BUCKWHEAT IN THE NUTRITION OF COCK LAYING AS A FACTOR OF EGG QUALITY

ORIGINAL SCIENTIFIC PAPER

Amir Hasić[1], Amir Zenunović[1], Jelena Nikitović[2], Toni Babić[3], Emir Mujić[4], Husein Vilić[4]✉, Refik Šahinović[4]

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[1] University of Tuzla, Faculty of Technology, Univerzitetska 8, 75000 Tuzla, Bosnia and Herzegovina
[2] University of Banja Luka, Institute of Genetic Resources, Bulevar vojvode Petra Bojovića 1, 78000 Banja Luka, Bosnia and Herzegovina
[3] Ministry of Agriculture, Water Management and Forestry of Tuzla Canton, Krečanska 57, 75000 Tuzla, Bosnia and Herzegovina
[4] University of Bihac, Biotecnical Faculty, Luke Marjanovica bb, 77000 Bihac, Bosnia and Herzegovina
✉ husein.btf@gmail.com

ABSTRACT:
The subject of this paper is the research of the influence of different ratios of buckwheat, in concentrated feed, on the qualitative values of laying hen eggs. The study was conducted in four groups of laying hens: one control and three experimental, which were formed with respect to different proportions of buckwheat in meals. Within the first group of laying hens, a concentrated feed mixture with 10% relative share of buckwheat was used, within the second group with 20% relative share of buckwheat and within the third group with 30% relative share of buckwheat, while in the control group standard concentrated food was used. Based on the conducted research, it can be concluded that buckwheat in the meal of laying hens has positive effects on quality, physical properties, sensory properties and frequency of carrying. It was shown that there are statistically significant differences in mean values for the following variables: protein content in egg white, protein content in egg yolk (%), fat content in egg yolk (%), where the highest value was recorded in the third group of laying hens. Also, statistically significant differences were found in terms of shell weight (g), shell thickness (mm), yolk diameter (mm) and egg white pH. The highest average frequency of egg laying was found in the first group and the lowest average frequency of egg laying was in the control group. The general conclusion is that buckwheat can be used in poultry feed, because it has a much greater positive than negative effect on the production and quality characteristics of eggs for consumption.

KEYWORDS: Buckwheat, Laying hens, Quality, Eggs

INTRODUCTION

Chicken eggs are intended for human consumption or use in the food industry. Number of eggs produced in Bosnia and Herzegovina in the period 2006-2020 fell from 724 million to 673 million pieces [1]. The biological and nutritional value of eggs is irreplaceable. Eggs are an excellent source of nutrients, so one egg provides 4.5-6 g of protein, all essential amino acids in the right proportions, also the egg contains unsaturated fatty acids. Although eggs are high quality food, their nutritional value, ie their quality can vary significantly, which depends on a number of factors, such as hen genetics, way of keeping laying hens, storage conditions, age of laying hens, and especially on nutrition. The composition and quality of the meal affects the weight of the eggs, the quality of the shell, the internal quality of the eggs, their chemical composition, etc. Therefore, special attention should be paid to the composition and quantity of meals for laying hens.

MATERIALS AND METHODS

The research was conducted in 4 groups of laying hens: one control and three experimental, where experimental groups were formed on the basis of different proportions of buckwheat (10%, 20% and 30%) in concentrated food, and the control was fed a standard concentrated meal.

The qualitative properties of eggs, the content of Ca and Mg in the shell (%), the protein content in the egg white and the content of proteins, fats, ash and minerals (iron, phosphorus and potassium) in the yolk, and the physical properties of eggs were examined: weight, egg length, egg width, shell mass, yolk mass, yolk pH, egg white mass and pH.

The protein content of egg yolk and egg white was determined by the Kjeldahl method, which is based on the destruction of organic matter by heating with sulfuric acid, where all protein and non-protein nitrogen (except nitrate and nitrite) is converted into ammonium sulfate. The addition of sodium hydroxide releases ammonia, which is pre-distilled into a certain amount of boric acid, and the resulting sodium borate

is treated with a solution of 0.02 mol / l sulfuric acid. The amount of protein is expressed as a percentage.

The fat content of the yolk was determined by the Weibl and Stoldt procedure. The method is used to determine the fat in liquid, frozen and dried egg yolk and melange. The egg sample is hydrolyzed with hydrochloric acid, and the released fats are extracted with petroleum ether. The fat was separated again and the quantity was expressed as a percentage of the mass, calculated on the sample.

The ash content in the yolk was determined by a method based on drying and burning the samples at a certain temperature to a constant mass. The process of this method was performed by crushing, homogenizing and drying the sample. after that, the samples were burned annealed to a constant mass which was weighed. The amount of ash is expressed as a percentage.

The method for determining the metal content in the yolk and magnesium in the egg shell consists of two phases. In the first phase, the extraction of metals was performed using a gold ball (aqua regia), and in the second phase, their content in the extract was determined by atomic absorption spectrometry (AAS). The extraction of metals in the gold smelter was performed according to the ISO 11464 standard, which specifies the method of extraction with the gold smelter of trace elements in different products. According to the principle of this standard, the dried samples were then extracted with an acid mixture. The AAS flame technique method was used for this research. This method determined the content of metals and magnesium.

Testing of calcium in the shell was performed according to the method BAS EN ISO 13805: 2002, IDT. The sample was dried, homogenized and treated with nitric acid and hydrogen peroxide. The samples were heated in a microwave oven for digestion in two steps. Calcium content readings were performed on a flame photometer and on AAS.

The results of physical properties were obtained using measuring instruments for length and weight values. Thus, length measures of height, width, shell thickness, diameter and height of yolks and egg whites were performed with a digital movable scale (caliper) whose accuracy is 0.01 mm and are expressed in millimeters (mm), while weight measures such as mass whole egg, the mass of the contents (yolks and whites), the mass of the shell obtained by measuring with a digital technical scale to the nearest 0,01 g and expressed in grams (g).

The pH of egg yolks and egg whites was determined with a pH meter type HANNA HI 8424 with pre-adjustment (calibration) of the instrument by immersing the pH electrode in a buffer solution (neutral) whose pH value is 7. pH values of egg yolks and egg whites were read on the display.

For all observed characteristics, the data collected in the research were analyzed by the statistical program SPSS 17.0.

RESULTS AND DISCUSSION

The obtained results in terms of the tested properties are shown in the following tables.

Table 1. Protein content in egg whites and yolks

Proteins (%)	Group of laying hens			
	Control	I experimental	II experimental	III experimental
Egg white	11,11	10,26	10,54	11,35
Yolk	16,51	15,76	15,96	16,64

From the presented data it can be seen that egg whites contain less protein than egg yolks, and that the addition of buckwheat to the rations of laying hens was not important for the protein content of egg whites and egg yolks. According to Nemanic and Beric [2], the average protein content in egg white is 10.60, and in egg yolk 16.6%, which agrees with our results.

The same authors state that the fat content in egg yolk is 32.6%, while our results are slightly lower, but it can be noticed that the addition of buckwheat to the meals of laying hens increases the fat content in egg yolk, and that the differences between groups were statistically significant. Petersen [3] state that the ash content in egg yolk is 1.70%. Our results are somewhat higher, but there were no statistical significant differences between the control and experimental groups, ie the addition of buckwheat did not result in significant changes in the ash content in the yolk (Table 2).

Table 2. Fat and ash content in egg yolk

%	Group of laying hens			
	Control	**I experimental**	**II experimental**	**III experimental**
Fats	29,43	30,02	30,40	30,67
Ash	1,75	1,72	1,78	1,76

Table 3. shows the content of basic minerals in egg yolk (iron, phosphorus and potassium).

Table 3. Mineral content in egg yolk

Mineral (mg/kg)	Group of laying hens			
	Control	**I experimental**	**II experimental**	**III experimental**
Iron	57,83	47,70	60,29	49,42
Phosphorus	6480,32	6546,19	6760,77	7031,03
Potassium	964,16	772,76	835,65	900,79

The richness of buckwheat in minerals led to an increase in the mineral content in the yolk. Thus Peterson [3] according to Naber and Bergquist (1997) states that the iron content in egg yolk was 47.70 mg, and in our study it was significantly higher (60.29 mg/kg, in the experimental group II.) Đelilovic [4] states that the potassium content is 448 mg / kg, while our results are significantly higher, which indicates that the addition of buckwheat has a significant effect. Also, the literature data show that the phosphorus content in egg yolk is 5.080 mg/kg, while in our research it was significantly higher.

As for the quality of the egg shell, it was determined on the basis of the content of minerals, calcium and magnesium, and the results are shown in Table 4.

Table 4. Calcium and magnesium content in egg shell

	Group of laying hens			
	Control	**I experimental**	**II experimental**	**III experimental**
Ca (%)	38,09	36,74	38,03	38,28
Mg (mg/kg)	1.736,68	2.206,67	1.991,26	1.732,20

The addition of buckwheat to the rations of laying hens did not have a significant effect on the calcium content in the shell, while the addition of 10% buckwheat to the meals resulted in a significant increase in magnesium in the shell. Shen [5] states that the calcium content in the shell was 36.4% and magnesium 0.33%.

Investigating the existence of differences in average values between groups

After the descriptive-statistical parameters, we determined the existence of statistically significant differences in the mean values of the observed characteristics between the groups of laying hens. To select the appropriate test, we present below the results of the Kolmogorov-Smirnov test on whether the observed characteristics follow a normal distribution.

Table 5. Kolmogorov-Smirnovljev test

Observed features	Kolmogorov-Smirnov Z	Significance (p)
Protein content in egg white (%)	0,622	0,834
Protein content in egg yolk (%)	0,518	0,951
Fat content in egg yolk (%)	0,527	0,944
Ash content in egg yolk (%)	0,661	0,775
Iron content in egg yolk (mg / kg)	0,884	0,415
Potassium content in egg yolk (mg / kg)	0,502	0,962
Phosphorus content in egg yolk (mg / kg)	0,825	0,504
Calcium content in shell (%)	1,541	0,017
Magnesium content in the shell (mg / kg)	0,809	0,530

The results of the mentioned test support the conclusion that all observed characteristics-variables listed in the table follow the normal distribution, except for the variable calcium content in the shell (%) which does not follow the normal distribution since p <0.05 is the level of significance at which it is testing performed. Below for the variables that follow the normal distribution, the results of the variance analysis of the F-test, which is used to test hypotheses about the difference of the means of three or more sets, are presented.

Table 6. Results of F-test variance analysis

Observed features	Control group	The first group	Another group	Third group	F	df1	df2	P
	μ ± σ	μ ± σ	μ ± σ	μ ± σ				
Protein content in egg white (%)	11,11 ± 0,67	10,26 ± 0,78	10,54 ± 0,22	11,35 ± 0,19	4,40	3	16	**0,019**
Protein content in egg yolk (%)	16,51 ± 0,10	15,76 ± 0,25	15,96 ± 0,29	16,64 ± 0,37	12,39	3	16	**0,000**
Fat content in egg yolk (%)	29,43 ± 0,87	30,02 ± 0,41	30,40 ± 0,52	30,67 ± 0,38	4,33	3	16	**0,021**
Ash content in egg yolk (%)	1,75 ± 0,03	1,72 ± 0,01	1,78 ± 0,05	1,76 ± 0,01	2,77	3	16	0,076
Iron content in egg yolk (mg / kg)	57,83 ± 2,62	47,70 ± 1,11	60,29 ± 2,20	49,42 ± 1,61	49,17	3	16	**0,000**
Potassium content in egg yolk (mg / kg)	964,16 ± 56,34	772,76 ± 13,98	835,65 ± 31,15	900,79 ± 28,61	26,41	3	16	**0,000**
Phosphorus content in egg yolk (mg / kg)	6.480,32 ± 306,42	6.546,19 ± 151,88	6.760,77 ± 406,84	7.031,03 ± 453,99	2,53	3	16	0,094
Magnesium content in the shell (mg / kg)	1.736,68 ± 72,92	2.206,67 ± 175,47	1.991,26 ± 154,70	1.732,20 ± 70,83	16,00	3	16	**0,000**

According to the results of the test on the difference of mean values of the observed characteristics between groups of laying hens, we conclude that there is a statistically significant difference of mean values between groups of laying hens in the following variables: protein content in egg white (%), protein content in egg yolk (%). egg yolk (%), where the highest average value was recorded in the group of laying hens in whose diet a concentrate mixture with 30% buckwheat was used; yolk iron content (mg / kg) with the highest average in the second group of laying hens in whose diet a concentrate mixture with 20% buckwheat was used, yolk potassium content (mg / kg) where the highest percentage was recorded in the control group and shell magnesium content (mg / kg) where the highest

percentage was recorded in the first group of laying hens where a concentrate mixture with 10% buckwheat was used.

For a variable that does not follow the normal distribution, the results of the Kruskal Wallis test, ie the test on the difference (equality) of arithmetic means of three or more sets, are presented below.

Table 7. Kruskal Wallis test

Variable	A group of respondents	Number of respondents	Rank middle	Kruskal Wallis test		
				Chi-Square	df	P
Calcium content in shell (%)	Control group	5	12,70	13,579	3	0,004
	The first group	5	3,00			
	Another group	5	10,00			
	Third group	5	16,30			
	Total	**20**				

According to the results in the table and the results of the Kruskal Wallis test, there is a statistically significant difference between the four groups of laying hens, with the variable calcium content in the shell (%), since $p < 0.05$. According to the rank values, the highest average value of calcium content in the shell is in the third group where a concentrate mixture with 30% buckwheat was used, then in the control, second and lowest average values in the first group of laying hens where a concentrate mixture with 10% buckwheat was used.

Investigations of differences in physical characteristics among groups of coca carriers

Table 8. Physical properties of eggs

Characteristic	Group of laying hens			
	Control	I experimental	II experimental	III experimental
Egg mass (g)	63,05	63,45	63,73	64,27
Egg length (mm)	56,28	56,88	56,36	56,66
Egg width (mm)	44,52	44,49	44,77	45,06
Egg shell mass (g)	7,59	7,66	7,31	6,53

As for the weight of eggs from the presented results, it can be seen that it was approximate in all tested hens, which means that the addition of buckwheat to the meals of laying hens did not affect this property. Buckwheat had a positive effect on egg length. Supić et al. [6] state that the average length of eggs for consumption is about 57 mm, which agrees with our results.

The same authors [6] state that the average width of eggs for consumption is about 42 mm. Our results were somewhat higher, but there was no difference within the examined groups, and it can be concluded that the addition of buckwheat did not affect this property. Supić et al. [6] state that the average weight of an eggshell is about 11 g. Our results were significantly lower, which indicates that the addition of buckwheat to meals has a negative effect on the weight of the shell, ie the share of buckwheat in the meal decreases.

Table 9. Mass and pH value of egg yolks and egg whites

Characteristic	Group of laying hens			
	Control	I experimental	II experimental	III experimental
Yolk mass (g)	14,34	14,29	14,87	16,61
Egg white mass (g)	40,14	40,34	40,46	40,05
pH of the yolk	6,41	6,44	6,38	6,32
pH of the egg white	8,58	8,69	8,77	8,83

Buckwheat has a positive effect on the mass of egg yolks. Perić and Birkhold [7] state that the pH of fresh eggs is around 7.5, and in our research the pH was significantly lower, which indicates that the addition of buckwheat to the meals of laying hens leads to a decrease in the pH of eggs. Adding buckwheat to meals did not have a significant effect on egg white mass and pH.

Table 10. Difference of physical properties, statistical parameters

Observed features	Kolmogorov-Smirnov Z	Significance (p)
Egg mass (g)	0,611	0,850
Egg length (mm)	0,412	0,996
Egg width (mm)	0,966	0,308
Egg shell mass (g)	1,009	0,261
Yolk mass (g)	0,467	0,981
pH of the yolk	0,743	0,639
Egg white mass (g)	0,770	0,593
pH of the egg white	0,654	0,786

Since the p-values of all observed characteristics-variables are greater than 0.05 (5%) levels of significance, we conclude that each of the variables follows a normal distribution.

The following table shows the results of testing hypotheses on the difference of means between three or more sets using analysis of variance, ie F-test.

Table 11. Results of F-test variance analysis

Observed features	Control group	The first group	Another group	Third group	F	df1	df2	P
	$\mu \pm \sigma$	$\mu \pm \sigma$	$\mu \pm \sigma$	$\mu \pm \sigma$				
Egg mass (g)	63,05 ± 2,28	63,45 ± 2,95	63,73 ± 4,46	64,27 ± 4,23	0,203	3	36	0,894
Egg length (mm)	56,28 ± 1,35	56,88 ± 1,26	56,77 ± 2,28	56,40 ± 1,69	0,289	3	36	0,833
Egg width (mm)	44,52 ± 0,60	44,49 ± 0,88	44,77 ± 1,10	45,17 ± 1,15	1,088	3	36	0,367
Egg shell mass (g)	7,59 ± 0,40	7,66 ± 0,65	7,31 ± 0,64	6,53 ± 0,88	6,125	3	36	0,002
Yolk mass (g)	14,34 ± 0,89	14,29 ± 1,62	14,87 ± 1,05	16,61 ± 1,26	7,775	3	36	0,000
pH of the yolk	6,41 ± 0,19	6,44 ± 0,14	6,38 ± 0,10	6,32 ± 0,16	1,077	3	36	0,371
Egg white mass (g)	40,14 ± 2,42	40,34 ± 1,95	40,46 ± 4,61	40,05 ± 3,41	0,034	3	36	0,991
pH of the egg white	8,58 ± 0,14	8,69 ± 0,27	8,77 ± 0,14	8,83 ± 0,15	3,330	3	36	0,030

Based on the test results of hypotheses on the difference of mean values between groups of laying hens, we conclude that there is a statistically significant difference of mean values between four

groups of laying hens in the following variables: shell mass (g) with the highest average value in the first group, yolk mass) with the highest average value in the third group and pH of the egg whites with the highest average values in the third group.

CONCLUSION

From the obtained results, it can be concluded that the addition of buckwheat to the meals of laying hens has a positive effect on a number of qualitative and quantitative properties of eggs (protein content, mineral content, egg mass, as well as egg shell quality). In addition, such meals are tastier, laying hens are happy to consume them, and there is less food breakdown, and thus less harmful impact on the environment.

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