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Fat deposition of broiler chickens fed a high-fat diet contained *Sauropus androgynus* leaf extract plus turmeric powder

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ABSTRAK

Rancangan acak lengkap faktorial digunakan untuk menganalisis pengaruh ekstrak daun katuk (EDK) plus tepung kunyit (TK) terhadap deposisi lemak pada ayam broiler yang diberi pakan tinggi lemak. Seratus lima puluh ayam broiler berumur 21 hari digunakan dalam penelitian ini. Faktor pertama adalah sumber lemak (6% lemak sapi dan 6% minyak sawit), dan faktor kedua adalah EDK plus TK [0 g EDK plus 0 g TK (G1), 9 g EDK plus 0,5 g TK (G2), 18 g EDK plus 0,5 g TK (G3), 9 g EDK plus 1 g TK (G4), 18 g EDK plus 1 g TK (G5)]. Suplementasi EDK plus TK mempengaruhi kolesterol, asam laurat, asam miristat, asam palmitat, asam stearat dan asam eikosapentaenoat daging (p <0,01). Sumber lemak mempengaruhi lemak, kolesterol, asam laurat, asam miristat, asam palmitat, asam stearat dan asam eikosapentaenoat daging (p <0,01). Terdapat interaksi yang signifikan antara dua faktor pada kadar lemak, kolesterol, asam laurat, asam palmitat, asam stearat, dan asam eicosapentaenoat daging. Kesimpulannya, suplementasi 18 g EDK plus 1 g TK pada pakan berlemak tinggi menghasilkan asam stearat yang lebih rendah, tetapi menghasilkan asam eikosapentaenoat yang lebih tinggi. Suplementasi EDK plus TK pada pakan tinggi lemak menurunkan kadar kolesterol daging dan mengubah komposisi asam lemak.

Kata kunci: Sauropus androgynus, tepung kunyit, penimbunan lemak, asam lemak, broiler

ABSTRACT

A factorial design was used to analyze the influence of *Sauropus androgynus* leaf extract (SALE) and turmeric powder (TP) on fat deposition in broilers fed high-fat diet. The first factor was the source of fat (6% beef fat and 6% palm oil), and the second factor was SALE plus TP [0 g SALE plus 0 g TP (G1), 9 g SALE plus 0.5 g TP (G2), 18 g SALE plus 0.5 g TP (G3), 9 g SALE plus 1 g TP (G4), 18 g SALE plus 1 g TP (G5)]. SALE plus TP affected cholesterol, lauric acid, myristic acid, palmitic acid, stearic acid and eicosapentaenoic acid contents (p<0.01). Fat sources affected fat, cholesterol, lauric acid, myristic acid, palmitic acid, stearic acid and eicosapentaenoic acid (p<0.01). There was a significant interaction between the two factors on fat, cholesterol, lauric acid, palmitic acid, stearic acid, and eicosapentaenoic acid contents. In conclusion, 18 g SALE plus 1 g TP supplementation to high-fat diet resulted in lower stearic acid, but it resulted in higher eicosapentaenoic acid. Supplementation of SALE plus TP to a high-fat diet lowered cholesterol content and changed fatty acids composition.

Keywords: Sauropus androgynus,turmeric powder,fat deposition,fatty acid, broilers

INTRODUCTION

Dietary fats are important in the diet of broiler chickens as a source of energy and essential fatty acids, and these fats also enhance the palatability of the diet and the absorption of fat-soluble vitamins. Therefore, feeding a high-fat diet may be useful in meeting the energy requirements of broiler chickens. Moreover, feeding a high-fat diet improves growth efficiency because of enhanced feed efficiency (Breslin *et al.*, 2010). A high-fat diet also causes longer feed retention in the gastrointestinal tract; and thus, improves nutritional digestion and absorption (Fouad and El-Senousey, 2014). However, feeding a high-fat diet may produce low quality meats because of high-fat deposition (Fouad and El-Senousey, 2014). In addition, consuming high-fat meats may induce obesity, hypercholesterolemia, atherosclerosis, coronary heart disease, stroke (Winter *et al.*, 2008; Pijlman *et al.*, 2010). To induce high fat deposition broiler chickens could be fed fat sources range from 4-8% (Baiao and Lara, 2005).

To minimize negative effects, a high-fat diet should be balanced by feeding supplements that could reduce fat deposition (Santoso *et al.*, 2000). *Sauropus androgynus* leaf is rich in palmitic acid, linolenic acid, chlorophyll, alkaloids and benzoic acid (Samad *et al.,* 2014), β-carotene and glutamic acid (Santoso *et al.*, 2015[a]), flavonoids and phenols (Santoso *et al.*, 2017). These compounds are detected to have antilipid and antioxidant properties. *Sauropus androgynus* leaf extract (SALE) reduced the cholesterol and triglyceride content of meats, and the fat deposition in poultry fed a normal-fat diet (Santoso and Sartini, 2001; Santoso *et al*., 2005; Santoso *et al*., 2010[a], 2013). SALE could be provided at 9-18 g/kg (Santoso *et al.*, 2005; Santoso *et al.,* 2010[a]) to reduce fat deposition in broiler chickens. However, no research is conducted in order to analyze the influence of *Sauropus androgynus* leaf on fat deposition in broiler chickens fed a high-fat diet.

To increase the ability of SALE in decreasing fat deposition it is necessary to add other antilipid ingredients. One potential ingredient is turmeric. Turmeric has potential to reduce blood triglyceride concentration in broiler chickens (Nouzarian *et al.*, 2011; Asai and Miyazawa. 2001.), enhances low-density lipoprotein receptors, hemeoxygenase and cholesterol 7 α-hydroxylase (Yiu *et al.*, 2011). Lone *et al.* (2014) found that curcumin (an active compound in turmeric) inhibite adipogenesis and induce the brown fat-like phenotype. Curcumin also increase fatty acids oxidation and reduce fatty acids esterification, resulting in net catabolism in adipose tissue (Ejaz *et al.*, 2009). Supplementation of turmeric powder at 1 g/kg diet is adequate for reducing fat deposition in broiler chickens (Samarasinghe *et al.*, 2003). Therefore, the influence of SALE-TP supplementation on fat deposition in broiler chickens fed a high-fat diet was studied. It was hypotesized that supplementation of SALE-TP mixture to a high-fat diet would reduce fat deposition in broiler chickens.

MATERIALS AND METHODS

The Extraction of *Sauropus andrognus* Leaf

The leaves were extracted according to Santoso *et al*. (2005), whereas turmeric powder was obtained from the traditional market. Basal diet contained 19,64% crude protein and 3,215 kcal ME/kg diet (Santoso *et al.*, 2010b).

Animals and Diets

Broilers (*Arbor Acres*) used in this study were maintained according to Santoso *et al*. (2015a) and Santoso (2015b). One hundred and fifty broiler chickens aged 21 days were weighed and selected, and were distributed into ten treatment groups of 15 broiler chickens each. The present research was arranged as completely randomized factorial design (2 x 5) in which two dietary fat sources, namely 6% beef tallow (BT) and 6% palm oil (PO), and five mixtures of SALE plus TP, namely 0 g SALE plus 0 g TP (G1), 9 g SALE plus 0.5 g TP (G2), 18 g SALE plus 0.5 g TP (G3), 9 g SALE plus 1 g TP (G4), and 18 g SALE plus 1 g TP (G5) were evaluated. Body weight of broilers were measured weekly and feed intakes were recorded daily. To induce high fat deposition broiler chickens could be fed fat sources range from 4-8% (Baiao and Lara, 2005), whereas SALE could be provided at 9-18 g/kg (Santoso *et al.*, 2005; Santoso *et al.*, 2010). Supplementation of turmeric powder at 1 g/kg diet was adequate to lower fat deposition in broiler chickens (Samarasinghe *et al*., 2003). Drinking water and diets were given *ad libitum*.

Sampling and Laboratory Analysis

Four broiler chickens aged 42 days in each group were slaughtered. After that, the abdominal and neck fat were removed and weighed. Fatty liver score was measured by comparing liver color with liver color standard from 1-5. Furthermore, leg meats were then removed and stored at -30°C. Fat and cholesterol contents were measured by the method of AOAC (1990), where as fatty acid composition was measured by the method of Almeida *et al*. (2006).

Data Analysis

All data were subjected to analysis of variance as a 2 × 5 factorial arrangement of dietary treatments with dietary fat sources and SALE-TP mixtureas main effects. If it was significantly different, the data were then further tested using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Fat Deposition and *Salmonella sp.*

Dietary fat sources did not influence abdominal fat, neck fat or fatty liver score (P>0.05), but it influenced meat fat or cholesterol content (P<0.01) (Table 1). It was found that beef-tallow diet resulted in higher the contents of fat or cholesterol in meats. The addition of SALE-TP mixture did not influence abdominal fat, neck fat, fatty liver score or fat content (P>0.05), but it reduced cholesterol content (P<0.01) (Table 2). SALE-TP inclusion significantly reduced meat cholesterol content in G4 and G5 (P<0.01). No interaction was found in abdominal fat, neck fat or fatty liver score, whereas interaction was found in meat fat (P<0.05) or cholesterol (P<0.01) contents (Table 3). Meat fat contents in BT.G4, BT.G5, PO.G1, PO.G2, PO.G3, PO.G4 and PO.G5 were significantly lower than BT.G1 (p<0.05), whereas meat cholesterol contents in BT.G3, BT.G4, BT.G5, PO.G1, PO.G2, PO.G3, PO.G4 or PO.G5 were significantly lower than BT.G1 and BT.G2 (P<0.01). No *Salmonella sp*. was found in broiler meats of all treatment groups.

The present study showed that a high-fat diet caused fatty liver disease as indicated by a high fatty liver score. A high-fat diet produced fatty liver disease, obesity and metabolic syndrome in mice (Bose *et al.,* 2008). Thus, SALE-TP supplementationis unable to prevent the occurrence of fatty liver disease.

Beef-tallow diet resulted in similar abdominal fat and neck fat deposition to palm-oil diet, which is in contrary to Smink *et al*. (2010). SALE-TP did not reduce fatty liver score, the fat deposition in abdomen or neck, and meat fat content.

The reduction of cholesterol content by SALE-TP supplementation might be caused by active compounds such as methylpyroglutamate, flavonoid, tannin, saponin (Warditiani *et al*., 2016) alkaloid (Santoso *et al*., 2010[c]) that present in *Sauropus androgynus* leaf and curcumin (Kim and Kim, 2010). Kamboh and Zhu (2013) reported that the inclusion of flavonoid reduced cholesterol content in serum, liver and breast meat. Afrose *et al*. (2010) reported that supplementation of 25 mg saponin reduced meat cholesterol content in breast and thigh of broiler chickens. Kim and Kim (2010) found that curcumin increased cholesterol 7a-hydroxylase (CYP7A1) gene expression, and Asai and Miyazawa (2001) found curcumin stimulated hepatic acyl-CoA oxidase activity, whereas FAS activity was not influenced. This suggested that curcumin influences fatty acid catabolism rather than fatty acid synthesis in the liver.

A high beef-tallow diet feeding produced a higher meat fat or cholesterol content a than high palm-oil diet feeding. Beef-tallow relatively contains similar saturated fatty acids to palm oil, but it has lower PUFA than palm-oil. The fatty acids composition of beef-tallow was as follows: myristic acid 3.7%, palmitic acid 21.5%, stearic acid 17.7% (saturated fatty acid), oleic acid 41.4% (monounsaturated fatty acids), linoleic acid 3.1% and linolenic acid 0.6% (PUFA) (Ramos *et al.*, 2009), whereas the composition of fatty acids of palmoil was as follows: myristic acid 0.7%, palmitic acid 36.7%, stearic acid 6.6%, oleic acid 46.1%, linoleic acid 8.6%, linolenic 0.3% (Chowdhury *et al*., 2007. Saturated fat source increase fat, cholesterol and triglyceride contents in comparison with unsaturated fat source (Katun *et al*., 2018; Smink *et al*., 2010).

The present results found that there was interaction between SALE-TP mixture and dietary fat sources on meat fat or cholesterol content. It is unknown that why this feed supplement decreased fat or cholesterol contents of meats in broiler chickens fed a high-beef tallow diet, but it did not reduce them in broiler chickens fed a high palm-oil diet. Feeding beef-tallow diet produced higher cholesterol levels as compared to palm-oil diet (Table 1). It is suspected that broiler chickens which had higher meat cholesterol contents are more easily modified. Low cholesterol content in the body is difficult to be reduced by a diet due to partly related to the amount of cholesterol needed

Table 1. The Effect of Dietary Fat Sources (Main Effect) on Fat Deposition of Broiler Chickens

Variables	6% BT	6% PO	SD	P
Fatty liver score	4.42	4.22	0.22	NS
Abdominal fat (g/100 g)	2.63	2.45	0.28	NS
Neck fat (g/100 g)	0.66	0.62	0.07	NS
Meat				
Fat (%)	3.02	2.51	0.31	P<0.01
Cholesterol (mg/100 mg)	1.56	1.38	0.11	P<0.01

BT= Beef Tallow, PO= Palm Oil, NS= non significant.

Table 2. The Effect of *Sauropus androgynus* LeafExtract Plus Turmeric Powder (Main Effect) Supplementation on Fat Deposition of Broiler Chickens

Variables	G1	G2	G3	G4	G5	SD	P
Fatty liver score	4.06	4.66	4.47	4.28	4.15	0.36	NS
Abdominal fat, %	2.54	2.58	2.95	2.24	2.35	0.28	NS
Neck fat, %	0.77	0.70	0.69	0.47	0.57	0.14	NS
Meat							
Fat , %	3.00	2.70	2.80	2.70	2.55	0.43	NS
Cholesterol (mg/100 mg)	1.57^a	1.60^a	1.50^a	1.31^b	1.31^b	0.28	P<0.01

G1= 0 g *Sauropus androgynus* leaf extract (SALE) + 0 g turmeric powder (TP); G2=9 g SALE + 0.5 g TP; G3=18 g SALE + 0.5 g TP; G4=9 g SALE + 1 g TP; G5=18 g SALE + 1 g TP. NS= non significant. Means within a row not followed by the same supercripts are significantly different.

by the body. It is assumed that low cholesterol content is only enough to meet the need of cholesterol in the body, therefore it is difficult to be modified by a diet. There is cholesterol resistance in the body to modification by diet. If the amount of cholesterol in the body is in accordance with the needs, the body will tend to maintain the levels. For example, cholesterol in eggs is more difficult to be modified by diet because cholesterol in eggs is prepared for embryo development later. Wood *et al.* (1961) reported that laying hens were less susceptible to hypercholesterolemia induced by dietary cholesterol than were mature cockerels. Santoso (1992) found that male broilers that have lower fat content are more difficult to be modified by feed restrictions when compared to female broilers that have higher fat content.

No *Salmonella sp.* was detected in broiler meats suggested that broiler chickens were maintained in proper condition, and therefore, it resulted in *Salmonella sp*. free meats. *Salmonella* is a major public health burden in many countries (Atterbury *et al*., 2007).

Meat Fatty Acid Composition

Dietary fat sources significantly affected lauric acid, myristic acid or stearic acid (P<0.01), but it did not influence other fatty acids (Table 4). Feeding a beef-tallow diet resulted in lower lauric acid, but it had higher myristic acid or stearic acid as compared to feeding a palm-oil diet. SALE-TP supplementation significantly affected lauric acid, myristic acid, palmitic acid, stearic acid or

Table 3. Interaction Effect of *Sauropus androgynus* Leaves Extract Plus Turmeric Powder Supplementation and Dietary Fat Sources on Fat Deposition in Broiler Chickens

Variables	Beef Tallow (BT)					Palm Oil (PO)					SD	FSxFT
	G1	G2	G3	G4	G5	G1	G2	G3	G4	G5		
FLS	4.56	4.81	4.50	4.00	4.24	3.56	4.50	4.44	4.56	4.06	0.56	NS
Abdominal fat, %	2.72	2.52	3.13	2.37	2.40	2.38	2.64	2.77	2.14	2.31	0.49	NS
Neck fat, %	0.93	0.63	0.73	0.45	0.56	0.61	0.77	0.66	0.49	0.59	0.22	NS
Meat												
Fat , %	3.72^{c}	3.09^{bc}	2.87^{b}	2.94^{b}	2.43^{ab}	2.26^{a}	2.34^{a}	2.67^{ab}	2.47^{ab}	2.70^{ab}	0.39	P<0.05
Cholesterol (mg/100 mg)	1.98^{c}	1.90^{c}	1.50^{b}	1.27^{a}	1.17^{a}	1.16^{a}	1.31^{a}	1.50^{b}	1.36^{b}	1.57^{b}	0.27	P<0.01
Salmonella sp.	0	0	0	0	0	0	0	0	0	0	0	

G1= 0 g *Sauropus androgynus* leaf extract (SALE) + 0 g turmeric powder (TP); G2=9 g SALE + 0.5 g TP; G3=18 g SALE + 0.5 g TP; G4=9 g SALE + 1 g TP; G5=18 g SALE + 1 g TP. Feed supplement (FS) contained SALE and turmeric powder mixture. FT= dietary fat sources. NS= non significant. Means within a row not followed by the same supercripts are significantly different. FLS = fatty liver score.

eicosapentaenoic acid (P<0.01), but it had no effect on oleic acid, linoleic acid, linolenic acid, docosapentaenoic acid or docosahexaenoic acid (Table 5). It was shown that lauric acid and myristic acid in G3 and P4 were higher than those in G1, G2 and G5. Furthermore, palmitic acid in G1 was lower than in G4, but it was higher than in G2 and G3. Moreover, eicosapentaenoic acid in G1 or G2 was lower than that in G3, G4 and G5.Interaction was found in lauric acid, palmitic acid, stearic acid or eicosapentaenoic acid (P<0.01), but it had no interaction in other fatty

Table 4. The Effect of Dietary Fat Sources (Main Effect) on Fatty Acid Composition of Broiler Meat

Fatt acid (% total fatty acid)	6% BT	6% PO	SD	P
Lauric acid	0.124	0.145	0.018	P<0.01
Myristic acid	0.147	0.09	0.029	P<0.01
Palmitic acid	9.42	9.57	0.165	NS
Stearic acid	2.03	1.775	0.148	P<0.01
Oleic acid	31.80	31.74	0.076	NS
Linoleic acid	22.371	21.539	0.455	NS
Linolenic acid	2.185	2.05	0.081	NS
Eicosapentaenoic acid	1.64	1.64	0.010	NS
Docosapentaenoic acid	1.437	1.311	0.074	NS
Docosahexaenoic acid	1.237	1.155	0.108	NS

BT= Beef Tallow, PO= Palm Oil

Table 5. The Effect of *Sauropus androgynus*LeafExtract PlusTurmeric Powder (Main Effect)Supplementation on Fatty Acid Composition of Broiler Meat

Fatty acid (% total fatty acid)	G1	G2	G3	G4	G5	SD	P
Lauric acid	0.0595^{a}	0.080^{a}	0.220^{b}	0.207^{b}	0.105^{a}	0.099	P<0.01
Myristic acid	0.0775^{a}	0.1105^{a}	0.179^{b}	0.149^{b}	0.085^{a}	0.057	P<0.01
Palmitic acid	9.505^{b}	8.792^{a}	10.095^{bc}	10.61^{c}	8.474^{a}	1.418	P<0.01
Stearic acid	1.957^{b}	2.118^{b}	2.134^{b}	1.966^{b}	1.338^{a}	0.468	P<0.01
Oleic acid	31.487	31.430	31.577	32.856	31.506	1.360	NS
Linoleic acid	23.584	21.854	20.853	21.793	21.555	1.127	NS
Linolenic acid	2.048	1.952	2.260	2.211	2.118	0.257	NS
Eicosapentaenoic acid	1.485^{a}	1.5^{a}	1.712^{b}	1.677^{b}	1.82^{b}	0.383	P<0.01
Docosapentaenoic acid	1.508	1.265	1.329	1.552	1.260	0.224	NS
Docosahexaenoic acid	1.162	1.106	1.217	1.435	1.074	0.194	NS

G1= 0 g *Sauropus androgynus* leaf extract (SALE) + 0 g turmeric powder (TP); G2=9 g SALE + 0.5 g TP; G3=18 g SALE + 0.5 g TP; G4=9 g SALE + 1 g TP; G5=18 g SALE + 1 g TP. Ns= non significant. Means within a row not followed by the same supercripts are significantly different.

Table 6. Interaction Effect of *Sauropus androgynus* Leaves Extract Plus Turmeric Powder Supplementation and Dietary Fat Sources on Fatty Acid Composition in Broiler Meat

Fatty acid (% total FA)	Beef Tallow (BT)					Palm Oil (PO)					SD	FSxFT
	G1	G2	G3	G4	G5	G1	G2	G3	G4	G5		
Lauric acid	0.054^{a}	0.08^{a}	0.106^{a}	0.300^{b}	0.079^{a}	0.065^{a}	0.081^{a}	0.335^{b}	0.114^{a}	0.131^{a}	0.17	P<0.01
Myristic acid	0.109^{b}	0.146^{bc}	0.175^{bc}	0.218^{c}	0.089^{ab}	0.046^{a}	0.075^{a}	0.183^{bc}	0.081^{ab}	0.081^{ab}	0.06	P<0.01
Palmitic acid	9.168^{a}	8.862^{a}	8.568^{a}	12.42^{b}	8.066^{a}	9.842^{a}	8.722^{a}	11.62^{b}	8.799^{a}	8.884^{a}	1.39	P<0.01
Stearic acid	1.91^{b}	2.065^{b}	2.167^{b}	2.710^{c}	1.301^{a}	2.004^{b}	2.172^{b}	2.101^{b}	1.223^{a}	1.377^{a}	0.46	P<0.01
Oleic acid	32.47	31.57	30.33	34.45	30.19	30.50	31.29	32.83	31.26	32.82	3.93	NS
Linoleic acid	23.36	22.31	21.51	22.20	22.21	23.81	21.40	20.20	21.39	20.90	1.06	NS
Linolenic acid	2.473	1.893	2.080	2.368	2.112	1.623	2.011	2.439	2.054	2.125	0.26	NS
Eicosapentaenoic acid	1.746^{c}	1.490^{b}	1.373^{b}	2.167^{d}	1.426^{b}	1.228^{a}	1.512^{b}	2.055^{d}	1.188^{a}	2.216^{d}	0.38	P<0.01
Docosapentaenoic acid	1.565	1.285	1.135	1.885	1.316	1.358	1.245	1.524	1.221	1.206	0.16	NS
Docosahexaenoic acid	1.132	1.097	1.215	1.304	1.069	1.193	1.117	1.219	1.166	1.079	0.19	NS

G1= 0 g *Sauropus androgynus* leaf extract (SALE) + 0 g turmeric powder (TP); G2=9 g SALE + 0.5 g TP; G3=18 g SALE + 0.5 g TP; G4=9 g SALE + 1 g TP; G5=18 g SALE + 1 g TP. Feed supplement (FS) contained SALE and turmeric powder mixture. FT= dietary fat sources. FA= fatty acid. Means within a row not followed by the same supercripts are significantly different.Ns= non significant.

acids (Table 6). Lauric acid was higher in BT.G4 and PO.G3, and palmitic acid was higher in BT.G4 and PO.G3 as compared to other treatment groups. Furthermore, stearic acid was the lowest in BT.G5, PO.G4 and PO.G5, whereas eicopentaenoic acid was the lowest in PO.G1 and PO.G5.

The higher myristic acid and stearic acid in broiler fed high beef-tallow diet were as result from higher their contents in beef tallow as compared with palm oil (Chowdhury *et al*., 2007; Ramos *et al.*, 2009). Bonoli *et al*. (2007) reported that feeding animal fat produced chicken meats with higher myristic acid, palmitic acid and similar lauric acid and stearic acid as compared to vegetable oil.

Sauropus androgynus leaf contains a high palmitic acid (Santoso *et al*., 2015a) or linolenic acid (Samad *et al.*, 2014). However, the mixture of SALE and TP inconsistently affected palmitic acid with no effect on linolenic acid.This result is in contrary with the study of Santoso *et al.* (2018) who showed lower meat linolenic acid in broilers fed a diet contained 5% *Sauropus androgynus* leaves. It was unknown why this mixture influenced lauric acid, myristic acid, palmitic acid, stearic acid and eicosapentaenoic acid. Lower stearic acid with higher eicosapentaenoic acid in meat of broiler chickens fed high-fat diet supplemented with 18 g SALE plus 1 g TP might be beneficial for consumers because it was known that consuming a product with higher eicosapentaenoic acid reduced the risk of cardiovascular diseases (Schacky and Harris, 2007). Curcumin inclusion would prevent the oxidation of unsaturated fatty acids in broiler meats (Khan *et al.*, 2012).

There was significant interaction between the two factors on the lauric acid, myristic acid, palmitic acid or eicosapentaenoic acid. It was shown that supplementing 9 g SALE plus 1 g TP to 6% beef tallow diets produced meats with higher lauric acid, myristic acid, palmitic acid, stearic acid and eicosapentaenoic acid, whereas supplementing 18 g SALE plus 0.5 g TP to 6% palm oil diets produced meats with higher lauric acid, myristic acid, palmitic acid, stearic acid and eicosapentaenoic acid.

In overall, supplementation of 18 g SALE plus 1 g TP to 6% beef-tallow diet produced meats with lower cholesterol, fat and stearic acid contents. This similar mixture supplementation to 6% palm-oil diet produced meats with lower stearic acid, higher eicosapentaenoic acid, fat and cholesterol. It appears that this mixture is more useful when it is supplemented to 6% beef-tallow diet than that to 6% palm-oil diets.

CONCLUSION

Supplementation of SALE-TP to a high-fat diet reduced meat cholesterol content and changed fatty acid composition. Supplementation of 18 g SALE plus 1 g TP to a high-fat diet produced lower stearic acid and higher eicosapentaenoic acid meats. This mixture was more useful when it was supplemented to 6% beef-tallow diet than that to 6% palm-oil diet. Feeding a beef-tallow diet increased fat and cholesterol content of broiler meats. This research discovers the potential of *Sauropus androgynus* leaf extract plus turmeric powder for normalizing or reducing fat deposition in broiler chickens fed high-fat diet.

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