Influence of dietary lavender *(Lavandula angustifolia)* essential oil on broilers under stocking density

Alaa Abdulmajeed Mustafa

College of Agricultural Engineering Science / Salahaddin University/ Kurdistan region /Erbil/ Republic of Iraq.

Corresponding author Email: alaa.mustafa@su.edu.krd

DOI: https://doi.org/10.36077/kjas/2025/v17i3.12710

Received date: 23/7/2023

Accepted date: 17/10/2023

Abstract

This study was conducted to evaluate the effect of two inclusion levels of lavender *(Lavandula angustifolia*) essential oil (LEO) supplementation in broiler diet where broilers were reared under stocking density on productive performance and physiological traits. In this study 378 one-day old Ross-308 broiler chicks were used during 35-day of the study. The birds were randomly assigned into 4 experimental treatments with 3 replicates for each treatment including T0 (Negative control) 72 birds, 24 birds in each replicate, 12 birds in each m^2 standard stocking density were given basal diet without additive. From T1 until T3 the birds were reared under stocking density 102 birds, 34 birds each replicate, 17 birds each m^2 and the supplementation were T1 (Positive control) basal diet no supplemented, T2 basal diet supplemented with % 0.3 of LEO and T3 basal diet supplemented with % 0.5 of LEO. For analyzing the data Completely Randomized Design (CRD) were used. The results in 35^{th} day showed that experimental treatments had a significant effect on productive performance; live body weight (LBW) T2 2450, T3 2515 g significantly ($P \leq 0.01$) compared to T1 2230 g. In addition, improved feed intake (FI) and feed conversion ratio (FCR) in treatments chickens received LEO and under stocking density. Concerning physiological traits, significantly increased red blood cells (RBCs) 10^6 cells/mm^3, packed cell volume (PCV%) lymphocyte% decreased heterophil% and H/L ratio. Serum cholesterol and glucose (mg/dL) were significantly decreased. However, increased the production of antibodies against Newcastle disease (ND) and Infectious bronchitis virus (IBV). In conclusion, the addition of 0.3 and 0.5% of LEO to broiler chicken diets have the potential effect to improve productive performance, physiological traits, and raising immunity against diseases.

Key words*;* LEO, stocking density, broiler, productive performance, physiological traits.

Introduction

In poultry farming, stocking density is one the method for increasing poultry income, with increasing the number of birds per unit of area or the kilograms per unit of the area could return higher profitability (17). Besides, poultry overcrowding leads to a higher quantity of meat production with lower quality, higher mortality and immunosuppression due to causing stress (13). Furthermore, to minimize the hazard effect of stocking density stress its essential to use feed additives. Recently, antibiotics growth promotes have been restricted due to causing more health issues to chickens and transports to humans (12).

The non-antibiotic feed additives frequently used in chicken production, such as medicinal herbs or herbal extracts and their essential oils, could be used to preserve overall health and growth performance (5).

Lavender (*Lavandula angustifolia L.)*, which can be added to the diets, provides an alternative to antibiotics (AGPs). It is a well-known member of the "*Labiatae*" family of medicinal and fragrant plants. The main part of lavender is its essential oil (LEO). LEO is one of the most beneficial aromatherapy oil, a physiologically active and volatile chemical having a distinctive smell (fragrance) return to containing compounds such as lavandulol, linalool, linalyl acetate, eucalyptol, or geraniol. LEO can be found in up to 3% of lavender blossoms (2). Additionally, it has significant concentrations of polyphenols like flavonoids, which have a variety of biological and chemical activities, as well as qualities that can scavenge free radicals (4).

The previous characteristics make the herb displays antioxidant, antifungal, antibacterial, antiviral, spasmolytic, and sedative properties (2). Morever, lavender might have an impact on the productivity and health of animals as well as the standard of animal products and boosting lymphocytes, including antibodies against avian influenza and Newcastle disease viruses (13). This study was conducted in response to the limited research available regarding the potential benefits of adding lavender essensial oil (LEO) in broiler diet to mitigate the stress associated with increasing stocking density in broilers. The primary objective was to assess the feasibility of supplementing LEO into the broiler diet to alleviate stress resulting from higher stocking densities, while also minimizing adverse effects on production and physiological parameters which was caused by this stress.

Materials and methods

Study area; This experiment was conducted in a poultry field in Qushtapa side located outside of Erbil governorate in January 2023 for 35 days.

The Source of chicks; feed and *Lavandula angustifolia* essential oil (LEO): The chicks were Ross-308, brought Evan Hatchery commercial company-Erbil, as well as, the feed was bought from the same company. However, the source of LEO was bought in the place that specific for the herbs in bazaar.

Experimental design; Three hundred and seventy-eight (378) one-day old Ross-308 chicks were randomly distributed to four groups, with three replicas in each group. The

structures of all boxes area were 2 m^2 and the birds were assigned as the following;

T0 (negative control, normal density) 72 birds, 24 birds each replicate, 12 birds in each m^2. The birds were fed basal diet. T1 (positive control, high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed basal diet. T2 (0.3% lavender essential oil (LEO), high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed basal diet + 0.3% LEO. T3 (0.5% LEO, high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed basal diet + 0.5% LEO. The feed was provided to the birds free and weighed weekly. However, water was provided *ad-lib.* Table.1 shows the chemical composition of the broilers' diet.

Table 1. Compounds and chemical compositions of broiler diet.

Periods / Ingredients%	Starter 1-14d	Grower 15-28d	Finisher 29-35d
Corn	46.6	50.50	52.0
Wheat	16.0	15.0	15.4
Soybean meal 46%	32.5	28.00	26.5
Di-calcium phosphate	2.05	1. 70	1. 70
Oil	1.45	3.50	3.0
Limestone	1.35	1.22	1.33
*Vitamins-**Minerals mix	0.025	0.025	0.025
Salt	0.05	0.05	0.05
Calculated analysis:			
Energy K. cal/g	2931.17	2990.85	3150.622
Methionine	0.7415	0.7082	0.7336
Lysine	1.17036	1.0824	0.9316
Phosphorous	0.2573	0.2497	0.2568
Calcium	0.4347	0.4253	0.9795
Sodium	0.1423	0.1428	0.2487
Analyzed nutrient composition			
Crude Protein	23	20.62	18.62
Crude Fat	2.1745	2.226	2.3735
Crude Fiber	2.20	3.45	3.75
Crude Ash	3.0	3.50	3.90

*Vitamins were provided in 1 kg in diet as the followings 1: Vitamin A=24.000. IU, Vitamin D3 (Cholecalciferol)=6.000IU,VitaminE (Alphatochopherol acetate) = 60. mg, VitaminK3 (Menadoin) =6 mg, VitaminB1= 4 mg, Vitamin B2= 10 mg, Vitamin. B6 = 10 mg, Vitamin B12 =30 mg, Biotin= 0.1 mg, Pantothenic acid = 20 mg, Nicotinic acid=80 mg, Folic acid = 1.6 mg, Antioxidant (BHT)= 5 mg. **Minerals the following trace elements were included in 1kg diet: Fe(from Iron Sulphate)= 100mg, Cu (from Copper Sulphate= 20 mg, Mn (from Manganese Oxidase)= 160 mg, Zn(from Zinc oxidase)= 120mg,I(from Calcium iodate)= 2 mg, Se(from Sodium Selenite)= 0.5mg. All feed chemical analysis were done in the laboratory of Evan feed company depending on (15).

Studied traits:

1- Productive performance traits were Live body weight (LBW), body weight gain (BWG),

feed intake (FI), feed conversion ratio (FCR) and production index (PI) were recorded weekly.

2- Physiological (hematology) traits: when the experiment finished in the 35th day, blood was collected from birds in each replicate of treatments and sent to the laboratory for blood tests: A- Blood cells: blood was collected in a tube with anticoagulants (heparin) for blood counting Red blood cells (RBCs), Package cell volume PCV%, Lymphocyte%, Heterophil% and heterophil/ lymphocyte (H/L) ratio tests.

B-Serum biochemical: blood was collected in a tube without anticoagulants for Cholesterol, Total protein and Glucose tests.

C- Immunity: Newcastle disease (ND) and Infectious bronchitis virus (IB).

Statistical analysis: All data will be statistically analyzed by using the SAS (19) system's Completely Randomized Design (CRD), and the differences between the means of groups will be separated using the Duncan Multiple Range Test (8). Statements of statistical significance are based on ($P\leq 0.01$) and ($P\leq 0.05$).

$Yij = \mu + Ti + eij$

Results and discussion

1- Productive performance: Nowadays due to the world population increasing quickly and due to poultry production meat and egg are the main food in all countries. Poultry breeders tended to increase this production to cover the world population's food, and stocking density was considered the main method. Nevertheless, the raising stocking density led to stress on broilers. That's why it's essential to use feed additives to minimize this effect. In this study, lavender essential oil (LEO) was used as a feed additive. The influence of LEO on broiler performance is presented in table 2. Depending on the results, there was an improvement in live body weight (LBW g), body weight gain (BWG g) and feed intake (FI g). The improvement was shown in the third week (21th days old) until 35th day. In 35th days broilers under stocking density, while treatments received LEO (T2 0.5% and T3 0.3%) led to significant ($P\leq 0.05$), ($P\leq 0.01$) increases of (LBW g), (BWG g) and (FI g) and close to T0 (negative control +normal density) compared to T1 (positive control+ under stocking density) which recorded the lowest value. In addition, feed conversion ratio (FCR) and production index (PI) shows an improvement started in the second week (14th days old), FCR improved in the two LEO supplemented treatments with under stocking density T2 and T3 compared to non-supplemented treatments (T0 and T1) which significantly ($P\leq 0.05$) recorded a poor FCR and PI.

The results in this experiment showed that using 0.3% and 0.5%, particularly 0.5% of LEO in broilers' diet under stocking density recorded a good performance and significantly ($P\leq 0.01$) improved LBW, BWG, FI , FCR and PI. The results agreed with those of (6 , 10) who reported that decreased performance indicators as a result of crowded circumstances, stress, and lack of dietary supplements. Similarly, (13) documented that adding medicinal herbs

products to broilers' diets could reduce stocking density stress and improve performance.

The current result is similar to those of (11, 2) who reported that BWG and FCR were significantly (P≤0.01) improved by the addition of LEO in broiler chickens' drinking water. Interestingly, the present study is in agreement with (5) when observed a significant (the main chemical ingredients) Linalool 38.12%; linalyl acetate 25.79% it displays antimicrobial activity towards intestinal pathogens (*Escherichia coli, coliform bacteria*), without inhibiting the number of lactic fermentation bacteria, and it even promotes the growth of beneficial bacteria (2).

It has been suggested that EO may stimulate salivary and gastric glands which in turn improves digestibility and FCR. It has been suggested that an increase in appetite brought on by the stimulation of salivary and gastric glands by essential oils, the reduction of pathogenic bacteria during stress, and better digestibility could all contribute to an improvement in FCR (1, 2, 5 and 11).

According to extensive mechanistic research on the potential advantages of essential oils and/or phytogenic products in poultry production, phytogenic additives increase productivity through a variety of different mechanisms, including altering mucosa architecture, increasing antioxidant capacity and digestive enzymes, stabilizing the enteric microbiota, and lowering lipid oxidation (5, 11). Superoxide and hydrogen peroxide, are free radicals produced during regular metabolic activity, can be eliminated in a number of methods. However, as broiler stocking density rises, improvement in performance parameters when broilers fed 0.6% of LEO. However, the present findings is contrast with those findings of (20) who reported that dietary LEO did not have significant effect on layers performance. The influence of LEO on chickens that are kept in stock is not commonly known. Besides, due to LEO containing antioxidants and flavonoids

stress results in a lack of antioxidants, an excess of free radicals that cause tissue damage, and fatty acid lipid peroxidation (LPO) that harms a variety of biological components. It is hence the oxidative stress indicator that is most sensitive. The availability of oxygen is the most important factor in the onset of lipid oxidation. In the meantime, protein oxidation makes meat products more durable by oxidizing it and creating myosin heavy chain (7).

On the other hand, antioxidants given to animal diet may help manage and minimize meat's oxidative rancidity. Since lavender essential oil contains linalool, it is one of the EOs that can give free radicals hydrogen or electrons. EOs are powerful antioxidants that shield other biological molecules from oxidation's negative effects. Additionally, the antioxidative state of chicken flesh can be improved by adding natural antioxidants such lavender EO or their components (18).

Recently, lavender acquired popularity as a potent stress reliever due to several of its benefits, including antianxiety, antiviral, blood circulation-improving, aromatherapy, and insect-repellent properties. These properties may help chickens raised in crowded environments and given powdered lavender to relax and cope with stress (14).

2- Physiological (hematology) traits

A- Blood cells The influence of using LEO in the diet of broilers reared under stocking density is shown in table 3. The results show that chickens that received LEO in their diet, led to a significant (P≤0.01) increasing the red blood cells (RBCs 10 6 cells/mm^3), packed cell volume (PCV %) and lymphocyte%, while heterophil % and heterophil/ lymphocyte (H/L) ratio decreased in T2 and T3 led to close chickens in T0, while compared to T1. The present findings are similar to the findings of (9) when declared that adding LEO in broiler diet significantly (P≤0.01) improved blood cells properties and decreased H/L ratio. Regardless of the reduced oxygen supply caused by overcrowding stress, birds experience hypoxia, which stimulates the production of erythropoietin and causes erythropoiesis. Using medicinal herbs or their compounds will assist to reduce this effect by cooling the body (13)

B- Serum biochemical**.** The impact of adding LEO inbroilers' diet under stocking density on serum biochemical is given in table 4. The result in LEO treatments (T2 and T3) demonstrates that significantly (P≤0.05) raised levels of serum total protein (mg/dL), while significantly (P≤0.01) reduced level of serum cholesterol and glucose (mg/dL) and close to T0 compared to T1. The findings are similar to those of (17) when recorded that overcrowding increases serum glucose levels. The current results are in agreement with those of (5) which showed that adding LEO to a broiler diet dropped serum cholesterol level. The current results are opposite of those of (20) when found that LEO did not have significant effect on serum glucose and cholesterol. antibody titers (9).

On the other hand, extreme inflammation can result in a considerable rise in cytokines, which is a key immunological response of the organism (4). Lavender (*Lavandula angustifolia L.)*, which can be added to feed, provides an alternative to antibiotics. It's used as the antioxidant, antifungal, antibacterial and antiviral characteristics of lavender, it has been demonstrated that LEO can lower serum glucose and cholesterol levels. One of the most beneficial aromatherapy oils is lavender oil, whose key constituents are lavandulol, linalool, linalyl acetate, eucalyptol, and geraniol (3). Nevertheless, it has high concentrations of polyphenols including flavonoids, which have a variety of biological and chemical functions, as well as the ability to scavenge free radicals during oxidative damage of lipids in edible tissue and poultry meat, particularly broiler chicken. Moreover, increasing the level of high-density lipoprotein (HDL), decrease the level of low density lipoprotein (LDL), and then cholesterol level decreases (4).

The reason for lowering serum cholesterol levels may be return to that linalool is one of the LEO's active ingredients that has been shown to have cholesterol-lowering properties. The effects of linalool on hypercholesterolemia were investigated and it was discovered that oral linalool administration to mice reduced the expression of the protein 3-hydroxy-3-methyl glutaryl-CoA reductase, a marker for hepatic cholesterol synthesis (HMG-CoA), which in turn reduced total cholesterol and LDL-C concentrations (5). Although there have been

numerous research and attempts to fully describe LEO with a knowledge of its method of action and uses, they have not yet been developed.

C- Immunity. The influence of using LEO in broilers diet on raising immunity against diseases is presented in table 5. The results of this study observed that chickens who received LEO in their diet led a significant (P≤0.01) increase in producing antibodies against Newcastle disease (ND) and Infectious bronchitis disease (IB) compared to T0 and T1. According to the result of this study adding 0.3, 0.5% LEO could increase the production of antibodies against Newcastle disease (ND) and Infectious bronchitis virus (IBV) this result is in line with the result of (4, 9) which documented that LEO works as immunomodulatory.This study is totally in agreement with earlier research findings of (13) who reported that immunity will drop when broilers under high stocking density and without feed additives. The result collaborates with (11) who supplemented 48 mg/kg LEO and raised the proportional weight of the spleen, an organ with a vital contribution to the immunological defense system. Depending on the study, consuming plant essential oils might encourage the release of immunoglobulin, protecting the body from dangerous microorganisms and increasing immunity and disease resistance. This result comes from the rise in IgG and IgM immunoglobulin levels in brooding chickens (16). Consequently, when herbs essential oils were given to 52-day old layers raised the blood levels of antibodies to the infectious bursal and Newcastle disease viruses. Moreover, when breeder hens supplemented with 20 mg/kg of plant essential oil had higher serum levels of IgA and IgG, as well as a higher titer of the serum NDV antibody. It was once thought that including plant essential oils in the diet would encourage immunoglobulin secretion and raise antibody titers (9). Recently, extreme inflammation can result in a considerable rise in cytokines, which is a key immunological response of the organism (4).

Table 2. Effect of LEO on productive performance in broilers under stocking density

	RBCs 10^6 cells/mm^3	PCV %	Lymphocyte %	Heterophil %	H/L ratio
P value	*	**	**	**	**
T0	3.33 ± 0.35^{ab}	35.32 ± 3.45^{a}	68.3 ± 3.00^{b}	22.69 ± 0.59^{b}	0.33 ± 0.01^{b}
T1	2.91 ± 0.34^{b}	28.53 ± 2.69^{b}	59.77 ± 5.20^{c}	26.73 ± 0.69^{a}	0.45 ± 0.04^{a}
T2	3.43 ± 0.33^{ab}	35.08 ± 3.12^{a}	69.71 ± 4.33^{ab}	20.5 ± 0.79^{bc}	0.29 ± 0.01^{b}
T3	4.28 ± 0.33^{a}	36.58 ± 2.64^{a}	74.4 ± 5.01^{a}	19.8 ± 1.08^{c}	0.27 ± 0.01^{b}

Table 3. Effect of LEO on blood cells in broilers under stocking density.

	Live body weight g (LBW g)					
	Zero day	7th days	14th days	21th days	28th days	35th days
P value	N.S	N.S	*	*	*	*
T0	45.92±0.91	171.67±8.37	438.67±5.93^{b}	908.0 ±9.07^{b}	1644.33±9.77^{ab}	2463.33±29.63^{a}
T1	42.38±1.6	171.0± 3.61	439.33±2.03^{b}	889.0 ±3.79^{c}	1536.67±14.53^{b}	2230 ±15.28 ^{b}
T2	42.30±1.06	177.67±6.57	461 ± 3.06 ^{a}	946.33±4.91^{a}	1655 ±10.41^{a}	2450±28.87^{a}
T3	42.42±0.45	171.33±2.91	457.33±2.67^{a}	956±2.65 ^{a}	1657.67±24.33^{a}	2515±12.58^{a}
	Body weight gain g (BWG g)					
	7th days	14th days	21th days	28th days	35th days	Total
P value	N.S	*	**	**	**	**
T0	125.75±7.65	267.00±13.2^{b}	469.33±14.95^{bc}	736.33±8.01^{a}	819.00±38.66^{a}	2417.4±75.23^{a}
T1	128.62±2.18	268.33±3.84^{b}	449.67± 5.36^{c}	647.67±18.22^{c}	693.33±3.33^{b}	2187.62±34.55^{b}
T2	135.37±6.17	283.33±4.06^{a}	485.33±4.33^{ab}	708.67±13.2^{b}	795.00±27.84^{a}	2407.7±57.39^{a}
T3	128.91±3.04	286.00±4.16^{a}	498.67±0.88^{a}	701.67±26.03^{b}	857.33±11.85^{a}	2472.58±47.36^{a}
	Feed intake g (FI g)					
P value	N.S	N.S	**	*	**	**

T0	145.2 ± 6.3	340.2 ± 11.13	651.33±5.7^{a}	1125.00±7.64^{a}	1590.0±32.15^{a}	3851.73±66.49^{a}
T1	151.34±7.38	338.27±4.14	607.67±8.45^{c}	1010.33±40.7^{b}	1374.67±17.57^{b}	3482.28±78.58^{c}
T2	152.8 ± 5.96	336.4 ± 5.09	617.67±6.49^{bc}	1018.33±26.03^{b}	1417±17.58^{b}	3542.2±67.34^{ab}
T3	143.23±1.54	338 ± 4.37	631.67 ± 1.86^{b}	1034.33±8.09^{b}	1437±31.07^{b}	3584.23±47.34^{b}
	FCR					
P value	N.S	**	**	*	**	*
T0	1.16 ± 0.02	1.28 ± 0.02^{a}	1.39 ± 0.03^{a}	1.53 ± 0.01^{a}	1.95 ± 0.05^{a}	1.462±0.03^{a}
T1	1.18 ± 0.04	1.26 ± 0.0^{a}	1.35 ± 0.01^{a}	1.56 ± 0.03^{a}	1.98 ± 0.03^{a}	1.466±0.02^{a}
T2	1.13 ± 0.02	1.19 ± 0.01^{b}	1.27 ± 0.01^{b}	1.44 ± 0.01^{b}	1.79 ± 0.04^{b}	1.364±0.02^{b}
T3	1.11 ± 0.02	1.18 ± 0.0^{b}	1.27 ± 0.00^{b}	1.48 ± 0.07^{b}	1.68 ± 0.06^{c}	1.344±0.03^{b}
	(Production index) PI					
P value	N.S	**	**	*	**	*
T0	108.79±4.56	305.17 ± 3.0^{b}	673.33 ± 1.69^{b}	1276.17 ± 8.54^{b}	2053.83±10.63^{a}	883.45±50.45^{b}
T1	106.69±2.57	305.17±2.2^{b}	664.17 ± 1.42^{c}	1212.83 ± 5.45^{c}	1883.33±14.81^{b}	834.43±38.55^{b}
T2	109.98±3.55	319.33±4.7^{a}	703.67±3.47^{a}	1300.67±4.76^{ab}	2052.5 ± 16.65^{a}	897.23±69.45^{a}
T3	106.88±1.42	314.33±1.86^{ab}	706.67 ± 2.62^{a}	1306.83±11.41^{a}	2086.33±18.44^{a}	904.20±44.50^{a}

T0 (negative control, normal density) 72 birds, 24 birds each replicate, 12 birds in each m^2. The birds were fed standard feed. T1 (positive control, high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed standard feed. T2 (0.3% lavender essential oil (LEO), high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed standard feed+ 0.3% LEO. T3 (0.5% LEO, high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed standard feed+ 0.5% LEO. $^{a-c}$ Means within columns with different superscripts significantly differ. ** (P<0.01), * (P <0.05) ± Standard error.

Table 4. Effect of LEO on serum biochemical in broilers under stocking density

	Cholestrol (mg/ dL)	Total protein (mg/dL)	Glucose (mg/ dL)
P value	**	*	**
T0	118.0±15.53^{ab}	2.66±0.08^{b}	214.0±12.65^{b}
T1	132.33±22.93^{a}	2.48±0.04^{b}	252.0±4.04^{a}
T2	110.33±19.15^{b}	3.55±0.16^{a}	145.0±27.68^{c}
T3	85.67±10.57^{c}	2.54±0.25^{b}	217.0±7.94^{b}

T0 (negative control, normal density) 72 birds, 24 birds each replicate, 12 birds in each m^2. The birds were fed standard feed. T1 (positive control, high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed standard feed. T2 (0.3% lavender essential oil (LEO), high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed standard feed+ 0.3% LEO. T3 (0.5% LEO, high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed standard feed+ 0.5% LEO. $^{a-c}$ Means within columns with different superscripts significantly differ. ** (P<0.01), * (P <0.05) ± Standard error.

Table 5. Effect of LEO on immunity against diseases in broilers under stocking density

	ND	IBV
P value	**	**
T0	7221.67±1729.6^{b}	5894.00±163.30^{ab}
T1	1245.33±27.42^{c}	2312.00±131.23^{b}
T2	10098.00±1754.63^{a}	7079.00±281.93^{a}
T3	11042.67±1777.57^{a}	6326.00±804.44^{a}

T0 (negative control, normal density) 72 birds, 24 birds each replicate, 12 birds in each m^2. The birds were fed standard feed. T1 (positive control, high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed standard feed. T2 (0.3% lavender essential oil (LEO), high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed standard feed+ 0.3% LEO. T3 (0.5% LEO, high density) 102 birds, 34 birds each replicate, 17 birds each m^2. The birds were fed standard feed+ 0.5% LEO.. $^{a-c}$ Means within columns with different superscripts significant differ. ** (P<0.01), * (P <0.05) and N.S= Non-Significant. ±Standard error.

Conclusion

In summary, the findings of this study prove that adding 0.3 and 0.5% of lavender essential oil (LEO) to broiler chicken diets effectively improves productive performance. They also show that broilers raised in high stocking density at 35 days old had good live body weight and feed conversion ratios. In addition, dietary supplementation of LEO increased blood cells number and reduced H/L ratio (a stress indicator), however, lowered blood

cholesterol and glucose of broiler chickens and increased immunity against diseases. Therefore, the inclusion of 0.3, 0.5% might provide as a natural source to minimize the effect of stress happened during raising broiler chickens in high stocking density and promote broiler chicken production as broilers raised in normal density and comparable to broilers raised under stocking density without feed supplementation.

Conflict of interest

The author has no conflict of interest.

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