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Physical and Chemical Qualities of Spent Layer Duck Meat Fed Diets Supplemented with *Garcinia atroviridis* Leaf Meal

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Abstract | This study aims to improve the physical and chemical qualities of the meat of spent layer duck through *Garcinia atroviridis* supplementation. Although their meat quality is not as good as that of young ducks, spent layer ducks can still be used as a meat source. In general, quality of ducks'meat can be improved by providing the ducks with rations that meet their needs for nutrients. However, to improve the meat quality of spent layer ducks, relying on the provision of rations is not appropriate; antioxidant supplementation is considered necessary. Leaves of Asam gelugur (*Garcinia atroviridis*) contain hydroxy citric acid and other active substances that function as antioxidants, so the use of them in ration is expected to improve the meat quality of spent layer ducks. Sixty spent layer ducks were fed four rations including commercial rations (R1), nonconventional rations + 2% Asam gelugur leaf meal (AGLM) (R2), nonconventional rations + 4% AGLM (R3), and nonconventional rations + 6% AGLM (R4) in a completely randomized design with five replicates containing three ducks each. Ducks were reared in battery cages for five weeks. Measurements were taken on meat physical quality (pH, water binding capacity, cooking loss, tenderness) and chemical quality (moisture content, protein, fat, ash, and phosphorus) parameters. Data were subjected to an analysis of variance and a Duncan's multiple range test. Results revealed that meat cooking loss and fat content were significantly lowered ($P<0.05$) in ducks treated with treatment rations. No significant differences were found in other physical and chemical quality parameters. It was concluded that supplementation of 2, 4, and 6% AGLM reduced cooking loss and fat content of spent layer duck meat.

Keywords | Antioxidant, Cooking loss, Hydroxy citric acid, Spent layer duck, Nonconventional rations

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INTRODUCTION

Ducks are primarily reared for producing eggs and meat. They are usually reared for egg production until 72 weeks before rejection. The rejected ducks, usually known as spent laying ducks, can still be used as meat source even though the quality of the meat is not as good as that of young ducks. The meat of spent layer duck has a high-fat content, a tough texture, and a sharper off-flavor (Rukmiasih et al., 2011). As waterfowl, ducks have more subcutaneous fat. The fat content of duck meat is two times higher than that of chicken meat and mainly consisted of unsaturated fatty acids, which often cause off-flavor in duck meat (Hustiany, 2001). This has made demand for duck meat lower than that for broiler meat.

Meat palatability is the primary sensory trait of consumer acceptance (Choi & Kim, 2009). The main attribute of palatability that influences consumer acceptance and consumer decision is tenderness (Grunert et al., 2004; Men-

necke et al., 2007; Piao et al., 2015). Physical and chemical qualities of animal meat can, in general, be improved by providing the animal with ration supplying nutrients needed by the animal. However, in spent layer ducks, this is considered inappropriate and antioxidant supplementation in ration is required.

The leaves of Asam gelugur (*Garcinia atroviridis*) contain hydroxy citric acid and other active substances having antioxidative property. The use of Asam gelugur leaf meal (AGLM) by up to 6% in rations of spent layer ducks did not give significant effects on their performance, but it lowered cholesterol and low density lipoprotein cholesterol and increased triglycerides in meat (Dihansih et al., 2019). Based on the above notion, a study on the supplementation of AGLM in rations of spent layer ducks and its effects on the physical and chemical qualities need to be conducted.

MATERIALS AND METHODS

Animals and Experimental Design

All applicable international, national, and institutional guidelines for the care and use of animals were followed. The research was conducted for five weeks in the Trial Farm of the Animal Science Department, Djuanda University. Sixty spent layer ducks aged 72 weeks were allocated into 4 treatments in a completely randomized design. Treatments consisted of commercial rations (R1), nonconventional rations + 2% AGLM (R2), nonconventional rations + 4% AGLM (R3), and nonconventional rations + 6% AGLM (R4). Each treatment consisted of 5 replicates and 3 ducks were allocated into each replicate. Nonconventional rations were formulated from corn, rice bran, soybean meal, fish meal, fermented coconut meal, and palm kernel cake fermented by *Aspergillus niger*, and AGLM (Table 1).

Research Procedures

Prior to the commencement of the trial, cages and all equipment were cleaned and disinfected. Ducks were physically examined to assure that only those with excellent health and physical conditions were used. The ducks were then weighed before they were randomly placed into individual cages.

Asam gelugur leaves were sun-dried before they were dried in an oven at 62°C. Dried leaves finely ground by using a blender to produce AGLM. Treatment rations were fed to the animals in gradual amount within a week feeding adaptation period. Full amount of treatment rations was given within five-week feeding period.

In the end of the feeding period, ducks were slaughtered in accordance to Islamic slaughtering method. The slaughtered ducks were hung to drain the blood as completely as possible before the feather were remove to get the carcass. After the carcass was obtained, samples of breast meat were taken and subjected to physical and chemical quality tests.

Measured Parameters

Measurements were taken on meat physical quality parameters including pH, tenderness, water binding capacity, and cooking loss and meat chemical quality parameters including water, protein, fat, crude fiber, ash, and phosphorus content.

Meat pH values were measured by using a calibrated pH meter based on the method adapted from van Laack et al. (2000). Meat tenderness was examined based on the method used by Bouton et al. (1976) as follows:
Cooking loss (%) = (initial weight–final weight)/(initial weight)×100%.

Free water content in the meat is an indicator that determines the binding power of water in the meat. In this study, it was measured by using 0.3 g of a sample placed between 2 sheets of filter paper number 41 and then pressed with a load of 35 kg/cm_2 on an iron plate for 5 minutes. The area on the filter paper was covered with flattened meat samples, and the wet area around it was marked (Soeparno 2005). Meat free water content was calculated by using the following formula:

H_2O(mg) = (wet area (cm^2))/0.0948-8.0.

The percentage of free water is calculated using the following formula:
H_2O(%) = (H_2O(mg))/(300 mg)×100%.

The nutritional contents of meat (water, protein, crude fiber, ash, and phosphorus content) were analyzed by using the AOAC (2005) procedure.

Statistical Analysis

Data were subjected to an analysis of variance (ANOVA) and a Duncan's multiple range test using the SPSS 25 application.

RESULTS AND DISCUSSION

Meat Physical Quality

Meat of spent layer ducks fed diets supplemented with AGLM was shown to have significantly different coocking loss but no diffeences in other physical quality parameters were found (Table 2). The average meat pH ranged from 6.00 to 6.09, however, no significant effects (P>0.05) of AGLM supplementation were found. For comparison, breast meat of male and female Pekin ducks

Table 1: Nutrient composition of the experimental ration.

Composition	Experimental ration			
	R1	R2	R3	R4
Water content (%)	11.61	10.74	10.23	9.21
Ash (%)	8.43	7.71	7.54	7.80
Extract ether (%)	2.57	3.76	3.74	3.34
Crude protein (%)	13.32	13.08	13.18	12.00
Crude fiber (%)	4.25	6.20	8.97	9.30
Nitrogen free extract (%)	59.82	58.51	56.34	58.35
Gross energy (kcal/kg)	3814	4099	3918	4022

R1 = ration + 0% of Asam gelugur leaf meal (AGLM), R2 = ration + 2% AGLM, R3 = ration + 4% AGLM, and R4 = ration + 6% AGLM.

Table 2: Average physical quality of spent layer duck meat fed Asam gelugur leaf meat in unconventional rations.

Variables	Experimental ration			
	R1	R2	R3	R4
pH	6.04±0.06	6.06±0.26	6.00±0.02	6.09±0.08
Tenderness (kg/cm^2)	5.69±0.38	5.40±0.44	5.45±0.53	5.12±0.32
Cooking loss (%)	49.46±2.62^c	46.65±2.26^b	43.35±0.35^a	42.44±0.33^a
Water holding capacity (%)	39.58±1.86	39.81±0.92	42.22±2.37	41.80±1.97

Different superscripts on the same row showed significantly different results ($P < 0.05$).
R1 = ration + 0% of Asam gelugur leaf meal (AGLM), R2 = ration + 2% AGLM, R3 = ration + 4% AGLM, and R4 = ration + 6% AGLM.

Table 3: Chemical quality of spent layer duck meat fed with Asam gelugur leaf meal in nonconventional feed.

Variables (%)	R1	R2	R3	R4
Water content	71.96±2.46	71.39±0.90	72.55±2.10	71.88±1.08
Crude protein	15.40±0.87	15.18±0.51	15.22±0.78	15.09±0.55
Crude fat	20.03±0.49^b	12.64±1.52^a	15.10±0.56^a	13.85±1.05^a
Crude fiber	0.24±0.07	0.21±0.10	0.25±0.10	0.30±0.05
Ash	4.81±0.20	4.79±0.25	4.58±0.25	4.85±0.09
Phosphorus	0.75±0.01	0.74±0.01	0.73±0.01	0.74±0.01

Different superscript on the same row shows significantly different results ($P < 0.05$).
R1 = ration + 0% of Asam gelugur leaf meal (AGLM), R2 = ration + 2% AGLM, R3 = ration + 4% AGLM, and R4 = ration + 6% AGLM.

aged 112 weeks had pH values of 5.7 to 6.1 and 5.8 to 6.2, respectively (Kokoszyński et al., 2020). In recent studies, meat pH of the spent layer ducks was in the same range as that of layer ducks (5.81–6.62) (Alvarado & Sams, 2000; Wawro et al., 2004; Qiao et al., 2015). A high meat pH value was associated with a shorter shelf life (Lacin et al., 2008) and darker color (Fletcher et al., 2000).

In recent studies, the average tenderness of spent layer ducks was 5.12–5.69 kg/cm^2, which was almost the same as that (5.20–5.88 kg/cm^2) of meat at 9-week old Muscovy duck (Tugiyanti et al., 2013; Qiao et al., 2017). However, these meat tenderness figures spent layer ducks were lower than those of spent layer hens (1.26 kg/cm^2) (Semwogerere et al., 2018) and crossbred ducks (Oiao et al., 2016). In another study by Hadi et al. (2021) feeding spent layer ducks with different types of vegetable oils including 4% palm oil, 4% canola oil, and soybean oil resulted in meat tenderness of 2.98 ± 0.53, 2.28 ± 0.44, and 2.38 ± 0.43 g/ cm^2, respectively. Meat tenderness of spent layer duck was shown to be similar results (P>0.05) among the treatments (Table 2). This insignificant meat tenderness between treatments was thought to be closely related to the same muscle fiber diameter size of spent layer ducks in each treatment. This result agrees with those of Lepetit (2008) who found a close relationship between muscle fiber diameter and meat tenderness; meat with a smaller muscle fiber diameter tends to be more tender.

In this study, meat cooking loss was found to be signifi-

cantly different ($P < 0.05$). The highest meat cooking loss (49.46%) was found in the control group. Supplementation of 2, 4, and 6% AGLM resulted in lower cooking loss ($P < 0.05$) of 46.65, 43.35, and 42.44%, respectively. Meanwhile, in a study by Ali et al. (2007), the inclusion of rice meals in rations did not change the cooking loss of the duck meat. However, in another recent study, the cooking loss was higher than that 20.26–21.08% reported by Qiao et al. (2016). Moreover, in 110-week-old Peking ducks, the cooking loss of males duck meat was higher than that of females (Kokoszyński et al., 2020). In contrast, sex did not influence cooking loss (Tanganyika & Webb, 2019). The cooking loss was closely corelated with meat final product; therefore, it became an essential indicator of meat quality in the food industry (Huda et al., 2011). A lower value of the cooking loss indicated a better meat quality (Patriani et al., 2021). Cooking loss is also an indicator of water holding capacity (WHC), which influences meat quality (Tanganyika & Webb, 2019).

In this study, WHC value of spent layer duck meat ranged from 39.58 ± 1.86% to 42.22 ± 2.37% and was not significantly changed with the administration of AGLM. These findings indicated that the inclusion of AGLM in ration by up to 6% did not improve meat ability to bind and retain free water. Insignificant differences in meat WHC values found in this study might be attributed to the way AGLM was used. In this study, AGLM was prepared as a feedstock used in ration formulation. Patriani et al. (2021) found that the use of Asam gelugur fruit as a material to marinate meat of culled chickens significantly increased meat WHC values. Meat WHC values in this study were lower than those rejected duck meat soaked in 1% NaCl solution (Sumarmono & Warsito, 2010) and of culled chicken meat marinated with Asam gelugur fruits (54.06 ± 3.62%) (Patriani et al., 2021), but higher than that (13.28%) of duck meat marinated with 10% ginger extract (Suryanti et al., 2015). In another study that used various types of vegetable oils included in rations, WHC values were not significantly changed (Hadi et al., 2021).

Meat Chemical Quality

The inclusion of 2, 4, and 6% AGLM in rations was found to result in meat containing significantly ($P<0.05$) lower fat content. No differences were found in other nutrient contents of the meat (Table 3). This lowered meat fat content in treated groups might be attributed to the fact that HCA which is much contained in AGLM increases carbohydrate oxidation rate which then leads to reduced availability of fatty acids to be deposited as adipose tissue (de novo synthesis). Furthermore, inhibited fat accumulation results in greater oxidation of the existing fat tissue to produce energy (Chuah et al., 2013) which, in turn, results in a lower meat fat content.

In this study, the water content of the spent layer duck meat ranged from 71.39% to 72.55%. In a previous study, the water content of duck meat was almost the same as that 71.3–73.3% of meat of spent layer ducks given rations containing 2.91–8.26% ginger (Yadnya et al., 2010) but slightly lower than that 73.29–75.42% of the spent layer duck meat reported by Qiao et al. (2016) and somewhat higher than that 66.2–71.1% of the spent layer Pekin duck meat (Kokoszyński et al., 2020).

Meat protein contents (15.09–15.40%) were not found to be significantly different. These figures of protein contents were lower than those (22.14–24.34%) of meat of 500-day-old spent layer ducks and those (21.73 – 21.96%) of meat of Cerry Valley ducks (Qiao et al., 2016).

CONCLUSIONS

It was concluded that the inclusion of AGLM by up to 6% in rations improved cooking loss and reduce fat content of spent layer duck meat.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTIONS

Dede Kardaya worked on conceptualization, methodology, supervision, and validation. Dewi Wahyuni worked on investigation, data analysis, and project administration. Elis Dihansih developed proposal and conceptualization.

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