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Department of Animal Hygiene and Environment Faculty of Biology
and Animal Breeding University of Life Science,
Akademicka 13, 20-950 Lublin, Poland
e-mail: malgorzata.dmoch@up.lublin.pl

MAŁGORZATA DMOCH, ANTONI POLONIS

Effect of vitamin C with rutin and herbal mixture supplements on chosen hematological and biochemical blood parameters and production results of slaughter turkeys

Wpływ witaminy C z rutyną i mieszanki ziołowej na wybrane parametry hematologiczne i biochemiczne krwi indyków rzeźnych

Summary. The present research objective was to determine the influence of supplemental vitamin C with rutin in drinking water or herbal mixture additive to a diet of chosen hematological and biochemical blood parameters of slaughter turkeys. The studies involved 120 male turkeys Big-6 toms. From the 3rd week of age, the birds received a dietary addition of vitamin C with rutin to drinking water (group II) and a 1% herbal mixture to feed (group III). Blood was collected from the brachial vein twice and the results were averaged. The blood samples were examined for chosen hematological and biochemical indices in plasma. Suplementary vitamin C with rutin and herb mix in turkeys diet improved the final weight gains and reduced the feed intake/kg weight gain. Addition of herbal mixture to feed decreased the number of leucocytes but neutrophiles number in turkey's blood from II group was lower than control ($p < 0.05$). Vitamin C with rutin decreased the uric acid level (2.55 mg · dl^{-1}) and phosphorus (1.95 mg · dl^{-1}) in comparison with control group (respectively, 3.7 mg · dl^{-1} 2.51 mg · dl^{-1}), while herbal mixture supplement increased the content of cholesterol (115.33 mg · dl^{-1}), phosphorus (3.44 mg · dl^{-1}), and TIBC (total iron-binding-capacity) (97.2 mg · dl^{-1}), and declined blood triglyceride (87.66 mg · dl^{-1}), (respectively, 96.6 mg · dl^{-1}, 2.51 mg · dl^{-1}, 61.0 µg · dl^{-1}, 124.5 mg · dl^{-1}), concentration in turkeys.

Key words: vitamin C, rutin, herbal mixture, hematological and biochemical blood parameters, production results, turkey

INTRODUCTION

The hematological and biochemical indices constitute major markers providing information on animal health status. Intensive management system of turkeys exposes the birds to harmful environmental factors (high temperature, excessive stocking density, transportation, stress) and thus, contributes to high incidence of diseases. Dietary feed supplements may lessen the negative environmental impact on birds body condition. The hematological and biochemical indices provide valuable information concerning the hematopoietic system functioning as well as a number of organs, e.g. liver, kidneys or endocrine glands. They serve as the basis for the assessment of intensity and direction of metabolic changes occurring in organism, possible health disturbances in animals or their response to feed additives given [Faruga *et al.* 2003, Koncicki and Krasnodębska-Depta 2005]. The present studies explored the effect of vitamin C with rutin and herbal mixture supplement on biological responses of turkeys determined level chosen chematological and biochemical indices. It is common knowledge that these feed additives provide health benefits and should be supplied to maximize health and well-being of animals and to minimize disease challeges. Domestic animals, in them poultry, have the ability to synthesize own vitamin C from glucose, which grows with progressing age. However, under stressful environmental conditions such as, high temperature, excessive stocking density, transportation or cold symptoms and stress, the synthesis process may be inadequate. Vitamin C belongs to substances that alleviate the negative effects of these factors [Madej and Grzęda 2000]. Adding vitamin C to birds' drinking water increases birds' survivability and lead to increase in weight [Ahmad and Johan 1993, Dmoch and Solan 2008]. Ascorbic acid improves not only productivity rate but also influences red blood cells creating, hemoglobin content, hematocrit value and iron assimilation. This vitamin stimulates white blood cells activity and their transformation [Kontecka *et al.* 1997]. It is commonly administered with rutin as it facilitates ascorbic acid absorption and thus, enhances the assimilation of natural vitamin. Rutine is a glicosides flawonoid**,** originally isolated from common rute after that from tobacco leaves and later from buckwheat. Spontaneous rupturing of arteries because of lathyrism is a serious problem in industrial breeding of slaughter turkeys. Extintion in male turkeys reach even 6% of the flock and appear among the best breeded and healthy-looking males which weigh 6–8 kg. This is caused by stress which leads to a sudden blood pressure increase leading to rupturing of weakened arteries walls. Vitamin C combined with rutine is of great importance in turkeys rupturing arteries prophylaxis. It takes part in collagen synthesis and seals blood vessels which makes them elastic and resistant to inflammatory condition and ruptures. Giving vitamin C is justified as its demand increases during stress which very often accompanies turkeys industrial breeding.

Herbal preparations formulated from good quality raw material compose valuable addition to full ration diets [Gonkowski and Wojtkiewicz 2003].

The content of biologically active compounds determines herbs haling value. One of the largest compounds group among the plant world are flawonoids which level was defined in the present research. They are able to modify a lot of enzymes and to reduce blood pressure. They have anti-inflammatory, antifungal and detoksyfying properties. They reveal antioxidative activity which supports immunological system. They protect

important antioxidants such as vitamin C, E and glutathion. The also reduce cholesterol level [Sitarska *et al.* 2003].

Despite extensive studies evaluating the efficacy of herbs in poultry production, only few researches analyzed their impact on the hematological or biochemical indices in turkey blood, yet the parameters are important markers of animal health and body condition.

The research purpose of the paper was to determine the effect of vitamin C with rutin supplement to drinking water and herbal preparation feed additive of chosen hematological and biochemical parameters in slaughter turkeys.

MATERIAL AND METHODS

The investigations included 120 BIG-6 male turkey toms that from 1 week of age throughout the 3 week were fed the same diet and had free access to water. At the third fattening week, the turkeys were assigned to three groups, 40 birds each (two replications for each group of 20 birds), and the supplementation of the feed and drinking water launched. The rearing period lasted till 17 week of age. The experimental design is presented in Table 1.

Table 1. Design of experiment
Tabela 1. Układ doświadczenia

Control group Grupa kontrolna	Experimental groups Grupy doświadczalne	
I	II	III
Standard full ration diets, water *ad libitum* Standardowe mieszanki pełnoporcjowe i woda *ad libitum*	Standard full ration diets, water *ad libitum* + vit. C (5 g · l^{-1}) H_20 and rutin (25 mg · l^{-1}) H_2O to drinking water Standardowe mieszanki pełnoporcjowe i woda *ad libitum* + dodatek witaminy C (5 g · l^{-1}) H_2O i rutyny (25 mg · l^{-1}) H_20 do wody pitnej	Standard full ration diets *ad libitum* + 1% herbal preparation to feed Standardowe mieszanki pełnoporcjowe i woda *ad libitum* + dodatek 1% mieszanki ziołowej do paszy

In the investigations, vitamin C was administered with rutin to boost its effectiveness. Solution of vitamin C and rutin was prepared by dilution of 5 g vitamin C and 26 mg rutin in 1l water and supplied to the birds at amount of 1l of solution per 9l of drinking water. A herbal preparation was prepared from dried, precisely mixed herbs such as: *Achillea millefolium* – 10%, *Calendula officinalis calathidum* – 10%, *Crataegus fruit* – 20%, *Ground garlic* – 10%, *Equisetum arvense* – 10%, *Nettle leaf* – 20%, *Oenothera seeds* – 10% and *Melissa officinalis* – 10%. The blend prepared in this way constitute 1% of the feed.

Throughout the experiment, the microclimate conditions, bird body weight gains (Tab. 3) and feed intake (Tab. 4) were monitored. The birds were maintained at straw bedding in compliance with the zoohygienic standards. The temperature in poultry houses in the first week of turkeys life was 32°C. Every week it was lowered by 2°C.

The temperature was about 20°C till the end of the bird's fattening. The air humidity was 65%. Lighting was 20 lx at the beginning of the rear, then 5–10 lx and at the end of the fattening – 2–5 lx.

The turkeys had free access to fresh water and were fed full ration diets. A qualitative composition of feeds was dependent on the growth rate associated with birds' age. The birds received a complete Cargill feed during the research period. Essential feed nutrients and choose mineral elements are summarized in Table 2.

During the research period, blood was collected from the brachial vein of turkeys aged 12 and 16 week and the obtained results averaged. The blood was used for hemato-

Table 2. Content of feed essential nutrients and choose mineral elements in mixtures
Tabela 2. Zawartość podstawowych składników pokarmowych i wybranych pierwiastków w mieszance paszowej

Component Składnik	Feed mixtures Rodzaj paszy					
	turkey 1 indyk 1	turkey 2 indyk 2	turkey 3 indyk 3	turkey 4 indyk 4	turkey 5 indyk 5	turkey 6 indyk 6
Total protein, % Białko ogólne, %	27.5	25.5	23.0	20.0	18.5	17.0
Crude fiber, % Włókno surowe, %	4.00	4.00	4.00	4.00	4.00	4.00
Crude fat, % Tłuszcz surowy, %	7.00	6.02	5.70	7.10	9.20	9.60
EM, kcal/kg	2800	2870	3000	3170	3220	3280
Arginine, % Arginina, %	1.70	1.60	1.20	1.00	0.90	0.75
Lysine, % Lizyna, %	1.70	1.60	1.20	1.00	0.90	0.75
Tryptopfan, % Tryptofan, %	0.32	0.23	0.18	0.15	0.14	0.13
Methionine and cystine,% Metionina i cystyna, %	1.10	1.05	0.80	0.70	0.65	0.60
Choline, mg · kg^{-1} Cholina, mg · kg^{-1}	2200	2000	1600	1100	1100	1100
Calcium, % Wapń, %	1.30	1.30	1.20	0.95	0.85	0.85
Available phosphorus, % Fosfor przyswajalny, %	0.70	0.65	0.60	0.50	0.40	0.40
Sodium, % Sód, %	0.15	0.15	0.15	0.15	0.15	0.15
Potasium, % Potas, %	0.60	0.63	0.66	0.48	0.40	0.43
Iron, mg · kg^{-1} Żelazo, mg · kg^{-1}	210.0	200.0	170.0	170.0	120.0	100.0
Cooper, mg · kg^{-1} Miedź, mg · kg^{-1}	13.0	14.0	19.0	24.0	23.0	23.0

logical and biochemical determinations. The hematological parameters were studied in blood drawn into the EDTA tubes, while the biochemical ones in that taken into test tubes with heparin. Hematocrit and hemoglobin content was determined in full blood by means of a hematological analyzer MS 4–5. Blood plasma was examined for total protein, uric acid, cholesterol and triglycerides, ALT (alanine aminotransferase), ASP (asparaginian aminotransferase), phosphorus, iron, TIBC (total iron-binding capacity). The parameters were determined using a blood analytical analyzer HITACHI 704.

The obtained numerical data were prepared using the spread sheet of Excel program, Microsoft Windows software 2003. Then single-factor variance analysis and the Duncan's test were performed in the SPSS 12.OPL statistical software. The following significance levels were assumed: 0.01 and 0.05 ($p \leq 0.01$ and $p \leq 0.05$).

RESULTS

In the first weeks of life, the weight of birds from each group was similar. In the four week of growth, the turkeys from control group were the heaviest (0.61 kg $p < 0.05$ vs. groups II), whereas birds from herbal group – were the lightest (0.54 kg $p < 0.01$) (Tab. 3).

Table 3. Body weight of turkeys (kg)
Tabela 3. Masa ciała indyków (kg)

Age (weeks) Wiek (tygodnie)	Groups Grupy					
	I		II		III	
	$\bar{x}$	S D	$\bar{x}$	S D	$\bar{x}$	S D
1	0.06	0.004	0.06	0.000	0.06	0.004
2	0.13	0.019	0.13	0.007	0.15	0.005
3	0.32	0.019	0.31	0.026	0.31	0.025
4	0.61^{aA}	0.036	0.56^{b}	0.021	0.54^{B}	0.029
5	1.06	0.070	0.99	0.047	0.99	0.051
6	1.71^{a}	0.117	1.55^{b}	0.102	1.59^{b}	0.086
7	2.56^{Aa}	0.089	2.13^{B}	0.154	2.3^{b}	0.189
8	3.33	0.192	2.93	0.185	3.18	0.260
9	4.26	0.218	3.9	0.283	4.15	0.209
10	5.45^{A}	0.259	4.95^{B}	0.379	5.23	0.142
11	6.5	0.305	6.12	0.546	6.39	0.216
12	7.71	0.651	7.29	0.739	7.78	0.259
13	8.99^{ab}	0.585	8.54^{a}	0.887	9.58^{b}	0.406
14	9.81	0.583	9.62	0.856	9.97	0.660
15	11.0	0.844	10.87	0.978	11.9	0.768
16	12.85	1.266	13.08	1.664	14.09	1.294
17	13.22^{a}	1.232	14.74^{ab}	1.535	15.04^{b}	1.431

a, b – values in the same rows with different letters differ significantly at $p < 0.05$
a, b – wartości w wierszach oznaczonych różnymi literami różnią się istotnie przy $p < 0,05$
A, B – values in the same rows with different letters differ significantly at $p < 0.01$
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In the 6, 7 and 10 weeks of life the turkey from I group were the heaviest than those from the other groups. This tendency maintained for as long as 15 fattening week but the age of 13 week the birds from treatment III were significantly heavier than those from group II ($p < 0.05$). The best body weight was obtained by the birds from group III fed supplemented with 1% herb mix (15.04 kg). The highest feed conversion rate (Tab. 4) during first 3 weeks of breeding was observed in control group. During 5th week of breeding the highest feed conversion rate was observed in turkeys to which feed the herbal mixture was added. In 7th, 8th and 16th week of life turkeys from control group ate the largest amounts of feed.

Table 4. Feed conversion (kg) ratio of turkeys on kg of body weight
Tabela 4. Zużycie paszy (kg) na kg masy ciała

Age (weeks) Wiek (tygodnie)	Groups Grupy		
	I	II	III
1	0.45	0.43	0.40
2	0.97	0.96	0.95
3	1.28	1.26	1.27
4	1.36	1.40	1.40
5	1.46 ^{a}	1.51	1.58 ^{b}
6	1.64	1.60	1.59
7	1.75 ^{a}	1.63	1.65 ^{b}
8	1.95 ^{A}	1.72 ^{Bb}	1.87 ^{a}
9	1.98	1.90	1.91
10	2.00	1.96	2.02
11	2.05	1.98	2.04
12	2.10	2.00 ^{a}	2.12 ^{b}
13	2.25	2.05 ^{b}	2.27 ^{a}
14	2.32	2.18	2.30
15	2.39	2.37	2.35
16	2.78 ^{a}	2.65	2.60 ^{b}
17	2.86	2.77	2.71

a, b- values in the same rows with different letters differ significantly at $p < 0.05$
a, b – wartości w wierszach oznaczonych różnymi literami różnią się istotnie przy $p < 0,05$
A, B - values in the same rows with different letters differ significantly at $p < 0.01$
A, B - wartości w wierszach oznaczonych różnymi literami różnią się istotnie przy $p < 0,05$

The reduced number of leucocytes was stated in the experimental groups (Tab. 5). The lowest level ($27.02 \cdot 10^9 \cdot 1^{-1}$) was observed in group III and it was significant

($p < 0.05$) in comparison with control group ($33.58 \cdot 10^9 \cdot 1^{-1}$). Neutrophiles are the most numerous among the granulocytes. Their highest content was observed in blood of turkeys from the control group whereas the lowest share in total leucocytes was observed in blood of turkeys which drank water contained vitamin C with rutine. However, a significant influence of the experimental factors on the diversification of the number of erythrocytes, hematocrit and the level of hemoglobin has not been observed.

The blood biochemical findings show, that vitamin C with rutin used as water supplement resulted in a significant ($p < 0.05$) decrease of uric acid level ($2.55 \text{ mg} \cdot \text{dl}^{-1}$) compared to the control group. While a herbal mixture additive contributed to the rise of cholesterol concentration as against the control. A reverse relationship was noted in the case of triglycerides as the lowest level ($87.66 \text{ mg} \cdot \text{dl}^{-1}$) was found in blood of turkeys from the group with herbal supplement. Blood phosphorus appeared to be lowest in the group of turkeys receiving vitamin C with rutin supplement. Herbal mixture inclusion, just like in the case of cholesterol, increased TIBC level.

Table 5. Hematological parameters of turkey's blood
Tabela 5. Parametry hematologiczne krwi indyków

Parameter Parametr	Groups Grupy					
	I		II		III	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Leucocytes, $l0^9 \cdot 1^{-1}$ Leukocyty, $l0^9 \cdot 1^{-1}$	33.58^a	4.86	28.87^{ab}	2.33	27.02^b	8.08
Limfocytes, % Limfocyty, %	43.59	7.33	49.39	3.30	47.64	9.63
Monocytes, % Monocyty, %	6.94	0.47	6.96	0.25	6.81	0.22
Neutrophiles, % Neutrofile, %	45.47^a	6.43	38.64^b	3.13	42.89^{ab}	7.51
Eosynophiles, % Eozynofile, %	4.49	1.56	4.61	3.11	4.01	2.74
Basophiles, % Bazofile, %	0.34	0.16	0.40	0.25	0.46	0.25
Erytrocythes, $l0^{12} \cdot 1^{-1}$ Erytrocyty, $l0^{12} \cdot 1^{-1}$	2.67	0.12	2.72	0.25	2.60	0.20
Hematocrit, $l \cdot l^{-1}$ Hematokryt, $l \cdot l^{-1}$	0.36	0.02	0.37	0.01	0.39	0.02
Hemoglobin, $\text{mmol} \cdot l^{-1}$ Hemoglobina, $\text{mmol} \cdot l^{-1}$	8.32	1.49	9.51	0.35	9.05	1.18

a, b – values in the same rows with different letters differ significantly at $p < 0.05$
a, b – wartości w wierszach oznaczonych różnymi literami różnią się istotnie przy $p < 0,05$

Table 6. Biochemical parameters of turkeys' blood
Tabela 6. Biochemiczne parametry krwi indyków

Parametr Parametr	Groups Grupy					
	I		II		III	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
Glukose, mg · dl^{-1} Glukoza, mg · dl^{-1}	310.12	19.30	296.75	11.12	319.43	30.88
Total protein, g · dl^{-1} Białko całkowite, g · dl^{-1}	31.1	5.72	28.30	7.493	30.29	9.592
Uric acid, mg · dl^{-1} Kwas moczowy, mg · dl^{-1}	3.7^{a}	0.3	2.55^{b}	0.87	3.06^{ab}	1.41
Cholesterol, mg · dl^{-1} Cholesterol, mg · dl^{-1}	96.6^{a}	17.3	104.39^{ab}	8.63	115.33^{b}	20.05
Triglyceries, mg · dl^{-1} Triglicerydy, mg · dl^{-1}	124.5^{a}	26.5	90.32	17.27	87.66^{b}	50.83
ALT, U/L	31.2	22.73	25.88	25.127	30.13	26.104
AST, U/L	50.2	17.16	52.01	17.246	44.44	4.220
Phosphorus, mg · dl^{-1} Fosfor, mg · dl^{-1}	2.51^{ab}	1.18	1.95^{a}	0.63	3.44^{b}	0.80
Iron, µg · dl^{-1} Żelazo, µg · dl^{-1}	229.0	47.91	224.0	81.97	227.7	119.82
TIBC, µg · dl^{-1}	61.0^{a}	14.53	90.80^{ab}	29.09	97.2^{b}	41.66

a, b – values in the same rows with different letters differ significantly at $p < 0.05$
a, b – wartości w wierszach oznaczonych różnymi literami różnią się istotnie przy $p < 0,05$

DISCUSSION

Inclusion of vitamin C and rutin to drinking water and 1 % herbal preparation to feed improve turkey weight gains (15.04 kg $p < 0.05$). Although the nearly entire study period, average weight of turkeys from experimental groups was lower than the control, in the final fattening weeks, these birds' weight was higher as compared to the control, which was confirmed statistically. The highest weight was also noted in the turkey group fed mixture with 1% herbal preparation addition. Similarly, Faruga *et al.* [2002] proved statistically confirmed weight increase of turkeys fed a herb supplemented diet in both, 4 and 18 breeding week. The studies on slaughter chickens did not reveal any effect of herb extracts additives (*Achillea, Melissa, Hypericum, Urtica*) to drinking water on final body weight. Only the birds provided with nettle extract had body weight 3,6% more than the control [Fritz *et al.* 2000]. In the other researches of these authors Fritz *et al.* [1990] chickens fed supplemented dried herbs showed raised weight (by ca 15%) in the first three weeks. During the most time of breeding herbal mixture lead to the smaller feed conversion than in control group. Other authors [Faruga and Pudyszak 1999, Faruga *et. al.* 2002], observed lower feed conversion on one kilogram of weight increase during the whole breeding. Vitamin C with rutine had similar influence. These results are in

correspondence with study of Kontecka *et. al* [1997] who observed that average feed conversion rate in case of chickens was also lower while using feed with vitamin C, however, after withdrawing of this ingredient the feed conversion rate decreased significantly.

The conducted research revealed the reduction of the total number of leucocytes after applying the supplementation of herbal mixture but addition vitamin C with rutine has decreased a number of neutrophiles in slaughter turkeys nutrition. However, the number of white blood cells contained in the reference values [Bounous *et al.* 2000]. A hematocrit content physiological surpassed the recommendations, while hemoglobin was found within the physiological range presented by Koncicki and Krasnodębska-Depta [2005]. A review of the available literature indicates that vitamin C supplied in feedstuff has a beneficial effect on a number of hematological indices of blood. This dietary supplement at amount of 200 mg · kg^{-1} to laying hens' feed has been shown to produce growth in red blood cell count, hemoglobin content, hematocrit value as well as more substantive differentiation in the share of particular leukocyte forms [Kontecka *et al.* 1997]. The studies performed by Kontecka *et al.* [2000] revealed higher numbers of erythrocytes and hematocrit along with elevated hemoglobin content in blood of day-old ducklings supplied with vitamin C at the dose 500 mg · kg^{-1} in feed.

Comparing the impact of a herbal mixture on the investigated parameters with the research findings of other authors, it was concluded that they were consistent with those reported by Sembratowicz [2004] in study turkey hens.

The analysis on the biochemical parameters of the experimental turkeys blood has shown a significant reduction of uric acid level caused by supplemental vitamin C with rutin as compared to the control. However, despite the genuine decline of the index value, its blood plasma content maintained within the physiological limits for and wild turkeys [Bounous *et al.* 2000] but higher than values for Bronze turkeys [Schmidt *et al.* 2009]. Besides, a triglyceride level and the alanine aminotranferase activity diminished as well. These results were not confirmed statistically. According to the available literature, only few authors were concerned with the determination of biochemical parameters in blood of turkeys after ascorbic acid administration. Interestingly, the triglyceride reference level for wild turkeys set by Bounous *et al.* [2000] appeared to be higher compared to that in the present research. Whereas, Koncicki and Krasnodębska-Depta [2005] reporting the physiological values of different blood parameters established lower triglyceride level in turkey hens in 6, 9 and 16 week of life. Low ALT is indicative of the appropriate health status of birds. A cholesterol content and asparaginian aminotranferase activity in the blood plasma slightly increased under the influence of vitamin C with rutin addition. These indices values were comparable with the results of Szabó *et al.* [2005] who investigated the metabolism intensity in growing birds.

Vitamin C affects absorption of many mineral elements [Vasicek *et al.* 1991, Melluzzi *et al.* 1992]. In the present study, only a level of phosphorus and iron in blood was evaluated. In blood of the experimental turkeys, the phosphorus content was found to be lower after the vitamin C with rutin dietary inclusion as compared to the herbal group. It was also beyond the lower limit of the reference range defined by Vasicek *et al.* [1991] and Melluzzi *et al.* [1992]. It is generally known that ascorbic acid promotes intestinal iron absorption, yet the process intensity is dependent, among others, on body's iron requirements – increased at this micronutrient deficiency and decreased at iron body

homeostasis [Nagórna-Stasiak and Lechowski 1994]. Nagórna-Stasiak and Lechowski [1994] in their studies revealed unexpected capacity of ascorbic acid to inhibit the ferric sulphate absorption from small and large intestines in chickens. This capacity is most likely to protect organism from an iron overload effect. Ascorbic acid is essential in the process of iron incorporation into body cells and thus, affects this micronutrient distribution throughout the body tissues, blood iron level and its expelling. In the present studies, phosphorus concentration, declined under the impact of vitamin C with rutin supplementation as compared to the herbal group, while the iron-binding capacity [TIBC] enhanced in III group.

Herbal mixture added to the turkeys' diet caused the differentiation of cholesterol, triglyceride, phosphorus content and TIBC. The herbs increased a cholesterol level which was confirmed statistically. In most experiments studying the implementation of herbs in poultry nutrition, this parameter was associated with desired effects [Faruga *et al.* 2002, Sembratowicz 2004, Dmoch 2007]. The hypocholesterolemic effect may be attributed to polyphenol acids or other compounds responsible for the lipid metabolism, like D-catechins. A lower cholesterol content is also likely to arise from a fact that some herbs increase bile acid secretion and thus, the conversion of nearly half of body cholesterol pool to bile acids proves to be a major pathway for its elimination [Sembratowicz 2004].

Triglyceride concentration declined markedly under the influence of herbs. This parameter value appeared to be as much as by 29.8% lower compared to the control. Importantly, it was found beyond the physiological range limits set for wild turkeys [Bounous *et al.* 2000]. However, it is noteworthy that the turkeys from the control group and supplied with vitamin C with rutin in drinking water had also blood triglyceride level going beyond the boundaries of the physiological norm [Bounous *et al.* 2000]. Therefore, the obtained research results have provided strong evidence that the studied parameter value in the discussed case was genetically conditioned.

A herbal mixture has contributed to the rise of phosphorus level and enhancement of total iron-binding capacity as compared to the control group. In the present study, a phosphorus level proved to be lower than the reference interval determined by Meluzzi [1992] – (6.1–6.8 mg%).

CONCLUSIONS

Summing up, the foolowing conclusions can be drawn:

1. Suplementary vitamin C with rutin and herb mix in turkeys diet improved weight gains and reduces feed intake/kg weight gain of turkeys.

2. Addition of herbal mixture to feed has decreased number of leucocytes, but neutrophiles number in turkey's blood from vitamin C with rutin group was lower than control ($p < 0.05$).

3. Addition of vitamin C with rutin to drinking water has decreased uric acid level and phosphorus content in blood of the studied turkeys.

4. Feed supplemented with 1% herbal mixture contributed to elevated content of cholesterol, phosphorus and TIBC and depressed triglyceride concentration in blood of slaughter turkeys.

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Streszczenie. Celem pracy było określenie wpływu dodatku witaminy C z rutyną do wody pitnej oraz mieszanki ziołowej do paszy na kształtowanie się wybranych parametrów hematologicznych i biochemicznych krwi indyków rzeźnych. Badania przeprowadzono na 120 sztukach indorów zestawu komercyjnego Big-6. Od 3 tygodnia życia dodawano ptakom witaminę C z rutyną do wody pitnej (grupa II) oraz 1% mieszankę ziołową do paszy (grupa III). Z żyły ramiennej pobrano krew dwukrotnie, a wyniki uśredniono. We krwi oznaczono poziom wybranych parametrów hematologicznych, a w osoczu wybranych wskaźników biochemicznych. Suplementacja witaminy C z rutyną i mieszanki ziołowej wpłynęła korzystnie na końcową masę ciała indyków i wykorzystanie paszy. Dodatek mieszanki ziołowej do paszy spowodował spadek liczby leukocytów we krwi indyków, a liczba neutrofili we krwi indyków z grupy II zmniejszyła się w porównaniu z grupą kontrolną. Witamina C z rutyną spowodowała obniżenie poziomu kwasu moczowego (2,55 mg · dl^{-1}) i fosforu (1,95 mg · dl^{-1}) w porównaniu z grupą kontrolną (odpowiednio 3,7 mg · dl^{-1}, 2,51 mg · dl^{-1}), a mieszanka ziołowa przyczyniła się do wzrostu poziomu cholesterolu (115,33 mg · dl^{-1}), fosforu (3,44 mg · dl^{-1}) i TIBC (całkowita zdolność wiązania żelaza) (97,2 mg · dl^{-1}) oraz do spadku poziomu triglicerydów (87,66 mg · dl^{-1}) (w grupie kontrolnej odpowiednio 96,6 mg · dl^{-1}, 2,51 mg · dl^{-1}, 61,0 µg · dl^{-1}, 124,5 mg · dl^{-1}).

Słowa kluczowe: witamina C, rutyna, mieszanka ziołowa, parametry hematologiczne i biochemiczne krwi, indyki