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Effect of garlic (*Allium sativum*) on selected indices of blood metabolic profile and rearing efficiency turkey hens

Wpływ czosnku *(Allium sativum)* na wybrane wskaźniki profilu metabolicznego krwi oraz efektywność odchowu indyczek

Summary. The objective of this study was to establish the effect of water extract of raw garlic and *Allivet* garlic preparation administered to drinking water for turkey hens and their impact on selected biochemical indicators of blood lipid profile, plasma enzymes, production factors and chemical composition of breast muscle. The study was carried out on 400 turkey hens of medium-heavy type BIG-6 divided into four experimental groups. Each group included 25 hens in four replications. Group I (control) did not receive experimental additives. The turkey hens from the experimental groups received garlic extract and *Allivet* garlic preparation with drinking water. The birds in group II were given raw garlic extract in doses of 0.1 g/dm^3 of water, group III – water with an addition of extract of raw garlic at 0.5 g/dm^3. The turkeys of group IV were given *Allivet* garlic preparation (company Centaur) daily in the amount of 0.5 ml/dm^3 drinking water. The birds were kept since the 6th till the 16th weeks of life in pens, on straw litter. Turkeys had regular access to drinking water, and in the experimental groups garlic supplements were given twice week, in the morning. At the end of 9, 11 and 15th weeks of life, blood from 20 birds was sampled from the brachial vein for biochemical analyses which included determinations of: AST, ALT, ALP, TP, GLU, UA, UREA, BIL and ALB. There were analyzed the size of selected indicators of changes in plasma lipid levels, i.e. TG, CHOL, and HDL cholesterol fraction, the level of free fatty acids (NEFA) and LDL cholesterol expressed. After the end of rearing (16th week of life), the birds were slaughtered.

The strongest modifications of biochemical markers were observed in the group receiving garlic extract in the amount of 0.5 g/dm^3 and in the group receiving *Allivet* garlic preparation. In the blood plasma of birds from groups III and IV there were also observed significantly reduced levels of total protein, uric acid, free fatty acids, cholesterol and HDL cholesterol fraction. The addiction of garlic to drinking water for turkey hens affected an increase in the levels of non-

enzymatic antioxidants such as: urea, bilirubin, creatinine and albumin, which protect from free radicals and oxidative stress. The application of garlic supplements decreased the activity of LDH and AST in blood plasma. Turkeys treated with garlic had a significantly higher fat content in the breast muscle. The addition of garlic in the dose of 0.5 g/dm^3 significantly improved the survival rate of birds. The best production results were obtained in group III, with the highest addition of raw garlic extract – 0.5 g/dm^3, which was demonstrated in an increase in the final body weight by about 4% and the lowest feed consumption per kilogram of weight gain (7%).

Key words: turkey hens, garlic, biochemical indicators of blood, lipid profile, plasma enzymes, performance

INTRODUCTION

Garlic (*Allium sativum*) has been valued and used in traditional medicine for thousands of years [Steiner and Li 2001] due to its antibacterial, fungicidal, virucidal, antioxidant, anti-inflammatory and antiseptic [Kwiecień and Winiarska-Mieczan 2011]. *Allium sativum* destroys 20 species of gram-positive and Gram-negative bacteria and 60 species of fungi [Lutomski 2001, Shalaby 2006]. A number of studies confirmed that the most biologically active substance present in garlic is allicin, generated from alline as a result of crushing tissues garlic bulbs [Jones and Collin 2007]. During mechanical grinding takes place tissue lysis, catalysed by allinase. In intact tissues are identified only one isomer alline, not having the biological activity as allicin [Van Damme 1992, Williamson 2003]. Due to the rich composition of active substances such as flavonoids, phytosterols, pectin, vitamins, bioelements, sugar and garlic sulfur compounds can act cholagogue and regulate the composition of intestinal microflora. The biggest sensitivity to the extract of fresh garlic have strains belonging to *E. coli*, its application may prevent in poultry colibacteriosis [Sasaki *et al.* 1999, Kleczkowski *et al*. 2004]. Appeared on the market a new commercial product called *Allivet* and is a liquid extract of garlic contains allyl sulfides, which have high stability and good bioavailability. Allyl sulfides contained in this preparation have a potent antibiotic and it is supposed that *Allivet* has antibacterial, antiviral and antifungal properties. This extract, due to its composition, can act anti-inflammatory and antiparasitical, increase appetite, normalized effect on the intestinal flora, and preferably work on the functioning of the liver, acting by helping in the defense of her regeneration. Vitamins, minerals, proteins and glycosides present in garlic together, contribute to strengthen the immune system of birds. In addition to these functions use *Allivet* preparation can contribute to stimulate lipid metabolism [Korzewski 2009].

The objective of this study was to establish the effect of water extract of raw garlic and *Allivet* garlic preparation administered to drinking water for turkey hens and their impact on some biochemical indicators of blood lipid profile, plasma enzymes, production factors and chemical composition of breast muscle.

MATERIAL AND METHODS

The study was carried out on 320 turkey hens of medium-heavy type BIG-6 divided into four experimental groups. Each group included 80 turkey hens (four replications, 20 birds each). Group I (control) did not receive experimental additives. The turkey hens

from experimental groups received garlic extract and *Allivet* garlic preparation with drinking water. The birds in group II were given raw garlic extract in doses of 0.1 g/dm^3 of water, group III – with the addition of water extract of raw garlic at 0.5 g/dm^3. The turkeys of group IV were given *Allivet* garlic preparation (company Centaur) in the amount of 0.5 ml/dm^3 drinking water. The birds were kept since the 6th till the 16th week of life in pens, on straw litter. The turkey hens in each group were fed identical granulated standard feeds in a 5-stage system. Contents of basic nutrients in the feed mixtures corresponded with current recommendations of Poultry Feeding Standards [Smulikowska 2005]. Turkeys have regular access to drinking water, and in experimental groups 2 times a week, the morning was given garlic supplements. Water extract of raw garlic were prepared immediately before receiving their to birds and for this purpose crushed and triturated in a mortar, fresh garlic bulbs and the appropriate weight of raw material (0.1 g or 0.5 g) was added to drinking water.

At the end of the 9, 11 and 15 week of life, blood from 20 birds was sampled from the brachial vein for biochemical analyses. These analyses, conducted with the kinetic method using monotests by Cormay company, included determinations of the activities of the following enzymes in blood plasma: aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP). Blood samples were analyzed using monotests by Cormay company also for contents of: total protein (TP), glucose (GLU), total cholesterol (CHOL), uric acid (UA), urea (UREA), bilirubin (BIL) and albumin (ALB) and HDL fraction of cholesterol. There were analyzed the size of selected indicators of changes in plasma lipid levels, ie triacylglycerols (TG), total cholesterol (CHOL), and HDL cholesterol fraction, the level of free fatty acids (NEFA) and LDL cholesterol expressed. The level of free fatty acids (NEFA) were determined using diagnostic kits company Waco Chemicals GmbH. LDL cholesterol concentration expressed in mmol/l was calculated by the formula: LDL cholesterol = total cholesterol – HDL cholesterol – (TG/2.2) [Friedewald *et al.* 1972]. Analysis of indicators of metabolic profile were performed on blood turkeys Humalyzer 2000 semi-automatic analyzer. After completed rearing (16th week of life), the birds were slaughtered (40 birds from each group) after 12-h fasting. Slaughter and simplified dissection were performed following recommendations by Faruga and Jankowski [2000]. The chemical composition was assayed in samples of breast muscles according to AOAC procedures [2000].

Numerical data achieved were subjected to a statistical analysis using Statistica ver. 5 software, one-way analysis of variance ANOVA, and assuming the level of significance at 0.05.

RESULTS AND DISCUSSION

Data referring to analyses of biochemical indices of blood plasma of turkey hens were collated in Tables 1-3 and correspond with results of research Koncicki [2005] and Krasnodębska-Depta and Koncicki [1999]. The obtained results show that garlic has contributed significantly to decrease the concentration of the protein levels, some indices of lipid and uric acid.

The additives did not significantly affect the level of glucose (Tab. 1) in plasma of turkeys hens. In the 11th week of life birds watered with fresh garlic extract was found much lower concentration of protein and this value was significantly ($p \leq 0.05$) lower by

6.8% in group II and 22% in group III than in the control group. This is a critical period for turkeys rearing in which they are very sensitive to disease. In the control group was higher protein level, because the body had to defend itself and produce antibodies. Obtained differences for the content of uric acid in the 15th week of life, between control and experimental groups were also statistically significant ($p \leq 0.05$). The results obtained in the experimental groups was lower than control by 24.5% in group II, 1.3% in the third and 19% in group IV. Significant reduction in uric acid concentration has large ecological importance because of the efforts efforts to reduce nitrogen excretion from the organism to the environment. The concentration of uric acid in blood plasma is an indicator of the proper conduct of the protein metabolism in the body. In the case of a well-balanced protein in the feed, and its high nutritional value, only a small amount of amino acids are excreted in faeces. It can therefore be assumed that fresh garlic has contributed to a better use of feed protein [Fritz *et al.* 1994].

In the 11th and 15th week of birds life in both groups receiving supplement fresh garlic and *Allivet* significantly increased ($p \leq 0.05$) levels of non-enzymatic antioxidants than in the control group. In the case of bilirubin in group II concentration increased by 35%, in III by 32%, and IV by 23%. In plasma, turkeys receiving fresh garlic supplement urea levels in group II was increased by 13% in the third by 6.5%, and IV of 5.2% compared with control measurements. It was also observed that the content of creatinine increased by 20.6% higher in group II, 20.1% in the third and 11.6% in the fourth, for the result obtained in the control group. That could be the result intensity of protein catabolism, under the influence of garlic bioactive substances. In the 15th week of life significantly ($p \leq 0.05$) has increased the level of albumin and this result differed from the control group gained 22.2% in the group with 0.1 g of garlic and 25% in the group, which together with water to drinking have taken an extract prepared from 0.5 g of fresh garlic per liter of water. The increase levels of non-enzymatic antioxidants can be associated with positive antioxidant effects of garlic. Infer that could be improved antioxidant status and antioxidant defense mechanisms, as manifested by changes in activity of antioxidant enzymes and the increased value of the ferric reducing ability of plasma (FRAP) [Krzyściak *et al.* 2009]. The level of fat conversion metabolites in blood plasma studied turkeys are shown in Table 2. Turkeys, which were added to the water extract of raw garlic showed a significant reduction ($p \leq 0.05$), triglyceride level. This indicator in the group II and III decreased in value by an average of 27% (mean of the measurements in the 9th, 11th and 15th week of turkeys-hens' life) during the whole experiment. Birds treated with water extract of fresh garlic decrease of the contents uric acid, which can be correlated with a significant reduction of triglyceride levels. Pure cykloalline, produced by the cyclization of S-methyl-L-cysteine-sulfo-peroxide, reduces levels of triglycerides in the blood serum, but does not affect the biosynthesis of these compounds in liver [Jakubowski 2003]. According to this author allicin and ajoen are the most effective inhibitors of cholesterol biosynthesis, inhibits the synthesis of 3-hydroxy-3-metyloglutaryloCoA, a compound necessary for the synthesis of mevalonic acid, the precursor of all isoprenoids. The action of garlic, reducing cholesterol level is proved, but is not fully understood the mechanism, because according to some inhibition of cholesterol synthesis muscle tissue and blood vessels is caused by the present in garlic compounds, soluble in water, with an unidentified chemical structure [Jakubowski 2003]. In studies Konjufca *et al*. [1997] application garlic powder in mixtures for chickens in the

amount of 3% caused a decrease blood cholesterol levels by 23% of birds. In studies Majewska *et al*. [2004] in laying hens using a water extract of raw garlic at 0.5 g/dm^3 in egg yolk cholesterol levels were reduced by 14%. The administration of the hens in the form of garlic pulp in an amount from 0.5 to 1 g/head per day resulted in decrease cholesterol levels in egg yolk by 25% to 35% [Ryś *et al*. 1996], and application garlic paste in an amount of 2% to 8% in feed for laying hens resulted in decrease cholesterol levels in egg yolks from 6% to 38% [Chowdhury *et al*. 2002]. In 10th week of birds life there were significantly lower levels of plasma NEFA in groups treated with garlic supplement, rather than in the control group. Increasing level of free fatty acids after administration of garlic probably can be explained by the fact that fat cells of these birds were more sensitive to activation of lipolysis. Perhaps this is due to the fact that the garlic is rich in L-carnitine, which includes fatty acids in energy metabolism processes.

Table 1. Levels of biochemical markers in blood plasma of slaughter turkey hens
Tabela 1. Poziom wskaźników biochemicznych w osoczu krwi indyczek rzeźnych

Parameter Cecha	Week of life Tydzień życia	Experimental groups Grupy doświadczalne				p-value
		I	II	III	IV	
GLU (mmol/l)	9	12.74 ±0.54	13.34 ±0.35	13.21 ±0.56	12.06 ±0.43	0.057
	11	15.05 ±0.55	14.47 ±0.52	13.99 ±0.51	14.30 ±0.46	0.071
	15	13.15 ±0.57	12.51 ±0.83	12.62 ±0.66	12.45 ±0.42	0.069
	$\bar{x}$	13.64 ±0.55	13.44 ±0.57	13.27 ±0.58	12.94 ±0.44	0.065
TP (g/dl)	9	3.61 ±0.25	3.14 ±0.26	3.46 ±0.25	3.52 ±0.31	0.054
	11	6.93^{a} ±0.26	6.66^{ab} ±0.23	5.41^{b} ±0.60	5.91^{b} ±0.45	0.018
	15	8.09 ±0.43	7.86 ±0.21	7.85 ±0.25	8.06 ±0.42	0.065
	$\bar{x}$	6.21 ± 0.31	5.82 ± 0.23	5.57 ± 0.37	6.06 ± 0.39	0.046
UA (µmol/l)	9	43.41 ±3.254	43.95 ±3.6	41.04 ±2.4	39.42 ±2.53	0.057
	11	45.26 ±3.61	28.08 ±3.22	25.65 ±3.52	46.27 ±2.45	0.054
	15	34.96^{a} ±2.24	26.4^{c} ±2.94	28.55^{b} ±2.61	28.18^{b} ±2.47	0.028
	$\bar{x}$	41.21 ±3.03	32.81 ±3.25	31.74 ±2.84	37.95 ±2.5	0.139
UREA (mmol/l)	9	0.72^{a} ±0.05	0.57^{b} ±0.02	0.58^{b} ±0.05	0.56^{b} ±0.04	0.028
	11	0.77^{b} ±0.03	0.87^{a} ±0.02	0.82^{a} ±0.04	0.81^{a} ±0.03	0.034
	15	0.68 ±0.02	0.69 ±0.03	0.64 ±0.04	0.68 ±0.02	0.068
	$\bar{x}$	0.72 ±0.03	0.71 ±0.02	0.68 ±0.04	0.68 ±0.03	0.04

Table 1 – cont.
Tabela 1 – cd.

BIL (µmol/l)	9	3.85 ±0.25	3.73 ±0.58	3.78 ±0.48	3.73 ±0.58	0.059
	11	3.24^{c} ±0.26	4.37^{a} ±0.22	4.29^{a} ±0.25	3.99^{b} ±0.46	0.031
	15	3.63^{c} ±0.25	4.70^{a} ±0.13	4.58^{a} ±0.41	3.76^{b} ±0.37	0.028
	$\bar{x}$	3.57 ±0.25	4.26 ±0.31	4.21 ±0.38	3.82 ±0.47	0.039
CREAT (µmol/l)	9	16.08 ±2.54	16.79 ±2.3	16.47 ±2.14	16.54 ±1.96	0.078
	11	21.63^{c} ±1.58	26.09^{a} ±1.58	26.14^{a} ±1.49	24.13^{b} ±1.69	0.019
	15	33.19^{b} ±1.98	37.40^{a} ±2.36	36.40^{a} ±2.49	34.40^{ab} ±1.99	0.021
	$\bar{x}$	23.63 ±2.03	26.76 ±2.08	26.33 ±2.04	25.02 ±1.88	0.039
ALBUMIN (g/l)	9	14.58 ±1.69	13.59 ±1.58	14.48 ±1.49	14.28 ±1.58	0.054
	11	13.59 ±1.69	13.52 ±1.47	14.52 ±2.06	14.42 ±2.07	0.057
	15	13.64^{b} ±1.36	16.67^{a} ±1.66	17.04^{a} ±1.69	14.64^{ab} ±1.58	0.036
	$\bar{x}$	13.93 ±1.58	14.59 ±1.57	15.34 ±1.75	14.45 ±1.74	0.049

a, b, c – values in the same rows with different letters differ significantly at $p \leq 0,05$ – wartości w wierszach oznaczone różnymi literami różnią się istotnie przy $p \leq 0,05$
I – control group – grupa kontrolna, II – addition of raw garlic extract at a dose of 0.1 g/dm^3 water – dodatek wyciągu z surowego czosnku w dawce 0,1g/dm^3 wody, III – addition of raw garlic extract at a dose of 0.5 g/dm^3 water – dodatek wyciągu z surowego czosnku w dawce 0,5 g/dm^3 wody, IV – garlic preparation *Allivet* at 0.5 ml/dm^3 drinking water – preparat czosnkowy *Allivet* w ilości 0,5 ml/ dm^3 wody pitnej
TP – total protein – białko ogólne, GLU – glucose – glukoza, UA – uric acid – kwas moczowy, UREA – urea – mocznik, BIL – bilirubin – bilirubina, CREAT– creatynin – kreatynina, ALBUMIN – albumina

Analysis of HDL-cholesterol levels in the 9th week showed a significant ($p \leq 0.05$) increase in plasma turkey hens of group II by 23%, group III and IV 39% to 22% for the control group. In turn, the 11th week this indicator was much higher in the groups given fresh garlic, and so in the group receiving the supplement in an amount of 0.1 g/dm^3 this value was higher than control by 22% in the group with the addition of 0.5 g/dm^3 of water by 24%. In turkey hens receiving garlic supplement 0.5 g/dm^3 of water was significantly ($p \leq 0.05$) lower AST activity by 22.7% and for group with *Allivet* observed decrease in activity was significantly different by 22.8%, than in the control group. In the group receiving *Allivet* was significant ($p \leq 0.05$) increase of LDH activity in the 9th and 15th week of life, amounting to 5 and 15%. The obtained results of our studies indicate also the positive effect of biologically active substances contained in fresh garlic and *Allivet* preparation on the formation of HDL and triglycerides in blood plasma. A significant increase ($p \leq 0.05$) levels of albumin in group II and III (by 22 and 24%), in relation to the control group could probably be due to the presence of zinc, in which garlic is very wealthy.

Table 2. The size of individual indicators of changes lipids in plasma of slaughter turkey hens
Tabela 2. Wielkość poszczególnych wskaźników przemian lipidów w osoczu krwi indyczek rzeźnych

Parameter Cecha	Week of life Tydzień życia	Experimental groups Grupy doświadczalne				p-value
		I	II	III	IV	
TG (mmol/l)	9	0.79^{a} ±0.01	0.65^{b} ±0.04	0.64^{b} ±0.01	0.72^{ab} ±0.01	0.012
	11	0.82^{a} ±0.06	0.53^{b} ±0.05	0.54^{b} ±0.08	0.68^{ab} ±0.06	0.012
	15	0.83^{a} ±0.09	0.6^{b} ±0.09	0.61^{b} ±0.09	0.68^{ab} ±0.06	0.019
	$\bar{x}$	0.81 ±0.05	0.59 ±0.06	0.60 ±0.06	0.69 ±0.04	0.014
NEFA (µmol/l)	9	34.41 ±3.23	44.15 ±3.16	38.07 ±2.14	39.48 ±2.73	0.057
	11	39.27 ±3.61	40.18 ±3.22	35.65 ±3.52	36.27 ±2.45	0.054
	15	34.94^{b} ±2.21	46.9^{a} ±2.41	49.5^{a} ±2.64	48.07^{a} ±2.78	0.036
	$\bar{x}$	36.20 ±3.01	43.71 ±2.93	41.07 ±2.76	41.27 ±2.65	0.049
CHOL (mmol/l)	9	3.4 0 ±0.24	3.26 ±0.25	3.23 ±0.13	3.26 ±0.11	0.059
	11	3.11 ±0.23	2.94 ±0.23	2.68 ±0.24	2.95 ±0.12	0.061
	15	3.76^{a} ±0.24	2.88^{b} ±0.22	2.79^{b} ±0.23	2.97^{b} ±0.10	0.048
	$\bar{x}$	3.42 ±0.24	3.02 ±0.23	2.90 ±0.20	3.06 ±0.11	0.056
HDL (mmol/l)	9	1.24^{c} ±0.04	1.53^{b} ±0.02	1.73^{a} ±0.02	1.51^{b} ±0.10	0.028
	11	1.56^{b} ± 0.05	1.91^{a} ± 0.06	1.93^{a} ± 0.09	1.82^{ab} ± 0.08	0.019
	15	1.84 ±0.06	2.01 ±0.05	2.05 ±0.06	1.91 ±0.60	0.054
	$\bar{x}$	1.54 ±0.05	1.82 ±0.065	1.90 ±0.05	1.75 ±0.26	0.195
LDL (mmol/l)	9	0.62 ±0.02	0.37 ±0.01	0.4 ±0.02	0.47 ±0.02	0.054
	11	0.33 ±0.01	0.23 ±0.02	0.1 ±0.02	0.2 ±0.01	0.057
	15	0.27 ±0.01	0.12 ±0.01	0.06 ±0.01	0.17 ±0.01	0.056
	$\bar{x}$	0.40 ±0.01	0.24 ±0.01	0.18 ±0.01	0.28 ±0.01	0.056

a, b, c – values in the same rows with different letters differ significantly at $p \leq 0,05$ – wartości w wierszach oznaczone różnymi literami różnią się istotnie przy $p \leq 0,05$

I – control group – grupa kontrolna, II – addition of raw garlic extract at a dose of 0.1 g/dm^3 water – dodatek wyciągu z surowego czosnku w dawce 0,1g/dm^3 wody, III – addition of raw garlic extract at a dose of 0.5 g/dm^3 water – dodatek wyciągu z surowego czosnku w dawce 0,5 g/dm^3 wody, IV – garlic preparation *Allivet* at 0.5 ml/dm^3 drinking water – preparat czosnkowy *Allivet* w ilości 0,5 ml/ dm^3 wody pitnej

TG – triacyloglycerols, NEFA – free fatty acids – wolne kwasy tłuszczowe, CHOL – cholesterol, HDL – fraction of cholesterol – frakcja cholesterolu, LDL – fraction of cholesterol – frakcja cholesterolu

Table 3. Activity of selected enzymes in the blood plasma of slaughter turkey hens
Tabela 3. Aktywność wybranych enzymów w osoczu krwi indyczek rzeźnych

Parameter Cecha	Week of life Tydzień życia	Experimental groups Grupy doświadczalne				p-value
		I	II	III	IV	
LDH (U/l)	9	1057.72^{b} ±8.67	1057.48^{b} ±7.31	1046.15^{c} ±8.55	1114.3^{a} ±4.31	0.015
	11	1016.11 ±2.03	1054.34 ±2.91	1057.04 ±6.34	1124.46 ±4.20	0.08
	15	998.64^{c} ±7.51	1072.76^{b} ±14.22	1055.1^{b} ±68.04	1147^{a} ±7.96	0.017
	$\bar{x}$	1024.16 ±6.07	1061.52 ±8.15	1052.76± 27.64	1128.59 ±5.49	0.037
AST (U/l)	9	121.5 ±7.17	131.5 ±7.39	122.9 ±9.18	126.9 ±5.44	0.058
	11	163.5^{a} ±7.55	154.6^{a} ±7.72	126.4^{b} ±7.79	126.2^{b} ±8.48	0.028
	15	130.5 ±6.60	119.5 ±8.67	115.3 ±9.94	117.9 ±9.84	0.069
	$\bar{x}$	138.5 ±7.11	135.2 ±7.93	121.5 ±8.97	123.7 ±7.92	0.052
ALT (U/l)	9	6.12 ±1.83	4.55 ±0.81	6.49 ±1.43	6.70 ±1.94	0.058
	11	7.60 ±3.27	6.21 ±1.47	5.62 ±1.25	6.21 ±5.01	0.087
	15	5.71 ±2.35	6.05 ±1.46	6.06 ±1.38	6.10 ±3.31	0.058
	$\bar{x}$	6.48 ±2.48	5.60 ±1.25	6.06 ±1.35	6.34 ±3.42	0.068
ALP (U/l)	9	1269.4 ±113.3	1146.4 ±167.4	1196.3 ±125.3	1366.2 ±137.7	0.069
	11	1212.6 ±112.1	1115.4 ±142.9	1261.2 ± 135.5	1265.8 ±136.5	0.057
	15	1276.5 ±132.7	1245.8 ±180.9	1287.6 ±128.1	1245.1 ±135.1	0.059
	$\bar{x}$	1252.8 ±119.37	1169.2 ±163.7	1248.37 ±129.6	1292.4 ±136.4	0.061

a, b, c – values in the same rows with different letters differ significantly at $p \leq 0.05$ – wartości w wierszach oznaczone różnymi literami różnią się istotnie przy $p \leq 0,05$
I – control group – grupa kontrolna, II – addition of raw garlic extract at a dose of 0.1 g/dm^3 water – dodatek wyciągu z surowego czosnku w dawce 0,1g/dm^3 wody, III – addition of raw garlic extract at a dose of 0.5 g/dm^3 water – dodatek wyciągu z surowego czosnku w dawce 0,5 g/dm^3 wody, IV – garlic preparation *Allivet* at 0.5 ml/dm^3 drinking water – preparat czosnkowy *Allivet* w ilości 0,5 ml dm^3 wody pitnej
AST – asparagine aminotransferase – aminotransferaza asparaginianowa, ALT– alanine aminotransferase – aminotransferaza alaninowa, ALP – alkaline phosphatase – fosfataza zasadowa, LDH – lactate dehydrogenase – dehydrogenaza mleczanowa

The addition of garlic and *Allivet* preparation caused a decrease in AST activity, which may leads them to believe the inhibitory effects of garlic on protein catabolism. In most works authors point to the lack of significant effect of plant and herbal additives on

the activity of transaminases and alkaline phosphatase [Schleicher *et al.* 1998, Faruga *et al.* 2002]. The increase in LDH activity in the 9th and 15th weeks of birds life may indicate excessive secretion of this enzyme into the blood [Ward *et al.* 1973]. As follows of the received data, both triglycerides and HDL cholesterol increased along with age. Similar results were received Gryzińska *et al.* [2010], who analyzed the concentration of these components in the consolidated Polbar genetically breed chickens. Likewise carried out by Wójcik [2003] analysis of total cholesterol in the blood serum of hens breed Greenleg Partridge chicken hens showed that with age does the average total cholesterol level in blood serum.

Health condition of birds included an experiment did not raise any objections, and during the study period, there was no invasive disease. Although the control group experienced 14% mortality of birds, mainly in the initial stage of the experiment (Tab. 4). In the group receiving garlic at 0.5 g/dm^3 water phenomenon was much smaller and was 5%. In intensive poultry rearing may occur feather pecking, lack of appetite and eating litter. It can therefore be assumed that the sharp flavor of garlic can replace turkey very bitter plants, stimulating the secretion of hydrochloric acid to lower pH of the intestinal contents and boost the activity of endogenous enzymes. It may also be a consequence of the high proportion of zinc in the garlic, the ions stimulate the enzyme and prevent many problems associated with lack of appetite. In the groups receiving garlic birds were also more feathered.

Table 4. The production results of slaughter turkey hens
Tabela 4. Wyniki produkcyjne indyczek rzeźnych

Description Wyszczególnienie	Week of life Tydzień życia	Experimental groups Grupy doświadczalne				p-value
		I	II	III	IV	
Starting body weight (kg) Początkowa masa ciała (kg)	6	1.54 ±0.18	1.48 ±0.19	1.52 ±0.18	1.58 ±0.17	0.051
Final body weight (kg) Końcowa masa ciała (kg)	16	8.98^{b} ±0.98	9.24^{ab} ±0.69	9.35^{a} ±0.87	9.32^{a} ±0.57	0.012
Feed consumption (kg/kg b.w.) Zużycie paszy (kg/kg m.c.)	6–16	2.60^{a}	2.43^{b}	2.42^{b}	2.51^{ab}	0.044
Survival rate (%) Przeżywalność (%)	6–16	86.18^{b}	89.99^{ab}	94.99^{a}	89.76^{ab}	0.014

a, b, c – values in the same rows with different letters differ significantly at $p \leq 0.05$ – wartości w wierszach oznaczone różnymi literami różnią się istotnie przy $p \leq 0,05$
I – control group – grupa kontrolna
II – addition of raw garlic extract at a dose of 0.1 g/dm^3 water – dodatek wyciągu z surowego czosnku w dawce 0,1 g/dm^3 wody
III – addition of raw garlic extract at a dose of 0.5 g/dm^3 water – dodatek wyciągu z surowego czosnku w dawce 0,5 g/dm^3 wody
IV – garlic preparation *Allivet* at 0.5 ml/dm^3 drinking water – preparat czosnkowy *Allivet* w ilości 0,5 ml/dm^3 wody pitnej

Table 5. Chemical composition of breast muscle 16-week-old turkey hens
Tabela 5. Skład chemiczny mięśni piersiowych 16-tygodniowych indyczek

Examined indicators Badane wskaźniki	Experimental groups Grupy doświadczalne				p-value
	I	II	III	IV	
Dry matter (%) Sucha masa (%)	26.18 ±0.32	27.96 ±0.34	27.98 ±0.32	27.34 ±0.33	0.064
Crude protein (%) Białko surowe (%)	22.98 ±0.44	23.43 ±0.29	23.76 ±0.32	22.98 ±0.34	0.057
Crude fat (%) Tłuszcz surowy (%)	1.25^{b} ±0.54	1.38^{a} ±0.56	1.39^{a} ±025	1.38^{a} ±0.45	0.037
Ash (%) Popiół (%)	1.18 ±0.05	1.20 ±0.06	1.19 ±0.04	1.21 ±0.05	0.076

a, b, c – values in the same rows with different letters differ significantly at $p \leq 0.05$ – wartości w wierszach oznaczone różnymi literami różnią się istotnie przy $p \leq 0,05$
I – control group – grupa kontrolna, II – addition of raw garlic extract at a dose of 0.1 g/dm^3 water – dodatek wyciągu z surowego czosnku w dawce 0,1g/dm^3 wody, III – addition of raw garlic extract at a dose of 0.5 g/dm^3 water – dodatek wyciągu z surowego czosnku w dawce 0,5 g/dm^3 wody
IV – garlic preparation *Allivet* at 0.5 ml/dm^3 drinking water – preparat czosnkowy *Allivet* w ilości 0,5 ml/dm^3 wody pitnej

The turkey hens breast muscles (Tab. 5) treated with water extract of garlic had a higher fat (11%), dry matter content (7%) and crude ash (about 2%). Infer that garlic supplement a positive influence on health condition of turkey hens, which contributed to the stimulation of muscle protein synthesis without protein consumption for the production of antibodies [Majewska *et al.* 2007]. Higher proportion of dry matter in meat turkey hens receiving garlic supplement may also indicate an improvement in its quality [Barbut *et al*. 1995].

CONCLUSIONS

1. The strongest modifications of biochemical markers were observed in the group received an garlic extract in an amount of 0.5 g/dm^3 and group received *Allivet* garlic preparation and in the group receiving Allivet.
2. In the blood plasma of birds group III and IV were also observed a significant reduction levels of total protein, uric acid, free fatty acids, cholesterol and HDL cholesterol fraction.
3. Addiction of the garlic to drinking water for turkey hens affected increased in the levels of non-enzymatic antioxidants such as: urea, bilirubin, creatinine and albumin, which protect against free radicals and oxidative stress.
4. Application garlic supplements decreased the activity of LDH and AST in blood plasma.
5. Turkeys treated with garlic had a significantly higher fat content in breast muscle.
6. Addiction of garlic in dose of 0.5 g/dm^3 significantly improved survival rate of birds.

7. The best production results were obtained in group III, with the highest addition water extract of raw garlic – 0.5 g/dm^3, which demonstrated an increase in final body weight by about 4% and the lowest feed consumption per kilogram of weight gain (7%).

The obtained results show the usefulness of both water extract of fresh garlic (*Allium sativum*) and *Allivet* preparation in order to improve blood lipid indicators of turkey-hens in rearing effects.

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Streszczenie. Celem niniejszych badań było określenie wpływu podawania wraz z wodą do picia wodnego wyciągu z surowego czosnku oraz preparatu *Allivet* i ocena ich wpływu na kształtowanie się wybranych wskaźników profilu metabolicznego krwi oraz efektów produkcyjnych indyczek rzeźnych. Badania przeprowadzono na 400 indyczkach rzeźnych typu ciężkiego Big-6, podzielonych na 4 grupy. Każda grupa liczyła 25 indyczek w czterech powtórzeniach. Grupa I była grupą kontrolną. Grupie II podawano do picia wodę z dodatkiem wyciągu z surowego czosnku w ilości 0,1 g/dm^3 wody, grupie III – wodę z dodatkiem wyciągu z surowego czosnku w dawce 0,5 g/dm^3, a grupie IV – preparat czosnkowy *Allivet* (firmy Centaur) w ilości 0,5 ml/dm^3 wody pitnej. Ptaki odchowywano od 6. do 16. tygodnia życia w tych samych warunkach zoohigienicznych, optymalnych dla tuczu indyków rzeźnych. Indyczki miały stały dostęp do wody pitnej, a w grupach doświadczalnych 2 razy w tygodniu rano podawano dodatki czosnkowe. Pod koniec 9., 11. i 15. tygodnia życia z żyły skrzydłowej ptaków pobierano krew do badań biochemicznych i oznaczano: AST, ALT, ALP, TP, GLU, UA, UREA, BIL oraz ALB. Analizowano wielkość wybranych wskaźników przemian lipidowych w osoczu krwi, tj. poziom TG, CHOL oraz frakcji cholesterolu HDL, poziom wolnych kwasów tłuszczowych (NEFA) i stężenie frakcji LDL cholesterolu wyrażonego. Po zakończonym odchowie (16. tydzień życia) z każdej grupy wybrano po 6 sztuk ptaków i poddano dysekcji w celu pobrania mięśnia piersiowego, który poddano analizie chemicznej.

Najsilniejsze modyfikacje markerów biochemicznych obserwowano w grupie otrzymującej ekstrakt z czosnku w ilości 0,5 g/dm^3 oraz w grupie otrzymującej preparat czosnkowy *Allivet*. W osoczu krwi ptaków grupy III i IV zaobserwowano również znaczące obniżenie poziomu białka całkowitego, kwasu moczowego, wolnych kwasów tłuszczowych oraz cholesterolu i jego frakcji HDL. Podawanie indykom do picia dodatku czosnku wpłynęło na podwyższenie poziomu przeciwutleniaczy nieenzymatycznych: mocznika, bilirubiny, kreatyniny i albuminy, chroniącymi przed wolnymi rodnikami oraz stresem oksydacyjnym. Zastosowanie dodatków czosnkowych spowodowało obniżenie aktywności LDH i AST w osoczu krwi. W mięśniu piersiowym indyczek, którym podawano czosnek, stwierdzono znacznie większą zawartość tłuszczu. Dodatek czosnku w dawce 0,5 g/dm^3 znacząco poprawił przeżywalność ptaków. Najlepsze wyniki produkcyjne uzyskano w grupie III, otrzymującej największy dodatek ekstraktu z surowego czosnku (0,5 g/dm^3), co przejawiało się zwiększeniem końcowej masy ciała o ok. 4% i najmniejszym zużyciem paszy w przeliczeniu na kilogram przyrostu masy ciała (o 7%).

Słowa kluczowe: indyczki, czosnek**,** wskaźniki biochemiczne krwi, profil lipidowy, enzymy osocza, czynniki produkcyjne