Biotechnology in Animal Husbandry 30 (4), p 669-676 , 2014
Publisher: Institute for Animal Husbandry, Belgrade-Zemun
ISSN 1450-9156
UDC 636.087.7:591.11'65
DOI: 10.2298/BAH1404669P

EFFECTS OF DIETARY GARLIC ADDITION ON PRODUCTIVE PERFORMANCE AND BLOOD LIPID PROFILE OF BROILER CHICKENS

N. Puvača[1], Lj. Kostadinović[2], D. Ljubojević[3], D. Lukač[1], S. Popović[2], B. Dokmanovć[1], V. S Stanaćev[1]

[1]University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia
[2]University of Novi Sad, Institute for Food Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia
[3]Scientific Institute of Veterinary Medicine Novi Sad, Rumenački put 20, 21000 Novi Sad, Serbia
Corresponding author: nikola.puvaca@stocarstvo.edu.rs
Original scientific paper

Abstract: The aim of this study was to investigate the effect of dietary garlic powder addition on productive performance and blood lipid status of broiler chicken. At the beginning of experiment, three treatments of 150 one day old broiler chickens of hybrid line Hubbard per treatment, on a total of 450 chickens were formed. Every treatment was divided in four groups which represents four replicates of the experiment. Control treatment (T1) was fed with mixtures without addition of garlic powder, while experimental treatments were fed with addition of 0.5% (T2) and 1.0% (T3) of dietary garlic powder, respectively. Experiment lasted 42 days. After the completion of experimental period the highest achieved body weight of chicken was at treatment T2 (2371.1g) which was followed by treatment T3 (2336.1 g) with statistically significant differences ($p<0.05$) compared to control treatment. For the entire experimental period, feed conversion ratio was lowest in treatment T2 (1.8 kg/kg) and the highest in control treatment T1 (2.1 kg/kg), without statistically significant ($p>0.05$) differences. Addition of garlic powder led to a statistically significant ($p<0.05$) increase in values of EBI in compare to a control treatment T1. The highest mortality rate (5.1 %) and the lowest EBI (220.4 %) were recorded in control treatment. Addition of garlic powder in the amount of 1.0% (T3) significantly ($p<0.05$) decreased LDL concentrations in blood serum. The lowest concentration of total cholesterol was recorded at treatment T2 ($p<0.05$). The highest concentration of HDL (44.8 and 39.6 mg/dl) was recorded in treatments T3 and T2. It could be concluded that the addition of garlic has positive influence on chicken production and blood lipid status, but the further investigation of their mode of action is still necessary.

Key words: garlic, lipids, cholesterol, nutrition, broilers

Introduction

Drug resistance in bacteria and the drug residues in meat are important reasons for restriction and ban of in-feed antibiotics (*Demir et al., 2003*). Attempts were made to find other alternatives dietary supplements to overcome the poor performance and the increase susceptibility to diseases resulted from removal of antibiotics from poultry nutrition. Use of growth promoters of natural origin become of an interest in lasts decades (*Iji et al., 2001*). Garlic (*Allium sativum* L.) have bioactive substances like sulphur compounds such as alliin, diallylsulfides and allicin, that act as antibacterial, antifungal, antiphrastic, antiviral, antioxidant and antithrombotic.

Garlic has been found to lower serum and tissue cholesterol levels (*Issa and Omar, 2012; Stanaćev et al., 2012),* inhibit bacterial growth (*Cavallito et al., 1994*), inhibit platelet growth and reduce oxidative stress. In broilers, it was reported that garlic, as a natural feed additive, improved broiler growth and feed conversion ratio, and decreased mortality rate (*Tollba and Hassan, 2003; Puvača et al., 2014*).

Improvement of broilers performance, blood lipid profile and tissues can be achieved by supplementation of diets with garlic powder (*Amagase et al., 2001; Demir et al., 2003; Stanaćev et al., 2011*). It was reported that feeding garlic powder at levels of 1.5, 3 and 4.5% had no effect on poultry performance (*Konjufca et al., 1997*), but caused a significant reduction in poultry serum and liver cholesterol. However, *Horton et al.* (1991) concluded that triglyceride was not affected by dietary garlic addition in broiler chickens nutrition. Tissues cholesterol levels were decreased with feeding garlic powder to broiler chickens (*Stanaćev et al., 2012)* which showed that addition of garlic to broilers diet has effects on chicken performance and lipid profile. In research of *Puvača et al.* (2014), addition of various spice herbs and their mixture such as garlic, black pepper and hot red pepper led to an improved performance results and reduced mortality rate of chicken fed with addition of these spice herbs. Using garlic powder in broilers diet in research of *Horton et al.* (1991) had no significant effect on performance but had positive influence on meat quality and carcass yield. However, garlic effects on broiler performance and blood lipid status is still not enough researched and need further research investigation.

The aim of this study was to investigate the effect of dietary garlic powder addition on productive performance and blood lipid profile of broiler chicken.

Materials and Methods

Biological tests were carried out under production conditions at the experimental farm "Pustara" in property of the Faculty of Agriculture, Department of

Animal Science in Novi Sad. At the beginning of experiment, three treatments of 150 one day old broiler chickens of hybrid line Hubbard per treatment on a total of 450 chickens were formed. Every treatment was divided in four groups which represents four replicates of the experiment. For broilers nutrition three mixtures were used, starter, grower and finisher with 22, 20 and 18% of crude protein content, respectively. The first 14 days, during the preparatory period, chicks were fed with starter mixture. Following the preparation period, chicks were fed the next 21 days with grower mixtures, and then the last 7 days of fattening period with finisher mixtures according the experimental design given in Table 1. During the experiment, which lasted 42 days, chicks were fed and watered ad libitum, and microclimate conditions were regularly monitored. Chickens were on the floor holding system and control of body weight and feed consumption was performed weekly, every seven days.

Table 1. Experimental design

Experimental treatmens		Concetration of additives in chicken diets		
		In starter, %	In grower, %	In finisher, %
		1 – 14 days	15 – 35 days	36 – 42 days
T1	Control treatment	0.0	0.0	0.0
T2	Garlic powder	0.0	0.5	0.5
T3	Garlic powder	0.0	1.0	1.0

The European broiler index (EBI) was calculated for the entire feeding period according to the equation (Koreleski et al., 2010):

$$EBI = \frac{\text{average body weight (kg)} \times \text{survival rate (\%)}}{\text{age (days)} \times \text{feed convesrion ratio (kg feed/kg body weight gain)}} \times 100$$

At the end of 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 analyse the serum for triglycerides, total cholesterol, HDL and LDL on a biochemical autoanalyzer Cobas Mira Plus (Roche Diagnostics). Values were expressed as mg/dl. Statistical analyses were conducted using the statistical package program Statistica 12. Significant effects were further explored using analysis of variance (ANOVA), LSM and Fisher's LSD post-hoc multiple range test to ascertain differences among treatment means. A significance level of $p<0.05$ was used.

Results and Discussion

Based on the obtained results it can be noted that the addition of garlic in the diet of broiler chickens led to a statistically significant ($p>0.05$) differences in body weight. From the preparatory period chickens have exit with uniform body weight with no statistical significant differences ($p>0.05$).

Table 2. Body weight of chickens, g

Experimental treatments		Age of chickens						
		1 day	7 days	14 days	21 days	28 days	35 days	42 days
T1	LSM	42.8[a]	162.7[a]	388.6[a]	785.6[b]	1162.4[b]	1643.8[b]	2075.8[b]
	SE_{LSM}	0.47	1.52	3.64	8.38	11.84	12.2	24.23
T2	LSM	42.1[a]	160.2[a]	389.7[a]	818.5[a]	1202.3[a]	1743.1[a]	2371.1[a]
	SE_{LSM}	0.47	1.63	3.84	8.41	11.8	12.16	23.96
T3	LSM	42.2[a]	159.7[a]	386.4[a]	804.6[ab]	1204.9[a]	1737.2[a]	2336.1[a]
	SE_{LSM}	0.47	1.64	3.79	8.5	11.75	11.94	23.43

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

At the end of the third week, chickens in treatment T2 achieved the highest body weight (818.5 g) with statistically significant differences ($p<0.05$) compared to the treatment T1. The same tendency was observed at the end of fourth week where the highest body masses was recorded in chickens with dietary addition of 0.5 and 1.0 g/100g of garlic powder (1202.3 and 1204.9 g) with statistically significant differences ($p<0.05$) compared with T1. After the completion of experimental period the highest achieved body weight of chicken was at treatment T2 (2371.1g) which was followed by treatment T3 (2336.1 g) with statistically significant differences ($p<0.05$) compared to control treatment.

Table 3. Chicken feed conversion ratio, kg/kg

Experimental treatments		Periods of nutrition			
		Starter phase	Grower phase	Finisher phase	Entire period
		1 – 14 days	15 – 35 days	36 – 42 days	1 – 42 days
T1	LSM	1.3[a]	1.8[a]	3.0[a]	2.1[a]
	SE_{LSM}	0.01	0.05	0.14	0.15
T2	LSM	1.4[a]	1.7[a]	2.3[b]	1.8[a]
	SE_{LSM}	0.01	0.05	0.14	0.15
T3	LSM	1.4[a]	1.8[a]	2.5[b]	1.9[a]
	SE_{LSM}	0.01	0.05	0.14	0.15

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

The feed conversion ratio is given in table 3. In preparation period of chicken feed conversion ratio was uniform and ranged between 1.3 and 1.4 kg of feed per kg of gain, without statistically significant ($p>0.05$) differences. In the grower phase the lowest achieved feed conversion ratio was in treatment T2 (1.7 kg/kg). Feed conversion ratio in finisher phase was highest in control treatment T1

(3.0 kg/kg) with statistically significant ($p<0.05$) differences compare to the treatments T1 and T2. For the entire experimental period, feed conversion ratio was lowest in treatments T2 (1.8 kg/kg) and the highest in control treatment T1 (2.1 kg/kg), without statistically significant ($p>0.05$) differences. Lowest feed conversion ratio in treatment T2 shows that addition of garlic in amount of 0.5% had positive influence on feed utilization and efficiency.

Table 4 gives overview in European broiler index (EBI) and chicken mortality rate. Addition of garlic powder led to a statistically significant ($p<0.05$) increase in values of EBI in compare to a control treatment T1. The highest mortality rate (5.1 %) and the lowest EBI (220.4 %) were recorded in control treatment.

Table 4. European broiler index and chicken mortality, %

Experimental treatments		EBI	Mortality
T1	LSM	220.4^{c}	5.1^{a}
	SE_{LSM}	2.77	0.96
T2	LSM	295.1^{a}	3.2^{b}
	SE_{LSM}	2.77	0.96
T3	LSM	283.7^{b}	1.3^{c}
	SE_{LSM}	2.77	0.96

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

The highest recorded EBI value was 295.1 % in treatment T2 with significant ($p<0.05$) differences with control T1 and T3 experimental treatment. Addition of garlic powder as feed additive to a broiler chicken nutrition led to a high improvement of blood lipid profile. From the results given in Table 5 can be noticed that the highest amount of triglycerides (65.9 mg/dl), total cholesterol (97.2 mg/dl) and LDL (36.7 mg/dl) was in treatment T1 with statistically significant ($p<0.05$) differences in compare with experimental treatments. Addition of garlic powder in the amount of 1.0% (T3) significantly ($p<0.05$) decreased LDL concentrations in blood serum. The lowest concentration of total cholesterol was recorded at treatment T2 ($p<0.05$). The highest concentration of HDL (44.8 and 39.6 mg/dl) was recorded in treatments T3 and T2.

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

Experimental treatments		Triglycerides	Total cholesterol	HDL	LDL	non HDL	HDL/LDL
T1	LSM	65.9^{a}	97.2^{a}	19.2^{c}	36.7^{a}	78.0^{a}	0.5^{c}
	SE_{LSM}	0.8	0.9	1.16	1.01	1.03	2.33
T2	LSM	19.3^{c}	54.1^{b}	39.6^{b}	5.8^{b}	14.5^{b}	7.7^{b}
	SE_{LSM}	0.8	0.9	1.16	1.01	1.03	2.33
T3	LSM	22.4^{b}	55.7^{b}	44.8^{a}	0.9^{c}	10.9^{c}	48.9^{a}
	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 ($p<0.05$)

The significant effect of garlic powder on the mean values of HDL compared to control treatment can be explained by the hypocholesterolaemic mechanism and the hypolipidemic action of garlic powder. The compound allicin combines with the -SH group that is important in activation of Acetyl CoA which is essential for the biosynthesis of cholesterol. Results of this study indicate the significant ($p<0.05$) increase of HDL by addition of garlic powder. Both levels of garlic powder decreased LDL levels compared to the level in chickens of the control treatment. This effect can be explained by the possible mechanism of antioxidant and antiperoxide lowering action on LDL or the decrease in hepatic production of very low density lipoprotein (VLDL) which serves as the precursor of LDL in the blood circulation (*Kim et al., 2009*).

Conclusion

Based on the obtained results, it can be concluded that the addition of garlic powder in broiler chicken nutrition has positive effect on production performances and blood lipid status. Addition of garlic in amount of 0.5% has led to highest final body weight, lower feed conversion ratio and higher feed utilization, with the highest percentage of European broiler index. Also in conclusion, significantly lowering of plasma cholesterol, triglycerides, LDL and increase of HDL in broiler diet indicate that garlic is very effective in regulation of lipid metabolism in a favourable manner with the aim for prevention of atherosclerosis or coronary heart diseases of people who consumed meat products from this type reared chickens. Therefore the general conclusion would be that the addition of garlic has positive influence on chicken production and blood lipid status, but the further investigation of their mode of action is still necessary.

Acknowledgments

This paper is a part of the project III 46012 which is financed by Ministry of Education, Science and Technological Development of Republic of Serbia and project 114-451-4685/2013-03 financed by the Provincial Secretariat for Science and Technological Development of the Autonomous Province of Vojvodina. Also the realization of one part of this experiment was supported by the Perutnina Ptuj – Topiko a.d., Petefi brigade 2, 24300 Bačka Topola, Serbia.

Efekti belog luka na proizvodne performanse i lipidni status krvi brojlerskih pilića

N. Puvača, Lj. Kostadinović, D. Ljubojević, D. Lukač, S. Popović, B. Dokmanović, V. S. Stanaćev

Rezime

Cilj ovog rada je bio da se ispita efekat belog luka u prahu u ishrani brojlerskih pilića na proizvodne performanse i lipidni status krvi. Na početku tova formirana su tri tretmana sa po 150 jednodnevnih pilića linijskog hibrida Hubbard po jednom tretmanu, sa ukupno 450 pilića u eksperimentu. Svaki tretman je podeljen u četiri grupe koje su predstavljale četiri ponavljanja ogleda. Pilići na kontrolnom tretmanu (T1) su hranjeni smešama bez dodatka belog luka, dok je u eksperimentalnim smešama za ishranu pilića bilo uključeno dve koncentracije belog luka 0,5% (T2) i 1,0% (T3). Eksperiment je trajao 42 dana. Na kraju eksperimentalnog perioda najveća zabeležena telesna masa je bila kod pilića na tretmanu T2 (2371,1 g) a potom na tretmanu T3 (2336,1 g) sa statistički značajnim razlikama ($p<0,05$) u poređenju sa kontrolnim tretmanom. Najmanja konverzija hrane za ceo eksperimentalni period zabeležena je na tretmanu T2 (1,8 kg/kg), a najveća na tretmanu T1 (2,1 kg/kg), bez statistički značajnih ($p>0,05$) razlika. Uvođenje belog luka u ishranu pilića je dovelo do statistički značajnih razlika ($p<0,05$) u povećanju vrednosti EBI u poređenju sa kontrolnim tretmanom T1. Najveći stepen mortaliteta (5,1 %) i najmanji EBI (220,4 %) je zabeležen kod pilića kontrolnog tretmana. Beli luk u prahu u koncentraciji od 1,0% (T3) je značajno uticao ($p<0,05$) na smanjenje sadržaja LDL u krvnom serumu. Najmanje koncentracije ukupnog holesterola u krvi pilića su zabeležene na tretmanu T2 ($p<0,05$). Najveće koncentracije HDL (44,8 i 39,6 mg/dl) su zabeležene na eksperimentalnim tretmanima T3 i T2. Na osnovu dobijenih rezultata može se zaključiti da je dodatak belog luka u prahu ispoljio pozitivan uticaj na proizvodne performanse pilića i lipidni status krvi, ali su dalja ispitivanja njegovih mehanizama delovanja još uvek neophodna.

References

AMAGASE, H., PETESCH, B.L., MATSUURA, H., KASUGA, S., ITAKURA, Y. (2001): Intake of garlic and its bioactive components. Journal of Nutrition, 131, 955-962.

CAVALLITO, C.J., BUCK, J.S., SUTER, C.M. (1994): Allicin, the antibacterial principle of *Allium sativum*. Determination of the chemical composition. Journal of American Chemical Society, 60, 1952-1958.
DEMIR, E., SARICA, S., OZCAN M.A., SUICMEZ, M. (2003): The use of natural feed additives as alternatives for an antibiotic growth promoter in broiler diets. British Poultry Science, 44, 44-45.
HORTON, G.M.J., FENNELL, M.J., PRASAD, B.M. (1991): Effects of dietary garlic (*Allium sativum*) on performance, carcass composition and blood chemistry changes in broiler chickens. Canadian Journal of Animal Science, 71, 939-942.
IJI, P.A., SAKI, A., TIVEY, D.R. (2001): Body and intestinal growth of broiler chicks on a commercial starter diet. 1. Intestinal weight and mucosal development. British Poultry Science, 42, 505-513.
ISSA, K.J., OMAR, J.M.A. (2012): Effect of garlic powder on performance and lipid profile of broilers. Open Journal of Animal Science, 2(2), 62-68.
KIM, Y.J., JIN, S.K., YANG, H.S. (2009): Effect of dietary garlic bulb and husk on the physicochemical properties of chicken meat. Poultry Science, 88, 398-405.
KONJUFCA, V.H., PESTI, G.M. BAKALLI, R.I. (1997): Modulation of cholesterol levels in broiler meat by dietary garlic and copper. Poultry Science, 76, 1264-1271.
KORELESKI, J., ŚWIĄTKIEWICZ, S., ARCZEWSKA, A. (2010): The effect of dietary potassium and sodium on performance, carcass traits, and nitrogen balance and excreta moisture in broiler chickens. Journal of Animal Feed Science, 19, 244-256.
PUVAČA, N., LUKAČ, D., STANAĆEV, V., KOSTADINOVIĆ, LJ., BEUKOVIĆ, M., LJUBOJEVIĆ, D., ZEC, S. (2014): Effect of spice herbs in broiler chicken nutrition on productive performances. Procedings of XVI International symposium „Feed Technology“, 28-30 October, Novi Sad, Serbia, 123-129.
STANAĆEV, V., GLAMOČIĆ, D., MILOŠEVIĆ, N., PERIĆ, L., PUVAČA, N., STANAĆEV, V., MILIĆ, D., PLAVŠA, N. (2012): Influence of garlic (*Allium sativum* L.) and copper as phyto additives in the feed on the content of cholesterol in the tissues of the chickens. Journal of Medicinal Plants Research, 6, 2816-2819.
STANAĆEV, V., GLAMOČIĆ, D., MILOŠEVIĆ, N., PUVAČA, N., STANAĆEV, V., PLAVŠA, N. (2011): Effect of garlic (*Allium sativum* L.) in fattening chicks nutrition. African Journal of Agricultural Research, 6, 943-948.
TOLLBA, A.A.H., HASSAN, M.S.H. (2003): Using some natural additives to improve physiological and productive performance of broiler chicks under high temperature conditions. Black cumin (*Niglla sativa*) or Garlic (*Allium sativum*). Poultry Science Journal, 23, 327-340.

Received 25 November 2014; accepted for publication 22 December 2014