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The effect of medicinal herb on fat deposition, meat composition, amino acid and fatty acid composition of broiler meats

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ABSTRAK

Penelitian ini bertujuan untuk mengevaluasi pengaruh pemberian tumbuhan obat terhadap deposisi lemak, komposisi kimia, asam amino dan asam lemak daging broiler betina. Seratus enam puluh delapan broiler betina umur 15 hari didistribusikan ke dalam 7 kelompok sebagai berikut: 1) broiler diberi pakan tanpa tumbuhan obat sebagai kontrol (P0) 2) broiler diberi pakan yang mengandung katuk 5% (P1); 3) broiler diberi pakan yang mengandung daun salam 5% (P2); 4) broiler diberi pakan yang mengandung 5% daun kemangi (P3) 5) broiler diberi pakan yang mengandung 5% daun pepaya (P4); 6) broiler diberi pakan yang mengandung daun kelor 5% (P5) dan; 7) broiler diberi pakan yang mengandung buah mengkudu 5%. Hasil penelitian menunjukkan bahwa pemberian tumbuhan obat meningkatkan protein (P<0,01), besi (P<0,05), kalium, kalsium, fosfor, *linolenic acid* (P<0,01), *methionine* dan asam lemak tak jenuh omega 3 (P<0,05), tetapi menurunkan kadar lemak, *oleic acid, lignoneric acid* (P<0,01) dan omega-9 (P<0,05). Dapat disimpulkan bahwa daun katuk merupakan tumbuhan obat yang paling efektif untuk menghasilkan daging broiler yang rendah lemak tetapi tinggi protein, *linolenic acid* dan mineral.

K*ata Kunci: tumbuhan obat, deposisi lemak, komposisi daging, asam amino, asam lemak, broiler*

ABSTRACT

The present study was conducted to evaluate the effect of medicinal herb inclusion on fat deposition, chemical composition, amino acid and fatty acid of broiler meats. One hundred-sixty eight female broiler chickens aged 15 days were distributed into 7 groups as follows: 1) broilers were fed a diet with no medicinal herb as the control (P0) 2) broilers were fed a diet with 5% *Sauropus androgynus* leaf powder (P1); 3) broilers were fed a diet with 5% bay leaf powder (P2); 4) broilers were fed a diet with 5% basil leaf powder (P3) 5) broilers were fed a diet with 5% papaya leaf powder (P4); 6) broilers were fed a diet with 5% *Moringa* leaf powder (P5) and; 7) broilers were fed a diet with 5% noni fruit powder. Experimental results showed that the inclusion of medicinal herbs significantly increased protein (P<0.01), iron (P<0.05), kalium, calcium, phosphorus, linolenic acid (P<0.01), methionine, omega 3 unsaturated fatty acid (P<0.05), but significantly reduced fat (P<0.01), glutamic acid, alanine, lignoceric acid, oleci acid (P<0.01) and omega 9 unsaturated fatty acid (P<0.05). It was concluded that *Sauropus androgynus* leaf was the most effective to produce low fat-high protein and mineral meats.

Keywords :medicinal herbs, fat deposition, meat composition, amino acid, fatty acid, broilers

INTRODUCTION

Although commercial feed additive containing antibiotics can increase productivity, antibiotic residues in meats might have negative effects on human health when meats were consummed (Barton and Hart, 2001; Imik *et al*., 2006; Khaksefidi and Rahimi, 2005). In addition,

commercial feed additives do not contain compounds in order to produce enriched meats (meats with low-fat but rich in protein and mineral). Thus, it needs alternative feed additives, which are safer, drug-free residue and to meet consumer demand.

To overcome these problems, some antioxidant medicinal herbs have been suggested as replacements for antibiotics (Liu *et al.*, 2006; Santoso, 2001; Santoso *et al.*, 2000). These medicinal herbs have low side effect and maintain product quality and livestock performance (Simitzis *et al.*, 2008). Antioxidant compounds found in medicinal herbs include α-tocopherol (vitamin E), β-carotene, ascorbic acid, flavonoids, carotenoids, anthocyanins, phenols, zinc and selenium (Moyo *et al.*, 2012; Atowadi *et al.*, 2010). Basil leaves, *Sauropus androgynus* leaves, bay leaves, noni fruit, papaya leaves, and *Moringa* leaves have potential as alternative feed additives.

Santoso *et al.* (2005) showed that the supplementation of aqueous extract of *Sauropus androgynus* leaves reduced egg cholesterol contents at 40%. In another study (Santoso *et al.*, 2001), the aqueous extract reduced abdominal fat deposition at 20% and decreased carcass fat content at 10%. Santoso and Sartini (2001) reported that the inclusion of *Sauropus androgynus* leaves powder at 3% reduced abdominal fat as much as 30%.

Santoso and Fenita (2015) reported that papaya leaves powder increased protein levels in eggs. Fenita *et al.* (2011) showed that 75 mL noni juice/1 liter of drinking water reduced fat content by 30% and increased protein content by 20%. Hamiyanti *et al.* (2013) reported that adding 0.75% basil leaves powder to the diet increased protein levels, but lowered fat and cholesterol levels of broiler meat. Restiayanti *et al.* (2014) reported that the administration of *Moringa* leaf extract at 50 g/liter drinking water decreased abdominal fat deposition and blood cholesterol in broiler chcikens. The inclusion of bay leaves powder reduced cholesterol levels of broiler carcasses (Suharti *et al.*, 2008). Few studies have reported pertaining effect of medicinal herbs on amino acid and fatty acid compositions of broiler meats.

The present study was conducted to compare the effectiveness of selected medicinal herbs in modifying fat deposition, the contents of protein, fat, moisture, cholesterol, iron, kalium, calsium, phosphorus, amino acid, and fatty acid of broiler meats.

MATERIALS AND METHODS

Medicinal Herb Powder

Basil leaves, *Sauropus androgynus* leaves, bay leaves, noni fruit, papaya leaves, and *Moringa* leaves obtained from the field were air-dried for 5 days, milled (1 mm size) and stored in plastic bags before formulating into experimental diets.

Animal and Exprimental Diets

Three hundred broiler chickens aged one day were placed in the brooder. Broilers were given drinking water containing sugar to eliminate the stress. Brooder temperature was set in accordance with the standards of maintenance procedures. At the age of 4 and 21 days, broiler chickens were vaccinated Newcastle Disease. They were diet commercial diets from 1-13 days of age.

One hundred sixty-eight female broiler chickens aged 15 days were distributed into 7 groups. Each treatment group consisted of 4 replicates, and each replicate consisted of 6 female broiler chickens. The 7 treatments were as follows: 1) female broilers were fed a diet with no medicinal herb as the control (P0) 2) female broilers were fed a diet with 5% *Sauropus androgynus* leaf powder (P1); 3) female broilers were fed a diet with 5% bay leaf powder (P2); 4) female broilers were fed a diet with 5% basil leaf powder (P3) 5) female broilers were fed a diet with 5% papaya leaf powder (P4); 6) female broilers were fed a diet with 5% *Moringa* leaf powder (P5) and; 7) female broilers were fed a diet with 5% noni fruit powder. Experimental diets contained 19% crude protein and 3.200 kcal ME/kg. The feedstuffs composition used in the present study was published elsewhere (Santoso *et al.*, 2017b).

Sampling and Laboratory Analysis

At the end of the study (aged 35 days), four female broiler chickens from each treatment group were selected and slaughtered. Fat from abdomen, gizzard, sartorial, neck and heart were removed and weighted. Fatty liver score was determined by comparing the liver color with color standard from 1-5 values. Greater values showed greater fat deposition in the liver.

The leg meats were then collected, grounded and stored at -30^{o}C before analysis. Fat, protein, moisture, iron, kalium, calcium and phosphorus

were determined by the method of AOAC (2012), whereas cholesterol was determined by the method as described by Dinh *et al*. (2008, 2011). Amino acid composition was measured by the method as described by Henderson and Brooks (2010), and fatty acid composition was determined by the method as described by Almeida *et al.* (2006).

Statistical Analysis

The experimental results were subjected to a one-way analysis of variance. Significant differences among the treatment groups were determined by Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Fat Deposition

Table 1 shows the effect of medicinal herb on fat deposition and fatty liver score in female broiler chickens. Experimental results showed that the inclusion of medicinal herbs had no effect on abdominal fat, sartorial fat, neck fat, gizzard fat, heart fat and fatty liver score.

The results showed that selected medicinal herbs could not reduce fat deposition in female broiler chickens. Santoso *et al.* (2017b) reported that *Sauropus androgynus* leaves, papaya leaves, bay leaves, basil leaves, *Moringa* leaves and noni fruit contained flavonoids, tannins and phenols. It has been established that these compounds had antilipid properties (Aiura and de Carvalho, 2007; Zang *et al*., 2006; Zarrouki *et al*., 2010). Thus, the contents of these compounds in those medicinal herbs were inadequate to reduce fat depostion.

This study disagrees with the observation of Santoso and Sartini (2001) that the inclusion of *Sauropus androgynus* leaf powder at 3% reduced abdominal fat deposition, and Restiayanti *et al.* (2014) that the supplementation of *Moringa* leaf extract through drinking water reduced abdominal fat deposition. However, the present study agrees with the observation of Tazi (2014) in which the inclusion of *Moringa* at 3-7% had no effect on abdominal fat deposition in broiler chickens. Gurbuz and Ismael (2016) reported that the inclusion of basil leaves at 3% did not reduce abdominal fat deposition in broiler chickens. Fenita *et al.* (2011) stated that the supplementation of noni juice did not reduce abdominal fat in broiler chickens. Abdalla *et al.* (2013) reported that the inclusion of papaya leaves powder at 10% did not reduce abdominal fat pad. Santoso (2015) stated that the supplementation of papaya leaf extract had no effect on the fatty liver score.

Meat Composition

Table 2 shows the effect of medicinal herb on chemical composition of female broiler meats. Experimental results showed that the inclusion of medicinal herbs significantly affected fat ($P<0.05$), protein ($P<0.01$), iron ($P<0.05$), kalium, calcium and phosphorus ($P<0.01$) but had no effect on cholesterol and moisture. DMRT test showed that fat content of P1 and P4 were lower than the other treatment groups ($P<0.01$). The protein content of P3 was lower than P0, P1, P2, P4 and P5. The iron content of P1 and P5 were higher than P0 and P2. Kalium content of P0 was lower than the other treatment groups, whereas that of P6 was the highest. The calcium content of P0 was lower than that of P1, P2, P4 and P6. The phosphorus content of P0 was lower than that of P1, P4, P5 and P6. The phosphorus content of the P6 and P4 was higher than that of P1 and P5.

The compounds that play a role in lowering fat contents in P1 and P4 might be flavonoids, tannins and phenols (Aiura and de Carvalho, 2007; Zang *et al*., 2006; Zarrouki *et al*., 2010). Santoso *et al.* (2017b) reported that *Moringa* leaves, noni fruit, papaya leaves, *Sauropus androgynus* leaves, basil leaves and bay leaves contained iron at level of 2.00 ppm, 7.80 ppm, 5.61 ppm, 4.02 ppm, 6.43 ppm and 1.59 ppm, respectively. Thus, *Moringa* leaves and *Sauropus androgynus* had lower iron content than noni fruit, papaya leaves and basil leaves. It is assumed that the iron availability of *Moringa* dan *Sauropus androgynus* leaves may be higher resulting in higher iron content of meats. These selected medicinal herbs had high kalium content. The kalium content of *Moringa* leaves, *Sauropus androgynus* leaves, papaya leaves, basil leaves, bay leaves and noni fruit were 1324 mg kalium, 2610 mg kalium, 6762.50-8754.50 mg kalium, 550 mg kalium and 875-2271.2 mg kalium/100 g dry weight, respectively (Alaa *et al*., 2016; Basar and Westendorf, 2012; Dzida, 2010; Gopalakkrishnan *et al*., 2016; Hoe and Siong, 1999; Sharma *et al.,* 2013). Thus, higher kalium content of the selected medicinal herbs might contribute to higher meat kalium content. The contents of calcium and phosphorus in the experimental diets were relatively similar among the treatments (Santoso *et al.*, 2017b). It is postulated that the availability of calcium and phosphorus in the certain medicinal herbs might

Table 1. The Effect of Medicinal Herb on Fat Deposition and Fatty Liver Score in Female Broiler Chcikens

Variables	P0	P1	P2	P3	P4	P5	P6	P-values
Abdomen, %	1.30±0.53	1.22±0.24	1.30±0.60	1.29±0.08	1.17±0.12	1.08±0.29	1.60±0.29^{ns}	0.378
Sartorial, %	0.55±0.21	0.54±0.23	0.59±0.17	0.79±0.09	0.52±0.11	0.54±0.18	0.61±0.25^{ns}	0.558
Neck, %	0.05±0.01	0.04±0.02	0.05±0.02	0.04±0.01	0.04±0.01	0.05±0.02	0.04±0.01^{ns}	0.836
Gizzard, %	0.68±0.20	0.49±0.15	0.60±0.17	0.62±0.09	0.54±0.06	0.47±0.05	0.45±0.14	0.199
Heart, %	0.06±0.02	0.05±0.03	0.07±0.01	0.06±0.02	0.07±0.01	0.06±0.02	0.05±0.02^{ns}	0.885
FLS	1.2 ±0.24	1.0 ±0	1.3 ±0.29	1.3 ±0.47	1.4 ±0.48	1.0 ±0	1.3±0.29^{ns}	0.523

P0= the control; P1= *Sauropus androgynus* leaf; P2= Bay leaf; P3= Basil leaf; P4= Papaya leaf; P5= *Moringa* leaf; P6= Noni fruit. FLS= fatty liver score

Table 2. The Effect of Medicinal Herb on Chemical Composition of Female Broiler Meats

Variables	P0	P1	P2	P3	P4	P5	P6	P-values
Fat, %	7.72±1.04^{b}	5.66±0.38^{a}	6.95±0.40^{b}	6.99±1.60^{b}	5.96±0.88^{a}	6.83±0.10^{b}	7.55±0.37^{b*}	0.019
Protein, %	16.27±0.38^{bc}	16.75±0.14^{c}	16.20±0.12^{b}	15.74±0.38^{a}	16.47±0.19^{bc}	15.89±0.13^{ab}	16.40±0.24^{bc**}	0.000
Moisture, %	69.89±0.72	69.24±0.24	69.69±0.44	69.20±0.84	68.72±0.27	69.49±1.34	68.18±1.12^{ns}	0.100
Cholesterol, mg/100 g	2.17±0.10	1.94±0.07	1.89±0.11	2.04±0.11	2.07±0.25	2.05±0.03	1.93±0.12^{ns}	0.066
Iron, mg/100 g	1.55±0.07^{ab}	1.65±0.10^{c}	1.59±0.03^{ab}	1.60±0.04^{abc}	1.64±0.05^{bc}	1.52±0.03^{a}	1.63±0.03^{bc*}	0.027
Kalium, mg/100 g	1.35±0.03^{a}	1.41±0.03^{b}	1.41±0.03^{b}	1.41±0.02^{b}	1.43±0.02^{bc}	1.40±0.02^{b}	1.46±0.02^{c**}	0.000
Calcium, mg/100 g	13.50±0.38^{ab}	14.13±0.14^{c}	14.15±0.10^{c}	13.35±0.30^{a}	13.98±0.20^{c}	13.91±0.27^{bc}	14.16±0.56^{c**}	0.004
Phosphorus, mg/100 g	197.3 ±5.74^{a}	209.5 ±6.24^{b}	208.0 ±0.82^{ab}	208.5±6.40^{ab}	225.8±11.76^{c}	213.8±7.93^{b}	224.3 ±5.74^{c**}	0.000

P0= the control; P1= *Sauropus androgynus* leaf; P2= Bay leaf; P3= Basil leaf; P4= Papaya leaf; P5= *Moringa* leaf; P6= Noni fruit.

be higher. The mechanism of lower meat protein content of meats in female broiler chcikens fed diet containing basil leaves is unkown.

This study agrees with the observation of Santoso and Sartini (2001) that the inclusion of *Sauropus androgynus* leaves powder at 3% reduced carcass fat in broiler chickens. Santoso *et al.* (2015) reported that the inclusion of fermented *Sauropus androgynus* leaves powder at 5% reduced meat fat in broiler chickens. However, the present study disagrees with the observation of Fenita *et al.* (2011) in which supplementation of noni fruit juice at 25-75 mL/litre drinking water reduced fat content of broiler meats; Hamiyanti *et al.* (2013) that basil leaf reduced fat content in broiler meat; Santoso and Fenita (2015) that the inclusion of papaya leaf powder increased fay content in quail eggs and; Ismoyowati *et al.*

(2016) that the inclusion of bay leaf at 6-9% reduced meat fat of duck. It appears that the medicinal herb effect is affected by species and animal ages.

The present study showed lower protein content of meats in broiler chickens fed diet containing basil leaf as compared with the control, whereas other treatment groups statistically similar to the control. The present study disagrees with the results of Fenita *et al.* (2011) that noni fruit juice increased meat protein in broiler chickens; and Santoso and Fenita (2015) who reported that the inclusion of papaya leaf powder increased protein contents in quail eggs. The low protein content in broiler chicken fed diet containing basil leaf in the present study was in contrast with the observation of Hamiyanti *et al.* (2013) who reported that the inclusion of basil leaf powder at 0.75-1.25% increased protein content of broiler meat.

The present study showed that the inclusion of the selected medicinal herbs had no effect on the cholesterol content of broiler meats. This study disagrees with Hamiyanti *et al.* (2013) who reported that basil leaf reduced cholesterol; Tonga *et al.* (2016) who reported that the inclusion of *Moringa* leaf powder at 3-12% reduced cholesterol content of broiler meat; Ismoyowati *et al.* (2016) who reported that the inclusion of bay leaf at 9% reduced meat cholesterol in duck and Sujana *et al.* (2007) who reported that the noni fruit powder reduced cholesterol content of broiler meat. The present study agrees with the observation of Suharti *et al.* (2008) that the inclusion of bay leaf podwer at 1-3% did not reduce cholesterol content of broiler carcass.

Santoso *et al.* (2017b) reported that *Moringa* leaf, noni fruit, papaya leaf, *Sauropus* leaf, basil leaf, and bay leaf contained iron at a level of 2 ppm, 7.80 ppm, 5.61 ppm, 4.02 ppm, 6.43 ppm, 1.59 ppm, respectively. It appears that the availability of iron of *Sauropus androgynus* leaf is higher than the others resulting in the highest iron content of broiler meats. This study agrees with Santoso *et al.* (2015) who reported that the supplementation of fermented *Sauropus androgynus* increased iron content of broiler meats.

Iron from *Moringa* leaf may be not adequate to improve the iron content of broiler meat in the present study, resulting in similar iron content of broiler meat as compared with the control. This study disagrees with the results of Suzana *et al.* (2017) that the *Moringa* leaves extract could improve iron deficiency anemia in women, and Tessera *et al.* (2015) who reported that 5% *Moringa* leaves powder blended cookies have a potential to supply 53.6% of Fe to satisfy the RDA (9 mg/day) required by lactating mothers. In general, it might have a possibility to contribute better Fe content for lactating mothers to combat Iron deficiency problems. The difference of results may be caused by difference of species used in the study.

All the selected medicinal herbs increased kalium content of broiler meats. The present study disagrees with the observation of Santoso *et al.* (2010) that the supplementation of *Sauropus androgynus* did not increase the kalium content of broiler meat. No study was found on the effect of the other medicinal herbs on the kalium content of broiler meats. A higher kalium in broiler meat in P1, P2, P3, P4, P5 and P6 may be benefit for human health. Avani (2013) stated that within the body, kalium is the principal cation in intracellular fluid and participates in acid-base balance, regulation of osmotic pressure, conduction of nerve impulses, muscle contraction, cell membrane function and more. A high dietary intake of kalium has been shown to protect people from a number of conditions that affect the cardiovascular system, kidneys, and bones, and decrease blood pressure.

There is no study pertaining effect of the selected medicinal herbs on calcium and phosphorus contents of broiler meats. A higher phosphorus in broiler meat in P1, P4, P5 and P6 and calcium in P1, P2, P4 and P6 may be benefit for human helath. Renkema *et al.* (2008) stated that the control of plasma calcium (Ca^{2+}) and phosphate (Pi) levels is essential to the performance of many vital physiological functions. Muscle contraction, blood clotting and neuronal excitation all require Ca^{2+}, whereas Pi is vital to intracellular signaling, as a component of membrane lipids and to build the backbone of DNA. Moreover, significant elements of bone are Ca2+ and Pi. Thus, *Sauropus androgynus* leaves, bay leaves, papaya leaves and noni fruit may be able to prevent osteoporotic conditions.

Amino Acid Composition

The effect of medicinal herb on amino acid composition of female broiler meats is presented in Table 3. Experimental results showed that the inclusion of medicinal herbs significantly affected glutamic acid ($P<0.01$) and alanine ($P<0.01$), and methionine ($P<0.05$) but had no effect on other

amino acids. P0 had higher glutamic acid than P1, P2, P3, P4, P5 and P6 (P<0.01). P5 and P6 had lower alanine than P0, P1, P2, P3 and P4. P0 and P2 had lower methionine than P1, P3, P4 and P6 but statistically similar to P5.

Moringa leaves, *Sauropus androgynus* leaves, basil leaves and bay leaves contained glutamic acid at level of 15.14 g/100 g protein (Okereke and Akaninwor, 2013), 2.221% (Santoso *et al*., 2015), 0.11 mg/g extract (Bleiziffer *et al*., 2017), 621.2 mg% dry basis (Lee *et al.*, 2005), respectively. Although selected medicinal herbs contained relatively high glutamic acid, the glutamic acid contents of meats were lower than the control group. The mechanism of lower meat glutamic acid is unknown.

Moringa leaf contained 0.99 g methionine/100 dry weight (Olaofe *et al.*, 2013); noni fruit contained 3 mg methionine/100 g pulp (Lindsay and Golden, 2012); bay leaf contained methionine 80.3 mg% dry weight (Lee *et al*., 2005), *Sauropus androgynus* leaf (sun-dried leaf) contained 0.281% methionine (Santoso *et al*., 2015). Methionine present in the selected medicinal herbs may contribute to an increase in methionine content of broiler meats. *Sauropus androgynus* leaf extract increased the number of *Bacillus subtilis* and *Lactobacillus sp.* in gastrointestinal tract (Santoso *et al.*, 2001). Al-Fataftah *et al.* (2013) reported that an increase in *Lactobacillus sp* enhanced the methionine content of broiler meats. They also reported that the microbial strains had potential for enhancing biosynthesis of methionine.

The mechanism of lower meat alanine in broiler fed diets containing either *Moringa* leaf or noni fruit is unknown. *Moringa* leaf contained 3.29 g alanine/100 g dry weight (Olaofe *et al.*, 2013), whereas noni fruit contained 15 mg alanine/100 g noni pulp (Lindsay and Golden, 2012). Alanine can be synthesized from pyruvate and branched chain amino acids such valine, leucine and isoleucine. It appears that *Moringa* leaf and noni fruit may have antinutrition,whch inhibit alanine synthesis or reduce alanine availability.The present study disagrees with the observation of Santoso *et al.* (2015) who reported that fermented *Sauropus androgynus* leaf powder increased glutamic acid, aspartic acid, glysine, histidine, arginine, alanine, proline, tyrosine, valine, leucine, phenylalanine, and lysine of broiler meats but did not increase methionine. Santoso and Fenita (2016) reported that the inclusion of *Sauropus androgynus* leaf extract increased glutamic acid of egg but no effect on methionine and alanine. Santoso *et al.* (2017a) reported that the inclusion of *Sauropus androgynus* leaf extract had no effect on methionine and alanine of eggs. There is no study pertaining effect of bay leaf, basil leaf, papaya leaf, *Moringa* leaf and noni fruit on amino acid composition of broiler meats.

Fatty Acid Composition

The effect of medicinal herb on fatty acid composition of female broiler meats is presented in Table 4. Experimental results showed that the inclusion of medicinal herbs significantly affected oleic acid (P<0.05), linolenic acid (P<0.01), lignoceric acid (P<0.05), omega 3-unsaturated fatty acid P<0.05), and omega 9-unsaturated fatty acid but had no effect on other fatty acids. P2 and P3 had lower oleic acid than P0, P2 and P5. P0 had lower linolenic acid than P1, P2, P3, P4. P5, and P6. P4, P5 and P6 had lower lignoceric acid than P0, P1, P2 and P3. P2 had the highest lignoceric acid. P0 had lower omega 3 unsaturated fatty acids than the other groups. P3, P4 and P6 had lower omega 9 than P0, P1, P2 and P5.

Moringa leaves oil contained 9.32% linolenic acid, 48.88% oleic acid and 0.72% lignoseric acid (Al Juhaimi *et al.*, 2016). *Sauropus androgynus* leaves contained 21.39% oleic acid and 0.14% linolenic acid (Santoso, 2014). Basil leaves contained 325.88 ppm oleic acid, 29.57 ppm linolenic acid (Vidhani *et al.*, 2016). Bay leaf contained 12.3% oleic acid, 17.8% linolenic acid and 6% lignoceric acid (Lee *et al.*, 2005). The data may indicate that higher meat linolenic acid in broiler chickens fed diet containing medicinal herbs may result from the inclusion of linolenic acid from medicinal herbs. However, it is unkownm why meat oleic acid in P3, P4 and P6 were lower than the control.

An increase in linolenic acid in the broiler fed diet containing *Sauropus androgynus* leaf in the present study agrees with the observation of Santoso *et al.* (2015, 2017c) that fermented *Sauropus androgynus* leaf powder or fermented *Sauropus androgynus* leaf extract increased linolenic acid of broiler meats. The present study disagrees with Kurniawan *et al.* (2015) who reported that the inclusion of noni fruit did not increase linonelic acid of duck meat. The improvement of linolenic acid of broiler meats in the present study is in contrast with the observation of Dany *et al.* (2016) in which

Table 3. The Effect of Medicinal Herb on Amino Acid Composition of Female Broiler Meats

Variables, %	P0	P1	P2	P3	P4	P5	P6	P-values
Aspartic acid	1.71±0.11	1.71±0.38	1.63±0.09	1.81±0.15	1.68±0.07	1.60±0.07	1.58±0.26^{ns}	0.366
Glutamic acid	3.87±0.07^{c}	3.04±0.43^{b}	2.75±0.20^{ab}	2.98±0.41^{b}	2.52±0.81^{a}	2.50±0.33^{a}	2.36±0.43^{a**}	0.0006
Serine	0.41±0.18	0.64±0.13	0.62±0.08	0.63±0.12	0.62±0.07	0.57±0.08	0.51±0.09^{ns}	0.074
Histidine	0.44±0.04	0.50±0.05	0.46±0.03	0.49±0.06	0.47±0.03	0.39±0.06	0.42±0.12^{ns}	0.735
Glycine	0.53±0.15	0.87±0.07	0.84±0.07	0.88±0.46	0.77±0.12	0.64±0.21	0.68±0.08^{ns}	0.187
Threonine	0.60±0.15	0.74±0.14	0.70±0.04	0.65±0.24	0.65±0.21	0.62±0.14	0.60±0.14^{ns}	0.834
Arginine	1.11±0.11	1.21±0.14	1.14±0.06	1.05±0.39	1.19±0.10	1.02±0.20	1.00±0.20^{ns}	0.644
Alanine	1.24±0.16^{b}	1.09±6.13^{b}	1.08±0.02^{b}	1.07±0.07^{b}	1.08±0.06^{b}	0.89±17^{a}	0.83±0.22^{a**}	0.007
Tyrosine	0.54±0.08	0.63±0.08	0.52±0.09	0.59±0.14	0.71±0.23	0.51±0.06	0.51±0.09^{ns}	0.240
Methionine	0.39±0.07^{a}	0.55±0.06^{b}	0.41±0.11^{a}	0.54±0.09^{b}	0.52±0.02^{b}	0.43±0.06^{ab}	0.51±0.11^{b*}	0.027
Valine	0.95±0.0.03	0.92±0.13	0.88±0.09	1.03±0.10	0.92±0.08	0.81±0.13	0.77±0.15^{ns}	0.084
Phenylalanine	0.63±0.23	0.78±0.11	0.72±0.04	0.83±0.05	0.70±0.07	0.68±0.08	0.62±0.11^{ns}	0.478
I-leucine	0.90±0.10	0.95±0.11	0.80±0.19	1.05±0.09	0.91±0.11	0.82±0.14	0.83±0.12^{ns}	0.451
Leucine	1.38±0.11	1.47±0.21	1.42±0.04	1.22±0.29	1.56±0.20	1.30±0.15	1.26±0.21^{ns}	0.172
Lysine	1.33±0.24	1.67±0.34	1.41±0.15	1.52±0.25	1.63±0.25	1.53±0.27	1.36±0.25^{ns}	0.419
Amino acid total	14.68±0.62	15.08±1.90	13.95±0.87	14.79±1.60	14.27±1.14	12.77±1.63	12.47±1.96^{ns}	0.176

P0= the control; P1= *Sauropus androgynus* leaf; P2= Bay leaf; P3= Basil leaf; P4= Papaya leaf; P5= *Moringa* leaf; P6= Noni fruit.

Moringa leaf meal inclusion reduced linolenic acid in the intramuscular fat of the *Longissimus dorsi* muscle of pig. The present results showed similar results to the observation of Kirubakaran *et al.* (2011) that the inclusion of basil leaf meal at 1 and 2 g/kg contributed significantly to elevating the yolk linolenic acid. Jafari *et al.* (2017) reported that the inclusion of papaya leaf extract increased linolenic acid of the rumen liquor.

Reduction of meat oleic acid in broiler chickens fed diet containing either noni fruit or papaya leaf in the present study is in contrast with Kurniawan *et al.* (2015) who reported that the inclusion of noni fruit at 3% did not reduce oleic acid of duck meats, and Jafari *et al.* (2017) who reported that papaya leaf inclusion did not reduce oleic acid of rumen liquor. The present study, however, agrees with the observation of Kirubakaran *et al.* (2011) who reported that basil leaf inclusion reduced oleic acid of layer yolk.

This research might help to maintain broiler chickens without the need for antibiotics as a feed additive and to develop organic farming for broiler chickens.In addition, the present study might help to develop enriched meats (these meats contained lower fat but higher in protein, mineral, methionine, linolenic acid with no antibiotic residue), which will meet the demand of consumers.

CONCLUSION

The inclusion of medicinal herbs did not reduce fat deposition in female broiler chickens. The selected medicinal herbs increased linolenic and omega 3 unsaturated fatty acids and kalium of broiler meats but reduced glutamic acid of broiler meats. Female broiler chickens fed diet containing either *Sauropus androgynus* or papaya leaves had lower meat fat as compared with the control. Furthermore, female broiler chickens fed diet containing *Sauropus androgynus* leaf increased

Table 4. The Effect of Medicinal Herb on Fatty Acid Composition of Female Broiler Meats

Variables, % fat	P0	P1	P2	P3	P4	P5	P6	P-values
Lauric acid, C12:0	0.04±0.02	0.04±0.01	0.04±0.01	0.03±0.00	0.03±0.01	0.03±0.01	0.03±0.00^{ns}	0.620
Myristic acid, C14:0	0.44±0.02	0.48±0.02	0.45±0.06	0.44±0.05	0.50±0.03	0.47±0.02	0.48±0.02^{ns}	0.836
Myristeloic acid, C14:1	0.13±0.02	0.13±0.01	0.12±0.03	0.13±0.02	0.14±0.03	0.13±0.01	0.13±0.01^{ns}	0.158
Penthadecanoic acid, C15:0	0.06±0.01	0.07±0.01	0.06±0.01	0.06±0.01	0.06±0.01	0.06±0.01	0.07±0.01^{ns}	0.839
Palmitic acid, C16:0	19.90±0.25	18.73±0.67	19.04±0.85	18.74±1.08	18.96±1.00	19.52±0.56	19.61±0.62^{ns}	0.414
Palmitoleic acid, C16:1	4.64±0.70	4.48±0.18	4.26±0.77	4.80±0.66	4.61±0.80	4.77±0.43	4.50±0.51^{ns}	0.891
Heptadecanoic acid, C17:0	0.08±0.02	0.10±0.01	0.09±0.02	0.09±0.01	0.10±0.01	0.10±0.01	0.10±0.01^{ns}	0.645
Cis-10-heptadeca-noic acid, C17:1	0.07±0.01	0.08±0.01	0.07±0.01	0.08±0.01	0.08±0.01	0.07±0.01	0.07±0.01^{ns}	0.633
Stearic acid, C18:0	3.68±0.35	3.65±0.18	3.86±0.17	3.57±0.28	3.78±0.10	3.80±0.14	3.97±0.19^{ns}	0.206
Elaidic acid, C18:1n9t	0.23±0.02	0.33±0.30	0.23±0.05	0.22±0.04	0.19±0.05	0.22±0.03	0.22±0.03^{ns}	0.779
Oleic acid, C18:1n9c	37.15±1.66^{b}	35.91±0.93^{ab}	37.00±0.75^{b}	34.15±1.27^{a}	34.37±1.47^{a}	36.01±1.40^{b}	35.06±1.88^{a*}	0.030
Linoleic acid, C18:2n6c	11.74±1.09	14.20±2.43	13.73±1.23	12.70±0.90	14.22±2.10	13.28±0.40	14.31±1.48^{ns}	0.202
Arachidic acid, C20:0	0.05±0.01	0.06±0.01	0.05±0.01	0.05±0.01	0.06±0.01	0.05±0.01	0.06±0.01^{ns}	0.117
γ-linoleic acid, C18:3n6	0.12±0.01	0.13±0.03	0.13±0.01	0.12±0.02	0.15±0.03	0.12±0.01	0.14±0.04^{ns}	0.451
Cis-11-eicoseneic acid, C20:1	0.18±0.05	0.18±0.03	0.16±0.02	0.16±0.02	0.16±0.03	0.19±0.0.01	0.16±0.01^{ns}	0.493
Linolenic acid, C18:3n3	0.36±0.06^{a}	0.64±0.08^{b}	0.55±0.08^{b}	0.55±0.09^{b}	0.58±0.11^{b}	0.52±0.05^{b}	0.53±0.05^{b**}	0.002
Cis-11,14-icose-dienoic acid, C20:2	0.11±0.03	0.12±0.02	0.12±0.01	0.11±0.02	0.12±0.01	0.12±0.01	0.12±0.01^{ns}	0.905
Behenic acid, C22:0	0.03±0.01	0.04±0.01	0.03±0.01	0.03±0.01	0.04±0.01	0.03±0.01	0.03±0.01^{na}	0.317
Cis-8,11,14-eicose-trienoicacid,C20:3n6	0.13±0.01	0.16±0.02	0.16±0.01	0.14±0.02	0.17±0.02	0.17±0.02	0.15±0.03^{ns}	0.093
Arachidonic acid, C20:4n6	0.39±0.08	0.54±0.17	0.56±0.10	0.48±0.22	0.61±0.10	0.53±0.07	0.52±0.08^{ns}	0.369
Lignoceric acid, C24:0	0.02±0.02^{b}	0.02±0.02^{b}	0.04±0.02^{c}	0.02±0.01^{b}	0.02±0.01^{a}	0.01±0.01^{a}	0.01±0.01^{a*}	0.012
Cis-5,811,14,17-eicosapentaenoic acid, C20:5n3	0.03±0.01	0.04±0.01	0.04±0.02	0.04±0.01	0.03±0.01	0.04±0.01	0.04±0.02^{ns}	0.771

Table 4. The Effect of Medicinal Herb on Fatty Acid Composition of Female Broiler Meats (continues)

Variables, % fat	P0	P1	P2	P3	P4	P5	P6	P-values
Cis-4,7,10,13,16,19-docosahexaenoic acid, C22:6n3	0.05±0.01	0.06±0.03	0.04±0.02	0.07±0.05	0.05±0.03	0.05±0.02	0.05±0.02	0.853
Total fatty acids	79.60±1.08	80.15±3.26	80.80±1.90	76.72±1.90	79.02±2.83	80.26±2.17	80.33±03.73^{ns}	0.365
Saturated fatty acids	24.19±1.41	23.06±0.64	23.53±0.74	22.92±1.24	23.43±1.03	23.98±0.67	24.25±0.50^{ns}	0.333
Unsaturated fatty acid	55.17±1.19	56.84±3.55	57.01±1.31	53.56±1.31	55.33±2.91	56.04±1.55	55.85±3.54^{ns}	0.494
- Omega 3	0.44±0.07^{a}	0.74±0.11^{b}	0.63±0.08^{b}	0.63±0.14^{b}	0.67±0.11^{b}	0.61±0.04^{b}	0.63±0.05^{b*}	0.010
- Omega 6	12.30±1.14	14.93±2.59	14.46±1.30	13.35±1.13	15.03±2.20	13.98±0.45	15.02±1.58^{ns}	0.198
- Omega 39	37.38±1.66^{b}	36.24±1.07^{b}	37.23±0.72^{b}	34.36±1.30^{a}	34.57±1.46^{a}	36.22±17^{b}	35.27±1.86^{a*}	0.030

P0= the control; P1= *Sauropus androgynus* leaf; P2= Bay leaf; P3= Basil leaf; P4= Papaya leaf; P5= *Moringa* leaf; P6= Noni fruit

meat iron. Broiler fed diet containing either *Sauropus androgynus* leaf, bay bay leaf, papaya leaf or noni fruit increased meat calcium. Broiler fed diet containing either *Sauroupus androgynus* leaf, papaya leaf, *Moringa* leaf or noni fruit increased meat phosphorus. It was concluded that *Sauropus androgynus* leaf was the most effective to produce broiler meats, which low in fat content but high in protein, mineral and omega 3 unsaturated fatty acids.

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