella H Antiserum Poly A-Z and Salmonella O Poly A-I & Vi Antiserum, Difco) methods. Serotyping was performed by the Institute of Veterinary Department in Penang and Ipoh, Malaysia following the Kauffmann-White Scheme for designation of *Salmonella* serotypes.

RESULTS AND DISCUSSION

Table 1 gives a breakdown of the type of samples analyzed and the prevalence of *Salmonella* species. The overall prevalence for *Salmonella* species was 27.73%. The highest frequency for the occurrence of *Salmonella* species was found in the faecal samples (39.65%); this was followed by the intestinal content (31.67%), wash water (28.57%) and soil sample (20.59%). The lowest frequency was found in feed and drinking water (10%).

In Vietnam, Tran et al. (2004) examined 357 faecal/intestinal samples of ducks out of which 31 (8.7%) were found positive for *Salmonella*. Phan et al. (2000) found that 1 out of 20 (5%) duck faecal samples analyzed contained *Salmonella* species in Tan Thanh village, Vietnam. In 6 California poultry niche markets McCrea et al. (2006) found the prevalence of *Salmonella* serovars to be 3.3 ± 1.3, 3.3 ± 1.3, 23.3 ± 3.9, 11.3 ± 2.0, 0.0 and 0.0% for on-farm (cloacal swab), post-transport (cloacal swab), post-picker (carcass swab), post-wax (carcass swab), post-evisceration (carcass swab) and pre-packinng (carcass swab), respectively.

With regards to the *Salmonella* serovars isolated (Table 2); *S.* Typhimurium (12.27%) was the highest, followed by *S*. Enteritidis (6.82%), *S.* Braenderup (3.64%) and *S.* Gallinarum (1.36%). *Salmonella* Hader, *S*. Derby, *S*. London and *S*. Newbrunswick showed the lowest prevalence of 0. 45%. McCrea *et al.* (2006) isolated *S.* Typhimurium from cloacal swabs on-farm, *S.* Heidelberg from drag swabs on-farm and *S*. Seftenberg from crates swabs. Deng et al. (2009) also isolated a high pathogenic strain of *S.* Enteritidis (No. CD1) in Pekin ducks.

Salmonella species were isolated from all the samples tested. The gastrointestinal tract of animals harbours and serves as reservoirs for a number of pathogens. The isolation of *Salmonella* species from the intestinal contents indicates that, Pekin ducks like other animals are primary source of *Salmonella* species. Once *Salmonella* species are present in the intestines of ducks, they can be shed during defaecation. As such healthy ducks could potentially share *Salmonella* species. This study also showed that the highest occurrence of *Salmonella* species was from the faeces which could be due to defaecation of contaminated faeces, the ability of *Salmonella* species to survive and grow in faeces and the relatively unhygienic environment under which some of the ducks were reared in the farms. Furthermore, our study reveals that, survival of salmonella in the soil, feed and drinking water is possible, although this might have happened from cross-contamination from other samples. Additionally, a high prevalence of *Salmonella* species in wash water samples (28.57%) was found. The possible source could be rupture of the intestines, from faeces or skin of ducks during processing. Analysis of the wash water (water used for washing and rinsing

carcasses after dressing but not scalding water) also showed that the temperature ranged between 30 to 40^{o}C of which survival of *Salmonella* species is possible.

Salmonella Typhimirium occurred in all the samples analyzed except for feed and water samples. While *S*. Enteritidis was isolated from only the intestines and faeces. These two *Salmonella* serovars have been implicated in recent times in most food-borne illnesses (Suresh et al., 2006). Although *S*. Typhimirium was the most dominant *Salmonella* serovars isolated, CDC report 1997 showed that there has been a decline in *S.* Typhimirium while others (*S*. Enteritidis, *S*. Heidelberg and *S*. Javiana) are increasing (CDC, 1997; Coburn et al., 2007). Most studies have found *S*. Enteritidis as the most prevalent *Salmonella* serovar (Fuzihara et al., 2000; Herikstad et al., 2002; Fernandes et al., 2006) in poultry. In ducks such information is scare. Nevertheless, Tsai and Hsiang (2004) found *S.* Potsdam (31. 9% of the isolates), to be the most predominant serovar in their work carried out in Taiwan. Other serovars such as *S.* Gallinarum, *S*. Braenderup, *S.* Albany, *S.* Hader, *S*. Derby, *S.* London and *S.* Newbrunswick were also present in the duck samples we analyzed but occurred in smaller percentages compared to *S.* Typhimirium and *S*. Enteritidis. *Salmonella* Gallinarum is known to cause high morbidity and mortality in chicken (Singh et al., 2010) and thus can cause similar problem in ducks.

Table 1: Occurrence of *Salmonella* serovars in Pekin duck intestines, wash water, feces, soil drinking water and feed obtained from farms, wet markets and slaughter houses

Type of sample	No of samples tested	Prevalence (No. & % positive)
Intestinal content	60	19 (31.67)
Wash water	28	8 (28.57)
Faecal sample	58	23 (39.65)
Soil sample	34	7 (20.59)
Feed	20	2 (10.00)
Drinking water	20	2 (10.00)
Overall	220	61(27.73)

Table 2: Prevalence of different *Salmonella* serovars in Pekin duck intestines, wash water, feces, soil drinking water and feed obtained from farms, wet markets and slaughter houses

	Intestinal content	Wash water	Faecal sample	Soil sample	Feed sample	Drinking water	(%) Prevalence
S. Typhimirium	6	7	10	4	-	-	12.27
S. Enteritidis	6	-	9	-	-	-	6.82
S. Gallinarum	3	-	-	-	-	-	1.36
S. Braenderup	4	1	-	2	1	-	3.64
S. Albany	-	-	4	-	-	-	1.82
S. Hader	-	-	-	-	-	1	0.45
S. Derby	-	-	-	1	-	-	0.45
S. London	-	-	-	-	1	-	0.45
S. Newbrunswick		-	-	-	-	1	0.45

CONCLUSION

Salmonella species in the Pekin duck intestines and their environmental samples ranged from 10 to 40%. Therefore, ducks are potential reservoirs for *Salmonella* species. Higher levels of *Salmonella* species are likely to occur in the intestines, faeces, soil and wash water samples. These pathogens can be released to the farming and processing environments under poor handling conditions. Duck meat or other food samples can be contaminated with *Salmonella* species from ducks which can infect people through consumption under inadequate cooking condition. *Salmonella* Typhimirium and Enteritidis continue to be the two most predominant *Salmonella* serovars of much interest.

ACKNOWLEDGEMENTS

This research was supported by the Post Graduate Research Grant Scheme (1001/PTEK1ND/843007) of the Universiti Sains Malaysia. The authors express with outmost sincerity for the support provided by IPS-USM in running this research.

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CHANGES IN PHYSICAL, CHEMICAL, MICROBIOLOGICAL AND SENSORY PROPERTIES OF KHAO DAK MALI 105 BROWN RICE DURING STORAGE

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ABSTRACT

Changes in quality of Khao Dawk Mali 105 brown rice that packed in polyethylene plastic bag, polyethylene plastic bag with vacuum, clear polypropylene plastic bag and dull polypropylene woven bag and kept without control of temperature and relative humidity for 3 months were investigated. It was found that with increasing time of storage, Khao Dawk Mali 105 brown rice from 4 different packages had ΔE value, volume expansion, free fatty acid content, total plate count and yeast and mould counts significantly increased ($p \leq 0.05$) while moisture, protein, oil and fatty acid content decreased ($p \leq 0.05$). In overall, polyethylene plastic bag with vacuum possessed a significantly better ($p \leq 0.05$) quality stability of Khao Dawk Mali 105 brown rice than the other packages.

Keywords: brown rice, Khao Dawk Mali 105, quality, shelf life

INTRODUCTION

Brown rice has become one of the popular health food due mainly to it is rich in dietary fibre, minerals, unsaturated oils and vitamins, particularly thiamine (Houston and Kohler, 1970). After harvest and dehulling, changes were still happened all the time during storage. Storage conditions such as temperature, time and moisture affected the quality of brown rice which resulted from changes in physical, chemical and physicochemical properties (Muramatsu, *et al*., 2007) with temperature being the most influent factors (Khongkietkhajorn, *et al*., 2004). Therefore, control of storage conditions is very essential for minimizing deterioration of brown rice quality. The main objective of storage was to minimize loss of brown rice during storage both quantitatively and qualitatively which could be achieved by storage of the brown rice in a silo or conditions where the relative humidity and temperature was low. Storage of brown rice in a normal silo without control of temperature and relative humidity is a common practice for rice processors since it is inexpensive but there is a high opportunity of deterioration occurred during storage. Utilization of vacuum packaging of brown rice and storage in a common silo without control of temperature is commonly adopted by rice processors. This practice could keep quality of brown rice for a long period and could be the best method for minimizing quality loss, however, it is still an expensive method. The objective of this research was to find out the appropriate type of package for storage of Khao Dawk Mali 105 (KDML105) brown rice through determination of changes in physical, chemical, microbiological and sensory properties of KDML105 brown rice during storage for 3 months without control of temperature and relative humidity.

MATERIALS AND METHODS

Sample preparation and analysis

Newly harvested and dried KDML105 paddy rice grown in Phitsanulok Province, Lower North of Thailand were obtained from 2007 season with a moisture content of 12%. The paddy was dehusked using the Sahakit's small miller and 500 g of well selected brown rice grains were packed in polyethylene plastic bag (PE), polyethylene plastic bag with vacuum (PE vacuum), clear polypropylene plastic bag (clear PP) and 5 kg in a dull polypropylene woven bag (dull PP). All samples were kept in a normal storage room of Sahakit Rice Mill for 3 months without control of temperature and relative humidity. The samples were taken for analysis at monthly intervals for color, volume expansion (Department of Internal Trade, 1997), free fatty acid, protein, moisture content (AOAC, 1995), total plate count, yeast and mould count (APHA, 1984) and sensory evaluation using Line scaling and 10 trained panelists, and at 0 and 3 months of storage for amino acid and fatty acid (AOAC, 2000).

Experimental design

The experimental design used was Completely Randomized Design (CRD) with three replications. Data were subjected to analysis of variance and Duncan's New Multiple Range Test was used to separate means.

RESULTS AND DISCUSSIONS

Color

ΔE of samples that packed in 4 different packages showed significantly increased (P≤0.05) with time of storage (Figure 1). The sample that packed in PEvac showed slower increased in ΔE than other samples for the first 2 months of storage but sharply increased thereafter. After 3 months storage, the brown rice became darker brown.

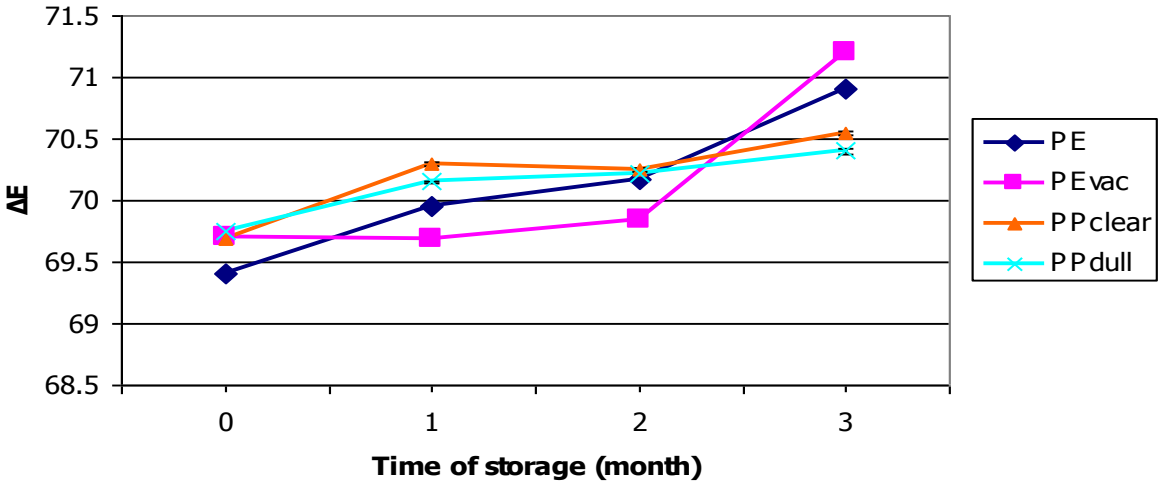

Figure 1 : ΔE of KDML105 brown rice that packed in different packages.

Volume expansion

Newly harvested and stored KDML105 brown rice that packed in different packages showed no significant difference (P>0.05) in volume expansion. However, as the storage time increased, the volume expansion was significantly increased (P≤0.05). At 3 months storage, the volume expansion of all samples were not significantly different (P>0.05). This was in agreement with finding of Chaitip *et al.* (2004) and Kongseree (1996) who reported that old rice possessed high volume expansion. Furthermore, Phadungsak

(1995) reported that old rice had more volume expansion than new rice which supported the finding of this research.

Table 1 : Physicochemical and chemical composition of KDML105 brown rice.

Packaging materials	Content (±SD)			
	Newly harvested	Storage time (month)		
		1	2	3
Volume expansion				
PE	$1.99^{ns/z}$±0.10	$2.04^{ns/y}$±0.01	$2.34^{ns/x}$±0.07	$2.47^{ns/w}$±0.01
PE vacuum	$1.91^{/z}$±0.14	$1.93^{/y}$±0.05	$2.28^{/x}$±0.08	$2.31^{/w}$±0.14
Clear PP	$1.96^{/z}$±0.03	$2.00^{/y}$±0.11	$2.32^{/x}$±0.07	$2.41^{/w}$±0.05
Dull PP	$2.09^{/z}$±0.10	$2.01^{/y}$±0.01	$2.31^{/x}$±0.07	$2.36^{/w}$±0.07
Free fatty acid (%)				
PE	$0.24^{ns/z}$±0.01	$0.33^{ns/y}$±0.02	$0.50^{ns/x}$±0.03	$0.52^{ns/w}$±0.02
PE vacuum	$0.28^{/z}$±0.01	$0.31^{/y}$±0.01	$0.50^{/x}$±0.02	$0.50^{/w}$±0.03
Clear PP	$0.24^{/z}$±0.01	$0.37^{/y}$±0.01	$0.50^{/x}$±0.03	$0.53^{/w}$±0.03
Dull PP	$0.24^{/y}$±0.01	$0.36^{/x}$±0.01	$0.56^{/x}$±0.04	$0.56^{/w}$±0.04
Moisture content (%)				
PE	$12.25^{ns/w}$ ±0.10	$8.97^{b/x}$±0.19	$8.75^{b/y}$±0.25	$8.58^{b/z}$±0.18
PE vacuum	$12.14^{/w}$±0.07	$8.96^{b/x}$±0.06	$8.43^{b/y}$±0.10	$8.28^{b/z}$±0.13
Clear PP	$12.29^{/w}$±0.02	$9.12^{b/x}$±0.12	$8.97^{b/y}$±0.13	$8.79^{b/z}$±0.08
Dull PP	$12.25^{/w}$±0.11	$10.38^{a/x}$±0.19	$11.44^{a/y}$±0.22	$9.86^{a/z}$±0.14
Protein content (%)				
PE	$8.19^{ns/w}$ ±0.09	$8.15^{b/x}$±0.13	$8.09^{b/y}$±0.30	$8.07^{ns/z}$±0.06
PE vacuum	$8.24^{/w}$±0.03	$8.23^{a/x}$±0.05	$8.20^{a/y}$±0.14	$8.18^{/z}$±0.07
Clear PP	$8.27^{/w}$±0.07	$8.22^{a/x}$±0.11	$8.16^{a/y}$±0.16	$8.11^{/z}$±0.32
Dull PP	$8.28^{/w}$±0.05	$8.28^{a/x}$±0.05	$8.15^{a/y}$±0.14	$8.12^{/z}$±0.10

Mean values followed by the same letter in the same column (a-b) and row (w-z) are not significantly different (P>0.05)

^{ns} Mean values are not significantly different (P>0.05)

Free fatty acid

KDML105 brown rice that packed in all packages at 0 month of storage had no significant differences (P>0.05) in free fatty acid values (Table 1). As storage time increased, free fatty acid values of brown rice of all storage conditions significantly increased (P≤0.05). This was mainly due to brown rice composed of unsaturated fatty acids which easily degraded from auto-oxidation that accelerated by light and temperature. Therefore, for commercial storage, brown rice should not be kept for a long period of time. Increasing in free fatty acid values in brown rice would result in abnormal odor (rancid).

Moisture content

The moisture content of newly harvested KDML105 brown rice that packed in 4 different packages did not show significant difference (P>0.05) (Table 1). However, as the storage time increased, the moisture content of all samples significantly decreased (P≤0.05) in which those packed in dull PP woven bag was significantly higher than that of all other conditions (P≤0.05). This was mainly due to the ability of moisture to penetrate through

the holes or spaces between the dull PP bag. The moisture content of brown rice depended on the relative humidity of the storage room, in that if the storage room had low moisture content than that of rice, brown rice would released the moisture through the packaging materials to the air in the storage room, resulted in decreasing in moisture content of the brown rice. The National Standard of Agricultural Products and Foods (2003) stated that the moisture content of the brown rice that packed in any packaging materials should not exceed 14%. Therefore, all the samples had the moisture content conformed to the standard value.

Protein content

The protein content of brown rice from all packages at 0 month storage was not significantly different (P>0.05) (Table 1). As storage time increased, the protein content of brown rice from all packages significantly decreased (P≤0.05). However, the protein content of brown rice from all packages at 3 months storage was not significantly different (P>0.05). This was affected by changes in temperature and oxygen during storage (Chrastil, 1994) which reacted with protein and changed in molecular weight of oryzanin which was the main type of protein found in brown rice. This alteration made protein changed to a new form and denatured. However, the protein content of brown rice found in this study was in agreement with that (7.1-8.3%) of Rice Research Center (2003).

Fatty acid profiles

The fatty acids found in KDML105 brown rice both newly harvested and kept for 3 months were presented in descending order (Table 2) as cis-9-oleic, cis-9,12-linoleic, palmitic, stearic, α-linoleic, myristic, arachidic, lignoceric, palmitoleic, cis-11-eicosenoic and behenic acids. The stored brown rice had fatty acid content lower than that of newly harvested due mainly to lipid oxidation occurred in brown rice which resulted in fatty acid destruction.

Table 2 : Fatty acids found in newly harvested and 3 months storage KDML105 brown rice that packed in different packages.

Fatty acids	Content (g/100 g)				
	Newly harvested	3 months storage			
		PE	PE vacuum	Clear PP	Dull PP
Saturated fatty acids					
Myristic acid	0.02	0.02	0.02	0.02	0.02
Palmitic acid	0.94	0.79	0.75	0.69	0.70
Stearic acid	0.09	0.08	0.07	0.07	0.07
Arachidic acid	0.02	0.02	0.02	0.02	0.02
Behenic acid	0.01	0.01	0.01	0.01	0.01
Lignoceric acid	0.02	0.02	0.02	0.02	0.02
Monounsaturated fatty acids					
Palmitoleic acid	0.01	0.01	0.01	0.01	0.01
cis-9-Oleic acid	1.20	1.08	0.99	0.92	0.93
cis-11-Eicosenoic acid	0.01	0.01	0.01	0.01	0.01
Polyunsaturated fatty acids					
cis-9,12-Linoleic acid	1.14	0.98	0.90	0.85	0.85
α-Linoleic acid	0.04	0.03	0.03	0.03	0.03

Amino acid profiles

Amino acids found in KDML105 brown rice both newly harvested and that kept for 3 months were presented in descending order (Table 3) as phenylalanine, lysine, leucine, glutamic acid, isoleucine, histidine, valine, tyrosine, aspartic acid, proline, alanine, tryptophan, glycine, serine, methionine, arginine, threonine, cystine, hydroxyproline and hydroxyiysine.

Table 3 : Amino acids found in newly harvested and 3 months storage KDML105 brown rice.

Amino acids	Content (mg/100 g)				
	Newly harvested	3 months storage			
		PE	PE vacuum	Clear PP	Dull PP
Alanine	260.77	256.27	266.98	254.11	237.63
Arginine	96.75	138.44	126.12	120.16	132.56
Aspartic acid	358.71	393.62	378.68	384.56	361.60
Cystine	20.77	62.56	60.83	56.40	40.67
Glutamic acid	775.73	882.09	892.18	885.10	935.57
Glycine	169.07	167.54	172.01	168.57	158.50
Histidine	493.71	407.81	499.67	527.44	527.13
Hydroxyiysine	<5.00	<5.00	<5.00	<5.00	<5.00
Hydroxyproline	29.12	<5.00	<5.00	<5.00	22.93
Isoleucine	558.61	529.22	539.45	538.31	518.56
Leucine	1107.80	1188.23	1100.78	1093.25	1058.51
Lysine	1222.79	1075.04	1243.86	1276.47	1115.17
Methionine	115.92	82.42	100.29	102.64	84.43
Phenylalanine	1322.49	1270.51	1214.76	1237.31	1337.92
Proline	307.00	300.16	309.08	302.81	287.39
Serine	116.07	115.07	125.49	116.76	109.42
Threonine	97.59	92.39	97.79	96.27	87.86
Tryptophan	199.18	195.61	212.48	194.39	165.09
Tyrosine	368.23	603.03	438.57	415.82	373.97
Valine	449.28	470.76	465.04	466.64	416.38

Total plate count and Yeast and Mould counts

Total plate count and yeast and mould counts in brown rice that packed in different packages were increased with time of storage. After 3 months storage, brown rice that packed in PE bag had higher numbers of microbial growth than that of other packages. On the other hand, brown rice that packed in dull PP bag had higher yeast and moulds growth than other packages. This was resulted from the penetration of moisture through the packaging that facilitated microbial growth.

Sensory quality

The overall quality scores of newly harvested brown rice packed in all packaging materials were not significantly difference (P>0.05) (Table 4). As storage time increased, the overall quality of brown rice packed in all packaging materials were significantly decreased (P≤0.05). This was probably due to the component of brown rice such as lipid, protein and carbohydrate started to deteriorate, therefore, the quality of brown rice decreased. After 3 months storage, brown rice that packed in PE bag and PE vacuum bag maintained significantly better (P≤0.05) overall quality than other packaging materials.

Table 4 : Sensory scores of newly harvested and 3 months storage of KDML105 brown rice packed in different packages.

Attributes/ Packaging materials	Acceptance scores (±SD)			
	Newly harvested	Storage time (month)		
		1	2	3
Colour				
PE	$47.70^{ns/y}$±0.82	$66.60^{b/w}$±1.06	$48.03^{b/y}$±0.99	$55.00^{ns/x}$±1.05
PE vacuum	$48.60^{/y}$±1.01	$71.20^{a/w}$±0.27	$58.62^{a/x}$±0.86	$55.00^{/x}$±1.15
Clear PP	$50.70^{/x}$±0.65	$43.90^{c/z}$±0.57	$46.32^{b/y}$±0.94	$53.29^{/w}$±1.19
Dull PP	$51.50^{/x}$±0.72	$40.80^{d/y}$±0.22	$53.59^{a/w}$±0.82	$53.57^{/w}$±1.18
Adhesive				
PE	$51.50^{ns/w}$ ±1.06	$38.00^{c/y}$±1.08	$52.71^{c/w}$±1.14	$49.29^{ns/x}$±1.21
PE vacuum	$55.60^{/w}$±1.05	$41.00^{b/z}$±1.07	$51.17^{d/x}$±1.11	$49.71^{/y}$±1.19
Clear PP	$53.90^{/w}$±0.87	$46.00^{a/y}$±1.00	$55.12^{b/w}$±1.17	$50.14^{/x}$±1.21
Dull PP	$55.90^{/w}$±0.99	$45.03^{a/z}$±0.50	$60.40^{a/w}$±1.05	$50.36^{/y}$±1.25
Rancid odour				
PE	$14.00^{ns/z}$ ±1.18	$20.30^{ns/y}$ ±1.08	$23.80^{b/x}$±1.01	$25.43^{b/w}$±1.06
PE vacuum	$14.11^{/y}$±1.06	$21.60^{/x}$±1.13	$25.50^{b/w}$±0.77	$25.14^{b/w}$±1.04
Clear PP	$14.22^{/y}$±1.14	$19.20^{/x}$±1.14	$15.10^{c/y}$±0.52	$26.86^{b/w}$±1.11
Dull PP	$13.89^{/z}$±1.03	$20.50^{/y}$±1.05	$29.70^{a/x}$±0.21	$32.43^{a/w}$±1.05
Brown rice odour				
PE	$60.80^{ns/x}$ ±1.49	$60.20^{b/x}$±1.53	$69.92^{a/w}$±1.24	$51.00^{a/y}$±1.19
PE vacuum	$71.92^{/w}$±1.39	$67.40^{a/x}$±1.22	$67.20^{a/x}$±1.38	$53.86^{a/y}$±1.02
Clear PP	$61.10^{/w}$±1.25	$62.90^{a/w}$±1.42	$60.93^{b/w}$±0.74	$46.00^{b/x}$±1.14
Dull PP	$63.30^{/w}$±1.42	$59.00^{b/x}$±1.39	$54.18^{c/y}$ ±1.16	$42.14^{b/z}$±1.06
Sweetness				
PE	$34.20^{ns/x}$±1.46	$36.30^{a/w}$±1.26	$24.39^{a/y}$±1.69	$24.14^{ns/z}$±1.19
PE vacuum	$35.50^{/w}$±1.36	$31.90^{a/x}$±0.87	$24.98^{a/y}$±1.52	$23.86^{/z}$±1.12
Clear PP	$34.10^{/w}$±1.03	$26.60^{b/x}$±1.63	$20.47^{b/z}$±1.50	$23.71^{/y}$±1.15
Dull PP	$37.90^{/w}$±1.21	$25.20^{b/x}$±1.32	$16.71^{c/z}$±0.43	$23.29^{/y}$±1.05
Cohesiveness				
PE	$24.40^{a/y}$±1.12	$45.00^{ns/z}$±1.17	$47.66^{ab/x}$±1.11	$57.71^{a/w}$±1.15
PE vacuum	$24.90^{a/y}$±1.17	$45.60^{/z}$±1.20	$49.43^{a/x}$±1.09	$58.86^{a/w}$±1.29
Clear PP	$24.20^{b/y}$±0.80	$44.50^{/z}$±1.30	$46.08^{b/x}$±1.07	$55.00^{a/w}$±1.12
Dull PP	$33.90^{b/z}$±1.96	$47.80^{/x}$±1.13	$47.29^{ab/y}$±1.00	$50.29^{b/w}$±1.23

Softness				
PE	68.56$^{ns/w}$±0.88	53.80$^{c/y}$±1.15	56.86$^{b/x}$±1.34	46.70$^{c/z}$±1.34
PE vacuum	68.38$^{/w}$±0.86	55.20$^{b/x}$±1.03	58.43$^{a/x}$±1.32	48.00$^{c/y}$±1.50
Clear PP	65.47$^{/w}$±1.87	55.20$^{b/x}$±0.99	53.90$^{c/y}$±1.40	54.43$^{a/x}$±1.35
Dull PP	71.43$^{/w}$±1.41	60.60$^{a/x}$±1.12	55.60$^{b/y}$±1.36	51.86$^{b/z}$±1.22
Hardness				
PE	42.10$^{a/z}$±1.47	42.89$^{ab/y}$±1.47	46.43$^{b/x}$±1.24	47.50$^{a/w}$±1.17
PE vacuum	42.50$^{a/z}$±1.46	44.43$^{a/y}$±1.50	47.06$^{a/x}$±1.36	48.00$^{a/w}$±1.21
Clear PP	35.80$^{b/z}$±1.36	37.71$^{c/y}$±1.47	41.00$^{c/x}$±1.22	46.10$^{b/w}$±1.14
Dull PP	31.14$^{b/z}$±1.39	40.83$^{b/y}$±1.41	46.50$^{b/x}$±1.12	48.30$^{a/w}$±0.81
Oveall quality				
PE	64.30$^{ns/w}$±0.96	63.8$^{a/x}$±0.49	62.68$^{a/y}$±1.19	61.71$^{a/z}$±1.30
PE vacuum	70.10$^{/w}$±1.02	65.6$^{a/x}$±1.29	64.24$^{a/y}$±1.02	63.14$^{a/z}$±1.16
Clear PP	64.80$^{/w}$±0.93	47.6$^{c/x}$±0.47	58.01$^{b/y}$±1.15	55.86$^{b/z}$±1.35
Dull PP	66.70$^{/w}$±1.01	54.4$^{b/x}$±1.92	57.42$^{b/y}$±0.92	52.43$^{c/z}$±1.26

Mean values followed by the same letter in the same column (a-d) and row (w-z) are not significantly different (P>0.05)

^{ns} Means in column are not significantly differences (P>0.05)

CONCLUSION

Without control of temperature and relative humidity in the package and storage room, storage of KDML105 brown rice in the polyethylene plastic bag with vacuum shown the best result as it maintained the better physical, chemical, microbiological and sensory quality of KDML105 brown rice than other packaging materials.

ACKNOWLEDGEMENT

Sincere thanks were expressed to Thailand Research Fund (TRF) for financial support and Mr. Sittidet Siranuparp, general manager of Sahakit Rice Mill for KDML105 rice.

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EXTRACTION AND BLEACHING OF CELLULOSE FROM BANANA PEELS

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ABSTRACT

Processing of many OTOP products from banana in Phitsanulok province, Thailand contributed waste such as banana peel, finger and bunch which created unpleasant smell and might be a place for disease distribution to the community if lacking of a good management. Attempts have been made to utilize these banana wastes into organic fertilizers. However, there were still some wastes available. This research was aimed to change banana peel to a more value added product, cellulose. Banana peels from banana stages 5, 6 and 7 were examined for its cellulose content in order to select one appropriate stage of ripening for production of cellulose. It was found that banana peel stage 5 had significantly higher ($p \leq 0.05$) cellulose content than that of stages 6 and 7. However, banana peel stage 7 was the major one that caused a problem. Therefore, it was selected for further studies. Banana peel cellulose (BPC) was obtained by alcoholic and alkali extraction with a bleaching process due to elimination of lipid, protein and color, respectively. The suitable condition for alcoholic extraction included 90% of ethanol and 16 h of extraction time while for the alkali extraction included pH 12 and 24 h of extraction time. Finally, the suitable beaching condition was 15% hydrogen peroxide and 3 h of bleaching time. These extraction and bleaching conditions provided the BPC with better quality than other conditions. The obtained BPC had moisture, total lipid, protein, carbohydrate, ash, crude fiber and cellulose content of 5.61, 2.57, 1.65, 52.56, 4.04, 33.57 and 75.90%, respectively. In addition, the BPC had pH 6.05, aw of 0.47, L* of 84.66, water and oil retention capacity of 2.91 and 0.08 g oil/ g dried sample, respectively. The BPC had the physical and chemical properties similar to that of commercial cellulose.

Keywords: cellulose, banana peel, waste, extraction, bleaching

INTRODUCTION

Banana is one of the most extensively consumed fruits in the world and represents 40% of world trade in fruits. Thailand is one of the largest producing countries of banana, especially in Phitsanulok province with planting area of 64,000 ha with production of 43,750 ton/ha and the OTOP products from banana 60-70 ton/day. From the OTOP factories, there are a lot of banana peels which caused an environmental problem such as bad smell and source of disease. One way of reducing the problem was to change the banana peel to the more valuable product, cellulose that can be more extensively used in the food industry.

MATERIALS AND METHODS

1. Raw materials

The fresh banana peels were collected from the OTOP factories of banana flour, dried, roasted and grilled banana right away after peeling.

2. Sample preparation

The fresh peels of banana stages 5, 6 and 7 of maturity were chopped into 0.3x2.5 cm. size and weighed before placing in the hot air oven at 55°C for 10 h. After cooling to room temperature, it was weighed, ground and passed through 35 mesh sieve before keeping in the refrigerator until analysis.

3. Chemical analysis of banana peel

The obtained banana peel powder of 3 stages of maturity was analyzed for moisture, total lipid, protein, carbohydrate, ash, fiber (AOAC, 1995) and cellulose content (Robinson, 1981) in order to select one appropriate maturity stage of banana peel for extraction of cellulose.

4. Extraction of cellulose

The chemical extraction was carried out to remove unwanted compounds such as lipid, protein and pigments due to obtain the most purity cellulose.

4.1 Extraction of lipid

The banana peel powder was soaked in ethanol solution concentrations of 90, 95 and 99% for 8, 16 and 24 h in order to remove lipid. The experiment was done in a water bath at 50°C with 150 rpm. The sample that had lowest lipid content was selected.

4.2 Extraction of protein

The defatted banana peel powder was soaked in sodium hydroxide solution at 3 pH levels of 11.6, 11.8 and 12 (using sodium hydroxide solution 25%) and control (without pH adjusted) for 8, 16 and 24 h in order to remove protein in a water bath at 50°C with 150 rpm. The sample that had lowest protein content was selected.

5. Bleaching of cellulose

The defatted and protein removed banana peel powder was soaked in hydrogen peroxide solution concentrations of 0, 20, 25 and 30% for 30, 60 and 90 min. The sample that had the most similar color to the commercial cellulose was selected.

6. Properties of banana peel cellulose compare to the commercial cellulose

The obtained BPC and commercial cellulose were chemically analyzed for moisture, total lipid, protein, carbohydrate, ash, fiber (AOAC, 1995) and cellulose content (Robinson, 1981) and water activity. The physical properties of both celluloses were analyzed for L* (Hunter Lab Model DP–9000), pH (AOAC, 1995) and water and oil retention capacity (Ang, 1991).

7. Experimental design

The experimental design used was Completely Randomized Design (CRD) with three replications. Data were subjected to analysis of variance and Duncan's New Multiple Range Test was used to separate means.

RESULTS AND DISCUSSIONS

1. Chemical composition of banana peel

The banana peel of stages 5, 6 and 7 contained mainly carbohydrate, following by fiber, ash, total lipid, protein and moisture, respectively (Table 1). The moisture content increased significantly ($P \leq 0.05$) with stage of maturity while the total lipid significantly decreased ($P \leq 0.05$). However, the fiber content was not significantly different ($P > 0.05$) for all samples. The banana peel stage 5 had significantly higher ($P \leq 0.05$) cellulose content than that of other stages. Even though the banana peel stage 7 contained less cellulose than that of stage 5 but it was the one that caused a major problem to the community. Therefore, it was selected for further studies.

Table 1 : Chemical composition of banana peel stages 5, 6 and 7

Stage of banana peel	Content (% dry basis)						
	Moisture	Total lipid	Protein	Carbohydrate	Ash	Fiber^{ns}	Cellulose
5	3.15±0.11^{c}	19.19±0.31^{a}	5.68±0.22^{a}	44.58±1.70^{b}	12.37±0.05^{ab}	15.03±0.28	63.02±0.19^{a}
6	4.68±0.13^{b}	6.82±0.56^{b}	6.57±0.02^{a}	54.51±1.14^{a}	12.12±0.07^{b}	15.23±0.38	59.43±0.12^{b}
7	7.65±0.05^{a}	4.34±0.74^{c}	3.74±0.42^{b}	56.21±0.37^{a}	12.62±0.09^{a}	15.30±0.85	59.04±0.11^{b}

Mean values followed by the same letter in the same column (a-d) are not significantly different ($P > 0.05$)

^{ns} Means in column are not significantly differences ($P > 0.05$)

2. Extraction of cellulose

The control sample (non-defatted banana peel powder) had significantly higher ($P \leq 0.05$) total lipid content than that of other samples (Table 2). This was mainly due none ethanol extraction since ethanol is a solvent used to extract lipid from the sample. As the extraction time increased, the total lipid content of the sample significantly decreased ($P \leq 0.05$). It can be seen that concentration of ethanol did not affect the total lipid content but the extraction time. For saving of chemical and time, the ethanol concentration of 90% and extraction time of 16 h was selected. This condition was different to that reported by Pongnori (2004) in that the condition to extract cellulose from corn core was ethanol 95% and extraction time of 8 h.

The protein content of banana peel powder significantly decreased ($P \leq 0.05$) with time of extraction (Table 3). With regard to the same extraction time, there was no significantly different ($P > 0.05$) in protein content between the samples. This indicated that both time of extraction and pH had more affect on removing of protein from the samples mainly after 24 h and at pH 12. Therefore, it was selected for further experiment. This condition was in agreement with those reported by Prakongpan *et al.* (2002) who reported that the appropriate pH and time of extraction cellulose from pineapple core was pH 12 and 24 h of extraction time. It was also concurrent to the extraction of cellulose from soy bean (US

Patent Number 5,057,337). However, Pongnori (2004) extracted cellulose from corn core by using sodium hydroxide 15% for 30 min whereas the US Patent Number 4,649,113 reported that cellulose from peanut shell was extracted by using sodium hydroxide pH 11.2-11.8 for 24 h. This was because the solubility of protein increased with increasing pH, reaching the maximum at pH 12 and decreasing thereafter pH >12 (Intarasil and Sringam, 2006; Praksash, 1996).

Table 2 : Total lipid content of banana peel powder stage 7 after ethanol extraction

Sample	Total lipid content (%)
Control	4.34 ± 0.74^{a}
90% EtOH, 8 h	0.89 ± 0.07^{b}
95% EtOH, 8 h	0.72 ± 0.07^{bc}
99% EtOH, 8 h	0.35 ± 0.19^{cd}
90% EtOH, 16 h	0.48 ± 0.02^{bcd}
95% EtOH, 16 h	0.37 ± 0.04^{cd}
99% EtOH, 16h	0.23 ± 0.02^{d}
90% EtOH, 24 h	0.28 ± 0.02^{cd}
95% EtOH, 24 h	0.18 ± 0.02^{d}
99% EtOH, 24 h	0.21 ± 0.02^{d}

Mean values followed by the same letter in the same column (a-d) are not significantly different (P>0.05)

Table 3 : Protein content of banana peel stage 7 after sodium hydroxide extraction

Sample	Protein content (%)
Control	3.74 ± 0.42^{a}
pH 11.6, 8 h	3.83 ± 0.45^{a}
pH 11.8, 8 h	4.15 ± 0.12^{a}
pH 12.0, 8 h	3.57 ± 0.41^{ab}
pH 11.6, 16 h	3.85 ± 1.00^{a}
pH 11.8, 16 h	3.27 ± 0.04^{abc}
pH 12.0, 16 h	3.77 ± 0.85^{a}
pH 11.6, 24 h	2.75 ± 0.48^{bc}
pH 11.8, 24 h	2.48 ± 0.03^{c}
pH 12.0, 24 h	2.48 ± 0.02^{c}

Mean values followed by the same letter in the same column (a-c) are not significantly different (P>0.05)

3. Bleaching of cellulose

The L* significantly increased ($P \leq 0.05$) with increasing concentration of hydrogen peroxide and time of extraction (Table 4). Sample with hydrogen peroxide 20% had significantly higher ($P \leq 0.05$) L* than that of other samples except those extracted with hydrogen peroxide 15% for 3, 6 and 7.5 h. For saving of chemical and time, using hydrogen peroxide of 15% for 3 h for bleaching was selected for further experiment. When comparing this finding with cellulose from other raw materials, it was found that for pine apple core used hydrogen peroxide 35% for 3 h (Prakongpan *et al*., 2002), rice straw used hydrogen peroxide 1% for 3 h (Chareonsinsap *et al*., 2005), and for soybean residues used hydrogen peroxide 50% for 30 min (Yunchalard *et al*., 1997). The

concentration of solution and time of bleaching differed entirely depending on natural pigments presented in the raw materials to be bleaching.

Table 4 : Color of banana peel stage 7 after hydrogen peroxide extraction

Condition	Color		
	L*	a*^{ns}	b*^{ns}
10%, 1.5 h	82.08±0.12^{d}	-1.75±1.11	15.17±0.08
10%, 3.0 h	83.44±0.21^{c}	-1.85±1.06	15.97±1.30
10%, 4.5 h	83.53±0.10^{c}	-1.89±1.04	15.87±1.15
10%, 6.0 h	83.51±0.17^{c}	-1.87±1.07	15.90±1.23
10%,7.5 h	84.21±0.15^{b}	-1.96±1.06	15.94±1.18
15%,1.5 h	83.68±0.10^{c}	-1.95±1.09	15.25±0.03
15%, 3.0 h	84.66±0.11^{a}	-1.91±1.13	16.10±1.18
15%, 4.5 h	84.37±0.24^{b}	-1.84±1.06	15.87±1.18
15%, 6.0 h	84.72±0.15^{a}	-1.90±1.11	15.94±1.16
15%, 7.5 h	84.65±0.07^{a}	-1.95±1.10	16.00±1.28
20%, 1.5 h	84.21±0.11^{b}	-1.87±1.05	15.34±0.08
20%, 3.0 h	84.77±0.10^{a}	-1.91±1.10	16.14±1.05
20%, 4.5 h	84.75±0.09^{a}	-1.89±1.06	16.18±0.88
20%, 6.0 h	84.73±0.11^{a}	-1.89±1.04	16.54±0.88
20%, 7.5 h	84.89±0.10^{a}	-1.96±1.08	16.57±0.74

Mean values followed by the same letter in the same column (a-d) are not significantly different (P>0.05)

^{ns} Means in column are not significantly differences (P>0.05)

6. Properties of BPC compared to the commercial cellulose

BPC had moisture, total lipid, protein, carbohydrate, ash and water activity significantly higher ($P \leq 0.05$) than that of commercial cellulose (Table 5). On the other hand, the commercial cellulose had fiber and cellulose significantly higher ($P \leq 0.05$) than that of BPC. It was obvious that the unwanted compounds in BPC should be further removed in order to produce more purity cellulose.

Table 5 : Chemical properties of cellulose from banana peel compared to that of commercial cellulose

Chemical properties	Cellulose from banana peel	Commercial cellulose
Moisture (%)	5.61±0.15[a]	2.25±0.02[b]
Total lipid (%)	2.57±0.10[a]	0.66±0.06[b]
Protein (%)	1.65±0.01[a]	0.26±0.06[b]
Carbohydrate (%)	52.56±0.64[a]	24.44±2.87[b]
Ash (%)	4.04±0.14[a]	0.03±0.01[b]
Fiber (%)	33.57±0.65[b]	72.36±2.87[a]
Cellulose (%)	75.90±1.39[b]	98.89±0.17[a]
Water activity	0.47±1.27[a]	0.11±0.02[b]

Mean values followed by the same letter in the same row (a-b) are not significantly different (P>0.05)

BCP had significantly lower (P≤0.05) L* and oil holding capacity than that of commercial cellulose but had significantly higher (P≤0.05) pH and water holding capacity than that of commercial cellulose (Table 6). Even though the L* of BCP was significantly lower (P≤0.05) than that of commercial cellulose but the value was higher than 80 and light enough in color (Figure 1) which considered accepted for utilization in food products.

Table 6 : Physical properties of cellulose from banana peel compared to that of commercial cellulose

Physical properties	Cellulose from banana peel	Commercial cellulose
L*	84.66±0.11[b]	98.61±0.05[a]
pH	6.05±0.05[a]	4.92±0.77[b]
Water holding capacity (g water/g dried sample)	2.91±0.15[a]	1.93±0.82[b]
Oil holding capacity (g oil/g dried sample)	0.08±0.00[b]	3.17±0.06[a]

Mean values followed by the same letter in the same row (a-b) are not significantly different (P>0.05)

(A) banana peel cellulose (B) Commercial cellulose

Figure 1 : Color of BPC (A) compared to commercial cellulose (B)

CONCLUSION

The production process of BPC was succeeded by using 3 types of chemicals; ethanol, sodium hydroxide and hydrogen peroxide. The appropriate extraction and bleaching of BPC included using ethanol 90% for 16 h for removal of lipid; using sodium hydroxide pH 12.0 for 24 h for elimination of protein and using hydrogen peroxide 15% for 3 h for bleaching and washed twice with distilled water and dried at 50°C for 8-10 h. Finally the BPC was obtained with L* of 84. The commercial cellulose had more purity than that of BPC.

ACKNOWLEDGEMENT

Sincere thank was expressed to Office of National Research Council of Thailand (NRCT) for financial support.

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PESTICIDES DISSIPATION ON VEGETABLE: IMPACT OF CLIMATE ON FOOD SAFETY

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Pesticides are applied repeatedly in intensive vegetable production system. Their persistency and residue need to be studied to ensure food safety. From our residue monitoring, about 10 % of the green mustard (*Brassica juncea*) samples analysed annually were found to contain excessive pesticide residues. Acephate, chlorpyrifos, and cypermethrin accounted for 70% of the pesticides violation in vegetables. A study was carried out to determine the dissipation of these pesticides in green mustard at two experimental sites with different climatic conditions. Commercial products consisted of Impact 75 (acephate) and Agent 505 (cypermethrin and chlorpyrifos) were applied four times at weekly intervals before harvest. Dissipation of acephate, chlorpyrifos and cypermethrin followed first-order kinetics with half-lives of 1.6-2.1, 1.1-1.5, and 1.6-3.1 days, respectively. Higher rainfall and sunlight appeared to accelerate pesticide dissipation but with least effect of rainfall on chlorpyrifos. Pesticides with higher vapour pressure appeared to degrade faster. A pre-harvest interval of 13, 13 and 3 days were required for acephate, chlorpyrifos, cypermethrin and their metabolite residues to comply with the permissive level. The results showed that the dissipation of pesticides was influenced by the climatic conditions and the metabolite need be taken into account when establish the food safety levels and making recommendation for their use.

INTRODUCTION

Green mustard (*Brassica juncea*) is a vegetable crop widely grown and consumed in Malaysia. It is grown throughout the year with very short crop cycles of about one month. Different types of insecticides are used on green mustard depending partly on the types of insects, and the pre-harvest interval (PHI) of the insecticides. Frequency of spray mainly depends on size and nature of insect populations, and partly on climatic and other site characteristics. From our residue survey, 10.5% of the green mustard analysed in 2009 were found to contain pesticide residues exceeding the Maximum Residue Limits (MRL) (Chai, 2009). Acephate (*O,S*-dimethyl acetylphosphoramidothioate), chlorpyrifos (*O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate), and cypermethrin [(RS)-α-cyano-3phenoxy benzyl(1RS)-cis,trans-3-(2,2-dichlorovinyl)2,2-dimethyl cyclopropane carboxylate] are commonly used for the control of insects in vegetable production. These three insecticides accounted for 70% of pesticide violation in vegetables.

Many factors contribute to pesticide deposition and residue dissipation including the morphology of the crop, cuticle characteristics, stage of growth at treatment, growth

rate, pesticide application method, and climate (Ebeling, 1963). Pesticide dissipation rates are crop-specific, and hence its residues must be examined individually according to the prevalent climatic conditions of a country (Ripley *et al*., 2001). Dissipation of pesticides in temperate vegetable crops has been studied (Anthonius, 2001; Ripley *et al*., 2003; Zhang *et al*., 2006). However, data on dissipation of pesticides in tropical vegetables are relatively few. Higher and frequent rainfall, high temperature and higher solar radiation can increase the rate of pesticide dissipation in the tropics (Chai *et al*., 2009a). However, the fate of some pesticides in tropical soils has been studied (Chai *et al*., 2008, 2009b, 2010). The Malaysian MRLs for acephate, chlorpyrifos, cypermethrin and acephate metabolite, methamidophos, in green mustard are 0.01, 0.01, 1.0, and 0.01 mg kg^{-1}, respectively (Anon, 2002). The three insecticides selected in our study have different water solubility (Montgometry, 1993). Acephate is hydrophilic with very high water solubility of 650 g L^{-1} (at 25 ^{o}C) while both chlorpyrifos and cypermethrin are hydrophobic with low water solubilities of 0.4 and 0.004 mg L^{-1}, respectively (at 25 ^{o}C). Also the vapour pressures (25 ^{o}C) of the insecticides differ widely: acephate (0.2 mPa), chlorpyrifos (2.5 mPa), and cypermethrin (8.7 x 10^{-4} mPa). The aim of the present investigation was to determine the dissipation kinetics of acephate, chlorpyrifos and cypermethrin on green mustard after foliar application. The effect of climate on their degradation and the actual PHI required to comply with the food safety levels were also studied.

MATERIALS AND METHODS

Field dissipation studies

Two locations differing in climate were used for the experiments: Balai Ringin (N 01^{0} 02' 48.9", E 110^{0} 48' 21.7'), and Tarat (N 01^{0} 12' 01.9", E 110^{0} 31' 15.3'). Young seedlings of green mustard (20 days old) were transplanted from nursery into the field at a density of 16 per m^{2}. The two commercial pesticide formulations used in this study were Impact 75 (acephate, 75% w/w) and Agent 505 (cypermethrin, 4.59 % w/w; chlorpyrifos, 45.9 % w/w). Five liters of diluted Impact 75 (1 g L^{-1}) or Agent 505 (1 mL L^{-1}) solutions were sprayed onto the three replicate plots of green mustard using a knapsack sprayer, immediately after young seedlings had been transplanted into the field. Pesticides were applied again on green mustard three more times, at weekly intervals, on day 7, 14 and 21 after transplanting. For each site, 1 kg of green mustard was harvested from the three plots with the same treatment at day 21 (2 h after the 4^{th} pesticide application), 23, 25, 27, 34 and 41. The experiment at Balai Ringin site was repeated for Agent 505 as the vegetables were destroyed by pests.

Climate

The maximum and minimum air temperatures during the experimental periods were close to 32^{o}C and 23^{o}C, respectively, while the average relative humidity was 84 %. The meteorological data for mean air surface temperature, sunshine and rainfall varied at the experimental sites (Table 1). In general, the mean air surface temperatures were

quite similar ranging from 25.7 to 27.1 ^{o}C. The amount of sunshine was higher at Tarat (20.3-41.6 h) and Balai Ringin (26.8-35.8) as compared to the repeated experiment at Balai Ringin site (10.4-25.0 h). Mean while, the amount of rainfall was also higher at Tarat (66.5-154 mm) as compared to Balai Ringin (28.0-91.5 mm) and repeated experiment at Balai Ringin (21.0-71.5 mm).

Table 1. Climatic data at Tarat and Balai Ringin sites during the experimental period

Day	Tarat			Balai Ringin			Balai Ringin-repeat		
	Mean air surface temperature [a] (^{o}C)	Sunshine [b] (h)	Rainfall [c] (mm)	Mean air surface temperature [a] (^{o}C)	Sunshine [b] (h)	Rainfall [c] (mm)	Mean air surface temperature [a] (^{o}C)	Sunshine [b] (h)	Rainfall [c] (mm)
Day 0-6	26.3	32.5	154	26.3	10.4	54.5	26.4	31.5	21
Day 7-13	26.1	20.3	66.5	26.7	20.5	53.5	26.3	33.2	71.5
Day 14-20	25.9	41.6	106	26.9	18.5	70.5	26.8	30.1	31
Day 21-27	26	26.5	131	26.5	25	91.5	26.4	28.3	41.5
Day 28-34	25.8	27.4	106	27.1	12	28	27.0	35.8	64.5
Day 35-41	25.7	31.5	98	26.4	18.6	40.5	26.2	26.8	46.5

[a] Air temperatures were measured using a platinum thermometer (Korea)

[b] Sunshine was measured using a solar remeter (Kipp Zonen, The Netherlands)

[c] Precipitation was recorded using a Rimco tipping bucket instrument (Australia)

Analysis of pesticide residues in vegetables

The pesticides were extracted from the vegetable samples using an established procedure (Steinwandter, 1985). A vegetable sample (50 g) was homogenized with acetone (100 mL), dichloromethane (75 mL) and sodium chloride (15 g). The extract was concentrated and injected into a gas chromatograph (GC) equipped with a flame photometric detector for acephate, methamidophos and chlorpyrifos determination. For cypermethrin, the extract was cleanup with deactivated silica gel (10 g). The eluate was injected into a GC equipped with an electron capture detector.

Data Analysis

The data for pesticide dissipation was fitted by first-order kinetics; $C_t = C_0 e^{-kt}$ using a non-linear least squares regression analysis of residue concentration against time using TableCurve (Systat Software Limited, U.S.A.), where C_t is the concentration at time *t,* C_o is the initial concentration and *k* is the rate constant.

RESULTS AND DISCUSSIONS

Recoveries of pesticides and metabolite in green mustard were better than 85.5 % with standard deviations below 5.1 % (data not shown). The limit of quantification for pesticides and metabolites in green mustard was 0.01 mg kg^{-1}. The concentrations of acephate in green mustard were monitored after the last application on day 21. An exponential dissipation was observed with 30–45 % decrease in acephate concentrations from day 0 to 2 (Figure 1). At day 4, acephate residues were between 3.50–4.47 mg kg^{-1}. A period of 13 days was needed before acephate dissipated completely to comply with the MRL. Differences in acephate concentrations among the two sites were observed after the last spraying, day 0 (8.8–14.0 mg kg^{-1}). The highest concentration of methamidophos was detected between day 0 and 2 (Figure 1). The dissipation data for acephate were fitted by first-order degradation kinetics (r^2 > 0.94) resulting in rate constants and corresponding half-lives of 0.432±0.089 d^{-1} (1.6 d), and 0.331±0.066 d^{-1} (2.1 d) for Tarat and Balai Ringin, respectively.

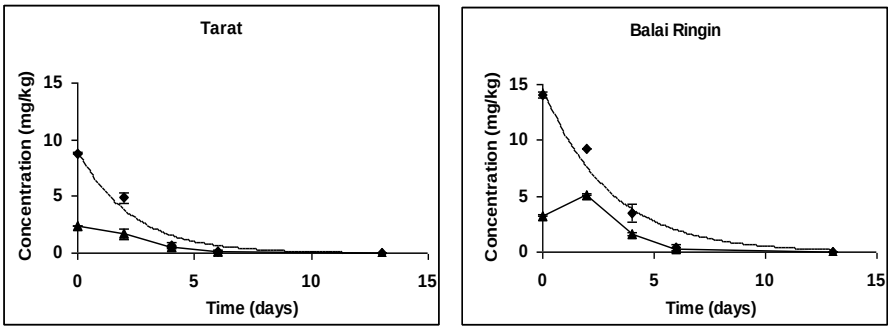

Figure 1. Concentration of acephate (♦) and methamidophos (▲) versus time after the last (4th) acephate application on green mustard at day 21 (= day 0 in graph) at Tarat and Balai Ringin (n=3).

Chlorpyrifos dissipated exponentially with time, more rapidly than acephate with 57–70 % degraded within the first two days (Figure 2). The concentrations of chlorpyrifos were below 1.0 mg kg^{-1} at day 4 for Tarat, while, additional two days were required for Balai Ringin. A period of 21 days was needed for complete chlorpyrifos dissipation. Initial chlorpyrifos concentrations after the last spraying were in the range of 5.91–12.7 mg kg^{-1}. The rate constants and corresponding half-lives for chlorpyrifos, fitted by first-order degradation kinetics (r^2 > 0.99), were 0.642±0.042 d^{-1} (1.1 d), and 0.467±0.022 d^{-1} (1.5 d) for Tarat and Balai Ringin sites, respectively. Cypermethrin quickly dissipated with 29–43 % degradation occurring within the first two days after the last cypermethrin application (Figure 2). Cypermethrin dissipated below 1 mg kg^{-1} at day 3 and dissipated completely at day 21. The initial concentrations of cypermethrin after the last spraying were quite similar at the three sites (1.56–2.2 mg kg^{-1}). The rate constants and corresponding half-lives for cypermethrin fitted by first-order degradation kinetics (r^2 > 0.97) were 0.432±0.031 d^{-1} (1.6 d), and 0.222± 0.033 d^{-1} (3.1 d) at Tarat and Balai Ringin, respectively.

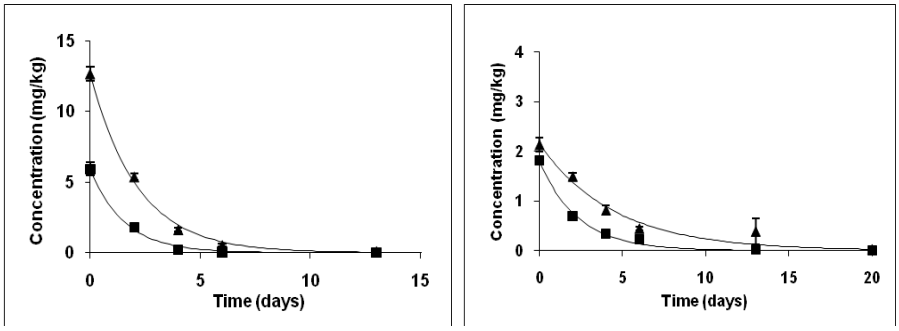

Figure 2. left: Concentration of chlorpyrifos versus time after the last (4th) application on green mustard at day 21 (= day 0 in graph) at Tarat (■) and Balai Ringin (▲) (n=3). Right: Concentration of cypermethrin versus time after the last (4th) application on green mustard at day 21 (= day 0 in graph) at Tarat (■) and Balai Ringin (▲) (n=3).

Dissipation of pesticide residues

Acephate degraded rapidly in green mustard. A PHI of 13 days was required for acephate to comply with the MRL and dissipated completely. The differences in initial acephate concentrations (8.8–14.0 mg kg^{-1}) among sites at day 0 were probably due to different plant sizes as bigger plants with larger leaf surface area trap higher amounts of pesticide compared to smaller plants (Anthonius, 2001). The green mustard at the Balai Ringin site had the largest leaf area and hence had the highest content of pesticide residues. The half-lives of acephate reported in our study (1.6–2.1 d) were shorter compared to those reported earlier for tomato (5.8 d) (Anthonius, 1994), cucumber (3.7 d) and pepper (6 d) (Anthonius, 1995) grown under a temperate climate. It has been previously reported that the application of acephate in lettuce and celery resulted in residues of methamidophos, which is more toxic than the parent compound (Anthonius, 1994). Methamidophos dissipated gradually to 0.01 mg kg^{-1} in compliance with the MRL at day 13 after the last acephate application. Thus, the usage of acephate on green mustard requires a PHI of 13 days in order for both acephate and methamidophos to comply with the MRL.

Similar fast degradation was seen for chlorpyrifos and cypermethrin. The half-lives for chlorpyrifos (1.1–1.5 d) obtained in this study were shorter compared to those reported for cabbage (2.9–3.6 days) (Ripley *et al*., 2003; Zhang *et al*., 2006), tomato and green bean (4– 5 days) (Vidal *et al*., 1998) grown in a temperate climate. Among the three pesticides, cypermethrin was the most persistent one and could be detected up to 21 days after the last pesticide treatment, which is equal to or longer than observed for temperate areas, despite having the lowest active ingredient of 4.59% (Ripley *et al*., 2001). The half-lives for cypermethrin (1.6–3.1 d) are quite similar to those reported for cabbage (2.6–4.9 days) (Ripley *et al*., 2003; Zhang, *et al*., 2006, 2007), and head lettuce (2.8–3.3 days) (Ripley *et al*., 2001) grown in a temperate climate. Hence, contrary to acephate and chlorpyrifos, cypermethrin does not appear to dissipate faster in tropical than in temperate vegetables. The number of pesticide applications, and type of vegetables (leafy/fruit or leaf size) may contribute to the persistence.

Impacts of climate

Rainfall, and hence pesticide wash-off from leaves can cause rapid dissipation of pesticides (Zhang *et al*., 2006; Xu, *et al*., 2008). The acephate and cypermethrin dissipation from day 0 to 4 after the last pesticide application followed the order Tarat > Balai Ringin. This is in reasonable agreement with rainfall data: Tarat (27 mm, day 0) and Balai Ringin (10.5 mm, day 0; 33.5 mm, day 1). However, rainfall showed a lesser effect on the dissipation of chlorpyrifos, in agreement with a previous study on cabbage (Zhang *et al*., 2006). Rapid dissipation of cypermethrin due to rainfall has also been reported for cabbage (Zhang *et al*., 2006). The losses of pesticides by solar radiation are directly related to the input of solar radiation and heat (Anthonius *et al*., 1994; Rudel, 1997). High volatility of organophosphorus compounds have been commonly observed (Preito *et al*., 2002; Vidal *et a*l. 1998), and photodegradation influences both organophosporus and pyrethroid insecticides (Zhang *et al*., 2006, 2007). Sunshine can caused rapid pesticide degradation. The amount of sunshine from Day 14-20 before the last spray for Tarat, Balai Ringin and repeated experiments at Balai Ringin were 41.6, 18.5, and 30.1 h, respectively. It was observed that the higher amount of sunshine at Tarat resulted in shortest half-lives of all three insecticides in green mustard. Similar observation was noted when comparing degradation of pesticides at Balai Ringin site. The vapour pressures for the three pesticides are: chlorpyrifos (2.5 mPa) > acephate (0.2 mPa) > cypermethrin (0.00019 mPa). This is the reverse sequence of the average half-lives with cypermethrin (2.4 days) > acephate (1.9 days) > chlorpyrifos (1.3 days) indicating that solar radiation and hence volatilization and photo degradation may also contribute to dissipation in green mustard.

CONCLUSION

The results from this study showed that the persistence and dissipation of the three pesticides on green mustard varied among sites and may have been affected by plant size, rain and solar radiation. The rate of dissipation could all be fitted by first-order kinetics. The average half-lives of acephate were 1.9 days while for chlorpyrifos and cypermethrin the half-lives were 1.3 and 2.4 days, respectively. Rainfall was associated with acephate and cypermethrin dissipation but evidently did not affect chlorpyrifos dissipation. High solar radiation and hence volatilization and photo degradation appeared to increase pesticide dissipation on the vegetables. A PHI of 13, 13 and 3 days were required for acephate (including its metabolite), chlorpyrifos and cypermethrin to degrade below the national tolerance levels in green mustard. The results from this study show that the metabolites need to be taken into account when establishing the national tolerance levels and also when making recommendations for their use.

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NONDESTRUCTIVE SPECTROPHOTOMETRIC ASSESSMENT OF FOOD QUALITY

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The important aspects on quality food production are the acceptable nutritional values and its internal properties such as vitamin C, sweetness, total soluble solids and ripeness. Most analytical techniques used in the quality control of such parameters required isolation and destruction of the food component of interest which resulted in destroying the original properties of the food during sample preparation. The analyses also require expensive, time consuming and sophisticated instrumentation. This study aims to evaluate the ability of near infrared spectroscopy (NIRS) as a nondestructive technique to predict the fruit quality using honey pomelo as example. Major emphasis is placed on the development of a calibration-predictive model as a possible on-line measurement tool for quality control. NIR spectra was obtained from a total of 315 pamelo fruit samples from Sungai Sadit, Kabuloh, Tarat, Sungai Ilas and Semongok in Sarawak. Calibration equations for the quality parameters were optimized and developed using partial least squares (PLS) regression analysis. The robustness of the calibration model was tested by validation sets with independent honey pomelo samples. Results demonstrated that all the quality parameters being studied could be predicted precisely. The standard error of prediction (SEP) for brix, TSS, pH, acidity and Vitamin C were 0.51%, 0.88 g/100mL, 0.13, 0.08% and 5.46 mg/100mL, respectively. NIRS had shown to be an efficient and accurate tool for measuring internal quality of honey pomelo. Such rapid and precise nondestructive technique could help growers to determine the fruit quality during harvesting and post-harvest storage, thus ensuring proper utilization and food security.

INTRODUCTION

In the context of food security, individuals need adequate amounts of a variety of quality and safe foods in order to be healthy and well-nourished. However, qualitative losses usually occur in horticultural crops between harvest and consumption. Qualitative losses such as loss in edibility, nutritional quality, caloric value and consumer acceptability of the produce are much more difficult to assess than quantitative losses. Furthermore, elimination of defects before marketing based on the appearance quality of a given commodity is often over-emphasized, causing great amount of postharvest losses. It is estimated that about one third of all fruits and vegetables produced are never consumed by humans (Kader, 2005).

To date, most commercial quality classification systems for fruit and vegetables are based on the external aspect of the produce like color, size and presence of blemishes. This is because only these attributes could be determined by human eyes non-destructively in short time. As food security also takes into consideration on the nutritional needs, assessment on the internal qualities of fruits in addition to its appearance are also important. Nevertheless, the fruit quality cannot be guaranteed unless it has been sent to the laboratory for destructive analysis. Commercially, the use of destructive analyses can be expensive and time consuming as it involves protocols that destroy the whole fruits. Destructive method can only be applied to a sample of produce. Non destructive method on the other hand can be used for the whole production without having to destroy high fruit numbers during quality control, thus reducing unnecessary wastage and operative cost.

Current technology involved non-destructive quality measurement includes Magnetic Resonance Imaging (MRI) (Andaur *et. al*., 2004), Fourier Transform Infrared (FTIR) (Bellincontrol *et.al*., 2009), Laser-induced Fluorescence Spectroscopy (LIFS) (Wulf *et. al.,* 2005), Time-Resloved Reflectance Spectroscopy (Zerbini *et. al.,* 2005), Proton Transfer Reaction Mass Spectrometry (PTR-MS) (Barbon *et. al.,* 2005), and Near Infrared Spectroscopy (NIRS) (Dolores, *et. al*., 2009). Among the non-destructive technologies, the measuring procedure based on NIRS shows most promising with a wide range of application. In NIRS, the fruit is irradiated with light in the near infrared spectral region (600-2500nm). The spectra in this region contain abundant information reflecting the structure of molecules as well as attributes of fruits such as firmness, total soluble solids, etc. NIR absorption bands are produced when NIR radiation at specific frequencies resonates at the same frequency as the molecular bond in the test sample. This allows association of a specific wavelength with a specific chemical bond vibration generating a specific spectra that in turn is related to concentration of a specific component. The reflected or transmitted radiation by test samples is then mathematically compared with the spectra of reference samples that have been assayed previously by standardized wet chemistry or non-NIR methods. A specialized computer software (chemometrics) then uses the mathematical relationship to combine the NIR spectra and accompanying chemistry analysis as reference to generate a NIR predictive model used to predict composition of the test samples (Sapienza *et. al.*, 2008).

Numerous studies on the application of NIR for estimation of TSS and firmness have been undertaken for fruits like apple, mango, peaches and kiwi (Zanella *et. al*., 2005). However, little information is available on the use of NIR devices for pomelo. The pomelo fruit has recently gained much attention because of its antioxidant properties as studies found extracts of carotenoids, phenolic, lycopene and anthocyanin in the fruit (Keshani *et. al*., 2010). The honey variety of the pomelo is most popular in Sarawak because of it sweet taste, high percentage of edible portion, thin skin and easy to peel. An important quality criterion regarding internal properties of honey pomelo fruits is its sweetness. In addition, routinely determined total soluble solids, acidity and juiciness as well as the composition of organic compounds represent important organoleptic quality criteria of the fruit. It is thus crucial to develop a method to determine its quality parameters objectively to ensure that fruit meets certain expected standards in both local and export markets. This paper reports on the findings of NIRS as non-destructive method to determine honey pomelo fruit quality.

MATERIALS AND METHODS

Samples preparation

A total of 315 honey pomelo samples were used in this study where 241 samples of different quality from Sg. Sadit (Sibu Division), Kabuloh (Miri Division) and Tarat (Samarahan Division) were used to provide a normal distribution for calibration. Forty independent samples from the same location were used for internal validation where the prediction residuals were calculated by applying the calibration model to the validation set. Another 24 honey pomelo samples obtained from a different orchard at Sg. Ilas (Sarikei Division) were used in external validation where the validation dataset is independent. In addition, 10 honey pomelo samples harvested from Semongok (Kuching Division) were used for comparison study. All fruits were harvested by hand and transported to the Postharvest Technology Centre in an air-conditioned land cruiser, except fruits from Kabuloh were sent by air cargo.

Spectral Acquisition

Fruit samples were measured at the near infrared short wavelength region of 680nm to 2500nm. A commercially available NIR spectrometer 'SpectraStar 2500 N.I.R. Analyser' (Unity Scientific) was used for this purpose. The NIR spectrum was obtained at

the fruit base by averaging 15 scans. Periodic reference measurement was performed every 30 minutes.

Chemical Analysis

Fruits which were illuminated by NIR radiation for acquisition of spectra were taken immediately and analyzed for brix, pH, TSS, vitamin C and percentage of acidity. For destructive analysis, brix reading and pH were measured by a refractometer and pH meter respectively on homogenized fruit juices. Total soluble solid was measured by drying sample at 75^{o}C for 16 hours while vitamin C was measured by iodine titration with 1% soluble starch as indicator solution. Determination of titratable acidity was performed by titration with 0.1N NaOH using phenolphthalein as indicator solution.

Data Analysis and Modeling

For all NIR calculations, samples were manually separated into calibration and validation sets as described above. Data pre-processing procedures was conducted to optimize the data set by sample set compression, spectral data compression, system error removing and data smoothing. Calibration was performed by a calibration development software for chemometric applications, Calstar^{TM} (Version 2.02). Multiple linear regressions (MLR) and partial least squares regression (PLSR) were used to develop calibration equations. The calibration models were then applied to the validation set to generate a "goodness of fit" prediction model.

The accuracy and robustness of the models used for estimating brix, pH, TSS, vitamin C and acidity were evaluated based on the calculated statistics for multiple coefficient correlation (R), standard error of calibration (SEC), standard error of prediction (SEP) and the model bias.

Prediction of fruit quality

The predictive models generated from NIRS were tested on honey pomelos from five different locations, namely Sg. Sadit, Tarat, Kabuloh, Sg. Ilas and Semongok. The differences in quality performance of fruits from different locations were analyzed with one-way ANOVA ($P<0.05$), using Duncan multiple range test (DMRT) for mean comparison (Genstat 5).

RESULTS AND DISCUSSION

Calibration results for determining the brix, TSS, pH, acidity and vitamin C are shown in Table 1. Calibration based on PLSR showed best result. Fifteen factors were used for the PLS regression equation for optimized result. Brix and TSS showed the multiple correlation coefficients (R) nearest to 1.0 which indicates a perfect correlation. In reality, the optimum value of 1.0 can never be achieved and as a rule of thumb a value above 0.75 normally indicates a useable correlation (Abdi, 2007).

Validation procedure was applied to assess the accuracy of the calibration model and to identify overfitting. Validation results are also shown in Table 1 where standard error of prediction (SEP) for brix, TSS, pH, acidity and vitamin C indicated a low prediction error. In addition, external validation using fruit samples from Sg. Ilas showed sufficiently accurate prediction with SEP similar to that from internal validation.

Table 1: Calibration and validation results for nondestructive prediction of honey pomelo fruit quality.

Properties	[1]N	[2]F	[3]R	[4]SEC	Internal validation		External Validation	
					[5]SEP	[6]Bias	[5]SEP	[6]Bias
Brix (^{o})	238	15	0.91	0.99	0.51	0.01	0.61	0.42
TSS (g/100mL)	241	15	0.91	1.19	0.88	-0.09	0.97	0.87
pH	241	15	0.85	0.14	0.13	-0.08	0.11	0.01
Acidity (%)	217	15	0.88	0.09	0.08	0.01	0.08	0.03
Vitamin C (mg/100mL)	234	15	0.79	7.55	5.46	-0.84	5.47	4.09

[1]**N** Number of sample/spectra used for calibration.
[2]**F** Number of factor used for PLS calibration equation.
[3]**R** Multiple correlation coefficients.
[4]**SEC** Standard error of calibration.
[5]**SEP** Standard error of prediction.
[6]**Bias** The average of difference between actual value and NIR predicted value.

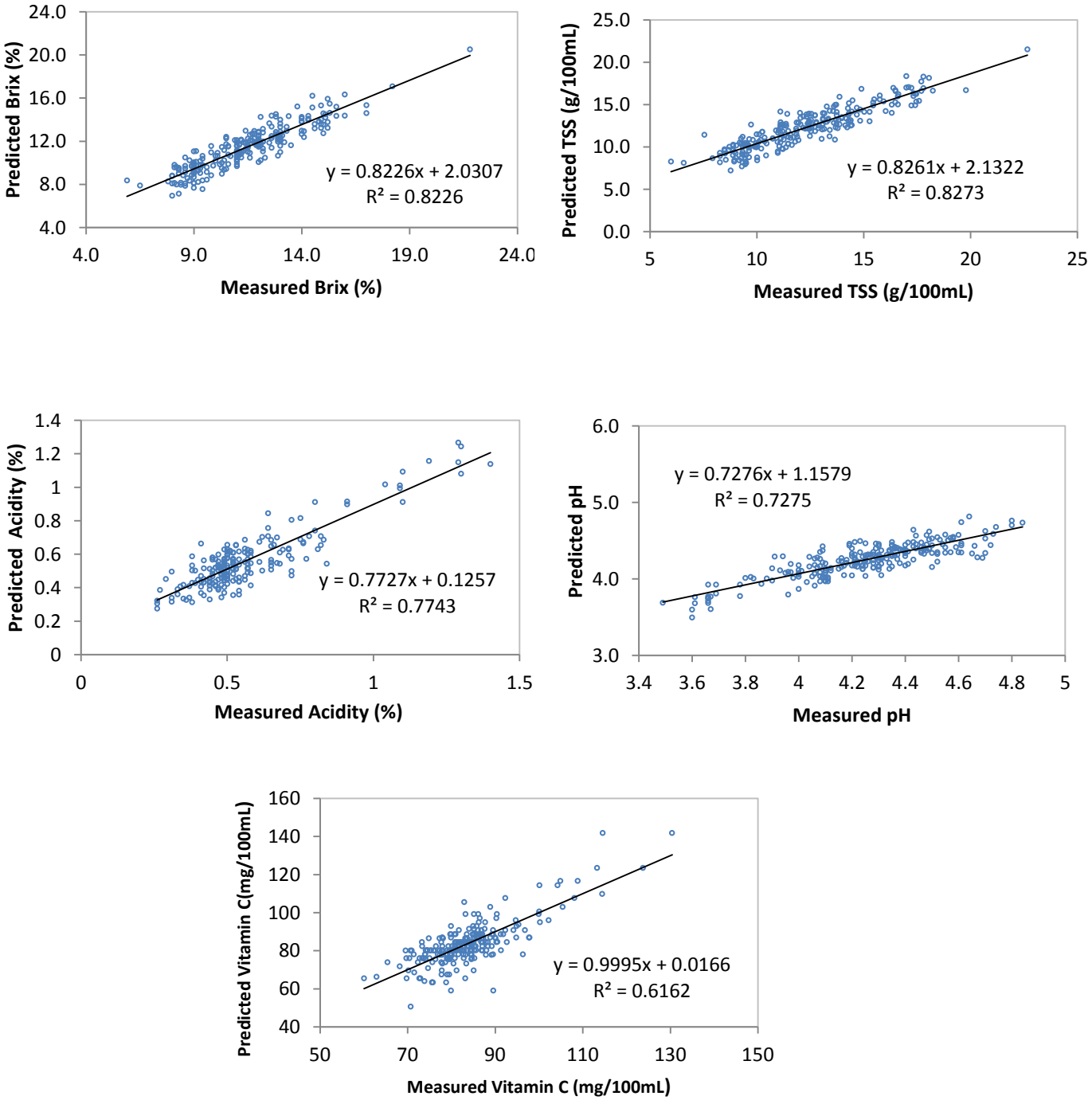

Figure 1: Prediction of fruit quality parameters from NIRS data. The measured quality value (destructive) is plotted against the predicted value by PLS calibration model (non-destructive). Each point represents a single fruit at measurement.

The degree to which the measured fruit quality parameters are related to the predicted value is expressed as R^2 (coefficient of determination n) and is used to evaluate model fit (Figure 1). R^2 close to 1.0 indicates a good regression equation. The model were able to predict the brix and TSS more precisely as shown by the high R^2 values (>0.82). The regression equations obtained for acidity, pH and vitamin C also indicated a reliable model fit with R^2 values of more than 0.61.

According to Sapienza *et. al*. (2008), reliable NIRS values comes from carefully selected and prepared reference samples to calculate the relationship of absorbance to concentration based on Beer's Law (light absorbance = adjustment factor x path length x concentration). The accuracy of the developed calibration equations were successfully validated both internally and externally by using independent honey pomelo samples from the same and different orchards. This implies that the predictive models developed can be used to assess pomelo fruits from other orchards as well.

The prediction of fruit quality from different locations showed that the brix reading and TSS for fruits from Kabuloh, Sg. Sadit and Sg. Ilas were significantly higher than fruits from Semongok and Tarat (Table 2). Pomelos from Sg. Sadit had the highest TSS content of 12.06 g/100mL whilst Sg. Ilas showed the highest brix reading of 11.56% similar to previous work reported by Pearlycia and Lau (2009). The quality parameters for acidity (0.55-0.64%), pH (4.08-4.35) and vitamin C (91.91-77.45mg/100mL) were quite similar for fruit samples from Semongok, Tarat, Kabuloh, Sg. Sadit and Sg. Ilas. There were no significance differences between Sg. Sadit and Sg. Ilas for all the quality parameters studied. This showed the fruits from these two orchards were of same quality. From this study, non-destructive measurements of internal quality of pomelo by NIRS were successfully determined. This is in contrary to the report by Nicolai *et. al.* (2005) that the applicability of NIR to fruit with a thick peel might be limited because of their relatively small penetration depth. In this case, honey pomelo has shown to be the variety of better choice for NIRS analysis as it has a thinner skin (1-1.5cm) compared to other varieties of pomelos (2-3cm).

Table 2: Average fruit quality of honey pomelo predicted by NIRS.

Location	Brix (%)	Acidity (%)	pH	TSS (g/100mL)	Vitamin C (mg/100mL)
Semongok	8.06[b]	0.55	4.35	8.53[b]	82.29
Tarat	8.60[b]	0.64	4.18	8.76[b]	91.91
Kabuloh	10.98[a]	0.63	4.33	10.98[a]	77.45
Sg. Sadit	11.19[a]	0.64	4.09	12.06[a]	88.31
Sg. Ilas	11.56[a]	0.62	4.08	11.73[a]	86.43

Different letters in superscript indicate means are significantly different ($p<0.05$).

CONCLUSION

This work showed that NIR spectroscopy can be used to determine several parameters of internal quality such as sweetness, total soluble solids, acidity, pH and vitamin C in honey pomelo. The introduction of this non-destructive measurement technique will ensure premium quality fruits that command premium market price in addition to their good appearance. The application of NIRS in the agriculture production line will help to reduce waste, increase productivity and eventually save cost because of its rapid and non-destructive measurement capability. It could also help to ensure that fruit meets the expected quality standards for both local and export markets. Further work on the prediction of ripeness index by NIRS prior to fruit being harvested would play an important role in improving the harvest quality of honey pomelo.

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DETERMINATION OF 16 POLYCYCLIC AROMATIC HYDROCARBONS IN OIL MATRIX USING DONOR-ACCEPTOR COMPLEX CHROMATOGRAPHY

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ABSTRACT

Palm oil is traded all over the world as food uses for many decades ago. Hence the safety of the traded oils is an important especially the issues on health problems become critical . One of the important issue is polycyclic aromatic hydrocarbons (PAHs), which are known as food borne contaminants and can be analyzed in edible oils. The analysis is categorized as trace analysis due to low level quantification of individual PAHs at microgram per kilogram. Generally, the analysis of PAHs in fatty matrix involves tedious sample preparation and time consuming. In this study, 16 PAH compounds in oil matrix were analyzed within 50 minutes compared to conventional method, 8-10 hours. PAHs in edible oils were determined by on-line coupling of DACC column onto HPLC with fluorescence detection. The oil samples were eluted over the DACC column which would act as an electron acceptor. The column would retain the PAHs compound (electron acceptor) by π-π interactions. After the oil has eluted, the PAHs were transferred on-line to analytical reversed phase column. Then, the individual PAHs were detected at different wavelengths. The retention time of individual PAHs were used to identify the individual compound and the levels of PAHs in oil samples were calculated by external calibration. The 16 PAH compounds were successfully separated using this method . The method validation for 16 individual compound was carried out based on linearity and limit of detection (LOD) and limit of quantification (LOQ) determination. Results showed that R^2 values were in the range of 0.9989–0.9917 and the LOD and LOQ of this method was 0.1 ppb.

Keywords: polycyclic aromatic hydrocarbons, donor-acceptor complex chromatography, HPLC, trace analysis, LOD, LOQ

INTRODUCTION

PAHs constitute a large class of organic compounds containing two or more fused aromatic rings made up of carbon and hydrogen atoms. Hundreds of individual PAH may be formed and released as a result of incomplete combustion or pyrolysis of organic matter, during various processes and other human activities. These include processing and preparation of food and carbonization of wood to make charcoal. Most of the PAHs are carcinogenic and mutagenic to the living things.

PAHs are contaminants in food. The sources of PAHs contamination could be from food processing or from the environment. PAHs may be formed during processing both in the industry and in domestic food preparation, such as smoking, drying and cooking (roasting, baking, frying, and grilling/barbecuing). Among the cooking process, grilling/barbecuing result in the highest levesl of PAHs in food. There are several pathways of PAHs formation such as pyrolysis of melted fat dripping onto the heat source (as in barbecuing) and pyrolysis of food as a result of cooking temperatures above 200°C. In data reviewed by Scientific Committee on Food (SCF), cereals and vegetable, fats and oils were found to be the major contributors to PAHs in diet while grilled/smoked/barbecued fish and meat showed relatively low contribution except in cultures where those two products are a significant part of the diet. Furthermore, cereals and oil seeds also may have a major impact on PAHs intake, There is a need to control the levels of PAHs in agriculture crops, post-harvest, with particular attention to storage and drying procedures.

Numerous investigators have reported the presence of PAHs in edible oils and fats. The PAHs are formed during the pyrolytic process like incomplete combustion of organic substances or are of petrogenic origin mineral oils. Edible oils may be contaminated by environmental pollution and or processing steps prior to refining. Their presence in edible oils is a health concern because of their carcinogenicity.Different levels of PAHs have been observed in crude edible oils. Refining of the oils (deodorization, bleaching, charcoal treatment) under appropriate conditions, depending on initial levels of the PAHs, reduces the content of the individual PAH to μg/kg (ppb) levels.

MATERIALS AND METHODS

Chemicals and Reagents

- A mixture of standard solution consists of Napthalene, Acenapthalene, Acenapthane, Fluorene, Phenanthrene , Anthracene, Fluoranthene, pyrene, chrysene, benzo[a]pyrene, dibenz[ah]anthracene, Benzo[a]anthracene, benz[j]fluoranthene, benzo(ghi)perylene , benzo[k]fluoranthene and Indenol (1,2,3 cd)pyrene was obtained from BCR Standard SRM 1647 (Geel, Belgium), 5 methylcrysene, Benzo(j)fluoranthene, dibenzo(ah)pyrene, Dibenzo(ae)pyrene, Dibenzo(ai)pyrene, Dibenzo(al)pyrene and Benzo(chrysene) standards in acetonitrile, 99% purity were obtained from Dr Erhenstofer.
- Isopropanol
- Acetonitrile
- Ethylacetate
- Deionised water
- Palm Olein (Blank Oil)
- Crude Palm Oil,canola oil, corn oil, red palm olein, rice bran oil, single fractionated palm oil, soya bean oil, and sunflower oil

Apparatus

- analytical balance, 0.001g
- HPLC-vials with septum
- Microfilters 0.4um
- Liquid chromatography system with
  HPLC-pump (isocratic) from Agilent 1200, gradient-pump from Agilent 1200, autosampler, injection volume 200 µL, Agilent 1200 G1329 ALS with heating plate temperature up to 45C,donor-Acceptor Complex chromatography (DACC) column, chrompack,80*3 mm Chromspher PI, RP18, diameter = 7um,reversed Phase Column, Chrompack, 250*4.6 mm Chromspher 5 PAH, diameter = 7 um (2 unit), column oven, heating temperature, 25°C for PAHs group A and 37°C for PAHs group B) and fluorescence detector

Preparation of the samples

1.0 gram of oil sample was weighed and dissolved in 1.5 mL isopropanol prior to injecting into the HPLC system**.**

Experimental

Column switching programme

The automated clean-up method using DACC column was carried by injecting sample into the sample loop and at the same time DACC column was conditioned with the initial mobile phase composition using gradient mode. Then, within 10 min to 12 min, the injector valve was switched and clean-up process was performed on the DACC column. Meanwhile, the syringe and the needle of the auto sampler were then rinsed. Within 145s, SPE valve, extra valve and the solvent select mode were switched and the DACC column was set back to flush mode. Then, the redundant isopropanol was discarded as waste by the extra valve and the injection system was rinsed for the injection of next sample. Within 5 min, the extra valve was switched and the back flush eluent was set to the analytical column. With the length of time of 57 min, the SPE valve was switched, then the DACC column was set back to normal mode and rinsed. Then, the separation on the analytical column was continued for 50 min.

RESULTS AND DISCUSSION

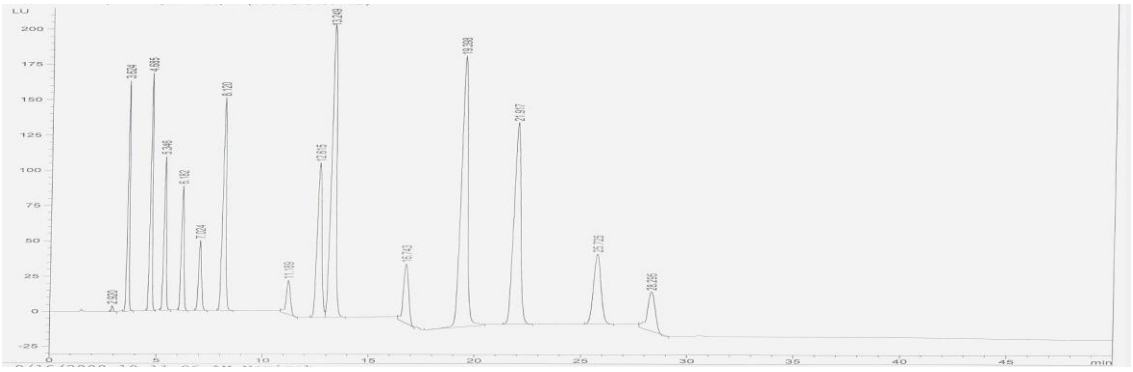

Figure 1: HPLC chromatogram for PAHs standard

Result ppb	Canola Oil	Corn Oil	Red Palm Olein	Rice Brain Oil	Single – Fractionated palm oil	Soya Bean Oil	Sun Flower Oil	Palm Oil
Light	**FSC/PAH 000010708**	**FSC/PAH 000020708**	**FSC/PAH 000030708**	**FSC/PAH 000040708**	**FSC/PAH 000050708**	**FSC/PAH 000060708**	**FSC/PAH 000070708**	**FSC/PAH 000080708**
Benzo (a) anthracene	ND (< 0.5 ppb)	1.0 ppb	ND (< 0.5 ppb)	1.8 ppb	1.9 ppb	0.7 ppb	ND (< 0.5 ppb)	1.6 ppb
Chrysene	ND (< 0.5 ppb)	0.6 ppb	0.7 ppb	2.3 ppb	2.4 ppb	ND (< 0.5 ppb)	ND (< 0.5 ppb)	1.9 ppb
Total								
Heavy								
Benzo(a) Pyrene	0.1 ppb	0.3 ppb	0.2 ppb	ND (< 0.1 ppb)	0.5 ppb	0.1 ppb	0.1 ppb	1.0 ppb
Benzo(b) fluoranthene	0.1 ppb	0.9 ppb	0.3 ppb	0.2 ppb	1.6 ppb	0.1 ppb	0.2 ppb	0.8 ppb
Benzo(c) fluorene	ND (< 1.0 ppb)	ND (< 1.0 ppb)	ND (< 1.0 ppb)	ND (< 1.0 ppb)	ND (< 1.0 ppb)	ND (< 1.0 ppb)	ND (< 1.0 ppb)	ND (< 1.0 ppb)
Benzo(j) fluoranthene	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)
Benzo(k) fluoranthene	0.1 ppb	0.2 ppb	0.1 ppb	0.1 ppb	0.4 ppb	ND (< 0.1 ppb)	ND (< 0.1 ppb)	0.4 ppb
Benzo(g,h,i) perylene	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)
Cyclopenta(c,d) pyrene	ND (< 1.0 ppb)	ND (< 1.0 ppb)	0.1 ppb	ND (< 1.0 ppb)	ND (< 1.0 ppb)	ND (< 1.0 ppb)	ND (< 1.0 ppb)	ND (< 1.0 ppb)
Dibenzo(a,h) anthracene	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)
Dibenzo(a,e) pyrene	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)
Dibenzo(a,h) pyrene	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)
Dibenzo(a,i) pyrene	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)	ND (< 0.4 ppb)
Dibenzo(a,l) pyrene	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)	ND (< 0.2 ppb)
Indeno(1,2,3-cd) pyrene	ND (< 0.5 ppb)	ND (< 0.5 ppb)	ND (< 0.5 ppb)	ND (< 0.5 ppb)	ND (< 0.5 ppb)	ND (< 0.5 ppb)	ND (< 0.5 ppb)	ND (< 0.5 ppb)
5-methylchrysene	0.1ppb	0.2 ppb	0.2 ppb	0.6 ppb	0.2 ppb	ND (< 0.5 ppb)	ND (< 0.1 ppb)	ND (< 0.1 ppb)

The PAHs content varies due to different smoking point and processing of the oils. The smoking point of palm olein, corn oil and canola oil is 212°C, 210°C and 205°C respectively. The processing of palm oil from palm fruit does not involved “direct drying with fuel gases” such as for seed oils, where there is a possibility of direct contact of PAHs with raw material.

PAHs are lipophilic compounds it can be either environment-born or food-born contaminant to human. The presence of PAHs and other potentially chemicals in edible oils are due to various ways such as handling and processing of the oil seeds and cooking style. A proper handling and processing of the oil seeds and selection of cooking style can minimize the occurring of contamination and the risk of lung cancer. Hence, the selection of the type of cooking oils has also contributed to the various health problems. The processing of crude oil to refine oils has reduced all contaminants in edible oils and the levels are within the acceptable range (table 1). Hence, for the countries where the primitive population still uses crude oils for cooking, the chances to obtain chronic diseases are very high. From this study, we can conclude that, vegetable oils are safe to be consumed while contamination occurs due to human activities

CONCLUSION

Palm oil and palm oil products are safe for consumers . The level of PAHs are below the reccomended limit of 2 µg/kg.

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SUGARCANE QUANTITATIVE AND QUALITATIVE CHARACTERS UNDER THE INFLUENCE OF HARVESTING DATES

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ABSTRACT

The field and laboratory studies were conducted at Sindh Agriculture University, Tandojam, Pakistan on different harvesting dates viz. 1st November, 15th November, 30th November, 15th December and 30th December. Harvesting date had significant (P<0.01) effect on almost all the quantitative and qualitative characters of promising variety GT-11. Cane yield ha^{-1} improved gradually with the increase in period between sowing to harvesting, but it started reducing when harvesting delayed over 15th December. Sugar recovery improved remarkably with each delay in the cane harvesting and crop harvested latest by 30th December produced the highest sugar recovery. This increase in the sugar recovery was mainly association with prolonged maturity of the cane and reduction of moisture which resulted in increased ratio of sugars over moisture content. The results suggested that early harvested crop in November could produce higher cane yields as compared to the crop harvested later in December. However, the sugar recovery was remarkably higher in late harvested sugarcane in the end of December as compared to the crop harvested in November.

Keywords: Sugarcane, harvesting dates, qualitative, quantitative, characters

INTRODUCTION

Sugarcane harvesting is a critical step that must be managed to maintain its quality and quantity (IKisan, 2005). Usually farmers harvest sugarcane crop during crushing season of mills without considering crop maturity or delayed crashing after cutting. Tinnangwattana (2008); Ahmed and El-Sogheir (2002) found considerable reduction in sugarcane yield and its associated qualitative characters due to delayed or earlier crop harvesting. Many researchers; Bekheet (2006); El-Shafai and Ismail (2006); Ahmed *et al.* (2008); Ahmed and Khaled (2009) also observed that brix, sucrose, purity and reducing sugar differed significantly due to harvesting dates and varieties. Other investigators Rizk

and Normand (1966); Ahmed and El-Sogheir (2002); Besheit *et al.* (2003); Abazied (2005) reported that delaying delivery of sugar cane reduced the qualitative characters of sugarcane. Improper harvesting time and delayed crushing markedly affected brix and cane juice (Taha *et al*., 2008), increased percentage of soluble solids, decreased cane weight and losses in sugar conversion (Besheit*et al.* 2003), decreased sucrose percentage (Hoekstra, 1975; Bekheet, 2006), affected sugar recovery (El-Shafai and Ismail, 2006; Ahmed *et al.,* 2008). Looking the facts of sugar shortage and low sugarcane yields in the country, the present study was taken in hand to examine the effect of different harvesting dates on the quantitative and qualitative characters of sugarcane.

MATERIALS AND METHODS

The field and laboratory studies were conducted at Sindh Agriculture University, Tandojam, Pakistan on different harvesting dates viz. 1st November, 15th November, 30th November, 15th December and 30th December. The experiment was set in randomized complete block design. Growth and cane yield characters of sugarcane promising variety GT-11 were measured at the field in standing crop, while brix and sugar recovery analyses were done at Sugarcane Section, Agriculture Research Institute, Tandojam, pakistan. The experimental land was prepared well before sowing by deep plowing followed by precise leveling. The ridges/ furrows were prepared at the distance of 100 cm. The 2-4 budded sets treated with Vitavax @ 120 g/100 litre water were placed in the furrows and then covered with soil and field was irrigated immediately. In all 20 irrigations were given during the entire growing period. The NPK fertilizers were applied at the recommended dose of 272-111-173 kg ha-1. Weeds were removed from young crop, until the crop reached at certain height to shed the weeds. The weeds were controlled through Gezapex Combi within a period of 3 months after planting. Earthing were was done when ever necessary. Furadan 3G was applied against the stem borers. The data collected were analyzed statistically using analysis of variance, and LSD test was applied to discriminate the superiority of the means of different harvesting dates as suggested by Gomez and Gomez (1984)..

RESULTS AND DISCUSSION

Cane length

Cane length increased significantly with increase in period between sowing to harvesting. However, the differences in cane length were statistically non-significant ($P>0.05$) when harvesting was delayed beyond 436 days after sowing. Crop harvested after 466 days of sowing (30th December) produced significantly greater cane length (193.80 cm) on average, closely followed by 192.50 and 189.30 cm average cane length recorded in sugarcane crop harvested after 451 days (15th December) and 436 days of sowing (30th November), respectively. The sugarcane crop harvested after 421 days of sowing (15th November) produced average cane length of 185.00 cm, while the minimum cane length (178.30 cm) on average was recorded in crop harvested after 406 days of sowing (1st November). The results suggested that there was no economical effect on the sugarcane crop in relation to cane length if crop is harvested after 30th November. These results are in concurrence to those of Mamet et al. (1996) that early ripening sugarcane varieties are a prerequisite for improving sugar yields at the beginning of the harvest.

Cane girth

The cane harvested after 436 days of sowing (30th November) produced significantly greater cane girth (3.33 cm) on average, closely followed by 3.32 and 3.32 cm average cane girth

recorded in crop harvested after 451 days (15th December) and 466 days of sowing (30th December), respectively. The sugarcane crop harvested after 421 days of sowing (15th November) produced average cane girth of 3.22 cm, while the minimum cane girth of 3.11 cm was recorded in crop harvested after 406 days of sowing (1st November). The cane girth was improved gradually with the increase in period between sowing to harvesting. However, the differences were statistically non-significant (P>0.05) when harvesting was delayed beyond 436 days after sowing and there was no economical effect on the standing sugarcane crop in relation to cane girth if the harvesting is delayed beyond 30th November, because the differences in cane girth in crop received growth periods of 436, 451 and 466 days were statistically non-significant. In contrast, Ahmed et al. (1999) reported that prolonging growth period had no effect on cane height and thickness.

Internodes cane^{-1}

Harvesting of cane after 436 days of sowing on 30th November produced relatively greater number of internodes (19.85) cane-1, followed by crop harvested after 466 and 451 days of sowing (30th and 15th December) that produced equally 19.05 and 19.05 internodes cane-1 on average, respectively. The sugarcane crop harvested after 421 days of sowing (15th November) produced 17.40 average number of internodes cane-1, while the lowest number of internodes cane-1 (17.30) on average was recorded in crop harvested after 406 days of sowing (1st November). Internodes cane-1 increased significantly with increase in period between sowing to harvesting. However, the differences in internodes cane-1 were not so remarkable when harvesting was delayed beyond 436 days after sowing. These results are in close conformity to those of Ghosh and Singh (2001) growth traits were superior early harvested (October) crop compared to late harvested crop of November.

Weight of 10 canes

Sugarcane harvested after 436 days of sowing (30th November) produced significantly greater weight of 10 canes (12.40 kg) on average, followed by 11.77 kg and 11.56 kg average weight of 10 canes recorded in crop harvested after 421 days (15th November) and 451 days of sowing (15th December), respectively. The sugarcane crop harvested after 466 days of sowing (30th December) produced 10.45 kg average weight of 10 canes, while the early harvested sugarcane crop on 1st November (406 days after sowing) produced 10.63 kg average weight of 10 canes. The results suggested that there was no economical effect on the standing sugarcane crop in relation to weight of 10 canes if the harvesting is delayed beyond 30th November, because weight of 10 canes was considerably decreased when the crop was harvested on 15th December or later. These results are further supported by Rajput (2005) also reported significant increase in cane weight in prolonged growth periods.

Cane yield

Cane yield ha-1 was significantly maximum (85.90 m.t) in crop harvested after 436 days of sowing (30th November), followed by average cane yield of 83.60 m.t and 83.17 m.t ha-1 recorded in crop harvested after 421 days (15th November) and 451 days of sowing (15th December), respectively. The sugarcane crop harvested after 466 days of sowing (30th December) produced average cane yield of 79.97 m.t ha-1, while the early harvested sugarcane crop on 1st November (406 days after sowing) produced lowest cane yield of 78.40 m.t ha-1. Cane yield started reducing considerably when harvesting delayed over 15th December. Supporting the findings of the present study, Ghosh and Singh (2001) that cane yield, number of millable canes, plant height, number of shoots, germination, and sucrose percentage in the juice and juice brix in October harvested crop was relatively less as compared to November harvested crop. Rajput (2005) also reported different results of cane yield at different harvesting times.

Brix

Brix content was significantly higher (20.82 %) in juice obtained from the crop harvested after 466 days of sowing (30th December), followed by average brix content of 19.17 % and 17.48 % noted in crop harvested after 451 days (15th December) and 436 days of sowing (30th November), respectively. The sugarcane crop harvested after 421 days of sowing (15th November) produced average brix content of 16.73 percent, while the early harvested sugarcane crop on 1st November (406 days after sowing) produced lowest brix content of 16.05 percent. The brix content was improved linearly with each delay in the crop harvesting and crop harvested latest by 30th December had the highest brix contents. This increase in the brix content might have the association with prolonged maturity and moisture reduction with delay in harvesting. Chang (2000); Singh et al. (2000) also suggested to adjust the time of harvest of sugarcane crop for achieving satisfactory brix and yield.

Sugar recovery

Sugar recovery was significantly higher (10.24 %) in juice obtained from the crop harvested after 466 days of sowing (30th December), followed by average sugar recovery 9.81 % and 8.63 % noted in crop harvested after 451 days (15th December) and 436 days of sowing (30th November), respectively. The sugarcane crop harvested after 421 days of sowing (15th November) produced average sugar recovery of 8.30 percent, while the early harvested sugarcane crop on 1st November (406 days after sowing) produced lowest sugar recovery of 7.75 percent. Sugar recovery improved remarkably with each delay in the crop harvesting and crop harvested latest by 30th December produced the highest sugar recovery. While in contrast, Ahmed et al. (1999) reported that prolonging growth period had no effect on cane height and thickness, but cane weight was deteriorated a little. Moreover, recovery was also in decreasing trend with delayed harvesting.

Conclusions

The context of the findings from the present study suggested that early harvested crop in November will produce higher cane yields as compared to the crop harvested later in December. However, the sugar recovery was remarkably higher in late harvested sugarcane in the end of December as compared to the crop harvested in November.

Table 1. Quantitative and qualitative traits of sugarcane as affected by different harvesting dates.

Harvesting dates	Cane length (cm)	Cane girth (cm)	Internodes cane^{-1}	Weight of 10 canes (kg)	Cane yield (m.t ha^{-1})	Brix (%)	Sugar recovery (%)
Harvesting after 406 days of sowing (1st November)	178.30b	3.11b	17.30b	10.63c	78.40c	16.05d	7.75e
Harvesting after 421 days of sowing (15th November)	185.00ab	3.22ab	17.40b	11.77b	83.60b	16.73d	8.30d
Harvesting after 436 days of sowing (30th November)	189.30a	3.33a	19.85a	12.40a	85.90a	17.48c	8.63c
Harvesting after 451 days of sowing (15th December)	192.50a	3.32a	19.05ab	11.56b	83.17b	19.17b	9.81b
Harvesting after 466 days of sowing (30th December)	193.80a	3.32a	19.05ab	10.45c	79.97c	20.82a	10.24a
S.E±	3.258	0.0562	0.918	0.0561	1.109	0.1250	0.0260

CD1	7.113	0.3490	1.413	0.3490	1.553	0.5215	0.2378
CD2	9.703	0.4761	1.928	0.4761	2.119	0.7113	0.3244
CV%	4.89	5.33	4.44	6.33	7.22	1.69	1.85

Means followed by common letter do not significantly differ at 5% probability level.

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PROJECTING CLIMATE CHANGE IMPACTS ON AGRICULTURE AND FOOD SECURITY IN IRAN

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ABSTRACT

Climate change plays a significant role in reducing food security although there is controversy over its importance in the present circumstances of extraordinarily rising prices of foods. Future climate change is likely to affect agriculture and pose a risk of hunger and water resource scarcity. Although Iran has not so far been a major contributor to rapid climate change, the global impacts of climate change are inevitable in this country. With rapid population growth, economic development and dependency on traditional energy sources, we anticipate the agricultural sector to receive the hardest hit, along with a concomitant deepening rural poverty and falling overall economic development process. In this study, a global climate change model (GCCM) was employed as a tool to project the climate change scenarios in Iran. Two of the Java Climate Change Model (JCCM) scenario families, A1 and B1, were employed and helped us to identify the challenges of climate change over the next decades. The results illustrated that Iran will experience an increase in the temperature from16.41◦C to18.60◦C in next 80 years. Model predictions demonstrated that the wheat production in Iran will be 57% higher than current levels though the FAO projected it to increase should to 70 %. It was concluded that management options and adaptation strategies would improve the land and agricultural production conditions, thus reducing the pressure arising from climate change and concomitant risks in Iran.

Key words: Climate change, Agriculture sector, Food security, Iran, IPCC scenarios

INTRODUCTION:

Future climate change is likely to affect agriculture and a risk of hunger and water resource scarcity is expected with increased and fluctuating climate change variability (Cruze, et al., 2007) The third assessment report (TAR) of IPCC predicted that the area-averaged annual mean warming would be about 3 ºC in the decade of 2050 and about 5 ºC in the decade of 2080 over the land regions of Asia as a result of future increases in atmospheric concentrations of green house gases (Lal, et al., 2001a)

Production of rice, maize and wheat in the past few decades declined in many parts of Asia due to increasing water stress arising from increasing temperature, increasing frequency of El Niño and decline in the number of rainy days (Aggarwal.P.K., et al., 2000;

fischer, M.Shah, & Velthuizen, 2002; Jin, C.L.Shi, and, & W.Gao, 2001; Tao.F., M.Yokozawa, Y.Hayashi, and, & E.Lin, 2003a; Tao.F., et al., 2004; Wijeratne, 1996).

Climate change, biodiversity loss, hunger and poverty, rural development and regulation of world trade are challenges that face the global agriculture and the available and exploited agricultural area(BirdLife, 2009). Projections based on population growth and food consumption patterns indicate that agricultural production should increase by at least 70 % to meet demands by 2050.(Leslie Lipper & al., 2010)

Iran is a Middle Eastern country located south of the Caspian Sea and north of the Persian Gulf. Its size is three times the size of Arizona. Its population was estimated in early 2010 to be 67,037,517 capita with a yearly growth rate of 0.9%.According to data released by statistics office of the American ministry of agriculture, the production rate of the three main cereals crops in Iran have been increased. .(Zare feyz abadi,ahmad et al,2006.). Further research is still needed for decision makers in Iran to better understand the complex mechanisms linking agricultural production, food consumption, environmental degradation and social problems. The root problem is that many people cannot afford food because of poverty. Poverty has many causes including lack of access to credit and secure land tenure, poor governance and infrastructure and lack of access to health care and education(BirdLife, 2009). Many studies on the impacts of climate change on agriculture and possible adaption options have been published.(BatimaP., et al., 2005c; Cruze, et al., 2007; IPCC, 2000; Lal, 2007; Parry, 2002)

In this study we try to project the increases in temperature using time series analysis with real historic data covering more than 40 years and then compare our findings with the six main IPCC climate change A and B scenario families. Warming projections under the A1F1 emissions scenarios showed that there will be a decrease in crop yields ranging from 2.5 to 10% in 2020 and from 5 to 30 % in 2050 in parts of Asia(Parry, Rosenzweig, Iglesias, Livermore, & Fischer, 2004). The yield of rice was observed to decrease by 10% for every 1 ºC increase in the minimum temperature during the growing season (Peng, et al., 2004). Cereal yields may decrease to 30% of the current amounts by 2050 even in south west Asia and climate change is likely to cause severe water stress in the 21st century.

MATERIAL AND METHOD

The model recommended by the IPCC for projecting the Scenarios Factors is Java Climate Change Model (JCCM) which is a very useful tool for projecting indicators, especially temperature for next decades. According to a special report of emission scenarios (SRES), four qualitative storylines yield four sets of scenarios called "families" of A1, A2 B1, and B2. three groups within the A1 family characterizing alternative developments of energy technologies of the A1F1 (fossil fuel intensive), A1B (fossil fuel balanced), and A1T (predominantly non-fossil fuel) (IPCC, 2000). Within each family and group of scenarios, some procedures share "harmonized" assumptions on global population, gross world product, and fuel energy (IPCC, 2000).

This paper has computed the increase in temperature in Iran using 40-year time series secondary data under the A1B1 and A1F1 scenarios. We have used time series methods for model selection, parameter estimation, temperature forecasting and testing for fitness of the time series model to the input data. The model type which is reported to fit similar data sets is the so-called ARIMA (p, q, r) model. The confidence level in all of our tests was set at 95%. In the other words, the results of the tests, parameter estimations, and model estimations are accepted at the 5% level of error.

RESULT AND DISCUSSION:

The results illustrate that the Iranian agricultural GDP will increase over the study period and that the oil GDP will also increase, but to a greater extent. It seems that dependency on oil production is very high. In descending order, the components of the Iranian GDP are services, oil, industry and agriculture. So, what will be the situation of the Iranian agriculture GDP in the future?

Time series analysis revealed that the rural population of Iran is decreasing whereas the urban one is increasing. The average rate of the inflation is increasing too. Production rate of wheat and rice exhibit a trend of increase while the production rates of other products don't change. Additionally, the levels of production rates of protein products such as milk, meat and chicken are increasing in Iran. On the other hand, the time series forecasts of other variables and parameters in Iran are summarized in Table 1 below.

Table 1.time series forecasts of changes in population and agricultural production in Iran

No	Variable	Remarks on changes from current status	No.	Parameter	Remarks on changes from current status
1	Population	Sharp increase	6	Milk production	Increasing
2	Total population	Increasing	7	Meat production	Increasing
3	Urban population	Increasing	8	Chicken	Increasing
4	Rural population	Decreasing	9	Milk production	Increasing
5	Average annual inflation	Increasing	10	Rice land area	Increasing

The time series analysis and predictions demonstrate that, without taking the effects of climate change on agricultural production, the Iranian wheat production will increase in the foreseeable future. The time series forecasts of agricultural production in Iran are summarized in Table 2 below.

Table 2.Forcasting the change of agricultural productions from current status

No.	Table 1. Time series forecasts of agricultural production in Iran		
1	Crop	Production Volume (ton)	Changes in Production Volumes
2	Grains	2932,000	no change
3	Rice	4615,000	increasing
4	Beet	7521,000	increasing
5	Green Tea	163,000	No change
6	Oil seed	615,000	No change
7	Cereals	678,000	No change
8	Wheat	26085,000	Increasing

The time series analysis of the temperature presented in figure 1 below, the temperature of Iran will increase same the A1F1 and A1B1 scenarios

We will experience increasing temperature in these decades. But the time series projections show that the temperatures predicted are almost same to A1B1 scenario. So, what we can do for reducing the impact of the climate change? Forecasting the temperature in Iran, from 16.41◦C in 2090 years it will be 18.60◦C in year . Also, it will change with minimum 15.31◦C to maximum 19.96 ◦C. this forecasting is very close to scenario A1B1 of the IPCC.

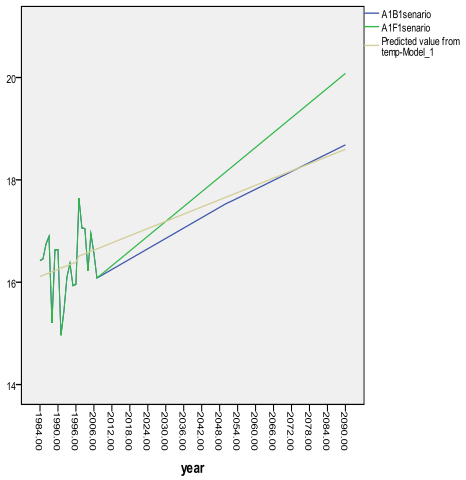

Figure1.projecting the change of temperature ◦C according predicted value and scenario A1B1 and A1F1 in Iran

With growing rate of the population in Iran the demands on food security are rising. So we will be experiencing increases in population, production and demand. Until 2020 the production will be more than the demand. But according to the A1F1 scenario, if the production rates decline to some level between 5 to 30 %, then after 2020 the demand will become more than the production rate. Due to the inflation and rising price products

such as that of rice, the people in rural areas will be facing poverty and their ability of the people to buying Iranian rice will be limited and hence consumption of this product will be limited and hence consumption of this product will be almost restricted to the rich population..

The government imports cheap rice from Pakistan and Thailand. The time series projecting of wheat production according forecasting value and scenario A1F1 in Iran are summarized in figure 2 below.

Also, we have increasing the rice cultivated land for wheat and rice. But for other products don't have very changing. According to the time series forecasting of the wheat as a major product of Iran, production rates will increase from 14,943,000 ton in 2005 it will increase to 26085000 ton in 2050 i.e., a 57% increase, which is lower than the FAO projection of a 70 % increase. Also, regarding A1F1 scenario if the products reduce 5 to 30 percent will be face to very less than demand amounts

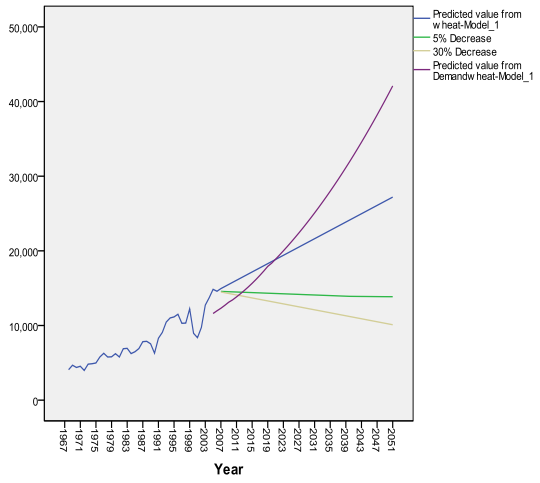

Figure2. Projected of wheat production ºC changes in Iran under model 1 and A1F1 scenario

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CONCLUTION:

Finally, policy should assist farming in adapting to the level of climate change that is unavoidable. So we have three main dilemmas to tackle of the increase the temperature in Iran around two degrees until 2050; the increases in demand on agricultural products;, and impact of climate change on production rate. Adaption strategies for tackling these challenges are badly needed. Means to deal with these challenges include choice suitable crop and cultivar like suitable varieties; management of agricultural practices, like use of fertilizers, pesticides; timing of planting; and adaptive strategies at farm level. Additional means include development of agricultural bio technologies, improvement of agricultural infrastructure like improving irrigation system, flood management, using or storing rainwater, farmers' access to timely weather forecasts. Adaptation strategies for reducing poverty as an important factor in sustainability of every sector are needed. These are may consists of providing fertilizer subsidies, especially for farmers in rural areas; conducting awareness programs about new agricultural technologies, securing fair prices for agricultural crops and implementing insurance policies. government policies recommendation should be consist of assist farmers in coping with current climatic risks, intensify food production systems, improve land and water management, support regional cooperation and Strengthen research for enhancing adaptive capacity. This policy framework should fit sustainable agricultural development at the global, national and local levels. rather than contributing to, climate change and tackles the prevalent challenges of agricultural areas and production degradation.

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ANALYTICAL METHODS FOR DETERMINATION OF 3-MCPD ESTERS IN REFINED OILS/FATS

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Abstract

Currently, the issue on 3-monochloropropane-1,2-diol (3-MCPD) esters is highly discussed at the global level. It is a process developed contaminants under the chloropropanols group and was first reported in 2004 by Svejkovska *et al*. In vegetable oils, formation of 3-MCPD esters occurs during refining of the crude oils at deodorization step. The main factors for the formation of 3-MCPD esters in oils/fats are the chloride content present in the processing aids, and high temperature during the deodorization step. It was reported that all vegetable oils contain certain amount of 3-MCPD esters, however some literature stated that palm oil products have the highest level of 3-MCPD esters determined using the DGF method (German Society for Fat Science). Since then, a few methods to determine 3-MCPD esters content in oils/fats have been developed by the German Federal Institute for Risk Assessment (BfR) and Archer-Daniels-Midland Company (ADM) in Europe and USA, respectively. The result from these methods varies depending on the reagents and hydrolysis time used in the analysis. This paper will discuss the method of analysis for the determination of 3-MCPD esters in edible oil and 3-MCPD esters content from commercial vegetable oils analysed in the laboratory.

Keywords: 3-MCPD esters, refined vegetable oils, DGF, BfR, ADM

Introduction

3-monochloropropane-1,2-diol (3-MCPD) is a member of a group of chemical contaminants known as chloropropanols that also includes known genotoxic carcinogens such as 1,3-dichloro-propan-2-ol (1,3-DCP) (Joint FAO/WHO Expert Committee on Food Additives 2001). They can be formed in foods as a result of processing/storage conditions (CCFAC 2005).

In fats and oils, 3-MCPD occurs in its free (diol) form as well as in an esterified (with fatty acids) form (Seefelder *et al.* 2008). Fatty acid esters of 3-MCPD are known precursors to the formation of 3-MCPD in model mixtures consisting of hydrochloric acid and triacylglycerols, phospholipids, soybean oil, soybean meal, wheat lipids and maize gluten lipids (Davídek *et al.* 1980; Velíšek *et al.* 1982).

In 2006, Zelinková *et al.* suggested that the 3-MCPD level strongly depends on temperature and the content of lipids, glycerol, salt and water. They believed that the precursors (acylglycerols and glycerol) will react with negatively charged nucleophiles, hydroxyl and chloride anions, which leads to the formation of 3-MCPD esters and to the free 3-MCPD. Their findings indicate that the formation of 3-MCPD esters (monoesters and diesters with higher fatty acids) is characteristic of a variety of processed foods (Divinová *et al.* 2004b; Svejkovská *et al.* 2004; Doležal *et al.* 2005), which is known as bound form of 3-MCPD. Svejkovská *et al.* (2006) also indicates that formation of bound 3-MCPD is a multivariate problem as it depends (at a given temperature) on water, fat, and salt contents as well as on the fat composition.

From the last few years, researchers have started to study the formation of 3-MCPD esters in the refined oils/fats. The levels of 3-MCPD esters in different types of vegetable oils / fats were also being investigated. However, different method of analysis has been used for identification of this compound since there was no standard method available yet. Recent data showed that the possibility of getting different results is high when different method is used. Research institutes / organizations such as the Federal German Institute for Risk Assessment (BfR) and the German Fat Science Society (DGF) have developed methods for determination of bound 3-MCPD in refined oils/fats. BfR for instance, has developed three different methods and round robin test was conducted to determine the repeatability, reproducibility and robustness of the methods. This paper will discuss on the determination of bound 3-MCPD in vegetable oils, particularly palm oil, by using one of the method which was developed by BfR, and to discuss other methods available.

Materials and Method

Chemicals and samples

3-chloropropane-1,2-diol (98%, 3-MCPD) was purchased from Merck (Darmstadt, Germany), 3-MCPD-d_5 (98%) from Cambridge Isotope Laboratories, Inc. (MA, USA), phenylboronic acid (PBA) from Merck (Darmstadt, Germany). All other reagents and solvents were of analytical grade.

Palm oil samples were collected from different refineries in Malaysia and stored in cold room before analysed.

Analysis of bound 3-MCPD

100 mg of the oil / fat sample is dissolved in t-BME and spiked with deuterium labeled 3-MCPD as an internal standard. Cleavage of the ester bond is performed by acid hydrolysis (methanol:sulphuric acid) and fatty acids and free 3-MCPD is formed. Reaction is stopped with saturated sodium hydrogen carbonate, defatted with hexane and the released 3-MCPD is derivatized with phenylboronic acid (PBA). After extraction with cyclohexane, sample is evaporated to dryness and dissolved in *iso*-octane before injected into the GC-MSD for quantification *(Method as described and developed by the Federal German Institute for Risk Assessment, BfR)*.

Instrumentation

Final detection of the analyte is by means of Gas Chromatography coupled with Mass Selective Detector (GC-MSD) from Agilent Technologies; equipped with a Series 5975C quadrupole detector and controlled by a programmable GC 7890A. Chromatographic separation was performed on a fused silica capillary column, DB-5MS inert (30 m length, 0.25 mm id, 0.25 µm film thickness). Gas Helium (purity 99.999%) is the carrier gas with a constant flow of 1.2 mL min^{-1}. The column temperature was programmed at 60^0C (1 min) to 190^0C (1 min) at the rate of 6^0C min^{-1}. Then, the temperature was accelerated to 280^0C at the rate of 30^0C (5 min). The injector was held at 180^0C with 1 µL sample was injected in a splitless mode. The quantitative analysis was carried out by monitoring characteristics ions at m/z 91, 147 and 196 respectively for derivative 3-MCPD; whereas for d_5-3-MCPD, characteristics ions were at m/z 93, 150 and 201. Qualifiers ions were m/z 147 towards m/z 201.

Results and discussion

Figure 1 shows the 3-MCPD esters level in palm oil samples collected from different stages of the refining process (Set 1, 2, 3, 4 and 5). The graph shows that 3-MCPD esters level was highest in RBD palm olein samples (3.0 – 3.9 mg/kg), and lower values were detected in bleached oil samples (0.25 – 0.9 mg/kg). The 3-MCPD esters level in RBD palm stearin samples were the same in all sets (1.5 – 1.7 mg/kg); however there was variation in the 3-MCPD esters level for RBD palm oil and RBD palm olein. 3-MCPD esters were preferentially partitioned into the RBD palm olein compared to RBD palm stearin.

Method verification was conducted and recovery was in the range of 70-120%. Linear calibration curve was established with r^2= 0.999.

Figure 2 shows a measurement of 3-MCPD esters through indirect method (BfR 008).

ADM has developed a method using LC-MS as a quantification toll. The method is a direct method for determination of 3-MCPD mono-esters and di-esters and glycidyl esters without chemical modifications (derivatization step) that may give incorrect results.

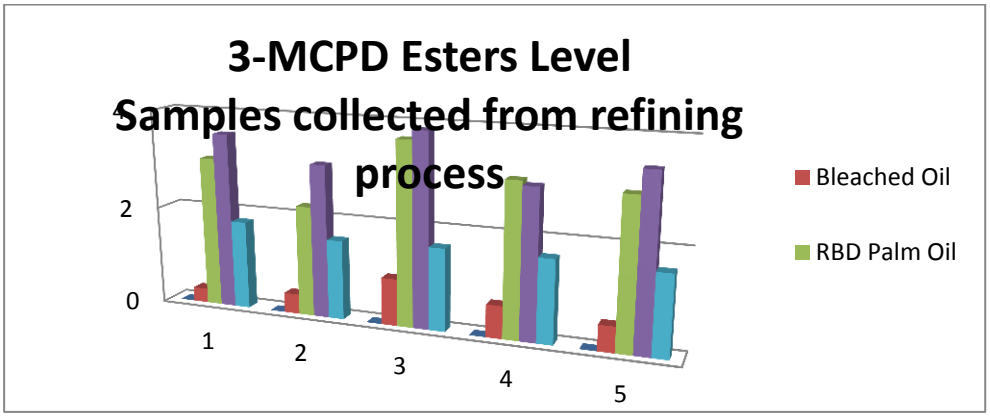

Figure 1: 3-MCPD esters level in palm oil samples collected from refining process

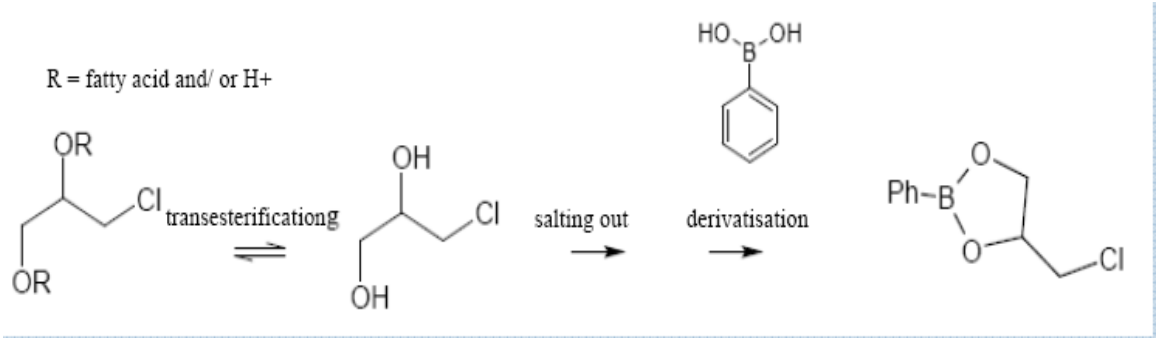

Figure 2: Measurement of 3-MCPD esters by indirect method *(Prof. Matthaus, Euro Fed Lipid Congress, 2010)*

Conclusion

3-MCPD esters are not detected / detected below the quantification level in CPO. The esters are partitioned preferentially in the olein phase during fractionation. Further investigation at the refinery and mills will be conducted.

There are a few methods that have been developed for determination of 3-MCPD esters. As far as the method is concerned, different methods may give different results. These methods will be widely used before a standard method has been established.

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VALIDATION OF THE HPLC-FLD METHOD FOR SIMULTANEOUS DETERMINATION OF MYCOTOXINS IN CEREALS

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Abstract

The validation of the procedure for quantitative analysis of aflatoxins (AFs), ochratoxin A (OTA), and zearalenone (ZEA) in cereals using a high-performance liquid chromatography (HPLC) with fluorescence detector (FLD) is described. Mycotoxins were extracted with methanol: water (80:20) and purified with a multifunctional AOZ immunoaffinity column before HPLC analysis. The validation of the analytical method was performed based on the following parameters: specificity, selectivity, linearity, limit of detection (LOD) and quantification (LOQ), accuracy, precision (within and between-day variability), stability, and robustness. The calibration curves were linear ($r > 0.999$) over the concentration range, from the LOQ to 26, 40 and 400 ng/ml for AFs, OTA, and ZEA, respectively. LOD and LOQ were 0.0125 and 0.05ng/g for AFB1 and AFG1, 0.0037 and 0.015 ng/g for AFB2 and AFG2, as well as 0.05 and 0.2ng/g for OTA and 0.5 and 2 ng/g for ZEA, respectively. The mean recovery values for AFs, OTA, and ZEA were 77.31 – 104.1% in the spiked cereal samples. Both intra-day and inter-day accuracy and precision were within acceptable limits. This method was successfully applied for the simultaneous measurement of mycotoxins for 60 cereal samples collected from Malaysian markets. A total of 50% of the cereal samples was contaminated with at least one of these mycotoxins, at a level greater than the limit of detection. Only one wheat sample and two rice samples were contaminated with levels greater than the regulatory limits of AFs and OTA (4 and 5 ng/g). The means and standard deviations of mycotoxins obtained for the analyzed cereal samples were 0.39 ± 1.12, 0.18 ± 0.96, and 2.76 ± 10.56 for total AFs, OTA, and ZEA, correspondingly. The results indicated that the procedure was suitable for the simultaneous determination of AFs, OTA, and ZEA in cereals and could be implemented for the routine analysis.

Key words: Validation; HPLC; Mycotoxin; Cereal; Multi-detection

Introduction

Due to widespread contamination of foods and feeds by mycotoxins and their adverse effects on humans and animals, determination of these toxic secondary metabolites of fungi was prompted. However, the legal limits vary significantly both from country to country and by mycotoxin type and matrix; the determination methods need to provide accurate and reproducible results both within and between laboratories. Analytical methods used by enforcement laboratories for the implementation of legislations must be subjected to validation procedures, in order to show that the method produces reliable results (Anklam et al. 2002). For adaptation as an official method, any proposed method should be validated not only in a collaborative trial study, but also in the matrices of concern and at levels close to the regulatory limits (Gilbert and Anklam 2002). However, established minimum requirements for the method performance depend on the contamination level; in most cases, methods were required to have recovery in the range of 70 – 110% and RSDr and RSDR values of ≤

20% and ≤ 30%, respectively (Gilbert and Anklam 2002). European community lists several performance parameters for methods, such as, trueness, specificity, applicability, limits of detection and determination, as well as, repeatability (RSDr), reproducibility (RSDR), and analyte recovery (EC/657/2002; EC/401/2006).

Aflatoxins OTA, and ZEA, which can be found in different agricultural products, especially cereals are thought to be in the list of most potent mycotoxins (Gilbert and Anklam 2002). Since the discovery of mycotoxins, several methods have been developed for their determination. Göbel and Lusky (2004) reported an HPLC method for simultaneous determination of AFs, OTA, and ZEA in rye, rice, and pig feed that included an extraction process with acetonitrile–water, followed by an isolation of mycotoxins in an AOZ multi functional immunoaffinity column. Trifluoroacetic acid (TFA) was used for an enhanced fluorescence activity of AFB1 and AFG before HPLC-FL analysis. The detection and quantification limits were 0.002 and 0.25 ng/g for aflatoxins; 0.07 and 0.5 ng/g for OTA, as well as 1 and 5 ng/g for ZEA, while the recovery rates were between 86 and 93%.

The aim of the present article was to validate a modified HPLC-FLD method for the simultaneous quantitative analysis of AFs, OTA, and ZEA in cereals. It includes a solvent extraction with methanol-water, followed by an extract cleanup with IAC, before its HPLC analysis with fluorescence detection. Derivatization was performed by using the online PHRED derivatization system (Photochemical Reactor for Enhanced Detection) due to its simplicity and time and labor efficiency in comparison with TFA. The validation procedure was performed according to Decision 2002/657/EC (European Commission, 2002). It was successfully applied to the analysis of 60 cereal samples collected from Malaysian market.

Material and methods

Materials and reagents

The analytical standards of all mycotoxins (AFB1, AFB2, AFG1, AFG2, ZEA and OTA) were supplied by Sigma-Aldrich (St Louis, MO, USA). All the solvents used for the preparation of the mobile phase were LC grade and obtained from Merck (Darmstadt, Germany). All eluent were filtered through 0.45 µm membrane filters (Whatman, Maidstone, UK). De-ionized distilled water was obtained from a Milli-Q purification system (Bedford, MA, USA). AOZ immunoaffinity columns were supplied by VICAM (Watertown, MA USA). These columns have a quoted capacity (the total amount of antibody which can be bound to the column gel) of 100, 100 and 1000 ng for AFs, OTA and ZEA, respectively, with at least 85% recovery. Afla test, Ochra test and ZEA test individual immunoaffinity columns were purchased from VICAM (Watertown, MA, USA). These individual mycotoxin columns have a quoted capacity of 100, 100 and 4000 ng for AFs, OTA and ZEA, respectively. Certified reference materials for OTA (BCR 472, wheat flour containing OTA residues 8.2ng/g ±1 ng/g) and ZEA (BCR 717, maize flour containing ZEA residues 83ng/g) were supplied by the European Community Bureau of Reference (CBR, Belgium). Phosphate buffered solution (PBS) was prepared by dissolving PBS tablets (Sigma-Aldrich) in distilled water.

Instrumentation

The HPLC system was from Waters (Milford, MA, USA), consisted of an 717 auto-sampler system, four pumps (type W 600), a column oven, and a fluorescence detector (type W2475). The chromatographic separation was performed on a reverse phase symmetry C18 column (4.6×150 mm, 100 Å, and 3.5 µm particle size) with a guard column (5 µm, 3.9×20 mm) (Waters, Milford, MA, USA).To enhancement fluorescence activity of AFB1 and AFG1 a PHRED photochemical derivatization system (AURA Industries, New York, USA) was applied before fluorescence detector. A six position air pump stand manifold (Vicam, Watertown, MA USA) was used to push the extracts through the IACs. Cereal meal samples were grounded using a model ML1204 Bühler mill (Bühler S.P.A., Milan, Italy).

Prior to analysis the reversed phase HPLC columns were equilibrated with methanol: water (50: 50 (v/v)). To achieve a fluorescence spectrum of mycotoxins, a time-based program for excitation and emission wavelengths was utilized. The wavelengths of excitation and emission were 360 and 455 nm (0-18 min) for aflatoxins, 276 and 460nm (18-25 min) for ZEA and 335 and 460 nm (25-30 min) for OTA. The injection volume was 100 µL. The mobile phase was pumped at a flow rate of 1.0 mL/min under gradient elution at 40ºC. The optimal HPLC condition has been achieved by following program of the mobile phase consisted of methanol, acetonitrile and acetic acid (concentration=0.1%) which started (0-10 min) with 27% methanol, 14% acetonitrile and 59% acetic acid (0.1%), then changed to gradient elution with 10% methanol, 50% acetonitrile and 40% acetic acid (10-12min). This contribution was continued with isocratic elution using the same ratio until 28 min and finished with 27% methanol, 14% acetonitrile, and 59% acetic acid for re-equilibration of column (28 - 30 min). For column re-equilibration 5 min delay was considered between injections.

Samples

Commercial cereal samples include of rice (n=31), wheat (n=6), oat (n=4) and barley (n=11) grains and maize meal flacks (n=8) of 400-1000 g were obtained from different markets in Kuala Lumpur, Malaysia from September to December 2009. The number of samples was almost according to their consumptions in Malaysia. All samples were kept in cool and dark place (cold room, 4ºC) before analysis. Each sample was mixed carefully prior to grinding.

Sample preparation for analysis

Applicability and verification of the method was performed by analysis of replicate spiked samples. Thus, blank cereal samples (including rice, oat, maize, barley and wheat) spiked with appropriate amount of mixture of mycotoxins to achieve 0.5, 2.5, 5 and 10 ng/g AFB1 and AFG1, 0.15, 0.75, 1.5 and 3 ng/g AFB2 and AFG2 as well as 2, 10, 20 and 40 ng/g OTA, and 20, 100, 200 and 400 ng/g ZEA. The spiked samples were then kept for 2 hours at room temperature and then extracted, cleaned up and analyzed using a previously optimized method as described here. 25 g of the grounded spiked cereal sample was extracted with 100 mL methanol: water (80:20) in high speed blender (Waring, Milford, MA, USA) for 2 minutes. 10mL of the filtrate was diluted with 40 mL PBS and 10 mL of the diluted extract was applied to a multifunctional AOZ clean-up column without pre-conditioning. The air pump stand was used to pass the extract through column at about 1-2 drops per second flow rate. Optimal recovery and peak shape of mycotoxins obtained using 1.3 mL HPLC grade methanol and 1.5 mL 0.1% acetic acid as final elution, after washing with 10 mL PBS followed by 10 ml water. After filtration, the sample was directly subjected to HPLC analysis.

Validation procedure

Validation of the analytical method was based on the following criteria: specificity, selectivity, linearity, sensitivity, specificity, precision, accuracy, stability, robustness, measurement of performance and measurement of uncertainty. All analyses were subject to quality control procedures. To ensure method validity, each analytical batch contained at least one reagent blank and one spiked sample fortified at a specific level for each of the toxins analysed. Spiked samples were used to assess recovery, and recoveries between 70 and 110 per cent were classed as valid.

Results and discussion

Selectivity and Specificity

All six mycotoxins exhibited good chromatography with acceptable baseline and resolution of each compound. From chromatograms of a blank sample and a sample spiked with mycotoxins, it was evident that the peaks of mycotoxins were well separated from each other. Also, there were no foreign peaks that interfered with analytes at the retention times of each mycotoxin, which were 7.7, 8.9, 9.8, 11.6, 23.8, and 25.8 minutes for AFG2, AFG1, AFB2, AFB1, ZEA, and OTA, respectively. Hence, the selectivity and specificity of the procedure was considered satisfactory.

Linearity and sensitivity

The calibration curves were determined using linear regression analysis based on seven data points. The calibration curves were linear in the range of 0.0125 – 10 ng/g for AFB1 and AFG1, 0.00375 – 3 ng/g for AFB2 and AFG2, as well as 0.05– 40 ng/g for OTA and 0.5 – 400 ng/g for ZEA, respectively. The correlation coefficients of determination (R2) were greater than 0.999 for all analytes. The mean values of regression equation of the analytes of mycotoxins and LOD and LOQ for AFG2, AFG1, AGB2, AFB1, ZEA, and OTA, for standard and samples, are summarized in Table 1. The LOD and LOQ in spiked samples were 0.0125 and 0.05 ng/ g for both AFB1 and AFG1, 0.0037 and 0.015 ng/g for AFB2 and AFG2, as well as 0.05 and 0.2 ng/g for OTA and 0.5 and 2 ng/g for ZEA, respectively which shows lower quantification levels for analytes compared to the previous HPLC-FLD assay described by Göbel and Lusky (2004).

Table 1. Linearity and sensitivity data of mycotoxins using optimal HPLC conditions

Analyte	Range (ng/g)	Slope ± SD	Intercept ± SD	R2	LOD	LOQ
					In spiked rice (ng/g)	In spiked rice (ng/g)
AFB1	0.0125–10	3.880283e+006	-7.485526e+005	0.9999	0.0125	0.05
AFB2	0.00375–3	9.139188e+006	8.077362e+004	0.9996	0.0037	0.015
AFG1	0.0125–10	2.927487e+006	-6.036253e+004	0.9999	0.0125	0.05
AFG2	0.00375–3	6.707466e+006	-1.531235e+004	0.9999	0.0037	0.015
OTA	0.05-40	8.663638e+005	1.201183e+005	0.9996	0.05	0.2
ZEA	0.5-400	2.229829e+004	5.756479e+004	0.9991	0.5	2

Note: LOD: limit of detection. LOQ: limit of quantification.

Accuracy and precision

The accuracy and precision of the method were assessed by analyzing three replicate samples of standard mycotoxin solutions and spiked rice at defined concentrations. The procedure was repeated on the same day and between three different days on the same spiked standard series. The within-day and between-day accuracy and precision of the method for mycotoxin standard are shown in Table 2. The precision (RSD%) were all less than 10%. The results indicated that the accuracy and precision of the method were acceptable, according to the EC 401/2006.

Recovery of all compounds of interest was tested in spiked rice samples at different concentrations. The results are expressed in Table 3. The results obtained from the within-day accuracy study at three concentrations indicated high recoveries of mycotoxins by the

proposed method: 97.78 – 102.67% for standards and 81.51 – 107.2% for the spiked rice sample, with RSD in the range of 0.83 – 16.14%. Between-day recovery was 99.47 – 102.22% for standards and 78.14 – 108.59% for the spiked rice sample. RSD values were in the range of 1.07 – 22.05%, indicating high precision. They were all in the range of 70 – 110%, required by the EC regulation 401/2006 (European Commission, 2006), hence they were considered satisfactory.

Recovery values of the spiked cereals (rice, oat, wheat, barley and maize) are summarized in Table 3. The recovery values for the contamination levels of 6.5 and 13ng/g for AFs, 10 and 20ng/g for OTA, and 100 and 200 ng/g for ZEA were between 74.13 – 104.83%, and the RSD values were in the range of 2.45 – 11.91%. These results were within satisfactory levels, as suggested by the European Community (EC 401/2006).

Table 3. Recovery and relative standard deviation of mycotoxins in different cereal samples (n=3)

Analytes	Spiked level (ng/g)	Rice		Wheat		Oat		Barley		Maize	
		Recovery (%)	RSD (%)	Recovery (%)	RSD (%)	Recovery (%)	RSD (%)	Recovery (%)	RSD (%)	Recovery (%)	RSD (%)
AFB1	5	95.05	9.39	80.40	4.42	79.28	6.12	85.28	7.66	84.72	11.91
	2.5	86.73	5.55	85.86	5.12	79.12	6.97	89.18	8.12	88.12	10.01
AFB2	1.5	104.83	7.27	87.07	8.36	82.13	8.35	96.53	8.01	82.80	8.43
	0.75	104.1	8.27	91.97	8.16	86.25	9.45	101.34	9.08	84.14	9.03
AFG1	5	86.25	6.92	79.64	7.4	76.64	11.67	78.40	7.19	74.13	7.22
	2.5	92.63	8.19	82.14	8.43	77.31	10.46	81.95	6.74	78.24	8.20
AFG2	1.5	96.00	8.43	84.53	6.21	80.20	5.52	85.33	4.37	79.13	8.78
	0.75	97.2	3.10	86.13	7.11	83.25	6.12	89.64	5.17	84.14	7.82
OTA	20	86.71	6.81	101.48	6.31	94.52	4.18	91.39	10.09	81.61	5.39
	10	93.96	2.45	97.42	7.04	95.16	6.12	94.23	10.19	82.64	8.09
ZEA	200	94.96	7.12	88.87	9.29	103.84	9.84	90.56	5.32	92.46	6.77
	100	96.85	6.61	93.43	10.02	100.43	11.14	91.62	7.15	93.09	7.17

Measurement of performance

Average recoveries of simultaneous AOZ IAC method and individual IAC methods showed that there was no significant difference between simultaneous and individual methods. Also, three measurements of mycotoxins on CRM confirmed the trueness of measurements. The measured OTA was 8.1±0.8 ng/g and for ZEA 85 ± 8 ng/g.

Application to Real Samples

This analytical procedure has demonstrated its versatility after it has been successfully applied to cereal samples. This method was used for simultaneous determination of AFs, OTA, and ZEA in different cereals. The levels of mycotoxins detected in different cereal samples for this survey are summarized in Table 6. The results on the mycotoxin determination using HPLC showed that 30 samples (50%) out of 60 total numbers of analyzed samples were contaminated with at least one mycotoxin at levels more than HPLC quantification limits (0.01-73.11ng/g). It can be conclude that the contamination percentage of different mycotoxins were 11.67, 23.33, 18.33, 18.33, 15 and 18.33% for AFB1, AFB2, AFG1, AFG2, OTA and ZEA, respectively. A total of 24 samples (40%) were contaminated with at least one aflatoxin. The average and standard deviation of total amount of AFs using HPLC was 1.02±1.59ng/g and determined contamination ranged 0.01-5.93ng/g.

The maximum contamination levels of OTA and ZEA were 5.32 and 73.11 ng/g, respectively. A total of 5% of the samples (3 out of 60) exceeded the European community proposed regulatory level of 4 and 5 ng/g for the total AFs and OTA, respectively. Only one wheat sample was contaminated with 5.93ng/g for AFs and two rice samples were contaminated with OTA at levels of 5.25 and 5.32 ng/g. However, contamination with ZEA was found in 18.33% of the samples, in the range of 2.38-73.11 ng/g; all these values were lower than the EC regulatory limits (EC 1881/2006).

Table 6. Mycotoxin contamination in cereal samples in Malaysian market

Type of cereal	Number of samples analyzed	Number of samples found contaminated by mycotoxin		
		Aflatoxins	Ochratoxin A	Zearalenone
Barley	11	4 (0.1-2.86)	1(0.03)	4 (2.38-24.43)
Wheat	6	2 (0.1-5.93)	1 (0.1)	ND
Maize meal	8	5 (0.1-0.34)	ND	2 (2.5-2.9)
Oat	4	2 (0.21-0.29)	1(0.07)	1(2.8)
Rice	31	11 (0.01-3.83)	6 (0.05-5.32)	4 (2.8-73.11)
Total	60	24	9	11

Note: Values in bracket represents the range of mycotoxin level in ng/g; ND stands for not detected.

Conclusions

The method describes a specific, sensitive, and reproducible assay using HPLC and fluorescence detection for simultaneous determination of aflatoxins (B1, B2, G1, and G2), OTA and ZEA in cereals. LOD and LOQ of the spiked samples were 0.0125 and 0.05 ng/g for AFB1 and AFG1, 0.0037 and 0.015 ng/g for AFB2 and AFG2, as well as, 0.05 and 0.2ng/g for OTA and 0.5 and 2 ng/g for ZEA, respectively. The proposed method indicated high accuracy and precision. The within-day and between-day accuracy study indicated 81.51 – 107.2% and 78.14 – 108.59% recoveries for mycotoxins in the spiked rice samples, whereas, the RSD values were16.14% and 22.05%, respectively. In comparison with previous methods this method improved the LOD and LOQ values in simultaneous determination of mycotoxins at least in case of OTA and ZEA. Also, newly validated method offered more simplicity and time and labor efficiency due to its derivatization technique and direct injection of purified mycotoxins to the HPLC. Consequently, it was suitable for the determination of mycotoxins in cereals with the accuracy corresponding to the requirements of European regulation. Recoveries ranged from 74.13 – 104.83% with RSD values in the range of 2.45 – 11.91% for spiked cereal samples. The present method has a comparable sensitivity as compared to the existing methods, for the determination of mycotoxins. The method has a potential to be used for routine analysis and it used less expensive instrumentation. The method has been successfully applied to real cereal samples collected from Malaysian markets and is suitable to be used for mycotoxin determination and cereal quality control.

Acknowledgements

The authors acknowledge Universiti Putra Malaysia for the financial support through the Research University Grant Scheme (RUGS), Project Number 02-01-07-0024RU.

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POSTER PRESENTATION

CLIMATE CHANGE AND ITS IMPACTS ON FOOD SECURITY: AN ACTION RESEARCH IN THE NATURAL DISASTER PRONE AREAS OF NORTHERN BANGLADESH

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ABSTRACT

Bangladesh is one of the most populous nations in the world with 153 million people of which nearly a quarter of the people are very poor, and they face severe food insecurity every year. The northern parts of Bangladesh are more vulnerable to periodic food deficit due to recurrent floods, huge river bank erosion, and severe drought. Frequent natural disasters and unfavorable agricultural production cycles, believed to be due to climate change, multiples new landless farmers, worsens the situations of tenants-landowners relationship and ultimately disfavours the higher cropping intensity that creates a near-famine (*monga*) situation in these regions.

Agricultural activities are vital for food security in Bangladesh because it not only supplies the food but also provides employment opportunities to rural people. Therefore, if agricultural production is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased. Climatic impacts on the production of food may also affect food supply at the local and regional levels.

In this context, to cope with the changing climatic scenario, community based food storage system may be a crucial innovation in addition to create income generation opportunities for affected people, especially, during the disaster period. Also, skill development training, advocacy programmes and training programmes on climate change and food security may be useful to disseminate learned lessons to different stakeholders. Keeping all these issues in consideration, this action research programme is designed and offered skill development training in different trades to the affected people for employment generation. In addition, education and advocacy programmes are regularly offered to them to increase their food production aiming to secure food deficit during crisis period by establishing a community food bank to deposit surplus food.

Keywords: climate change, *monga*, food security, community food bank.

INTRODUCTION

Since the discovery of agriculture in 12,000 years ago, men's capacity to increase food production has grown several thousand fold, enabling them to sustain a human population today of nearly 7 billion. However, a major part of the human race is still malnourished, and nearly 25% of the world's population is extremely hungry and their survival is threatened by food insecurity and under consumption (FAO, 2000).

Bangladesh is one of the most populous and least developed nations in the world with 162 million (July 2009 est.) people living in a bounded space of 147,570 sq km of which about 25% people are poor and ultra poor, and they face severe food insecurity every year (RDRS, 2005; Rahman *et al.,* 2008). In addition, nearly 75% of population is rural, engaged largely in farming, fishing and various artisans' pursuits. Low literacy, high unemployment, extreme poverty, and rampant malnutrition are prevalent among rural people.

Despite significant economic and social progress made over the past few decades, and the food grain production has increased steadily with an average growth rate of 3.1% and the amount become more than double since 1972 (BBS, 2007); still, national food production is inadequate to meet the actual demand, let alone a huge food deficit. Food crop production in Bangladesh entirely depends on climatic factors, particularly frequency and magnitude of floods as farmers make their decisions based on traditional predictive factors related to flooding characteristics.

In the recent past, Bangladesh faced shortages of food grain production believed to be due to climate-induced natural flooding (Mirza *et. al.*, 2003; Younus *et. al.*, 2007). Using empirical models, Mirza *et. al.* (2003) predicted that under climate change conditions peak discharge in all three major rivers (Ganges, Brahmaputra and Meghna) will rise, resulting severe flooding and about 55% of the flooded agriculture land will be under deeper water. According to Douglas (2009), food production in south Asian countries will be disrupted by flooding which is likely to be more severe and more frequent as a result of climate change. Therefore, if crop production is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased.

The geographical location and morphological condition of the northern part of Bangladesh are more susceptible to periodic food deficits due to frequent floods and huge river bank erosion in the rainy season, and severe drought in the dry period. The action research project area (mainly *charlands*), Roumari *Upazila* of Kurigram District, situated in the north-

eastern part of Bangladesh along the both sides of the Jamuna River and its tributaries and distributaries (Figs. 1 & 2). It is revealed from different studies that the Roumari *Upazila* is one of the very high food insecured *upazilas* in Bangladesh (e.g. RDRS, 2005; BBS, 2007). The inhabitants living in this region become the regular victim of the floods and bank erosion (EGIS 1999; Islam, 2006), and specifically by the *monga* [5]. The hydrological and meteorological data of the study area also suggests that there were some climatic shocks over this information and as a consequence of these, catastrophic flooding took place (Younus *et. al.*, 2007; Islam, 2009). Moreover, the people of this area are somewhat bypassed from the mainstream due its remote location from main land. Apart from income poverty, high malnutrition, poor health, poor education, high infant and mother mortality rates among the hardcore poor still remain very high in this area.

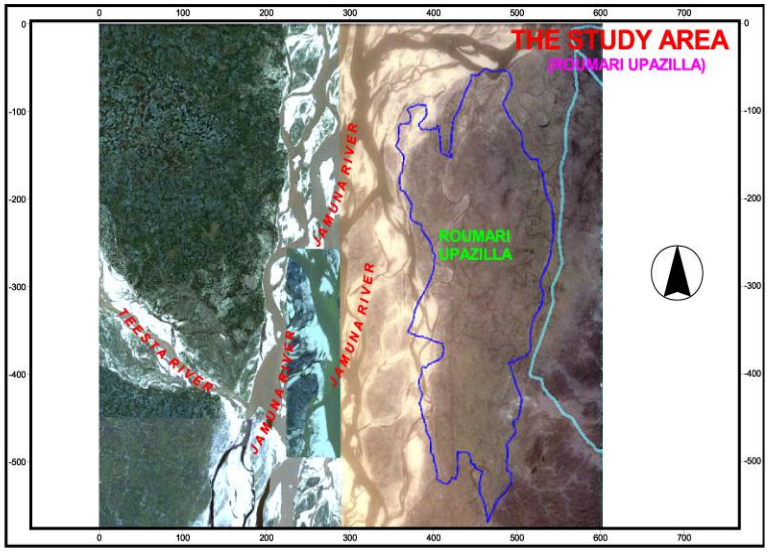


Figure 1 : Google image of the study area.

[5] *Monga* (near-famine situation) is an indicator of seasonal and chronic food shortage which prevails in some north-western districts in Bangladesh.

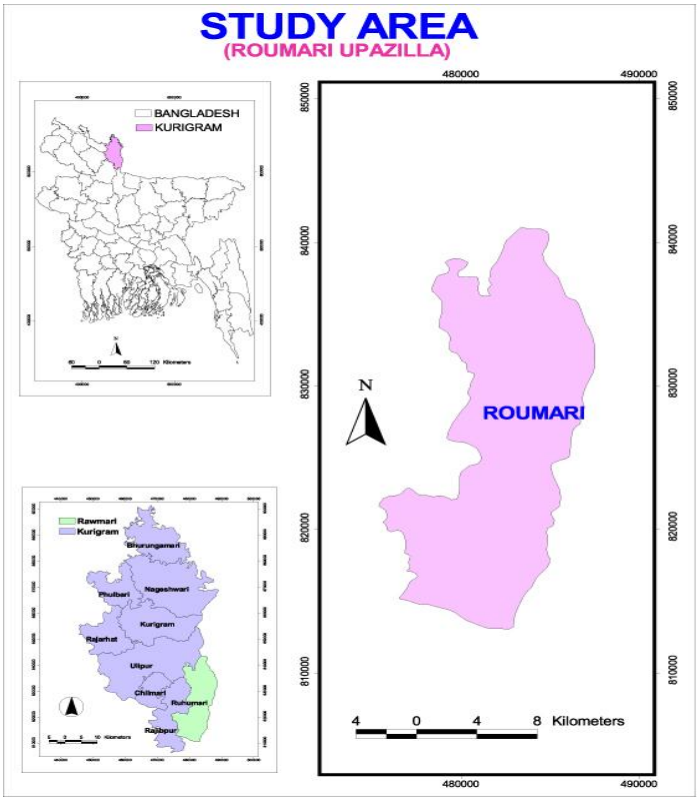


Figure 2 : Location of the study area.

Since food deficit is a recurring phenomenon in the project area due to scarcity of jobs in agriculture during the flood season and the local economy is based on traditional crop agriculture (Islam, 2009), there is a necessity for creating jobs in non-crop agriculture and agro-processing businesses and off-farm services. Moreover, the provision of physical supply of food and its accumulation in a bank to be managed by the community can be a justifiable approach. This approach may be able to lessen the pressure on the vulnerable feeding programmes those are taken by the governments and different non-governmental organizations (NGOs) in the name of social safety net that undermines the human potentiality, dignity and self-reliance. Rather, it can be rational to reduce the dependency of the poor on those types of programmes and, therefore, can contribute substantially to the national economics by savings their own foods for the crisis period through community food bank (CFB).

The stated background persuaded more comprehensive multi-institutional (Department of Geography and Environment of Jahangirnagar University, Bangladesh; Department of Geography of the University of Hull, UK and Unnayan Uddog, an NGO of Bangladesh) action research regarding climate change, *monga* and food security. The main objective of this action research project is to increase the self-employment opportunities of a disadvantaged group of poor farmers by conducting skill development training programmes that could enable them to acquire necessary skills through hands-on-tips, helping them to choose self-

employment in off-farm sectors. Another important objective is to establish a model community food bank that can ensure food security throughout the year to the *monga* affected people. It is believed that the outcome of this multi-institutional action research will bring positive changes in the disadvantaged people, and may be replicated at national and international levels in eradicating poverty and ensure food security in disaster-prone areas in Bangladesh.

METHODOLOGY

As the main objective of the action research project is to achieve the food security of the climate sensitive *monga* affected poorest section through employment generation, the landless people are included as target groups **(**During baseline survey, 550 people are randomly selected from the two study villages of Roumari *Upazila* as target beneficiaries of the project. However, out of 550, 50 people are chosen as *target group* for case study and rest of the people will be included in the project phase by phase**)**. During the selection of target group, female headed households were given preference because they are the oppressed class in the rural areas of Bangladesh. During the beginning of the research project in 2008, male-female ratio among the target beneficiaries was 16:84 and at the end of the second year this figure revised to 10:90.

Both qualitative and quantitative information have been collected from household surveys to assess the project activities and achievements until now. Key informant interviews, focus group discussion, and community workshops have also been conducted. Questionnaire surveys are carried out in the selected two villages of the study area. A good number of people from different government departments, educational institutions, and local NGOs who are involved in poverty alleviation programmes were interviewed to gather information on extent and trends of hunger and food security in the project sites. In addition, pertinent literature and personal communication are also used when felt necessary.

ACTION RESEARCH FINDINGS

Since the beginning of the food security and employment generation research project, continuous orientation, advocacy programmes and skills development training have been giving to the target group. The aim of the skill development training is to create the opportunity to be involved in income generating economic activities. The skill development training and advocacy programmes are continual process because these programmes enable the target group to increase their income substantially.

After completion of two years of the action research project, impact survey data shows that the income of the target group has increased during the two-year period. The average monthly income has reached at Bangladesh Taka (BDT) 5,110 [BDT 71=US$ 1 (approximately)] which was BDT 3,690 at the end of the first year (Table 1, Fig. 3). It is revealed from field observation that the economic capability of target families has risen and now they are spending more money for family consumption. The findings show that the beneficiaries spent averagely BDT 1,031 in 2010 which was only BDT 691 in 2008 and BDT

723 in 2009 (Table 2, Fig. 4). This statistics signifies that the target beneficiaries can achieve economic freedom if the assistance is provided to them for an extended period of time.

Table 1 : Comparison of average monthly family income of target groups.

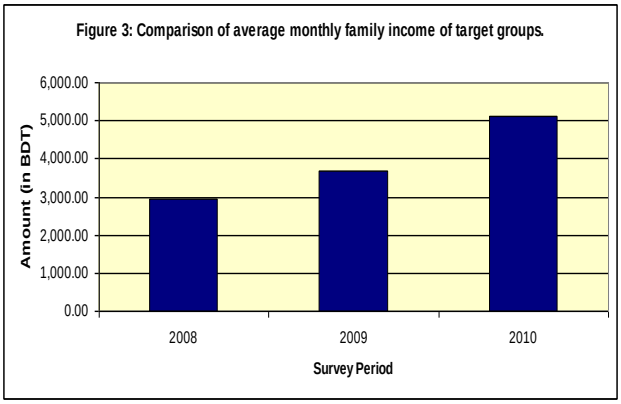
Survey period	Amount (in BDT)
Before joining of the project (2008)	2,954.00
In the 1st year after joining the project (2009)	3,690.00
In the 2nd year after joining the project (2010)	5,110.00

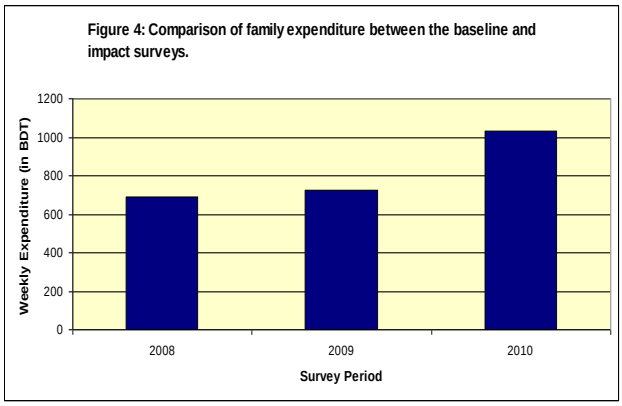
Source: Baseline, Impact surveys.

Table 2 : Comparison of family expenditure between the baseline and impact surveys.

Survey period	Weekly expenditure (in BDT)
All households in baseline survey (2008)	691.07
Target Group in impact survey (2009)	723.18
Target Group in impact survey (2010)	1,031.70

Source: Baseline, Impact surveys.





The role of micro-credit in poverty alleviation strategy is well established in Bangladesh. In rural areas, micro-credits are used for supporting small trades, buying of inputs for non-crop agricultural products, and many other income-augmenting economic pursuits. Before joining this research project, target beneficiaries borrowed money form different micro-financing organizations on a regular basis. This scenario has been changed after the inception of the project. Field survey reveals that 16 % respondents' families (8 out of 50) borrowed money on an average BDT 12,125 during the second year of the project. They have already repaid 52% borrowed-money in due time. The purpose of borrowing were to do business (25%), purchase of land (25%), purchase of cow (12.5%), purchase of books for children (12.5%) and to meet up the family expenditure (25%). Except the last one, the other purposes definitely indicate positive changes towards social development.

The project is dealing with four different income generating trades, such as Bamboo and Cane, *Nakshi Kantha* (Embroidery Quilt), Jute Products and Paraffin Candle. Skill development trainings are providing them to acquire necessary skills through hands-on- tips helping them choose remunerative jobs or organize self-employment. According to field study, majority of the target beneficiaries said that training has been helpful to their current profession. On the other hand, cent percent beneficiaries acknowledged that they are now getting more benefits from the current profession compare to their earlier ones (e.g. day labour, *rickshaw* pulling, boat paddling). They also believe that training provided to them is adequate to earn better livelihood.

The project is also providing an outlet service in Dhaka city to sell out the products made or produced by the target groups as the small producers are not getting the fair prices because they do not have direct marketing mechanism. This outlet is similar to a cooperative shop

which replaces the intermediaries in marketing farmers' products. Now the project has been emphasizing to increase the rate of production so that the target group can increase their income in future.

Knowledge sharing meeting along with training programmes are regularly offered to provide the target group adequate knowledge on different aspects of community food bank, social issues and marketing of the products. Therefore, the impact studies tried to asses the perception of the target group on them. Research findings reveal that 96% respondents viewed that this type of action project will help to eradicate *monga* from their locality and cent percent respondents agreed that it has been creating self-employment opportunities, and therefore, would be helpful to achieve the food security in the locality.

Setting up a food storage (community food bank) run by the target beneficiaries is a vital component of the project. Many socio-economic issues should be considered before setting up the storage facilities unless project could create adverse impacts among the locality. Therefore, prior to establishing a community food bank, a community savings programme has been introduced and the target groups are saving money through this programme. Target beneficiaries are agreed that this savings could be used to purchase foods during the *monga* or any disaster period. Besides, it is also agreed that this savings could be used to purchase food to store in the community food bank once it is established.

Finally, the action project envisages material growth and social security of the target beneficiaries through its advocacy and knowledge sharing component. It is believed that if the target groups can achieve economic freedom and understand the cause and effect of different social and economic issues they will be able to eliminate poverty, and ensure food security through the process of self-determination.

CONCLUSIONS

Bangladesh is facing serious food-insecurity with its big population and over exploiting agricultural land that is decreasing at alarming rate due to unplanned industrialization and growing demand of housing space. Moreover, it is well documented that agricultural production will be adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased. Compared to national context, food deficit is a recurring phenomenon in the northern regions of Bangladesh due to scarcity of jobs in agriculture during the lean period because the local economy is mainly based on traditional crop agriculture. Therefore, there is a necessity for creating jobs in non-crop agriculture and agro-processing businesses and off-farm services. Self employment in different small trades together with micro-credit for income-earning pursuits may improve incomes of the asset-less poor, and also create part-time jobs for the small and marginal farmers.

As the overall purpose of the action research work is to ensure the food security and poverty alleviation, therefore, to establish a community food bank along with community savings programme and an outlet to join the target group in the fair trade movement may open the new horizon in thinking of policy issues by changing behaviour and attitudes towards the existing development paradigm.

The ultimate aim of the multi-institutional research project is therefore to oversee the food security for the victims of natural disasters and the community at large through management of food at community level storing during favourable period, sustainable employment and income generation for those at the bottom of the society, demonstrate and replicate the result in other areas so that the millennium development goal in food security could be achieved.

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CHANGES IN MORPHOLOGY AND YIELD OF FIELD GROWN MR219 AFTER PACLOBUTRAZOL TREATMENT

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ABSTRACT

Rice is the most important staple food crop in Malaysia. Currently the country is about 80% self-sufficient in rice and the target for 2010 is to become 90% self sufficient. In order to achieve this target, the average yield per/ha has to be increased. In most cases increase in yield is attained through improved fertilization as well as agronomic practices. However, minimization of loses is also of utmost importance. Lodging in rice is a serious problem which can cause yield decline. Lodging normally occurs when the plants are tall combined with heavy rainfall and wind. In this study we used a plant growth retardant to control plant height and thus reduce the incidence of lodging. The study was conducted in the rice field in two locations with different environments namely MADA in Kedah and IADA in Perak. Paclobutrazol (PBZ) at concentrations of 0, 200, 400 and 600 mg/L were applied as foliar application at panicle initiation (PI) on variety MR219. The effect of this growth retardant on plant height, culm length, bending resistance and yield were studied. Plants treated with Paclobutrazol were significantly shorter compared to control in both locations. Culm height was also shorter in treated plants as compared to the control. The shorter culm height was due to retardation of the internodes especially in the lower part of the plant. Bending resistance (BR) also differed between the treated compared to control with no significant difference between two locations. Increase in the concentration of Paclobutrazol increased the bending resistance up to 400mg/L but no significant difference was found between 400 and 600mg/L. Although, the effect of Paclobutrazol was to minimize lodging through the retardation of internodes, in this study we found that application with Paclobutrazol at 400 and 600 mg/L was able to increase yield by 16.3%. This increase is attributed to the increase in the number of panicle per meter^2. PBZ has a high potential as a GA inhibitor to control plant height and to improve bending resistance in rice. This study proved that increased lodging resistance was provided to the culm and in addition the treatment also had positive effect on yield.

Keyword: Paclobutrazol, bending resistance, plant height, yield and yield component

INTRODUCTION

Rice is the most important staple food crop in Malaysia and is mainly grown in eight granary areas in Peninsular Malaysia covering 676,034 hectares. Therefore, the issue of self-sufficiency and increased yield has been a priority in the Government's development agenda (Azmi and Abdullah, 1998). Malaysia is currently about 80% self-sufficient in rice and the target for 2010 is to become 90% self sufficient (RMK9, 2006). To reduce food imports, the Ministry of Agriculture and Agro-based Industry Malaysia has targeted to increase the rice grain yield from current average yield of 4.5 t/ha to 10 t/ha (MOA, 2004). The crop has the potential of producing over 10 tons per hectare especially through the application of higher nitrogen fertilizer rates combined with efficient agronomic practices. At the same time, the issue of labor shortage among the rice grower is being solved by shifting the cultivation technique from transplanting to direct seeding. The shifts began in the late 1970s in Malaysia and by the year 2000, this method accounted for more than 90% of the total rice area (Azmi and Abdullah 1998). Consequently, due to the above mentioned change in planting as well as fertilization practice, two problems were encountered namely the problem with weedy rice and lodging (Abdullah *et al*., 1991). Lodging causes difficulties in harvesting using the combine harvester; and during the ripening period results not only in a reduction in yield but also in a decrease in the grain quality, due to increased colouring of brown rice and/or decreased flavor (Setter *et al*., 1997). Direct seeded rice plants have roots that are dispersed only on the top as compared to the transplanting method where the plant it placed deeper in the soil. This makes it more susceptible to lodging. In addition the use of high N fertilizer rates which are suited to increase yield, also causes excessive internode elongation resulting in tall plants which are susceptible to lodging. If the elongation of the internode can be controlled in plant the culm specifically will be shorter, and render the plant to higher resistance to lodging. Paclobutrazol (PBZ) is a triazole derivative and has been reported to inhibit GA biosynthesis in plant by inhibiting kaurene oxidase, a Cyt P-450 oxidase, thus, blocking the oxidation of kaurene to kaurenoic acid (Rademacher, 2000) resulting in retardation of plant height. Various researchers have reported on the positive effect of PBZ in controlling internodes elongation (Wahyuni, 2002; Yim *et al*., 1997; Yoshinaga *et al*., 2005).

This study was undertaken with the intention that application of PBZ on rice would result in internodes retardation causing plants to be shorter thus having increased ability to withstand lodging.

MATERIALS AND METHODS

A field trial was carried out from August 2007 to December 2007 at the Sungai Buaya village, Mukim Bandar, Ulu Dedap, Seberang Perak, Perak (under IADA Seberang Perak) and Sungai Limau village, Mukim Sala Besar, Yan, Kedah (under MADA greenery) Malaysia. The two locations differenced in the environment and allowed the testing of the chemical to a broader scope. Kedah (Alor Setar) was situated at with Lat; 06°12'N, Long; 100°24'E and 3.9 m above M.S.L, while Perak (Setiawan) with Lat; 04°13'N, Long; 100°42'E and 7.0 m above M.S.L. The weather condition at both locations is given in Table 1. A plot of 0.5 hectare was divided into 20 subplots of 5 m x 5 m and the experiment was done in five replicates using a complete random block design. The variety of paddy used was MR219 with a sowing rate of 150 kg/ha using the broadcast method. The field was flooded when the paddy plants were about two weeks old and water in the field was maintained at about 15-20 cm deep. Subplots were separated by 2 meter distance among them. PBZ with a concentration of 0, 100, 200, 400 and 600mg/L was applied at panicle initiation stage (55-57 days after showing). The treatment was applied with a knap-sack sprayer using a spray volume equivalent to 350 l/ha at a pressure of 300 kPa. All other applications were as per the farmer's normal agronomic practice namely the use of inorganic fertilizer at the rates, 120 kg N (Urea), 50 kg P_2O_5 (TSP) and 60 kg K_2O (MOP) per hectare. TSP and MOP as sources of P_2O_5 and K_2O, respectively, was applied as basal fertilizer, and Urea was applied as split application of three equal splits at 10 and 30 days after rice emergence, and at heading stage. Weeding, control of pest and diseases was done based on the standard practice for paddy planting in Malaysia with pesticides when necessary to eliminate enemy in the rice field. The plant height was measured three times; before application, two weeks after application (2WAA) and at harvest, while the bending resistance was measured twice, 2WAA and at harvest. Bending resistance was recorded using a modified method of Kaacky and Schwarz (2001) using a texture analyzer. The culm length, internode length and yield were measured upon harvesting. Data were analyzed using an analysis of variance procedure (ANOVA) in Syntax. Treatment means were compared by LSD test.

Table1: General weather conditions during the experiment at Kedah & Perak in 2007

Month	Rainfall (mm)		Rain days (days)		Wind velocity ($m.s^{-1}$)		Temperature (^0C)		Relative Humidity (%)	
	Kedah	Perak	Kedah	Perak	Kedah	Perak	Kedah	Perak	Kedah	Perak
August	202.3	156.8	16	14	15.1	13.7	27.4	27.1	83.5	82.0
Sept	229.3	97.6	18	12	15.0	12.7	27.2	27.3	84.1	82.0

Oct	291.3	162.6	19	21	14.2	14.3	26.9	26.6	85.4	85.5
Nov	235.2	209.8	17	20	13.9	13.4	26.9	26.5	84.2	85.6
Dec	114.5	126.8	14	14	14.0	12.7	26.8	26.3	79.8	85.1
Mean	214.52	150.72	-	-	14.44	13.36	27.04	26.76	83.4	84.04
Min	114.5	97.6	-	-	13.9	12.7	26.8	26.3	79.8	82.0
Max	291.3	209.8	84	81	15.1	14.3	27.4	27.3	85.4	85.6

RESULTS AND DISCUSSION

The two locations selected for this study were different in terms of total rainfall and wind speed but was similar in temperature, rain days and relative humidity (Table 1). The paddy plants were treated with PBZ at PI in order to control the elongation of the internodes. Paddy treated with PBZ had a considerable influence on plant height depending on the concentration used. At 2WAA (80 days), plants treated with 200, 400 and 600 mg/L PBZ showed significant reduction in plant height as compared to control. Effective reduction in plant height however was only observed for 400 and 600 mg/L treated plants. The plant height continued to increase till around 95-100 days. Measurement on plant height made at harvest showed that the effect of PBZ followed a similar trend as observed at 2WAA.

Plant grown in Kedah also had the same effect, with PBZ at 400 and 600 mg/L giving an effective reduction in plant height with no significant difference between the two locations studied. PBZ treatment at 400 and 600 mg/L effectively shortened the plant by about 7-10 cm as compared to control plant which measured 100 cm (Table 2).

Table 2 : Effect of PBZ application at different concentrations on plant height (cm) in rice MR219 at two locations; Kedah and Perak.

PBZ (mg/L)	Plant height 2 weeks after application		Plant height at harvest time	
	Perak	Kedah	Perak	Kedah
control	93.36a	92.94 a	100.40a	101.55a
100	92.22a	90.68ab	98.95a	98.87ab
200	90.14b	88.41b	96.53b	95.29b

400	87.26c	85.91c	93.13c	91.68c
600	85.99c	84.89c	92.02c	90.50c
LSD	1.53	1.71	1.87	2.01
CV (%)	1.28	1.44	1.45	1.57

Means followed by the same letter(s) in the same column are not significantly different using LSD Test at p=0.05.

In rice, the final plant height is influenced by the culm length. The culm is the more important parameter in relation to lodging resistance. Data for the culm length is given in Table.3. Application of PBZ at 200 mg/L onwards retarded internode especially the last three internodes thus influencing the culm length. Same trend as well as similar values was recorded for both locations. Treatment with 400 and 600 mg/L had significantly higher retardation effect compared to control but was not significantly different between them. Although the individual internodes were measured but as the effect could be clearly distinguished into two categories, the results for internode 1, 2 and 3 and that for internode 4 and 5 were pooled (Table 3). These observations indicate that the application of PBZ at the correct concentration at PI affected the lower internodes (significantly different) but did not affect the elongation of the upper internodes. It is important that the upper internodes are minimally affected as excessive retardation of the upper internode will prevent the panicle exertion.

Table 3 : Effect of paclobutrazol application at different concentrations on culm and internode length (cm) in rice MR 219 at two locations; Kedah and Perak.

PBZ (mg/L)	Culm length		Perak (intermode)		Kedah (internode)	
	Perak	Kedah	1 & 2	3, 4 & 5	1 & 2	3, 4 & 5
control	74.78 a	75.71 a	52.32 a	22.12 a	51.74 a	24.64 a
100	73.08 ab	74.15 ab	51.25 a	21.30 ab	52.28 a	23.05 ab
200	70.2 b	71.14 b	50.03 a	20.18 bc	51.52 a	22.24 ab
400	66.29 c	65.5 c	48.75 a	19.39 c	48.94 a	20.66 b
600	65.5 c	64.3 c	48.39 a	18.92 c	48.46 a	19.99 b
LSD	2.54	2.66	4.51	1.85	3.54	3.43
CV (%)	2.70	2.50	6.71	6.76	5.21	11.58

Means followed by the same letter(s) in the same column are not significantly different using LSD Test at p=0.05.

Plant height has been proposed as the critical factor for lodging resistance. The result showed that plant height was significantly decreased (Table 2) by reducing the culm length due to retardation of internode length (Table 3). The retardation of plant height was inversely proportional to the increase in concentration of PBZ. Plant growth retardant (PGRs) treatment has been reported to reduce plant height in rice (Street *et al*., 1986), rice seedling (Yim *et al*., 1997), barley (Sanvicente *et al*., 1999) and cereal (Rajala and Sainio, 2001).

Culm strength is another parameter of concern in relation to lodging. The charges in morphological traits such as decrease in culm height are expected to increase culm strength. In this study culm strength was measured by placing pressure at a specific point of the culm in order to obtain the value in gram required to cause the culm to break. As shown in Table 4, there was an increase in culm strength with increased concentration of PBZ. This increase in strength was observed for both locations as well as at both data collection time. At 2WAA the culm is still developing and has not completed the deposition phase, as in general the cellulose content increase with age thus providing higher strength to the culm. Therefore, the value for bending resistance is relatively low at 2 WAA. The increase in strength can be seen when data was collected at harvest. Contrary to the results obtained thus far on plant height, culm length and internode length whereby no significant difference were observed due to location, the bending resistance was higher for plant grown in Kedah, both 2WAA and at harvest.

Table 4 : Effect of paclobutrazol application at different concentrations on bending resistance (g) and yield (g/m^2) in MR 219 at two locations; Kedah and Perak.

PBZ	2WAA		at harvest		Yield (g/m^2)	
(mg/L)	Perak	Kedah	Perak	Kedah	Perak	Kedah
control	56.80c	59.17c	88.53d	98.10d	657.6b	647.4c
100	64.36c	67.04c	97.61c	111.14c	658.0b	663.8bc
200	73.82b	76.89b	107.94b	120.64bc	694.8ab	689.4bc
400	83.33a	86.80a	120.25a	129.74ab	717.2a	708.4ab
600	84.41a	87.92a	121.31a	133.08a	725.8a	752.6a

LSD	6.21	6.46	7.39	10.29	48.99	23.18
CV (%)	6.34	6.38	5.14	6.47	5.29	2.52

Means followed by the same letter(s) in the same column are not significantly different using LSD Test at p=0.05.

Bending resistance of the lower part tended to be enhanced by application of higher concentration of PBZ (Table 4). Bending resistance in Perak did not show the same values as compared to that obtained in Kedah. Plants grown in Kedah had higher bending resistance than Perak. The reason for this difference could be related to the amount of deposition in the culm, which cannot be confirmed here as these elements were not measured. The increase in the amount of deposition can be in response to environmental condition, such as higher rain fall and the higher wind velocity in Kedah. The effects of high rainfall in Kedah might influence the turgidity in the lower part of the rice stem. These results indicated two important findings, namely that high concentration of PBZ contribute to the improvement of the physical strength of the lower part, and that environmental condition such as high rainfall and wind velocity (Kedah location) improves the physical strength of the lower part, independent of the concentration of PBZ.

It is important that the morphological changes to the rice plant induced through application of PBZ in order to control lodging do not result in yield decrease. Data on yield was collected from a plot of one meter square (Table 4). In both locations, it was found that there was a significant increase in yield with the application of 400 and 600 mg/L of PBZ, which would translate to an increase of 14-16% in total yield per hectare. Lower concentration of PBZ (100 and 200 mg/L) did not show a significant increase in yield but PBZ at 400 and 600 mg/L had significantly higher yields compared to control with no significant (at $p<0.05$) difference among the two treatments. Preliminary data has shown that application of PBZ increased the tillering ability in rice thus increased the number of panicle per plant. According to Rajala and Sainio (2001), enhanced tillering may result in higher yield potential due to more spike-bearing tillers per main shoot. On the other the retardation in plant height can increase root-to-shoot ratio and increase partitioning of assimilates to economically important plant parts such as grains and bulbs (Yim *et al*., 1997).

CONCLUSION

Paclobutrazol appears as an effective growth retardant to control plant height and to improve bending resistance in rice plants. This study proves that added resistance was provided to the culm and also had positive affect on yield. Nonetheless, it may be of interest to carry out more experiments on different time of application to optimize the system for the best effect.

ACKNOWLEDGEMENT

This project was funded by Government of Malaysia through the Science Fund under MOSTI Grand number: 05 - 01 – 04 – SF0164.

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CHEMICAL USE IN TIDAL LOWLAND AGRICULTURE

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Despite continuing debates over the use of chemicals in agriculture, the use of pesticides in food crop production in tidal lowlands has been unavoidable partly due to the uncertainty caused by climate change. The reason behind this is to maintain current productivity and to prevent loss due to pest and disease threats caused by a shift in planting season. A survey has been conducted to study the cost (including environmental cost) of chemical use in rice production in tidal lowland. A random sample of 500 farm-households was drawn to prove whether the use of chemicals has an economic support. The result indicates that the use of chemical has significant effect on rice production. However, chemical use has caused externality and the cost required to recover this externality is higher than the external cost itself. Therefore, reducing the use of chemicals would possibly be a choice for rational farmers.

Keywords: chemicals, agriculture, tidal lowland

INTRODUCTION

Tidal lowland development in Indonesia aimed at supporting transmigration program and increasing rice production to compensate the conversion of irrigated farm land in Java (Suprianto et al., 2009; Schultz et al., 2005; Suriadikarta et al., 2001). Farm land conversion to non-agriculture was estimated 40,000 to 50,000 ha per year. In order to maintain current level of rice production, each ha lost of irrigated farm land must be replaced by more than 3 ha upland or rain-fed lowland.

Tidal lowland development was carried out through reclamation. Reclamation of lowlands in Sumatra has reached 692,000 ha, of which 373,000 ha is located in South Sumatra Province (Directorate of Lowland and Coasts, 2007). In spite of this large reclaimed area, its utilization for agriculture production is considered low. In addition, its productivity is yet considered lower than that of irrigated areas (Simatupang and Rusastra, 2003). This is due to the limited knowledge and information regarding agro-physical and chemical characteristics of tidal soil as well as the implementation of water management strategy on tidal lowlands.

The objective to increase rice production in tidal lowlands was restated after severe droughts in 1991, 1994, and 1997 which resulted in import of rice up to 4.5 million tons in each of these years. The objective to increase rice production by pushing up the productivity of rice in tidal lowlands was adopted as the objective of tidal lowland development which previously was focused on transmigration. Further development in tidal lowlands is aimed at increasing productive capacity of tidal lowlands to accommodate recent development in agriculture technology, including the introduction of new varieties, use of equipments, fertilizers, and pesticides, and improvement of water management. Recent climate change that shifts planting season has increased the risk of pest and disease threats and confirmed the use of chemicals.

As a result, about 30 percent of the area suitable for rice has reached the productivity above 5 tons per ha. In addition, 10 percent of the area can be cultivated twice to three times a year. However, the negative impact of modern input use has emerged. As a consequence of chemical use, canal water which was previously used for various domestic needs is no longer safe, raising externality among farmers themselves.

The objective of this study was to examine the chemical use in food crop production in tidal lowlands and to consider the cost (including environmental cost) of chemical use in rice cultivation. This study is expected to provide inputs for reconsidering chemical use in tidal lowland rice production.

METHODS

This study was carried out in Telang, a rice production center in tidal lowland area of South Sumatra, through a survey. This deltaic area is administratively located in Sub-district Muara Telang, District Banyuasin, South Sumatra Province. This area was selected as research area since it was among the most productive reclaimed tidal lowland areas due to the use of

modern inputs (high-yielding varieties, chemicals) and supported by relatively better water management system.

Research sample of 500 farm households were randomly drawn from some 10,000 farm households, covering 12 secondary blocks of approximately 3,072 ha. Data were collected through field observation and structured interview with the farmers.

Data were mostly quantitative in nature. Therefore, data analysis was carried out using some statistical tools. The effect of chemical use on rice production was analyzed using linear regression based on a Cobb-Douglas production function (Hair et al., 2010; Coelli, 1995) as the following:

$$\ln Y_i = \beta_0 + \beta_1 \ln SEED + \beta_2 \ln CHEM + \beta_3 \ln FERT + \beta_4 \ln LABOR + \beta_5 D_{ws} + \varepsilon_i \qquad (1)$$

where Y_i = total rice production in tons

$SEED$ = seed used in kg

$CHEM$ = chemical used in Rupiah

$FERT$ = fertilizers used in Rupiah

$LABOR$ = labor used in man days

D_{ws} = dummy variable water service for 1 = with water service 0 = without

RESULTS AND DISCUSSION

As a primary process, rice cultivation employs primary inputs such as seed, fertilizers of several kinds, some types of pesticides, labor and some basic equipments. Three kinds of fertilizers are used, namely Nitrogen, Phosphorous, and Potassium fertilizer. The first two were recommended, whereas the third was used according to particular need. Pesticide consisted of three types, namely herbicides, insecticides, and fungicides. The following result described the cost of rice cultivation (including chemical cost), production, and productivity of rice.

The costs of rice cultivation were presented in Table 1. These costs were estimated based on per hectare rice cultivation in the first planting season. The cost of each input was derived from the whole research sample based on its average value (mean). The cost of pesticides accounts for 10.57 percent of the total cost, excluding the labor cost of pesticide application. Among three types of pesticide, the cost of herbicide was the highest and accounted for 65.76 percent of total pesticide cost. Herbicides were used during pre and post planting to control weed.

Table 1. Cost of rice cultivation per hectare in the study area

Inputs	Types of Inputs	Unit	Volume	Unit Cost (Rp)	Total Cost (Rp)
Seed	Rice seed	Kg	63.5	6,000	381,000
Pesticides	Herbicides[1]	n.a	n.a	n.a	344,770
	Insecticides[1]	n.a	n.a	n.a	72,480
	Fungicides[1]	n.a	n.a	n.a	107,000
Fertilizers	Nitrogen	Kg	220	1,300	286,000
	Phosphorus	Kg	121	2,300	278,300
	Potassium[2]	Kg	n.a	n.a	13,910
Labor	Land preparation	Man day	10	50,000	500,000
	Planting	Man day	4.5	50,000	225,000
	Fertilizing	Man day	2	50,000	100,000
	Controlling	Man day	2	50,000	100,000
	Harvesting[3]	Man day	51	50,000	2,550,000
Total					4,958,460

[1]Various types with various unit (l, ml, kg, gram) such that only total cost was applied.

[2]Only few samples used this type of fertilizer such that average volume was not relevant.

[3] Consists of harvesting and threshing. Harvesting cost was in shared product with the ratio 1:7 (12.5% for labor, 87.5% for owner). Threshing cost was Rp 50 per Kg output. All of these expenses were made equivalent to man day.

n.a not applicable

Production is the output of farming activities as the result of employing several inputs such as seed, pesticides, fertilizers and labor. The amount of production depends on the acreage of the cultivation such that it varies among farmers with different land holding. In order to measure a standard output of farming activities, a measure of productivity is employed. Besides its independency on the use of inputs, measure of productivity uses cultivation acreage as a reference. Therefore, productivity refers to the output per unit land cultivated. In the study area, reference for the acreage of cultivation is hectare.

Analysis on the data on rice production among respondents of this research indicated that rice production varied from as low as 1.5 tons to as high as 79.2 tons of on-farm dried paddy due to the variation in area cultivated from as low as 0.25 hectare to as high as 12 hectares. The average production was 9.75 tons (standard deviation = 5.70 tons) and the average cultivation area was 1.84 hectares (standard deviation = 0.99 hectare). Whilst, the average productivity was 5.35 tons per hectare on-farm dried paddy (standard deviation = 0.88 ton).

Rice production is a function of several input factors such as seed, chemicals (herbicides, insecticides, and fungicides), fertilizers (Nitrogen, Phosphorous and Potassium fertilizers), and labor for various activities during the whole process of rice cultivation starting from land preparation, planting, fertilizer application, pests and diseases control until harvesting. In order to estimate the effect of these variables including the effect of chemical used, a regression analysis was performed with all of the independent variables considered in the model.

Cobb-Douglas production function was estimated using multiple regression analysis. This model was robust based on the R^2 statistics. Model fit analysis for the Cobb-Douglas production function indicated that the overall model was statistically significant at 95 percent confidence interval.

Analysis on the effect of each of the independent variable was performed using t-test and the results of the analysis were presented in Table 2. Among all of the independent variables assumed to affect rice production, all but seed have significant effect on the dependent variable.

All coefficients were positive as expected. The coefficient of chemicals was positive and significant. Chemicals consist of herbicides, insecticides, and fungicides. Herbicides were used during land preparation as pre-planting weeding and during growth stage as post-planting weeding. Insecticides were used incidentally according to the existence and intensity of insect attacks. Fungicides were used to control fungus and to enhance growth. These three types of chemicals have been consistently used by farmers in the study area

and became part of farming practices regardless their effects on the environment. As indicated by its coefficient, one unit increase in chemical used associated with 0.034 unit increase in rice production. The effect of chemicals on rice production was proved to be statistically significant.

Table 2. Regression coefficients and the value of t-test statistics

Variables	Coefficients	Std. Error	t	Sig.
(Constant)	-3.910	.212	-18.449	.000
Seed	.023	.026	.901	.368
Chemicals	.034	.018	1.828	.068*
Fertilizer	.128	.026	5.030	.000***
Labor	.782	.028	28.374	.000***
Water service (dummy variable: 0 = without; 1 = with)	.040	.013	3.026	.003***

Dependent variable was total rice production.

All variables were in logarithmic, except water service.

R Square = 0.936; F-test = 57.083; Sig. of F-test = 0.000

*Significant at 10% **Significant at 5%; ***Significant at 1%

The environmental impact of chemical use in rice production was observed through its impact on canal water. Being the main domestic water source, visible change in canal water has shifted household need for drinking water to bottled water. Therefore, environmental cost of chemical use was estimated using avoidance cost. In this case, avoidance cost was the cost of bottled water purchased to avoid contaminated canal water during cultivation period which was Rp 11,520,000 per secondary block of 256 ha (one water management unit).

Based on the above calculation, the external cost of chemical use was estimated to be Rp 45,000 per ha. Assuming farmers were responsible for this external cost according to polluters pay principle, this cost was expected to be recovered through the increase in production. Taking the local price of Rp 2,250 per kg on-farm dried paddy, the required increase in production was equivalent with 20 kg on-farm dried paddy per ha. This was also equivalent to 0.37 percent increase in productivity, considering the average productivity was 5.35 tons per ha.

Based on the value of elasticity, 0.37 percent change in production was associated with 10.88 percent change in chemical use. Since the average cost of chemical use was Rp 524,250 per ha, the required change in chemical cost was Rp 57,038. Therefore, to recover the external cost of Rp 45,000 per ha requires Rp 57,000 additional cost of chemical per ha. This meant that the cost to recover the external cost of chemical use was higher than the externality itself. As such, reducing the use of chemical would possibly be a choice of rational farmers.

CONCLUSION

It can be concluded from the study that

1. The use of chemical was currently unavoidable in tidal lowland rice cultivation due to present threat of pests and diseases and the increasing risk of pest and disease attacks due to the shift in planting season caused by climate change.

2. Despite undervaluing the economic cost of chemical contamination in canal water, the use of avoidance cost is considered the most tangible since majority of farm households experienced this impact in tidal lowlands.

3. The use of chemicals, especially herbicide, should be reduced and replaced by mechanical practice to control weed during pre and post planting.

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FRYING PRACTICES AFFECTING VARIATION IN ACRYLAMIDE CONCENTRATION IN FRENCH FRIES PRODUCTION IN MALAYSIA FOOD SERVICE ESTABLISHMENTS

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Abstract

Dietary intake studies observed a significant variation in acrylamide concentrations, a probable human carcinogen. The objective of this study was to obtain an insight of variation in acrylamide concentration in French fries as affected by variable frying practices in different types of Malaysia food service establishment (FSE). Besides acrylamide, frying time, frying temperature, and reducing sugars were measured and direct observation was performed during frying to understand how FSE actually prepare French fries. The study found that the chain fast-food service had significantly lower mean of acrylamide concentration with least variation as compared to institutional caterers and restaurants. This is due to the usage of fryer that allows an adequate control of acrylamide formation such as setting a low and uniform frying temperature and a short and narrow range of frying time. Acrylamide concentration of as high as 1023 µg/kg was obtained in the restaurant due to the usage of frying pan, which makes it impossible to control the frying temperature and time. Acrylamide concentration showed significant correlation, positively with frying temperature, frying time, and reducing sugars, but negatively with thawing practice. The study concluded that due to variable frying practices, the French fries prepared by different types of FSE had different distributions profiles of acrylamide concentrations. The results of the study can be used for the development of dedicated quality control at FSE which contribute to a sustainable reduction in acrylamide intake.

Keywords

Acrylamide; Variation; French fries; Frying practices; Food service establishments

Introduction

Acrylamide is a probable human carcinogen (IARC, 1994) and its presence in a range of fried and oven-cooked foods (Tareke, Rydberg, Karlsson, Eriksson, & Tornqvist, 2000, 2002) have raised considerable health concern world-wide. The highest concentrations have been identified in carbohydrate-rich food, i.e. potato based products such as French fries (Friedman, 2003; DiNovi, 2006). French fries are widely prepared in the food service establishment (FSE) and the effect of final production of French fries is crucial because most of acrylamide is formed towards the end of the frying process (Fiselier, Bazzocco, Gama-Baumgartner, & Grob, 2006; Amrein, Andres, Escher, & Amado, 2007). Dietary intake studies observed a significant variation in acrylamide concentrations (Dybing & Sanner, 2003; Konings et al., 2003; Svensson et al., 2003; Matthys, Bilau, Govaert, Moons, De Henauw, & Willems, 2005). A qualitative study identified that besides the initial concentration of reducing sugars, the actual frying practices is the major technological factor affecting variation in acrylamide concentration (Sanny, Luning, Marcelis, Jinap, & Van Boekel, 2010). To the authors' knowledge, literatures are lack of quantitative insights in the contribution of technological factors that could have caused variable and unacceptable high acrylamide concentration as well as what are its distribution profile. The distribution profile of acrylamide concentrations (besides mean concentration) has to be known to judge the actual risk of acrylamide in order to develop control measures (FAO/WHO, 2007). Many studies focused on the influence of product properties and processing conditions on acrylamide formation under carefully controlled laboratory conditions (Becalski, Lau, Lewis, & Seaman, 2003; Jung, Choi, & Ju, 2003; Taeymans et al., 2004). However, much less is known about the effects of these properties and conditions under actual practices in FSE.

Frying practices applied by different FSE varied in term frying conditions (temperature-time regime), frying equipment selection (design, capacity, heating system and material of fabrication), and quality control during frying (Al-Kahtani, 1991). These variable frying practices are expected to contribute to variable and unacceptable high acrylamide concentrations in French fries. This situation underpins the need to survey frying practices in FSE to identify technological factors that contribute to variable and unacceptable high acrylamide concentrations. The objective of this study was to obtain an insight of variation in acrylamide concentration in French fries as affected by variable frying practices in different types of Malaysia FSE. We expect that due to variable frying practices, different types of FSE prepare French fries with different distribution profiles of acrylamide concentrations.

Materials and methods

Characteristics of FSEs.

The study was focused on FSE located in Selangor, Malaysia. Three types of FSE, i.e. chain fast-food service (CFS), institutional caterer (IC) and restaurant (R) were selected to

reflect FSE as a whole. From each FSE type, three different establishments with more than 5 workers were selected. The establishments consisted of locally or internationally chain fast-food services for CFS type; caterers in a college or in a university for IC type; and family style restaurants for R type.

Sampling and data collection

French fries and frozen par-fried potato stripes samples

The study was focused on French fries samples of a straight cut type with a size of 8 mm x 8 mm (diameter x length). Samples were collected over three days of French fries production. Each day, samples were taken from five different frying batches. A total of three servings of the French fries were collected in each frying batch for measurement of acrylamide in triplicates. Similarly, a total of three servings of the frozen par-fried potato stripes were collected in each frying batch for measurement of reducing sugars in triplicates. Each serving was coded and stored in polyethylene bags at -18C prior to analysis.

Measurements and observations data

The food handler was asked to fry four servings of French fries as their common practice. During frying, the following frying practices were measured; frying temperature and time, serving size and volume of oil. The following frying practices were also observed; receiving supplied materials, brand of frozen par-fried potato stripes, type of fryer, mode of heating, oil type, thawing practice and presence of procedures and guidelines. Measurements and observation data were recorded in each frying.

Analysis methods.

Analysis of fructose, glucose, and sucrose

The procedure was adapted from Vivanti and co-authors (2006). Briefly, after extraction with mobile phase consisting of acetonitrile/water (80:20, v/v) and addition of maltose as an internal standard, the supernatant was filtered and injected into a Waters HPLC instrument equipped with a refractive index (R.I.) detector.

Analysis of acrylamide

The scheme described by Becalski and co-authors (2005) was generally followed. After aqueous extraction, using $^{13}C_3$-labelled acrylamide as internal standard, the acrylamide

extract was further cleaned-up by solid phase extraction. The extract was analysed using Gas Chromatography-Time of Flight-Mass Spectrometry (GC-TOF-MS).

Statistical analysis

A one-way analysis of variance (ANOVA) was used to determine the equality of mean of $\log_e$ transformed acrylamide concentration in three FSE types. Their significant differences were determined using Fisher's LSD comparisons test. The obtained means of $\log_e$ transformed acrylamide concentration were back-transformed to an original scale of measurement and they were named as geometric mean (Bland & Altman, 1996; Petrie & Sabin, 2009). The standard deviation of the $\log_e$ transformed acrylamide concentration was calculated as approximately equal to the coefficient of variation (CV) in the original scale (Hopkins, 2003; Dallal, 2009). The exact CV was calculated using a formula of $100(e^{SD} - 1)$, where e is exponential e and SD is the standard deviation of the $\log_e$ transformed acrylamide concentration (Hopkins, 2003; Dallal, 2009). Bivariate correlations analysis and standard multiple linear regression analysis were also used to analyse the data. The p-Value less than or equal to 0.05 was considered significance. Statistical analyses were performed using the SPSS version 16.0 (SPSS Inc., Chicago, IL.).

Results and discussion

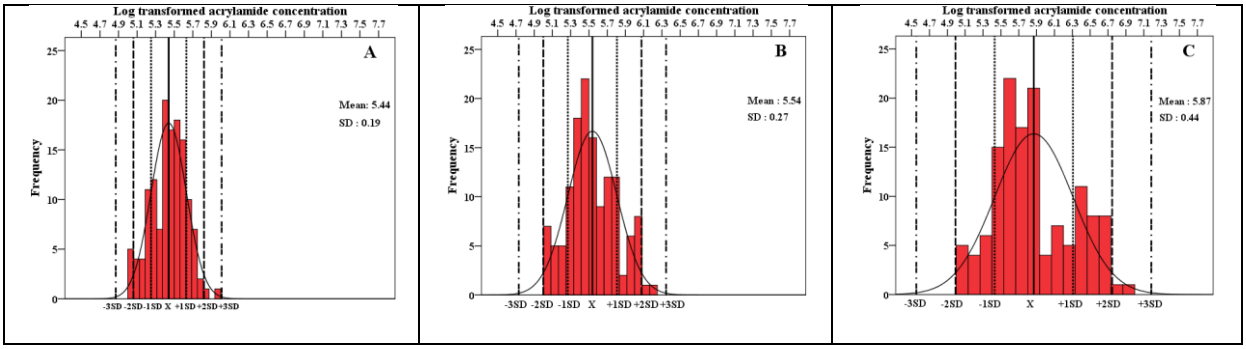

Figure 1: Histograms of $\log_e$ transformed acrylamide concentration for the three FSE types (A) Chain fast-food service (B) Institutional caterer, and (C) Restaurant.

Figure 1 illustrates that mean (standard deviation) of $\log_e$ transformed acrylamide concentration of French fries was lower in CFS (X= 5.44, SD= 0.19) than in IC (X= 5.54, SD= 0.27) and in R (X= 5.87, SD= 0.44). These mean values were back transformed to an original scale using an anti-logarithmic and the geometric means (coefficient variation) were corresponding to 231 µg/kg (21%) for CFS, 254 µg/kg (31%) for IC and 354 µg/kg (55%) for R. The study found mean acrylamide concentration of French fries was significantly lower with least variation in CFS than in IC and in R, which means that fryer setting in CFS such as a low and uniform frying temperature of 177°C and a short and narrow range of frying time (150-165 seconds) allows an adequate control of acrylamide formation. The uniform frying

temperature in CFS is consistent with Al-Kahtani (1991) who found that chain fast-food services in Saudi Arabia also adopted frying temperatures of 177°C to fry French fries. Short frying time furthermore according to Rodgers (2008) is important for the CFS in terms of the quality of service (waiting time) and labour costs.

Our next approach was to examine whether acrylamide formation correlates with any of the influencing factors. A small correlation between frying time and acrylamide concentration was found ($r=0.104$, $n=360$, $p<0.05$), which is contradicting with previously published studies who reported a linear relationship between frying time and acrylamide concentration (Matthaus, Haase, & Vosmann, 2004; Gokmen & Senyuva, 2006). The observation could be possibly explained with what has been found by Romani and co-authors (2008) who reported that the increase of time became a key factor in acrylamide formation in French fries only after around 240 seconds of frying (frying temperature of 180°C). In this explorative study, most of IC and CFS (with exception of R) reported frying time ranged between 150 – 240 seconds that were shorter than the identified critical time, which explains the small correlation between the two variables.

The higher mean acrylamide concentration in R could be explained by a wide range of measured frying temperature (148-215°C) with a mean temperature of 185°C. These observations show the pronounced effect of frying temperature on formation of acrylamide as repeatedly demonstrated by various researchers (Grob et al., 2003; Matthaus et al., 2004; Amrein, Limacher, Conde-Petit, Amado, & Escher, 2006). Furthermore, unlike frying time, there was a strong correlation between frying temperature and acrylamide concentration ($r=0.596$, $n=360$, $p<0.05$). Also, our results are consistent with studies conducted to survey frying conditions in FSE (Gere, 1985; Al-Kahtani, 1991; Morley-John, Swinburn, Metcalf, Raza, & Wright, 2002). For example, Morley-John and co-authors (2002) reported that a wide range of temperature, i.e. 136-233°C with a mean temperature of 182°C was used by the independent fast-food services (similar to R in this study) as well as by the fast food outlets in New Zealand to fry French fries.

A small correlation was also observed between reducing sugars and acrylamide concentration ($r=0.127$, $n=360$, $p<0.05$). The finding is in agreement with two recent published studies who reported similar observations (De Vleeschouwer, Plancken, Van Loey, & Hendrickx, 2008; Knol, Viklund, Linssen, Sjoholm, Skog, & van Boekel, 2009) although it is contradicting to studies that have shown a strong correlation between acrylamide formation and the reducing sugar available in potatoes (Amrein et al., 2003; Becalski et al., 2004; Williams, 2005). The finding could be possibly explained with what has been found by Williams (2005) who reported that sufficient quantities of precursors still remained for acrylamide formation when frying at lower temperature (150^{o}C for 3 minutes) unlike frying at the higher temperatures (175^{o}C) where precursors are used effectively to generate acrylamide. Furthermore, this is an explorative type of study and thus further research is

necessary under carefully controlled conditions in FSE to further investigate this initial observation.

It was unexpected to find a moderate, negative correlation between thawing practice and acrylamide concentration ($r=-0.482$, $n=360$, $p<0.05$), which implied that thawing practice contributes significantly to the reduction of acrylamide concentration in French fries. The finding however is consistent with Tuta and co-authors (2010) who recently have shown that thawing of par-fried potato strips reduced the acrylamide formation by 89% (frying temperature of 180°C).

In a standard multiple linear regression model, all influencing factors (except sucrose) are making a significant unique contribution to the prediction of acrylamide formation ($r2=0.492$, $p<0.05$). It was expected for non-reducing sugars, i.e. sucrose not to make a statistically significant contribution, which is in line with those of previously published studies (Amrein et al., 2003; Williams, 2005). The influencing factor of frying temperature makes the largest unique contribution (beta=0.513), although thawing practice also made a statistically significant contribution (beta=-0.368). Both reducing sugars (beta=-0.101) and frying time (beta=0.143) make less of contributions. This supports the findings of various researchers who observed that these influencing factors contribute significantly to the formation of acrylamide (Grob et al., 2003; Becalski et al., 2004; Matthaus et al., 2004; Amrein et al., 2006; Tuta et al., 2010).

Conclusion

The CFS has significantly lower mean acrylamide concentration with least variation as compared to IC and R, which indicates that CFS practised a better quality control in setting a low and a uniform frying temperature of 177°C and realising a short and a narrow range of frying time (150-165 seconds). The better quality control in setting a lower and a uniform frying temperature and time to fry French fries is expected to be a practical solution for high and variable acrylamide concentration in French fries.

This explorative study provides directions for further research that include investigating the effects of technological (focused on raw material properties) and managerial control interventions (focused on food handlers) on the variation of acrylamide concentrations in French fries prepared under FSE circumstances.

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OCCURRENCE OF CAMPYLOBACTER SPECIES IN PEKIN DUCK INTESTINES AND THEIR ENVIRONMENT

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Abstract: The occurrence of *Campylobacter* species in Pekin duck intestines and their environmental samples were examined using the conventional method. In all, seventy five (75) duck intestines, twenty five (25) duck wash water, sixty (60) duck faeces, thirty (30) duck soil samples, fifteen (15) duck feed samples and fifteen (15) duck drinking water samples were analyzed. The overall prevalence for *Campylobacter* species was 3.18%. Six (8 %) and 1 (4.0%) intestines and wash water, respectively were positive for *Campylobacter* species. *Campylobacters* were not isolated from the faecal, soil, feed and drinking water samples. Five *C. jejuni's* (4 from intestines and 1 from wash water) and 2 *C. coli's* (all from the intestines) were isolated from the duck samples. The percentage rate of isolating *C. jejuni* to *C. coli* was 71.42 % to 28.57 %, respectively. This study suggests that healthy ducks can be potential sources and reservoirs for *Campylobacter* species.

Keywords: Pekin duck intestines, *C. coli*, *C. jejuni* and prevalence

Introduction

Campylobacters are Gram-negative, oxidase and catalase positive bacteria that are unable to grow aerobically at 25^{o}C. They do not form spores, are curved spiral or rod shaped and microaerophilic in nature (Corry et al., 2003). These pathogens have emerged to become the most common food-borne pathogen and thus Meat et al. (1999) estimated *Campylobacter* species to be the leading cause of food-borne illnesses among all food-borne pathogens. They are the predominant cause of systematic and chronic sequelae infections such as meningitis, endocarditis, septic abortion, reactive arthritis, Guillain-Barré syndrome, inflammation of the liver and kidney (Blaser, 1997; Boyd et al., 2005; EFSA, 2005). They also cause infections such as gastroenteritis, septicaemia and invasive diseases (Zhao et al., 2001).

Ducks rearing for the production of meat and eggs, and to a lesser extent, feathers, control of water snails or other purposes have been practice for thousands of years and in

most countries on small-scale family farms. However, industrial rearing and processing of ducks is increasing rapidly (FAOSTAT, 2004). With increasing production, the problem of increasing microbial contaminations and transmissions by ducks as in other poultry species is anticipated. There is no published literature regarding the occurrence of *Campylobacter* species in ducks reared in Penang, Malaysia. Therefore, this work aimed at describing for the first time in literature the occurrence of *Campylobacter* species in Pekin duck intestines and their environment in Penang Malaysia.

Materials and method

Location, duration and data collection

In this study, a total of 220 samples from Pekin duck intestines and their environmental samples were collected aseptically from various commercial local duck farms and abattoirs within a 5 month period in Penang, Malaysia. Duck intestines and wash water samples (water used for washing ducks carcasses) were obtained from the local abattoir in the wet market while faecal, soil, feed and drinking water samples were taken from the farms. The samples collected were stored under 4^{o}C, transported to laboratory under aseptic conditions and analyzed immediately for the presence of *Campylobacter* species.

Isolation, confirmation and identification of Campylobacter species

The samples collected were first enriched in Bolton Broth (Oxoid, UK), and incubated at 41±1^{o}C for 48hours under microaerobic condition created using Anaerocult (Merck, Germany). After enrichment, about 10µl aliquots were streak onto modified Charcoal Cefoperazone Desoxycholate (mCCD) agar (Merck, Germany), and incubated at 41±1^{o}C for 48 hours microaerobically. Approximately 30-40g intestinal, faecal and soil samples were thoroughly mixed before transferring 1g portions into 9ml enrichment broths. For the feed (10g), wash (10ml) and drinking water (10ml) were used for the enrichments in 90ml Bolton Broths. Presumptive *Campylobacter* colonies were purified on mCCD agar without supplement. They were confirmed and identified using Gram staining, oxidase, catalase, growth test, and glucose utilization. Additionally, Dryspot Campylobacter Test Kit (Oxoid, UK) was used to confirm the *Campylobacter* isolates. Species identification was achieved by Hippurate hydrolysis and susceptibility of the isolates to Nalidixic and Cephalothin antibiotics.

Results and Discussion

The results for the occurrence of *Campylobacter* species in the samples we analyzed are presented in table 1. From table 1 the overall occurrence of *Campylobacter* species in the samples analyzed was 3.18%. The prevalence for Pekin duck intestines and wash water samples was 8.00 and 4.00%, respectively. *Campylobacters* were not isolated from the soil, faecal, feed and drinking water samples (0.00%). In Malaysia, higher occurrences of *Campylobacter* species have been reported by Usha et al. (2010) in retail broiler chickens

parts (from 3 to 290MPN/g-chilled parts and from 3 to more than 2400MPN/g-fresh parts), Saleha (2002) in broiler chicken (46-93%) and Chai et al. (2007) in salad vegetables (29-68 %). In a review by Suzuki and Yamamoto (2009), *Campylobacters* were not found in frozen chickens imported from Malaysia to Japan although they were present in those imported from USA, China, Brazil and Thailand.

Among the samples tested the frequency of occurrence for *C. jejuni* and *C. coli* was 2.27 (5/220) and 0.91% (2/220), respectively. Four *C. jejuni's* and two *C. coli's* were isolated from the intestines. One *C. jejuni* was present in wash water sample. The ratio of isolating *C. coli* to *C. jejuni* was 1(28.57): 2.5 (71.43). Usha et al. (2010) found 92.5% *C. jejuni's* (fresh) and 53.8% (chilled) while *C. coli* were 80.0% (fresh) and 56.3% (chilled broiler parts). Saleha (2002) reported 73.2% *C. jejuni* and 26.8% *C. coli* in broiler chickens. Official and published literature on the occurrence of *Campylobacter* in ducks raised in Malaysia appears to be unavailable.

The isolation of *Campylobacter* species from Pekin duck intestines and wash water samples save that of soil, faecal, feed and drinking water samples suggest that *Campylobacter* species survive poorly in soils, faeces, feed and drinking water samples expose to high oxygen tension (personal commununication with Prof. Rusul Gulam) and sunlight since soil and faecal samples were collected from the bare ground. Feed and drinking water samples were also collected from feeding and water troughs exposed to varying degree of oxygen and sunlight. Therefore the survival of *Campylobacter* species in the intestine and wash water might have been contributed by the reduced oxygen tension present in both samples. *Campylobacter* species in wash water may have been released from the intestines, skin of ducks or feaces during carcass processing. Analyses of the wash water during sampling revealed that the temperature ranged was between 35 to 45^{o}C; therefore *Campylobacters* can survive in water within these temperatures. Our results conform to that of (EFSA, 2005). EFSA (2005) reported that persistence of *Campylobacter* in the environment and water depends on temperature and light. In Norway, water at 2.18 °C was significantly more contaminated (72% positive samples) with *Campylobacter* species than water above 15°C (20% positive samples) (Brennhovd et al., 1992). Sunlight on a sunny June day would eliminate natural population of *C. jejuni* in river water within 30 minutes (EFSA, 2005).

We also obtained 2.27% (5/220) *C. jejuni* and 0.91% (2/220) *C. coli* from the duck intestines and wash water samples. Nonga and Muhairwa (2010) sampled ninety (90) intestinal duck samples and reported that the isolation rate of *C. jejuni* (81.9%) was significantly ($P<0.001$) higher than *C. coli* (18.1%). Boonmar et al. (2007) analyzed 140 duck meat and intestinal samples and found 21 samples to be positive for *C. jejuni* and 7 positive for *C. coli*. *C. jejuni* and *C. coli* were isolated from 15.0% and 45.0% of ducks, respectively by Fumihiko et al. (2004).

Table 1. Presence of *Campylobacter* species in Pekin duck intestines, faeces, soil and wash water samples

Type of Sample	Number of samples tested	Prevalence (No. & % positive)	% *C. jejuni*	% *C. coli*
Intestinal	75	6 (8.00)	4 (5.33)	2 (2.27)
Wash water	25	1 (4.00)	1 (4.00)	0(0.00)
Faecal sample	60	0 (0.00)	0 (0.00	0 (0.00)
Soil sample	30	0 (0.00)	0 (0.00)	0 (0.00)
Feed	15	0 (0.00)	0 (0.00)	0 (0.00)
Drinking water	15	0 (0.00)	0 (0.00)	0 (0.00)
Overall	220	7 (3.18)	5 (2.27)	2 (0.91)

Conclusion

The overall occurrence of *Campylobacter* species in the samples tested was 3.18% and it ranged from 4 to 8%. This indicates a low prevalence rate, although transmissions and cross contaminations can occur under faulty handling and favourable atmospheric conditions. With the industrialization and increasing consumption of duck meat, there is the need to carry out more research into the occurrence of food-borne pathogens in ducks, since they can serve as potential sources for outbreaks of food-borne illness in humans.

Acknowledgements

This research was funded by the Post Graduate Research Grant Scheme (1001/PTEK1ND/843007) of the Universiti Sains Malaysia. The authors are grateful to IPS-USM for the support provided to carry out this research.

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NORMATIVE DIMENSIONS' PREFERENCES TOWARDS INTENTION TO PURCHASE GREEN FOOD PRODUCT

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ABSTRACT

Normative dimensions constitute one of the important elements in the Theory of Reasoned Action (TORA) model. However, the changes of lifestyle over period and different societies have spurred the TORA model constitution and also to vary interpretation of the model itself towards intention to purchase the green food product. Therefore, this paper aims to explore the underlying dimensions of normative factor that influencing the consumers' intention behavior to purchase the green food product and relationships with intention to purchase the green food product among Malaysian consumers through 9 questions, both on salient referents, motivation to comply and intention subject to the green food product using six-point Likert scale (1 representing definitely disagree, unimportant and not purchase while 6 representing definitely agree, important and purchase). A total of 600 respondents were interviewed via structured questionnaire where they need to rank their agreement and importance level of statements given in the questionnaire to gather information of the normative dimensions that influence them to purchase the green food product. The Reliability Test was used to measure the reliability of the constructs given. Then, Exploratory Factor Analysis was used to determine the underlying dimensions of norms and Pearson Product Moment Correlation Analysis to determine the positive and negative relationships of the underlying dimensions with the intention behavior. These underlying dimensions from the factorization of norms were found to be the positively correlated to the Malaysian consumers' intention to purchase the green food products.

INTRODUCTION

Consumer's interest in environmental friendly or green food products has grown tremendously in many industrialized countries during the past ten years. Malaysia as a developing country also faced the increasing environmental concern behavior among the people which demanding the more environmental friendly food product and more safety food choices resulting from the changes of lifestyle and purchasing power ignite from the good economic performance recently. An environmental friendly or green food product can be described as goods that have more environmentally sound contents or packaging or both (Elkington & Makower, 1988). This study will focused on no chemical in raw material or environmental friendly food products, to be called green food products. Parallel to the objectives of Malaysian government in reducing the pollution and emission to the environment, the idea of environmental friendly or green food products is one of the appropriate solutions to the environmental problems occurred.

Green concept implementation readily applied aggressively during recent years. Governments' efforts by introducing the schemes such as Hazard Malaysian Certification

Scheme for Hazard Analysis and Critical Control Point system (MCS HACCP) and Good Agricultural Practices (GAPs) which comprising many schemes that specifying towards many field of agriculture (SALM, SPLAM and SALT) can be seen as an action of concerning and taking the responsibilities to the society and environment. Although the implementation of HACCP, ISO 22000 certification, Good Agricultural Practices which were consisting the SALM, SPLAM, SALT and SOM were not truly direct in developing the green food production, this initiative can be seen as an effort to introduce and expanding the idea of producing the new beneficial food consumption called the environmental friendly or green food products, which were reconsidering the social welfare of society and could overcome the problem occurred between producers and environment.

The normative factor, or subjective norm, represents another major variable that has been considered in context of environmentally responsible behavior. While the green food product can be determine as a product of food that were produced according to certain production standards, meaning they were grown without the use of conventional pesticides, artificial fertilizers, human waste, or sewage sludge, and that they were processed without ionizing radiation or food additives. According to Ottman (1992), consequently, consumers accepted the green products when their primary needs for performance, quality, convenience, and affordability were met, and when they also understood how a green product could help to solve environmental problems. The green consumers always consider the effects to the environment have the correlation or associated with the product purchasing. Chern et. al (2003) described such changes as Westernization, where the Asian countries were consuming similar foods and quantities like western countries. The changes consumption patterns were considerably triggered from the behavior of environmental concern in food consumption among the developed countries. Conceptually, this study was focusing in studying and exploring the normative underlying dimensions among consumers and how the factors can affect the intention to purchase the green food product whether in direct or indirect manner.

MATERIALS AND METHODS

The structured questionnaires were distributed to the respondents from main city of all states in Malaysia using stratified random sampling with help from 3 trained enumerators. Every single respondent got a simple explanation from interviewers about the study purposes or objectives and guidelines in answering the questionnaires. Six hundred and twenty set of questionnaires were distributed and only 600 sets were usable after data screening processes and proceed to perform the exploratory factor analysis. The determination of respondents was determined from the significant assessment of the appropriate sample size in performing the exploratory factor analysis used in this study which summarizes and provides a crude yardstick for determining the sample size. The races and other socio-economic profiles proportion were based on the statistic prepared by the Department of Statistics, Malaysia.

Based on the modified Theory of Reasoned Action (TORA) model by Fishbein & Ajzen (1975), the attitude divided to 2 major components namely salient referents and motivation to comply. Both attitude components in the questionnaire consists of ten questions that related to the consumers' attitude which was focusing the attributes towards environmental issues such as the quality, taste and price of green food products. A few other issues such as the avoidance of poisonous or hazardous food ingredients, allergic effects of green food products and the convenience in purchasing the green food consumption also have been asked in the questionnaire. In order to conduct the analyses, the salient referents items were rated using six-point Likert scale. A value come out from the sum of all items in intention represent the intention variable value in further analysis of correlation in order to

determine the correlation between the normative dimensions with intention to purchase the green food product.

The Cronbach's alpha coefficient was used to assess the reliability of the Likert scale in the survey by investigating the internal consistency of the responses for both items in salient referents and motivation to comply variables concerning the affection of normative factors towards intention to purchase the green food product. Further to the analysis, exploratory factor analysis was performed to identify common threads linking the 18 items (including both variables) for affection of normative factors towards intention. Factor analysis is a suitable statistical tool for estimating the underlying factor pattern for a number of attributes which have been consolidated into a manageable sort for analysis (Kim & Mueller, 1978). Principal component analysis was used as the factor extraction method and Varimax Normalization was used as the rotation method only after the Kaiser-Mayer-Olkin (KMO) test was conducted to satisfy the analysis needs and requirements. Bartlett's test of Sphericity and KMO test of sampling adequacy were initially performed on the data to confirm the appropriateness of conducting factor analysis (Tabachnick, 2001). The underlying dimensions occurred in the previous analysis then were analyzed using the Pearson Product-Moment Correlation to determine the positive or negative relationships between the variables as stated both from salient referents and motivation to comply with the intention to purchase the green food product.

RESULTS AND DISCUSSION

Socio-economic Profiles of Respondents

In the 600 filled questionnaires, about 60 percent of respondents were female, and 62 percent of respondents were Malays. The results also indicated that 47.7 percent of respondents' age was between 22-30 years. The average age of respondents was about 27 with standard deviation of 7.980. The results also presented that 60.3 percent of respondents were single, 49.7 percent of respondents had family members in range between 4 to 6 members and 54.2 percent of respondents had family members below 12 years in range 1 to 3. This study also presented 54.8 percent of respondents were passed secondary school graduation, 51.5 percent of respondents were in private sector and 29.3 percent of respondents earned a monthly household income more than RM5000.

Factor Analysis Results

The reliability analysis was conducted to ensure the internal consistency was at least maintained if not improved. The result shows Alpha if item deleted for all of the items did not exceed alpha standardized item. The Cronbach's alpha based on standardized items showed a reliable and stable value $\alpha = .910$ and $\alpha = .876$ for both salient referents and motivation to comply. The Kaiser Mayer-Olkin measure of sampling adequacy test for the set of predetermined items reached values of at least 0.856 and 0.837 and Bartlett's test of Sphericity was statistically significant, $x^2 = 3765.677$, $p = 0.000$ and $x^2 = 2891.693$, $p = 0.000$. The KMO values mean that the degrees of common variance among the items are meritorious according to Kaiser (1974). Two components from both of salient referents and evaluation of the outcomes were adapted for further analysis which succeed the suppress value of factor loading based on sample size (Hair, Black, Babin & Anderson 2006).

The Exploratory Factor Analysis (EFA) in data extraction performed 2 factors namely; *Non-Family (NF) and Family (F)* with eigenvalue above 1.0 and total variance explained 73.779 percent from the salient referents dimension. Eigenvalue is the column sum of squares for a factor; it also presents the mount of variance accounted for by a factor (Hair et. al., 2006). The analysis identified two latent factors or dimensions that may have relationships with the intention to purchase the green food products as follows. The Non-

family (NF) was recognized as the first factor. This factor consists of 5 sub-variables and has a total variance of 58.454 percent. The Family (F) was the other factor which has a total variance of 15.325 percent and comprises of 4 sub-variables. Two components emerged from the factorization of motivation to comply namely *Non-Family Importance (NFI) and Family Importance (FI)* with eigenvalue above 1.0 and total variance explained 67.871 percent. The Non-Family Importance (NFI) was recognized as a first factor. This factor consists of 5 sub-variables and has a total variance of 50.698 percent. The Family Importace (FI) was the other factor which has a total variance of 17.173 percent and comprises of 4 sub-variables.

Pearson Product-Moment Correlation Analysis

The correlation analysis had been employed to determine the existing of relationships between the salient referents and motivation to comply dimensions selected with intention to purchase the green food products.

Table 1: Pearson Product-Moment Correlation of Subjective Norms

Dimension	**Intention**	
	Pearson Correlation	**Sig. (2-tailed)**
Salient Referents		
Non-Family (NF)	0.602**	0.000
Family (F)	0.246**	0.000
Motivation to Comply		
Non-Family Importance (NFI)	0.557**	0.000
Family Importance (FI)	0.186**	0.000

Note: ** Correlation is significant at the .01 (2-tailed) and the numbers in parenthesis are alpha coefficient

The results found positive relationships between all normative dimensions; NF, F, NFI and FI with intention to purchase the green food product as can be seen in Table 1. This study identified the relationship between subjective norms with respect to purchase the green food product and intention to purchase the green food was positive as proposed by Warren & Warren (1977) and Gill, et al. (1986). These two early conclusions can be accepted based on the findings in hypothesis-testing analysis. Two basic determinants that represent subjective norm with sub-factors existed as significant factors or underlying dimensions in determining the intention to purchase the green food product among Malaysian consumers.

From the results, Non-Family Importance (NFI) which was the representative of motivation to comply dimension has been identified as the highest factor that has positive relationship with the intention to purchase the green food product. The Non-Family (NF) that represents the salient referents also showed some high correlation to the intention. In both of the normative determinants (salient referents and motivation to comply) the family roles of influencing the intention to purchase the green food products positively correlated to the intention in weaker manner. However, all of dimensions exist as normative factor determinants considered satisfy in determining the norms that have the positive relationships with intention to purchase the green food product among Malaysian consumers. This study

findings yield the same results as the previous norm-intention relationship research in the area of environmental responsible behavior proposed by Rozendal et al. (1983) and Mielke (1985). They found that the normative factors were more important determinants of environmental responsible behavior using the Theory of Reasoned Action (TORA) model. Derksen & Gartrell (1993) concluded that "the social context alone was sufficient to produce the behavior". Consistent with the results of this study, the preferences from the normative dimensions itself positively correlate to the intention to purchase the green food product.

Respectively, Malaysian consumers' actions were depending on the environment or people surrounding them and belonging to a certain group. In other words, their intention to purchase the green food product were more influenced by the collectivism activities which represents the level of mental programming which is shared with some people (Hoftede, 1981). In this case, the supposition of the interaction between the people in a group to gain knowledge and information is high.

CONCLUSION

This study enriches existing intention behavior theory originated from the Theory of Reasoned Action (TORA) model. This study sought to determine the Malaysian consumers' normative factors and identify the underlying dimensions that will influence consumers' intention to purchase green food product in order to enhance the implementation of sustainable or environmental friendly food production, marketing and formulate policies in improving Malaysia's food industry. Basically the normative dimensions play some major role in developing the group of consumers that intent in purchasing the green food product. The results consistently agree with the determination of many researchers about the norms preferences resulted in influencing the intention behavior whether it was direct or indirectly related with each other. Depend on the findings of the study which accomplished the objectives of dimensions identification and determination of relationships between normative dimensions and intention behavior, few suggestion have been remarks in term of theoretical and practical efforts. The principles for implementing green specifications have been discussed based on literature related to food production. Economically, the implementation of green principle in food production should be internalizing the social welfare concept which directly benefits the consumers in terms of healthier and safer food product. From the factor analysis, two factors emerged as important success dimensions, including ''Family'' and ''Non-Family'' from the factorization of salient referents determinant, as well as ''Family Importance'' and "Non-Family Importance" from motivation to comply determinant. In parallel with green technology and techniques, the study has identified that involvement by non-family factor of normative dimensions should be the most important factor for the enhancement of intention to purchase the green food product among consumers. The importance of influence level among underlying dimensions which were occurred from normative determinant in explaining the intention behavior may trigger some changes in consumers' practice and intention. Surprisingly, the study findings showed high positively correlate non-family dimensions with intention to purchase the green food product compare to the family factors. With contribution from different level of society from relatives to the politicians, the success of green food consumption among Malaysian consumers could be enhance depend on how these people playing their characters to achieve greener and healthier society which undoubted will conserve and take a good care to our environment.

Acknowledgements

The work described in this paper was fully supported by a grant from the Research University Grant Scheme (RUGS) of the Universiti Putra Malaysia.

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DETERMINATION OF ARSENIC IN PALM KERNEL CAKE BY MICROWAVE DIGESTER AND GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROMETRY

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Abstract

A method for the determination of arsenic in palm kernel cake (PKC) was developed. PKC sample were digested with hydrogen peroxide mixed nitric acid using microwave digester. The analyte was analyzed using graphite furnace atomic absorption spectrometry (GFAAS). The optimal ashing and atomizing temperatures were 800°C and 2400°C, respectively**.** The detection limit of the instrument was at 0.001ppm. The recovery study was performed at 1, 2 and 4 ppm spike levels of arsenic in PKC. The recoveries were in range of 79-81, 89-91 and 80-86%, respectively. Ten commercialize samples of PKC were analyzed to contain 0.18-4.000 ppm of arsenic. Therefore, it can be proposed, this method can be used to detect arsenic in PKC.

Key words: microwave digester, graphite furnace atomic absorption spectrometry, palm kernel cake, arsenic.

INTRODUCTION

Arsenic ranks 20th in abundance in the earth crust. It is a toxic element widely encountered in the environment and organisms (1). Arsenic is widely distributed in the environment because of its natural origin and its industrial production.

Natural arsenic concentrations in plants seldom exceed 1 mg/kg (2). Jones & Hatch (1945) reported that vegetable plants grown in arsenic-spiked soils exhibited 7.1 and 5.0 mg/kg in the roots and shoots respectively. Tomato and bean plants concentrate arsenic primarily in the roots, and a small quantity is translocated to the pods (4).

In Malaysia the level of arsenic in oil palm is not well established. Contamination of arsenic may come from the use of herbicides such a monosodium methyl arsenate (MSMA), disodium methyl arsenate (DSMA) and cacodylic acid (dimethylarsenic acid) in oil palm plantations.

Arsenic can be determined using the following methods: colorimetry (5), hydride generation system in combined with atomic absorption spectrometer (6) and atomic fluorescence spectrometry (7).

Graphite furnace atomic absorption spectrophotometer (GFAAS) is another analytical instrument used for trace element analysis. It has been widely used to determine lead in food, biological samples and environmental samples (8).

The main objective of this study was to test the effectives of microwave system for the digestion palm kernel cake and subsequently analysing using graphite furnace atomic absorption spectrophotometer.

MATERIALS AND METHODS

Palm kernel cake was homogenized to a fine powder, followed by digestion with nitric acid and hydrogen peroxide in a high-pressure microwave. After digestion, the solution was diluted with Milli-Q water and analysis by for determination of arsenic level using graphite furnace atomic absorption spectrometry.

RESULTS AND DISCUSSIONS

Method validation was carried out for determination of arsenic in palm kernel cake by GFAAS at 1, 2 and 4 ppm, respectively. The equation of the curve (Figure 1) and the R^2 value (0.999) shows the good linearity of the analytical method under examination and the method is feasible to be used. Values of coefficients of variation are less than 5% for all concentration (25 ppb, 50 ppb, 75 ppb, and 100 ppb) and to be considered acceptable. Limit of detection (LOD) and limit of quantification (LOQ) were 0.001 ppm and 0.006 ppm respectively.

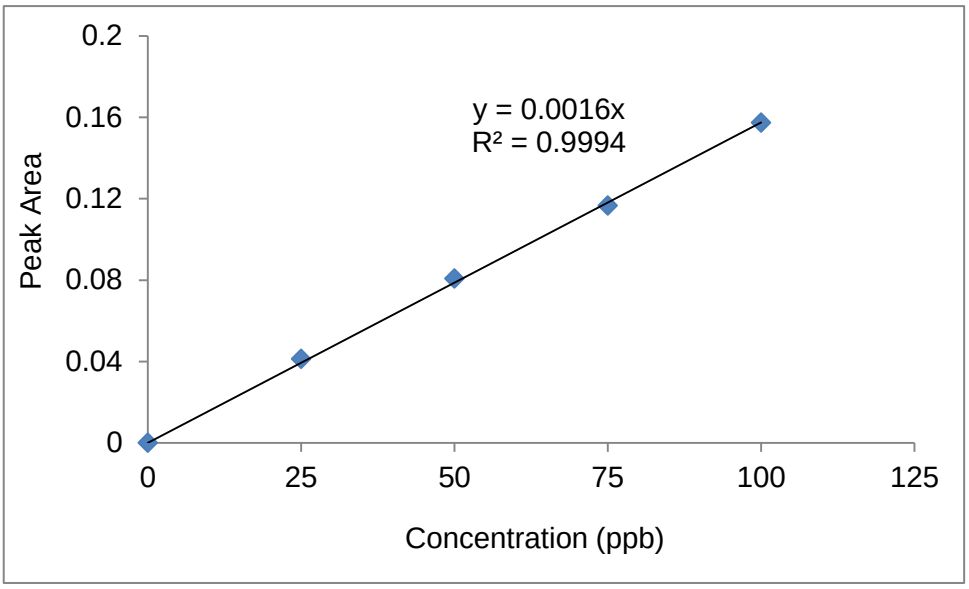

Figure 1: Calibration curve for standard arsenic.

Recovery test for repeatability and reproducibility were performed by spiking several concentrations of arsenic standard to palm kernel cake, which was then analyzed using the established method. Recoveries for repeatability from palm kernel cake at 1, 2, and 4 ppm were found to be 80 ± 4.5%, 90 ± 4.7%, and 85 ± 5.1%, respectively (Table 1). Recoveries for reproducibility from palm kernel cake at 1, 2, and 4 ppm were found to be 79 ± 3.2%, 89 ± 3.11%, and 80 ± 6.3%, respectively (Table 2). All recoveries were greater than 70% with coefficient of variation less than 10% and to be considered acceptable. Above results indicate the established method is capable of yielding a satisfactory recovery.

Table 3 shows the content of arsenic in palm kernel cake/meal sample collected from 10 palm kernel expellers A – J. Out of 10, only one sample (from palm kernel expeller/crusher C) showed slightly higher than 4 ppm maximum allowed by the EU as ingredient for animal feed.

Table 1: Arsenic recoveries for repeatability test in palm kernel cake.

Concentration of Spiked Arsenic (ppb)	Average value (ppb)	Standard Deviation	Recovery (%)	Coefficient of variation (%)
1	0.804	0.037	80.40	4.55
2	1.810	0.086	90.49	4.74
4	3.406	0.187	85.15	5.06

Table 2: Arsenic recoveries for reproducibility test in palm kernel cake.

Concentration of Spiked Arsenic (ppb)	Average value (ppb)	Standard Deviation	Recovery (%)	Coefficient of variation (%)
1	0.792	0.025	79.20	3.18
2	1.782	0.055	89.10	3.11
4	3.214	0.201	80.35	6.25

Table 3: Level of arsenic (ppm) in palm kernel cake from 10 selected Malaysia palm kernel crusher/expeller.

Palm Kernel Expeller/Crusher	**Arsenic**
A	1.39 ± 0.062
B	0.18 ± 0.009
C	4.05 ± 0.392
D	1.31 ± 0.050
E	0.22 ± 0.017
F	0.84 ± 0.049
G	1.54 ± 0.037
H	1.49 ± 0.118
I	2.12 ± 0.215

CONCLUSION

Microwave digestion is a reliable method for degradation of palm kernel cake prior to graphite furnace atomic absorption spectrometry measurement of arsenic.

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STORAGE STABILITY OF YELLOW ALKALINE NOODLES TREATED WITH MICROWAVE AND PULSE UV

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Abstract

Yellow alkaline noodles (YAN) are very susceptible to spoilage and have a very short shelf life. In an attempt to increase the storage stability, fresh YAN were treated using commercial microwave for 5 s followed by 3.5 kJ/cm^2 pulsed-UV prior to storage at ambient (28±2^{o}C) and chilled conditions (4±2^{o}C). The texture profile analysis, total aerobic mesophilic bacteria and yeast and mould count of YAN were monitored. Texture profiles of YAN such as hardness, chewiness, cohesiveness and adhesiveness were affected during storage period at both storage conditions except for springiness. Microwave and pulsed UV treatment reduced the initial load of total aerobic mesophilic bacteria and yeast and mould count in YAN. The growth rate of microorganism was unaffected by the treatment at ambient temperature, but it was reduced at chilled condition. It can be concluded that combination of microwave and pulsed UV treatment and chilled condition improved the storage stability of YAN.

Key words: yellow alkaline noodles; storage stability; microwave; pulsed-UV

INTRODUCTION

Yellow alkaline noodle (YAN) is very susceptible to spoilage and has a very short shelf life i.e. 1-1.5 days (Miskelly, 1998). This could be due to the intrinsic factors of the product itself such as its high moisture content and alkalinity. In addition, it has been reported that spoilage of YAN might be due cross contamination from the environment and operators during processing (Ghaffar, 2010).

Microwave heating had been known to have a potency to reduce the microbial load in food product. Emam *et al.* (1995) used microwave treatment to improve the hygienic quality of black pepper powder. They found that microwave treatment for 40 s and 75 s at a frequency of 2450 MHz and a power output of 750 watts were safe and suitable for decontamination of black pepper which does not result in a great loss of flavour compounds, as compared with recommended doses of gamma irradiation.

Pulsed-UV irradiation is a novel technology which has the ability to inactivate a wide range of spoilage microorganism in a short period of time. In a study on the

inactivation of *Staphylococcus aureus*, Krishnamurthy *et al.* (2004) found that a 7- to 8-log CFU/ ml reduction was observed for suspended and agar-seeded cells treated with pulsed-UV for 5 s or longer. In an attempt to extend the shelf life and quality of YAN a combination of microwave and pulsed-UV treatment were applied on partially cooked YAN. Thus, the objective of this study was to determine the effect of these treatments on the storage stability of YAN at ambient and chilled conditions.

MATERIALS AND METHOD

Noodles Preparation and treatment

Noodles were made in the laboratory using 100 parts of wheat flour, 34 parts of water, 1 part of cooking salt (NaCl), and 1 part of alkaline salt (comprising of 60% sodium carbonate (Na_2CO_3) and 40% potassium carbonate (K_2CO_3)). All the ingredients were mixed together to form a dough. The dough was passed through a pair of noodle roller for seven successive sheeting steps before it was cut into noodle strands using a cutting roll. Raw noodles strands were parboiled at 98±2^{o}C in boiling distilled water at a ratio of 1 part of noodles to 10 parts of water for 50 s, cooled immediately under running tap water for 1 min, drained to remove surplus water, and packed in polyethylene bags (10g/bag). After packaging, the noodles were subjected to 5 s of microwave followed by 3.5 kJ/cm^2 pulsed-UV treatment.

Textural properties of YAN

Texture profile analysis which includes hardness, springiness, adhesiveness, cohesiveness and chewiness of YAN was performed on 10 strands of noodles from each treatment using a Texture Analyzer (TA-XT2, Stable Micro Systems) equipped with Texture Exponent 32 software. A 5 kg load cell and the P/36R probe were used in this analysis. The texture analyzer settings were as follows: pre-test speed: 2.0 mm/s; test speed: 2.0 mm/s; post-test speed; 2.0 mm/s; mode: Strain; Strain: 75%; Trigger force: 10g.

Microbiological analysis

Standard methods were used to enumerate microorganisms present in the noodles samples at each sampling time. About of 10 g of noodles were homogenised in 90ml of sterile peptone water in a sterile stomacher bag with a Stomacher for about 60 s. Tenfold dilution series were made using sterile peptone water. The following media and incubation conditions were used: plate count agar (PCA) for total mesophilic bacteria, incubated at 37^{o}C for 48 h; Dichloran rose Bengal chloramphenicol (DRBC) for yeast and mould, incubated aerobically at 30^{o}C for 72 h. Microbial counts were expressed as log10 CFU/g.

Experimental design and data analysis

A complete randomized design with two replications were used and the data were analyzed using two-way ANOVA (Analysis of Variance) at a 95% confidence interval ($P<0.05$). The Tukey's test was carried out as the post hoc test.

RESULTS AND DISCUSSION

Texture profile analysis of YAN

The texture profile of YAN during storage is shown in Table 1. At the beginning of the storage period, the treated YAN were harder, more adhesiveness, springy, cohesive, and chewy compared to the control YAN. At the end of storage period, the treated YAN still had higher values for all the textural characteristics compared to the control YAN, except for adhesiveness. No significant decrease in hardness was observed in YAN that was stored at ambient temperature but significant ($P<0.05$) increment in hardness was recorded in YAN stored at chilled condition. This was probably due to loss of moisture and retrogradation process during chilled storage. The adhesiveness of YAN stored at ambient temperature increased significantly ($P<0.05$) during the storage period, whereas the adhesiveness of YAN stored at chilled condition increased at the beginning and decreased on the third week onwards. The increase in YAN adhesiveness at ambient temperature might be due to the growth and activity of microorganism causing slimy surface of YAN, whereas the decrease in noodles adhesiveness might be due to the retrogradation process during chilled storage. Cohesiveness of YAN stored at ambient temperature decrease significantly ($P<0.05$) during storage. During the 2nd week of storage, cohesiveness of YAN stored at chilled decrease, but the cohesiveness value started to increase on the 3rd week until the end of storage period. Springiness and chewiness of YAN at both storage condition increase significantly ($P<0.05$) during storage.

Microbiological Quality of YAN

YAN with high nutrient availability, high moisture and pH create a favourable environment for the growth of microorganism. Figures 1 and 2 showed the growth of total aerobic mesophilic bacteria of YAN during storage at ambient temperature and chilled condition, respectively. YAN treated with microwave and pulsed-UV has a lower initial load of total aerobic mesophilic bacteria (1.7 log CFU/g) compared to the control YAN (3.1 log CFU/g). At the end of storage period, the bacteria count increase significantly ($P<0.05$) to 8 log CFU/g for control and treated YAN stored at ambient temperature, and to 7 log CFU/g for control YAN and 4 log CFU/g for treated YAN stored in chilled condition. This finding is similar to Jensen *et al.* (2004) who observed that total mesophilic bacteria in fresh YAN ranged from 3-4 log CFU/g at the beginning of storage period and 8 log CFU/g at end of storage. Growth of aerobic mesophilic bacteria at ambient temperature was very rapid and chilling slowed down the growth rate of aerobic mesophilic bacteria.

Table 1. Textural properties of yellow alkaline noodles stored at ambient and chilled temperatures

Storage condition	Storage time	Hardness (g)		Adhesiveness (g s)		Springiness		Cohesiveness		Chewiness	
		control	Treated YAN	Control	Treated YAN	Control	Treated YAN	control	Treated YAN	control	Treated YAN
Ambient (28±2°C)	0 day	2359.44^{a}	2445.37^{b}	19.03^{a}	21.69^{b}	1.02^{a}	1.17^{b}	0.64^{a}	0.65^{a}	1427.82^{a}	1759.01^{b}
	1 day	2303.82^{a}	2404.25^{b}	21.85^{b}	23.89^{c}	0.96^{a}	1.49^{b}	0.61^{b}	0.64^{b}	1284.73^{c}	1350.1^{c}
	2 days	2308.23^{a}	2400.82^{b}	25.51^{c}	24.05^{c}	0.92^{a}	1.78^{b}	0.61^{b}	0.62^{b}	1285.18^{c}	1371^{d}
	3 days	2290.03^{a}	2401.64^{b}	26.65^{c}	24.50^{c}	0.95^{a}	2.46^{b}	0.59^{c}	0.62^{b}	1281.65^{c}	1334.34^{c}
	4 days	-	2283.4^{b}	-	25.94^{c}	-	2.76^{b}	-	0.62^{b}	-	1300.71^{c}
Chilled (4±2°C)	0 week	2359.44^{a}	2445.37^{b}	18.99^{a}	21.55^{a}	1.02^{a}	1.17^{a}	0.64^{a}	0.65^{a}	1427.82^{a}	1759.01^{a}
	1 week	2573.95^{c}	2713.54^{d}	26.40^{b}	24.44^{b}	3.51^{b}	3.8^{b}	0.61^{b}	0.62^{b}	5832.64^{b}	5879.4^{b}
	2 weeks	2872.33^{e}	2849.89^{e}	28.07^{c}	29.21^{c}	4.04^{c}	3.81^{c}	0.62^{b}	0.64^{a}	7332.5^{c}	8327.4^{c}
	3 weeks	2882.29^{e}	3243.9^{f}	26.50^{b}	23.59^{b}	4.12^{d}	4.73^{d}	0.65^{a}	0.66^{ac}	7369.3^{c}	8544.21^{c}
	4 weeks	2995.02^{e}	3386.31^{g}	22.73^{a}	22.4^{a}	4.46^{e}	4.86^{e}	0.65^{a}	0.67^{c}	8757.44^{cd}	9190.3^{d}

*Mean values with the same superscript letters within the same column are not significantly different at P<0.05.

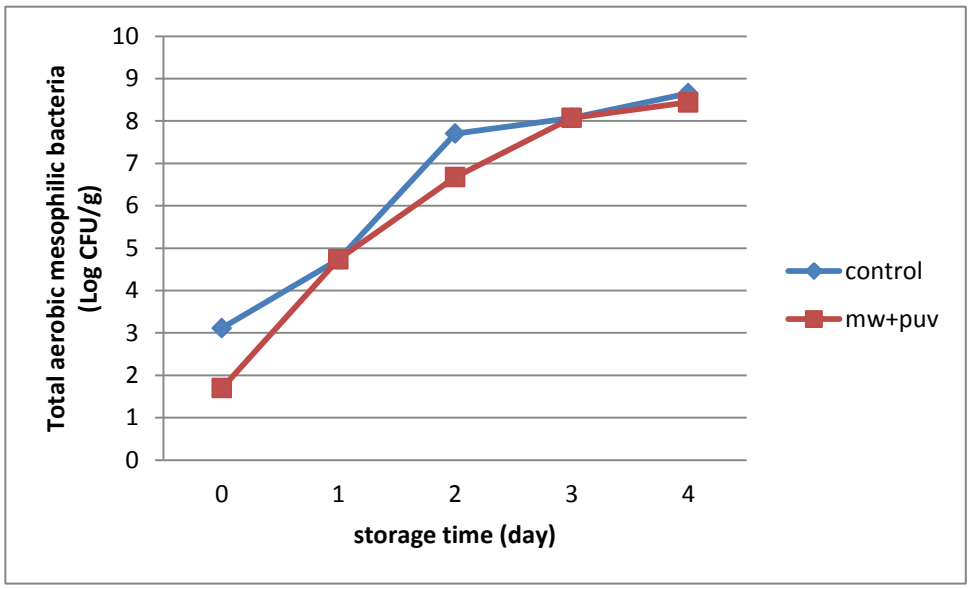

Figure 1. Total aerobic mesophilic bacteria of yellow alkaline noodles stored at ambient temperature

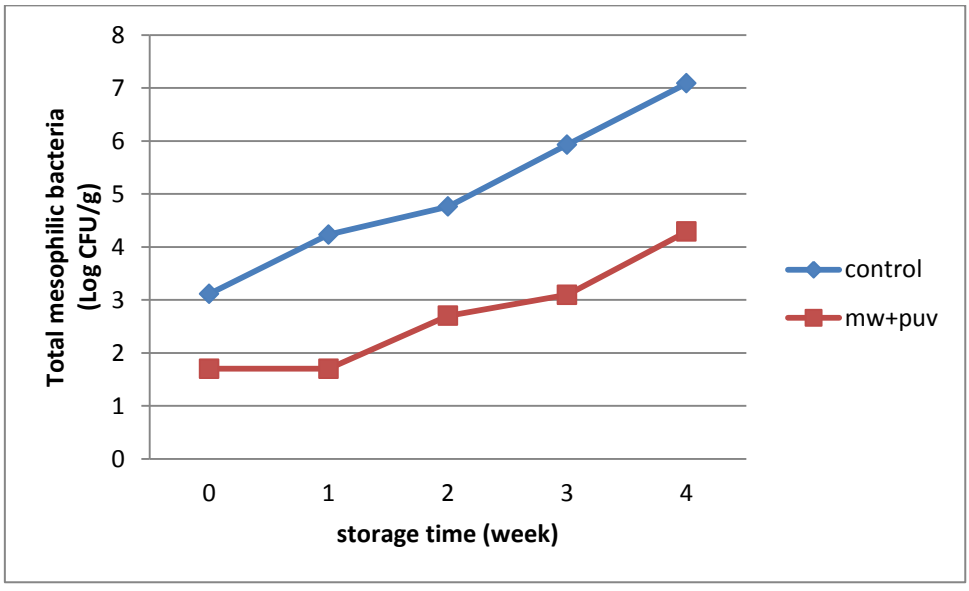

Figure 2. Total aerobic mesophilic bacteria of yellow alkaline noodles stored at chilled temperature

Yeast and mould count of YAN during storage at ambient temperature and chilled condition were shown in Figures 3 and 4, respectively. YAN treated with microwave and pulsed-UV has a lower initial load of yeast and mould count (1.8 log CFU/g) as compared to the control YAN (2.1 log CFU/g). But at the end of storage period, the of yeast and mould count increased significantly ($P<0.05$) to 8 log CFU/g for treated YAN and 9 log CFU/g for control

YAN stored in ambient temperature, and to 5.5 log CFU/g for control YAN and 4.5 log CFU/g for treated YAN stored in chilled condition.

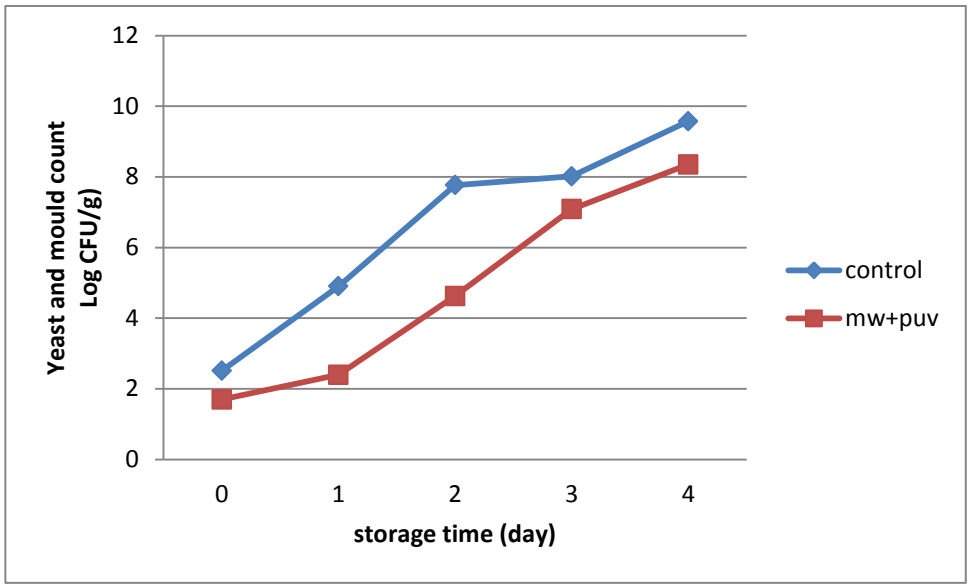

Figure 3. Yeast and mould count of yellow alkaline noodles stored at ambient temperature

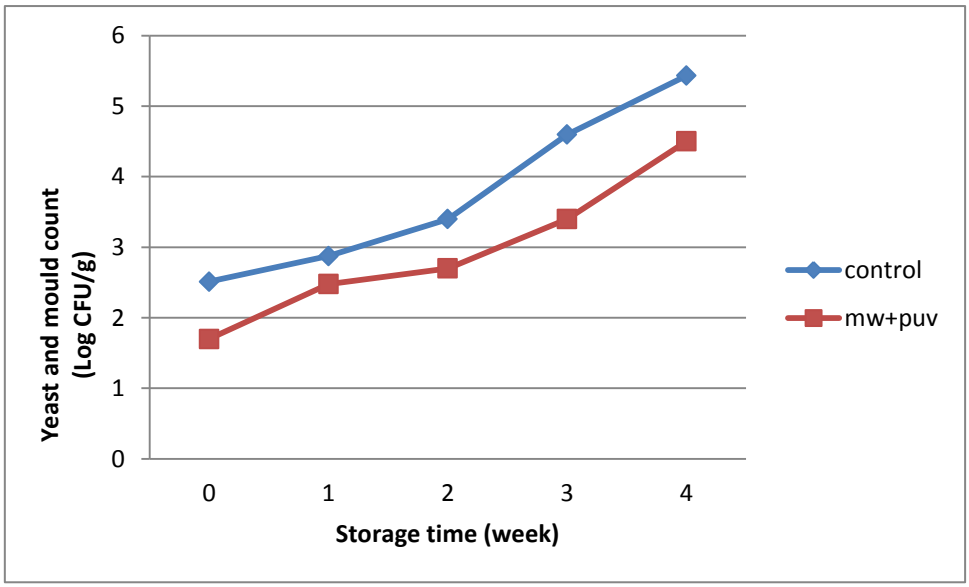

Figure 4. Yeast and mould count of yellow alkaline noodles stored at chilled temperature

CONCLUSION

Texture profiles of YAN such as hardness, chewiness, cohesiveness and adhesiveness were affected during storage period at both storage conditions except for springiness. Microwave and pulsed UV treatment reduced the initial load of total aerobic mesophilic bacteria and yeast and mould count in YAN. The growth rate of microorganism was unaffected by the treatment at ambient temperature, but it was slowed down at chilled condition. It can be concluded that combination of microwave and pulsed UV treatment and chilled condition improved the storage stability of YAN.

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DETERMINATION OF CORTICOSTEROIDS IN ANIMAL TISSUE BY LIQUID CHROMATOGRAPHY–TANDEM MASS SPECTROMETRY

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Abstract

Corticosteroids are well known drugs used to treat various inflammatory and imunonogically mediated disease but they are also illegally used as feed additives in livestock production to improve live weight gain. Determination of its residues in meat as well as target organ (liver) is important to ensure the meat is safe for human consumption while monitoring the residue in target organ will ensure the drugs are not illegally use in the farm. A simplified method that can be used for both matrixes has been developed and used for routine monitoring. Samples were extracted with acetate buffer followed by clean up procedure using Oasis HLB SPE and analysed by LC-MS/MS. The limit of quantification (LOQ) were 0.25 µg kg^{-1} for betamethasone and dexamethasone, 1 µg kg^{-1} for prednisolone, prednisone, cortisol and cortisone and 2.5 µg kg^{-1} for methylprednisolone. The mean recoveries were between 86-100%.
Keywords : Corticosteroids, meat, liver and LC-MS/MS

Introduction

Corticosteroids are well known drugs used to treat various inflammatory and imunonogically mediated disease but they are also illegally used as feed additives in livestock production, often in combination with β-agonists to improve live weight gain. European Union has banned the use of growth promoting agent in food producing animal but the administration of dexamethasone, betamethasone, prednisolone and methylprednisolone were approved for therapeutic indications only and maximum residue limits (MRL's) were established. Malaysia has also established maximum residue limits (MRLs) for selected corticosteroids in food-producing animals in Malaysian Food Regulation 1985 to protect the health of consumers.

In Malaysia, screening for steroids and corticosteroids are currently conducted only in urine samples related to doping control but not in meat and offal. As a developing country, Malaysia may encounter high activity involving growth promoters in the future livestock industries and therefore screening and confirmatory method need to be established and use

to monitor the status of such residues in food of animal origin which is required for quality control of food products.

A few authors have reported on analytical methods for determination of corticosteroids in tissue (Ronquist-Nii & Olof Edlund, 2005 ; Van den hauwe, Dumoulin, Elliott & Van Peteghem, 2005 ; Antignac, Bizec, Monteau, Poulain & Andre, 2001) and liver samples (Hamoir et al., 2002 ; Van den hauwe, 2005).

Other publications were on the determination in hair (Bevalot, Gaillard, Lhermitte & Pepin, 2000), plasma (Cherlet, Baere, Croubels & Backer, 2005 ; DiFrancesco et al., 2007) and urine samples (Leung et al., 2005 ; Ho, Leung, Wan & Yu, 2006 ; Touber, Van Engelen, Georgakopoulus, Van Rhijn & Nielen, 2007) specially for doping control. For this study, extraction methods by Van den hauwe (2005) has been adapted with some modification in SPE clean up procedure which make this procedure simpler, faster and sensitive.

Materials and Methods

Dexamethasone, betamethasone, prednisone, prednisolone, methylprednisolone, cortisone and flumethasone were purchased from Sigma Aldrich. Cortisol was purchased from Steraloids (Newport,USA). Helix pomatia juice, used for enzymatic hydrolysis, was purchased from Boehringer Mannheim and protease from Sigma. Disposable Oasis HLB 3cc (60mg) extraction cardtridges were purchased from Waters.

The samples were extracted with sodium acetate buffer, hydrolysed with protease and *Helix pomatia* and later purified on Oasis HLB cartridges. LC separation was achieved by using Hypersil Hypercarb column. Multiple reaction monitoring (MRM) was used for selective detection of each corticosteroids as adduct $[M+formate]^-$ ions. The procedure was optimised and validated for simultaneous determination of 7 corticosteroids namely dexamethasone, betamethasone, prednisone, prednisolone, methylprednisolone, cortisol and cortisone while flumethasone was used as internal standard. All compounds were eluted within 10 min and the total analysis time was 15 min including the stabilisation time required for the next injection.

Results and Discussion

The use of Oasis HLB cartridge where HLB is an acronym for hydrophilic–lipophilic balance which describes the two key features of the polymer: the ability to remain wetted and the ability to adsorb or retain analytes, the use of these cartridges permits a more precise and less tedious process than with the conventional silica based SPE allowing simultaneous analysis of a higher number of samples (AbuRuz, Millership, Heaney & McElnay, 2003). By replacing the normal C18 SPE with Oasis HLB make it possible to the elimination of methanol extraction procedure which makes this procedure simpler. This study showed that this simplified method gives sensitive and consistent results for both meat and liver samples. MRM chromatograms of meat and liver samples spiked with flumethasone (FLM), dexamethasone (DXM), betamethasone (BTM), cortisol (CRL), cortisone (CRN), prednisone (PRN), prednislone (PRL) and methylprednisolone (MPRL) are shown in Figure 1.

The calibration curves were linear in the 0.25–2, 1.0-8.0 and 2.5-20 µg kg^{-1} range, with typical correlation coefficients (r^2) values higher than 0.94 as shown in Figure 2. The quantification limits were 0.25 µg kg^{-1} for betamethasone and dexamethasone, 1 µg kg^{-1} for prednisolone, prednisone, cortisol and cortisone and 2.5 µg kg^{-1} for methylprednisolone. The

mean recoveries were between 86-100%, the coefficient of variation (CV, %) for intra-day was lower than 16%.

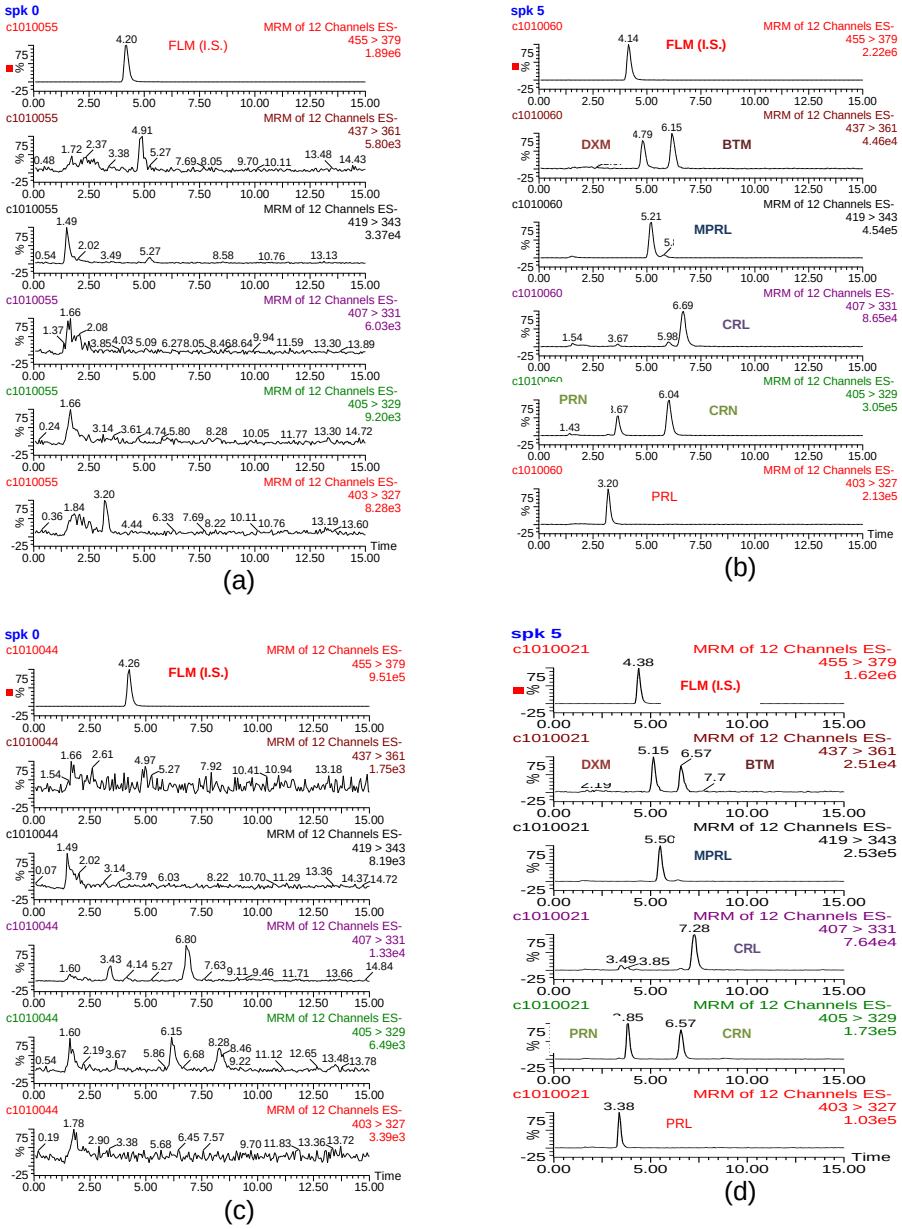

Figure 1: MRM chromatograms of meat and liver samples spiked with flumethasone (FLM), dexamethasone (DXM), betamethasone (BTM), cortisol (CRL), cortisone (CRN), prednisone (PRN), prednislone (PRL) and methylprednisolone (MPRL) (a) blank liver (b) spiked liver at 1ppb (c) blank meat (d) spiked meat at 1 ppb

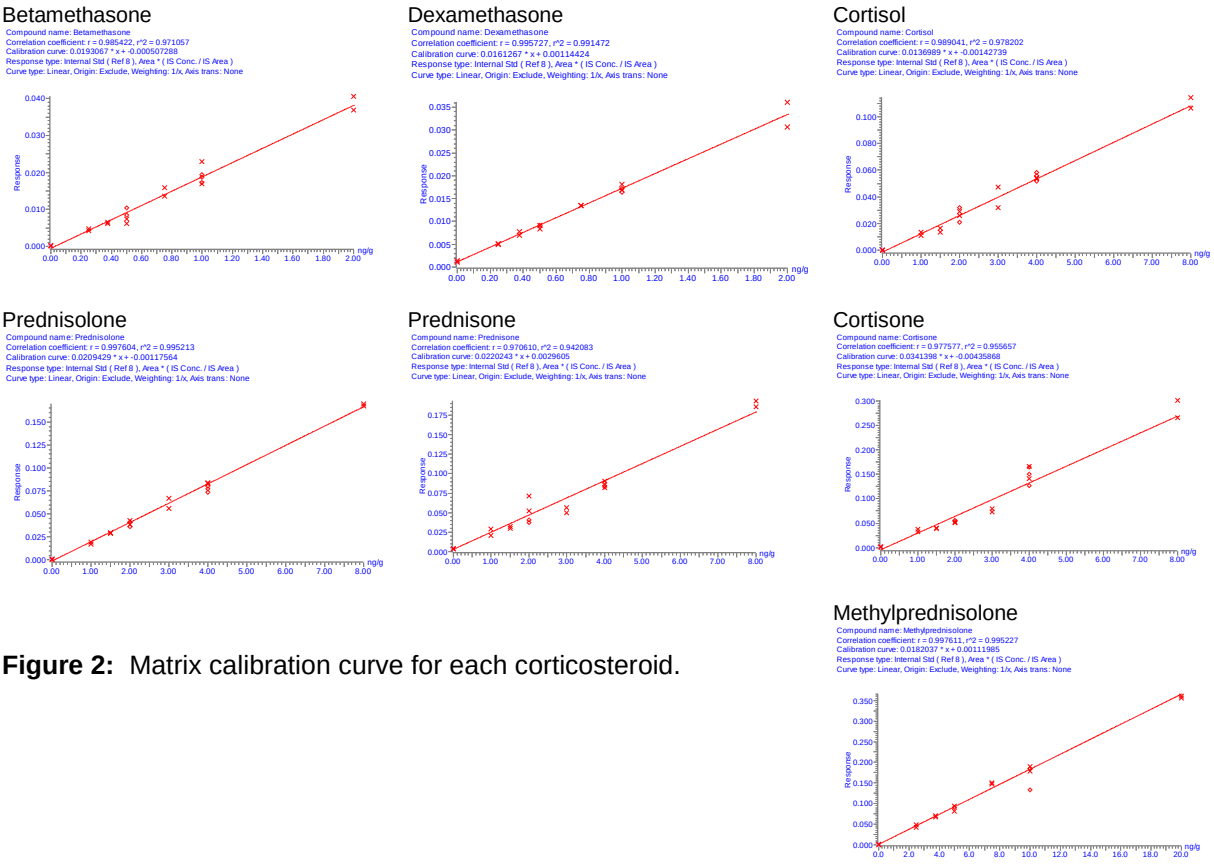

Figure 2: Matrix calibration curve for each corticosteroid.

Conclusion

In this work, an improved LC-MS/MS method has been developed and validated for the determination of 7 corticosteroids in meat and liver. Satisfactory results were obtained with respect to selectivity, linearity, accuracy, precision, Limit of detection and Limit of quantification. The proposed methods have been successfully applied to monitor residues of 7 corticosteroids in liver from slaughter houses and poultry processing plants throughout peninsular Malaysia.

Acknowledgment

The authors gratefully acknowledge University Malaya for the financial support for this research project. We also wish to acknowledge the Department of Veterinary Services Malaysia for the providing test samples and for the use of Quattro Ultima Pt.

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DIFFERENT LIGHT INTENSITIES EFFECT ON TOTAL PHENOLICS AND FLAVONOIDS CONTENT AND ANTI-OXIDANT ACTIVITIES IN LEAVES OF THREE VARIETIES OF LABISA PUMILA BENTH

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Abstract

Antioxidant research is an important topic in the medical field as well as in the food industry. Studies on the free radical-scavenging properties of flavonoids have allowed characterization of the major phenolic components of naturally named phytochemicals as antioxidants. Furthermore, the commercial development of plants as sources of antioxidants that can be used to enhance the properties of foods, for both nutritional purposes and for preservation. Antioxidants are substances that delays or inhibits oxidative damage when present in small quantities compared to an oxidizable substrate. Hence, antioxidants can help in disease prevention by effectively neutralizing the free radicals or inhibiting damages that are created by them. Free radical-induced oxidative damage is involved with various human diseases like cardiovascular diseases, diabetes and cancer. *Labisia pumila* (*Myrsinaceae* family), commonly known as Kacip Fatimah in Malaysia, is a member of a small genus of slightly woody plant. It is a popular herb that has long been recognized to contain high bioactive compounds and demanded for its medicinal value as female tonics and health products. Demand for *L. pumila* is expected to increase substantially with the recent discovery of its estrogenic activity. There are three varieties of *L. pumila* namely var. *pumila*, var. *alata* and var. *lanceolata* and each has its own use. In this study, two levels of glasshouse light intensities (310 and 630 µmol m−2s−1) were used in order to consider the effect of light intensity on the phenolic and flavonoid content and antioxidant activities in leaves of three varieties of *Labisa pumila.* Total phenolics and flavonoids content were highest in the all three varieties under 630 µmol m−2s−1. Leaf of var. *pumila* exhibited higher total flavonoids content (2.94 mg rutin equivalent (E)/g dry weight (DW)) than var. *alata* (2.73 mg rutin E/g DW) and var. *lanceolata* (2.54 mg rutin E/g DW) But higher total phenolics content was recorded by var. *alata* (3.92 mg Galic acid equivalent (GAE)/g DW) followed by var. *pumila* (3.59 mg GAE/g DW) and var. *lanceolata* (3.30 mg GAE/g DW).Also, antioxidant activities determined by the 1,1-Diphenyl-2-picryl-hydrazyl (DPPH) assay increased significantly ($p \leq 0.01$) with increasing total phenolics concentration in all varieties. The *L. pumila* var. *alata* also contained higher antioxidative activities compared to var. *pumila* and *lanceolata* at concentration of 400 µg/ml but lower activities than the antioxidant standards (BHT and α-tocopherol) were observed.

Keyword: 1,1-diphenyl-2-picryl-hydrazyl (DPPH) assay; light intensity; total flavonoids and phenolics contents.

INTRODUCTION

Labisia pumila, locally known as Kacip Fatimah, is a forest-floor herbal plant has tremendous potential in the herbal industry (Mohd Setafarzi, 2000). It is one of the five herbal plants identified by the governments as one of the national key economic areas to be developed for commercial purposes (Pemandu, 2010). In Malaysia, is a popular herb that has long been recognized and demanded for its medicinal value as female tonics and health products (Burkill, 1935). With recent discovery of estrogenic activity (Jamal et al., 1998; Ayida et al., 2007) demand for *L. pumila* is expected to soar. As little has been done to domesticate *L. pumila*, the current high rate of demand and methods of harvesting, particularly from the wild, has made research on domestication, propagation and cultivation of robust high quality plants urgent to ensure the prolonged richness of the tropical biodiversity and to avoid extinction of natural forest population from over harvesting of *L. pumila* (Jaafar, 2007). Phenols, being a major group of antioxidant phytochemicals, have profound importance due to their biological and free radical scavenging activities (Prakash et al., 2007), with amount varied from 2.8 mg g-1 (*Withania somnifera*, roots) to 107.8 mg g-1 (*Cassia fistula,* fruits). Raising *L. pumila* under greenhouses, where micro-climate could be manipulated, thus, seemed to be a promising alternative for controlling levels of phytochemicals and producing targeted quality raw material in a sustainable way (Jaafar et al., 2010). However, the existence of inter-specific differences to micro-environment (Jaafar, 2006) may influence plant accumulation and distribution of TP (Souza et al., 2004; Jaafar et al., 2008). The aims of the present work were to determine the effect of different levels of greenhouse irradiance on the accumulation of Total phenolic, flavonoid and antioxidant activity in three verities of *L. pumila.*

MATERIALS AND METHODS

Plant Materials

Seedlings collected from Kota Tinggi, Johore were raised under glasshouse for 18 months before used in the study. Leaves of plant were separated, frozen dried and kept for further analysis. For the light experiment plants were grown under two levels of glasshouse shade (30% and 70% shade) under glasshouse for 4 months. The average light intensity passing through in each shading treatment was 630 and 310 μmol m^{-2} s^{-1} of PPFD, respectively.

Plant Extraction

Samples were extracted using methanol and the extraction technique used reflux method based on Crozier et al. (1997) with slight modification.

Determination of Total Phenolic Compound

Total phenolic content of the extract was determined colorimetrically using the Folin-Ciocalteu method as illustrated by Halici et al. (2005). The extract was measured at absorbance 765 nm and the result expressed as milligrams of gallic acid equivalents (GAE) per gram of dry matter.

Determination of Total Flavonoid Compound

Total flavonoid content was determined using standard flavonoid rutin as described by Zhishen et al. (1999) with slight modification. The extract was measured using absorbance at 510 nm and the result was expressed as milligrams of rutin equivalents per gram of dry matter.

Free radical scavenging activity 1.1-diphenyl-2-picrylhydrazyl (DPPH)

The free radical scavenging activity of leaf of 3 varieties of *labisia pumila* was measured using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) method described by Burits and Bucar (2000). The BHT and α-tocopherol were used as control.

RESULTS AND DISCUSSIONS

The result obtained showed that Total phenolic and Total flavonoid content in the plant were considerably affected by the differing light intensity. The different light intensities had a significant ($p \leq 0.01$) effect on the TP and TF produced (Total phenolic and Flavonoid content were highest in the all three verities under 630 µmol m−2s−1. Leaf of var. *pumila* exhibited higher total flavonoids content (2.94 mg rutin equivalent (E)/g dry weight (DW)) than var. *alata* (2.73 mg rutin E/g DW) and var*. lanceolata* (2.54 mg rutin E/g DW) But higher total phenolics content was recorded by var. *alata* (3.92 mg Galic acid equivalent (GAE)/g DW) followed by var. *pumila* (3.59 mg GAE/g DW) and var. *lanceolata* (3.30 mg GAE/g DW). DPPH method was carried out to determine the total antioxidantive potential of *labisia pumia* leaf (*Pumila, Alata and lanceolata*). DPPH result showed the highest antioxidant activity at concentration of 400 µg/ml crude methanolic extract with 60.72%, 54.52% and 51.48% in variety of *Pumila*, *Alata and lanceolata*. Many phenolic compounds have been reported to possess potent antioxidant activity and have anticancer or anti-carcinogenic, anti-bacterial, anti-viral or antiinflammatory activities to a greater or lesser extent (Tapiero et al 2002). Also Plant flavonoids are an important part of the diet because of their effects on human nutrition (Frankel 1995). The most important function of flavonoids is the antioxidants properties.

CONCLUSION

This research indicate that the existence of varietal differences in three varities of Labisia *pumila* (var. *alata* , *pumila, Lanceolata*) and the impact of imposing varying levels of greenhouse irradiance in the accumulation and distribution of total phenolics and flavonoid content as well as antioxidant activity. The effects of growing microenvironments and their interactions with plant species in the accumulation and partitioning of secondary metabolite may pose a great challenge to establish an alternative method to biopharmaceutical production of local herbs, such that a factory-run like system in a multi-tiered controlled

environment system could be established for greenhouse niche production of targeted key metabolites.

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EFFECTS OF MICROWAVE TREATMENT ON PROXIMATE COMPOSITIONS OF RICE CHIPS FROM VARIOUS RICE MILLS IN SELANGOR

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Abstract

Microwave treatment has been applied to stabilize rice chips against deterioration. The effects of microwave treatment on the proximate compositions of rice chips were studied. Rice chips obtained from three different rice mills in Selangor Darul Ehsan, Malaysia were given microwave treatment and analyzed for their proximate compositions which include ash, moisture, carbohydrate and crude protein, fat and fibre. Results showed that microwave treatment did not affect the ash, carbohydrate, crude protein, fat and fibre contents, but it lowers the moisture content of rice chips. This implies that microwave treatment can be used to lower the moisture content and hence help to prevent deterioration of rice chips before further processing.

Keywords: Rice chips; microwave treatment; proximate compositions

INTRODUCTION

Rice (*Oryza sativa* L.) is an excellent source of complex carbohydrates, fibre (brown rice), protein and vitamins (Perretti *et al.*, 2003). It has become the most important staple food in Asia including Malaysia. Rice milling process produces many by-products including rice husk, rice bran, broken rice, and rice chips. It have been estimated that the amount of rice chips produced in Malaysia is 10,000 metric tons. Rice chips comprises of a mixture of very small broken kernels and broken kernels with 'intact rice germ' and usually separated during milling process of white rice as it passes through the rotary sieve after the final polishing step. The intact rice germ is high in essential lipids, quality protein, tocopherols, tocotrienol, B group vitamins, minerals and carbohydrates and its nutritive value is known to be comparable to that of wheat germ, a relatively high priced food ingredient (In-Hwan *et al.,* 2002). Hence, rice chips have the potential to be processed into value added functional and food ingredients.

Currently in Malaysia, rice chip is sold off as an animal feed since there are no other uses of this product and therefore it is regarded as a very cheap product. However, in other countries rice chip is normally used as a raw material for beer production. A major obstacle in using rice chips as an ingredient for the food industry is that it has a limited shelf life as it deteriorates rapidly at ambient temperature Therefore, it is necessary to stabilize and consequently preserve the nutritive value of rice chips before it can be further processed into nutritious food ingredients.

Several studies have been conducted on the stabilization of rice bran which include chemical treatment, gamma irradiation and microwave heat treatment (Nasirullah *et al.*, 1989; Prabhakar and Venkatesh, 1986; Wen-Chieh Sung, 2004; Malekian *et al.,* 2000). Among these treatments, microwave heat treatment was considered as the most popular and effective method. It is the most energy-efficient types and a rapid method for heating food items (Yoshida *et al.,* 1991; Ramezanzadeh *et al.,* 2000). At present, the effects of microwave treatment on the nutritional compositions of rice chips have not been reported. Therefore, the purpose of this study was to evaluate the effect of microwave treatment on the proximate compositions of rice chips.

MATERIALS AND METHODS

Reagents and standards

All chemicals used were of analytical grade and were purchased from Merck Sdn. Bhd.

Samples collection and preparation

Freshly milled rice chips were obtained from 3 different rice mills at Sekinchan, Sri Tiram Jaya and Sungai Besar which are located in Selangor Darul Ehsan, Malaysia.

The rice chips were pulverized into finer particles using Retsch® ZM 200 Ultra Centrifugal Mill at 6000 rpm. The powdered rice chips were passed through a 600 mm sieve to achieve appropriate particle sizes as described by Abdul-Hamid and Luan (2000) before they were packed in polyethylene (PE) bags and vacuum sealed.

About 250 g of sample was treated with microwave at 67 % power level for 8 min with intermittent mixing using Panasonic 1100 W Inverter Sensor Microwave Oven (Model: NN-ST667W). The final temperature of the samples was at 110 °C. During microwave treatment the samples were stirred manually at every 3 min intervals to prevent localized burning of samples. The samples were then placed in PE bags and vacuum packed. All samples were stored at room temperature until further analysis. Untreated rice chips were used as the control.

Proximate analysis

Moisture, ash, crude protein, fat and fibre of rice chips were determined according to the AOAC methods (AOAC, 1990). Percent carbohydrate was determined by difference using the formula below:

% Carbohydrate = 100 – (% crude protein + % crude fat + % moisture + % ash + % fiber)

Statistical analysis

Data obtained was analysed using the Statistical Analysis System. Significance of difference between the results obtained were evaluated using Duncan's multiple range test at 5 % level. Experiments were done in triplicate and average data was used for analysis.

RESULTS AND DISCUSSION

The milling process of white rice involved removal of bran layer from endosperm and produces rice by-products such as rice bran, broken rice, rice chips, and hulls. Freshly milled rice bran and rice chips usually have a short shelf life due to rancidity. Removal of bran layer from endosperm during milling process caused disruption of individual cells. The oil and enzymes in the ruptured bran layers came into contact with a highly reactive lipase enzyme which decompose the lipids into glycerol and free fatty acids. These rice bran and chips are unsuitable for human consumption and uneconomical for extraction of edible rice oil. Thus, they will be discarded or used as animal feed (Malekian *et al.,* 2000; Abdul-Hamid *et al.,* 2007). Hence, stabilization process of rice chips is very important before it can be further utilized for the production of value added food ingredients for human consumption.

In this study, chemical compositions of rice chips before and after microwave treatment were analysed. Table 1 shows the proximate compositions of untreated and microwave treated rice chips obtained from three different rice mills. There were no significant difference in ash content of untreated and microwave treated rice chips. The ash content of rice chips was in the range of 1.03 to 1.73%.

The moisture content of rice chips was significantly higher in untreated samples than in microwave treated samples. The moisture content of the samples ranged from 9.27 % to 10.35 % for untreated samples while after exposure to microwave treatment for 8 min it decreased to 0.37 % and 0.57 %. Previous studies had showed that moisture content of raw rice bran were found to be in the range of 8.4-14.7% (Houston, 1972), 10% (Rouanet *et al.,* 1993), 7.5% (Malekian *et al.,* 2000), and 11.9% (Abdul-Hamid and Luan, 2000). The decrease in moisture content of rice chips is due to the microwave heating process which reduces the moisture content by up to 60% (Ramezanzadeh *et al.* (2000). Water molecules play an important role in microwave heating process. During initial stage of microwave heating, the microwave irradiation becomes the main source of energy. The dipolar water molecules are excited by electromagnetic waves, undergo rotation and absorb microwave energy, resulting in an increase temperature and thereby reduction in moisture. However, as the irradiation proceeds, water is removed from the system and this dehydration process could cause the loss of moisture from samples (Roman, 1989; Yeo and Shibamoto, 1991).

Table 1 also shows that there were no significant different in crude fibre content of untreated and microwave treated samples. The content of crude fibre in untreated samples was in the range of 0.27% to 0.88%, while in microwave treated samples it was within 0.38% to 1.36%.

In general, the crude protein content of microwave treated rice chips was slightly higher compared to the untreated rice chips, but no significant difference was observed except for the samples from Sekinchan. Protein content in treated and untreated samples was in the range of 8.49% to 8.94% and 7.51% to 8.50%, respectively (Table 1). Abdul-Hamid *et al.* (2007) found that the protein content of rice bran that had undergone stabilization process through microwave treatment was 8.8-15.2%, while Houston (1972) stated that protein content in untreated rice bran was in the range of 9.8%-15.4%.

No significant difference in crude fat content was observed after the rice chips had been stabilized by microwave except for sample from Sekinchan. It was found that the untreated rice chips contained 2.07% to 8.10% of crude fat. These data were in agreement with earlier findings of Malekian *et al.* (2000). However, the minimum requirement of fat content for stabilized rice bran according to industrial standards was 16% (Saunders, 1990). Rice bran contains 15%-23% oil and three major fatty acids that are present in rice bran oil include palmitic (12%-18%), oleic (40%-50%) and linoleic (30%-35%).

Significantly difference ($p<0.05$) was observed in the carbohydrate content of untreated and treated rice chips. The content of carbohydrate in untreated rice chips were in the range of 73.01% to 80.18%, while the carbohydrate content seems to increase in treated samples (78.86%-87.86%). The high value of carbohydrate content in rice chips indicates that a higher amount of endosperm fraction was present in the form of fine broken rice in the rice chips. The breakage of rice during milling process was mostly influenced by the initial moisture content of paddy rice, kernel thickness, and fissures in rice. Major carbohydrates in rice bran comprise of hemicelluloses (8.7%-11.4%), cellulose (9%-12.8%), starch (5%-15%), and β glucan (1%) (Malekian *et al.,* 2000).

Table 2. Proximate compositions of untreated and microwave treated rice chips from different locations

Sample Source	Proximate composition (%)					
	Ash	**Moisture**	**Crude Protein**	**Crude Fat**	**Crude Fiber**	**Carbohydrate**
A – untreated*	1.03 ± 0.01^{a}	10.35 ± 0.00^{a}	$7.51 \pm 0.64^{c,d}$	8.10 ± 0.08^{b}	$0.88 \pm 0.00^{a,b}$	73.01 ± 0.27^{h}
A – treated#	1.55 ± 0.00^{a}	0.57 ± 0.00^{d}	$8.49 \pm 0.17^{a,b}$	10.54 ± 1.30^{a}	1.26 ± 0.00^{a}	78.86 ± 0.47^{e}
B - untreated	1.73 ± 0.00^{a}	9.34 ± 0.01^{b}	$8.30 \pm 0.12^{a,b,c}$	2.53 ± 0.09^{d}	$0.58 \pm 0.00^{b,c}$	78.10 ± 0.78^{f}
B - treated	1.60 ± 0.00^{a}	0.37 ± 0.00^{d}	8.94 ± 1.06^{a}	2.36 ± 0.01^{d}	$0.58 \pm 0.00^{b,c}$	86.74 ± 0.07^{b}
C - untreated	1.50 ± 0.00^{a}	9.27 ± 0.00^{b}	$7.85 \pm 0.42^{b,c}$	2.07 ± 0.10^{d}	0.27 ± 0.00^{c}	80.18 ± 0.47^{d}
C - treated	1.59 ± 0.00^{a}	0.52 ± 0.00^{d}	$8.55 \pm 0.23^{a,b}$	1.47 ± 0.12^{d}	0.38 ± 0.00^{c}	87.86 ± 0.64^{a}

Note: Means within a column followed by the same letter are not significantly different at $P < 0.05$.
*Untreated – refers to fresh untreated rice chips; #treated – refers to rice chips that was treated with microwave for 8 min.
A - Sekinchan; B - Sungai Besar; C - Sri Tiram Jaya.

CONCLUSION

This findings of this study revealed that microwave treatment can be applied to stabilized rice chips without affecting the nutritional composition of rice chips. No significant difference in the nutritional compositions which include ash, carbohydrate, crude protein, fat and fibre contents of untreated and treated rice chips was observed. Significant difference ($p<0.05$) was observed only in the moisture content of treated and untreated rice chips. This implies that microwave treatment can be used to lower the moisture content and hence help to prevent deterioration of rice chips before further processing.

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HPLC METHOD OPTIMIZATION FOR MULTI-MYCOTOXIN DETERMINATION USING EXPERIMENTAL DESIGN

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Abstract:

A reversed-phase high-performance liquid chromatography (HPLC) optimization strategy is presented for investigating the separation and retention behavior of aflatoxin B1, B2, G1, G2, ochratoxin A, and zearalenone, simultaneously. A fractional factorial design (FFD) was used to screen the significance effect of seven independent variables on chromatographic responses. The independent variables used were: (X1) column oven temperature (20 – 40ºC), (X2) flow rate (0.8 – 1.2 ml/min), (X3) acid concentration in aqueous phase (0 – 2%), (X4) organic solvent percentage at the beginning (40 – 50%), and (X5) at the end (50 – 60%) of the gradient mobile phase, as well as (X6) ratio of methanol / acetonitrile at the beginning (1 – 4) and (X7) at the end (0 – 1) of gradient mobile phase. Responses of chromatographic analysis were resolution of mycotoxin peaks and HPLC run time. A central composite design (CCD) using response surface methodology (RSM) was then carried out for optimization of the most significant factors by multiple regression models for response variables. The proposed optimal method using 40ºC oven temperature,1 ml/min flow rate, 0.1% acetic acid concentration in aqueous phase, 41% organic phase (beginning), 60% organic phase (end), 1.92 ratio of methanol to acetonitrile (beginning), and 0.2 ratio (end) for X1 – X7, respectively, showed good prediction ability between the experimental data and predictive values throughout the studied parameter space. Finally, the optimized method has been validated by measuring the linearity, sensitivity, accuracy, and precision parameters, and has been applied successfully to the analysis of spiked cereal samples.

Key words: Optimization; HPLC-FLD; Mycotoxin; Experimental design; Multi-detection

Introduction

Mycotoxins are secondary metabolites of fungi, which can contaminate agricultural commodities before and after harvesting. Among different kinds of mycotoxins, aflatoxins (AFs), ochratoxin A (OTA), and zearalenone (ZEA) are in the list of the more important and common contaminations in cereals (Zinedine et al. 2007). It is possible for commodities to be contaminated with more than one mycotoxin. There are some reports for co-occurrence of AFs, OTA, and ZEA in a wide range of agricultural crops (Abdulkadar et al. 2004; Ghali et al. 2008; Sangar-Tigori et al. 2006). Multi-mycotoxin determination using chromatographic techniques have been reported as a fast and cost-effective technique for screening mycotoxins in foods and feeds, especially when fast determinations are required (Rahmani et al. 2009). Widespread use of HPLC in mycotoxin determination accentuates the need for rapid and reliable HPLC multi-mycotoxin determination methods; however, not many HPLC methods have been developed for simultaneous mycotoxin determination. To the best of our knowledge the HPLC method has been developed and reported previously for simultaneous determination of AFs and OTA in ginseng and ginger, cereals, bee pollen, and olive oil (Trucksess et al. 2006; Chan et al. 2004; Garcia-Villanova et al. 2004; Ferracane et al. 2007). Also, Göbel and Lusky (2004) have reported a method for simultaneous determination of AFs, OTA, and ZEA (AOZ) in cereals by HPLC, with fluorescence detection (FLD), focusing more on sample preparation. In addition, there is a method for the determination of these mycotoxins in poultry air (Wang et al. 2008).

The design of experiment (DOE) is a method which enables scientists to simultaneously evaluate the effects and interactions of a high number of varying factors, with a limited number of runs (Destandau et al. 2006). In this respect, the factorial design (FD), fractional factorial design (FFD) and central composite design (CCD) using response surface methodology (RSM) are important tools to determine the optimal conditions.

The impetus for this study was to optimize HPLC-FLD method for simultaneous determination of AFs, OTA and ZEA by investigating the effects of different factors on the chromatographic responses with the aid of a FFD and RSM. To the best of our knowledge, this is the first time that such factors have been used in mycotoxin method optimization. Finally, the method was validated by parameters such as, linearity, accuracy, precision, and sensitivity.

Experimental

Materials and reagents

The analytical standards of all mycotoxins include of aflatoxins (AFB1, AFB2, AFG1 and AFG2), ZEA and OTA were supplied by Sigma-Aldrich (St Louis, MO, USA). All the solvents used for the preparation of the mobile phase were LC grade and obtained from Merck (Darmstadt, Germany). De-ionized distilled water was obtained from a Milli-Q purification system (Bedford, MA, USA).

Apparatus

The HPLC system was from Waters (Milford, MA, USA), consisted of an auto-sampler system (717), quaternary pumps (type W 600), column oven, and fluorescence detector (type W2475). The chromatographic separation was performed on a reverse phase symmetry C18 column (4.6×150 mm, 100 Å, and 3.5 µm particle size) (Waters, Milford, MA, USA). To achieve a fluorescence spectrum of mycotoxins, a time based program for excitation and emmition wavelength were utilized. To enhance fluorescence activity of AFB1 and AFG1 a PHRED photochemical derivatization system (AURA Industries, New York, USA) was applied before fluorescent detector. The injected volume into the chromatographic system was 100µL.

Experimental design and statistical analysis

In this study, a two-level FFD was employed in order to investigate the more significant factors affecting the HPLC responses. Then a CCD using RSM was used to fit the quadratic models and optimize the significant factors obtained from FFD. HPLC conditions were optimized by conducting an evaluation of effects of different factors (Table 1).

Table1. Factors examined in the screening phase (FFD) for screening most effective variables on HPLC responses

Symbol	Independent variables	Levels		
		low	centre	high
X1	Temperature (^{0}C)	20	30	40
X2	Flow rate (ml/min)	0.8	1	1.2
X3	Acetic acid concentration (%)	0	1	2
X4	Organic solvent at the beginning of gradient (%)	40	45	50
X5	Organic solvent at end of gradient (%)	50	55	60
X6	Ratio of methanol/ acetonitrile at the beginning of gradient	1	2	3
X7	Ratio of methanol/ acetonitrile at end of gradient	0	0.5	1

Validation

The validation was performed according to the recommendations of the performance of analytical methods and the interpretation of results (EC/657/2002) as well as method for sampling and analysis of mycotoxins (EC/401/2006) and validation of analytical methods for determining mycotoxins in foodstuffs, as described by Gilbert and Anklam (2002). Linear regression analysis was conducted with optimized HPLC conditions for a mixture of aflatoxins, OTA, and ZEA (AOZ).

Results and discussion

Screening experiments with the aid of fractional factorial design (FFD)

In this study seven factors were examined in two levels (low and high) (27-3 = 16 experiments) and two center points. In an FFD we performed 16 experiments. In order to evaluate the curvature effect of the factors on responses, two center point examinations were performed. The experiments were carried out in replication for more precision, so that all the experiments were for 36 runs. The following constraints were imposed on some responses: the retention time had to be as short as possible and resolutions as high as possible.

In order to evaluate the effects of variables on each response, FFD responses were analyzed. The results of the analysis of FFD indicated that all factors had a significant effect on the selected responses. Analytically, the proportion of the organic solvent at the beginning (X4) was significant variable for all five responses. The ratio of methanol/acetonitrile at the beginning of the gradient (X6) was the next important variable which had significant influence on three responses. Other variables include of X1, X2, X3, X5 and X7, had significant effect on two responses. In order to optimize conditions in CCD step among these five less significant variables we took X3 and X7due to its absolute and strong effect on resolution of ZEA-OTA and resolution of AFG1-AFB2, respectively.

Optimization using central composite design

The key factors examined in the optimization step are X3, X4, X6 and X7. Response surface design for four factors (X3, X4, X6 and X7) provided 30 experiments at different levels of each factor. Among the concerned ranges, points of –α and +α helped a better prediction of the responses. The resolution of the worst separated peaks AFG1 – AFB2 (Res G1 – B2), resolution of the ZEA – OTA (Res Z – O), and total run time (Run time) were selected as the responses. As we predicted, based on the FFD experiment, the first run of RSM suffered lack of the separation of ZEA and OTA, due to 0% acetic acid in the mobile phase.

The optimal conditions obtained by the response surface optimizer of the software; The proposed optimal point for optimized responses predicted to be in X3 = 0.1% (acetic acid concentration), X4 = 41% (organic solvent percentage at the beginning of the gradient), X6 = 1.93 (ratio of methanol / acetonitrile at the beginning of the gradient), and X7 = 0.2 (ratio of methanol / acetonitrile at end of gradient), while temperature, flow rate, and organic solvent percentage at the end of the gradient (X1, X2, and X5) kept constant at 40ºC, 1 mL/min, and 60%, respectively. Consequently, the final optimal HPLC condition was achieved by following the program of the mobile phase, which consisted of methanol, acetonitrile, and acetic acid (concentration = 0.1%), which started (0 – 10 min) with 27% methanol, 14% acetonitrile (as optimized for total organic solvent 41% and methanol / acetonitrile ratio 1.93), and 59% acetic acid, and subsequently changed to gradient elution (10 – 12 min) with 10% methanol, 50% acetonitrile, and 40% acetic acid. This contribution was continued with isocratic elution, using the same ratio for 28 min and completed with 27% methanol, 14% acetonitrile, and 59% acetic acid for re-equilibration of the column (28 – 30 min).

Method validation assay

The last step of the present study was to check the method's validation for specificity, linearity, accuracy and precision. The linearity of the proposed method was estimated by regression analysis at five concentrations. The correlation coefficients (R2) varied from 0.9987 to 0.9995. The LOD and LOQ were estimated at 0.005 and 0.0125 ng/g for AFG1 and AFB1, 0.0015 and 0.0037 ng/g for AFG2 and AFB2, as well as, 0.01 and 0.03ng/g for OTA and 0.2 and 0.5 ng/mL for ZEA, respectively.

Conclusion

An efficient reversed-phase high-performance liquid chromatography method was developed to separate the mycotoxins (AFB1, AFB2, AFG1, AFG2, OTA, and ZEA), which were optimized by using statistical experimental design, and validated. It was the first time that a systematic approach was explained in order to investigate the effects of different independent variables on chromatographic responses, for simultaneous determination of mycotoxins. All targeted mycotoxins separated in shorter than 30 min run time, with acceptable resolution. Consequently, it could be concluded that the optimized HPLC method was successful for the simultaneous determination of the named mycotoxins and would be suitable for routine mycotoxin determination. The experimental approach in the present research could provide a reference for optimizing other methods for mycotoxin determination.

Acknowledgment

Authors acknowledge Universiti Putra Malaysia for financial support through Research University Grant Scheme (RUGS), Project Number 02-01-07-0024RU.

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Parkroyal Hotel, Penang, Malaysia, 6-7 December, 2010

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