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Original Paper

Effects of Sage (*Salvia officinalis* L.) Supplementation in Hen Diets on Laying Productivity, Egg Quality, and Biochemical Parameters

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An experiment was designed to examine the effect of sage leaves (*Salvia officinalis*. L.) use in hens' diet on laying productivity, egg morphological and sensor properties, serum biochemistry, and egg chemical composition. A total of 90 hens from the Bulgarian synthetic population LB at the age of 40 weeks were randomly divided into three groups: S0 (without dried and milled leaves of *S. officinalis* L supplementation) and S25, and S50 experimental groups (diets supplemented with dried and milled leaves of *S. officinalis* L. at 0.25% and 0.50% respectively). The sage use in the daily dose of 0.50% led to a significant increase in hens' body weight (P <0.05); laying intensity (P <0.05); Haugh Units (P <0.01); albumen index (P <0.01) and egg yolk color (P <0.001). The addition of 0.25% *S. officinalis* significantly decreased the total cholesterol level in the blood serum (P <0.05) but significantly increased the content of protein (P <0.001); fat (P <0.05), and ash (P <0.01; P <0.05) in eggs. The supplementation of the tested product does not aggravate the eggs' sensor properties.

Keywords: *Salvia officinalis* L., hens, egg morphological properties; egg chemical composition; sensory indicators

1 Introduction

The use of herbs, spices, or extracts is a quick and easy way to distribute the natural antioxidants in the animal organism. These additives are a rich source of biologically active substances like phenol derivatives, oils, vitamins, glycosides, saponins, alkaloids, minerals (Grigorova, 2014). Herbs and spices have a wide spectrum of action. They can prevent lipid peroxidation by inactivating free radicals or by activating antioxidant enzymes. Antioxidants are involved in protecting animals' health, supporting their immune system, and increasing their productivity (Frankic et al., 2009). In addition, antioxidants from herbal supplements are more sustainable than synthetic antioxidants such as butylhydroxyanisole (E 320), butylhydroxytoluene (E 321), propyl gallate (E 310) and can be incorporated into feed or water to control diseases in poultry (El-Ghany, 2023; Chen et al., 2003).

One of the promising herbs utilised in the feed and water of poultry is sage (*Salvia officinalis* L., Labiaceae Family), which is grown in Bulgaria as a garden plant (Todorova, 2022). Sage is a perennial semi-shrub with numerous woody branches at the base and tender branches at the top (Fasseas et al., 2008). The leaves of the herb are gray-green, opposite, oblong, narrowed at the base, and with many hairs on them. They are rich in alkaloids, tannins, asparagine, glutamine, carotene, saponins, up to 2.5% essential oil (mainly contains the monoterpenes eucalyptol, alpha- and beta thujone, borneol) and a bitter substances (diterpene lactone carnosol, catechin tannins) (Landjev, 2010). The flowers are blue-violet and collected at the top of the stem in spike-shaped inflorescences. The whole plant has a specific and pleasant smell. *Salvia officinalis* extracts possess antimicrobial activity against Gram-positive and Gram-negative bacteria and have high antioxidant activity against DPPH(2,2-diphenyl1-picryl-hydrazyl-hydrate) (Mollova et al., 2016). Sage leaves or their extracts have been used in poultry nutrition for improving sperm quality and productivity in roosters (Ommaty et al., 2013); average daily gain (Farhadi et al., 2010; Levkut et al., 2020); blood biochemical parameters

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(Piesova et al., 2012) as well as for reducing the total number of Enterobacteriacea (Galamatis et al., 2021; Rasouli et al., 2020).

The available literature provides insufficient information on the effect of adding sage leaf meal to the diet of hens on their performance and health status. There is no data about the influence of this herb on the organoleptic qualities and eggs' chemical composition. So, the purpose of the present work was to investigate the effect of dried and milled sage addition on production, chemical composition, morphological and sensor properties of eggs, some blood parameters as well as on egg chemical composition in hens from the Bulgarian synthetic population LB.

2 Material and methods

The investigation was approved by the Bulgarian Animal Ethics Committee in accordance with Bulgarian Veterinary Law (2011) on the protection of animals used for experimental and other scientific purposes and relevant provisions of Council Directive 86/609/EEC (Permission for using the agricultural animals for scientific purpose, N177, expire data 18.06.2020 obtained on the base of Protocol N33/18.06.2015)

During March-May 2022, a feeding trial was carried out at the Poultry Experimental Farm of the Institute of Animal Science-Kostinbrod, Bulgaria. The trial comprised of 90 hens at 40 weeks of age from synthetic population LB (selected in the Experimental Poultry Breeding Center of the Institute). The hens were randomly divided into three groups (n = 30 hens/group): a control and two experimental groups (three replications per group, 10 poultry in each replicate). The hens from each replication were raised in separate boxes in a deep litter pen. Water was supplied via nipple watering troughs. The study duration was 66 days: preparatory period (n = 12 days) and experimental period (n = 54 days).

During the preparatory period all groups received 150 g.day^{-1}.hen^{-1} compound feed for broiler breeding hens with following composition: 61.96% wheat; 15% sunflower meal; 10% soybean meal; 3% sunflower oil; 7.50% limestone; 1.67% dicalcium phosphate; 0.3% salt; 0.20% vitamin premix; 0.20% salgard; 0.070% lysine 98%; 0.10% Optisim. During the experimental period the hens received 150 g/day/hen of this compound feed whereas the forage of experimental poultry was supplemented with 0.25% (I experimental group) and 050% (II experimental group) *Salvia officinalis* L. The diets of all the groups were formulated to contain: 2,763.890 kcal. kg^{-1} metabolizable energy; 16.13% crude protein; 5.158% crude fats; 4.737% crude fiber; 3.355% Ca; 0.754% P.

The dried and milled leaves of *S. officinalis* L.) were acquired from Karlovo region in Bulgaria. The chemical composition of the diets and sage leaves was determined as follows: dry matter (drying on 105 °C), crude protein (Kjeldahl method), crude fat (Soxlet method), crude fibres (ceramic fiber filter method), and crude ash (in furnace on 600 °C) – by Weende analysis; the contents of both Ca (wet ash method) and P (photometric method) – according to the AOAC, 2007. The pH values were determined using a pH meter (Stirrer, type OP-951) The antioxidant activity was measured by the photometric method (HI801 Iris Visible Spectrophotometer HANNA Instruments), which determines the reduction of a free radical DPPH and expressed as inhibition of DPPH in percentage. The samples were analysed according to the method by Deeseenthum and Pejovic (2010). The 0.004% (w/v) DPPH radical solution in 95% ethanol was prepared. Three mililiters of ethanolic DPPH solution was mixed with 0.1 ml of the sample or 95% ethanol (as a control), vortexed and incubated for 30 minutes in a dark room at room temperature. The absorbance of each sample at 517 nm was measured. The antioxidant activity was given as a percentage of DPPH scavenging, calculated as:

$$\frac{(control\ absorbance - extract\ abrsorbance)}{(control\ absorbance)} \times 100$$

The experimental diets' metabolizable energy was calculated according to Todorov et al. (2021). Daily laying capacity (in egg number/group) and daily laying intensity (in percent.group^{-1}), as well as mortality (in the hens' number.day^{-1}), were monitored throughout the experiment. Feed intake per one hen (in g) was calculated for each group.

At the beginning and at the end of the experimental period, the live weight of the hens of all groups was measured.

Thirty eggs from each group were taken at the beginning and at the end of the experimental period and the following measurements were made: weight of the egg, yolk, albumen, and eggshell (by balance with a precision of 0.001); shape index (by index meter Van Dorn De Bilt N 72205-1); yolk diameter and height (by caliper); albumen large and small diameters and albumen height (by caliper); yolk index (calculated by the formula: YI (%) = (h/d) × 100; albumen index (calculated by the formula: I_{al} (%) = $\left(h/[D + d]/2 \times 100\right)$ where h is the height of the thick albumen (in mm); D and d – big and small albumen diameter respectively; Haugh units (by index meter); eggshell thickness (mm) without the shell membrane (measured at three locations by a micrometer Ames 25EE with a precision of 0.0001 mm); egg yolk pigmentation (by the Roche Color Fan). The percentage

ratio of the weights of the yolk, albumen, and eggshell to the egg' weight was calculated. The content of Ca and P in the eggshell was determined (AOAC, 2007). At the end of the trial, 20 eggs per group were kept in a refrigerator at a temperature of 4 °C and 75% air humidity. After 28 days, Haugh Units, albumen, and yolk indices were measured and calculated, to determine the influence of the studied additive on the eggs' freshness. At the end of the experiment, six eggs per group were boiled (for 6 min) and the content of protein (by Kjeldahl) and ash in the albumen and yolk, as well as the fat content in the egg yolk (by Soxhlet) were determined.

Ten hens from each group were randomly chosen at the end of the trial and after 16 hours of fasting, blood samples were taken from *Vena cutanea ulnaris* (3 ml.hen^{-1}). Serum was separated by centrifugation at 3000 rpm for 10 minute (Kara et al., 2016). The total cholesterol, glucose, and triglycerides in the blood serum were measured by commercial kits (BioSystems S.A., Costa Brava, Spain) using a biochemical analyzer BioSystems BTS-350 (S.A. Costa Brava Spain).

At the end of the study 60 eggs boiled for 4 minutes, (20 from each group) were tested by ten people who were given sampling cards prepared in accordance with the requirements of Bulgarian State Standard 4336-73. Egg yolks and albumens were tested separately. The taste and smell of boiled eggs were evaluated while the eggs were warm.

The results obtained were processed statistically using the computer program Excel 2007. The statistical significance between the groups was determined by one-way analysis of variance (ANOVA). The values were presented as the mean X ±statistical error for each variable.

3 Results and discussion

The total chemical composition (in % of dry matter), pH value, and antioxidant activity of *S. officinalis* leaves used in our investigation are presented in Table 1. In the present study, the observed data on the sage chemical composition varied significantly with the reports of previous authors for crude protein, crude fat, crude fiber, and crude ash (Khalil et al., 2012; El-Rahman, 2018; Draz et al., 2021). In general, our results are within the range of values obtained by these authors. The differences in chemical composition are probably due to different geographic regions where the plants were grown, soil type, time of harvest, etc. The *S. officinalis* leaves has high antioxidant activity (85.35%), which supports the findings of Neagu et al. (2014).

Table 1 Total chemical composition (in % of dry matter) and pH value of *Salvia officinalis* leaves

Parameters	*Salvia officinalis*
Moisture 105 °C (%)	8.350
Crude protein (%)	15.280
Crude fat (%)	6.250
Crude fiber (%)	20.310
Crude ash (%)	9.870
Ca (%)	1.136
P (%)	0.154
pH	6.110
DPPH scavenging activity (%)	85.35 ±1.24

The pH values of the diets at the beginning and at the end of the experiment ranged within narrow limits: 5.98, 6.06, and 6.05 for control, I, and II experimental groups respectively.

The results of average body weight and average laying intensity of control and experimental groups can be found in Table 2. At the beginning of the experimental period, the values of the average body weight were 2,211.72 g, 2,222.76 g, and 2,277 g for the control, I, and II experimental groups respectively (P >0.05). At the end of the treatment, the body weight of the hens from the II experimental group was significantly higher (P <0.05) than those of the other groups. An increase in live weight was also observed in broiler chickens when sage was added to the feed (Hernandez et al., 2004; Traesel et al., 2011). Hernandez et al. (2004) attributed the improved weight gain to the appetite stimulation and enhanced digestive properties of sage.

The weekly average values of the laying intensity of hens from control and experimental groups are presented in Figure 1. The S25 group, which received 0.25% of the *S. officinalis* leaves, had the lowest initial value of laying intensity -70.95%. During the last week, the laying intensity of S25 group (76.19%) was higher than the control group (71.91%) and lower than the S50 group (78.09). Hens from the S0 and S50 groups started with the same laying intensity during the week 1. All the groups reached peak laying intensity during the week 8 (79.05%; 77.62% and 80.48% for S0, S25, and S50 groups, respectively).

Table 2 is indicating that the average laying intensity of the hens before the beginning of the experimental period was similar (P >0.05) for all the groups. During the experiment, average laying intensity of the poultry from the S50 group (78.16%) was significantly higher (P <0.05) than that of the S0 group (74.63%) and the S0 group (74.14%). Within the groups, an increase in this

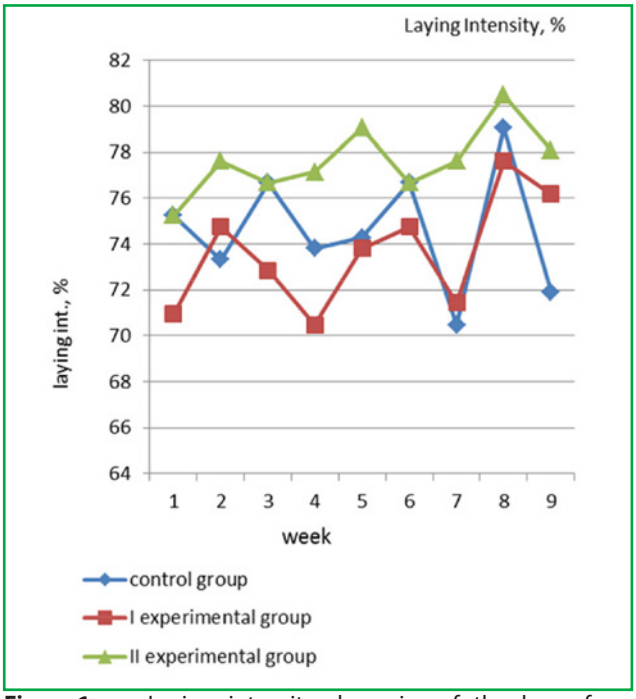

Figure 1 Laying intensity dynamics of the hens from control and experimental groups

parameter was observed at the end of the experiment compared to the beginning (by 1.55% in the S0 group and by 3.87, and 5.93% for S25 and S50 groups respectively). Our results agree with the study of Saleh et al. (2021), who reported an increase in egg productivity when including 1 kg of dry sage per ton compound feed for Bovans brown hens. The authors attributed the improvement in laying productivity to the phytoestrogens present in sage. They have estrogenic effect which affect oviduct development and have a positive effect on egg productivity.

Table 3 presents the feed intake, total number of eggs laid, and mortality during the experimental period. All hens were clinically healthy during the trial and there was no recorded mortality. Because all groups in the experiment received and consumed the same amount of feed, there was no difference between groups in terms of feed consumption per group and per hen per day. The highest number of eggs was observed in the S50 group (1266), followed by the S0 group (1209), and the lowest number of eggs were recorded in S25 group (1201). Therefore, the best feed conversion ratio was recorded by the hens reared on S50 group where 192g of feed was consumed to obtain one egg. The values of feed conversion ratio in the other groups were similarly poor (201g and 202g for S0 and S25 groups respectively). Traesel et al. (2011) also found an improvement in feed conversion ratio in Cobb chickens fed with 50 and 100 mg.kg^{-1} sage oil in feed. The components of sage essential oil (eucalyptol, alpha- and beta thujone) stimulate digestion, improved apparent fecal digestibility of dry matter and crude protein of the finisher diet and resulting in improved feed coversion ration (Hernandez et al., 2004).

The results of the eggs' morphological characteristics are presented in Table 4. The present findings indicated that the supplementation of dried sage leaves in the diets of layers had no effects on the weights of egg, yolk, albumen, and eggshell (P <0.05). At variance with our findings, Galamatis et al. (2021) observed a significant increase (P <0.05) in yolk weight when salvia plants was supplemented at 0.5% and 1% in the diets of Hy-Line Brown layers due to great abundance of antioxidant substrates which help laying hens to tolerate termal stress during production of yolk. Shell thickness is of great importance for egg quality because the eggshell protects the embryo from physical damage and the entry of pathogens via the cuticle layer. The shell thickness statistically did not vary for all groups.

The ratio of eggshell weight/egg weight (Table 5), which is an indicator of shell strength, were similar from 8.99% (in the control group) to 9.11% (in the II experimental group). The amount of calcium and phosphorus in egg shell is also important for its strength. The supplementation of sage leaves in the hens diet did not have any effect (P >0.05) on the mineral content of the eggshell (Table 6).

Table 2 Live body weight (g) and laying intensity (%) of hens from the control and experimental groups (X ±SE)

	Control	I experimental	II experimental
Body weight at the beginning of the experimental period (g)	2,211.72 ±28.60	2,222.76 ±25.40	2,277.93 ±27.63
Body weight at the end of the experimental period (g)	2,163.33 ±30.69 b_1*	2,150.67 ±28.33 c_1*	2,264 ±2,264 b_1* c_1*
Laying intensity before the beginning of experimental period	73.08 ±1.71	70.27 ±1.44	72.23 ±1.70
Laying intensity during the experimental period	74.63 ±0.86 b_2*	74.14 ±0.78 c_2*	78.16 ±0.75 b_2* c_2*

Control/II experimental group – $b_{1,2}$; significance: * P <0.05; I experimental group (EG)/II experimental group (EG) – $c_{1,2}$

Table 3 Feed intake, number of egg' numbers and mortality of the hens from control and experimental groups during the experimental period (*n* = 54 days)

Parameters	Groups		
	control	I experimental	II experimental
Feed intake during the whole experimental period (kg)	243.000	243.000	243.000
Total eggs number	1,209	1,201	1266
Feed intake.hen^{-1}.day^{-1} (g)	150	150	150
Feed intake per one egg (g)	201	202	192
Mortality (hens number %)	0	0	0

Table 4 Eggs' morphological characteristics (X ±SE)

	Control	I experimental	II experimental
At the beginning of the experimental period			
Egg weight (g)	58.957 ±0.909	57.548 ±0.811	58.797 ±0899
Albumen weight (g)	36.60 ±0.97	35.69 ±0.67	35.97 ±0.71
Yolk weight (g)	16.75 ±0.21 b_1*	16.68 ±0.19 c_1**	17.58 ±0.26 b_1*c_1**
Egg shell weight (g)	5.10 ±0.09 b_2*	5.34 ±0.10	5.43 ±0.12b_2*
Egg shell thickness (mm)	0.329 ±0.004	0.334 ±0.003	0.333 ±0.005
Shape index (%)	75.567 ±0.656	75.15 ±0.390	75.483 ±0.477
Haugh Units (%)	80.1 ±1.50	80.27 ±1.60	80.13 ±1.77
Albumen index (%)	10.37 ±0.50	9.97 ±0.50	10.04 ±0.66
Yolk index (%)	42.83 ±0.90 b_2**	41.52 ±0.55 c_2*	38.96 ±0.83 b_2** c_2*
Yolk color Roche	4.36 ±0.34	4.2 ±0.28	4.2 ±0.28
At the end of the experimental period			
Egg weight (g)	59.979 ±0.77	58.323 ±0.76	57.962 ±0.896
Albumen weight (g)	37.044 ±0.69	37.43 ±1.27	35.23 ±0.79
Yolk weight (g)	17.55 ±0.18	17.31 ±0.20	17.37 ±0.19
Egg shell weight (g)	5.39 ±0.07	5.28 ±0.11	5.28 ±0.10
Egg shell thickness (mm)	0.332 ±0.004	0.322 ±0.006	0.330 ±0.005
Shape index (%)	75.65 ±0.616	75.37 ±0.49	75.45 ±0.57
Haugh Units (%)	73.1 ±1.49 b_3**	77.27 ±1.71	78.83 ±1.39 b_3**
Albumen index (%)	7.585 ±0.45 b_4**	8.91 ±0.62	9.52 ±0.43 b_4**
Yolk index (%)	38.61 ±0.62	40.41 ±0.75	40.36 ±0.89
Yolk colour (Roche)	4.3 ±0.23 b_5***	4.33 ±0.19 c_3***	5.7 ±0.23 b_5***c_3***

Table 5 Percentage ratio of the weight of the yolk, albumen and shell to the weight of the egg

	Control	I experimental	II experimental
At the beginning of the experimental period			
Albumen (%)	62.82 ±0.40a_1*b_1*	61.85 ±0.39a_1*	60.93 ±0.45b_1*
Yolk (%)	28.53 ±0.38b_2*	29.06 ±0.39	29.90 ±0.43b_2*
Egg shell (%)	8.66 ±0.12a_2***b_3	9.31 ±0.10a_2***	9.24 ±0.15b_3*
At the end of the experimental period			
Albumen (%)	61.64 ±0.42	61.63 ±0.59	60.74 ±0.42
Yolk (%)	29.36 ±0.40	29.77 ±0.40	30.14 ±0.39
Egg shell (%)	8.99 ±0.09	9.05 ±0.14	9.11 ±0.10

control/I experimental group – a1,2; Significance: * *P* <0.05; *** *P* <0.001; control/II experimental group – $b_{1, 2, 3}$

Table 6 The content of Ca and P content in the egg shell

	Control	I experimental	II experimental
Ca At the beginning of the experiment (%")	33.990 ±0.110	34.040 ±0.100	34.064 ±0.090
P At the beginning of the experiment (%)	0.133 ±0.001	0.131 ±0.002	0.156 ±0.002
Ca At the end of the experiment (%")	34.226 ±0.08	34.258 ±0.110	34.235 ±0.100
P At the end of the experiment (%)	0.138 ±0.002	0.134 ±0.002	0.150 ±0.003

Table 7 Haugh Units, albumen index and yolk index after 28 days of egg storage in refrigerator (X ±SE)

Groups	Egg weight (g)	Haugh units (%)	Albumen index (%)	Yolk index (%)
Control	59.30 ±1.20	73.55 ±1.59	7.49 ±0.47	38.065 ±0.70
I experimental	57.88 ±1.15	75.81 ±1.32	8.11 ±0.58	39.196 ±0.63
II experimental	57.71 ±1.14	75.81 ±1.58	8,51 ±0.54	39.245 ±0.68

The shape index (Table 4) of the eggs were not affected (P >0.05) by the experimental diets. The yolk index was not affected by sage leave inclusion in hens' diet. At the end of the experiment, the values of the albumen index and Haugh units were significantly higher in hens reared on S50 when compared to other groups (P <0.01). The egg yolk color (Table 4) was significantly higher (P <0.001) in the S50 group (5.7 points) when compared to the S0 (4.3 points) and S25l group (4.33 points). The results obtained can be explained by the greater amount of carotenes at the higher dose of salvia. Similar results were reported by Saleh et al. (2021) when 1 kg salvia leaves per ton was supplementing the diets of hens.

The Haugh units, albumen, and yolk indices after 28 days of storage of the eggs in a refrigerator at a temperature of 4 °C and 75% air humidity are presented in Table 7. The values of these parameters in the hens of both experimental groups were higher than those in the control group, but the differences were not statistically significant (P >0.05).

Table 8 presents the total chemical composition of albumen and yolk of the groups. The chemical composition of albumen was not significantly affected by sage leave supplementation in the present experiment (P >0.05). The S25 group significantly (P <0.05) increased the content of protein, fat, and ash in egg yolk. The content of protein, fat, and ash in the egg yolk of the hens from II experimental group did not vary with those from the control group (P >0.05).

The values of blood serum total cholesterol, triglyceride, and glucose in poultry from all three groups are shown in Table 9. The total cholesterol content of the hens from I experimental group was significantly lower compared to the control group (P <0.05). However, hens reared on S50 and S0 had non significant blood serum total cholesterol levels (P >0.05). Our results are in accordance with those obtained by Saleh et al. (2021) in laying hens. The total cholesterol reduction in hens' blood serum can be explained by the action of borneol and other monoterpenes contained in the essential oil of sage leaves. As can be seen from Table 9, the values of triglycerides and glucose in both experimental groups were significantly higher than those in the control group, which contrasts with the reported results by Szaboova et al. (2008) in rabbits and by El Garhy et al. (2018) in broilers.

During the tasting of boiled eggs, no differences in taste and smell were found between the groups, as well as deviations from the normal color of the yolk and white. It is a positive fact that after 54 days of supplementing

Table 8 Total chemical composition of egg white and yolk of the control and experimental groups, in % relative to dry matter (X ±SE)

	Control group		I experimental group		II experimental group	
	albumen	yolk	albumen	yolk	albumen	yolk
Dry matter (%)	12.80 ±0.36	51.58 ±0.26	13.35 ±0.32	51.54 ±0.19 c_1*	12.79 ±0.14	50.09 ±0.36 c_1*
Protein (%)	97.14 ±0.68	35.77 ±0.53 a_1***	95.70 ±1.03	39.07 ±0.20 a_1*** c_2***	95.83 ±0.57	34.91 ±0.28 c_2***
Fats (%)	–	62.22 ±0.58	–	63.23 ±0.45 c_3*	–	62.13 ±0.20 c_3*
Ash (%)	3.50 ±0.40	3.19 ±0.19 a_2**	3.35 ±0.28	4.06 ±0.19 a_2** c_4*	3.44 ±0.18	3.51 ±0.11 c_4*

control/I experimental group – $a_{1,2}$; significance: * P <0.05; ** P <0.01; *** P <.0.001

Table 9 Content of total cholesterol, triglycerides and glucose in the blood serum of hens from the control and experimental groups (X ±SE).

	Control group	I experimental group	II experimental group
Total cholesterol (mg.dL^{-1})	320.76 ±66.19 a1	154.5 ±15.17 a1	203.10 ±17.09
Triglycerides (mg.dL^{-1})	566.29 ±61.49 a2*b1**	718.21 ±37.78 a2*	778.49 ±31.00 b1**
Glucose (mg.dL^{-1})	122.29 ±24.66 a3*b2***	171.14 ±17.44 a3*	196.37 ±15.12 b2***

control/I experimental group – $a_{1, 2, 3}$; significance *P <0.05; **P <0.01; control/II experimental group – b_1

dried sage leaves in the diets of layers, the bitter taste of the herb and its specific smell of monoterpenes (mainly camphor) did not pass into the final product (eggs).

4 Conclusions

This present study demonstrated beneficial supplementation of dried sage leaves in layers diet. Supplementation of 0.50% of the tested product led to a significant increase in hens' body weight, laying intensity, haugh units, albumen index, and egg yolk color. The birds reared on diets containing 0.50% dried sage leaves presented the best feed conversion ratio. The addition of 0.25% *Salvia officinalis* decreases significantly total cholesterol level in the blood serum, but significantly increases the content of protein, fat, and ash in egg yolk. The utilization of dried sage leaves in layers diet did not aggravate eggs' sensor properties. In conclusion the results of our research suggest that dietary addition of *Salvia officinalis* L. could be for improve laying productivity and egg quality.

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