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Effect of Turmeric and Garlic Inclusion to *Sauropus androgynus*-Bay Leaves Containing Diets on Performance, and Carcass Quality of Broilers

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ABSTRACT

This study aimed to examine the effect of turmeric or garlic supplementation to fermented *Sauropus androgynus*-bay leaves (FSBL) containing diet on performance, carcass quality and meat organoleptic status in broilers. This study used a completely randomized design. Two hundred 15-day-old female broilers were grouped into 5 groups with 4 replications as follows: Diet with 0.5% commercial feed additive (P0); 1.25% FSBL containing diet (P1); 1.25% FSBL containing diet plus 1 g turmeric powder (P2); 1.25% FSBL containing diet plus 2 g garlic (P3); 1.25% FSBL containing diet plus 1 g turmeric and 2 g garlic (P4). The results showed that the use of turmeric or garlic to FSBL containing diet did not affect body weight gain, feed intake, feed conversion ratio, carcass weight, meat bone ratio, drip loss, and taste, odor, and texture of broiler meats ($P>0.05$) but affected cooking loss ($P<0.05$). In conclusion, the inclusion of garlic and/or turmeric to fermented *Sauropus androgynus*-bay leaves containing diet did not improve performance and carcass quality in broiler chickens. Any combination of medicinal plants could replace commercial feed additive.

Keywords: Broiler chickens, Carcass quality, Garlic, Performance, *Sauropus androgynus*-bay leaves, Turmeric

Introduction

Medical plants are used as supplements or as drugs to prevent or cure diseases in both animals and humans. The use of medical plants in livestock is expected to increase in line with the prohibition of antibiotics as a feed additive to stimulate growth. This prohibition due to antibiotics that accumulate in livestock products can cause pathogenic microbial resistance to drugs so that treatment of drug to cure disease will be longer. Antibiotic residues can also cause allergies, toxicity, alter intestinal flora, reduce the immune response and harm the environment and economy (Manyi-Loh *et al*. (2018).

Several medical plants have been studied to evaluate its effectiveness as a feed additive in fish (Samad *et al*., 2014) and poultry (Nouzarian *et al*., 2011; Santoso *et al*., 2018a; Santoso *et al*., 2018b; Mulugeta *et al*., 2019). Our previous results (Fenita *et al.*, 2017) showed that giving *Sauropus androgunus* leaves or bay leaf powder at 5% level relatively resulted in similar body weight, feed consumption, feed conversion and carcass quality to the control. We also reported that giving 5% *Sauropus androgynus* leaves gave significantly a redder color to the meat. The above research is continued by Santoso *et al.* (2018b) by fermenting *Sauropus androgynus* and bay leaves and then given to broilers in the form of various combinations of fermented *Sauropus androgynus*-bay leaves (FSBL). This study showed that the use of 2.5% FSBL relatively resulted in similar performance and carcass quality to the control (Santoso *et al*., 2018b). It was further reported that the above treatment significantly produced a yellower carcass color and redder meat.

The availability of *Sauropus androgynus* and bay leaves is still very limited, so it will be difficult to use if this medicinal plant combination is applied in large-scale poultry industry. For this reason, the usage of these two medicinal plants needs to be lowered below 2.5%. However, decreasing the use of those leaves will reduce the amount of active compounds consumed by broilers. Therefore, it is necessary to add other medicinal plants which can be given in smaller amounts but are effective to improve the performance of broilers. Garlic and turmeric are very effective in increasing the performance of broilers even if given in very small amounts.

Curcumin is the dominant polyphenol found in the turmeric. Curcumin is known as antioxidant, anti-inflammatory, antimutagenic, antimicrobial and anticancer properties. Turmeric supplementation resulted in lowering feed conversion ratio (Nouzarian *et al*., 2011; Lukasiewicz *et al*., 2017), mortality and cooking loss but increasing shear force and meat color (Lukasiewicz *et al*., 2017). One gram turmeric/kg diet inclusion is adequate to increases body weight gain (Samarasinghe *et al*., 2003), and this level was used in the present study.

Garlic exhibits antibacterial activity (Al-Masaudi and Al-Bureikan, 2013), antimicrobial activity (Yetgin *et al*., 2018), antifungal activity (Burian *et al*., 2017, antiparasitic (Yildiz *et al*., 2019) and antiviral activity (Arify *et al*., 2018). The main compounds of this medical plant are allicin, diallyl disulphide, S-allylcysteine, and diallyl trisulfide (Mikaili *et al*., 2013). Sangilimandan *et al.* (2019) reported that the inclusion of 2 g garlic/kg diet improve production efficiency.

This study was conducted to analyze the effects of turmeric and/or garlic supplementation to fermented *Sauropus androgynus*-bay leaves (FSBL) containing diet on growth performance (body weight, body weight gain, feed intake and feed conversion ratio), carcass quality and meat organoleptic status in broiler chickens. It was hypothesized that the inclusion of garlic and turmeric to fermented *Sauropus androgynus*-bay leaves containing diet improve growth performance and carcass quality in broiler chickens.

Materials and Methods

Preparation of medical plant powder

Bay leaves and *Sauropus androgynus* leaves were air-dried for 5 days, and then dried in the sun for one hour to obtain 10-12% water content, and stored before fermentation. Garlic thinly sliced, dried in the sun to dry, milled and stored before use. Turmeric powder was obtained from traditional markets. All these medicinal plants were analyzed proximate and their energy levels. Gross energy was measured using a bomb calorimeter, whereas proximate analysis was done using the methods of AOAC (2012). The results of this analysis were used to calculate the nutritional composition of the experimental diets.

Fermentation

The leaves were fermented with cassava yeast (Santoso *et al*., 2015). In short, bay and *Sauropus androgynus* leaves were steamed for 30 minutes and then cooled. They were then fermented in closed plastic bags with cassava yeast at level of 0.5% of the leaves for 24 hours for *Sauropus androgynus* leaves and 48 hours for bay leaves. The fermented products were then milled and stored in plastic bags before use. The fermented leaves were analyzed proximate and their energy levels.

Animals and diets

Newly arrived 300 one day old female broiler chicks strain Lohman were placed in brooder ring and given sugar containing water to decrease stress due to travel. The temperature of the brooder was maintained between 32-33ºC at the first week and it was gradually lowered at the second week. At the end of second week the broiler chicks were not given additional heat. Broiler chicks were vaccinated against ND at the age of 21 days. Broiler chickens were given commercial diet before entering into the research period.

At the age of 15 days, female broilers were selected, and grouped into plots and given experimental diet up to the age of 35 days. The composition of experimental diets have been published elsewhere (Santoso *et al.*, 2020). The calculated crude protein of P0, P1, P2, P3, and P4 diets was 20.0%, 19.7%, 19.7, 19.7%, and 19.7%, respectively, whereas the calculated ME of P0, P1, P2, P3, and P4 diets was 3,130, 3,111, 3,111, 3,110, 3,110 kcal/kg, respectively (Santoso et al., 2020). One gram turmeric/kg diet supplementation (Samarasinghe *et al*., 2003) was able to increase body weight and to reduce fat deposition in broilers so that this level was used in this study. The use of garlic at level of 2 g/kg in this study was based on the research of Jimoh *et al.* (2012).

This study used a completely randomized design. Two hundred 15-days-old female broilers were grouped into 5 treatment groups with 4 replications of 10 birds as follows: Diet with 0.5% commercial feed additive (P0); 1.25% fermented *Sauropus androgynus*-bay leaves (the ratio was 1:3) (FSBL) containing diet (P1); 1.25% FSBL containing diet plus 1 g turmeric powder/kg diet (P2); 1.25% FSBL containing diet plus 2 g garlic/kg diet (P3); 1.25% FSBL containing diet plus 1 g turmeric and 2 g garlic/kg diet (P4). Broiler chickens were maintained in open house with a roof monitor, stocking density 10 broilers/1m^2, lighting 12 hours from 18.00 to 06.00. Broiler chickens were given experimental diets and drinking water *ad libitum*. Body weight, feed intake and feed conversion ratio were measured weekly.

Variables and sampling

At 35 days of age, six female broiler chickens from each treatment group were selected and slaughtered. Variables measured were carcass weight, meat bone ratio, cooking loss, carcass color, and drip loss. DSM broiler fan was used to measure carcass color. Breast meats were placed in closed plastic bags, boiled at 80ºC for 20 minutes and cooled. Cooking loss was measured by reducing the weight of breast meat before cooking by the weight of breast meat after cooking divided by the weight of breast meat before cooking multiplied 100% (Santoso *et al.*, 2002). Other breast meats were placed in closed plastic bags, stored at freezer for 72 hours. Drip loss was calculated by reducing the weight of breast meat before storage by the weight of breast meat after thawing divided by the weight of breast meat before storage multiplied by 100%. Meat bone ratio was measured by dividing the weight of breast and thigh meats by the weight of breast and thigh bones (Santoso *et al*., 2018b).

Twenty semi-trained sensory panelists were used in the present study. The meat color was assessed by comparing the color of the breast meat with the standard ID-DLO reference scale of 1-5 (Santoso et al., 2002). The meat odor was judged from very fishy (score 1) to not fishy/ (score 5). The meat taste was measured according to the method of Santoso et al. (2018b). The panelists were previously trained by testing the breast broth obtained by boiling the meat at various concentrations. The value 1 (bad taste) was obtained by making a broth from 1 g of meat boiled in 50 ml of water; value 2 (less taste delicious) 4 g meat/50 ml water; value 3 (taste quite good) 7 g meat/50 ml water; value 4 (good taste) 10 g meat/50 ml water and; value 5 (very tasty) 13 g meat/50 ml water. After the panelist could distinguish the meat taste, they were then asked to taste and to score the meat taste from 1 (bad taste) to 5 (very tasty). Texture test was done by biting boiled meat using the teeth, and scored from 1 (not soft) to 5 (very soft).

Data analysis

Data were analyzed using analysis of variance, and Duncan's Multiple Range Test was used as a further test if it had significant effect.

Result and Discussion

Chemical composition of medical plant used

The results of laboratory analysis of medicinal plants used in this study are presented in Table 1. Fermented bay leaves or *Sauropus androgynus* leaves had higher protein content with lower crude fat, crude fiber and energy as compared with unfermented ones. Turmeric contains 8.32% crude protein, 7.64% crude fiber, 1.04% crude fat, 0.23% calcium, 0.34% phosphorus and 1.675 kcal energy/kg. Garlic contains 4.38% crude protein, 8.45% crude fiber, 1.28% crude fat, 0.02% calcium, 0.18% phosphorus and 1.317 kcal energy/kg.

An increased crude protein in the fermentation process due to several factors, including the addition of protein from microbial culture, the ability of microorganisms to secrete several enzymes, and the use of carbohydrates, fats and crude fibers of feedstuffs by microorganisms to obtain energy and for cell activity (Oseni and Akindahunsi, 2011). Olukomaiya *et al.* (2019) stated that fermentation carbohydrate of feedstuffs were used by microorganism resulting in a lower dry matter of feedstuffs. Furthermore, they stated that the decreased in dry matter of feedstuffs as well as production of extra microbial protein during fermentation might contribute to an increase in protein of feedstuffs. In addition, the fermentation process in this study used cassava yeast where the yeast was dominated by *Saccharomyces sp.* Onofre *et al.* (2017) reported that *Saccharomyces cerevisiae* biomass contains 49.63% protein, whereas Yalçin *et al.* (2011) reported that *Saccharomyces cerevisiae* culture contains 44.53% protein.

During fermentation, microorganisms used carbohydrate, fat and crude fiber to obtain energy and for cell activity (Oseni and Akindahunsi, 2011) resulting in lower crude fiber, fat and energy contents of fermented products in the present study.

Growth performance of broiler

Table 2 shows the effect of turmeric and/or garlic inclusion to FSBL containing diets did not affect body weight, body weight gain, feed intake and feed conversion ratio (P>0.05). The present study showed that 1.25% FSBL itself or in combination with turmeric and/or garlic could replace commercial feed additive (the control group).

The tendency of lower body weight gain agrees with the Santoso *et al*. (2018b) research results who found that the inclusion of 2.5% FSBL tended to lower body weight gain. It is unknown why the addition of 1 g turmeric/kg to FSBL containing diet did not induce body weight gain, whereas (Samarasinghe *et al*., 2003) reported that the inclusion of 1 g turmeric/kg increased body weight gain. However, Kafi *et al*. (2017) reported that turmeric supplementation increased the body weight of broilers when turmeric was added at a 7.5 g/kg diet. It appears the turmeric quality may influence the results. Li *et al*. (2011) stated that both curcuminoids and essential oils (the main active compounds in turmeric) contents significantly varied depending on geographic locations, genotypes and storage condition. The addition of 2 g garlic/kg may not be adequate to increase weight gain. This assumption is supported by research by Mulugeta *et al*. (2019) and Karangiya *et al*. (2016) who reported that to increase body weight gain, garlic should be added at 10 g/kg diet.

Table 1. The chemical composition of medicinal herbs used in the present study

Feedstuffs*	Moisture (%)	Protein (%)	Crude fiber (%)	Crude fat (%)	Ca (%)	P (%)	Groos Energy (Kcal/kg)
Bay leaves	8.40	8.32	26.67	8.36	0.76	0.23	1.994
Fermented bay leaves	14.50	9.75	22.12	6.24	0.92	0.32	1.879
Sauropus androgynus leaves	12.39	23.13	26.54	3.35	1.76	1.12	2.054
Fermented *Sauropus androgynus* leaves	13.23	27.13	15.34	3.34	2.24	0.95	1.998
Turmeric	9.12	8.32	7.64	1.04	0.23	0.34	1.675
Garlic	10.31	4.38	8.45	1.28	0.02	0.18	1.317

*All samples were analyzed in duplicates.

Table 2. Effect of turmeric and garlic inclusion to *Sauropus androgynus*-bay leaves containing diets on performance of female broilers

Variables	P0	P1	P2	P3	P4	P
Body weight, g/bird	1,413.3±25.1	1,414.6±68.6	1,366.4±16.5	1,390.3±49.1	1,416.3±49.1	0.615
Body weight gain, g/bird	1,003.8±30.9	994.1±64.1	949.5±22.8	972.9±42.7	1,001.3±25.7	0.646
Feed intake, g/bird	1,838.2±57.7	1,904.6±136.2	1,823.3±97.6	1,569.6±76.4	1,809.8±55.9	0.481
Feed conversion ratio	1.83±0.07	1.92±0.06	1.92±0.09	1.62±0.50	1.81±0.27	0.473

P0 = Control; P1 = 1.25% fermented *Sauropus androgynus*-bay leaves (FSBL) containing diet; P2 = 1.25% FSBL containing diet plus 1 g turmeric powder; P3 = 1.25% FSBL containing diet plus 2 g garlic); P4 = 1.25% FSBL containing diet plus1 g of turmeric and 2 g garlic).

Carcass quality

The effect of turmeric and/or garlic inclusion to FSBL containing diets on carcass quality is shown in Table 3. The inclusion of turmeric and garlic to FSBL containing diets had no effect on carcass weight, meat bone ratio, and drip loss (P>0.05) but affected cooking loss (P<0.05). P1 had lower cooking loss than P0, P3. Carcass color was qualitatively more yellow in the medical plant groups than in the control group which was given a 0.5% commercial feed additive containing diet.

No change in carcass weight and meat bone ratio in the current study was in line with the observation of Santoso *et al.* (2018b). These investigators reported that the use of 2.5% or 5% FSBL did not improve carcass weight and meat bone ratio. The protein and energy levels of all experimental diets were relatively similar, which might cause no change in those variables.

The present study showed that cooking loss was lower in broilers fed diet with 1.25% FSBL. The previous study (Santoso *et al*., 2018b) showed that giving 2.5% FSBL did not reduce cooking loss. Thus, the level of FSBL inclusion may give different responses on cooking loss. However, It is unknown why garlic inclusion to FSBL containing diet increased cooking loss. It is assumed that the antioxidants contained in *Sauropus androgynus* and bay leaves are antagonist with antioxidants in garlic. Some antioxidants could have antagonism responses. For example, when flavonoid and trolox (a water-soluble analog of vitamin E and has an antioxidant like vitamin E) were mixed, the concentration of flavonoid becomes lower resulting in lower antioxidant activity (Tavadyan and Minasyan, 2019). Lower antioxidant activity may result in higher protein oxidation that may cause a higher cooking loss in the present study. In addition, lower cooking loss might also be caused by lower meat fat content. Santoso *et al.* (2020) used the same treatment as the current study, and found that the inclusion of 1.25% FSBL reduced meat fat content. Wong and Maga (1995) reported that meat with low fat content has a low cooking loss. The inclusion of turmeric plus garlic to FSBL containing diet normalize cooking loss as compared with FSBL containing diet.

Medical plant mixture inclusion tended to reduce drip loss except for P3. The reduction tendency of P1, P2 and P4 were 18,4%, 12,4% and 16,5%, respectively. The addition of turmeric and/or garlic tended to reduce the effectiveness of the FSBL containing diet to reduce drip loss. The antagonistic interaction of antioxidant compounds present in the medical plant mixture might cause lower activity of antioxidant resulting in higher drip loss.

Better carcass color in the medical plant mixture groups is assumed from an increase in β-carotene content of a carcass. Fermented *Sauropus androgynus* leaves contain 3,510.4 4 µg/g β-carotene (Santoso *et al*., 2015). Turmeric had total carotenoids 510 µg/100g with 60 µg/100g β-carotene (Kandlakunta *et al*., 2008), whereas garlic has a β-carotene range from 5.68-7.46 µg/100 g (Azzini *et al*., 2014). It appears that more yellow of carcass color was in part caused by the accretion of β-carotene content in the skin. Santoso *et al*. (2016) reported that the *Sauropus androgynus* leaves themselves enhanced carcass color in broilers.

Organoleptic properties

The effect of turmeric and garlic inclusion to FSBL containing diets on meat organoleptic properties is shown in Table 4. The inclusion of turmeric and garlic to FSBL containing diets did not affect taste, odor and texture of broiler meats. In qualitative value, meat color was relatively similar to among the treatment groups.

A similar broiler breast color indicates similar meat quality. Similar breast meat color resulted in similar muscle pH, percentages of marinade pick-up and amounts of retained moisture indicating similar meat quality (Allen *et al*., 1998). The present study used 1.25% FSBL, whereas higher inclusion of this mixture (2.5% FSBL) increased meat color (Santoso *et al*., 2018b). Thus, the influence of FSBL on meat color depends on the level of use of FSBL. Furthermore, the 2.5% FSBL containing diet (Santoso *et al*., 2018b) or 1.25% FSBL containing

Table 3. Effect of turmeric and garlic inclusion to *Sauropus androgynus*-bay leaves containing diets on carcass quality in female broilers

Variables	P0	P1	P2	P3	P4	P
Carcass weight, %	69.12±0.76	69.33±1.08	69.39±2.28	68.48±0.79	70.36±2.05	0.494
Meat bone ratio	6.41±0.65	6.00±0.63	6.29±0.58	6.22±0.32	6.40±0.43	0.780
Cooking loss	35.89±1.05^{b}	32.59±1.13^{a}	34.04±1.61^{ab}	35.16±0.87^{b}	33.86±1.60^{ab}	0.000
Drip loos	7.11±2.53	5.80±1.55	6.23±2.64	8.04±1.45	5.94±2.22	0.732
Carcass color	102.38±0.25	102.63±0.25	102.63±0.48	102.75±0.29	102.75±0.29	

P0 = Control; P1 = 1.25% fermented *Sauropus androgynus*-bay leaves (FSBL)] containing diet; P2 = 1.25% FSBL containing diet plus 1 g turmeric powder; P3 = 1.25% FSBL containing diet plus 2 g garlic); P4 = 1.25% FSBL containing diet plus1 g of turmeric and 2 g garlic).

Table 4. Effect of turmeric and garlic inclusion to *Sauropus androgynus*-bay leaves containing diets on organoleptic properties of broiler meats

Variables	P0	P1	P2	P3	P4
Taste	3.04±0.36	3.19±0.21	2.93±0.14	3.28±0.25	3.09±0.23
Odor	3.06±0.15	3.24±0.26	3.11±0.06	3.10±0.30	3.26±0.13
Texture	2.94±0.11	3.08±0.54	3.03±0.26	3.24±0.42	3.34±0.23
Meat color	3.00±0.54	2.94±0.43	3.00±0.54	2.94±0.37	3.00±0.35

P0 = Control; P1 = 1.25% fermented *Sauropus androgynus*-bay leaves (FSBL)] containing diet; P2 = 1.25% FSBL containing diet plus 1 g turmeric powder; P3 = 1.25% FSBL containing diet plus 2 g garlic); P4 = 1.25% FSBL containing diet plus1 g of turmeric and 2 g garlic).

diet (the present study) did not affect taste, texture and odor of broiler meat. Furthermore, the use of 5% FSBL improved taste, texture and odor of broiler meats (Santoso *et al*., 2018b).

The addition of 1 g turmeric/kg and/or 2 g garlic/kg to 1.25% FSBL containing diet did not improve taste, meat color and texture and did not reduce odor. Karangiya *et al*. (2016) reported that inclusion 10 g garlic/kg tended to improve appearance, aroma, color, flavor, juiciness, and tenderness of broiler meats.Thus, the use of various combinations of medical plants in current research could replace commercial feed additive without reducing organoleptic properties of broiler meat.

Conclusions

The inclusion of garlic and/or turmeric to fermented *Sauropus androgynus*-bay leaves containing diet did not improve performance and carcass quality in broiler chickens. The use of 1.25% FSBL containing diet reduced cooking loss. Any combination of medicinal plants could replace commercial feed additive.

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