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E-mail: editorijps@gmail.com

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Research Article
The Effect of Fermented *Sauropus androgynus* Plus Bay Leaf Inclusion on the Hematologic and Lipid Profiles of Female Broiler Chickens

Urip Santoso, Yosi Fenita and Kususiyah

Department of Animal Science, Faculty of Agriculture, Bengkulu University, Jalan Raya WR Supratman, Kandang Limun, Bengkulu, Indonesia

Abstract
Background and Objective: The use of antibiotics as a feed additive for poultry has been prohibited in many countries because the antibiotics accumulate in the meat, which may stimulate microbial pathogen resistance. The present study was conducted to evaluate the effect of fermented *Sauropus androgynus* plus bay leaf inclusion on the hematologic and lipid profiles of female broiler chickens. **Materials and Methods:** Two hundred and eighty female broilers aged 14 days were divided into 7 treatment groups as follows: 1) the control broiler chickens were fed a diet with a commercial feed additive (contained zinc bacitracin) (P0), 2) broiler chickens were fed a diet with medicinal herb mixture formula 1 at 2.5% (P1), 3) broiler chickens were fed a diet with medicinal herb mixture formula 2 at 2.5% (P2), 4) broiler chickens were fed a diet with medicinal herb mixture formula 3 at 2.5% (P3), 5) broiler chickens were fed a diet with medicinal herb mixture formula 1 at 5% (P4), 6) broilers were fed a diet with medicinal herb mixture formula 2 at 5% (P5) and 7) broilers were fed a diet with medicinal herb mixture formula 3 at 5%. **Results:** Experimental results showed that the inclusion of fermented *Sauropus androgynus* plus bay leaves had no effect on thrombocyte levels, erythrocyte sedimentation rate (ESR), WBC, RBC, PCV, MCV, MCH, MCHC, liver and spleen weights, intestine length and toxicity but significantly affected the gizzard; the intestine ($p<0.01$) and heart weights ($p<0.05$); triglyceride, cholesterol, HDL ($p<0.01$) LDL and VLDL ($p<0.05$) levels; and the LDL/HDL ratio ($p<0.01$). **Conclusion:** The inclusion of fermented *Sauropus androgynus* plus bay leaves improved the lipid profile without modifying the hematologic status in female broiler chickens.

Key words: Fermented *Sauropus androgynus* , bay leaves, hematologic status, lipid profiles, internal organ, broiler

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Corresponding Author: Urip Santoso, Department of Animal Science, Faculty of Agriculture, Bengkulu University Jalan Raya WR Supratman, Kandang Limun, Bengkulu, Indonesia

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Commercial feed additive contains antibiotics such as zinc bacitracin to promote the growth of poultry. Antibiotics destroy certain bacteria in the gastrointestinal tract and help poultry convert feed to muscle more quickly, thus causing more rapid growth. Moreover, antibiotics also improve the hematological profile and reduce blood lipid profiles[1]. The hematological profile is an important indicator of the physiological or pathophysiological status of an individual. However, the use of antibiotics as a growth promoter has been prohibited in many countries because these antibiotics accumulate in poultry products, which may stimulate microbial pathogen resistance. Antibiotics are shown to have high side effects such as damage to the hormonal and immune systems[2]. In addition, antibiotic residue in animal products may cause an allergy when the animals are consumed by people. Thus, an alternative feed additive is needed to substitute for antibiotics. An alternative feed additive should have the ability to stimulate growth, lower blood lipid concentrations and lead to normal hematological profiles as well as antibiotics.

Some antioxidant medicinal plants have been suggested as a substitute for antibiotics[3] because they contain antibacterial and antilipid compounds. These medicinal plants have a low side effect and are able to maintain product quality and livestock performance[4,5]. These natural antioxidant compounds include α-tocopherol, β-carotene, ascorbic acid, flavonoids, carotenoids, anthocyanins, phenol compounds, zinc and selenium[6,7].

Sauropus androgynus leaves have been shown to be potential substitutes for antibiotics[8-12] because this medicinal plant contains linolenic acid, palmitic acid, chlorophyll, benzoic acid and alkaloid[13], flavonoids[14] and phenols[15]. Bay leaves contain flavonoids and glycosides[16,17]. Santoso *et al.*[12] showed that *Sauropus androgynus* or bay leaf inclusion modified the hematologic and blood lipid profiles of broiler chickens. Bay leaves reduce the blood lipid profile[18]. A change in the hematologic profile may result in a change in poultry performance, whereas a change in the blood lipid profile may indicate a change in fat deposition in poultry. However, the changes generated by the administration of those medicinal herbs were still not high. Thus, a method to improve the medicinal herb quality is needed.

Fermentation may improve the quality of medicinal herbs. Fermentation reduces anti-nutrients such as trypsin inhibitor[19], oligosaccharide[20], tannin[21], phytic acid[22], phenol, phytin phosphorus and oxalate[22], saponin[21] and alkaloid[23]. In addition, fermentation improves nutritional values and feed utilization in poultry[24] and modifies lipid profiles[25-27]. Previous research[28] has shown that fermentation of the *Sauropus androgynus* leaf with *Saccharomyces cerevisiae* improved the quality of the *Sauropus androgynus* leaf. Bay leaf inclusion at 0.5% reduced serum triglyceride, total cholesterol, LDL and VLDL but increased serum HDL[29]. Furthermore, bay leaf inclusion had no effect on hemoglobin, leukocytes, erythrocytes and lymphocytes.

An improvement in the quality of medicinal herbs may support the improvement of hematologic status and blood lipid profiles in terms of a lower blood lipid profile and an optimum hematologic status of broiler chickens. Therefore, this study was designed to evaluate the effectiveness of fermented *Sauropus androgynus* plus bay leaves as a substitute for commercial feed additives on the hematologic and lipid profiles of female broiler chickens.

MATERIALS AND METHODS

Fermentation of medicinal herb mixture: The medicinal herb mixture was composed of fermented *Sauropus androgynus* and bay leaves. *Sauropus androgynus* and bay leaves obtained from the field or from traditional markets were air-dried for 5 days. They were subsequently dried in the sun for 1 h until the dryness was approximately 10-12% and then were milled and stored in a plastic bag. Fermentation of *Sauropus androgynus* and bay leaves was conducted according to the method of Santoso *et al.*[28].

Animals and diets: Seven hundred broiler chicks aged one day were placed in a litter house. New broiler chickens were given sugar water to reduce their stress due to travel. The brooder temperature was set in accordance with standard maintenance procedures. At the age of 4 and 21 days, broiler chickens were vaccinated against Newcastle disease. At the age of 1-13 days, broiler chickens were fed a commercial diet.

At the age of 14 days, female broiler chicks were selected and distributed into experimental units and were fed experimental diets up to age 34 days. The composition of experimental diets used is presented in Table 1. The medicinal herbs used were fermented *Sauropus androgynus* leaf and bay leaf. The level of medicinal herb mixture was 2.5 or 5%, as recommended by Santoso *et al.*[28].

Two hundred and eighty female broilers aged 14 days were distributed into the 7 treatment groups as follows: (P0) the control, broilers were fed a diet with a commercial feed additive (zinc bacitracin), (P1) broiler chickens were fed a diet

Table 1: The composition of experimental diets

Feed stuffs (%)	P0	P1	P2	P3	P4	P5	P6
Yellow corn	57.0	57.0	57.0	57.0	54.5	54.5	54.5
Rice bran	5.0	4.0	4.0	4.0	4.0	4.0	4.0
Broiler concentrate	34.2	33.2	33.2	33.2	33.2	33.2	33.2
Mineral mixture	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Salt	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Commercial feed additive*	0.5	0	0	0	0	0	0
Medicinal herb formula 1		2.5			5.0		
Medicinal herb formula 2			2.5			5.0	
Medicinal herb formula 3				2.5			5.0
Palm oil	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total	100	100	100	100	100	100	100
Calculated nutrient composition							
Crude protein (%)	19.86	19.82	19.79	19.75	20.09	20.02	19.95
ME (kcal kg^{-1})	3088.07	3097.63	3096.93	3096.22	3070.26	3068.85	3067.44
Ca (%)	0.947	0.975	0.961	0.964	1.031	1.017	1.003
P (%)	0.692	0.681	0.678	0.675	0.693	0.686	0.680

*Top mix (contained zinc bacitracin), FSAL: Fermented *Sauropus androgynus* leaves, FBL: Fermented bay leaves

with medicinal herb mixture formula 1 at 2.5%, (P2) broiler chickens were fed a diet with medicinal herb mixture formula 2 at 2.5%, (P3) broiler chickens were fed a diet with medicinal herb mixture formula 3 at 2.5%, (P4) broiler chickens were fed a diet with medicinal herb mixture formula 1 at 5%, (P5) broilers were fed a diet with medicinal herb mixture formula 2 at 5%, 7) broilers were fed a diet with medicinal herb mixture formula 3 at 5%.

All treatment groups consisted of 4 replications and each replication consisted of 10 female broilers. The broilers were maintained in accordance with the standard procedure of broiler maintenance. Diet and drinking water were provided *ad libitum*.

Sampling and laboratory analysis: At the end of the study (34 days), the blood of 4 broilers for each treatment group was collected for an analysis of the hematologic and lipid profiles. The Packed Cell Volume (PVC) was determined by the microhematocrit method[30]. Hemoglobin was determined using the cyanmethemoglobin method, while the Red Blood Count (RBC) was carried out using the hemocytometer method[31]. The thrombocyte count was determined using the Ress-Ecker method[32] and the White Blood Count (WBC) was determined using the hemocytometer method[31]. To obtain the plasma, blood samples were collected, then bottled with anticoagulant agent and centrifuged at 3000 rpm. The obtained blood plasma was then analyzed for triglyceride, cholesterol, high-density lipoprotein (HDL) and low-density lipoprotein (LDL). The total cholesterol and LDL were determined by the method of Kulkarni[33] and triglyceride concentrations were determined by the method of Fossati and Prencipe[34].

Data analysis: All data were subjected to one-way analysis of variance and if significantly different, the results were tested further with Duncan's Multiple Range Test (using SPSS software). Statistical significance was set at $p<0.05$ and $p<0.01$.

RESULTS

Fermented medicinal herb composition: Fermented *Sauropus androgynus* leaf powder contained 12.39% moisture, 21.13% protein, 2.13% crude fat, 15.12% crude fiber, 2.53% calcium, 0.47% phosphorus, 4.97 ppm iron and 1.56 ppm potassium, whereas fermented bay leaf powder contained 14.56% moisture, 15.56% protein, 3.56% crude fat, 14.34% crude fiber, 1.45% calcium, 0.25% phosphorus, 1.68 ppm iron and 1.67 ppm potassium.

Hematologic profiles: Table 2 shows the effect of the herbal mixture on the hematologic profile of broiler chickens. Experimental results showed that the inclusion of the herbal mixture had no effect on thrombocytes, ESR, WBC, RBC, PCV, MCV, MCH and MCHC.

Internal organ weight and toxicity score: The effect of the medicinal mixture on internal organ weight and the toxicity score is presented in Table 3. Experimental results showed that the inclusion of a medicinal mixture to the diet had no effect on the liver, spleen, intestine length and toxicity but significantly affected the gizzard, intestine ($p<0.01$) and heart weights ($p<0.05$). The control group had higher gizzard and intestine weights than the other treatment groups ($p<0.01$). The P1 group had a lower heart weight than the other treatment groups.

Table 2: Effect of the medicinal herb mixture on the hematologic status of female broiler chickens

	P0	P1	P2	P3	P4	P5	P6	P
Thrombocyte ($\times 10^3$ mm^{-3})	5.25±2.22	4.00±2.45	4.75±2.50	5.50±1.00	3.50±2.38	3.25±2.06	4.75±1.89	0.684
ESR (mm h^{-1})	3.00±0.82	3.25±0.96	3.25±0.50	3.50±1.00	3.25±0.50	3.00±0.00	3.25±0.50	0.954
Hb (g dL^{-1})	9.40±1.57	9.58±0.94	9.30±1.38	9.30±1.19	10.08±0.83	9.83±0.75	9.75±0.64	0.935
WBC ($\times 10^3$ mm^{-3})	276.1±12.8	279.0±15.0	271.7±21.9	270.8±17.6	281.3±8.7	282.7±9.6	282.0±9.2	0.821
RBC ($\times 10^6$mm^{-3})	2.33±0.34	2.40±0.24	2.13±0.67	2.35±0.39	2.65±0.24	2.50±0.16	2.48±0.22	0.554
PCV (%)	29.75±4.92	30.75±2.75	27.25±7.50	29.25±3.77	32.50±3.11	31.50±1.73	31.00±1.83	0.738
MCV (fL)	126.8±6.0	126.8±5.7	130.0±6.5	124.8±3.6	122.3±2.6	122.8±1.50	125.00±2.7	0.259
MCH (pg)	34.25±3.95	30.00±0.82	33.75±6.85	31.00±0.82	30.00±0.00	30.25±0.96	30.50±1.00	0.257
MCHC (g dL^{-1})	30.63±0.62	30.70±0.37	30.70±0.73	31.03±0.97	31.25±1.62	31.03±0.97	31.03±0.97	0.961

P0: Control, P1: Broiler chickens were fed a diet with formula 1 at 2.5%, P2: Broiler chickens were fed a diet with formula 2 at 2.5%, P3: Broiler chickens were fed a diet with formula 3 at 2.5%, P4: Broiler chickens were fed a diet with formula 1 at 5%, P5: Broilers were fed a diet with formula 2 at 5%, P6: Broilers were fed a diet with formula 3 at 5%

Table 3: Effect of the medicinal herb mixture on the internal organ weight of female broiler chickens

Internal organ	P0	P1	P2	P3	P4	P5	P6	P
Liver (%)	2.28±0.20	2.22±0.14	2.12±0.09	2.37±0.28	2.21±0.11	2.42±0.16	2.32±0.21	0.102
Spleen (%)	0.16±0.07	0.11±0.03	0.12±0.02	0.09±0.03	0.11±0.02	0.15±0.04	0.12±0.03	0.057
Gizzard (%)	2.01±0.12^{c}	1.82±0.11^{b}	1.85±0.05^{b}	1.58±0.11^{a}	1.75±0.12^{b}	1.77±0.06^{b}	1.82±0.08^{b}	0.000**
Heart (%)	0.26±0.03^{b}	0.21±0.02^{a}	0.26±0.02^{b}	0.26±0.02^{b}	0.26±0.02^{b}	0.27±0.04^{b}	0.25±0.03^{b}	0.019*
Intestine (%)	4.92±0.33^{c}	3.83±0.20^{a}	3.96±0.28^{a}	4.38±0.33^{b}	4.52±0.26^{b}	4.58±0.25^{b}	3.72±0.21^{a}	0.000**
Intestine length (cm 100^{-1} g BW)	14.4±0.98	14.16±0.95	13.53±1.16	14.26±1.43	14.18±1.20	14.89±1.19	13.21±0.35	0.181
Toxicity (%)	2.433±0.25	2.327±0.15	2.34±0.10	2.469±0.29	2.31±0.11	2.57±0.17	2.44±0.23	0.103

BW: Body weight, P0: Control, P1: Broiler chickens were fed a diet with formula 1 at 2.5%, P2: Broiler chickens were fed a diet with formula 2 at 2.5%, P3: Broiler chickens were fed a diet with formula 3 at 2.5%, P4: Broiler chickens were fed a diet with formula 1 at 5%, P5: Broilers were fed a diet with formula 2 at 5%, P6: broilers were fed a diet with formula 3 at 5%

Table 4: Effect of the medicinal herb mixture on the serum lipid profiles of female broiler chickens

Lipid (mg dL^{-1})	P0	P1	P2	P3	P4	P5	P6	P
Triglyceride	115.8±3.3^{d}	105.6±8.1^{c}	104.8±4.8^{c}	103.5±3.7^{bc}	93.9±5.3^{a}	96.8±1.8^{ab}	91.8±4.3^{a}	0.000
Cholesterol	127.8±3.4^{e}	118.0±4.6^{cd}	122.5±4.1^{de}	119.3±3.3^{d}	114.5±6.9^{bc}	106.5±1.9^{a}	109.0±5.3^{ab}	0.000
HDL	45.0±1.4^{a}	48.25±1.7^{b}	57.75±1.3^{d}	50.0±2.2^{bc}	51.0±1.2^{c}	48.50±1.7^{bc}	51.0±1.8^{c}	0.000
LDL	51,25±3.6^{c}	45.0±2.6^{ab}	49.0±3.7^{bc}	48.0±0.8^{abc}	44.75±4.0^{ab}	42.75±5.3^{a}	43.5±2.7^{ab}	0.020
VLDL	31.5±5.1^{b}	24.75±6.4^{ab}	15.75±4.6^{a}	21.75±3.2^{a}	18.75±7.6^{a}	15.25±5.8^{a}	14.50±9.3^{a}	0.010
LDL/HDL	1.138±0.06^{c}	0.935±0.06^{ab}	0.845±0.06^{a}	0.96±0.03^{b}	0.878±0.09^{ab}	0.880±0.08^{ab}	0.853±0.03^{a}	0.000

P0: Control, P1: Broiler chickens were fed a diet with formula 1 at 2.5%, P2: Broiler chickens were fed a diet with formula 2 at 2.5%, P3: Broiler chickens were fed a diet with formula 3 at 2.5%, P4: Broiler chickens were fed a diet with formula 1 at 5%, P5: Broilers were fed a diet with formula 2 at 5%, P6: Broilers were fed a diet with formula 3 at 5%

Blood lipid profiles: Table 4 shows the effect of the herbal mixture on blood lipid profiles. Experimental results showed that the inclusion of the herbal mixture significantly affected the levels of triglycerides, cholesterol, HDL ($p<0.01$), LDL and VLDL ($p<0.05$) and the LDL/HDL ratio ($p<0.01$). P4 and P6 had lower triglyceride levels than P0, P1, P2 and P3 but were statistically similar to P5. P0 (control) had the highest triglyceride level. P5 had a lower cholesterol level than P0, P1, P2, P3, P4 but was statistically similar to the P6. P0 had a higher cholesterol level than that of the other treatment groups, except for P2. P2 had the highest HDL level, whereas P0 had the lowest HDL level. P0 had a higher LDL level than P1, P4, P5 and P6 but was statistically similar to other treatment groups. P0 had a higher VLDL level than P2, P3, P4, P5 and P6 but was statistically similar to P1. P0 had a higher LDL/HDL ratio than the other treatment groups.

DISCUSSION

Fermented *Sauropus androgynus* leaf had higher protein, calcium, phosphorus and iron, whereas fermented bay leaf had higher crude fat and potassium. It appears that *Sauropus androgynus* leaf is rich in protein, calcium, phosphorus and iron. There was no change in the hematological status by fermented *Sauropus androgynus.* This result agrees with the observation of Santoso *et al.*[12], who reported that cassava yeast-fermented *Sauropus androgynus* leaf inclusion did not change the hematological status of broiler chickens. The results of this study are in contrast with those of Brata *et al.*[35], who found that *Sauropus androgynus* leaf extract supplementation decreased the number of erythrocytes with no effect on the Hb, PCV, MCH, MCV and MCHC. Furthermore, *Sauropus androgynus* leaf powder increased Hb, PCV and RBC in anemia-induced rats[36]. This difference in result may be caused by the difference in *Sauropus androgynus* leaf processing.

The RBC ranged from 1.45-4.64$\times$10^6/mm[4,37-40]; the Hb ranged from 6.88-13 g dL^{-1} [37-41]; PCV ranged from 22-35%[37,38,40,41]; the WBC ($\times$10^6 µL^{-1}) ranged from 4.10-5.12[40]; the MCV ranged from 90 to 140 fL[39]; the MCH ranged from 33-69.6 pg[37,39]; and the MCHC ranged from 26-35%[37,39]. Santoso *et al.*[12] found that in broilers aged 35 days, the RBC was 2.40-2.85, thrombocyte level was 2-6.25, PCV was 32.25-37.75, Hb was 9.88-11.95, MCH was 38.5-41.75, MCV was 128.75-135.5 and MCHC was 29.75-31.0. Santoso *et al.*[12] reported that the ESR ranged from 3.25 to 8.25 mm h^{-1}. Thus, the present study showed a normal range of hematologic status in broiler chickens.

Fenita *et al.*[42] reported that the inclusion of unfermented *Sauropus androgynus* leaf or bay leaf at 5% had no effect on the internal organ weight. The present study showed that although the intestine length was not reduced, the intestine weight of the treatment groups was lighter than that of the control. It is assumed that the thickness of the intestine was thinner in the treatment groups. Fernandes *et al.*[43] showed that the inclusion of probiotics tended to lower the thickness of the small intestine. Hu *et al.*[44] reported that fermentation increased the villus height and the villus height-to-crypt depth ratio and decreased the crypt depth and intestinal wall thickness in the duodenum, jejunum-ileum and cecum in broiler chickens. Furthermore, they assumed that the change in intestinal morphology may be due to lower antinutrition and an increase in the degradation of protein to peptides after fermentation. In addition, that improvement may result from the increased numbers of beneficial bacteria (*Saccharomyces cerevisiae*) in the intestine. This may explain the tendency for higher body weight gain in broiler chickens fed diet containing a fermented medicinal herb mixture.

The function of the gizzard includes particle size reduction, nutrient degradation, feed flow regulation and reduction in the coarseness of the diet. Fermentation causes a softer physical feed and a decrease in the crude fiber so that gizzard activity decreases to produce a gentle feed. This may be one of the reasons for the lower weight of gizzards in broilers fed diet containing the fermented medicinal herb mixture.

Santoso *et al.*[9] reported that the supplementation of unfermented *Sauropus androgynus* leaf extract reduced total cholesterol, triglyceride and LDL levels but increased the HDL concentration in the serum of layer chickens. Kamalia *et al.*[45] reported that the inclusion of *Sauropus androgynus* leaf at 3% increased serum HDL levels but decreased serum LDL levels. Santoso *et al.*[12] found that *Sauropus androgynus* or bay leaf powder at a 5% level decreased blood triglyceride and LDL levels but increased blood HDL levels. Bay leaves reduced total cholesterol, LDL, triglyceride and glucose levels and increased HDL levels in people with type 2 diabetes[18]. The bay leaf and its isolated flavonoids and glycosides reduced TC, TG, LDL-C and VLDL-C levels; therefore, bay leaf is a useful agent for reducing hyperlipidemia[46]. Belawa *et al.*[47] found that the inclusion of bay leaves reduced blood total cholesterol, LDL and triglyceride levels but increased blood HDL levels in local chickens. Khan *et al.*[48] reported that giving capsules containing 1 or 2 g of ground bay leaves per day for 30 days reduced serum triglyceride, total cholesterol and LDL levels increased HDL levels in people with type 2 diabetes. Aljamal[49] reported that bay leaves reduced the total cholesterol, LDL and triglyceride levels and increased HDL levels in people with type 1 diabetes. Sutrisna *et al.*[50] found that bay leaf extract reduced serum cholesterol, triglyceride and LDL levels and increased HDL levels in hypercholesterolemia male rats of the Wistar strain.

The phenolic content of bay leaf ranges from 69.76-103.91 depending on the method of extraction[51]. Bay leaf contains flavonoids and glycosides, such as kaempferol, quercetin, apigenin, luteolin, quercetin 3-O-α-L-rhamnopyranoside, kaempferol-3-O-β-glucopyranoside, quercetin-3'-O-β-glucopyranoside, quercetin-3-O-β-galactoside, isorhamnetin-3-O-β-glucopyranoside, isorhamnetin-3-O-βgalactopyranoside, quercetin-3-O-rutinoside, kaempferol-3-O-rutinoside, isorhamnetin-3-O-rutinoside and isorhamnetin[16,17]. Bay leaf has also been reported to contain flavonoids, saponin and steroid. *Sauropus androgynus* contains linolenic acid (31.75%), palmitic acid (12.14%), chlorophyll (9.33%), benzoic acid (8.58%) and alkaloid (7.2%)[13], flavonoids, tannins, saponins, triterpenoids[14] and phenols[15].

Phenolic substances[52,53] and flavonoids[54] inhibit LDL oxidation and decrease cholesterol and LDL levels by inhibiting HMG CoA reductase activity and oxidation of LDL[55]. Tannin reduces cholesterol levels by inhibiting cholesterol absorption in the intestine[56]. Saponin decreases the total cholesterol, triglyceride and LDL cholesterol levels and increases HDL cholesterol levels[57-59] as a result of lipase inhibition[60,61], thus stimulating the activity of superoxide dismutase and improved lipid peroxidation[62].

An increase in the level of HDL may be beneficial because Nofer *et al.*[63] documented its role in reverse cholesterol transport. HDL has recently been recognized to have several other important cardioprotective properties, including the ability to protect LDL from oxidative modification.

Santoso *et al.*[11] reported the following levels in broilers aged 35 days: cholesterol 113.8-126.3, TG 18.0-39.8, HDL 66.0-74.3, LDL 38.0-48.8 and VLDL 4-8.2 mg dL^{-1}. TG ranges from 104-224.28 mg dL^{-1} [36,37,39]; cholesterol ranges from 184.25-221.65 mg dL^{-1} [36,37,39]; HDL ranges from 80.0-151.6 mg dL^{-1} [37,39] and LDL ranges from 45.8-72.4 mg dL^{-1} [37].

CONCLUSION

The inclusion of a medicinal herb mixture improves the lipid profile without modifying the hematologic status and lowers the gizzard and intestine weights in female broiler chickens.

SIGNIFICANCE STATEMENT

This study discovers the possible uses of a medicinal herb mixture as beneficial for reducing triglyceride, LDL and VLDL levels and LDL/HDL ratios; these findings indicate a lower risk of atherosclerosis occurrence in broiler chickens. This study helps to reveal the critical area of atherosclerosis problems and free antibiotic livestock practices that many researchers were unable to previously explore. Thus, a new theory may be created based on the usefulness of medicinal herb mixtures in lowering the risk of atherosclerosis occurrence and developing organic farming for broiler chickens. In addition, the possible natural medicines for hyperlipidemia in poultry and human beings might be developed.

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CONFLICT OF INTEREST

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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