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Article

Chili Pepper and its Influence on Productive Results and Health Parameters of Broiler Chickens

Miloš Marić [1], Ivan Stajčić [1], Radivoj Prodanović [1], Nedeljka Nikolova [2], Erinda Lika [3] and Nikola Puvača [1,*]

[1] University Business Academy, Faculty of Economics and Engineering Management, Department of Engineering Management in Biotechnology, Cvećarska 2, 21000 Novi Sad, Serbia
[2] Ss Cyril and Methodius University in Skopje, Institute of Animal Science, Bul. Ile Ilievski 92a, 1000 Skopje, North Macedonia
[3] Faculty of Veterinary Medicine, Agricultural University of Tirana, Kodor Kamez, 1000 Tirana, Albania

* Correspondence: nikola.puvaca@fimek.edu.rs; Tel.: +381-65-219-1284 (N.P.)

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Abstract: An experiment was conducted to investigate chili pepper's effect in broiler nutrition on productive performances and blood lipid profile. For biological research, three treatments with a total of 450 broilers were formed within four replicates. Control treatment (CON) of chickens were fed with a standard feed mixture, while the experimental treatments were fed with the same mixture only with the addition of two levels of chili pepper 0.5 (CP-0.5) and 1.0% (CP-1.0). The addition of chili pepper in the amount of 0.5% has led to the highest final body weight of chickens (2460.6 g), followed by the addition of 1.0% (2442.4 g) with significant differences ($p<0.05$) compared to a control treatment (2075.8 g). The lowest amounts of triglycerides, total cholesterol, low-density lipoprotein (LDL), and non-high-density lipoprotein (non-HDL) were recorded in broilers in treatments with chili pepper with statistically significant ($p<0.05$) differences compared to a control treatment. The highest share of high-density lipoprotein (HDL) with statistical significance ($p<0.05$) was also determined in chili pepper treatments. Based on the obtained results, it can be concluded that the addition of chili pepper in broiler chicken nutrition has positive effects on production performances and in the improvement of chicken blood lipid profile.

Keywords: Chili pepper; cholesterol; nutrition; chickens; food.

1. Introduction

Besides the vital role of chili pepper in daily human nutrition for enhancement of taste, aroma, and color of food, this spice has also been efficiently used in animal nutrition to improve animal health and produce healthier meat and eggs [1]. Alternative growth promoters must be found with the ban of antibiotics use in animal nutrition due to the emergence of microbe resistance. Removal of antibiotics as growth promoters has led to animal performance problems, an increase in feed conversion ratio, and a rise in certain animal diseases [2]. The alternatives to synthetic drugs as growth stimulators are numerous [3,4]. Chili pepper (*Capsicum annuum* L.) plays a vital role in decreasing the deposition of cholesterol and fat in the body, contributes to decreased triglycerides, and supports the vascular system in the body [5]. Efficient chili pepper compounds consist of capsaicin, capsaicin, and capsanthin [6]. Chili pepper is rich in vitamin C, which has a considerable impact in improving production by reducing heat stress [7]. A recent study involved in chicken performance has shown that blends of active compounds for chili pepper have chemopreventive and chemotherapeutic effects [8]. The addition of chili pepper to the poultry diet expresses a significant effect on the heterophil/lymphocytes (H/L) ratio [9], which reflects the role of chili pepper, especially its active compound capsaicin, which is involved in stress hormones, and which supports the immune system of birds and enhances its resistance against disease through decreasing (H/L) ratio [10].

This study aimed to investigate chili pepper's influence in broiler nutrition on productive results and health parameters such as blood lipid profile.

2. Materials and Methods

Determination of bioactive components in chili pepper

Content of capsanthin or colored matter in a sample of hot red pepper powder is determined by the reference method SRPS EN ISO 7540:2020 [11]. The method is based on the extraction of colored substances from a sample of hot red pepper with benzene and then the spectrophotometric measurement of maximum absorbance at a wavelength of 477nm. Content of capsanthin in samples of ground pepper is expressed in g/kg of dry matter of the sample. The content of capsaicin in a pepper sample is determined according to the manual method for quality control of fresh and processed fruits, vegetables and mushrooms, and non-alcoholic beverages. The method is based on the extraction of capsaicin from a sample of hot red pepper, separation of coloring matters, and the development of color characteristic of capsaicin, followed by spectrophotometric measurement of maximum absorbance at a wavelength of 433nm. The color intensity of the solution is proportional to the concentration of capsaicin. The content of capsaicin in samples of chili pepper powder is expressed in % dry matter of the sample. The concentration of capsanthin and capsaicin is given in Table 1.

Table 1. The concentration of capsanthin and capsaicin in experimental chili pepper.

Chili pepper powder samples	Bioactive compounds	
	Capsanthin, g/kg	Capsaicin, g/kg
LSM	3.31[a]	0.96[b]
SE_{LSM}	0.58	0.04

Treatments with different letter indexes in the same row are statistically significantly different ($p<0.05$)

Animal trials

Biological tests were carried out under production conditions. At the beginning of the experiment, a total of 450 one-day-old broilers were distributed into three dietary treatments with four replicates each. Every dietary treatment included 150 chickens divided into four pens with 37-38 chicken per pen. Chickens were reared on the floor holding system with the chopped straw as litter material. Chickens were provided with a light regime of 23h per day per entire experimental period of 42 days with the incandescent light source. Three mixtures were used for chicks' nutrition, starter, grower, and finisher through pan feeders. For the first 14 days, during the preparatory period, chicks were fed with starter mixtures. Following the preparation period, chicks were fed with grower mixtures for the next 21 days, and then for the last seven days of the fattening period with finisher mixtures according to the experimental design given in Table 2 and dietary chemical composition of used starter, grower, and finisher mixtures which is given in Table 3.

During the experiment, chicks were fed and watered *ad libitum.* Chickens were watered through the nipple water system. Microclimate conditions were regularly monitored. Bodyweight was monitored at an individual level during the entire experimental period every seven days, while the feed consumption and feed conversion ratio were monitored at the pen level also every seven days.

Table 2. Experimental design with chickens.

Experimental treatments	The concentration of additives in chicken diets, %			
	Additive	Starter	Grower	Finisher
		1 – 14 days	15 – 35 days	36 – 42 days
CON	Control treatment	0.0	0.0	0.0
CP-0.5	Chili pepper	0.0	0.5	0.5
CP-1.0	Chili pepper	0.0	1.0	1.0

Table 3. Chemical composition of dietary mixtures, %.

Nutrients	Diet mixtures		
	Starter	Grower	Finisher
Dry matter	89.4	89.3	89.4
Moisture	10.5	10.7	10.5
Crude protein	21.1	20.7	17.3
Crude fat	3.9	3.9	4.7
Crude fibre	3.5	3.5	3.6
Crude ash	5.0	4.8	5.6
Ca	0.8	0.9	1.1
P	0.6	0.6	0.5
Metabolic Energy, MJ/kg	12.5	12.8	13.3

*Chili pepper is added *on top* of the basic diet.

Blood lipids

At the end of the 6th week, twelve birds were randomly chosen from each treatment and bled via wing vein puncture to obtain blood samples. Serum samples from blood were separated by centrifugation (4000 rpm for 5 min at 20°C). Commercially available kits (Randox Laboratories Limited - United Kingdom) were used to analyze the serum for triglycerides, total cholesterol, HDL, and LDL on a biochemical autoanalyzer Cobas Mira Plus (Roche Diagnostics). Values were expressed as mg/dl [12].

Statistical analyses

Statistical analyses were conducted within the statistical software program Statistica 12 for Windows to determine if variables differed between treatments. Significant effects were further explored using analysis of variance (ANOVA) with repeated measurements, least-square means (LSM), and standard errors of least-square means (SE_{LSM}), as well as Fisher's LSD post-hoc multiple range test with Bonferroni corrections to ascertain differences among treatment means. A significance level of $p<0.05$ was used.

3. Results and Discussion

From the results given in Table 1, it can be seen the concentration of capsanthin (3.31 g/kg) and capsaicin (0.96 g/kg) as the main bioactive components in chili pepper. According to the Serbian regulation (Fig. Gazette of SFRY, No. 1/79), chili pepper on 1 kg of dry matter should comprise at least 2 g of capsanthin and capsaicin 0.5 to 0.7 g. As can be seen from the results shown in Table 1, samples of chili pepper correspond to quality parameters requirements of Serbian regulations, except for the content of capsaicin, which in the tested samples was higher for 0.26 g of dry matter. Considering that the capsaicin is the alkaloid responsible for pepper's hot taste, this result was expected because the chili pepper is recognizable for its pungent quality [13]. The highest content of capsaicin was found in the placenta and dihydrocapsaicin, 10.48 and 6.43 g/kg, respectively, while the highest ratio of 3.71 estimated from the quantity of capsaicin and dihydrocapsaicin was calculated in the pericarp [14]. The placenta's determined pungency level of 272 211 SHU was almost five times and two times higher than the pungency level in the seed and pericarp, respectively [15].

Based on the obtained results, it can be concluded that the addition of chili pepper in the diet of broiler chickens led to statistically significant (p<0.05) differences in body weight (Table 4). Chickens have finished the preparatory period with uniform body weight with no statistically significant differences (p>0.05). At the end of the second fattening period, chili pepper's addition exerted the stimulating effect and led to statistically significant differences (p<0.05) in body weight concerning the control treatment. After the completion of the experimental period, the highest achieved bodyweight of chicken was in treatment CP-0.5 (2460.6 g), which was followed by treatment CP-1.0 (2442.4 g) with statistically significant differences (p<0.05) compared to control treatment.

Table 4. Bodyweight of chickens in the experiment, g.

Experimental treatments		**Age of chickens**						
		1 day	7 days	14 days	21 days	28 days	35 days	42 days
CON	LSM	42.8^{a}	162.7^{a}	388.6^{a}	785.6^{a}	1162.4^{a}	1643.8^{b}	2075.8^{b}
CP-0.5	LSM	42.5^{a}	162.5^{a}	385.3^{a}	770.5^{a}	1193.6^{a}	1815.1^{a}	2460.6^{a}
CP-1.0	LSM	42^{a}	161.6^{a}	385.1^{a}	762.4^{a}	1183.6^{a}	1812.1^{a}	2442.4^{a}
Pooled SE$_{LSM}$		0.47	1.6	3.87	8.38	11.84	12.2	24.33

Treatments with different letter indexes in the same column are statistically significantly different (p<0.05)

Our study has shown that chili pepper's addition has a positive effect on chickens' production results, which is also in agreement with previous findings with the use of chili pepper in broiler chicken nutrition [16–18]. Extensive research revealed that chili pepper inclusion at levels of 0.5%, 0.75%, and 1% in broiler chicken diets of hybrid line Ross 308 improved body weight gain and feed conversion ratio. Also, the different forms of chili peppers showed better growth performance results of chickens on experimental chili pepper treatments compared to control treatments [19–21].

The addition of chili pepper as feed additives to broiler chicken nutrition in this experiment led to high improvement of chickens' lipid profile [22]. From the results given in Table 5, it can be noticed that the highest amounts of triglycerides (65.9 mg/dl), total cholesterol (97.2 mg/dl), and LDL (36.7 mg/dl) were in control treatment with statistically significant (p<0.05) differences in comparison to treatments with the dietary addition of chili pepper.

Table 5. Biochemical blood parameters and lipid profile, mg/dl.

Experimental treatments		**Triglycerides**	**Total cholesterol**	**HDL**	**LDL**	**non HDL**	**HDL/LDL**
CON	LSM	65.9^{a}	97.2^{a}	19.2^{b}	36.7^{a}	78.0^{a}	0.5^{b}
CP-0.5	LSM	16.7^{b}	52.4^{b}	35.5^{a}	9.4^{b}	16.9^{b}	3.8^{a}
CP-1.0	LSM	17.7^{b}	54.3^{b}	35.7^{a}	10.3^{b}	18.6^{b}	3.6^{a}
Pooled SE$_{LSM}$		0.8	0.9	1.16	1.01	1.03	2.33

Treatments with different letter indexes in the same column are statistically significantly different (p<0.05)

This effect can be explained by the possible inhibition of the Acetyl CoA syntheses enzyme necessary for the biosynthesis of fatty acids. Both chili pepper levels in our study decreased LDL levels compared to the levels in chickens of the control treatment. The possible antioxidant mechanism can explain this effect, and anti peroxide was lowering LDL or the decrease in hepatic production of very-low-density lipoprotein (VLDL), the precursor of LDL in the blood circulation. The addition of chili pepper to the broiler diet in different amounts from 0.25 to 1% influenced decreased blood cholesterol concentration and other blood biochemical parameters [23]. Furthermore, spice, herbs, and medicinal plants can facilitate activity of enzymes involved in converting cholesterol to bilious acids and subsequently result in lower cholesterol concentration in the carcass. Similar results with the lowering effects of total cholesterol in red and white meat and skin of chickens fed with dietary garlic powder were obtained by Puvača et al. [24], as well with different onion species in Tashla et al. [25] research, respectively. Spices and herbs in human nutrition had a considerable influence on health promotion and lower blood cholesterol concentration and lipid oxidation. Besides the hot red pepper, garlic and black pepper had a high impact on altering the blood lipid profile of chickens and to influence on meat quality [26]. Capsaicinoids present in red peppers cause pungent, hot tasting sensations when consumed as a part of the diet and sensory properties of chicken meat that may affect human health because capsinoids include antimicrobial activities against disease caused by bacteria [27]. Meat obtained by chickens fed with chili pepper poses a better lipid profile and can be successfully used in daily human nutrition as a dietetic food [28].

4. Conclusions

Based on the obtained results, it can be concluded that the addition of chili pepper in broiler chicken nutrition has a positive effect on production performances. The addition of chili pepper in the amount of 0.5% has led to chickens' highest final body weights. Also, it can be concluded that significant lowering of plasma cholesterol, triglycerides, LDL, and increase of HDL by this spice supplementation in broiler diet could indicate effective in the regulation of lipid metabolism in a favorable manner for prevention of atherosclerosis or coronary heart diseases in humans who use this kind of chicken products in their daily nutrition.

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Conflicts of Interest: The authors declare no conflict of interest.

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