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Performance and Protein Efficiency Ratio of Starter Phase Pegagan Ducks Fed Fermented Rations Made from Locally Sourced Materials

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Abstract: This study examined locally sourced raw materials that were either fermented or not with different inoculums to determine the effect of diet on performance and protein efficiency ratio in young Pegagan ducks. A completely randomized design (CRD) with 5 treatments and 4 replications was used to examine five rations: R0, commercial ration (control), R1; locally sourced ration without fermentation; R2, locally sourced ration fermented with bread yeast; R3, locally sourced ration fermented with tape yeast and R4, locally sourced ration fermented with tempeh yeast. Variables measured were final body weight, feed intake, weight gain, feed conversion, protein intake, protein digestibility, protein degradation and protein efficiency ratio. Data were analyzed with ANOVA and Duncan's multiple range test. The use of locally sourced raw material feed fermented using different inoculums had significantly difference ($p<0.05$) on the final body weight, weight gain, feed conversion, protein digestibility, protein degradation and protein efficiency ratio, but did not have significantly difference ($p>0.05$) on feed and protein intake of Pegagan ducks. It was concluded that the use of local raw material feed fermented with different inoculums had the same result on increase the final body weight, body weight gain, feed conversion, protein digestibility, protein degradation and protein efficiency ratio in Pegagan ducks.

Key words: Ration, fermentation, local feed, different inoculum, pegagan ducks

INTRODUCTION

Pegagan ducks originated in watershed pegagan villages located in the Koto Daro district in South Sumatra. Pegagan ducks have round and flat bodies with dark brown beaks and feet. Females have dark brown coats and shiny blue-black wing feathers, with white eyebrows, while males have a grayish coat and shiny blue-black feathers around the head, neck, wings and tail (Pramudyati, 2003). Pegagan ducks have shown low productivity because fermentation technology using locally sourced raw materials for feed has not been implemented.

Local raw materials such as coconut pulp, cassava leaves, water hyacinth meal and conch rice flour ("gondang") have sufficiently good nutritional value to allow their use as alternative feed for livestock. Although these materials contain carotenoid pigments, particularly β-carotene and xanthophyll, locally sourced raw materials also have high crude fiber contents and low digestibility, which contributes to poor digestibility by ducks (Murwani, 2010). However, the nutritional value of locally sourced raw materials in feeds can be improved by processing methods such as fermentation.

Fermentation processes involving tape yeast, bread yeast and tempeh yeast can easily be carried out by farmers. These three yeasts produce amylase, amyloglucosidase and cellulases that can degrade cellulose to increase protein content and reduce the fiber content of feeds (Mahfudz *et al*., 1997). During fermentation, cellulose, hemicellulose and other polymers are broken down into simple sugars or derivatives and thus the nutritional value of the treated feed is improved. Moreover, fermenting yeasts are catabolic and can also synthesize vitamins such as riboflavin, vitamin B_{12} and provitamin A.

MATERIALS AND METHODS

This study used 200 female two-week old Pegagan ducks that were reared for 6 weeks. Ducks were obtained from "Maju Bersama" farmers in the village of Koto Daro, District Rantau Panjang, OKI, South Sumatra. Local feed ingredients used to prepare rations included yellow corn, water hyacinth meal, cassava leaf meal, gondang meal, coconut pulp, bran, eggshell meal, methionine and lysine. Tempeh yeast, tape yeast and bread yeast were used as innoculums for fermentation (Table 1). All rations contained 19% protein and the metabolic energy (ME) equivalent of 2,900 kcal/kg (Table 2). Ducks were housed in groups of 20 in 2 m x 2 m x 0.8 bamboo cages. Food and water were provided *ad libitum* at stations and other equipment included electric lighting and scales, as well as a hygrometer and thermometer.

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Research and methods: Locally sourced raw materials for feed were first dried and pulverized by grinding. The fermentation with different inoculums proceeded aerobically. All feed ingredients were mixed to homogeneity followed by steaming for 30 min and then cooling and drying to a humidity value of 50-60%. For fermented feeds, the mixtures were inoculated with either 0.5% tape yeast, 0.3% tempeh yeast or 0.8% bread yeast by stirring until thoroughly blended. The rations for fermentation were then sealed in plastic bags and the fermentation process was allowed to proceed for three days. At the end of three days, fermentation was stopped by drying the substrate under sunlight to prevent spoilage. The dried fermented rations were then used in the experiments.

Experimental design: This research used a completely randomized design (CRD), with 5 treatments and 4 replications. Each treatment unit involved a maximum of 10 starter phase Pegagan ducks. The treatments were as follows:

R0 = commercial ration (control)
R1 = locally sourced ration without fermentation
R2 = locally sourced ration fermented with bread yeast
R3 = locally sourced ration fermented with tape yeast
R4 = locally sourced ration fermented with tempeh yeast

Measured variables: Final body weight, weight gain, feed intake, feed conversion, protein intake, protein digestibility, protein degradation, protein synthesis and protein efficiency ratio were measured (Wahyu, 1997).

RESULTS AND DISCUSSION

Performance of pegagan ducks: Growth can be described as an increase in the size of bones, muscles, internal organs and body parts that occurs before birth and then after birth through to adulthood (Ensminger *et al.*, 1990). According to Bell and Weaver (2002), several factors affect growth, including strain, gender and environment. Body weight gain can be used as a reference to measure growth. In this study body weight gain and feed consumption were assessed (Table 3).

ANOVA results showed that feeding the ducks rations fermented with different inoculums did not significantly affect ($p>0.05$) feed intake. This outcome was expected given that all rations had essentially similar energy contents and thus consumption would be similar. Although feed consumption can be affected by various factors, including the nutrient content of the diet (Hernandez *et al.*, 2004; Fan *et al.*, 2008), the rations used here were formulated according to defined nutritional needs of 2-8 week-old ducks and included 19% crude protein and metabolism energy (ME) of 3,000 kcal/kg (NRC, 1994). The nutrient content of the rations, including metabolic energy (ME), did not meet the needs of the ducks so that the amount of feed consumed may have been insufficient to support growth of the ducks.

Table 1: Experimental diet compositions

Feed Ingredients	% Material (w/w)
Corn	55.00
Rice bran	9.00
Water hyacinth meal	2.00
Coconut pulp	2.00
Gondang meal	17.00
Cassava leaf meal	13.00
Eggshell meal	1.00
Methionine	0.40
Lysine	0.60
Total	100

Fan *et al.* (2008) found that rations with high ME values can increase feed intake and promote growth in poultry. However, total consumption of diets with high protein levels and ME values tends to decrease, but when both protein and ME levels are low, consumption increases (Leeson *et al.*, 1996; Hernandez *et al.*, 2004). High fiber is known to reduce the availability of energy and other nutrients and also influence the flow rate of feed material through the digestive tract (Siri *et al.*, 1992). Crude fiber that cannot be digested will likely be accompanied by nutrients that are excreted in feces, which in turn reduces the availability of nutrients such as protein and vitamins as well as energy-related components. However, the crude fiber content did not affect feed consumption levels in this study. Although the crude fiber content in each test ration differed from the control ration, which contained less than the ~6% fiber recommended for ducks (R0 (3.24%) and R1 (6.37%), R2 (6.08%), R3 (6.17%) and R4 (6.16%), Table 2), only small changes were seen in food consumption (Table 3). Thus, feed fermentation using tape yeast, bread yeast and tempeh yeast to increase the fiber content to recommended levels did not appear to be useful in increasing feed intake. The amount of enzymes produced by microbes in the tape yeast, bread yeast and tempeh yeast fermented rations could be relatively small such that enzyme hydrolysis of crude fiber makes only an insignificant contribution to feed intake. In addition, the ability of body caches to accommodate feed in large quantities is also limited (Wahyu, 1997).

Consistent with earlier studies (Amrullah, 2002; Koni *et al.*, 2013; Budiansyah, 2010; Kayadoe, 2009), fementation with tape yeast, bread yeast and tempeh yeast inoculums also did not appear to affect feed palatability or food consumption. The average feed consumption by 8 week-old Pegagan ducks ranged from 72.74 to 78.84 g/day, which is higher than the rates reported in a study by Dewi *et al.* (2014) that showed a range of 52.83 to 61.46 g/day. Notably, Anggorodi (1994) stated that feed consumption by ducks is dependent on the strain, enclosure temperature, production phase and

Table 2: Nutrient composition of experimental diet

Nutrient	R0	R1	R2	R3	R4
Crude protein (%)	19.2	18.37	19.74	19.88	19.22
Crude fat (%)	3.39	3.43	3.32	3.38	3.24
Crude fiber (%)	3.24	6.37	6.08	6.17	6.16
ME (kcal/kg)	2,995.39	2,827.34	2,842.96	2,824.92	2,843.66
Phytic acid (ppm)	3.87	4.48	3.08	3.03	3.02
Cyanide acid (ppm)	0	20.81	19.62	18.79	19.58
Ca^{2+} (%)	0.94	1.27	1.56	1.08	1.25
Phosphorus (%)	0.77	0.79	0.99	0.56	0.76
Methionine (g/100 g)	1.44	1.22	0.45	0.78	0.75
Lysine (kg/100 g)	1.47	0.93	0.63	0.69	0.80

Nutrient composition was determined by the laboratory of Feed Technology, Faculty of Animal Science, IPB Bogor (2015). R0 = commercial ration (control); R1 = locally sourced ration without fermentation, R2 = locally sourced ration fermented with bread yeast; R3 = locally sourced ration fermented with tape yeast; R4 = locally sourced ration fermented with tempeh yeast

Table 3: Body weight gain and feed intake of pegagan ducks

Treatment	Feed intake (g/day)	Final body weight (g)	Body weight gain (g/day)	Feed conversion
R0	72.79±2.48	1,270.00±150.00^{a}	33.72±4.05^{a}	2.19±0.36^{c}
R1	74.84±4.90	1,092.67±60.88^{b}	28.68±1.60^{b}	2.68±0.05^{bc}
R2	77.74±2.54	955.00±102.32^{b}	24.90±3.57^{b}	3.17±0.44^{a}
R3	76.60±2.87	971.67±42.98^{b}	25.43±1.31^{b}	3.01±0.08^{a}
R4	78.84±3.73	965.60±103.88^{b}	24.73±3.76^{b}	3.23±0.14^{a}

R0 = commercial ration (control); R1 = locally sourced ration without fermentation, R2 = locally sourced ration fermented with bread yeast; R3 = locally sourced ration fermented with tape yeast; R4 = locally sourced ration fermented with tempeh yeast

Table 4: Efficiency of protein use in starter phase Pegagan ducks

Treatment	Protein consumption (%)	Protein digestibility (%)	Protein degradation (%)	Ratio of protein usage (%)
R0	13.27	79.77±1.37^{a}	84.06±1.05^{a}	2.34±0.81^{a}
R1	12.49	75.30±3.41^{ab}	77.64±3.84^{ab}	2.088±0.24^{a}
R2	13.09	71.86±0.40^{b}	74.51±0.36^{b}	1.68±0.24^{b}
R3	14.05	68.67±3.42^{b}	76.22±4.19^{b}	1.70±0.08^{b}
R4	13.15	70.44±1.77^{b}	75.05±1.49^{b}	1.71±0.24^{b}

R0 = commercial ration (control); R1 = locally sourced ration without fermentation, R2 = locally sourced ration fermented with bread yeast; R3 = locally sourced ration fermented with tape yeast; R4 = locally sourced ration fermented with tempeh yeast

ration energy contents, such that any of these variables may have produced the different consumption rates seen in this study.

ANOVA showed that ration fermentation with an inoculum significantly ($p<0.05$) affected the final body weight of the Pegagan ducks. Duncan's test results showed that the final weight of ducks given the R0 ration was significantly higher (1,270.00 g) than the ducks fed R1 (1,092.67 g), R2 (955 g), R3 (971.67 g) and R4 (965.00 g) (Table 3). Given that the nutrient contents of R1 R2, R3 and R4 were similar, the lower weights seen for ducks fed these rations may be due to a decrease in the quality of dietary proteins and the presence of growth-inhibiting agents such as cyanide. Indeed, detoxification of cyanide in the body produces thiocyanate and increased thyiocyanate levels can deplete sulfur amino acids (Elsaid *et al*., 2006). The presence of cyanide can also affect thyroid function. The thyroid gland produces the hormone thyroxine, which cooperates with growth hormones to promote growth. Thyroxine production involves iodine binding to the phenol ring of the active component of thyroxine, tyrosine. Cyanide present in rations can inhibit the transfer of iodine to tyrosine and in turn affect thyroxine levels to directly affect growth (de Sousa *et al*., 2007; Monzana *et al*., 2007). In addition, increased thiocyanate levels can also inhibit the uptake of intra-thyroidal iodine that increases TSH secretion and decreases the thyroxine concentration needed for growth (Tewe, 1992). Another factor that can produce decreased final body weight is reduced quality of dietary protein. Fermentation of microbial proteins can increase dietary protein in the form of single cell protein (PST), which can be difficult for animals to digest and in particular cannot be utilized by poultry. As such, the presence of PST can affect poultry growth. Some researchers reported that PST in feed may affect the growth of young chickens (Sinurat *et al*., 1995). Meanwhile, Kompiang *et al*. (1994) stated that fermentation products used in animal feed have both advantages and disadvantages in the form of limiting factors. For example, microorganisms contained in fermented products have a high nucleic acid content and are difficult to digest due to the nature of their cell walls, which also contributes to difficulties in obtaining protein from these feeds. Surisdiarto (2000) stated that an imbalance of dietary amino acids is one factor that leads to lower digestibility of protein feed, which in turn lowers the nutritional value of these feed proteins.

ANOVA also showed that rations fermentated with different inoculums significantly affected ($p<0.05$) weight gain of Pegagan ducks. As with increases in final body weight, Duncan's test results showed that the R0 ration produced greater weight gains ($p<0.05$) compared to animals fed R1, R2, R3 and R4 rations. In addition, both the non-fermented (R1) and fermented R2, R3 and R4 rations produced similar weight gains. Body weight gain affects the final body weight (Wahyu, 1997) and decreases in body weight occur following draws on stored energy that are needed to meet current energy needs. In addition, like total body weight, the different weight gains seen among the rations could be due to differences in the protein digestibility of the rations.

The conversion ratio relates the amount of feed consumed to weight gain and this value can also be described as the level of efficiency ratio. Lower ratio values translate into the ration having a greater efficiency since less feed is needed to produce a given amount of weight within a certain period. ANOVA showed that fermentation with different inoculums significantly affected ($p<0.05$) feed conversion. Duncan's test results showed that the relative feed conversion for R0 was similar to R1, but the feed conversion ratio for both R0 and R1 was lower than that for R2, R3 and R4. According to Mairizal and Erwan (2008), feed conversion is closely connected to feed intake and body weight gain. For example, if feed consumption was high but did not promote weight gain, the feed conversion ratio would increase and translate to the feed being inefficient for promoting weight gain.

The average feed conversion ratio of this study ranged from 2.19 to 3.23, which is lower than that seen for previous studies. Assa (1995) reported that the average feed conversion ratio for ducks fed fermented cassava was 4.06 and Zulfatan (2004) showed that the average feed conversion ratio for ducks ranged from 5.80 to 6.00. Furthermore, Allaily (2006) found that the silage feed conversion ratio for complete local raw material ranged from 4.65 to 6.21. These high feed conversion rations indicated that ducks may be uneconomical and inefficient in terms of feed consumption. Furthermore, Anggorodi (1990) stated that increased feed intake followed by a decrease in body weight raises the feed conversion ratio and indicates that a particular feed is inefficient.

Efficiency of protein use by starter phase pegagan ducks: As expected, the average consumption of dietary protein by the ducks fed different rations did not significantly differ because each ration had protein levels that were between 18 and 19% (Table 4, $p>0.05$). In addition, feed consumption of some rations did not differ significantly ($p>0.05$). These results suggested that feed fermented with different inoculums had a palatability that was similar to the control diet. As such, the amount of feed consumption will reflect the amount of protein consumption and poultry are known to consume feed based on the ME and crude protein contents (Wahyu, 1997; Anggorodi, 1994).

Meanwhile, the average protein digestibility showed significantly different results ($p<0.05$), which may be due the *ad libitum* feeding, wherein the ducks were continuously digesting food that increased the flow of food into the intestines and ultimately reduced digestibility. This outcome is consistent with findings by Tillman *et al.* (1991), showing that increasing the amount of feed can accelerate the flow of feed through the gut that reduces overall digestibility and eventually decreases protein digestibility. Rations fermented with yeast have some of the organic matter pre-digested by microbes such that the feed is more easily absorbed by the body. Indeed, fermented rations appear to be palatable to ducks and the increase in protein consumption afforded by this palatability would increase protein digestibility and ultimately decrease the amount of protein found in the excreta. Lower protein levels in the excreta thus translate to increased digestibility (Anggorodi, 1990).

ANOVA showed that protein degradation and synthesis was significantly ($p<0.05$) influenced by the different rations. This difference can be related to protein digestibility, which also significantly differed ($p<0.05$) among the rations. Suthama (2010) stated that the quality of growth is synonymous with the ability to metabolize protein and that feeds with a suitable protein contact but insufficient ME value can inhibit the use and retention of nitrogen such that protein deposition and growth rates are low. The results of this study indicate a higher protein use efficiency given the lower amount of undigested protein in rations fermented with different inoculums, suggesting that proteins in these rations are more easily digested. According to Resnawati (2006), the protein retention value, which is related to protein synthesis, is dependent on the protein content of the rations. The fecal protein level also reflects protein retention, such that greater protein utilization decreases the amount of protein in the feces.

The protein efficiency ratio (REP) can illustrate the use of protein for growth (Mahfudz *et al.*, 1997) and is determined by measuring changes in weight gain and protein consumption. As with protein intake and weight gain, the average REP for the different rations differed significantly ($p<0.05$) (Table 4). These results indicate that the dietary protein quality was similar for all rations and that the growth processes in the ducks would be similar. One way to evaluate the protein quality of the feed material is to calculate the REP from daily weight gain and protein consumed. Higher protein efficiency ratios indicate a more efficient utilization of protein that is consumed (Anggorodi, 1994). Furthermore, the REP can be influenced by age, sex, experiment duration and ration protein content. A higher amount of digested and absorbed protein increases the amount of protein that is available for growth and this value should be optimized to enhance livestock growth.

Conclusion: This study showed that, relative to the control ration, locally sourced raw materials used in feed fermented with different inoculums did not increase the final body weight, body weight gain, feed conversion, protein digestibility, protein degradation and protein efficiency ratio of starter phase Pegagan ducks.

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