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The Effects of Some Additives on Egg Quality in Laying Hens

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Abstract. The research was performed on 108 laying hens, Isa-Brown hybrid, divided in four groups, 27 heads/group. Prebiotic Actigen was supplemented in total mixed ratio (TMR) in group 1E using a proportion of 0.06%, prebiotic Bio-Mos in proportion of 0.1% (group 2E) and organic Se (Sel-Plex) in proportion of 0.04% (group 3E). The trial developed within 6 weeks, first laying stage (33 weeks–39 weeks of age), respectively. During trial, the following issues were studied: average weight of egg structure, egg proportion, chemical composition of egg and egg quality (egg size index, egg volume, index white, index yolk, Haugh units, specific subject of egg weight). The use of prebiotics (Bio-Mos and Actigen) and organic selenium (Sel-Plex) in the mentioned doses determined increase in the average weight of egg structure (egg white, yolk and shell), and also an increased eggshell thickness and an increase in the protein content in egg white and yolk. Also is observed an increase in Ca content in eggshell and an increase in Se in egg (egg white+yolk). The results obtained confirm the favourable influence of prebiotics and organic selenium on the egg quality of laying hens in the first laying stage.

Keywords: prebiotics (Bio-Mos, Actigen), organic selenium, laying hens, egg quality.

INTRODUCTION

The nutrition of laying hens is an important factor in achieving high quality eggs. In this context, in recent years, greater attention has been given to the use of fodder additives in the diet of laying hens in order to improve egg quality.

Research conducted worldwide on laying hens showed that prebiotics (Bio-Mos, Actigen) and organic selenium (Sel-Plex) led to the improvement of the egg structural components weight and of some morphological and physical indexes of the quality of the egg. Thus, Dimovelis *et al.* (2004) administer the supplement Bio-Mos to laying hens during laying and determine the improvement of egg quality parameters. Cabuk *et al.* (2006), following the experiments carried out on laying hens, to which they administered the prebiotic Bio-Mos find a greater mass of eggs and fewer broken eggs, which means that the respective prebiotic influences the quality of the egg destined for consumption. Roberfroid *et al.* (2000) show that the use of prebiotics in the diet of laying hens stimulates the absorption of minerals, especially calcium and magnesium, leading to eggshell improved quality parameters.

Bozkurt *et al.* (2012), following research on laying hens, find beneficial effects of Bio-Mos prebiotic in terms of egg quality (yolk weight, shell weight, shell breaking strength). Kim *et al.* (2009) administer to laying hens the prebiotic Bio-Mos and observe at the end of the experience improvement of the shell quality and of the yolk colour.

The experiments conducted worldwide, on hens, eggs, consumption show that administration of organic selenium in the feed resulted in the improvement of the weight of

the eggs and of the egg components (shell, yolk and albumen) (Gjorgovka *et al.*, 2012; Pan and Rutz, 2003). In addition, it appears that organic selenium can be transferred in the eggshell, thus improving its quality (Gjorgovka *et al.*, 2012; Pan and Rutz, 2003).

Research conducted by Gajacevic (2009), Gjorgovka *et al.* (2012), Narahari *et al.* (2004), Panton *et al.* (2002) and Surai (2006), show that organic selenium supplementation in the feed of laying hens increases the content of selenium in eggs, as well as the content of vitamin E. Through the use of organic selenium (Sel-Plex) in the feed of hens, the authors cited achieved an increase in the content of selenium in the yolk and albumen of the egg, resulting in the improvement of the egg quality during storage. Organic selenium supplementation of the feed of hens not only improves the production and quality indicators, but can also be a natural means of producing functional foods, respectively selenium enriched egg production (Yaroshenko *et al.*, 2003).

The aim of the research is to highlight the influence of some probiotic products (Bio-Mos, Actigen) and organic selenium (Sel-Plex) administered in laying hens feeding upon the quality parameters of eggs in the first laying phase.

MATERIALS AND METHODS

The research was conducted on a number of 108 laying hens, the hybrid Isa-Brown, divided into 4 groups, 27 hens/group. To the experimental group 1, the prebiotic Actigen was added in the combined fodder in a proportion of 0.06%, to the experimental group 2, the Bio-Mos prebiotic was added in the combined fodder in proportion of 0.1%, and to experimental group 3 organic selenium (Sel-Plex) was added in a dose of 0.04%. The experimental period was of 6 weeks, representing the first phase of laying (age 33 weeks-39 weeks). The 108 laying hens in the early laying stage received the same microclimate conditions (batteries BP3), density, care and nutrition, the differences consisting only in the absence or presence of probiotic products (Bio-Mos, Actigen) and organic selenium (Sel -Plex) in the feed. The feeding of laying hens in the four groups was performed with mixed feed that had the same energy and protein level (2750 kcal EM/ kg, 17.5% raw protein). In order to determine the quality of eggs it was analysed: the mass of the egg, albumen, yolk and shell. The structural components of the egg were determined on a sample of 10 eggs for each group, taken randomly at the end of the experience.

In order to determine the influence of probiotic products and organic selenium introduced into the feed of laying hens on the quality of the eggs, a series of laboratory tests were performed upon some parameters such as: dry matter, protein, total fat, ash. The chemical composition of the egg was reported to the material as such. For the group 3E (Sel-Plex 0.04%) it was established by specific laboratory analysis (atomic absorption spectroscopy) the selenium and calcium egg content. At the end of the experiment, the main morphological and physical indices of the quality of the eggs were determined (egg shape index, egg volume, specific weight, albumen index, yolk index, Haugh units).

Data were statistically centralized using the Student test and the GraphPad InStat program ver. 3.10.

RESULTS AND DISCUSSIONS

In order to determine the quality of eggs, the average weight of egg, yolk, albumen and shell, and the proportion of the main components of the egg (albumen, yolk and shell) were determined (*Tab. 1* and *2*).

Tab. 1

The average weight of the main structural components of the egg (g)

Specification	n	Experimental groups			
		G (C)	G1(E)	G2(E)	G3(E)
Average weight of the egg (g)	10	63.31±1.54	64.19±1.84	65.28±1.62	65.55±1.27
Average weight of the yolk (g)	10	16.17±0.35	16.27±0.58	16.77±0.36	17.35±0.38
Average weight of the albumen (g)	10	38.15±1.17	38.91±1.21	39.21±1.27	39.29±0.91
Average weight of the shell (g)	10	8.67±0.24	8.67±0.23	8.94±0.22	8.72±0.19

G(C)-Control Group; G1(E)-Actigen; G2(E)-Bio-Mos; G3(E)-Sel-Plex
ns, p>0.05-insignificant differences

From the data presented, it can be ascertained that the average weight of the egg, yolk and albumen record the highest value for the group 3E (Sel-Plex), followed by the group 2E (Bio-Mos) and group 1E (Actigen), the lowest values being obtained by the control group, the differences being not significant (p>0.05).

The average weight of the shell presents the highest value in the group 2E (Bio-Mos), followed by group 3E (Sel-Plex), while groups 1E (Actigen) and the control group register equal values, the differences between the 4 groups being insignificant. Results on the average weight of the yolk in the experimental groups were comparable to those obtained by other authors (Gjorgovka *et al.*, 2012; Pan and Rutz, 2003 for organic selenium and Bozkurt *et al.*, 2012 for Bio-Mos).

Tab. 2

The proportion of the main structural components of the egg (%)

Specification	n	Experimental groups			
		G(C)	G1E (Actigen 0,06%)	G2E (Bio-Mos 0,1%)	G3E (Sel-Plex 0,04%)
Average weight of the egg	10	100.00	100.00	100.00	100.00
Average weight of the yolk	10	25.67	25.48	25.83	26.55
Average weight of the albumen	10	60.57	60.94	60.40	60.11
Average weight of the shell	10	13.76	13.58	13.77	13.34

G(C)-Control Group; G1(E)-Actigen 0.06%, G2(E)-Bio-Mos 0.1%. G3(E)-Sel-Plex

Analyzing the results presented in *Table 2* regarding the proportion of the main structural components of the egg, it can be ascertained that:

- the proportion of the yolk is higher in group 3E (Sel-Plex) as compared to the control group by 0.88% and compared to experimental groups 2E (Bio-Mos) and group 1E (Actigen) with 0.72% and respectively 1.07%, the proportion of the albumen presents a slightly higher value in the group 1E (Actigen) as compared to the other experimental and control groups, while the proportion of the shell presents approximately equal values for both the experimental and control groups.

Table 3 shows the average values of the quality parameters of the eggshell recorded at the end of the experiment.

Tab. 3

Average values of the quality parameters of the eggshell
recorded at the end of the experimental period

Specification	n	Experimental groups		
		n	X±sx	V%
Average weight of eggs (g)	G (C)	10	63.31±1.54	7.95
	G1 (E)	10	64.19±1.84	9.05
	G2 (E)	10	65.28±1.62	7.85
	G3 (E)	10	65.55±1.27	6.12
Average weight of the shell (g)	G (C)	10	8.67±0.24	8.63
	G1 (E)	10	8.67±0.23	8.34
	G2 (E)	10	8.94±0.22	7.79
	G3 (E)	10	8.72±0.19	6.96
The proportion of the shell in the egg (%)	G (C)	10	13.71±0.30	6.87
	G1 (E)	10	13.52±0.13	2.99
	G2 (E)	10	13.72±0.29	6.71
	G3 (E)	10	13.33±0.28	6.53
Shell thickness (mm)	G (C)	10	0.39±0.01	8.10
	G1 (E)	10	0.42±0.01	10.02
	G2 (E)	10	0.41±0.01	7.71
	G3 (E)	10	0.44±0.02*	11.73
Calcium (% of the shell)	G (C)	10	22.83±0.86	8.47
	G3 (E)	10	24.02±0.62	5.73

G(C)-Control Group; G1(E)-Actigen; G2(E)-Bio-Mos; G3(E)-Sel-Plex
* $p<0.05$- significant differences

Regarding the weight of the shell, there is an increase of 0.27 grams in group 2E (Bio-Mos) as compared to the control group and the group 1E (Actigen) and with 0.22 grams as compared to group 3E (Sel-Plex), the differences between the groups being insignificant.

Shell thickness records the highest value in group 3E (Sel-Plex) as compared to the control group, the differences being significant. There is an increase in the shell thickness of 0.05 mm in group 3E (Sel-Plex) as compared to the control group, and an increase of 0.02 to 0.03 mm in group 3E as compared to the groups 1E (Actigen) and 2 E (Bio-Mos), the differences between the experimental groups being insignificant.

The results regarding the egg structure confirm the favourable influence of prebiotic products and organic selenium administered in the feed of laying hens upon the eggshell thickness (Dimovelis *et al.*, 2004, Kim *et al.*, 2009 for Bio-Mos; Pan and Rutz, 2003 for Sel-Plex). Moreover, the proportion of calcium in the eggshell records a higher value in group 3E (Sel-Plex) 24.02% as compared to the control group 22.83% (Roberfroid *et al.*, 2000) the differences between the two groups being insignificant.

Table 4 presents the average values of the morphological and physical quality indices of the eggs.

Analyzing the index values obtained regarding the egg format, the egg volume, specific weight, yolk index and albumen index, it was found that they were not influenced by the presence of the prebiotic products and organic selenium in the laying hens feeding, the differences between the 4 groups being insignificant. The values recorded in these morphological and physical indexes are within the limits given in the scientific literature (Văcaru Opriş *et al.*, 2002).

Tab. 4

Average values of the morphological and physical quality indices of eggs registered at the end of the experimental period

Specification	Group	n	X±sx	V%
Index of the egg format (%)	G (C)	10	80.68±2.12	8.29
	G1 (E)	10	80.52±0.97	1.21
	G2 (E)	10	79.14±0.82	1.04
	G3 (E)	10	78.63±1.29	1.64
Egg volume (cm^3)	G (C)	10	60.12±1.67	2.77
	G1 (E)	10	62.19±1.14	1.83
	G2 (E)	10	60.98±1.51	2.48
	G3 (E)	10	61.25±0.87	1.42
Specific weight	G (C)	10	0.914±0.018	6.37
	G1 (E)	10	0.918±0.004	1.52
	G2 (E)	10	0.920±0.008	2.62
	G3 (E)	10	0.907±0.012	4.24
Index of the yolk	G (C)	10	0.488±0.008	5.20
	G1 (E)	10	0.494±0.008	5.24
	G2 (E)	10	0.470±0.005	3.32
	G3 (E)	10	0.482±0.006	3.94
Index of the albumen	G (C)	10	0.070±0.002	8.38
	G1 (E)	10	0.075±0.004	17.25
	G2 (E)	10	0.068±0.005	22.27
	G3 (E)	10	0.072±0.004	17.14
Haugh units (U.H.)	G (C)	10	87.10±1.197	4.34
	G1 (E)	10	88.6±1.447	5.16
	G2 (E)	10	85.2±2.581	9.58
	G3 (E)	10	86.8±1.659	6.04

G(C)-Control Group; G1(E)-Actigen; G2(E)-Bio-Mos; G3(E)-Sel-Plex
ns, p>0.05- insignificant differences

Regarding the Haugh units, it is found that the lowest value was recorded in group 2E (Bio-Mos) 85.2 U.H., followed by group 3E (Sel-Plex) 86.8 U.H., the highest values being obtained in the control groups 87.10 U.H. and 1E (Actigen) 88.6 U.H. The lowest value in Haugh units obtained in group 2E (Bio-Mos) is comparable to that obtained by Garcia *et al.* (2004).

In order to know the effects of the two prebiotics and of organic selenium, introduced in the feed of laying hens, upon the quality of the eggs, laboratory tests were performed on some parameters such as: dry matter, protein, ash, total lipids, and for the control group and L3 (Sel-Plex) determinations were performed regarding the egg shell calcium and selenium in the egg (albumen + yolk). The data is summarized in *Tables 5* and *6*.

The chemical analysis carried out on the main components of the egg show the following:

- the content of dry matter, raw protein, total lipids and ash of the albumen and yolk register values close to the experimental and control groups, the differences being insignificant. However, for the group 3E (Sel-Plex) the protein content in the egg albumen and yolk registers a slightly higher value than the other experimental and control groups, and the total lipid content of the yolk with the lowest value is found in group 1E (Actigen), which shows that organic selenium and prebiotic products favourably influence the egg quality as they increase the protein content and reduce the fat content.

Tab. 5

Chemical content of the egg (% of the component)

Chemical composition (%)		Group	n	X± sx	V%
Dry matter	Albumen	G(C)	10	12.51±0.51	9.06
		G1(E)	10	12.80±0.44	7.61
		G2(E)	10	11,88±0.38	7.15
		G3(E)	10	12.69±0.39	6.94
	Yolk	G(C)	10	50.65±0.52	2.28
		G1(E)	10	50.98±0.32	1.39
		G2(E)	10	50.29±0.35	1.57
		G3(E)	10	50.61±0.71	3.14
	Shell	G(C)	10	77.21±1.00	2.91
		G1(E)	10	83.44±3.45	9.24
		G2(E)	10	77.56±0.95	2.74
		G3(E)	10	76.81±1.60	4.64
Protein	Albumen	G(C)	10	10.67±0.44	9.26
		G1(E)	10	10.99±0.38	7.70
		G2(E)	10	10.20±0.40	8.70
		G3(E)	10	11.22±0.37	7.47
	Yolk	G(C)	10	16.40±0.39	5.29
		G1(E)	10	16.49±0.45	6.16
		G2(E)	10	16.21±0.39	5.40
		G3(E)	10	17.14±0.42	5.51
Total lipids	Albumen	G(C)	10	29.43±1.39	10.56
		G1(E)	10	28.32±1.64	12.98
		G2(E)	10	29.48±2.29	17.37
	Yolk	G3(E)	10	30.38±1.63	12.00
Ash	Albumen	G(C)	10	0.75±0.03	7.65
		G1(E)	10	0.78±0.04	13.01
		G2(E)	10	0.78±0.04	10.99
		G3(E)	10	0.83±0.03	8.04
	Yolk	G(C)	10	1.92±0.11	12.42
		G1(E)	10	2.02±0.09	10.25
		G2(E)	10	1.94±0.05	5.24
		G3(E)	10	1.90±0.06	6.80

G(C)-Control Group; G1(E)-Actigen; G2(E)-Bio-Mos; G3(E)-Sel-Plex
ns- p>0.05- insignificant differences

The analysis of the content of selenium in the egg (albumen + yolk) shows that it increased in group 3E (Sel-Plex), the differences between the control group and group 3E being very significant, the obtained results being comparable to those obtained by other authors (Gajacevic, 2009; Gjorgovka *et al.*, 2012; Narahari *et al.*, 2004; Panton *et al.*, 2002; Surai, 2006).

Tab. 6

The average values and the variability of the egg selenium content (albumen + yolk) and the egg shell calcium

Specification		Group	n	Statistical parameters	
				$X \pm S_X$	V%
Selenium (µg/ kg)	egg (albumen yolk)	G(C)	10	4.92±0.30	13.64
		G3(E) (Sel-Plex)	10	100.02±8.70***	19.46
Calcium (g)	shell	G(C)	10	2.03±0.08	9.17
		LG3(E) (Sel-Plex)	10	2.14±0.06	6.36

G(C)-Control Group; G3(E)-Sel-Plex
***- p<0.001- very significant differences; ns- p>0.05- insignificant differences

This fact demonstrates that the administration of organic selenium in laying hens feeding leads to the accumulation of selenium in the egg. Moreover, the calcium content in the shell is higher in group 3E (Sel-Plex), which shows that organic selenium can be transferred to the egg shell, thus improving its quality (Gjorgovka *et al.,* 2012; Pan. and Rutz, 2003).

CONCLUSION

The use of prebiotic products Bio-Mos (0.1%) and Actigen (0.06%) and organic selenium (Sel-Plex) in a dose of 0.04% resulted in the improvement of the main quality indices in the eggs of laying hens, in the first phase of laying (age 33 weeks- 39 weeks).

At the end of the experience, the best results concerning the average weight of the structural components of the egg were obtained by the laying hens from group 3E (Sel-Plex 0.04%), followed by group 2E (Bio-Mos 0.1%) and group 1E (Actigen 0.06%), the lowest values being obtained by the control group, the differences between groups being insignificant. The average weight of the shell presents the highest value in group 2E (Bio-Mos) 8.94 g, followed by group 3E (Sel-Plex) 8.72 g, and groups 1E (Actigen) and control group 8.67 g.

The shell thickness presents the highest value in group 3E (Sel-Plex), the differences between group 3E and the control group being significant. It can be noticed that the shell thickness in group 3E (Sel-Plex) is higher with 0.05 mm as compared to the control group and with 0.02 to 0.03 mm as compared to groups 1E (Actigen) and 2E (Bio-Mos).

The content of calcium from the eggshell increased with 1.19% in group 3E (Sel-Plex) as compared to the control group, following the administration of organic selenium in the laying hens feeding, in a dose of 0.04%.

The morphological and physical indices of the egg quality register values similar to the ones mentioned in the scientific literature. The content of dry matter, protein, total fat and ash in the egg albumen and yolk registers similar values in the experimental and control groups, the differences being insignificant.

The content of selenium from the egg (albumen + yolk) registers the highest value in the group 3E (Sel-Plex), the differences between group 3E and the control group being highly significant, which demonstrates that the administration of organic selenium in laying hens feeding leads to the accumulation of selenium in the egg.

Based on the obtained results, it is recommended to use the prebiotic products (Bio-Mos 0.1% and Actigen 0.06%) and organic selenium in a dose of 0.04% in the feed of laying hens in the first phase of laying, due to the fact that it improves the egg quality indices.

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