

## Effect of turmeric and garlic supplementation to fermented *Sauropus androgynus*-bay leaves containing diet on fat deposition and broiler meat composition

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### ABSTRAK

Penelitian ini bertujuan untuk menguji pengaruh suplementasi kunyit dan bawang putih ke dalam pakan yang mengandung daun katuk-salam fermentasi (DKSF) terhadap deposisi lemak, dan komposisi gizi daging broiler. Dua ratus ekor ayam betina berumur 15 hari didistribusikan ke dalam 5 kelompok perlakuan dengan 4 ulangan sebagai berikut: Kontrol, pakan dengan pakan imbuhan komersial (T0); Pakan dengan 1,25% DKSF (T1); Pakan dengan DKSF plus 1 g kunyit (T2); Pakan dengan DKSF plus 2 g bawang putih (T3); Pakan dengan DKSF ditambah 1 g kunyit plus 2 g bawang putih (T4). Deposisi lemak abdomen sangat nyata meningkat oleh perlakuan ( $P < 0,01$ ). Lebih lanjut, suplementasi kunyit dan bawang putih ke dalam pakan yang mengandung DKSF tidak mempengaruhi kadar lemak, protein, kelembaban dan abu, tetapi meningkatkan arginin, metionin, dan histidin ( $P < 0,01$ ). Penambahan kunyit dan/atau bawang putih ke dalam pakan yang mengandung DKSF secara nyata mempengaruhi asam laurat, asam miristat, asam linolenat, asam cis-11-eikosenoat, asam cis-4,7,10,13,16,19-docosahexaenoat ( $P < 0,05$ ), n-3 asam lemak dan rasio asam lemak n-6/n-3 ( $P < 0,01$ ). Jadi, suplementasi kunyit plus bawang putih meningkatkan profil asam amino dan mengubah profil asam lemak. Interaksi yang mungkin terjadi harus diperhatikan ketika membuat pakan imbuhan dari campuran tanaman obat.

*Kata kunci* : kunyit, bawang putih, daun katuk plus salam, deposisi lemak, komposisi gizi daging

### ABSTRACT

This study aimed to examine the effect of turmeric and garlic inclusion to fermented *Sauropus androgynus*-bay leaves (FSBL) containing diet on fat deposition, and chemical composition of broiler meats. Two hundred 15-day-old female broilers were distributed into 5 treatment groups with 4 replications as follows. Control feeds with commercial feed additive (T0); Feeds with 1.25% FSBL (T1); Feed with FSBL plus 1 g turmeric (T2); Feed with FSBL plus 2 g garlic (T3); Feed with FSBL plus 1 g of turmeric and 2 g garlic (T4). It was shown that the fat deposition in the abdomen was significantly affected ( $P < 0.01$ ). Furthermore, the inclusion of turmeric and garlic to FSBL containing diet did not affect fat, protein, moisture and ash contents, but increased arginine, methionine and histidine ( $P < 0.01$ ). The addition of turmeric and/or garlic to the FSBL containing diet significantly influenced lauric acid, myristic acid, linolenic acid, cis-11-eicosenoic acid, cis-4,7,10,13,16,19-docosahexaenoic acid ( $P < 0.05$ ), n-3 fatty acid and n-6/n-3 fatty acid ratio ( $P < 0.01$ ). In conclusion, turmeric plus garlic supplementation improved amino acid profiles and changed fatty acid profiles. The

possible interaction should be considered when we formulated feed additive from medicinal plant mixtures

*Keywords: turmeric, garlic, Sauropus androgynus-bay leaves, fat deposition, meat composition*

## INTRODUCTION

Antibiotics that function as growth promoters and optimize product quality have been banned for use by livestock by the Government of Indonesia since 2018. Antibiotics can increase bacterial resistance to drugs, which will complicate the treatment of diseases both in animals and in humans. Besides, the use of antibiotics triggers several diseases in consumers such as allergies. Therefore it is necessary to look for alternative ingredients as a substitute for antibiotics. One alternative to substitute antibiotics is medicinal plants (Nugraha and Keller, 2011; Sugiharto, 2016).

Medicinal plants as the main ingredients in herbal medicine have activities as anti-viral, antimalarial, anti-bacterial and anti-fungal agents (Nugraha and Keller, 2011), anti-inflammatory, anticancer (Faried *et al.*, 2007), antioxidants and antilipids (Aldegbola *et al.*, 2017; Casamassima *et al.*, 2017; Santoso *et al.*, 2018, 2019). Some medicinal plants that are antilipidemic (Casamassima *et al.*, 2017), antioxidant and antimicrobial (Aldegbola *et al.*, 2017) can be mixed into herbal medicine to replace antibiotics. The reduction of fat in poultry is very important because consumers want poultry products that are low in fat and high in protein. The tendency of consumers to consume low-fat poultry products is supported by research results that show a positive correlation between consuming high fat with metabolic disturbances (Ramalho *et al.*, 2017).

Our previous study showed that the inclusion of fermented *Sauropus androgynus*-bay leaves (FSBL) inclusion at 5% level reduced fat and cholesterol contents but increased protein and mineral contents (Santoso *et al.*, 2019). This combination of these herbs is still more expensive than commercial feed additive. To reduce feed costs, the use of those herbs needs to be reduced. It was assumed that the decrease in the administration of FSBL will have an impact on the ineffectiveness of the mixture of medicinal plants on decreasing fat deposition and increasing protein deposition in broilers (Santoso *et al.*, 2019). For that, we need to add other medicinal plant ingredients that can be given in small amounts but are thought to be able to reduce the

fat deposition. Potential medicinal plants are turmeric and garlic.

Turmeric contains mixed compounds especially sesquiterpenes and curcuminoids (especially curcumin) as the dominant active compounds (Lateef *et al.*, 2016), polyphenols, flavonoids and ascorbic acid (Hossen *et al.*, 2017). Saraswati *et al.* (2013) reported that turmeric powder inclusion reduced fat and cholesterol contents but increased protein content of quail egg. Daneshyar *et al.* (2011) reported that the inclusion of turmeric reduced thigh triglyceride, and saturated fatty acid content in the broiler. Garlic powder contains saponins, tannins, alkaloids, and flavonoids (Indrasanti *et al.*, 2017). Kim and Kim (2011) reported that the inclusion of garlic reduced epididymal fat tissue in mice fed high-fat diet. Giving turmeric powder as much as 1 g/kg reduces fat in broilers (Samarasinghe *et al.*, 2003), while giving garlic as much as 2 g/kg reduces fat in broilers (Jimoh *et al.*, 2012; Samanthi *et al.*, 2015).

The compounds contained in garlic and turmeric as described above have the ability to function as antimicrobial, antioxidant and antilipid. Furthermore, Daneshyar *et al.* (2011) found that turmeric supplementation increased thigh meat protein. Thus, it is suspected that the addition of garlic and turmeric to the FSBL diet will be able to reduce fat deposition and change meat composition in poultry. In addition, Lee *et al.* (2012a) reported that garlic supplementation increased glutamic acid, alanine, valine, phenylalanine, eicosapentaenoic acid and docosahexaenoic acid in muscle of fish. Daneshyar *et al.* (2011) reported that turmeric supplementation reduced saturated fatty acids of broiler meats. The information of garlic and/or turmeric effect on meat amino acids and fatty acids in broiler chick is very limited, and no study was done pertaining to those herbs effect when they are supplemented to FSBL containing diet. This investigation was done to analyze the effect of turmeric and/garlic to FSBL containing diets on fat deposition, nutritional composition, amino acids and fatty acids of broiler meat. It is hypothesized that turmeric and/or garlic inclusion to FSBL containing diets reduced fat deposition, increase protein content, and change fatty acids

and amino acids composition of broiler meat.

## MATERIALS AND METHODS

### Fermentation of *Sauropus androgynus* and Bay Leaves

*Sauropus androgynus* and bay leaves were fermented to decrease antinutrients, crude fiber, and to increase nutritive value (Cui *et al.*, 2012) and nutrient digestibility (Salem *et al.*, 2015). Fermentation was carried out using the method of Santoso *et al.* (2015) as follows. The leaves that have been cleaned were steamed for 30 minutes. After a cold, the leaves were given 0.5% cassava yeast and then anaerobically fermented for 24 hours for *Sauropus androgynus* leaves and 48 hours for bay leaves. Fermented products were then dried, ground and stored in a plastic bag before use.

### Animals and Diets

The experiment was done at Livestock Experiment Unit, Faculty of Agriculture, Bengkulu University. The house, brooder guards, feeders and waterers were cleaned before arriving the chicken. Seven hundred one day broiler

chickens were placed into the brooder and reared with a good hygienic condition. Brooder temperature was maintained at 32-33°C in the first week and was gradually reduced in the second week, and in the third week, the temperature of the brooder was under the temperature of the enclosure environment. Newly arrived broilers were given coconut sugar containing water to eliminate stress due to travel. At 21 days, broilers were vaccinated with ND (Lasota). The vaccine was given through drinking water. At the age of 1-14 days, broilers were given a commercial diet. Broilers spent 14 days of the brooding period.

At the age of 15 days, female broilers were selected, and distributed into experimental plots and given experimental diet up to the age of 35 days. The diets of T0, T1, T2, T3, and T4 contained crude protein levels of 20.0, 19.7, 19.7, 19.7, and 19.7% and ME 3,130, 3,111, 3,111, 3,111, and 3,111 kcal/kg, respectively (Table 1). Turmeric supplementation at 1 g/kg (Samarasinghe *et al.*, 2003) was able to increase body weight and reduce fat deposition in broilers so that this level was used in this study.

This study used a completely randomized

Table 1. The Composition of Experimental Diets

Feedstuffs (g/kg)	T0	T1	T2	T3	T4
Yellow corn	582.5	582.5	581.5	580.5	579.5
Rice bran	50	40	40	40	40
Broiler concentrate	342	332	332	332	332
Palm oil	15	15	15	15	15
Mineral mixture	17	17	17	17	17
Salt	1	1	1	1	1
Top mix	5	0	0	0	0
FSAL	0	3.125	3.125	3.125	3.125
FBL	0	9.375	9.375	9.375	9.375
Turmeric	0	0	1	0	1
Garlic	0	0	0	2	2
Total	1,000	1,000	1,000	1,000	1,000
ME, kcal/kg	3,130	3,111	3,111	3,110	3,110
Protein, %	20.0	19.7	19.7	19.7	19.7

FSAL = Fermented *Sauropus androgynus* leaves; FBL = Fermented bay leaves

design. Two hundred 15-day-old female broilers were distributed into 5 treatment groups with 4 replications (10 female broilers of each replication) as follows. Control feeds with commercial feed additive (T0); Feeds with 1.25% FSBL (T1); Feed with FSBL plus 1 g turmeric (T2); Feed with FSBL plus 2 g garlic (T3); Feed with FSBL plus 1 g of turmeric and 2 g garlic (T4). Broilers were maintained according to standard broiler maintenance procedures and were given diet and drinking water *ad libitum*. Broilers were kept in a 1 x 1 m bamboo enclosure on a rice husk base of 5 cm thickness for 21 days.

### Sampling

At 35 days of age, 4 female broilers for each treatment group were slaughtered. The accumulation of fat in the abdomen, gizzard, leg meats, heart, and neck were taken and weighed. To measure fatty liver scores, the colors of the broiler livers were compared with the standard colors from 1 to 5 (from dark brown (value 1) to yellowish-white (value 5)). The higher the value, the higher the fat content. The broiler thigh meats were taken, milled and frozen before analysis.

### Laboratory Analysis

Fat content was analyzed by Soxhlet extraction; moisture content was analyzed by drying the samples at 105°C, and protein content was analyzed using macro Kjeldahl (AOAC, 1990). The amino acid composition was measured by the method described by Ginting *et al.* (2017). Sixty milligrams of broiler thigh meat in erlenmeyer was added 4 ml of 6 N HCl and refluxed for 24 hours at 110°C. The results of hydrolysis were neutralized with NaOH 6 N and filtered with 0.2 µm wattman paper. 50µl was taken and 300 µL OPA (O-phthalaldehyde) solution and 1-2 drops of 2-mercaptoethanol was added and stirred for 5 minutes. Furthermore, a sample of 20 µL was inserted into the HPLC injector alternately and ready for analysis. For analysis of fatty acid composition, twenty gram broiler thigh meat was dried at 90°C for 24 hours. The sample was extracted in the soxhlet for 16 hours. The extraction was concentrated at 55°C for 2 hours. A total of 0.0298 g of sample was added to 1mL of NaOH 0.5 N within methanol and heated over a water bath at 80°C for 20 minutes. After cooling, 2mL BF3 was added and heated at 80°C for 20 minutes, then cooled and added 2mL of saturated NaCl and 1 mL of

hexane. The hexane layer was separated by a dropping pipette and put in a tube containing 0.1 grams of Na<sub>2</sub>SO<sub>4</sub> anhydrous, and left for 15 minutes. Sample solutions were separated and ready to be injected. The fatty acid composition was then measured by gas chromatography (Trembeke *et al.*, 2013).

The results of the study were analyzed by ANOVA and if significantly different were tested further with Duncan's Multiple Range Test. The fatty liver score was qualitatively analyzed.

## RESULTS AND DISCUSSIONS

### Fat Deposition

Effect of turmeric and garlic inclusion to fermented *Sauropus androgynus*-bay leaves on fat deposition in female broiler chickens is presented in Table 2. It was shown that the fat deposition in the gizzard, proventriculus, sartorial, neck and heart was not affected ( $P>0.05$ ), whereas abdominal fat was significantly increased ( $P<0.05$ ). T2, and T3 had higher abdominal fat than T0. The reduction of a fatty liver score in T1, T2, T3, and T4 as compared with T0 was 37.5%, 3%, 37.5%, and 18.5%, respectively.

It is unknown why the inclusion of turmeric (T2) or garlic (T3) increased abdominal fat depot. When two herbs are mixtured, the compounds of those herbs may interact to each other, either synergistic or antagonism interaction. Since the inclusion 1 g turmeric/kg (Samarasinghe *et al.*, 2003), and the inclusion of 2 g garlic/kg (Jimoh *et al.*, 2012; Samanthi *et al.*, 2015) lowered abdominal fat depots, it appears that there is antagonism interaction between turmeric or garlic with *Sauropus androgynus*-leaves when they are mixtured. Han *et al.* (2012) reported that unfavorable combinations of flavonoids and carotenoids resulted in antioxidant antagonism despite large potential differences. Thus, the combination of carotenoids and flavonoids in *Sauropus androgynus* plus in turmeric or garlic may result in antagonism interaction, and therefore it may reduce antilipid properties of those medicinal plants.

Lower fatty liver scores in T1, T2, T3, and T4 indicated lower fat content in the liver. This result showed that the addition of turmeric or garlic to the FSBL containing diet was not able to lower the fatty liver score further. Lower fat content in the liver would partly reduce the risk of fatty liver syndrome occurrence in broiler chickens. Decreased levels of fat in the liver are

Table 2. Effect of Turmeric and Garlic Inclusion to Fermented *Sauropus androgynus*-Bay Leaves on Fat Deposition in Female Broiler Chickens

Fat Deposition, %	T0	T1	T2	T3	T4	P
Neck	0.08±0.01	0.11±0.03	0.09±0.02	0.07±0.01	0.09±0.01	0.154
Heart	0.11±0.03	0.11±0.02	0.09±0.02	0.09±0.02	0.11±0.01	0.541
Proventriculus	0.09±0.01	0.10±0.01	0.09±0.02	0.10±0.02	0.11±0.03	0.758
Gizzard	0.37±0.10	0.30±0.05	0.34±0.06	0.36±0.04	0.37±0.08	0.562
Sartorial	0.21±0.05	0.22±0.04	0.24±0.06	0.26±0.06	0.26±0.07	0.645
Abdomen	0.71±0.06 <sup>a</sup>	0.81±0.04 <sup>ab</sup>	0.86±0.04 <sup>b</sup>	0.85±0.09 <sup>b</sup>	0.76±0.09 <sup>ab</sup>	0.035
Total fat deposition	1.59±0.15	1.64±0.13	1.72±0.13	1.75±0.17	1.68±0.13	0.542
Fatty liver score	2.00±0.41	1.25±0.29	1.94±0.31	1.25±0.50	1.63±0.48	

T0 = Control without herbs; T1 = Feeds with 1.25% fermented *Sauropus androgynus*-bay leaves (FSBL)]; T2 = Feed with FSBL plus 1 g turmeric powder; T3 = Feed with FSBL plus 2 g garlic); T4 = Feed with FSBL plus 1 g turmeric and 2 g garlic.

caused partly by a decrease in fatty acid synthesis and/or an increase in fatty acid degradation in the liver.

#### Meat Composition

The effect of turmeric and garlic inclusion to fermented *Sauropus androgynus*-bay leaves on meat composition of female broiler chickens is shown in Table 3. It was shown that the inclusion of turmeric and garlic to the FSBL containing diet did not affect fat, protein, moisture and ash contents ( $P>0.05$ ). Although the effect was not significant, T1 tended to have lower fat content than T0 of 24.4%. This shows that the decrease in the level of *Sauropus androgynus* plus bay leaves administration from 2.5% (Santoso *et al.*, 2019) to 1.25% is still able to reduce the level of meat fat. Santoso *et al.* (2018) found that the addition of *Sauropus androgynus* leaf or bay leaf at 5% level reduced meat fat content by 26.7% or 10.0%, respectively. When these herbs were fermented, combined, and fed at a level of 2.5% or 5% they reduced meat fat content ranging from 22.5% to 45.2% (Santoso *et al.*, 2019). When the fermented *Sauropus androgynus* plus bay leaves feeding was reduced at 1.25% just reduced fat content at 24.4%. Thus, the feeding level of that mixture may influence fat content. A fermented product has been known to reduce the meat fat content in broiler chickens (Santoso *et al.*, 2010). A reduction in the carcass fat content by fermented

product was partly caused by a reduction of fatty acid synthesis (Nie *et al.*, 2015). Flavonoids (Zarrouki *et al.*, 2010), tannins (Selvi and Bhaskar, 2012) and phenols (Qiong *et al.*, 2014) have been reported to have anti lipid properties. Li and Tian (2004) also reported that flavonoids inhibited fatty acid synthase activity. Supplementation of 1 g turmeric/kg diet and/or 2 g garlic/kg diet to FSBL containing diet tended to increase meat fat content. Antioxidant antagonism might play an important role in the tendency of meat fat accretion.

The present study showed that 1.25% FSBL did not increase the protein content of broiler meat. This result was similar to Santoso *et al.* (2019) who reported that giving 2.5-5% FSBL did not increase protein content. Thus, FSBL feeding could be reduced to 1.25% level without reducing protein content. The inclusion of 1 g turmeric/kg and/or 2 g garlic/kg to FSBL containing diet did also not increase protein content. Dzinic *et al.* (2013) reported that giving 2% garlic did not increase protein content. Kanani *et al.* (2017) reported that giving 0.5% turmeric powder did not increase protein content.

#### Amino Acid Profile of Broiler Meat

Table 4 shows the effect of turmeric and garlic to fermented *Sauropus androgynus*-bay leaves on meat amino acid composition of female broilers. The results of this research showed that

Table 3. The Effect of Turmeric and Garlic Inclusion to Fermented *Sauropus androgynus*-Bay Leaves on Meat Composition of Female Broiler Chickens

Variables (%)	T0	T1	T2	T3	T4	P
Fat	5.00±1.52	3.78±0.94	5.34±0.45	4.02±0.44	4.22±0.78	0.108
Moisture	75.19±2.33	75.80±1.34	74.16±0.38	75.56±0.83	75.34±0.93	0.495
Protein	19.00±0.67	19.28±0.45	19.16±0.26	19.27±0.37	19.34±0.05	0.880
Ash	1.34±0.12	1.15±0.15	1.34±0.10	1.16±0.19	1.11±0.12	0.074

T0 = Control without herbs; T1 = Feeds with 1.25% fermented *Sauropus androgynus*-bay leaves (FSBL)]; T2 = Feed with FSBL plus 1 g turmeric powder; T3 = Feed with FSBL plus 2 g garlic); T4 = Feed with FSBL plus 1 g turmeric and 2 g garlic.

Table 4. The Effect of Turmeric and Garlic to Fermented *Sauropus androgynus*-Bay Leaves on Meat Amino Acid Composition of Female Broilers

Amino acid (%)	T0	T1	T2	T3	T4	P
Aspartic acid	1.64±0.04	1.71±0.03	1.83±0.17	1.82±0.22	1.88±0.04	0.094
Glutamic acid	3.21±0.07	3.22±0.13	3.34±0.19	3.30±0.33	3.553±0.02	0.106
Serine	0.67±0.01	0.67±0.02	0.69±0.03	0.66±0.06	0.72±0.01	0.154
Histidine	0.54±0.02 <sup>ab</sup>	0.59±0.03 <sup>c</sup>	0.53±0.01 <sup>a</sup>	0.56±0.03 <sup>abc</sup>	0.57±0.01 <sup>bc</sup>	0.013
Glycine	0.86±0.09	0.93±0.053	1.03±0.11	1.07±0.22	1.06±0.12	0.171
Threonine	0.73±0.03	0.75±0.02	0.76±0.03	0.73±0.07	0.81±0.02	0.109
Arginine	1.24±0.08 <sup>a</sup>	1.24±0.16 <sup>a</sup>	1.15±0.03 <sup>a</sup>	1.18±0.15 <sup>a</sup>	1.57±0.01 <sup>b</sup>	0.000
Alanine	1.19±0.13	1.09±0.07	1.16±0.07	1.14±0.16	1.23±0.04	0.429
Tyrosine	0.54±0.04	0.57±0.01	0.56±0.01	0.57±0.06	0.62±0.01	0.075
Methionine	0.42±0.04 <sup>a</sup>	0.44±0.01 <sup>a</sup>	0.45±0.02 <sup>a</sup>	0.44±0.04 <sup>a</sup>	0.50±0.01 <sup>b</sup>	0.023
Valine	0.775±0.06	0.82±0.02	0.84±0.03	0.81±0.07	0.88±0.00	0.061
Phenylalanine	1.04±0.08	1.08±0.07	0.98±0.02	1.23±0.33	1.08±0.01	0.249
I-leucine	0.81±0.06	0.84±0.04	0.84±0.02	0.83±0.07	0.89±0.02	0.212
Leucine	1.44±0.09	1.46±0.05	1.47±0.04	1.47±0.14	1.59±0.01	0.117
Lysine	1.58±0.12	1.47±0.26	1.31±0.50	1.63±0.14	1.74±0.04	0.182
Total	16.72±0.54	16.91±0.55	16.96±0.91	17.46±1.90	18.70±0.15	0.080

T0 = Control without herbs; T1 = Feeds with 1.25% fermented *Sauropus androgynus*-bay leaves (FSBL)]; T2 = Feed with FSBL plus 1 g turmeric powder; T3 = Feed with FSBL plus 2 g garlic); T4 = Feed with FSBL plus 1 g turmeric and 2 g garlic.

turmeric and/ or garlic addition to FSBL containing diet significantly increased arginine,

and methionine ( $P < 0.05$ ), and tended to increased aspartic acid, tyrosine, valine, and total amino

acid. FSBL containing diet (T1) had higher histidine than T0, but the inclusion of turmeric to FSBL containing diet (T2) reduced it ( $P < 0.05$ ).

The inclusion of turmeric plus garlic to FSBL increased arginine, and methionine and tended to increased aspartic acid, tyrosine, valine, and total amino acid. Also, the present study showed that garlic was more effective than turmeric in increasing those amino acids. Lee *et al.* (2012<sup>a</sup>) reported that garlic supplementation increase glutamic acid, alanine, valine, leucine, phenylalanine, and total amino acid in fish (Lee *et al.*, 2012a). They showed that garlic inclusion improved body weight and nitrogen retention (Lee *et al.*, 2012b). Garlic is rich in organosulfur compounds such as allicin, S-allyl cysteine, diallyl disulfide, S-methyl cysteine sulfoxide and S-allyl cysteine. The sulfur compounds may contribute to insulin synthesis. An increase in insulin concentration may induce acceleration for blood free amino acid uptake into muscle. The presence of sulfur from garlic might also increase the synthesis of methionine by bacteria in the digestive tract and can then be absorbed by the body. In addition, fermentation may increase the availability of methionine. Turmeric plus garlic inclusion increased the arginine content of broiler meat. Turmeric or garlic inclusion individually did not increase arginine content, and therefore it could be predicted that there is synergistic interaction between them in increasing arginine content.

*Saccharomyces cerevisiae* (cassava yeast) could synthesize histidine from 5-phospho- $\alpha$ -D-ribose-1-diphosphate. It assumes that during fermentation of *Sauropus androgynus* and bay leaves, histidine is synthesized so that the histidine content of those leaves increases. This may contribute to an increase in histidine of broiler meat fed 1.25% FSBL containing diet. In addition, fermentation may increase the availability of histidine. It is unknown why turmeric inclusion to FSBL containing diet reduced histidine.

### Fatty Acid Profile of Broiler Meat

The effect of turmeric and garlic inclusion to fermented *Sauropus androgynus*-bay leaves on meat fatty acid of female broilers is presented in Table 5. These results showed that the addition of turmeric and/or garlic to the FSBL containing diet significantly influenced lauric acid, myristic acid, linolenic acid, cis-11-eicosenoic acid, cis-4,7,10,13,16,19-docosahexaenoic acid ( $P < 0.05$ ),

n-3 fatty acid and n-6/n-3 fatty acid ratio ( $P < 0.01$ ). Lauric acid of T0 was higher than the other groups. Myristic acid of T0 was higher than T1, T2, T3, and T4, whereas T1 and T2 had higher myristic acid than T3 but similar to T4. Linolenic acid of T0, T1, and T2 was higher than T3. cis-11-eicosenoic acid of T0, T1, T2, and T3 was higher than T4. Cis-4,7,10,13,16,19-docosahexaenoic acid of T0 was higher than T3 and T4, whereas T1 and T2 were not different from T0, T3, and T4. Fatty acid n-3 of T0, T1, and T2 was higher than T3, and T4. N-6/n-3 ratio of T0 was lower than T3 and T4, whereas T1, and T2 were lower than T3 but similar to T4.

Daneshyar *et al.* (2011) reported that 0.25% (2.5 g/kg) turmeric powder inclusion did change the fatty acid composition of broiler chickens. The present study showed that 1 g turmeric/kg inclusion to FSBL reduced only myristic acid. However, garlic differs from turmeric in which it changes more fatty acids. The inclusion of garlic to FSBL containing diet reduced myristic acid, linolenic acid, n-3 fatty acid but increased n-6/n-3 fatty acid ratio.

A reduction of myristic acid by FSBL as compared with the control group (T0) agrees with the observation of Santoso *et al.* (2019) who reported the inclusion of FSBL reduced myristic acid of broiler meat. Supplementation of 2 g garlic into the FSBL containing diet could reduce myristic acid higher so that the level is lower than the FSBL group (T1). It is suspected that there is a synergy interaction between FSBL and garlic in reducing myristic acid since Kim *et al.* (2009) showed that giving 2% garlic did not reduce myristic acid. This presumption does not apply to turmeric supplementation to the FSBL containing diet, because turmeric was not able to further reduce myristic acid. Temme *et al.* (1997) reported that myristic acid increased low density lipoprotein (LDL) cholesterol of healthy human. A similar result was reported by Zock *et al.* (1994) who found that myristic acid increased LDL cholesterol, apoB, and low HDL to LDL ratio. Thus, reducing broiler meat myristic acid may be beneficial for consumers.

Linolenic acid reduced in broilers fed FSBL plus garlic when compared to those fed 1.25% FSBL. Kim *et al.* (2009) reported that giving 2% garlic did not change linolenic acid. Therefore, a negative interaction between FSBL and garlic is suspected, which causes a decrease in linolenic acid. Supplementation of 1 g turmeric into FSBL plus garlic could increase levels of linolenic acid

Table 5. The Effect of Turmeric and Garlic Inclusion to Fermented *Sauropus androgynous*-Bay Leaves on Meat Fatty Acid of Female Broilers

Fatty Acids (% fat)	T0	T1	T2	T3	T4	P
Lauric acid	0.143±0.104 <sup>b</sup>	0.045±0.006 <sup>a</sup>	0.050±0.014 <sup>a</sup>	0.080±0.025 <sup>ab</sup>	0.040±0.016 <sup>a</sup>	0.050
Myristic acid	0.630±0.171 <sup>c</sup>	0.445±0.006 <sup>b</sup>	0.440±0.022 <sup>b</sup>	0.360±0.074 <sup>a</sup>	0.413±0.045 <sup>ab</sup>	0.002
Myristoleic acid	0.135±0.006	0.125±0.021	0.113±0.021	0.093±0.033	0.105±0.037	0.226
Pentadecanoic acid	0.063±0.009	0.057±0.005	0.053±0.005	0.057±0.005	0.050±0.000	0.061
Palmitic acid	17.967±1.058	17.040±0.134	17.700±0.512	18.193±0.377	17.670±0.795	0.111
Palmitoleic acid	4.633±0.269	4.287±0.715	4.170±0.392	4.680±0.634	4.390±0.344	0.051
Heptadecanoic acid	0.047±0.005	0.053±0.005	0.050±0.008	0.063±0.013	0.050±0.000	0.087
Cis-10-Hetadecanoic acid	0.077±0.017	0.087±0.005	0.070±0.000	0.080±0.008	0.073±0.005	0.420
Stearic acid	4.623±0.029	4.257±0.555	4.553±0.279	4.410±0.163	4.417±0.330	0.305
Oleic acid	29.960±1.035	29.583±1.793	31.833±0.356	32.290±2.275	29.560±1.533	0.058
Linoleic acid	10.970±0.833	12.397±0.866	11.897±0.379	11.527±2.448	11.467±0.077	0.569
Arachidic acid	0.047±0.005	0.047±0.005	0.040±0.008	0.050±0.000	0.047±0.005	0.368
γ-Linolenic acid	0.120±0.008	0.127±0.012	0.110±0.000	0.123±0.024	0.120±0.016	0.478
Linolenic acid	0.433±0.033 <sup>bc</sup>	0.487±0.024 <sup>c</sup>	0.450±0.008 <sup>bc</sup>	0.370±0.067 <sup>a</sup>	0.410±0.022 <sup>ab</sup>	0.006
Cis-11-Eicosenoic acid	0.287±0.031 <sup>b</sup>	0.257±0.005 <sup>b</sup>	0.267±0.009 <sup>b</sup>	0.270±0.037 <sup>b</sup>	0.220±0.000 <sup>a</sup>	0.010
Cis-11,14-Eicosadienoic acid	0.127±0.024	0.110±0.008	0.110±0.008	0.103±0.061	0.110±0.008	0.355
Cis-8,11,14-Eicosatrienoic acid	0.193±0.071	0.220±0.016	0.173±0.009	0.193±0.041	0.167±0.026	0.203
Erucic acid	0.033±0.012	0.033±0.005	0.023±0.005	0.030±0.000	0.027±0.005	0.203



Table 5. The Effect of Turmeric and Garlic Inclusion to Fermented *Sauropus androgynus*-Bay Leaves on Meat Fatty Acid of Female Broilers (continued)

Fatty acids (% fat)	T0	T1	T2	T3	T4	P
Arachidonic acid	0.407±0.170	0.580±0.134	0.347±0.021	0.440±0.149	0.413±0.098	0.197
Cis-5, 8, 11, 14, 17- Eicosapentaenoic acid	0.033±0.009 <sup>a</sup>	0.033±0.012 <sup>a</sup>	0.033±0.009 <sup>a</sup>	0.030±0.000 <sup>a</sup>	0.017±0.005 <sup>a</sup>	0.105
Cis-4, 7, 10, 13, 16, 19- docosahexaenoic acid	0.037±0.012 <sup>b</sup>	0.027±0.009 <sup>ab</sup>	0.027±0.005 <sup>ab</sup>	0.020±0.000 <sup>a</sup>	0.020±0.000 <sup>a</sup>	0.026
Nervonic acid	0.043±0.026	0.027±0.005	0.013±0.009	0.030±0.014	0.053±0.015	0.111
Total fatty acid	70.423±2.492	70.323±2.445	72.520±0.647	73.488±1.160	69.810±2.306	0.074
Non fatty acid	29.578±2.492	29.678±2.445	27.480±0.647	26.513±1.160	30.190±2.306	0.074
Saturated fatty acid	22.935±0.911	21.945±0.569	22.885±0.651	23.213±0.590	22.685±0.822	0.189
Unsaturated fatty acid	47.488±1.659	48.378±2.394	49.635±0.371	50.275±1.738	47.125±1.485	0.075
Fatty acid n-3	0.535±0.025 <sup>b</sup>	0.580±0.014 <sup>b</sup>	0.533±0.025 <sup>b</sup>	0.450±0.069 <sup>a</sup>	0.475±0.017 <sup>a</sup>	0.001
Fatty acid n-6	11.690±0.610	13.325±0.892	12.528±0.403	12.283±2.653	12.168±0.055	0.509
Fatty acid n-9	29.960±1.035	29.583±1.793	31.833±0.356	32.290±2.275	29.560±1.533	0.059
n6-n3 fatty acid ratio	21.859±0.856 <sup>a</sup>	22.956±0.999 <sup>ab</sup>	23.538±0.357 <sup>ab</sup>	27.197±3.694 <sup>c</sup>	25.642±0.979 <sup>bc</sup>	0.006

T0 = Control without herbs; T1 = Feeds with 1.25% fermented *Sauropus androgynus*-bay leaves (FSBL); T2 = Feed with FSBL plus 1 g turmeric powder; T3 = Feed with FSBL plus 2 g garlic; T4 = Feed with FSBL plus 1 g turmeric and 2 g garlic.

so that it is relatively the same as the control but still below T1. Stark *et al.* (2008) stated that linolenic acid had an important role in cardioprotective effect, modulation of the inflammatory response, and central nervous system function. Thus, the inclusion of garlic to the FSBL containing diet has a negative effect, namely lowering linolenic acid. It is recommended that palm oil in this study can be replaced with a linolenic acid source oil.

Cis-11-eicosenoic acid is not produced by humans and comes from the diet. It has been found in the red blood cell membrane with increased concentrations in children with regressive autism (Bu *et al.*, 2006). Delgado *et al.* (2017) cis-11-eicosenoic acid has direct correlations with markers of inflammation and endothelial activations as well as heart failure in humans. Thus, a decrease in this fatty acid by the inclusion of garlic plus turmeric to FSBL containing diet may be beneficial for consumers. DHA was decreased by garlic plus FSBL (T3) compared to the control but tends to decrease when compared to FSBL (T1), while T1 is relatively the same as T0. From these data, it can be assumed that there is a negative interaction between FSBL and garlic so that DHA levels at T3 are lower than T0. DHA levels remain lower than the control group although turmeric was added to FSBL containing diet plus garlic..

Based on the description above, when we formulate feed additive from medicinal plants, it is necessary to consider interactions between the compounds contained in medicinal plants, so that the feed additive prepared will have a synergistic interaction.

## CONCLUSION

The inclusion of turmeric plus garlic to FSBL containing diet increased arginine, and methionine, and tended to increased aspartic acid, tyrosine, valine and total amino acid of broiler meats. Thus, turmeric plus garlic supplementation improved amino acid profiles of broiler meats. Turmeric plus garlic to FSBL containing diet reduced myristic acid, linolenic acid, cis-11-eicosenoic acid, n-3 fatty acids but increased n6-n3 fatty acid ratio. The inclusion of turmeric and/or garlic did not change moisture, fat, protein and ash contents of broiler meats. The possible interaction should be considered when we formulated feed additive from medicinal plant mixtures

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