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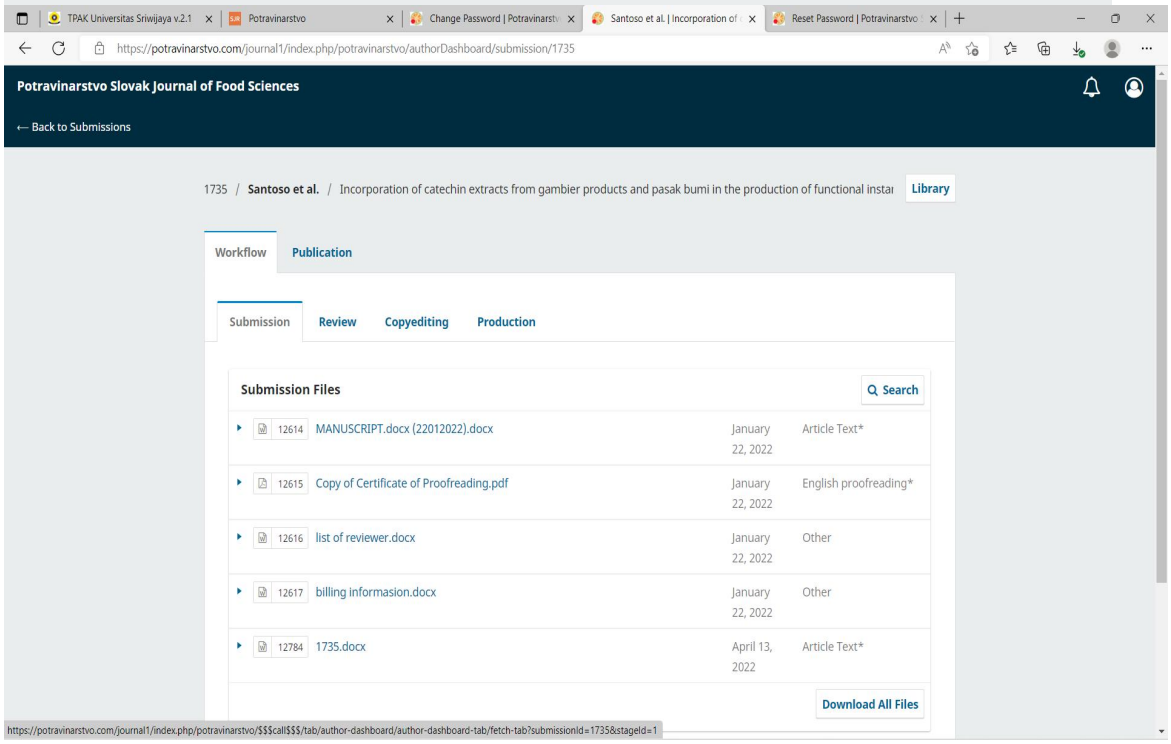

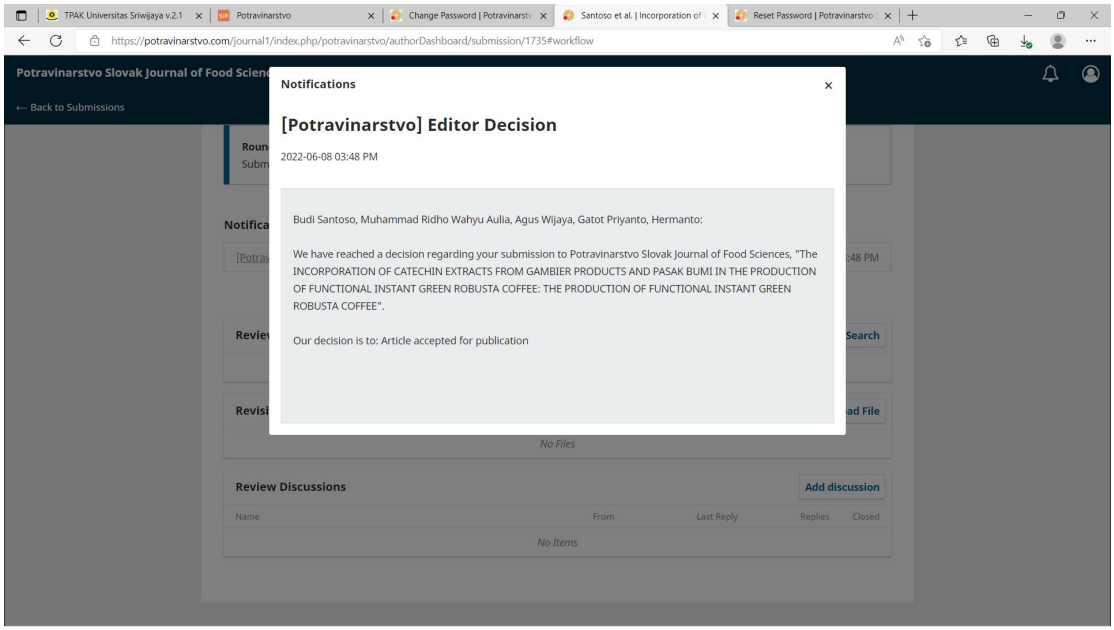
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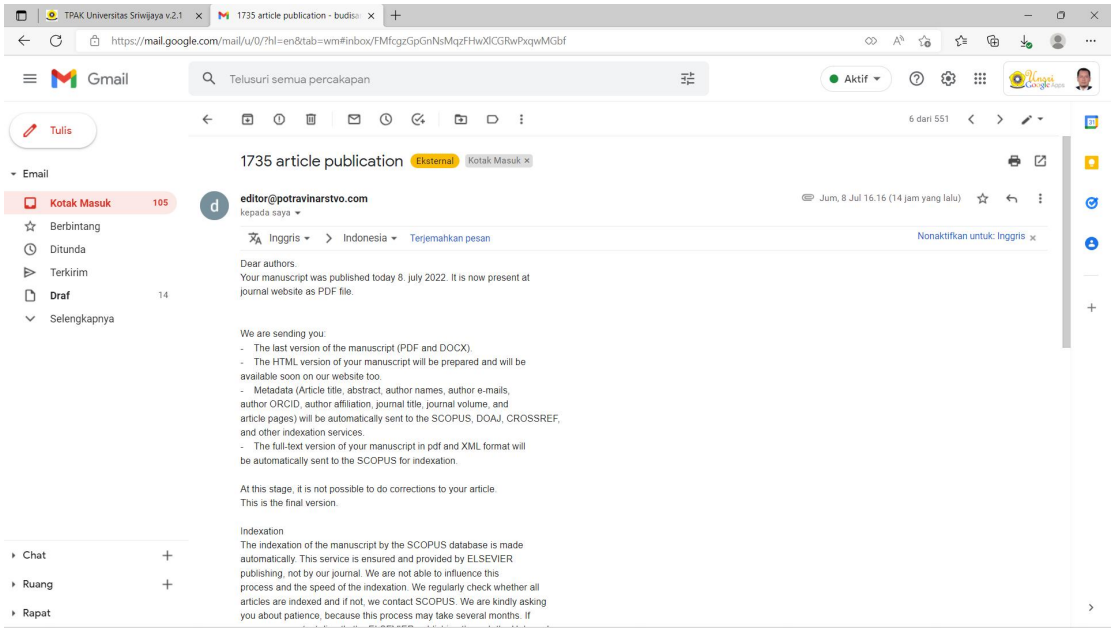
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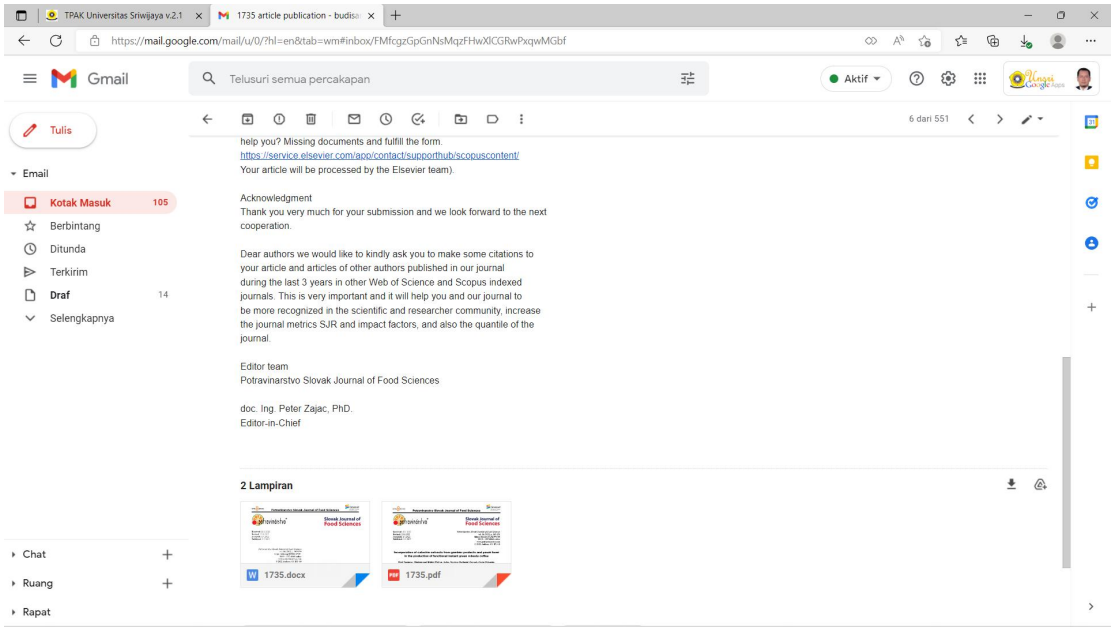
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INCORPORATION OF CATECHIN EXTRACTS FROM GAMBIER PRODUCTS AND PASAK BUMI IN THE PRODUCTION OF FUNCTIONAL INSTANT GREEN ROBUSTA COFFEE

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ABSTRACT

The research was used to produce functional instant green coffee through the combination of gambier catechin extract and pasak bumi powder. This involved using a non-factorial, completely randomized design with 5 treatments and 3 replications. The treatments consist of 5 formulations (F), including the instant green coffee (%), gambir catechin extract (%), and pasak bumi powder (%), where F1 was at 100:0:0, F2 was 80:15:5, F3 was 70:20:10, F4 was 60:25:15, and F5 was 50:30:20. The results showed the functional instant green coffee produced has a water content of 3.84-4.81%, soluble speed of 26.78-29.33 seconds, total phenol of 16.79-169.48 mg/L, and IC_{50} of 44.68- 207.59ppm. The addition of gambier catechin extract and pasak bumi powder to the formulation was observed to have significantly increased the functional properties and water content. Moreover, the soluble speed of the instant coffee fulfils the quality requirements of the Indonesian National Standard (SNI) number 2983 of 2014.

Keywords: gambier, instant, catechin, green coffee, pasak bumi

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INTRODUCTION

Humans accept coffee from both the sensory and functional aspects despite numerous information on its effects on body health. It has been reported that both robusta and arabica generally contain functional compounds in chlorogenic acid. This compound was also discovered by Skowron **et al. (2020)** to be present in coffee as an antioxidant, with robusta reported by **Wolska et al. (2017)** to contain higher content at 43. 63% than arabica which has 36.18%. According to **Kuncoro et al. (2018)**, roasting can reduce caffeine and chlorogenic acid levels in robusta by 13-25% and 37-59%, respectively. Several studies have been conducted to maintain the antioxidant properties of coffee, such as the addition of herbal cereals in **Samsonowicz et al. (2019)**, optimisation of roasting temperature to reduce damage to chlorogenic acid compounds in **Herawati et al. (2019)** and **Bobkova et al. (2020)**, and the use of a spontaneous fermentation with Wickerhamomyces anomalous (Strain KNU18Y3) on green coffee beans in **Haile and Kang (2020).**

Green coffee is currently gaining popularity among world coffee lovers, and it is mainly different from the ordinary types due to the effect of the beans processing method on its functional properties and aroma. According to **Gornas et al. (2016)**, green robusta has better functional properties than roasted coffee, as indicated by their total phenol contents of 208.89mg/L and 119.22mg/L, respectively. **Masek et al. (2020)** also showed that green robusta contains 81.6% antioxidant compounds and has higher caffeine content and its high antioxidant properties. This means it is important to add materials containing bioactive compounds in its production process to increase its antioxidants properties and reduce caffeine levels. One source of these bioactive compounds is catechin and pasak bumi extract.

Catechin is a product from the aqueous extraction of the leaves and twigs of the gambier plant (*Uncaria gambir Roxb*), which have been discovered to contain more than 52.25% catechin compounds by **Widiyarti et al. (2020)**. This extract was further reported by Ismail et al. (2021) to be an antioxidant with an IC_{50} of 2.74 g/mL, while **Santoso et al. (2019)** also showed its ability to form canna-based edible films, which are antioxidants. According to **Khanam et al. (2015)** and **Triawanti et al. (2020)**, the roots of the pasak bumi plant also contain eurikomanone, quassinoids, flavonoid, phenolic, and terpenoid compounds which are observed to have antioxidant potentials.

Scientific Hypothesis

The addition of gambir catechin extract has a significant effect on increasing the functional properties of instant green coffee, especially its antioxidant activity.

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MATERIAL AND METHODOLOGY

Sample

Instant coffee powder made from green robusta coffee powder incorporated with gambir catechin extract.

Chemical

The materials used consist of distilled water, tannic acid, gambier powder from Babat Toman Village, Musi Banyuasin Regency, South Sumatra, Indonesia, robusta green coffee powder from JagadRaye Coffee micro and small enterprise in Pagar Alam, South Sumatra, pasak bumi powder, 96% ethanol, 2,2-diphenyl-1-picrylhydrazil (DPPH), folin-ciocalteu, methanol, Na_2CO_3, and nutrient broth (NB).

Instruments

The tools used include autoclave, blender (Philips, Holland), hot plate, incubator (Memmert, Germany), filter paper, laminar airflow (LAF), brand analytical balance (Kenko, Japan), drying oven (Memmert, Germany), pH meter (Eutech, Malaysia), micropipette (Dragon Lab, China), rotary vacuum evaporator, 80 mesh filter, spectrophotometer (A and E Lab, USA), and vortex (Digisystem, Taiwan).

Laboratory Methods

The parameters evaluated include water content **(AOAC, 2012),** soluble speed **(AOAC, 2012)**, total phenol **(Septiana et al., 2002)**, and antioxidant activity **(Maesaroh et al., 2018)**. The data were analysed using analysis of variance through the SAS windows 9 program.

Description of the Experiment

Sample preparation

Instant green coffee

Green coffee beans were dried to a moisture content of 12% and ground using a grinder. The powder was filtered using an 80-mesh sieve, after which water was added at a temperature of 100ºC and a ratio of 1:2, stirred, left for 10 minutes, and later filtered using a filter cloth to obtain the filtrate. Moreover, maltodextrin (10% w/w) and egg white (20% w/w) were added to the filtrate, mixed using a mixer for 10 minutes at high speed to form foam, and spread out on an aluminium pan lined with Polypropylene plastic. The mixture was dried in a carbine dryer at a temperature of 60ºC for 4 hours, blended, and filtered using an 80-mesh filter to obtain a green coffee powder.

Gambier product catechin extract

The catechin extract was prepared using the maceration method (Damanik et al., 2014). This involved blending the dried gambier sticks until smooth and sieved through an 80-mesh sieve. The 100g gambier powder was macerated using ethanol for 1 day (24 hours) at a ratio of 3:1. Moreover, the catechin extract was filtered using Whatman filter paper No. 41 and evaporated at 85ºC with a rotary vacuum evaporator to vaporise the ethanol and remove the aroma. The catechin extract was later dried using an oven at a temperature of 85ºC for approximately 20 hours, blended, and sifted again.

Instant pasak bumi powder production

The instant pasak bumi powder was prepared by modifying the method used in Abidin et al. (2019). This involved the filtration of the powder using an 80-mesh sieve, after which water was added at 1:2 and a temperature of 100ºC; the mixture was stirred, left for 10 minutes, and filtered again using a filter cloth to obtain the pasak bumi filtrate. Moreover, maltodextrin (10% w/w) and egg white (20% w/w) were added to the filtrate, mixed using a mixer for 10 minutes at high speed to form foam, and spread out on an aluminium pan lined with Polypropylene plastic. The mixture was dried in a carbine dryer at a temperature of 60ºC for 4 hours, blended, and filtered using an 80-mesh filter to obtain a green coffee powder.

Functional instant green coffee drink production

The instant green coffee drink is made using the Fibrianto et al., 2015 method. According to the treatment, the instant green coffee powder, gambier catechin extract, and instant pasak bumi powder with a size of 80 mesh are mixed. Each treatment is put into a cup and then brewed with 100 ml of hot water at 80ºC and stirred using a magnetic stirrer.

Number of samples analysed

A non-factorial completely randomized design (RALNF) was used in this study. A total of five treatments are carried out using the percentage ratio of instan green coffee: gambier product catechin extract: instan pasak bumi. F1 = (100:0:0), F2 = (80:15:5), F3 = (70:20:10), F4 = (60:25:15), and F5 = (50:30:20).

Number of repeated analysed

Three repetitions for each treatment factor. The total sample analysed was 15 samples.

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Statistical Analysis

This study used a factorial, completely randomized design. The treatment with a significant effect was further tested using the honest real difference test (HSD) at = 5%. The data were analysed using the SAS software version of Windows 9 to analyse variance.

RESULTS AND DISCUSSION

Water content

The water content of the functional instant green coffee produced ranged from 3.84 to 4.81%, with the highest and lowest recorded in F5 and F1 treatments, respectively as indicated in the following Figure 1.

The diversity analysis in Figure 1 showed that the formulation treatment significantly affects the water content of functional instant green coffee. Moreover, the F3 treatment with 20% gambier catechin extract and 10% pasak bumi was observed to have increased the water content. This is associated with the fact that the catechin extract and pasak bumi contain phenolic compounds with a hydroxyl group (OH) that can bind water. It is also important to note that the existence of more OH groups usually leads to more water being bound. Meanwhile, the water content in foodstuffs comprises both bound and free water.

This instant coffee fulfils the quality requirements of the Indonesian National Standard (SNI) No. 2983 of 2014, which states that the maximum water content is 5%. The values obtained in this research were observed to be higher than the 1.57-1.61% reported by **Mursalin et al. (2019)** for instant coffee from Tungkal Jambi as well as the 2.34% by **Vareltzis et al. (2020)** for cold-brewed instant coffee. Meanwhile, the values are in the same range as 4.4.% found by **Ko et al. (2017)** for instant coffee produced from micro-size coffee combined with *Bacillus coagulans*.

Soluble Speed

This is one of the quality requirements for instant coffee according to SNI No. 2983 of 2014, which is set at a maximum of 30 seconds. The values obtained in this research were between 26.78-29.33 seconds, as indicated in Figure 2, and this means the requirements are satisfied. Meanwhile, the values are higher than the 152.26 seconds obtained by **Matanari et al. (2019)** for instant coffee made from robusta coffee incorporating maltodextrin but lower than the 11.48-13.95 seconds reported by **Praptiningsih et al. (2012)** while studying instant robusta with coconut sugar and cane sugar.

The diversity analysis showed that the formulation treatment significantly affects the soluble speed of functional instant green coffee. A higher concentration of gambier catechin extract in the formulation was found to cause a reduction in the soluble speed, as indicated in Figure 2. This is because the catechin compounds in gambier products are semipolar, and a higher concentration of catechin usually leads to higher semipolar nature of instant coffee, thereby causing a reduction in the solubility of the product in water. This phenomenon was also reported in **Pambayun et al. (2007).**

Total Phenol

The total phenol of the functional instant green coffee produced ranged from 16.79 to 169.48mg/L, as indicated in Figure 3. These values are slightly lower than 171,633mg/L reported by **Christianty et al. (2020)** and higher than 16.26-30.65mg/L and 42.4-59.8mg/L recorded by **Siva et al. (2016)** and **Dong et al. (2019)** respectively. However, the values are within the same range of 29.23-158.19mg/L found by **Ibtisam and Karim (2013).**

The diversity analysis showed the significant effect of the formulation treatment on the total phenol of functional instant green coffee. It was discovered that a higher concentration of gambier catechin extract and pasak bumi in the formulation increased the total phenol. This is, therefore, associated with the polyphenolic compounds in the catechin extract and pasak bumi. The result is in line with the findings of **Melia et al. (2015)** and **Rahmawati et al. (2013)** that gambier contains polyphenol compounds in the form of catechins by 50%, while **Yeni et al. (2017)** found phenolic compounds of catechins and tannins at 65.6-74.2% and 11.32-17.76%, respectively. Moreover, **Irawati et al. (2014)** showed that pasak bumi contains several secondary metabolites such as alkaloids, terpenoids, sterpenoids, steroids, flavonoids (phenols), and saponins.

Antioxidant Activity

The antioxidant activity of functional instant green coffee was measured using IC_{50} such that a higher IC_{50} value indicates lower antioxidant activity and vice versa. The values were observed to be from 44.68-207.59ppm as shown in Figure 4 and are the same as the findings of **Pranowo et al. (2020)** that the encapsulated green coffee extract has 87.65ppm

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and **Wolska et al. (2017),** which showed that green coffee brewed with cold water has 71.97-83.21ppm. However, the values are higher than the 25.187ppm reported for green coffee extract dried using the foam mat method by **Pranowo et al. (2021)** and lower than 167.426 to 294.710ppm recorded for green coffee from Ethiopia by **Tasew et al. (2020).**

The diversity analysis showed that the formulation treatment significantly affects the IC_{50} of functional instant green coffee, as indicated in Figure 4. This was observed because a higher concentration of gambier catechin extract and pasak bumi powder in the formulation caused a reduction in the IC_{50} and a higher antioxidant activity. This is associated with flavonoid compounds that are considered antioxidants in the gambier catechin extracts and pasak bumi powder. Moreover, it also indicates consistency with the total phenol data recorded in Figure 3, which showed the same trend. Phenol is also an antioxidant, and this means a higher content of this compound can increase the antioxidant properties of the product, as indicated by a decrease in IC_{50}.

CONCLUSION

The addition of catechin extract from gambier products and pasak bumi powder in the instant green coffee formulation can increase its antioxidant properties as indicated by the water content of 3.84-4.81%, soluble speed of 26.78-29.33s, total phenol of 16.79-169.48mg/L, and IC_{50} of 44.68-207.59ppm recorded in the product.

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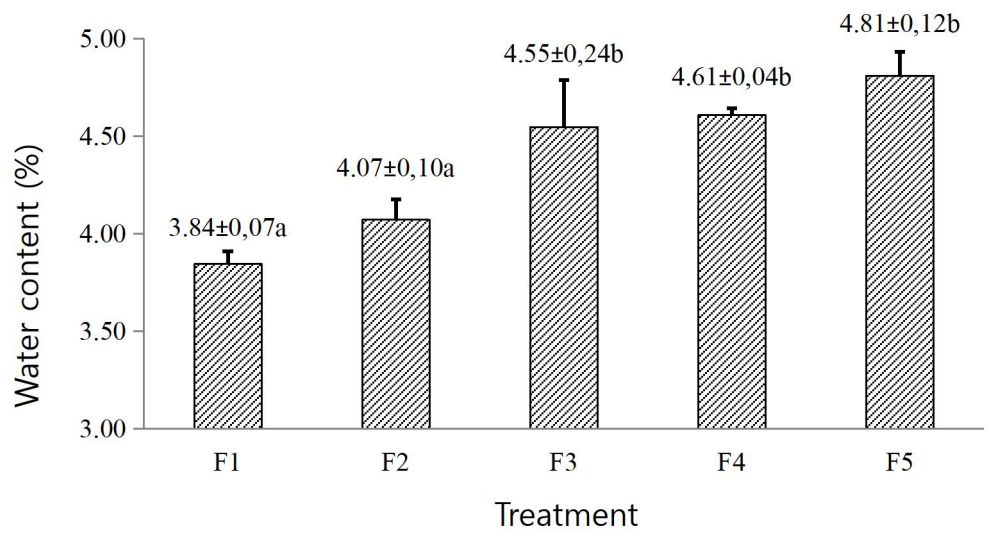

Description:
F1= 100% green coffee instan : 0% gambir catechin extract: 0% instan pasak bumi
F2= 80% green coffee instan : 15% gambir catechin extract: 5% instan pasak bumi
F3= 70% green coffee instan : 20% gambir catechin extract: 10% instan pasak bumi
F4= 60% green coffee instan : 25% gambir catechin extract: 15% instan pasak bumi
F5= 50% green coffee instan : 30% gambir catechin extract: 20% instan pasak bumi

Figure 1. Effect of formulation on the water content of functional instant green coffee

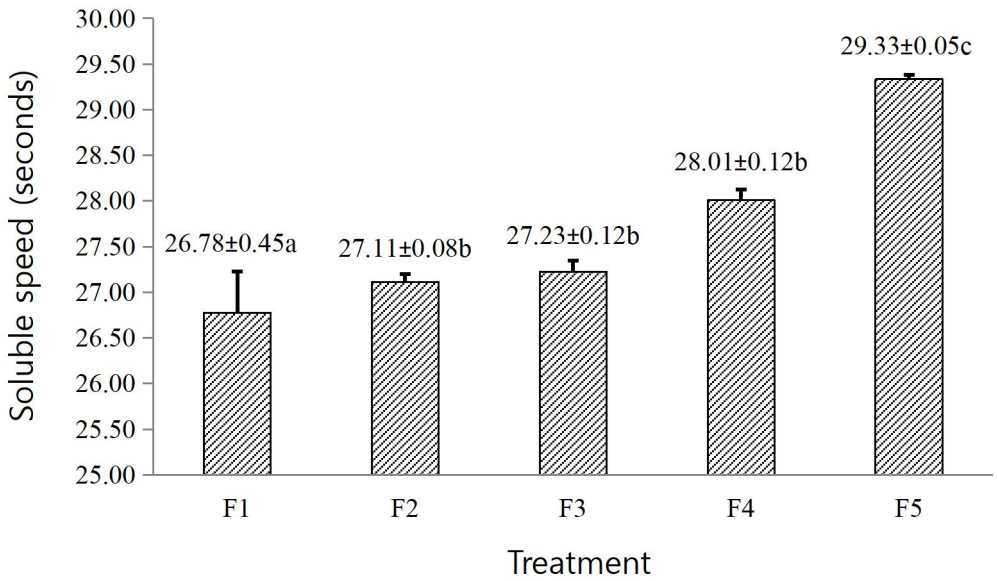

Figure 2. Effect of formulation treatment on the soluble speed of functional instant green coffee

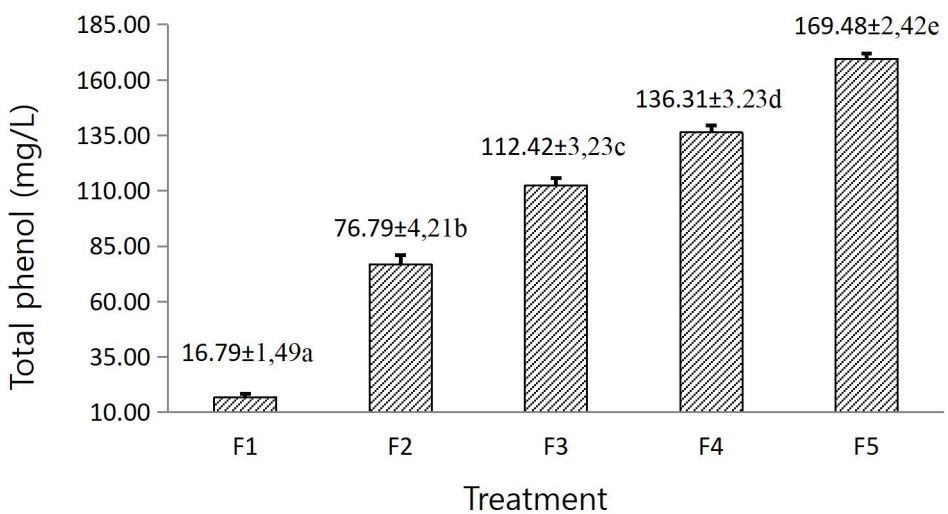

Figure 3. Effect of formulation treatment on total phenol of functional instant green coffee

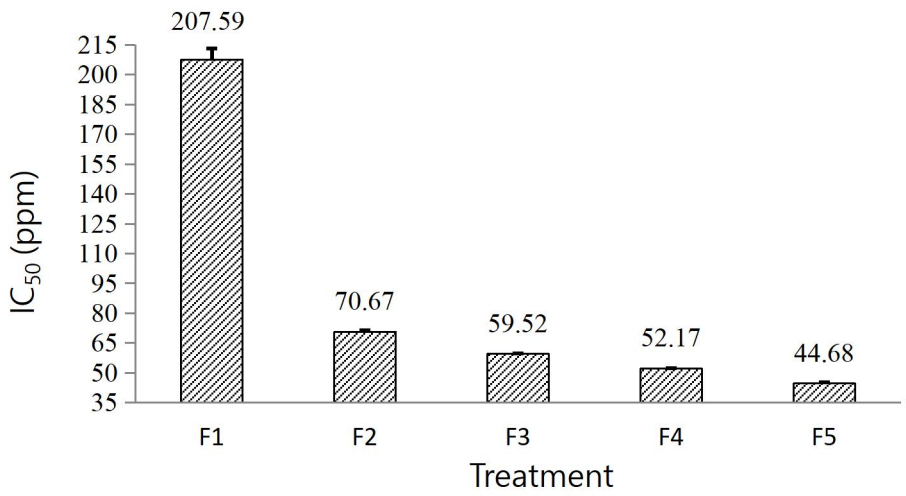

Figure 4. Effect of formulation treatment on IC_{50} of functional instant green coffee

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Article No.	**1735**
Article title	**INCORPORATION OF CATECHIN EXTRACTS FROM GAMBIER PRODUCTS AND PASAK BUMI IN THE PRODUCTION OF FUNCTIONAL INSTANT GREEN ROBUSTA COFFEE**
Authors	**Budi Santoso[*1)], Muhammad Ridho Wahyu Aulia[1)], Gatot Priyanto[1)], Agus Wijaya[1)] and Hermanto[1)]**
Reviewer's recommendation	**Minor revision**

Requirements	**OK/NO**
The Scope of the article: Is the article relevant to *Potravinarstvo Slovak Journal of Food Sciences*?	OK
Title: Is the title of article in English proper? Does the title clearly agree with the content? **Comment: -**	OK
Author names: First name (given name) Surname (family name), for all authors. Names should be the same as names in the Contact information section. **Comment: -**	OK
Abstract: Is the abstract clear, suitable and provide sufficient information for understanding the work? Minimum 150 words? **Comment: -**	OK
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Introduction: Is it clear, simple, with appropriate scientific literature sources? **Comment: -**	OK
Scientific Hypothesis Does the article contains the clear scientific hypothesis as separated chapter after introduction section? **Comment: -**	OK
Material and Methodology Is the structure the same like in the article template?	
Samples Xxxxxxxxx (Samples description). **Chemicals** ethanol, 2,2-diphenyl-1-picrylhydrazil (DPPH), folin-ciocalteu, methanol, Na_2CO_3, and nutrient broth (NB). Xxxxxxxxx (Chemical name, brand, producer, analytical purity). Xxxxxxxxx (Agar medium name, brand, producer). **Animals and Biological Material:** Xxxxxxxxx (Microorganism, producer). Xxxxxxxxx (Animal species, farm address). Xxxxxxxxx (Other material). **Instruments** Xxxxxxxxx (Instrument name, brand, producer, or distributor). **Laboratory Methods** Xxxxxxxxx (ISO standards, AOAC methods, Homemade laboratory methods, Method invented by the researcher). These methods should properly cited (ISO 12345, 2020; AOAC, 2020; Smith et al., 2020). If the standard method was used, provide only information about modification of this method. The data were analyzed using analysis of variance through the SAS windows 9 program. (move this sentence to the statistical section) **Description of the Experiment** **Sample preparation:** Xxxxxxx **Number of samples analyzed:** Xxxxxxx **Number of repeated analyses:** Xxxxxxx **Number of experiment replication:** Xxxxxxx **Design of the experiment:** Xxxxxxx (Provide full description of your experiment). **Comment: -**	OK only minor formal changes

Statistical analysis Xxxxxx (Statistical software, brand, version, producer). Xxxxxx (Statistical methods). **Comment: -**	OK
Results **Comment: -**	OK
Discussion Minimum 25 cited articles. No many multi-citations. New references, most of them from past 5 years. Are the p-values provided in results or discussion section? **Comment: -**	NO Minimum 25 cited articles.
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Incorporation of catechin extracts from gambier products and pasak bumi in the production of functional instant green robusta coffee

Budi Santoso, Muhammad Ridho Wahyu Aulia, Syerina Raihatul Jannah, Gatot Priyanto, Agus Wijaya, Hermanto Hermanto

ABSTRACT

The research was used to produce functional instant green coffee through ~~the combination of~~ gambier catechin extract and pasak bumi powder. This involved using a non-factorial completely randomized design with 5 treatments and 3 replications. The treatments consist of 5 formulations (F), including the instant green coffee (%), gambir catechin extract (%), and pasak bumi powder (%), where F1 was at 100:0:0, F2 was 80:15:5, F3 was 70:20:10, F4 was 60:25:15, and F5 was 50:30:20. The results showed the functional instant green coffee produced has a water content of 3.84-4.81%, soluble speed of 26.78 - 29.33 seconds, and total phenol of 16.79 - 169.48 mg/L, and IC50 of 44.68 - 207.59ppm. The addition of gambier catechin extract and pasak bumi powder to the formulation was observed to have significantly increased the functional properties and water content. Moreover, the soluble speed of the instant coffee fulfils the quality requirements of the Indonesian National Standard (SNI) number 2983 of 2014.

Keywords: gambier, instant, catechin, green coffee, pasak bumi

INTRODUCTION

Humans accept coffee from both the sensory and functional aspects despite numerous pieces of information on its effects on body health. It has been reported that both robusta and arabica generally contain functional compounds in chlorogenic acid. This compound was also discovered by **[34]** to be present in coffee as an antioxidant, with robusta reported by **[38]** to contain higher content at 43. 63% than arabica, which has 36.18%. According to **[14]**, roasting can reduce robusta caffeine and chlorogenic acid levels ~~in robusta~~ by 13-25% and 37-59%, respectively. Several studies have been conducted to maintain the antioxidant properties of coffee such as the addition of herbal cereals in **[29]**, optimisation of roasting temperature to reduce damage to chlorogenic acid compounds in **[8]** and **[3]**, and the use of a spontaneous fermentation with *Wickerhamomyces anomalous* (Strain KNU18Y3) on green coffee beans in **[7]**.

Green coffee is currently gaining popularity among world coffee lovers, and it is mainly different from the ordinary types due to the effect of the beans processing method on its functional properties and aroma. According to **[6]**, green robusta has better functional properties than roasted coffee, as indicated by their total phenol contents of 208.89mg/L and 119.22mg/L, respectively. **[18]** also showed that green robusta contains 81.6% antioxidant compounds and has higher caffeine content and its high antioxidant properties. It~~This means it~~ is important to add bioactive compounds materials~~materials containing bioactive compounds~~ in its production process to increase its antioxidant~~antioxidants~~ properties and reduce caffeine levels. One source of these bioactive compounds is catechin and pasak bumi extract.

Catechin is a product from the aqueous extraction of the leaves and twigs of the gambier plant (*Uncaria gambir Roxb*), which have been discovered to contain more than 52.25% catechin compounds ~~by~~ **[37]**. This extract was further reported by **[11]** to be an antioxidant with an IC_{50} of 2.74 g/mL, while **[30]** also showed its ability to form canna-based edible films,

which are antioxidants. According to **[13]** and **[36]**, the roots of the pasak bumi plant also contain eurikomanone, quassinoids, flavonoid, phenolic, and terpenoid compounds which are observed to have antioxidant potentials.

Scientific Hypothesis

The addition of gambir catechin extract has a significant effect on increasing the functional properties of instant green coffee, especially its antioxidant activity

MATERIAL AND METHODOLOGY

Do not change or delete the order of the subchapters in this section. The structure of this section is mandatory for all articles published in this journal. Specific requirements can be applied for a review, questionnaire survey, or economic analysis articles (you can change the order of subchapters or delete some of them only if your article is not a typical scientific article).

Samples

Instant coffee powder made from green robusta coffee powder incorporated with gambir catechin extract.

Chemicals

The materials used consist of distilled water, tannic acid, 96% ethanol, 2,2-diphenyl-1-picrylhydrazil (DPPH), folin-ciocalteu, methanol, Na2CO3, and nutrient broth (NB) obtained from the Laboratory of Chemical Agricultural Products, Faculty of Agriculture, Sriwijaya University, Indonesia.

Biological Material

Gambier powder from Babat Toman Village, Musi Banyuasin Regency, South Sumatra, Indonesia, robusta green coffee powder from JagadRaye Coffee micro and small enterprise in Pagar Alam, South Sumatra, Indonesia. Pasak bumi powder from the Laboratory of Chemical Agricultural Products, Faculty of Agriculture, Sriwijaya University, Indonesia.

Instruments

The tools used include an autoclave, blender (Philips, Holland), hot plate, incubator (Memmert, Germany), filter paper, laminar airflow (LAF), brand analytical balance (Kenko, Japan), drying oven (Memmert, Germany), pH meter (Eutech, Malaysia), micropipette (Dragon Lab, China), rotary vacuum evaporator, 80 mesh filter, spectrophotometer (A and E Lab, USA), and vortex (Digisystem, Taiwan).

Laboratory Methods

The parameters evaluated include: Water content **[2]**: measurement of water content using the gravimetric method. Soluble speed **[2]**: Dissolve 100g of instant coffee in 200 mL of water. Then the length of time instant coffee dissolves in water is calculated as the speed at which it dissolves in water using a stopwatch. Total phenol **[31]**: Determination of total phenol content was carried out by means of a spectrophotometric method using Folin-Ciocalteu reagent. –Antioxidant activity **[17]**: Antioxidant testing using the DPPH method (2,2 diphenyl-1-picrylhydrazyl) was used.

Description of the Experiment

Sample preparation: The instants green coffee powder, gambier catechin extract, and instants pasak bumi powder with a size of 80 mesh are mixed. Each treatment is put into a cup and then brewed with 100 mL of hot water at 80 °C—C and stirred using a magnetic stirrer.

Number of samples analyzed: A non-factorial completely randomized design was used in this study. A total of five treatments are carried out using the percentage ratio of instan green coffee: gambier product catechin extract: instan pasak bumi. F1 = (100:0:0), F2 = (80:15:5), F3 = (70:20:10), F4 = (60:25:15), and F5 = (50:30:20).

Number of repeated analyses: Three repetitions for each treatment factor. The total sample analysed was 15 samples.

Number of experiment replication: Each treatment was repeated 3 times

Design of the experiment:

Instant green coffee

Green coffee beans were dried to a moisture content of 12% and ground using a grinder. The powder was filtered using an 80-mesh sieve, after which water was added at a temperature of 100 °CoC and a ratio of 1:2, stirred, left for 10 minutes, and later filtered using a filter cloth to obtain the filtrate. Moreover, maltodextrin (10% w/w) and egg white (20% w/w) were added to the filtrate, mixed using a mixer for 10 minutes at high speed to form foam, and spread out on an aluminium pan lined with Polypropylene plastic. The mixture was

dried in a carbine dryer at a ~~temperature of~~ 60 ~~o~~°C~~C~~ for 4 hours, blended, and filtered using an 80-mesh filter to obtain a green coffee powder.

Gambier product catechin extract

The catechin extract was prepared using the maceration method. This involved blending the dried gambier sticks until smooth and sieved through an 80-mesh sieve. The 100g gambier powder was macerated using ethanol for 1 day (24 hours) at a ratio of 3:1. Moreover, the catechin extract was filtered using Whatman filter paper No. 41 and evaporated at 85 ºC with a rotary vacuum evaporator to vaporise the ethanol and remove the aroma. The catechin extract was later dried using an oven at a temperature of 85 ºC for approximately 20 hours, blended, and sifted again.

Instant pasak bumi powder production

The instant pasak bumi powder was prepared. This involved the filtration of the powder using an 80-mesh sieve, after which water was added at 1:2 and a temperature of 100 ºC; the mixture was stirred, left for 10 minutes, and filtered again using a filter cloth to obtain the pasak bumi filtrate. Moreover, maltodextrin (10% w/w) and egg white (20% w/w) were added to the filtrate, mixed using a mixer for 10 minutes at high speed to form foam, and spread out on an aluminium pan lined with Polypropylene plastic. The mixture was dried in a carbine dryer at a temperature of 60 ºC for 4 hours, blended, and filtered using an 80 mesh filter to obtain a green coffee powder.

Statistical Analysis

This study used a factorial completely randomized design. The treatment with a significant effect was further tested using the honest real difference test (HSD) at = 5%. The data were analysed using the SAS software version of Windows 9 to analyse of variance.

RESULTS AND DISCUSSION

Water content

The water content of the functional instant green coffee produced ranged from 3.84 to 4.81%, with the highest and lowest recorded in F5 and F1 treatments, respectively, as indicated in the following Figure 1.

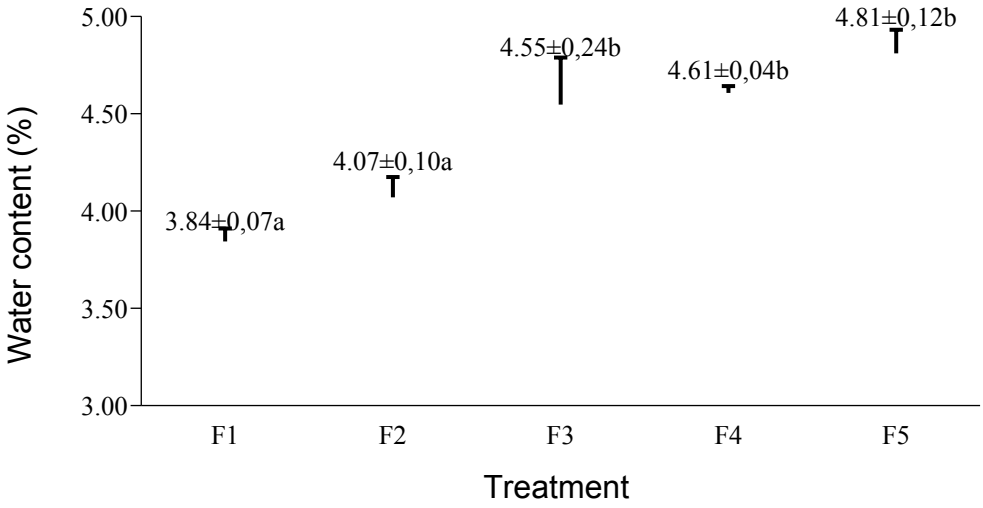

Figure 1 Effect of formulation on the water content of functional instant green coffee.

Description:
F1= 100% green coffee instan : 0% gambir catechin extract: 0% instan pasak bumi
F2= 80% green coffee instan : 15% gambir catechin extract: 5% instan pasak bumi
F3= 70% green coffee instan : 20% gambir catechin extract: 10% instan pasak bumi
F4= 60% green coffee instan : 25% gambir catechin extract: 15% instan pasak bumi
F5= 50% green coffee instan : 30% gambir catechin extract: 20% instan pasak bumi

The diversity analysis in Figure 1 showed that the formulation treatment significantly effects on the water content of functional instant green coffee. Moreover, the F3 treatment with 20% gambier catechin extract and 10% pasak bumi was observed to have increased the water content. This is associated with the fact that the catechin extract and pasak bumi contain phenolic compounds with a hydroxyl group (OH) that can bind water. It is also important to note that the existence

of more OH groups usually leads to more water being bound. Meanwhile, the water content in foodstuffs comprises both bound and free water.

This instant coffee fulfils the quality requirements of the Indonesian National Standard (SNI) No. 2983 of 2014, which states that the maximum water content is 5%. The values obtained in this research were observed to be higher than the 1.57-1.61% reported by **[21]** for instant coffee from Tungkal Jambi andas well as the 2.34% by **[39]** for cold-brewed instant coffee. Meanwhile, the values are in the same range as 4.4.% found by **[15]** for instant coffee produced from micro-size coffee combined with *Bacillus coagulans*.

Soluble Speed

This is one of the quality requirements for instant coffee according to SNI No. 2983 of 2014, which is set at a maximum of 30 seconds. The values obtained in this research were between 26.78-29.33 seconds, as indicated in Figure 2 and this means the requirements are satisfied. Meanwhile, the values are higher than the 152.26 seconds obtained by **[19]** for instant coffee made from robusta coffee incorporating maltodextrin but lower than the 11.48-13.95 seconds reported by **[28]** while studying instant robusta with coconut sugar and cane sugar.

The diversity analysis showed that the formulation treatment significantly affectseffects on the soluble speed of functional instant green coffee. A higher concentration of gambier catechin extract in the formulation was found to cause a reduction in the soluble speed as indicated in Figure 2. This is because the catechin compounds in gambier products are semi-polar, and a higher concentration of catechin usually leads to higher semi-polar nature of instant coffee, thereby, causing a reduction in the solubility of the product in water. This phenomenon was also reported in **[24]**.

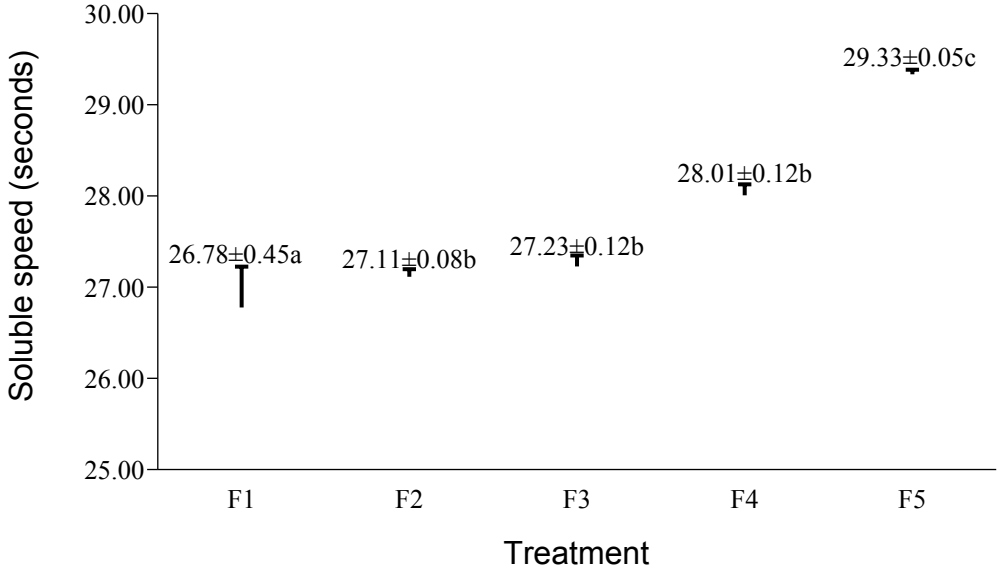

Figure 2 Effect of formulation treatment on the soluble speed of functional instant green coffee.

Total Phenol

The total phenol of the functional instant green coffee produced ranged from 16.79 to 169.48mg/L, as indicated in Figure 3.

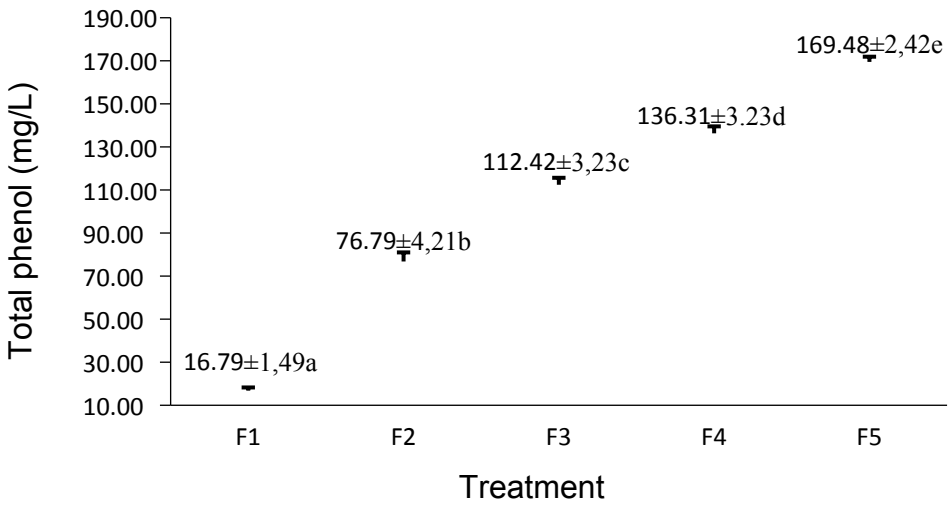

Figure 3 Effect of formulation treatment on total phenol of functional instant green coffee.

These values are slightly lower than 171.633mg/L reported by **[4]** and higher than 16.26 - 30.65mg/L and 42.4 - 59.8mg/L recorded by **[33]** and **[5]**, respectively. However, this coffee has a total phenol content similar to the results of research by **[9]**, which is 29.23 - 158.19mg/mLGAE, **[22]** regarding cinnamon coffee of 34.46mg/mLGAE, oven-roasted~~oven roasted~~ coffee, which is 16 - 66mg/mLGAE **[1]**, famous brand coffee circulating in Indonesia is 46.27mg/mLGAE **[16]** and roasted arabica coffee is 49.90mg/mLGAE **[23]**. Compared with the research of **[6]**, this total phenol is much lower, i.e.~~ie~~ unroasted coffee contains 208.89mg/mLGAE of total phenol and 119.22mg/mLGAE in roasted coffee.

The diversity analysis showed the significant effect of the formulation treatment on the total phenol of functional instant green coffee. It was discovered that a higher concentration of gambier catechin extract and pasak bumi in the formulation increased the total phenol. This is, therefore, associated with the polyphenolic compounds in the catechin extract and pasak bumi. The result is in line with the findings of **[20]** and **[29]** that gambier contains polyphenol compounds in the form of catechins by 50%, while **[40]** found phenolic compounds of catechins and tannins at 65.6 - 74.2% and 11.32 - 17.76%, respectively. Moreover, **[10]** showed that pasak bumi contains several secondary metabolites: alkaloids~~ such as alkaloids~~, terpenoids, sterpenoids, steroids, flavonoids (phenols), and saponins.

Antioxidant Activity

The antioxidant activity of functional instant green coffee was measured using IC_{50} such that a higher IC_{50} value indicates lower antioxidant activity and vice versa. The values were observed to be from 44.68-207.59ppm as shown in Figure 4 and are the same as the findings of **[25]** that the encapsulated green coffee extract has 87.65ppm and **[39]** which showed that green coffee brewed with cold water has 71.97-83.21ppm. However, the values are higher than the 25.187ppm reported for green coffee extract dried using the foam mat method by **[26]** and **[18]** reported that robusta green coffee contain antioxidants with an IC_{50} of 81.6µg/mL and lower than 167.426 to 294.710ppm recorded for green coffee from Ethiopia by **[35]** and **[12]** reported that robusta coffee contain antioxidants with an IC_{50} of 2210µg/mL

The diversity analysis showed that the formulation treatment significantly effects the IC_{50} of functional instant green coffee, as indicated in Figure 4. This was observed because a higher concentration of gambier catechin extract and pasak bumi powder in the formulation caused a reduction in the IC_{50} and a higher antioxidant activity. This is associated with flavonoid compounds that are considered to be antioxidants in the gambier catechin extracts and pasak bumi powder. Moreover, it also indicates consistency with the total phenol data recorded in Figure 3, which showed the same trend. Phenol is also an antioxidant, whichand this means a higher content of this compound can increase the antioxidant properties of the product as indicated by a decrease in IC_{50}.

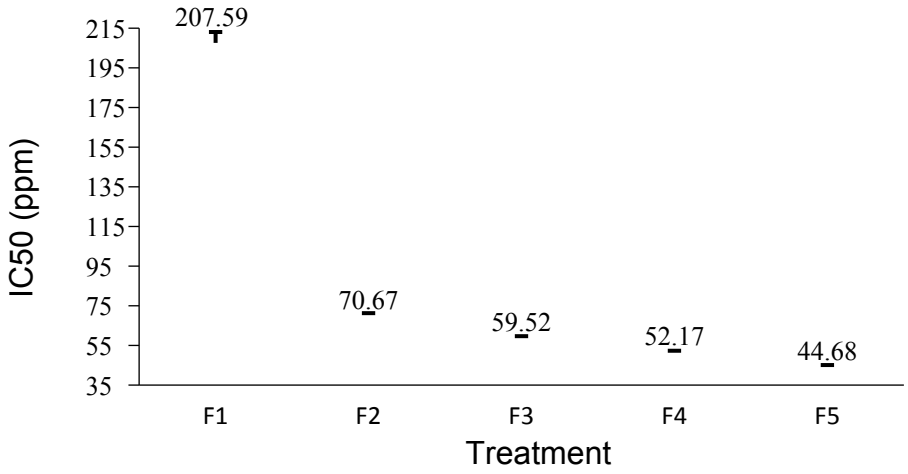

Figure 4 Effect of formulation treatment on IC_{50} of functional instant green coffee.

CONCLUSION

The addition of catechin extract of gambier and pasak bumi in instant green coffee significantly affected~~had a significant effect on~~ the increase in total phenol and IC_{50}. Besides that, there was also a change in the physical

properties of instant green coffee, namely an increase in water content and speed of dissolving. The functional instant green coffee produced has a water content value of 3.84 - 4.81%, soluble speed of 26.78 - 29.33s, total phenol of 16.79 - 169.48mg/L and an IC of IC_{50} of 44.68 - 207.59ppm.

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Conflict of Interest:

The authors declare no conflict of interest.

Ethical Statement:

This article does not contain any studies that would require an ethical statement.Contact

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Functional green coffee drink

Instant functional green coffee