Jurnal Kedokteran Hewan
P-ISSN : 1978-225X; E-ISSN : 2502-5600

June 2022, 16(2):49-56
DOI: https://doi.org/10.21157/j.ked.hewan.v16i2.24228

CARCASS YIELDS AND ORGANS OF BROILERS FED THE DIET CONTAINING THE FERMENTED MORINGA LEAF MEAL + YELLOW CORN

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ABSTRACT

The purpose of this study was to evaluate the characteristics of carcass yields and internal and external organs of the broilers fed the diets containing the fermented moringa leaf meal (FMOL) + yellow corn (YC), the moringa-corn (MC) diet formulated to replace parts of the commercial diet (CD). As many as 100 DOC of broiler chicken strain CP 707 were reared for up to 5 weeks to feed experimental diets. A Block Randomized Design (BRD) with subsamples consisted of 4 treatments, 5 blocks, and 2 subsamples were applied in the recent study. The results of studies indicated that removing parts of the CD diet to substitute with the mixture of FMOL + YC caused a significant effect (P<0.05) in declining the weights of the whole carcass and the cut-ups but in percentage no significant differences. The weights and percentages of all examined organs were not significantly affected (P>0.05). It was concluded that using the moringa mixed with yellow corn reduced the weight of the whole carcass and cut-up carcasses but it could use up to 7.5% in the diet without detrimental effects on the internal and external organs of the broilers.

Key words: broiler, carcass, corn, fermentation, moringa, organs

ABSTRAK

Tujuan penelitan ini adalah mengevaluasi pengaruh penggunaan tepung daun kelor fermentasi (TKF) ditambah dengan jagung kuning (JK) sebagai pengganti sebagian ransum komersil (RK) terhadap berat dan persentase karkas serta organ dalam ayam broiler. Materi yang digunakan terdiri atas 100 ekor DOC ayam broiler strain CP 707. Rancangan yang digunakan adalah Rancangan Acak Kelompok (RAK) subsampel terdiri atas empat perlakuan, lima kelompok, dan dua subsampel. Hasil penelitian menunjukkan bahwa penggunaan TKF + JK sebagai substitusi sebagian ransum komersil nyata (P<0,05) menurunkan berat karkas dan potongan karkas, namun secara persentase tidak nyata. Berat dan persentase organ dalam tidak nyata (P>0,05) berpengaruh. Disimpulkan bahwa tepung daun kelor fermentasi ditambah jagung kuning menurunkan berat karkas dan potongannya, akan tetapi dapat digunakan masing-masing sampai 7,5% tanpa berpengaruh negatif terhadap kinerja organ-organ dalam ayam broiler.

Kata kunci: broiler, karkas, kelor, jagung, fermentasi, organ dalam

INTRODUCTION

The problem of the broiler industry was not simply reflected in how to produce broiler with lower cost but also to serve the carcass with more desirable quality. The characteristics of the carcass may involve size, appearance, conformation, healthy, tenderness, coloration, and nutritional value. Meanwhile, the buyers' demand for the meat yielded from the free residues of chemical additives. The people with upper-middle classes conceivably prefer to spend more money to get the better carcasses. Nowadays, the most expected carcass might be resulted from the broiler fed the natural feed ingredients made up of leave powder such as moringa (*Moringa oleifera* Lam).

Moringa is also known as the drumstick leaf, the miracle tree, and the tree of life because of its excellent medicinal properties to cure a wide range of illnesses (Ciju 2019). Moringa contains high protein approximately 25.37% (Alnidawi *et al*. 2016) or 27.1% (Gopalakrishnan *et al*. 2016). Pullakhandam and Failla (2007) reported the relatively high bioaccessibility of *β-carotene* and *lutein* from drumstick leaves ingested with oil supports the potential use of this plant food for improving vitamin A nutrition and perhaps delaying the onset of some degenerative diseases such as cataracts. Meanwhile, extracts from the leaves can be used as a potential antioxidant, anticancer, anti-inflammatory, antidiabetic, and antimicrobial agent (Gopalakrishnan *et al*. 2016).

The additional values of moringa leaves are presumed in their ability to increase the immune system of the body and improve meat quality (Rahmat and Herdi 2016). According to Tshabalala *et al*. (2019), although there are numerous benefits of using *Moringa oleifera* for medicinal purposes, there are reports of contraindications, there are no major harmful effects of this plant that have been reported by the scientific community. Moringa can be used as a potentially high-quality feed alternative for the animal industry (Wang *et al*. 2018). The moringa leaves meal could replace up to 24% of groundnut cake meal in the diet of indigenous Senegal chickens without detrimental effects on mortality, carcass, and organs characteristics of these birds (Ayssiwede *et al*. 2011).

The problem of moringa leaves was low organoleptic properties and digestibility (Wang *et al*. 2018). As common plant leaves, the content of crude fiber within moringa leaves is so high with approximately 19.2 g/100 g (Gopalakrishnan *et al*. 2016) or 17.41% (Alnidawi *et al*. 2016). Another difficulty of these leaves is the presence of any antinutritional factors such as saponin, phytate acid, and phenol (Astuti *et al*. 2005). Phenolic acids, tannin,

Revised 13-04-2022, Accepted 21-05-2022

minerals, and vitamins in the moringa are in high amounts when compared to most vegetables and fruits (Tshabalala *et al*. 2019).

The feed ingredients can be more digestible as they are going to fermentation (Fardiaz 1992) resulting from lowering crude fiber (Pasaribu 2007). In addition, any possible antinutritional compounds highly excluded from the feed undergoing a fermentation procedure then enhance bird health. This circumstance has brought to intense that the moringa leaves should be fermented before feeding to the birds.

The moringa ultimately does not serve entirely the nutritional value of which the metabolizable energy (ME) was denoted so poorly. When the commercial diet was partially replaced with the only moringa then the dietary ME become a drawback causing an imbalanced diet. However, it would be better to include one or more feed ingredients rich in ME such as yellow corn to accompany the moringa in the diet. For this reason, the fermented moringa leaves were combined with yellow corn to replace slightly the commercial diet. The results on the performances and income over feed cost have been discussed in Zulfan *et al*. (2021), therefore, the recent paper aimed to evaluate the carcass yields and organs of broilers fed the commercial diet few substituted with the fermented moringa leaves + yellow corn.

MATERIALS AND METHODS

As many as 100 broiler chicks unsex with the strain of CP 707 were used in this research. Broiler commercial diet CP 511 was used as a control diet. The feed ingredients such as fermented moringa leaf meal FMOL and yellow corn (YC) were employed as partial substitution of the commercial diets. Vaccines of New Castle Disease and Infectious Bursal Disease were furnished to prevent the potential infection of ND and IBD, while effective microorganism 4 (EM4) and molasses were required to ferment the moringa. The 20 cages 1 x 1 m with incandescent light bulbs, feeders, and waterers each were constructed to perform experimental units.

Diets

The experimental diets were performed based on the inclusion of the FMOL + YC with the equal amount of 0, 2.5, and 7.5% each to replace fractionally a commercial diet of CP 511 Bravo. The nutritional contents of the diets refer to the recommendation of NRC (1994). The calculated composition and nutrition values of the experimental diets were presented in Table 1. Treatments were as follows: MC_0 = CP511, 100% (control); MC_1= CP511, 95% + FMOL 2.5% + YC 2.5%; MC_2= MC_3= CP511, 90% + FMOL 5% + YC 5 %; MC_4= CP511 85% + FMOL 7.5% + YC 7.5%

Experimental Design

This research used Block Randomized Design (BRD) with subsamples consisting of 4 treatments, 5 blocks, and 2 subsamples. Each block was an experimental unit consisting of 5 birds. Block was set up according to various body weights of birds collected on the last day of the second week. The linear model was $Y_{ijk} = \mu + \tau_i + \beta_j + \varepsilon_{ij} + \delta_{ijk}$ where Y_{ijk}= observation value, μ= an overall mean, τ_i= an effect due to diet, β_j= an effect due to body weight (BW), ε_{ij}= a sampling error, and δ_{ijk}= a subsampling error (Steel and Torrie 1991).

Fermentation Procedures

The leaves of moringa, the wild plants growing naturally in the unexploited areas in some villages in Banda Aceh and Aceh Besar, were collected and then removed the attached stems to result in the only leaves. Subsequently, the leaves were scattered on a surface area exposed to sunrise. When the leaves were so quite dry, they were powdered using a disk mill to proceed the fine leaves.

The leaves meal further was delivered to the fermentation procedures initially done by mixing 9 mL

Table 1. The composition and nutrition values of experimental diets (%)

Composition	2–5 weeks			
	MC_0	MC_1	MC_2	MC_3
Feed ingredients	--- % ---			
Commercial diet CP 511 Bravo[1]	100	95.75	91.50	87.50
Fermented Moringa Leaf Meal, FMOL[2]	0	2.50	5.00	7.50
Yellow corn (YC)[3]	0	1.75	3.50	5.00
Total	100	100	100	100
Calculated nutrition values				
Crude protein, CP (%)	21.00–23.00	21.00–22.92	21.01–22.84	21.04–22.79
Metabolizable energy, ME (kcal/kg)	2.900–3.000	2.868–2.964	2.836–2.927	2.802–2.890
Crude fiber, CF (%) (max)	5.00	5.05	5.10	5.16
Ether extract, EE (%) (max)	5.00	5.04	5.09	5.14
Methionine (%)	0.550	0.539	0.528	0.518
Lysine (%)	0.900	0.901	0.902	0.904

[1]Nutrition values refer to the marked label of commercial diet CP511B Bravo produced by PT Charoen Pokphand: CP min. 21.0-23.0%, CF 5.0%, EE 5.0%, Ca min. 0.9%, and P min. 0.6%, and ME 2.900-3.000 kcal/kg (Estimation for methionine and lysine 0.55% and 0.90%, respectively)
[2]Nutrition values refer to The Laboratory of Nutrition and Animal Feed, Brawijaya University, Malang 2007: CP 29.61%, CF 8.98%, fat 7.48%, and ME 1.380 kcal/kg (70% of the GE based on Patrick and Schaible 1990); methionine 0.35% and lysine 1.325% based on Aminah *et al*. (2015)
[3]Nutrition values refer to Hartadi *et al.* (2005)

EM4 with 9 mL molasses within a bucket filled with 3 liters of fresh water. All these liquids were blended thoroughly then transferred into a sprayer. They were squirt into 6 kg of moringa leaf meal while mingled homogenized then loaded densely into the plastic bags. The bags were wrapped tightly to achieve as possible as an anaerobe condition. Subsequently, they were stored in covered containers at room temperature for 7 days. On the 8^{th} day, the bags were untied to release the feed and kept allowing under room temperature.

Rearing the Broilers

All chicks were grown in a brooding area during the first two weeks and fed on a full commercial diet *ad libitum*. On the last day of the second week, all birds were weighed and then divided into 5 blocks of the BW ranked from the highest to the lowest. The 20 birds within the same block were selected randomly to occupy every treatment so that each treatment consisted of 5 birds for each block. With the number of 5 blocks placed 5 birds each, therefore, each treatment had 25 birds. The chicks were transferred into the cages which were an experimental unit each. During this time, the birds were fed experimental diets ad libitum until the last day of the 5^{th} week.

The ND vaccine was applied through eye drop on the 3^{rd} day and repeated through intramuscular injection on the 21^{st} day. The IBD vaccine was offered through mouth drop on the 10^{th} day. Drinking water was delivered *ad libitum* for which vita stress was added until the last day of the 4^{th} week.

As many as 2 birds from each experimental unit with the criteria of LW relatively close to the average LW of their unit were selected on the last day of growing broilers. The birds were slaughtered in the bleeding cone allowing the blood to flow down to the chamber. Afterward, the killed birds were removed to the scalder, and then immediately transferred into a de-feathering machine. No blood and feather were collected individually. The weights of the blood and feather were determined by the losing weights between pre and post-removal of these fragments, subsequently incorporated into the internal and external organs, respectively. The next process was evisceration resulting in the rest of the internal organs and cutting off the neck-head and shanks for which both included the rest of the external organs. The abdominal fat attaching to the abdomen and gizzard was pulled out of the body cavity. Once all procedures were finished, the resulted yield was a whole carcass and then weighed to carcass weight. The whole carcass was cut off based on the commercial parts and then weighed each.

The carcass sensory was only assessed by the team's researches. No objective scores on the preferences of the yields could be given by the caregivers since they were not invited to the laboratory due to an intense period of a pandemic of Covid 19.

Parameters

The examined parameters consisted of the average final body weight (FBW), the weight and percentage of the whole carcasses, cut-up carcasses, internal and external organs, carcass appearance, abdominal fat, and mortality. All birds in the experimental units were weighed to record FBW at the age of 5 weeks. Two broilers from their experimental unit were selected based on the average BW as near as the average BW of their experimental unit and noted as live weight (LW). The mortality was investigated based on the number of birds dead during the growing 5 weeks.

The percentage of the whole carcass was calculated by dividing carcass weight by the LW, while the percentages of the cut-up carcasses were computed by dividing the weight of each part by the carcass weight. The percentages of internal and external organs were defined by dividing the weight of each organ by the LW. The carcass appearance was evaluated based on the assessment of the researcher's team.

Data Analysis

Analyzing the data used analysis of variance (ANOVA). If there were significant differences in the results, the data were continued to analyze by Duncan's Multiple Range Test (Steel and Torrie 1991). The performances of the yields were examined visually by the researchers' team.

RESULTS AND DISCUSSIONS

The Whole Carcasses

The weights and percentages of the whole carcasses of broilers were presented in Table 2. Results of ANOVA indicated that including the fermented moringa leave meal + yellow corn (MC) in partial substitution of the commercial diet significantly ($P<0.05$) affected the weight of the whole carcass of the broiler. Broilers fed the diets containing the moringa (MC_1–MC_3) performed the carcass weights significantly lower than those fed the control diet (MC_0). This did not agree with Manihuruk *et al*. (2018) report the addition of fermented moringa leaves powder did not significantly ($P>0.05$) affect the carcass weight of broiler cut at 21 days old but it seemed tent to decline at 10% the inclusion of moringa in the diet. The differences in plant source or slaughtered age might generate different results.

Reduced carcass weights were the impact of reduced BW. The declined FBW on the broilers fed the diets containing the moringa was highly presumed because of the declined feed intake and possibly loss of any important nutrients particularly methionine. Lowering feed intake caused to lowering nutrient dietary as well resulting in optimally meat formation. At the level of dietary methionine 0.539, 0.528, and 0.518% in MC_1, MC_2, and MC_3, respectively with total feed intake 2782.9, 2767.4, and 2753.8 g/bird (Zulfan *et al*. 2021) resulted in methionine intake 0.43, 0.42, and 0.41 g/bird/day. According to NRC (1994), the methionine requirement for broiler is at least 0.55%. Ahmed and Abbas (2011) reported that body weight gain was significantly ($P<0.01$) affected by methionine levels.

It was not considered the moringa contains a low nutritive value. The results of ANOVA did not indicate any significant differences (P>0.05) on the carcass percentages of the broilers fed the diets containing the moringa and those of they fed the control diet even though the former tended to decline. All birds had similarities in the carcass percentages with the range of 71.26-72.15% meaning the nutrients contained within the moringa combined with yellow corn were still somewhat able to form yields. The drumstick leaves contain protein up to 26% and amounts of all the essential amino acids were higher than the amino acid pattern of the FAO reference protein and comparable to those in soybeans (Makkar and Becker 1997). However, this result was not in accordance with Kurniawan *et al.* (2017) reported the provision of 5% of moringa leaves water extract in drinking water could increase significantly (P<0.05) the live weight and the weights and percentages of broiler carcasses. The differences in how it was offered to the birds might lead to contradictive results.

The content of crude fiber (CF) in the moringa in the recent study was assumed to reduce after fermentation. Wang *et al.* (2018) reported that the feed quality and digestibility of *Moringa oleifera* leaves were greatly improved via solid-state fermentation by *Aspergillus niger*. It was also supported by Fardiaz (1992) that fermentation can improve the digestibility of the feed.

Cut-up Carcasses

The weights and percentages of the cut-up carcasses of the broilers were presented in Table 3. Results of ANOVA indicated that including the MC in partial substitution of the commercial diet reduced the weights of all parts of the carcasses with a significant difference (P<0.05) was found on the breast weight. The decline in these parts was due to the decline in the whole carcass since they are related to each other.

Significantly decreased breast weight signaled the potential loss of any nutrients believed essential amino acid (EAA) which was methionine in the diet containing the moringa + yellow corn. Makkar and Becker (1997) reported although moringa leaves served as good sources of EAA, some of them were deficient. As reported by Mune *et al*. (2016), moringa leaves contained high leucine and valine but low methionine and cysteine. Most legume meals which are widely used in the diets of most farm animals such as chickens were good sources of lysine and tryptophan but have limited sulfur-containing amino acids such as methionine and cysteine (Cho and Kim 2010). Similarly reported by Hong (2018), methionine is limited in plant protein sources. Aminah *et al.* (2015) reported the lowest EAA within the dried moringa was recorded as methionine (350 mg/100 g), while the highest was leucine (1.950 mg/100 g). Therefore, the limiting amino acids in moringa are sulfur amino acids of which methionine were suspected in the recent study.

Methionine plays many important metabolic fuctions in animals that affects poultry production parameters such as body weight gains, feed conversion ratio, and carcass quality (Jankovsky *et al*. 2014). It has many physiological functions for instance as an important methyl donor to provide the methyl group (CH_4) necessary for metabolism in the body. The absence of animal protein such as a fish meal in the substitute diets feasibly donated to lack of methionine. Sitompul (2004) reported that the methionine content in the fish meal was in the range of 0.99-2.71% indicated as a good source of this EAA potentially included in the poultry diet. Inopportunely, the yellow corn as the partial mixture for the moringa also contributed to less methionine (0.21% refers to Hartadi *et al*. 2005) potentially causing the decrease of this dietary EAA thus developing lower breast weight.

Nonetheless, the substitute diets were not quite extremely poor nutrients. The percentages of all parts of the birds fed the MC diets presented the results closely to the control. It was assumed to add such as L-

Table 2. Weights and percentages of carcasses and non-carcasses of broiler chickens

Live weight, carcass, and non-carcass	Experimental diets composed of moringa + yellow corn (MC)			
	MC_0	MC_1	MC_2	MC_3
Live weight (LW) (g)	2,084±139.45^a	1,953±81.94^b	1,953±97.54^b	1,937±114.85^b
Carcass				
Whole carcasses (g)	1,504±105.70^a	1,409±60.95^b	1,399±75.79^b	1,381±106.51^b
(%)	72.15±0.98	72.15±0.89	71.61±4.89	71.26±1.73
Non-carcasses (g)	580±41.05	544±29.25	555±48.67	555±26.70
(%)	27.85±0.98	27.85±0.89	28.39±1.89	28.74±1.73

^{a,b}Means in the same row with different superscripts differ significantly (P<0.05)

Table 3. Weights and percentages of cut-up carcasses of broiler chickens

Cut-up carcasses		Experimental diets composed of moringa + yellow corn (MC)			
		MC_0	MC_1	MC_2	MC_3
Breast	(g)	595.60±57.64^a	558.20±23.58^b	551.30±44.31^b	534.30±55.82^b
	(%)	39.56±1.72	39.63±1.02	39.39±1.77	38.65±2.16
Thighs	(g)	442.10±41.11	409.90±34.35	420.00±18.98	414.90±37.26
	(%)	29.40±1.68	29.08±1.85	30,10±1.95	30.08±2.03
Wings	(g)	153.10±10.54	143.60±8.86	145.10±593	145.40±9.83
	(%)	10.21±0.78	10.19±0.49	10.39±0.45	10.54±0.49
Back	(g)	313.00±31.70	297.20±24.75	282.20±35.17	286.60±30.51
	(%)	20.84±1.84	21.09±1.48	20.12±1.55	20.73±1.14

^{a,b}Means in the same row with different superscripts differ significantly (P<0.05) methionine, DL-methionine, or MHA-FA (the hydroxyl analogue of methionine) into the diets containing the moringa leaves to support muscle proportion mostly formed on the breast when the fish meal would not be considered to formulate into the diet.

Carcass Appearances

The appearances of the broiler carcasses such as formation, skin coloration, and flavor in the recent study were identified visually by the researchers' team. Ideally, these parameters should be evaluated by the way exploring the scores given by the participants to sensory test based on hedonic scale resulting in the numerical values which would be able to analyze by ANOVA. The restricted contact among the people during a peak pandemic of the Covid 19 has failed to collect these data. For this reason, the carcasses were simply assessed by the researchers' team kept following the procedure of the protocol of Covid 19 generating a particular judgment. The appearances of the carcass samplings from each treatment were presented in Figure 1.

The results of the examined carcasses exposed the broilers fed the MC diets (MC_1-MC_3) produced normal yields with the formation was so moderately compact without bad odor similarly found on those from the control diet (MC_0). In spite of this, the carcasses from the former emitted strongly yellow coloration compared to those from the absence of the MC (MC_0). The higher the inclusion of the MC the more yellow color on the carcasses (Figure 1). It indicated that including FMOL + YC in the diet increased the pigmentation of carotenoids on the yields mostly deposited on the bird skins. The higher deposits were also clearly found in the parts of non-carcasses such as shanks, heads, and abdominal fat. This result agreed to Ayssiwede *et al.* (2011), moringa leaves meal inclusion in the diets had produced significantly and proportionally yellow coloration of the skin and abdominal fat of carcasses in traditional chickens.

The pigmentation on carcass skin predominantly resulted from the deposit of carotenoid compounds highly localized in the moringa leaves. Saini *et al.* (2013) studied carotenoids from fresh leaves, flowers, and fruits of eight commercially grown cultivars of *Moringa oleifera* quantified by liquid chromatography-mass spectrometry. The result of their study reported that all *E*-lutein was located as the major carotenoid in leaves and fruits of moringa and accounted for 53.6 and 52.0% of the total carotenoids, respectively. Although relatively high concentrations of *β-carotene* and *lutein* have been reported in the drumstick leaves, the bioavailability of these carotenoids from this source is unknown. Pullakhandam and Failla (2017) have analyzed the digestive stability and bioaccessibility of carotenoids in fresh and lyophilized drumstick leaves using the coupled in vitro digestion/Caco-2 cell model and found that *β-carotene* and *lutein* were stable during simulated gastric and small intestinal digestion.

The carotenoids on the carcasses in the recent study could be derived from yellow corn. Yellow maize is a good source of pro-vitamin A carotenoids and xanthophyll. The major carotenoids in yellow maize were identified as all-*trans lutein*, *cis-* isomers of *lutein*, all-*trans-zeaxanthin*, α- and *β-cryptoxanthin*, all-*trans β-carotene*, 9-*cis* β-carotene, and 13-*cis β-carotene* (Muzhingi *et al.* 2008) and the highest abundance of enrichment as [(2)H(9)]*β-carotene* (Muzhingi *et al.* 2011). Rios *et al.* (2014) reported that the carotenoids present in corn grain were classified into carotenes (*ß-caroteno e a-caroteno*) and xanthophyll (*lutein, zeaxanthin,* and *ß-cryptoxanthin*) with higher concentrations of *lutein* and *zeaxanthin* compared to other carotenoids. Rich carotenoids both within FMOL and YC caused high concentrated yellow pigmentation on the yields of the broilers.

The Weights and Percentages of External Organs

The external organs of the broiler were not so valuable in comparison to carcass parts. The weights and percentages of the external organs of the broilers were presented in Table 4. The significant declines (P<0.05) in the weights of external organs were found on both head + neck and feet. The weights of the head + neck and feet reduced comparably with the decline of their LW. Hence, the percentages of these parts presented in similar ranges among the treatments result in insignificant differences (P>0.05).

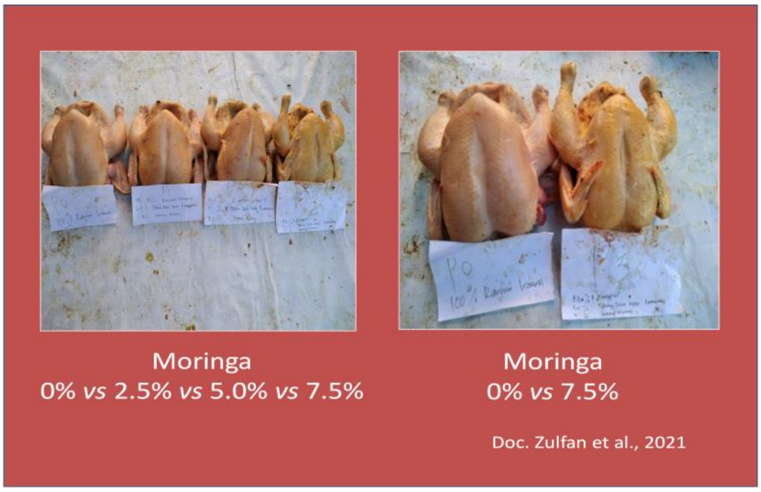

Figure 1. Carcass color

The weight of feathers of broiler fed the MC diets also tended to decline even though statistically not significant differences. The formation of the feathers seems to lack relation to the LW rather than head + neck and feet. The declined weight on the feathers appeared not proportionally to the declined LW. The function of methionine was primarily in body protein rather than in the feathers. However, the methionine also supports feather development but the most important component of keratin is cysteine (7.5%) *vs* 0.7% methionine. Many earlier studies have been reported the methionine level in the diet did not affect feather weight but significantly increased when the level of cysteine increased (Emous and Krimpen 2019). Therefore, the most possible insufficient EAA in the broiler fed the MC diets was methionine which was suggested to add L or DL-methionine or to include fish meal to the diet containing the moringa to anticipate the possibility of severely reduced methionine intake due to lowering feed intake.

The Weights and Percentages of Abdominal Fat

The weight and percentage of abdominal fat were presented in Table 5. Using MC to substitute fractionally of the commercial diet significantly ($P<0.05$) increased the deposits of abdominal fat on the broilers. In this study, it could not be passionate to the body weight due to an opposite result. The increased abdominal fat might be as the impact of less efficiency of the birds to utilize the feeds. According to Goulart *et al.* (2011), the deficiency in methionine in the moringa diets reduced weight gain and feed efficiency, and stimulate feed intake when this deficiency was not hard, contributing to additional energy causing an increase in body fat deposition. It hards to explain but both weight gain and feed efficiency might be related to the consumed methionine responsible for a fat pad. Reduced feed intake of the birds fed the MC diets caused to reduce methionine intake. A study reported by Kiraz and Sengül (2005), showed that the broilers in methionine-deficient feeding increased abdominal fattening. This result was not in agreement with Tonga *et al.* (2016) reported that feeding broilers with 12% of moringa significantly reduced subcutan fat.

Relatively to LW, the percentages of abdominal fats of broilers fed the MC diets significantly ($P<0.05$) higher detected in MC_1 compared to MC_0. However, with the amount of 0.82-1.04% in abdominal fats found on the broiler fed the MC diets, these were not supposed excessive deposits. According to Wahju (2004), the abdominal fat tissue in the broiler chicken constituted approximately 4% of live weight.

The Weights and Percentages of Internal Organs

The weights and percentages of the internal organs of the broilers were presented in Table 6. Results of

Table 4. Weights and percentages of the external organs of the broilers

External organs		Experimental diets composed of moringa + yellow corn (MC)			
		MC_0	MC_1	MC_2	MC_3
Head + neck	(g)	82.50±4.35^a	73.30±6.38^b	72.50±5.21^b	76.00±7.94^b
	(%)	4.14±0.39	3.89±0.34	3.87±0.30	4.08±0.51
Feet	(g)	82.50±10.39^a	72.90±8.32^b	76.60±12.10^b	77.40±9.07^b
	(%)	3.92±0.42	3.87±0.41	4.06±0.48	4.15±0.51
Feathers	(g)	111.20±25.92	99.10±10.35	96.30±18.18	100.30±13.06
	(%)	5.10±1.44	5.38±0.54	5.87±2.88	5.29±0.81

^{a,b}Means in the same row with different superscripts differ significantly ($P<0.05$)

Table 5. Weight and percentage of abdominal fat of the broiler

Fat		Experimental diets composed of moringa + yellow corn (MC)			
		MC_0	MC_1	MC_2	MC_3
Abdominal fat	(g)	12.79 ± 4.45^a	20.20 ± 5.16^b	15.90 ± 5.02^{ab}	16.70 ± 10.44^{ab}
	(%)	0.60 ± 0.19^a	1.04 ± 0.28^b	0.82 ± 0.27^{ab}	0.85 ± 0.51^{ab}

^{a,b}Means in the same row with different superscripts differ significantly ($P<0.05$)

Table 6. Weights and percentages of the internal organs of the broilers

Internal organs		Experimental diets composed of moringa + yellow corn (MC)			
		MC_0	MC_1	MC_2	MC_3
Liver	(g)	37.80±4.54	41.50±7.81	37.50±5.76	36.30±6.48
	(%)	1.82±0.22	2.12±0.36	1.92±0.30	1.87±0.31
Gizzard	(g)	37.00±6.39	34.70±2.79	31.60±8.98	31.20±3.22
	(%)	1.77±0.28	1.78±0.15	1.63±0.45	1.61±0.17
Heart	(g)	8.20±2.15	6.90±1.37	7.40±1.78	7.50±1.35
	(%)	0.39±0.09	0.35±0.07	0.38±0.08	0.39±0.07
Spleen	(g)	3.10±1.10	3.30±1.06	3.80±1.40	3.20±1.48
	(%)	0.15±0.06	0.16±0.05	0.18±0.07	0.15±0.07
Pancreas	(g)	3.90±1.10	3.20±0.42	4.00±1.63	3.60±0.70
	(%)	0.19±0.06	0.16±0.03	0.20±0.08	0.19±0.04
Intestine	(g)	68.50±8.28	60.60±21.09	65.70±6.58	62.70±8.30
	(%)	3.30±0.45	2.96±1.06	3.17±0.38	3.02±0.42
Blood	(g)	80.10±9.92	68.90±12.50	74.50±32.09	64.80±33.84
	(%)	4.00±0.42	3.65±0.61	3.99±1.74	3.51±1.78

ANOVA indicated that using the MC in partial substitution of the commercial diet did not significantly (P>0.05) affect the weights and percentages of all internal organs. Except for the spleens, the tendency in typically declined internal-organ weights of the broilers fed the MC diet resulted from the reduced BW.

Equating to the birds' live weights, all internal organs of broilers fed the MC diet presented closely to those fed the control diet being in the normal range. It indicated the moringa leaves satisfied to include up to 7.5% in the diet without a negative impression on the internal organs. Agree to Tshabalala (2019), there were no major harmful effects of *M. oleifera* that have been reported by the scientific community. Similarly reported by Ayssiwede *et al.* (2011), the moringa leaf meal inclusion in the diets did not significantly improve whole organ weights but no any adverse effects on health and indigenous organs including liver, heart, lungs, and spleen of the chickens.

Supplementation of moringa may support the immunity, health, and performance of poultry. Though, incorporating a high number of moringa in the diet may cause a detrimental impact on the organs. Ayssiwede *et al.* (2011) reported that the spleen's weight significantly increased in diets containing *Moringa oleifera* (MO) followed by those in MO_{16} (6.11), MO_{24} (7.24), and MO_0 in birds fed MO_8 and MO_{16} diets. Alnidawi *et al.* (2016) found spleen showed improvement and hyperactivity in 15% and 20% *Moringa oleifera* (MOL) in the broiler. In the recent study, the weights and percentages of the spleens of broilers fed the diets containing up to 7.5% moringa seemed quietly higher but not significantly different. Alnidawi *et al*. (2016) recommended adding *Moringa oleifera* at 15% and 20% in broiler diets to improve performance and health but a result of the recent study might not defend to explore high amounts of moringa in the broiler diet.

CONCLUSION

It was concluded that using the moringa mixed with yellow corn reduced the weight of the whole carcass and cut-up carcasses but it could use up to 7.5% in the diet without detrimental effects on the internal and external organs of the broilers.

ACKNOWLEDGMENTS

This study was funded by the Extension and Research Center, Syiah Kuala University, Darussalam, Banda Aceh.

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