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THE EFFECT OF DRIED FRUIT, VEGETABLE AND HERB CONCENTRATE ON THE QUALITY OF HENS EGGS

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Streszczenie. Celem pracy była ocena wpływu koncentratu wyprodukowanego w kraju z odpadów przemysłu spożywczego (owoców, warzyw i ziół), jako dodatku do standardowych mieszanek paszowych, na cechy fizyczne oraz profil mineralny treści jaj pochodzących od kur mięsnych zestawu „Ross 308”. Materiał badawczy stanowiły mieszańce kur mięsnych ROSS 308. Stado liczące 9900 osobników podzielono na trzy grupy. W grupie kontrolnej kurom podawano standardową pełnoporcjową mieszankę przeznaczoną na okres produkcji nieśnej. Kury z grup doświadczalnych II i III otrzymywały mieszankę standardową z dodatkiem koncentratu owocowo-warzywno-ziołowego w ilości odpowiednio 1,5 i 3,0%. W 48 tygodniu życia kur przeprowadzono ocenę jakości 180 jaj wybranych losowo, uwzględniającą: skład morfologiczny jaj, grubość skorupy, indeks kształtu, ciężar właściwy, pH żółtka i białka, a także zawartość wybranych składników mineralnych w żółtku i białku. Zastosowany czynnik doświadczalny nie miał istotnego wpływu na budowę i skład jaja, aczkolwiek udział żółtka i skorupy wykazywał tendencję wzrostową. Stosunek białka do żółtka był korzystniejszy w grupach, w których kury żywiono mieszankami doświadczalnymi. Nie stwierdzono istotnych różnic w zawartości makropierwiastków w żółtku i białku jaj. Preparat roślinny istotnie obniżył zawartość żelaza w żółtku i białku oraz ołowiu, kadmu i chromu w żółtku, zwiększył natomiast zawartość cynku w obu częściach treści jaj.

Key words: chemical elements, eggs, fruit, vegetable and herb concentrate, hens.
Słowa kluczowe: jajo, kury, pierwiastki chemiczne, susz owocowo-warzywno-ziołowy.

INTRODUCTION

In selection and formation of active substance mixtures, herbal plants, such as chamomile, lemon balm, black cumin, nettle, mint, St. John’s wort as well as garlic, have been taken into consideration most often in poultry nutrition (Cross et al. 2011, Olobatoke and Mulugeta 2011, Safari et al. 2011, Szczerbińska et al. 2012). Increased final body weight in layers and decreased feed conversion per kg eggs were observed in many studies.

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A significant increase in egg laying production, egg weight, egg shell quality, egg yolk colour intensity and a decrease in egg yolk cholesterol concentration were also shown (Połtowicz and Wężyk 2001, El-Bagir et al. 2006, Szczerbińska et al. 2012). Some researchers have been interested in the evaluation of possibility to use apple and tomato pomace being produced in their processing in poultry nutrition. One result of their feeding may be beneficial effects on intestinal bacterial flora composition. On the other hand, pectins may reduce the resorption of cholesterol and decrease its blood level, as well as that in eggs, by binding bile salts (Ayhan and Aktan 2004, Zafar et al. 2005, Ghazi and Drakhshan 2006, Mikulski et al. 2008, Ayhan et al. 2009).

This study aimed at evaluating the effect of concentrate made of food industry waste, i.e. fruits, vegetables and herbs, as an additive to standard compound feeds on the physical traits and mineral profile of the egg content of eggs of ROSS 308 meat hens.

MATERIAL AND METHODS

Research material consisted of ROSS 308 broiler chicken breeder hybrids, with the total number of 9900 birds. Before experiment, hens and cocks were weighed and randomly divided into three groups. Birds of respective groups were housed in separate buildings provided with similar feeding and watering equipment and nests. The control group numbered 3500 hens + 350 cocks, while experimental groups 2 and 3 included 2600 hens + 260 cocks and 2900 hens + 290 cocks, respectively. Birds were kept on straw bedding. In all three production houses, the lighting programme and environmental conditions were standardised and consistent with recommendations for proper management of this production line.

The control group was fed a standard complete feed intended for the laying production period with the nutritive value conforming to the ROSS 308 Parent Stock Management Manual (Table 1 and Table 2).

Table 1. Composition of feed mixture for adult hens
Tabela 1. Skład mieszanki dla dorosłych kur mięsnych

Ingredients of feed mixtures – Składniki mieszanki paszowej	Participation – Udział (%)
Ground wheat – Śruta pszenna	33.60
Ground corn – Śruta kukurydziana	35.00
Wheat bran – Otręby pszenne	2.70
Extracted soybean meal 46% – Śruta poekstrakcyjna sojowa 46%	20.00
Soybean oil – Olej sojowy	0.30
Dicalcium phosphate – Fosforan dwuwapniowy	0.85
Fodder lime – Kreda pastewna	5.70
NaCl	0.28
Humokarbowit	0.50
Lutamix DJ/R-1%	1.00
DL Methionine – DL-metionina	0.07

Table 2. Chemical composition of feed mixture
Tabela 2. Skład chemiczny mieszanki

Chemical composition – Skład chemiczny		Participation – Udział (%)
Dry matter – Sucha masa		87.11
Metabolizable energy – Energia metaboliczna	MJ/kg	11.71
Crude protein – Białko ogólne		16.01
Crude fiber – Włókno surowe		3.14
Ash – Popiół		9.97
Vitamin A – Witamina A	j.m.	13 500.00
Vitamin D_3 – Witamina D_3	j.m.	3000.00
Witamin E – Witamina E	mg	47.50

The hens of experimental groups 2 and 3 were given a standard compound feeds with a 1.5 and 3% addition of dried fruit-vegetable-herb concentrate, respectively. This dried concentrate was produced in a Polish company (TBM) with the trade name Nutritive Plant Concentrate KN for Layers. It comprised apple pomace, choke-berry pomace, strawberry pomace, tomato pomace, and dried parsley leaves, dried nettle, black-currant pomace and dried lemon balm. Basic chemical composition of the plant concentrate under evaluation was determined by conventional methods, while elemental content of dried plant concentrate and compound feeds was assayed by inductively coupled plasma optical emission spectrometry (ICP-OES). Analyses were made using a PerkinElmer® ICP model Optima™ 2000 DV under conditions being recommended by its manufacturer. Samples for spectrophotometric assays were mineralised in 65% HNO_3 in a high-pressure microwave mineralisation system. As a standard solution, certified multi-element reference material was used. Standard solutions were made up with and addition of nitric acid at such a concentration which was present in mineralised samples. All measurements of the intensity of emitted radiation were made choosing a longer, axial optical path in spectrophotometer (method developed at the Department of Poultry and Ornamental Bird Breeding).

At 48 weeks of hen age, evaluation of the quality of 180 randomly selected eggs (60 eggs per each group) was performed, taking into consideration the following: egg morphological composition, egg shell thickness, egg shape index, specific gravity (in sodium chloride solutions with a density of 1.068 g on cm^3 increasing sequentially by 0.004 unit to 1.122 g on cm^3), egg yolk and albumen pH, and the content of selected minerals in egg yolk and albumen, which had been earlier determined by inductively coupled plasma optical emission spectrometry (ICP-OES) being described above.

RESULTS

The chemical analysis of applied dried fruit-vegetable-herb concentrate showed that it contained 17.8% crude fibre, yet the feed consumption in groups 2 and 3 did not decrease (Table 3).

Table 3. Chemical composition of concentrate
Tabela 3. Skład chemiczny koncentratu roślinnego

Specification – Wyszczególnienie	%
Dry matter – Sucha masa	90.4
Crude protein – Białko ogólne	8.2
Crude fiber – Włókno surowe	17.8
Crude fat – Tłuszcz surowy	5.7
Ash – Popiół	5.2

One kilogram of plant concentrate contained the highest level of calcium, next potassium and phosphorus, and the lowest of cadmium and lead the least (Table 4). The aforementioned chemical elements did not have any effect on their contents in experimental compound feeds. The only chemical element being determined in plant concentrate which had induced an increase in its content in feed was zinc, but only in relation to group 3 with a 3% addition of experimental factor.

Table 4. The content of selected chemical elements in compound feeds and concentrat
Tabela 4. Zawartość wybranych pierwiastków w mieszankach paszowych i koncentracie

Specification Wyszczególnienie	Groups – Grupy			Concentrate Koncentrat
	I	II	III	
	mg/kg			
Na	1325.00	1311.57	1292.62	170.00
Mg	645.00	650.66	658.60	921.00
P	5981.00	5981.60	5898.75	2688.00
K	3107.00	3156.10	3167.10	3724.00
Ca	30125.00	29886.18	29734.53	4516.00
Mn	93.30	92.58	91.91	25.90
Fe	288.90	285.69	279.37	268.90
Zn	59.10	59.21	65.87	72.50
Cu	10.80	10.01	10.05	9.16
Se	0.15	0.15	0.15	0.17
Pb	0.0146	0.0140	0.0139	0.0105
Cd	0.00141	0.00139	0.00138	0.00110
Cr	0.0403	0.0401	0.0398	0.0265

No significant effect of feed additive on the percentage of egg albumen and yolk in egg weight was observed but the percentage of egg yolk in eggs of groups 2 and 3 was higher by 0.85 and 1.05%, respectively. The ratio of egg albumen to egg yolk was most favourable in group 3 (2.1:1) (Table 5).

The weight of egg shell did not show any significant differences either (Table 5).

In this study, egg shell thickness was at the upper limit of its range being determined for this poultry species. Eggs in respective groups had a uniform shape, with those from groups 1 and 2 being by 2% higher than the upper limit of the range being expected for eggs with desired shape. No statistically significant differences were observed between groups in egg yolk and albumen pH. The value of Haugha units ranged from 81.65 (group 1) to 85.37 (group 3). Egg albumen of the eggs obtained from hens being fed a compound feed with a 3% phytogenic additive were characterised by the highest quality.

In all groups, the amount of sodium (Na) in egg yolk was similar and amounted on average to 0.618 g on 1 kilogram of egg yolk. Its amount in egg albumen in all groups was also similar (Table 6).

Table 5. Composition and morphological evaluation of hen eggs
Tabela 5. Skład i ocena morfologiczna jaj kurzych

Specification – Wyszczególnienie		Groups – Grupy		
		I	II	III
Egg weight Masa jaj	g	6.45 ±4.11	62.20 ±3.97	60.10 ±3.89
Egg shape index Indeks kształtu	%	80.00 ±2.73	78.00 ±2.56	80.00 ±3.44
Specific gravity (egg density) Ciężar właściwy	g/cm^3	1.087 ±0.006	1.080 ±0.006	1.109 ±0.006
Egg yolk weight and percentage Masa i udział żółtka	g %	17.75 ±1.62 27.81	17.81 ±1.80 28.66	17.35 ±1.21 28.86
Egg albumen weight and percentage Masa i udział białka	g %	39.67 ±5.90 62.28	38.42 ±4.97 61.73	36.45 ±5.80 60.66
Egg shell weight and percentage Masa i udział skorupy	g %	6.23 ±0.91 9.78	5.97 ±0.67 9.61	6.30 ±0.87 10.48
Egg shell thickness Grubość skorupy	mm	0.410 ±0.0883	0.401 ±0.0886	0.414 ±0.0879
Egg yolk pH pH żółtka		6.66 ±0.012	6.81 ±0.023	6.82 ±0.017
Albumen pH pH białka		9.33 ±0.010	9.37 ±0.012	9.55 ±0.011
Haugh units Jednostki Haugha		81.65 ±5.87	83.90 ±5.96	85.37 ±5.27
Albumen to egg yolk ratio Stosunek białka do żółtka		2.23 : 1	2.16 : 1	2.10 : 1

Table 6. The content of macroelements in egg yolk and albumen (g/kg)
Tabela 6. Zawartość makropierwiastków w żółtku i białku jaja

Specification Wyszczególnienie		Groups – Grupy		
		I	II	III
Yolk egg Żółtko jaja	Na	0.624 ± 0.053	0.617 ± 0.084	0.613 ± 0.087
	Mg	0.117 ± 0.011	0.121 ± 0.012	0.125 ± 0.010
	P	5.80a ± 0.200	5.95a ± 0.240	6.00b ± 0.160
	K	1.130 ± 0.093	1.150 ± 0.084	1.140 ± 0.083
	Ca	1.360 ± 0.190	1.430 ± 0.160	1.420 ± 0.110
White egg Białko jaja	Na	1.350 ± 0.072	1.380 ± 0.095	1.380 ± 0.043
	Mg	0.123 ± 0.011	0.125 ± 0.013	0.120 ± 0.010
	P	0.125 ± 0.010	0.126 ± 0.011	0.123 ± 0.006
	K	1.080 ± 0.080	1.110 ± 0.100	1.050 ± 0.100
	Ca	0.112 ± 0.028	0.123 ± 0.027	0.111 ± 0.014

a,b – differences significant at P ≤ 0.05 – różnice statystycznie istotne przy P ≤ 0,05.

No differences were observed between groups in the amount of magnesium and calcium in these two parts of the egg contents either. A high level of phosphorus (P) is noticeable in the microelement composition of egg yolk. A difference in the phosphorus level in egg yolk between the control group and group 3, where hens had been given a 3% addition of plant concentrate in their diet, proved to be significant at P ≤ 0.05 (Table 6).

As far as microelements are concerned, egg yolk is characterised by high levels of iron (Fe) and zinc (Zn). In experimental groups, a statistically significant decrease was observed in the level of iron. An opposite tendency was observed in the zinc level. There was significantly more zinc in egg yolks of the hens of groups obtaining dried fruit-vegetable-herb concentrate (Table 7). The feed additive in the form plant concentrate being applied, irrespective of its level in diet, decreased statistically significantly the content of chemical elements included among toxic ones. In groups 2 and 5, there was less lead (Pb) and cadmium (Cd), by about 15 and 19%, respectively.

Table 7. The content of microelements in hen egg yolk and albumen (mg/kg)
Tabela 7. Zawartość mikropierwiastków w żółtku i białku jaj kurzych

Specification Wyszczególnienie		Groups – Grupy		
		I	II	III
Yolk egg Żółtko jaja	Mn	0.796 ± 0.147	0.801 ± 0.158	0.888 ± 0.161
	Fe	63.2A ± 4.200	57.0B ± 4.000	55.2B ± 3.300
	Zn	35.4A ± 3.900	42.0B ± 4.000	41.3B ± 4.000
	Cu	1.450 ± 0.180	1.420 ± 0.210	1.390 ± 0.200
	Se	0.169 ± 0.016	0.161 ± 0.015	0.161 ± 0.025
	Pb	0.0324Aa ± 0.0037	0.0273B ± 0.0039	0.0278B ± 0.0047
	Cd	0.0034A ± 0.00038	0.00273B ± 0.00036	0.00279B ± 0.00048
	Cr	0.0243A ± 0.00146	0.0225B ± 0.00151	0.0226B ± 0.00279
White egg Białko jaja	Mn	0.0417 ± 0.0049	0.0413 ± 0.0055	0.0413 ± 0.0064
	Fe	0.719A ± 0.058	0.635Bb ± 0.061	0.681b ± 0.0550
	Zn	0.141A ± 0.400	0.197B ± 0.0420	0.194B ± 0.0270
	Cu	0.188 ± 0.050	0.220 ± 0.047	0.218 ± 0.081
	Se	0.0667 ± 0.00126	0.673 ± 0.0173	0.068 9 ± 0.0179
	Pb	0.0645 ± 0.0108	0.0634 ± 0.0138	0.654 ± 0.0135
	Cd	0.00636 ± 0.0102	0.00624 ± 0.00131	0.00640 ± 0.00126
	Cr	0.00652 ± 0.00099	0.00649 ± 0.00114	0.00646 ± 0.00118

a,b – differences significant at P ≤ 0.05 – różnice statystycznie istotne przy P ≤ 0,05.
A,B – differences significant at P ≤ 0.01 – różnice statystycznie istotne przy P ≤ 0,01.

The iron level in egg albumen, as well as in egg yolk, decreased in experimental groups 2 and 3 by 0.084 and 0.038 mg on 1 kg, respectively. The differences being observed between the control group and experimental groups were confirmed statistically. The least amount of zinc was determined in egg albumen of control group eggs (0.141 mg in 1 kg). In experimental groups 2 and 3, there was more zinc on 1 kg, on average by 0.195 mg. A difference between group 1 and groups 2 and 3 was significant at P ≤ 0.01. The quantity of other chemical elements being determined in egg albumen in all groups was similar and did not differ significantly (Table 7).

DISCUSSION

As there has been no papers on the effect of fruit-vegetable-herb concentrate on egg quality, the results of this study can not be properly referred to. The results being obtained for experimental groups can be characterised against the data for the control group with standard diet and compared with the findings of experiments with plants containing different biologically active substances.

El-Bagir et al. (2006) showed an increase in the final body weight of laying hens which had been given compound feeds with black cumin, whereas Akhtar et al. (2003) observed a decrease in body weight of hens in a similar experiment, although these authors are of the opinion that this is a favourable factor as it indirectly affects an increase in egg production (negative correlation of hen body weight with laying performance). According to the above-cited authors, diet supplementation with black cumin induced a decrease in feed conversion per dozen eggs or 1 kg egg weight. Also, a significant increase in egg laying production (by several percent), egg weight and egg shell quality was shown, as well as a decrease in the cholesterol concentration in egg yolk. The results of experiment by Szczerbińska et al. (2012), with a diet being enriched with black cumin seeds in the feeding of Japanese quails, indicate a favourable effect of this ingredient on the laying performance and hatchability from fertilised eggs.

Chowdhury et al. (2002), when feeding a compound feed with dried garlic paste to hens for 6 weeks, did not observe any negative effect of this diet on egg shape and egg contents weight, while egg yolk weight was significantly higher in some hen hybrids. The findings of the above study also show a decrease in the cholesterol level in egg yolk and the blood of hens with an increase in dietary garlic level. Olobatoke and Mulugeta (2011) observed a significant increase in the albumen height, and thus in the Haugh units, in the eggs of hens being fed a diet with a 3% garlic addition. In the group of hens being fed a compound feed with a 5% garlic addition, egg production decreased, which was probably caused by a decrease in feed consumption. Egg organoleptic evaluation showed a strong garlic flavour in the eggs of hens being fed a diet with higher garlic level. In some papers, researchers evaluated the efficiency of dried tomato pomace application in poultry nutrition. In the experiment on hens with that ingredient as a substitute for wheat bran, Mansoori et al. (2008) observed higher egg laying performance and better egg quality. These authors are of the opinion that tomato pomace is a good source of protein and vitamins as well as is reach in carotenoids, which affects egg yolk colour. In another experiment, the efficiency of apple pomace application in poultry nutrition was evaluated. Ayhan et al. (2009) did not observe any differences in feed consumption in 6-week-old broiler chickens. However, the above-cited authors are of the opinion that apple pomace can be applied as a source of energy in a feed ration for broiler chickens in the amount up to 10% as a partial replacement for corn. According to them, a higher level of this feed additive may pose a wet bedding problem and decrease feed consumption due to high fibre content.

CONCLUSIONS

1. The feeding of layers with a mixture containing dried fruit-vegetable-herb concentrate did not have any significant effect on the egg characters and morphological composition although the percentage of egg yolk and egg shell showed an upward tendency. The ratio of egg albumen to egg yolk was more favourable in the groups where hens had been fed experimental diets.

2. No significant differences were found in the content of microelements in egg yolk and albumen.

3. The plant concentrate significantly decreased the iron content in egg yolk and albumen and that of lead, cadmium and chromium in egg yolk but increased the zinc content in egg albumen and yolk.

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Abstract. The aim of this dissertation was to evaluate the effect of concentrate being produced in the country from food industry waste, i.e. fruits, vegetables and herbs, as an additive to standard compound feeds on the physical traits and mineral profile of egg content from the eggs of ROSS 308 meat hens. Research material included ROSS 308 meat hen hybrids. The flock, composed of 9900 birds, was divided into three groups. The control group hens were fed a standard complete feed intended for the period of laying production. The hens of experimental groups II and III were fed a standard compound feed with addition of fruit, vegetable and herb concentrate in the amount of 1.5 and 3%, respectively. In week 48 of hen life, evaluation of the quality of 180 randomly selected eggs) was performed, taking into consideration the following: morphological composition of eggs, egg shell thickness, egg shape index, specific gravity, egg yolk and albumen pH, and the content of selected minerals in egg yolk and albumen. The experimental factor being applied did not have any significant effect on the egg characters and composition but the percentage of egg yolk and egg shell showed an increasing trend. The albumen to egg yolk ratio was more favourable in the groups where the hens were fed experimental diets. No significant differences were found in the content of macroelements in egg yolk and albumen. The plant concentrate significantly decreased the iron content in egg yolk and albumen and that of lead, cadmium and chromium in egg yolk, whereas increased the zinc content in both parts of egg content.