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# THE EFFECT OF *SAUROPUS ANDROGYNUS* LEAVES EXTRACT PLUS TURMERIC POWDER ON FAT DEPOSITION, CARCASS QUALITY AND BLOOD PROFILE IN BROILERS FED LOW PROTEIN DIETS

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## ABSTRAK

Penelitian ini dirancang untuk mengevaluasi efektivitas suplementasi ekstrak daun katuk (EDK) plus tepung kunyit (TK) terhadap mutu karkas dan profil darah pada broiler yang diberi pakan berprotein rendah. Enam puluh broiler umur 14 hari dibagi ke dalam 5 kelompok perlakuan sebagai berikut: 1) Broiler diberi pakan berprotein 19% tanpa suplementasi sebagai kontrol (P0); 2) Broiler diberi pakan berprotein 17% yang disuplementasi dengan 4,5 g EDK/kg pakan plus 0,5% TK; 3) Broiler diberi pakan berprotein 17% yang disuplementasi dengan 4,5 g EDK/kg pakan plus 1% TK; 4) Broiler diberi pakan berprotein 15% yang disuplementasi dengan 4,5 g EDK/kg pakan plus 0,5% TK dan; 5) Broiler diberi pakan berprotein 15% yang disuplementasi dengan 4,5 g EDK/kg pakan plus 1% TK. Suplementasi EDK plus TK berpengaruh nyata (P<0,05) terhadap pertambahan berat badan, konsumsi pakan, konsumsi protein, cacat daging paha dan deposisi lemak. Tidak ditemukan pengaruh nyata (P>0,05) dari perlakuan terhadap bau karkas, warna shank, cacat dada, berat paha, berat dada (P>0,05), kadar kolesterol daging, fatty liver score dan toksisitas. Dapat disimpulkan bahwa suplementasi EDK plus TK pada pakan berprotein rendah tidak mampu menurunkan deposisi lemak, tetapi menurunkan konsentrasi asam urat dan meningkatkan konsentrasi glukosa dalam darah pada broiler.

*Kata kunci: ekstrak daun katuk, tepung kunyit, deposisi lemak, broiler*

## ABSTRACT

The present study was designed to evaluate the effectiveness of *Sauropus androgynus* leaves extract (SALE) plus turmeric powder (TP) on carcass quality and blood profile in broilers fed low protein diets. Sixty broilers aged 14 days were divided to 5 treatment groups as follows: 1) Broilers fed 19% protein diet without SALE plus TP as control (P0); 2) Broilers fed 17% protein diet supplemented to 4.5 g SALE/kg diet plus 0.5% TP (P1); 3) Broilers fed 17% protein diet supplemented to 4.5 g SALE/kg diet plus 1% TP (P2); 4) Broilers fed 15% protein diet supplemented to 4.5 g SALE/kg diet plus 0.5% TP (P3) and; 5) Broilers fed 15% protein diet supplemented to 4.5 g SALE/kg diet plus 1% TP (P4). Supplementation of SALE plus TP significantly affected body weight gain, feed intake, protein intake, thigh meat haemorrhage and fat deposition (P<0.05). No significantly different was observed on carcass odor, shank color, breast meat haemorrhage, leg and breast weight, meat cholesterol, fatty liver score and tocixity (P>0.05). In conclusion suplementation of SALE plus TP had no beneficial effect on reducing fat deposition in broilers fed low protein diets, but it reduced blood uric acid but increased blood glucose concentration.

*Keywords: Sauropus androgynus leaves extract, turmeric powder, fat position, broilers*

## INTRODUCTION

Experimental investigation showed that feeding low protein diets to broilers reduced production cost and nitrogen pollution resulted from its excessive excretion (El-Hakim *et al*., 2009; Hernandez *et al*., 2012); reduced nitrogen convertion to ammonia; reduced heat stress (Furlan *et al.*, 2004) and increased nitrogen utilization efficiency in poultry (El-Hakim *et al.*, 2009; Parsons, 1995; Nahm, 2007). Schuttle *et al.* (1993) reported that the reduction of 1% nitrogen each in the diets would reduce nitrogen excretion as many as 10%. Hernandez *et al.* (2012) found that the reduction of 1.5% or 3.0% protein content in diets would reduce nitrogen excretion as many as 9.5% or 17% in male broilers, and 11.8% or 14.6% in female broilers. However, feeding low protein diets increased fat deposition and fat contents of meat and carcass (Bunchasak *et al.*, 1997; Farahdiba *et al.*, 2011; Jlali *et al*., 2012; Labussiere *et al*., 2008: Pesti, 2009; Wood *et al*., 2004). A high fat content of broiler meat and carcass reduced market value, because recently consumers tended to consume low fat poultry products. It was known that consuming a high fat meat would increase risk of hypercholesterolemia, atherosclerosis, coronary heart disease, stroke and cancer occurences (Pal *et al.*, 1999; Grundy dan Denke, 1990).

The disadvantage of feeding low protein diets should be balanced by feed additive supplementation which could inhibit fat deposition. Santoso *et al.* (2013) showed that supplementation of 4.5 g *Sauropus androgynus* leaves extract (SALE) to low protein diets could maintain fat level of broiler meat similar to control. It means that SALE could inhibit a high fat growth resulted from feeding low protein diets. However, it was known that broilers fed normal protein level diets still produced high fat broiler meats. Therefore, it might be benefit if SALE supplementaion is combined with another supplement to produce meat with lower fat content than the normal condition. One of the potential herbal is turmeric. Supplementation of 1 g turmeric powder (TP) per kg diet was proven to reduce abdominal fat deposition in broilers (Samarasinghe *et al*., 2003). Solichedi (2001) reported that 2% TP supplementation to diets reduced abdominal fat deposition and meat cholesterol content in broilers. Napirah (2013) also reported that 1% turmeric supplementation tended to reduce meat fat and cholesterol content in quail. Yiu *et al.* (2011) turmeric supplementation increased *cholesterol 7 α-hydroxylase*, *hemeoxygenase 1* and *low-density lipoprotein receptors*.

On the basis of reason above, the present study was conducted to evaluate the effect of SALE plus TP supplementation on fat deposition in broilers fed low protein diets. It was hypotized that supplementation of SALE plus TP reduce fat deposition in broilers fed low protein diets.

## MATERIALS AND METHODS

### *Sauropus androgynus* Leaves Extraction and Turmeric Powder

*Sauropus androgynus* (katuk) leaves obtained from local market was extracted by the method of Santoso *et al.* (2010). Nutritional composition of *Sauropus androgynus* leaves extacted by ethanol 70%, ethanol 95% and hexane were also observed. Turmeric was collected from local market, washed and dried under the sun for 5 days, dried, milled and stored.

### Animals

This study used a one-day old mixed sex broilers obtained from commercial hatchery. From 1 to 14 days of age, supplemental heat was provided with a hanging heat lamp. Temperature was maintained at 32.5°C in the first week and gradually decreased at the second week. The broilers were reared on the litter pens in a house under continuous fluorescent lighting with feed and water available *ad libitum*. Experimental diets are presented in Table 1.

### Feeding Treatments

SALE level resulted from previous study (Santoso *et al*., 2013) was used in the present study and combined with TP at various levels. Sixty broilers aged 14 days of age were divided to 5 treatment groups as follows: 1) Broilers fed 19% protein diet without SALE plus TP as control (P0); 2) Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP (P1); 3) Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP (P2); 4) Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP (P3) and; 5) Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP (P4). Broilers were weighed weekly, whereas feed intakes were measured daily. Body weight gain, feed intake, protein intake and feed

Table 1. Experimental Composition of Diets

| Feedstuffs (%) | P0 | P1 | P2 | P3 | P4 |
|---|---|---|---|---|---|
| Yellow corn | 57.00 | 60.69 | 60.69 | 59.44 | 59.44 |
| Rice bran | 5.00 | 8.37 | 7.87 | 17.12 | 16.62 |
| Concentrate | 34.20 | 26.69 | 26.69 | 19.19 | 19.19 |
| Mineral mixture | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 |
| Salt | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Top mix | 0.50 | 0 | 0 | 0 | 0 |
| SALE | 0 | 0.45 | 0.45 | 0.45 | 0.45 |
| Turmeric powder | 0 | 0.50 | 1.00 | 0.50 | 1.00 |
| Oil | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| Protein (%) | 19.35 | 17.13 | 17.13 | 15.06 | 15.06 |
| ME (kcal/kg) | 3155.60 | 3150.18 | 3150.18 | 3102.29 | 3102.29 |
| Ca (%) | 1.51 | 1.31 | 1.31 | 1.11 | 1.11 |
| P (%) | 0.86 | 0.81 | 0.81 | 0.81 | 0.81 |

P0 = Broilers fed 19% protein diet without *Sauropus androgynus* leaves extract (SALE) plus turmeric powder (TP); P1 = Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP; P2 = Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP; P3 = Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP and; P4 = Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP.

efficiency were then calculated.

**Sampling and Laboratorium Analysis**

At the end of experiment (35 days of age), 4 broilers for each treatment group were selected based on body weight, slaughtered and internal organs were weighed. Blood collection was conducted before slaughering for glucose and uric acid concentration analysis. Leg meats were collected, weighed and then analyzed for cholesterol contents (AOAC, 1980). Haemorrhage in thigh and breast meats, and meat color were scored according to Institute for Animal Science and Health, Netherlands reference scale of 1-5; shank colors were scored by broiler color fan from 101-108; and fatty liver score was measured by comparing liver color with standard color from 1-5 (Santoso *et al.*, 2013).

Hepatosomatic index (HIS) was calculated as follows: liver weight/body weight x 100%, whereas viscerosomatic index (VSI) was calculated as follows: internal organ weight/body weight x 100% and toxicity was calculated as follows: (liver + spleen) weights/body weight x 100%.

**Data Analysis**

All data were subjected to analysis of variance, and if there were significantly different they were then determined by Duncan's Multiple Range Test.

## RESULTS AND DISCUSSION

**Nutritional Composition of SALE**

Proximate analysis of *Sauropus androgynus* leaves extracted by different solution are presented in Table 2. It was shown that ethanol 70% extract was rich in ash and protein but low in extract ether and nitrogen free extrcat (NFE). Ethanol 95% extract was rich in protein and extract ether but low in ash and NFE. *Sauropus androgynus* leaves extracted by hexane had low in ash and protein but high in extract ether and NFE. These three solutions resulted in similar content

Table 2. Proximate Analysis of *Sauropus androgynus* Leaves Extract

| | Dry Matter | Ash | Protein | Crude Fiber | Ether Extract | NFE | Moisture |
|---|---|---|---|---|---|---|---|
| Ethanol 70%, % | 83.05 | 8.76 | 24.14 | 10.04 | 12.16 | 27.95 | 16.95 |
| Ethanol 95%, % | 89.40 | 2.52 | 23.68 | 13.25 | 24.01 | 25.94 | 10.60 |
| Hexane, % | 97.95 | 1.18 | 12.53 | 11.96 | 26.85 | 45.43 | 2.05 |

NFE = Nitrogen Free Extract

of crude fiber. In order to extract protein from *Sauropus androgynus* leaves ethanol was better than hexane.

**Performance of Broiler**

Effect of *Sauropus androgynus* leaves extract and turmeric podwer supplementation on performance of broilers fed low protein diets are presented in Table 3. Supplementation of SALE plus TP significant affected body weight gain ($P<0.05$). It was shown that P4 had lower body weight gain than P0 and P1 ($P<0.05$), but it was similar to P2 and P3 ($P>0.05$). Supplementation of SALE plus TP significantly affected feed intake and protein intake ($P<0.05$). It was shown that P3 and P4 had lower feed intake as compared to P0, P1 and P2. P3 and P4 had lower protein intake as compared to P0.

It was shown that supplementation SALE at level of 4.5 or 9 g/kg plus 0.5% or 1% TP to 17% protein diet or supplementation 4.5 g SALE/kg plus 0.5% TP to 15% protein diet resulted in similar body weight gain as compared to 19% protein diet. Nuraini *et al.* (2014) found that supplementation of SALE to 17% protein diets resulted in similar body weight to 19% protein diet, but supplementation of SALE to 15% protein diets resulted in lower body weight gain. It was interested that in the present study showed that the combination of 4.5 g SALE/kg and 0.5% TP resulted in similar body weight gain to 19% protein diet (control). It means that supplementation of 0.5% TP stimulated growth of broilers fed 15% protein diets. Hosseini-Vashan *et al*. (2012) reported that 0.8% TP supplementation tended to increase body weight in broilers under heat stress. Suvanated *et al*. (2003) reported that broilers under heat stress fed dietary turmeric powder had a higher body weight gain, energy efficiency ratio, yield of production and lower FCR than the basal diet. The present study was conducted in Bengkulu region which have temperatur range from 26$^{o}$C to 34$^{o}$C indicated that broilers might be reared under heat stress.

**Carcass Quality**

Effect of SALE plus TP supplementation on carcass quality of broilers fed low proteins diets are presented in Table 4. No significantly different was observed on carcass odor, shank color, haemorrhage in breast meat and leg weight ($P>0.05$). SALE plus TP supplementation significantly affected haemorrhage in thigh. It was shown that P2, P3 and P4 had lower score of haemorrhage in thigh as compared with P0 and P1, whereas P1 had lower score than P0. Similar results was reported by Santoso *et al.* (2013) who found that SALE supplementation reduced haemorrhage in thigh meat. *Sauropus androgynus* leaves is rich in flavonoids and antioxidants (Andarwulan *et al*., 2010), and anti-inflammantory (Selvi and Bhascar, 2012). These factors were predicted to play a role in the reduction of haemorrhages in thigh meat. In addition, turmeric powder supplementation might also contribute to this phenomenon, since turmeric exhibit anti-inflammatory, anti-human immunodeficiency virus, anti-bacteria, antioxidant effects and nematocidal activities (Araujo and Leon, 2001).

*Sauropus androgynus* leaves is rich in iron, i.e. 2.7 mg/100 g of fresh leaves (Wiradimadja *et al.*, 2006), but it did not improve the color of broiler meats. This result was in agreement with Santoso *et al*. (2013) finding who reported that supplementation of SALE did not increase the color of broiler meats. In addition, turmeric supplementation had also no beneficial effect on increasing meat color.

Although shank color was not significantly different, the value of P2 and P4 had higher shank color as compared to the control. Therefore,

Table 3. Effect of *Sauropus androgynus* Leaves Extract and Turmeric Powder Supplementation on Performance of Broilers Fed Low Protein Diets

| Variable | P0 | P1 | P2 | P3 | P4 | SD |
|---|---|---|---|---|---|---|
| Weight gain, g/bird/day | 74.4$^{b}$ | 72.2$^{b}$ | 69.8$^{ab}$ | 70.0$^{ab}$ | 59.6$^{a}$ | 26.2 |
| Feed intake, g/bird/day | 157.3$^{b}$ | 146.8$^{b}$ | 156.3$^{b}$ | 120.6$^{a}$ | 137.0$^{a}$ | 20.0 |
| Protein intake, g/bird/day | 30.4$^{b}$ | 25.2$^{ab}$ | 26.8$^{ab}$ | 18.2$^{a}$ | 20.6$^{a}$ | 3.9 |
| Feed efficiency, % | 47.3 | 49.2 | 44.7 | 58.0 | 43.5$^{ns}$ | 6.5 |

SD = standard deviation; P0 = Broilers fed 19% protein diet without *Sauropus androgynus* leaves extract (SALE) plus turmeric powder (TP); P1 = Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP; P2 = Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP; P3 = Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP and; P4 = Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP.

Table 4. Effect of *Sauropus andogynus* Leaves Extract and Turmeric Powder Supplementation on Carcass Quality of Broilers Fed Low Protein Diets

| Variable | P0 | P1 | P2 | P3 | P4 | SD |
|---|---|---|---|---|---|---|
| Carcass odor | 3.5 | 2.81 | 3.38 | 2.75 | 3.31$^{ns}$ | 0.72 |
| Shank color score | 102.3 | 102.3 | 103.0 | 102.0 | 103.5$^{ns}$ | 0,88 |
| Haemorrhage in thigh | 3.25$^{c}$ | 2.00$^{b}$ | 1.56$^{a}$ | 1.63$^{a}$ | 1.50$^{a}$ | 1.06 |
| Haemorrhage in breast | 2.06 | 1.63 | 1.56 | 1.50 | 1.50$^{ns}$ | 0,35 |
| Left leg weight, % BW | 10.76 | 9.99 | 10.16 | 10.26 | 10.58$^{ns}$ | 0,88 |
| Right leg weight, % BW | 10.36 | 10.62 | 10.43 | 10.79 | 10.39$^{ns}$ | 0.85 |
| Left breast weight, % BW | 11.77 | 10.67 | 11.25 | 10.01 | 10.96$^{ns}$ | 0.75 |
| Right breast weight, % BW | 11.56 | 10.12 | 11.05 | 9.98 | 9.95$^{ns}$ | 0.70 |
| Meat color score | 2.63 | 2.38 | 2.13 | 2.00 | 2.38$^{ns}$ | 0.43 |

SD = standard deviation; P0 = Broilers fed 19% protein diet without *Sauropus androgynus* leaves extract (SALE) plus turmeric powder (TP); P1 = Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP; P2 = Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP; P3 = Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP and; P4 = Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP.

although *Sauropus androgynus* leaves had high level of β-carotene (Hulshof *et al.*,1997), supplementation of SALE at level of 4.5 g SALE/kg diets was not addequate to induce shank color. This SALE level will induce shank color if SALE is combined with 1% TP. It means that turmeric powder had significant contribution on shank color.

No change in carcass odor was in agreement with Santoso *et al.* (2013) observation who found that SALE supplementation did not reduce carcass odor. Therefore, this result showed no beneficial effect of turmeric powder on reducing carcass odor.

**Fat Deposition, Blood, Uric Acid and Glucose Concentration**

Effect of *Sauropus androgynus* leaves extract and turmeric powder suppelementation on total fat deposition, meat cholesterol, fatty liver score,

Table 5. Effect of *Sauropus andogynus* Leaves Extract and Turmeric Powder Supplementation on Total Fat Deposition, Meat Cholesterol, Fatty Liver Score, Serum Glucose and Uric Acid Concentration in Broilers Fed Low Protein Diets

| Variable | P0 | P1 | P2 | P3 | P4 | SD |
|---|---|---|---|---|---|---|
| Total fat deposition, % BW | 2.14$^{a}$ | 2.46$^{ab}$ | 3.22$^{b}$ | 3.35$^{b}$ | 3.59$^{b}$ | 0.75 |
| Meat cholesterol, mg/100 mg | 0.68 | 0.64 | 0.66 | 0.66 | 0.65$^{ns}$ | 0.05 |
| Fatty liver score | 2.56 | 2.56 | 2.44 | 2.31 | 2.63$^{ns}$ | 0.33 |
| Glucose,mg/dl | 196.00$^{b}$ | 194.00$^{b}$ | 137.00$^{a}$ | 254.00$^{c}$ | 231.00$^{c}$ | 40.46 |
| Uric acid, mg/dl | 6.50 | 4.40 | 3.30 | Low | Low | - |

SD = standard deviation; P0 = Broilers fed 19% protein diet without *Sauropus androgynus* leaves extract (SALE) plus turmeric powder (TP); P1 = Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP; P2 = Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP; P3 = Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP and; P4 = Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP.

serum glucose and uric acid concentrations in broilers fed low protein diets are presented Table 5. Supplementation of SALE plus TP to low protein diets significantly affected fat deposition ($P<0.05$), but it had no effect on meat cholesterol and fatty liver score ($P>0.05$). It was shown that P0 had lower fat deposition as compared with P2, P3 and P4 ($P<0.05$) but it was similar to P1 ($P>0.05$).

A higher fat deposition in broiler chicken fed low protein diet showed that supplementation SALE plus TP failed to inhibit rapid fat deposition as a result of feeding low protein diets. The present study was in contrary with the observation Santoso *et al.* (2013) who found that SALE supplementation inhibit fat deposition in broiler fed low protein diets, and therefore fat deposition was similar to broilers fed normal protein diets. This difference might be caused by difference of slaughtered age where in the previous study broilers were slaughtered at 42 days of age whereas in the present study was slaughtered at 35 days age. It was unkown why TP could not inhibit fat deposition as a result of feeding low protein diets. SALE and TP might have antagonist compounds and therefore they failed to reduce fat deposition in broilers fed low protein diets.

SALE plus TP supplementation could inhibit rapid cholesterol deposition as a result of feeding low protein diets although its content was still similar to the control (broiler chicken fed 19% protein diets). Santoso *et al*. (2013) reported that supplementation of 4.5 g SALE/kg diet resulted in similar meat cholesterol content to the control. Therefore, TP supplementation at level of 0.5% or 1% could not reduce meat cholesterol content further.

The concentrations of blood glucose for P0, P1, P2, P3 or P4 were 196 mg/dl, 194 mg/dl, 137 mg/dl, 254 mg/dl or 231 mg/dl, whereas the concentration of blood uric acid for P0, P1, P2, P3 or P4 were 6,5 mg/dl, 4,4 mg/dl, 3,3 mg/dl, low or low, respectively (Table 5). Thus, feeding low protein diets reduced blood uric acid, and higher turmeric powder supplementation might also reduce it. Lower blood uric acid concentration might indicate lower nitrogen excretion and therefore reduce nitrogen pollution. This asumption was in agreement with the observation of Schuttle *et al.* (1993) and Hernandez *et al.* (2012) who found that feeding low protein diet reduced nitrogen excretion. Low protein diet reduced both plasma ammonia (Okumura and Tasaki, 1969) and ucid acid (Karasawa *et al.*, 1973; Okumura and Tasaki, 1969) in chickens. Lower blood uric acid was in agreement with Namroud *et al.* (2008) who found that feeding low protein diet resulted in lower plasma uric acid in broiler chicks. Furthermore, they reported that feeding low protein diet reduced nitrogen and uric acid contents in excreta. Gowda *et al.* (2008) found than inclusion of 0.5% turmeric powder tended to reduce serum uric acid (from 6.2 mg/dl to 5.8 mg/dl) in broilers. Kumari *et al.* (2007) also found that supplementation of turmeric powder (1 g/kg diet) reduced serum uric acid concentration

(from 6.31 mg/dl to 4.21 mg/dl) in broilers. It is a well documented that uric acid constitutes 60-80 % of total nitrogen in the urine of the birds. In birds it is synthesized in liver as well as kidney. Uric acid of birds is not catalyzed into allentoin, like mammals, due to absence of necessary enzyme like uricase (Kumari *et al.*, 2007).

It was unkown why low protein diets increased blood glucose concentration, and suplementation of 1% turmeric powder had lower glucose concentration than that of 0.5% turmeric powder. Feeding low protein diet might reduce glucose catabolism related hormon such as insulin. Hada *et al.* (2013) found that broilers fed low protein presented lower body weight, feed intake, and worse feed conversion ratio on day 42, as well as lower carcass and breast yields, higher leg and abdominal fat yields, higher triglyceride and lower uric acid blood levels (Hada *et al.*, 2013), but had no effect on blood glucose concentration. Gannon *et al.* (2003) found that low protein diet resulted in higher blood glucose concentration in persons with type 2 diabetes. It was unkown why higher turmeric powder resulted in lower blood glucose concentration. Klemens (2006) stated that turmeric may decrease blood sugar levels. The apparent blocking of enzymes that convert dietary carbohydrates into glucose may be involved in this lowing of blood sugar. Kumar and Salimath (2014) reported that supplementation turmeric extract reduced blood glucose concentration in streptozotocin-induced diabetic rats.

**Internal Organ Weight**

Effect of *Sauropus androgynus* leaves extract and turmeric powder on internal organ weights and toxicity in broilers fed low protein diets are presented in Table 6. It was shown that supplementation *Sauropus androgynus* extract plus turmeric powder had no effect on HIS, heart, spleen, gizzard, intestine, pankreas, shank, VIS, intestine length and toxisity. These data indicated that supplementation SALE plus TP to low protein diets had no negative effect on the function of internal organs. The present study was in agreement with the observation of Santoso *et al*. (2013) who found that SALE supplementation did not cause toxicity. In addition, Araujo and Leon (2001) reported that *Curcuma longa* L. (*Zingiberaceae*) exhibited anti-inflammatory, anti-human immunodeficiency virus, anti-bacteria,

Table 6. Effect of *Sauropus andogynus* Leaves Extract and Turmeric Powder Supplementation on Internal Organ Weights and Toxicity in Broilers Fed Low Protein Diets

| Variables (%BW) | P0 | P1 | P2 | P3 | P4 | SD |
|---|---|---|---|---|---|---|
| HIS | 2.72 | 2.33 | 2.57 | 2.34 | 2.10$^{ns}$ | 0.41 |
| Heart | 0.55 | 0.48 | 0.50 | 0.60 | 0.67$^{ns}$ | 0.09 |
| Spleen | 0.22 | 0.25 | 0.22 | 0.29 | 0.16$^{ns}$ | 0.10 |
| Gizzard | 1.92 | 1.77 | 1.94 | 2.11 | 1.98$^{ns}$ | 0.30 |
| Intestine | 2.61 | 2.50 | 2.69 | 3.00 | 2.97 $^{ns}$ | 0.32 |
| Intestine length | 11.63 | 10.92 | 12.10 | 13.66 | 13.34$^{ns}$ | 1.54 |
| Pankreas | 0.29 | 0.27 | 0.33 | 0.33 | 0.33$^{ns}$ | 0.06 |
| Shank | 3.53 | 3.50 | 3.87 | 3.96 | 4.02$^{ns}$ | 0.36 |
| VSI | 8.31 | 7.60 | 8.26 | 8.66 | 8.21$^{ns}$ | 0.58 |
| Toxicity | 2.94 | 2.58 | 2.79 | 2.63 | 2.26$^{ns}$ | 0.45 |

HIS = hepatosomatic index; VSI = viscerosomatic index; SD = standard deviation; P0 = Broilers fed 19% protein diet without *Sauropus androgynus* leaves extract (SALE) plus turmeric powder (TP); P1 = Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP; P2 = Broilers fed 17% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP; P3 = Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 0.5% TP and; P4 = Broilers fed 15% protein diet supplemented with 4.5 g SALE/kg diet plus 1% TP.

antioxidant effects and nematocidal activities. Curcumin is a major component in *Curcuma longa* L. being responsible for its biological actions. *In vitro*, curcumin exhibited anti-parasitic, antispasmodic, anti-inflammatory and gastrointestinal effects; and also inhibited carcinogenesis and cancer growth. *In vivo*, curcumin showed the antiparasitic and anti-inflammatory properties.

## CONCLUSION

Supplementation of SALE plus TP did not reduce fat deposition in broilers fed low protein diets. Supplementation of SALE plus TP reduced blood uric acid but increased blood glucose concentration.

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