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Effects of the Inclusion of Star Gooseberry (*Sauropus androgynus*) Leaf Meal in Ration on Physical and Nutritional Quality of KUB Chicken Breast Meat

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ABSTRACT: Local chickens are among the enormous poultry genetic sources in Indonesia. These chickens are potential to develop as they are found in big population throughout the country. Chicken meat is a nutritious food containing nutrients including carbohydrate, protein, fat, water, minerals, and vitamins in balanced proportion. Improvement of nutritive contents of Balitnak Superior Local Chicken (KUB chicken) meat can be achieved by providing the chickens with quality and nutritious feed. The inclusion of star gooseberry leaf meal can be an alternative as it is nutritious, cheap, and plenty. This study was aimed at assessing effects of star gooseberry leaf meal (SGLM) inclusion in ration on physical and nutritional quality of KUB chicken breast meat. Ninety-six (KUB chickens) aged 7 days were allocated into 4 treatments and 4 replicates in a completely randomized design. Treatments consisted of 0% SGLM inclusion in ration (R0), 1% SGLM inclusion in ration (R1), 2% SGLM inclusion in ration (R2), and 3% SGLM inclusion in ration (R3). Data were subjected to an analysis of variance (anova) and a Duncan test. Results showed that treatments significantly increased ($P<0.05$) water but not ($P>0.05$) ash, fat, and protein contents of breast meat. Meat water holding capacity, cooking loss, and tenderness were found to be improved ($P<0,05$) but no different ($P>0.05$) meat pH was observed.

Keywords: KUB chicken; Star gooseberry leaf; Meat physical quality; Meat nutrition

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INTRODUCTION

Background to the Study

Local chickens are meat producing fowls found throughout Indonesia. These chickens are potential to develop in both smallholder and industrial animal farming systems as they are highly adaptable to local climatic condition and have relatively high economic value. However, numerous local chicken farming businesses in rural areas are inefficient as most of them are run in an extensive system (Suprijatna, 2013).

Local chicken population in Indonesia in 2019 was 301.76 million (Direktorat Jenderal Peternakan dan Kesehatan, 2020). Increases in poultry population and production should be supported by adequate supplies of quality and affordable feed and feed additives. Cost of feed shares the highest component (60-80%) of the whole production cost in a poultry production system. Local chickens have been gaining their popularity since the last 10 years along with the improving trend in culinary practices and businesses in the country. Meat of local chicken is perceived as healthier than broiler chicken meat which contains more cholesterol. Another superiority of meat of local chicken is that it is tastier and crunchier.

Nevertheless, there are some problems faced by local chicken farmers. The problem which has been the major concern in local chicken farming is that, compared to broiler chickens, local chickens have slower growth rate and require longer raising period. This leads to higher feed requirement and production cost and make the selling price of local chicken meat is relatively more expensive. Efforts to create superior local chicken breeds with better production performance through genetic selection have been taken. Balitnak chicken (KUB chicken) is a superior local chicken resulted from the selection process of Indonesian native chickens. KUB chicken breed has some featured characteristics including faster growth rate. Nutritional and physical quality is used to determine the value of chicken meat. Meat of KUB chicken tends to be tough or low in tenderness. Improvement of nutritional and physical quality of KUB chicken meat can be achieved by providing the chickens with quality and nutritious feed additives. The inclusion of star gooseberry (*Sauropus androgynus*) leaf meal (SGLM) can be an alternative as it is nutritious, cheap, and plenty.The leaves of star gooseberry contain 29.36% protein, 9% fiber, and 4.45% crude fat (Hermanto BS, 2020). High contents of active compounds including quercetin, kaempferol, myricetin, luteolin, apigenin, and ascorbic acid make star gooseberry leaves as potential sources of food flavonoids and antioxidant (Andarwulan et al., 2010)(Andarwulan et al., 2012).

Studies have been done on the utilization of SGLM as animal feed. The inclusion of SGLM in ration was found to lower cholesterol level in egg, carcass, and liver of quails (Subekti et al., 2006) improve production performance of broiler and layer chickens (R. A. P. Nasution et al., 2014) (Santoso, 2018) and organoleptic values of local duck eggs (Anggraeni et al., 2021). Furthermore, active compounds contained in SGLM were found to inhibit fat absorption in digestive tract resulting in a decrease in fat and cholesterol levels (Letis et al., 2017) in broiler meat. Therefore, the inclusion of star gooseberry leaf meal in ration is expected to improve the nutritive value and reduce fat content of meat in KUB chickens.

Objectives of the Study

This study was aimed at assessing the effects of the inclusion of star gooseberry leaf meal in ration on the nutrient, fat, and cholesterol contents of KUB chicken meat.

MATERIALS AND METHODS

Materials

Ninety-six unsexed KUB chickens aged 7 days with initial body weight of 60-65 g were used. The chickens were obtained from PT Sumber Unggas Indonesia, Bogor. Fresh star gooseberry leaves were obtained from a vegetable market in Bogor. The leaves were separated from the stem before they were dried under the sun for a day. The leaves were then put in an oven at 80°C for 15 minutes.

Dried leaves were ground to produce a homogenously fine star gooseberry leaf meal (SGLM) which contained 16.46% water, 10.22% ash, 28.45% crude protein, 6.52% fat, 11% crude fiber, and 3831 kcal/kg gross energy. Rations were formulated from corn meal, rice bran meal, soybean cake, fish meal, premix, DCP, cooking oil, and SGLM. Feed composition and nutrient contents of the formulated rations are listed in Table 1.

Table 1. Feed composition and nutrient contents of rations used in the study

Feed	Amount (%)			
	R0	R1	R2	R3
Corn meal	55	55	55	55
Rice bran meal	14	13	13	12
Soybean cake	16	16	15	15
Fish meal	12	12	12	12
Premix	0.5	0.5	0.5	0.5
DCP	0.5	0.5	0.5	0.5
Cooking oil	2	2	2	2
SGLM	0	1	2	3
Total	100	100	100	100
Nutrients				
Crude protein (%)	20.28	20.34	20.09	20.15
Crude fiber (%)	3.98	3.99	4.04	4.04
Fat (%)	4.45	4.45	4.49	4.51
Metabolizable energy (kcal/kg)	3005	3015	3024	3034
Lysine (%)	1.25	1.27	1.20	1.02
Methionine (%)	0.55	0.57	0.49	0.51
Methionine + Cystine (%)	0.83	0.79	0.82	0.85
Calcium (%)	3.02	2.99	3.11	3.12
Available phosphorus (%)	0.5	0.6	0.6	0.6

Remarks: R0 = 0% SGLM inclusion in ration, R1 = 1% SGLM inclusion in ration, R2 = 2% SGLM inclusion in ration, R3 = 3% SGLM inclusion in ration.

Table 2. Nutrient contents of breast meat of KUB chicken fed rations containing SGLM (%)

Nutrient	Treatment			
	R0	R1	R2	R3
Water	73.98 ± 0.10^{a}	75.03 ± 1.00^{b}	73.42 ± 0.27^{a}	73.62 ± 0.25^{a}
Ash	1.35 ± 0.07	1.35 ± 0.19	1.37 ± 0.05	1.36 ± 0.03
Fat	0.19 ± 0.12	0.27 ± 0.11	0.32 ± 0.04	0.28 ± 0.05
Protein	21.57 ± 1.34	21.33 ± 0.79	21.80 ± 0.78	21.10 ± 0.40

Remarks: Different superscripts in the same row indicate significant difference ($P<0.05$). R0 = 0% SGLM inclusion in ration, R1= 1% SGLM inclusion in ration, R2= 2% SGLM inclusion in ration, R3= 3% SGLM inclusion in ration

Methods

A completely randomized design with 4 treatments and 4 replicates was used. Chickens were evenly allocated into 16 experimental cage units (6 chickens per unit). Treatments consisted of 0% SGLM inclusion in ration (R0), 1% SGLM inclusion in ration (R1), 2% SGLM inclusion in ration (R2), and 3% SGLM inclusion in ration (R3). Measurements were taken on meat protein, fat, water, ash contents, pH level, water holding capacity, cooking loss, and tenderness. Meat tenderness was measured by using a Warner-Bratzler Method and classified as very tender (≤ 3.3 kg/cm^2), tender (3.4 - 5.0 kg/cm^2), slightly tender (5.1 - 6.7 kg/cm^2), slightly tough (6.8 – 8.42 kg/cm^2), tough (8.43- 10.12 kg/cm^2), and very tough (≥ 10.12 kg/cm^2). Data were subjected to an analysis of variance and a Duncan test.

RESULT AND DISCUSSION

Nutritional contents of KUB chicken meat in this study are presented in Table 2. pH, water holding capacity, cooking loss, and tenderness of *breast meat of* KUB chicken fed rations containing SGLM are listed in Table 3.

Water Content

Water is the biggest component of meat and meat water content is highly affected by the age of the animal. Meat of older animals contains less water than that of younger animals (Soeparno, 2015). Water content in a food material determines the acceptability, freshness, and durability of the material. Water content in poultry carcass is inversely proportional to fat content. It was revealed that the inclusion of 1% SGLM in ration significantly increased (P<0.05) the water content of KUB chicken breast meat. The highest water content (75.03 ± 1.00%) found is this study was within the range of water content of local chicken meat found in other studies including 79.30-84.90% (Anamila *et al.* 2018), 68-80%(Soeparno, 2009), and 70-75% (Aberle et al., 2001). The amount of water contained in meat is affected by age, breed, feed, and type of animal (Arni *et al.* 2016). Water is a component in meat which is related to the water holding capacity of meat protein (Afrianti et al., 2013). This capacity is attributed to meat amino acids which are hydrophilic or tend to attract water. Higher water and protein contents found in breast than in thigh meat might also be attributed to this notion.

Ash Content

Calcium, phosphorus, ion, sodium, potassium, and magnesium share the main components of mineral content in meat (Soeparno, 2015). Results showed that the inclusion of SGLM by up to 3% in ration gave no significant effect on meat ash content. It was found that the ash content of KUB chicken meat in this study was much higher than those stated by Winarno (2004) (0.79%) and (Fauzi , 2006)(1%) but lower than that found by (Rukmini et al., 2019) (1.61-1.72%). Tannin and saponin are some of the important active compounds contained in SGLM (Santoso, 2018) which may reduce the absorption of mineralsincluding Ca and (Hassan et al., 2003). However, this was not confirmed in this study.

Fat Content

The amount of fat contained in meat is affected by type, sex, and age of animal (Aberle et al., 2001) Feeding rations at the right time can be used to regulate growth rate and fat deposition in broiler chickens(Sahraei, 2012).

Results showed that the inclusion of SGLM in rations gave no significant effects on meat fat content. Beta carotene, tannin, saponin, and flavonoid are active ingredients which can lower meat fat content (Chaudhary et al., 2018) and these active compounds are found in star gooseberry leaves (Santoso, 2018). However, the use of SGLM in ration by up to 3% in this study seemed to be inadequate to allow these ingredients contained in SGLM to profoundly work in suppressing meat fat deposition. Fat in chicken meat is formed from feed fat which is synthesized into body fat in liver. Meat fat content is inversely correlated with protein content (Hartono, 2013)

Protein Content

Protein is a compound used to repair body tissues and support body structure. It also accelerates chemical reaction, fights infection, and transports oxygen from lungs to body tissues. Meat protein content is affected by protein intake, protein synthesis rate, protein degradation, protein digestibility, and amino acid balance. No significant difference in breast meat protein content was found.

The inclusion of SGLM by up to 3% only seemed to give no significant increase in ration protein contents. Contrary to the findings by (Woyengo & Nyachoti, 2010) and (Hidayat et al., 2021) active compounds including tannin contained in SGLM in this study might not affect amino acid digestibility. These have led to similar protein intake and meat protein synthesis. Meat protein content found in this study (21.10-21.80%) was slightly higher than that (18.95-19.61%) found by Makmur *et al.* (2018).

pH Level

Meat pH levels (Table 3) in this study were within the normal range and not significantly affected by the inclusion of SGLM in rations. Meat of local chickens had a normal pH range of 5.91-5.93 (Dewi, 2013) and the mean meat pH level in this study was 5.45. Level of pH has a closed relationship with microbial existence in meat which determines meat durability and quality (Hajrawati et al., 2016). Several factors are known to affect meat pH level. These include animal species, muscle type, muscle glycogen, and animal variability. The extrinsic factors include feed, ambient temperature, additive substance treatment received and stress suffered by the animal prior to slaughter (Soeparno, 2015).

Table 3. pH, water holding capacity, cooking loss, and tenderness of breast meat of KUB chicken fed rations containing SGLM

Parameter	Treatment			
	R0	R1	R2	R3
pH	5.46 ± 0.06	5.44 ± 0.01	5.46 ± 0.05	5.46 ± 0.02
Water holding capacity (%)	44.37 ± 0.71^{ab}	45.81 ± 1.11^{c}	43.43 ± 0.58^{a}	43.43 ± 0.58^{a}
Cooking loss (%)	41.13 ± 1.90^{ab}	38.07 ± 2.17^{a}	42.97 ± 2.62^{bc}	45.83 ± 1.46^{c}
Tenderness (kg/cm^2)	2.43 ± 0.05^{a}	2.50 ± 0.16^{a}	2.93 ± 0.17^{b}	2.37 ± 0.19^{a}

Remarks: Different superscripts in the same row indicate significant difference (P<0.05). R0 = 0% SGLM inclusion in ration, R1= 1% SGLM inclusion in ration, R2= 2% SGLM inclusion in ration, R3= 3% SGLM inclusion in ration

Water Holding Capacity

Water holding capacity (WHC) shows the ability of meat to hold water stated in percentage. It was found in this study that the inclusion of SGLM in ration of KUB chicken significantly affected (P<0.05) meat WHC. Mean meat WHC (44.73%) in this study was profoundly higher than that (28.93%) revealed by (A. Nasution et al., 2016) in their study on the use of coconut pulp as a substitute for commercial ration in local chicken.

Meat WHC is positively correlated with meat pH level and other factors including animal species, animal age, muscle function, feed, transportation prior to slaughter, animal health, ambient temperature, animal sex, treatment prior to slaughter, and intramuscular fat deposition (Soeparno, 2015). However, the high meat WHC found in this study seemed to contardict with this notion. The basal ration used in this study contained 10.33% fiber which was higher than the recommended fiber content in ration of 3-5% for broiler chickens and 7.0-8.0% for local chickens (Badan Standarisasi Nasional, 2013).

Cooking Loss

Cooking loss in meat indicates the losses through dripping and volatile loss causing meat to shrink during cooking. Cooking loss is affected by pH, length of muscle fiber sarcomeres, length of muscle fiber cuts, myofibril contraction status, meat sample size and weight, and meat transverse section (Soeparno, 2015). Meat cooking loss in this study was found to be significantly different ($P<0.05$). Meat cooking loss of chickens treated with the highest level of SGLM inclusion in ration was the highest (45.83%). This might be caused by the findings that pH level and WHC of meat in this treatment group were decreased. In addition, SGLM was high in fiber content and this could contribute to low ration digestibility which in turn increased meat cooking loss. Furthermore, high meat WHC leads to less dripping and volatile loss resulting in low cooking loss (Komariah *et al*., 2009,(Sriyani et al., 2015). However, the findings in this study did not support this notion as meat with high WHC was also found to have high cooking loss.

Tenderness

Meat tenderness shows perception on meat texture which involves three aspects including ease of teeth penetration, ease of meat chewing, and amount of residue after chewing process (Soeparno, 2015). Results in this study showed that treatments gave significant effects ($P<0.05$) on meat tenderness. Meat of KUB chickens fed ration containing 2% SGLM had the highest tenderness level (2.93). However, all meat was found to be very tender with tenderness levels below 3.3.

Meat of broiler chicken had a tenderness of about 5.78 kg/cm^2 (Prayitno et al., 2010). Broiler chickens fed rations containing banana hump meal and moringa leaf meal were found to have meat tenderness of 3.61-4.01 kg/cm^2 (Taran et al., 2015), (Hidayat et al., 2019), by using a penetrometer, found that meat of KUB chickens had a tenderness level of 3

CONCLUSIONS

The inclusion of SGLM by 1% in ration increased meat water content. Fat, ash, and protein contents of KUB chicken meat did not change with the inclusion of 2-3% SGLM in ration. The inclusion of SGLM by up to 3% in ration improved meat WHC and cooking loss but did not change meat pH level. Meat tenderness of KUB chickens increased by the inclusion of 2% SGLM in ration. The inclusion of SGLM in ration by 2% was recommended. A further study on the use of star gooseberry leaf extract rather than SGLM in chicken ration is suggested.

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