

# Effects of Mineral Supplements on Bioproductive Results in Egg-Laying Hens Farmed in Organic Systems

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## Abstract

The experiment on mineral supplementation of feed, in egg-laying hens, was carried out in concordance with the national and common legislation, with the feeding and maintenance conditions specific to the organic system. According to the experimental organization scheme, a group of 90 egg-laying hens, with the age of 19-34 weeks, was randomly distributed in three experimental variants and fed on a basic CM; the differentiating nutritional factor was represented by the level of microelement supplementation, as follows: -V<sub>1</sub> – fed on CM, without mineral premix; the micromineral participation was provided by the CM basic components, determined according to specific chemical analyses, at the level of 60.68 mg Fe, 20.33 mg Mn, 28.16 mg Zn, 7.73 mg Cu, 0.12 mg Co, 0.06 mg I, 0.26 mg Se/kg SU – CM; -V<sub>2</sub> – fed on CM, with supplementation of mineral premix; the microelement participation was adapted to the extensive breeding and the supplementation was 70.68 mg Fe, 40.33 mg Mn, 48.16 mg Zn, 9.23 mg Cu, 0.24 mg Co, 0.26 mg I, 0.36 mg Se / kg SU CM; -V<sub>3</sub> – fed on CM + mineral premix with double microelement supplementation, reaching the level of 80.68 mg Fe, 60.33 mg Mn, 68.16 mg Zn, 10.73 mg Cu, 0.37 mg Co, 0.46 mg I, 0.46 mg Se / kg SU CM. In this experiment, we determined nutritive indices and also bioproductive indices related to egg quantity and quality. The results prove the necessity of feed supplementation with microminerals in the egg-laying hens bred in organic systems as well, but with levels reduced with 50% compared with the intensive systems.

**Keywords:** egg characteristics, egg-laying hens, organic production, mineral nutrition

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## 1. Introduction

The terms “organic poultry” are commonly used among both consumers and producers of eggs and poultry meat. Because of the wholesomeness associated with the term “organic”, many consumers take for granted that all certified organic poultry kept for meat and eggs are kept outside on green pasture. However, when someone purchases poultry products labelled “organic”, many of the birds may never have actually seen the light of day or green grass during their entire life [1].

The legal requirement for organic eggs sold in the European Union is that they should be produced by hens that have “continuous daytime access to open-air runs mainly covered with vegetation and not used for other purposes except for orchards, woodland and grazing livestock, if the latter is authorised by the competent authorities” (RCE 889/2008) [2].

According to the effective legislation (RCE 889/2008) [2], when a poultry livestock is constituted for the first time, renewed or reconstituted and the number of ecologically-farmed birds is not sufficient, we may introduce, in an ecological poultry farm, birds that have been farmed with non-ecological methods, on the condition that the egg-laying hens and the meat poultry are younger than three days old.

In literature average egg production was better than reported for Danish organic and free-range

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non-organic farms, but feed consumption and feed conversion rate were slightly higher. The results of this study do not provide a definite answer to the question whether or not hens should be kept outside [3].

Egg quality was affected by the pasture available. The hens that ingested grass (organic-plus), produced eggs with higher shell weight and percentage, darker yolk colour and higher  $\alpha$ -tocopherol, carotenoid and polyphenol contents [4].

Eggs have been analysed at the beginning, in the middle and at the end of the laying cycle in organic and conventional farms. The egg obtained from the organic system were lighter (64.4 vs 66.2 g) being yolk, albumen and eggshell weights statistically lower in comparison with those produced in conventional system. The yolk/albumen ratio resulted lower in the organic eggs (0.38 vs 0.39) [5].

The information of interest regarding mineral supplementation of the feed for ecologically-farmed poultry come mainly from abroad [4], [6-8], and is usually limited to the recommendation to use premix formulae including minerals within their structure [9-12]. To cover the macro and microelement requirements of the egg-laying hens, there is a project that may be licensed on a mineral premix structure whose effect has been determined in experiments on poultry organic-breeding systems. This premix will be incorporated in proportion of 10% and contains minerals approved in the E.U. (CE Regulation No. 889/2008) [2], for organic poultry breeding farms.

## 2. Materials and methods

The experiment, for the quantification of feed mineral supplement result on the food made for egg-laying hens was carried out on an organic poultry system (Regulation CE no 889/2008).

According to the experimental organization scheme (table 1), a group of 90 egg-laying hens, ISA Brown hybrid, with the age of 19-34 weeks, was randomly distributed in three experimental groups and fed on a basic concentrated mixture (CM); (ME 2660 kcal –CP 15.81%) The differentiating nutritional factor was represented by the level of microelements supplementation, as follows (table 1): V<sub>1</sub> – fed on CM, without microelements in mineral premix; the micromineral participation was provided by the CM basic components, determined according to specific chemical analyses, at level: 60.68 mg Fe, 20.33 mg Mn, 28.16 mg Zn, 7.73 mg Cu, 0.12 mg Co, 0.06 mg I and 0.26 mg Se/ kg DM feed, V<sub>2</sub> fed on CM, with supplementation of mineral premix with a participation of microelements adapted to extensive hen breeding. In this experimental variant, the mineral supplementation level was: 70.68 mg Fe, 40.33 mg Mn, 48.16 mg Zn, 9.23 mg Cu, 0.24 mg Co, 0.26 mg I, 0.36 mg Se/ kg DM of feed, V<sub>3</sub> fed on CM + mineral premix with double microelement supplementation, adapted to the intensive breeding systems, reaching the levels of: 80.68 mg Fe, 60.33 mg Mn, 68.16 mg Zn, 10.73 mg Cu, 0.37 mg Co, 0.46 mg I and 0.46 mg Se/ kg DM of feed.

In this experiment, we determined indices of productive performances (feed intake, egg mass, Egg-laying percentage (%), feed conversion ratio-(FCR) and indices of physical analysis of eggs: whole egg weight, weight of yolk, weight of albumen, yolk/albumen ratio, and weight of shell. The primary data recorded were statistically processed, with the help of the Excel software for calculation. To test the significance of differences, we used the ANOVA test, with the help of the software SPSS 19. The statistical indices of egg-laying percentage and the percentage of yolk, albumen and respectively the shell of total egg were determined successive to the transformation of these data in angular degrees.

**Table 1.** The general scheme for organizing the experiment

Specification		V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>
Experimental period	16 weeks	ME 2660 kcal –CP 15.81%, Lis 0.66%, met+cist 0.53%		
		mineral premix (0%)	mineral premix+microelements (50%)	mineral premix+microelements (100%)
supplemented through premix	Fe	-	10.0	20.0
	Mn	-	20.0	40.0
	Zn	-	20.0	40.0
	Cu	-	1.5	3.0
	Co	-	0.125	0.25
	I	-	0.2	0.4
	Se	-	0.1	0.2
total provided / kg DM CM	Fe	60.68	70.68	80.68
	Mn	20.33	40.33	60.33
	Zn	28.16	48.16	68.16
	Cu	7.73	9.23	10.73
	Co	0.12	0.24	0.37
	I	0.06	0.26	0.46
	Se	0.26	0.36	0.46
Indicators established	*productive performances:			
	- feed intake			
	-egg production			
	- Egg-laying percentage (%)			
	- feed conversion ratio (FCR)			
	* physical analysis weight			
	-weight of yolk (%)			
	-weight of albumen (%)			
	-yolk/albumen ratio (%)			
	- weight of shell (%)			
* statistical analysis:				
-statistical indices of the main bioproductive indicators;				
-ANOVA test				

### 3. Results and discussion

The first index determined from the category of productive results was represented by the *feed intake* in the three experimental variants, presented in table 2. According to this table, we may conclude that the combined forage ingestion ranged between 117 g/hen/day and 119 g/hen/day; this intake level may be classified in the standard of these hybrids, and the percentage differences between groups, of 1.68% in V<sub>2</sub>/V<sub>1</sub> and respectively 0.84% in V<sub>3</sub>/V<sub>1</sub> show that different microelement levels in egg-laying hens do not influence the combined mixture intake.

According to the feed intake recorded in the three experimental variants and the specific egg mass production, we determined another bioproductive index – the feed conversion ratio (FCR) – presented in table 2 as: g CM/kg egg mass, respectively kg CM/kg egg mass.

We may again remark the experimental variant V<sub>2</sub> (on one hand due to the reduced CM intake, and also due to the production obtained – egg mass) with the most reduced specific intake, of 187.57 g CM/piece egg, respectively 3.34 kg CM/kg egg mass; the biggest intake was recorded in V<sub>1</sub> (234.73 g CM/egg, respectively 4.31 kg CM/Kg egg mass), a variant whose micromineral participation was given by the structure of the concentrated mixture.

**Table 2.** Feed intake and FCR in egg-laying hens from the experimental groups

Specification	Experimental variant			
	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	
CM intake	total/hen/period (kg)	13.38	13.13	13.20
	<b>Percentage differences</b>	<b>100</b>	<b>98.13</b>	<b>98.65</b>
	Daily mean intake (g/hen/day)	119	117	118
	<b>Percentage differences</b>	<b>100</b>	<b>98.32</b>	<b>99.16</b>
FCR	g CM/ egg	234.73	187.57	200.00
	<b>Percentage differences</b>	<b>100</b>	<b>79.91</b>	<b>85.20</b>
	Kg CM/kg egg mass	4.31	3.34	3.69
	<b>Percentage differences</b>	<b>100</b>	<b>77.49</b>	<b>85.61</b>

Regarding the productive effect of the mineral supplementation level in egg-laying hens, expressed as *egg production* (number of eggs) and egg-laying percentage (%), according to the data presented in table 3 we may draw the following conclusions:

- the egg production determined according to the number of eggs, respectively to the egg-laying percentage, was 22% bigger in V<sub>2</sub> whose mineral supplementation was carried out at the level of extensive egg-laying poultry breeding;
- in the case of a mineral supplementation corresponding to the intensive system, the increase of egg production, respectively of egg-laying percentage, is of only 16% compared with the reference group, where the microelements were supplied only by the basic feed components;
- statistically significant differences were observed between the variants V<sub>2</sub> and V<sub>1</sub> (p<0.05), and between the variants V<sub>2</sub>-V<sub>3</sub> and V<sub>1</sub>-V<sub>2</sub> we did not record any significant differences (p>0.05).

Another index studied was represented by the *mean egg weight* (g). In order to determine this index, we weighed the eggs produced by the hens from the three experimental

groups. We may remark the experimental variant V<sub>2</sub> with a mean weight of 62.36±3.43 g, 22% bigger than the mean weight of the eggs produced in V<sub>1</sub> (53.09±1.48 g) and only 5.1% bigger than the eggs produced in V<sub>3</sub> (53.29±1.28 g). We did not record any statistically significant differences related to the mean weight of the eggs produced during the entire experimental period (p>0.05).

According to the number of eggs produced and to the mean egg weight, we determined the *egg mass index*, with the help of the mathematical calculation. This index was determined for each experimental week and also for the entire experimental period. The experimental variant V<sub>2</sub>, whose mineral supplementation was carried out at the level required by extensive poultry breeding, produced the highest amount of egg mass during the entire experimental period, 3.93 kg/hen/period, with a weekly mean of 0.245±0.018 kg, 27% (p<0.05) more than in the reference experimental variant V<sub>1</sub> (0.194±0.016 kg) and 9.8% more than in the experimental variant V<sub>3</sub> (0.223±0.016 kg) (p>0.05).

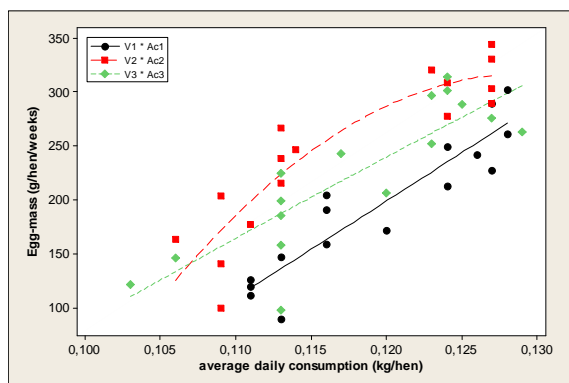
**Table 3.** Statistical indices of egg production in egg-laying hens from the experimental variants

Specification	Experimental variant			
	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	
n	30	30	30	
total/group/period	1712	2096	1985	
total/hen/period	57	70	66	
<b>Percentage differences</b>	<b>100</b>	<b>122</b>	<b>116</b>	
Number of eggs	$\bar{x} \pm Sx$ /group/week	107.00 <sup>a</sup> ±6.46	131.00 <sup>b</sup> ±7.20	124.00 <sup>a, b</sup> ±7.16
	$\bar{x} \pm Sx$ /hen/week	3.56 <sup>a</sup> ±0.216	4.36 <sup>b</sup> ±0.240	4.31 <sup>a, b</sup> ±0.239
	<b>Percentage differences</b>	<b>100</b>	<b>122</b>	<b>116</b>
Egg-laying percentage (%)	$\bar{x} \pm Sx$	50.93±3.08	62.36±3.43	59.05±3.41
	<b>Percentage differences</b>	<b>100</b>	<b>122</b>	<b>116</b>
Mean weight/egg (g)	$\bar{x} \pm Sx$	53.09 <sup>a</sup> ±1.48	55.10 <sup>a</sup> ±1.35	53.29 <sup>a</sup> ±1.28
	<b>Percentage differences</b>	<b>100</b>	<b>103.8</b>	<b>100.4</b>
Egg mass (kg)	total/group/period	93.11	117.77	107.21
	total/hen/period	3.10	3.93	3.57
	<b>Percentage differences</b>	<b>100</b>	<b>127</b>	<b>115</b>
	$\bar{x} \pm Sx$ /group/week	5.82 <sup>a</sup> ±0.490	7.36 <sup>b</sup> ±0.546	6.70 <sup>a, b</sup> ±0.506
	$\bar{x} \pm Sx$ /hen/week	0.194 <sup>a</sup> ±0.016	0.245 <sup>b</sup> ±0.018	0.223 <sup>a, b</sup> ±0.016
<b>Percentage differences</b>	<b>100</b>	<b>127</b>	<b>115</b>	

\*there are not any significant differences between the means with the same index  $p>0.05$ ,

\*\*there are differences at  $p<0.05$  between the means with different index

Figure 1 graphically presents the weekly evolution of the index egg mass in all the three experimental variants during the experiment, according to the mean daily intake, modeled with the help of the second degree polynomial regression

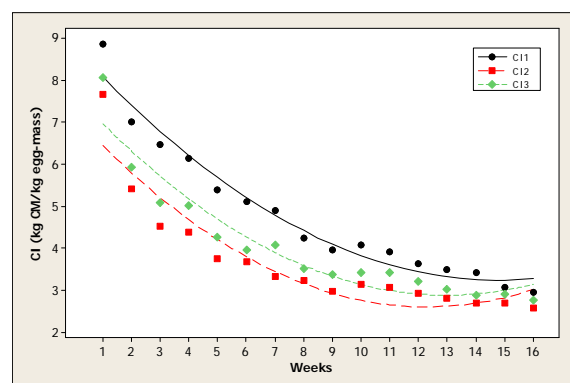


**Figure 1.** Evolution of egg-mass according to the mean daily intake, modelled with the help of the second degree polynomial regression

In the graphic representation from Figure 1, we may observe that the experimental variant 2 presented the best egg-mass evolution during the experiment, at a mean daily intake similar with the one of the other experimental

variants, followed by the experimental variant 3 (but the difference is statistically insignificant,  $p>0.05$ ).

Figure 2 represents graphically the weekly specific intake, expressed in kg CM/kg egg-mass, in the three experimental variants, modeled with the help of the second degree polynomial regression.



**Figure 2.** FCR (kg CM/kg egg-mass) evolution, modelled with the help of the second degree polynomial regression

The graphic representation from Figure 2 presents that, during the entire experimental period, the best feed conversion index was observed in the

experimental variant V2, too, with a microelement supplementation level of 50%; the experimental variant V1, not mineral supplemented, presented the most reduced feed conversion index.

The physical analysis indicators of eggs are presented in table 4.

**Table 4.** Statistical quality indices of the eggs produced by egg-laying hens from the experimental groups

Specification	Experimental variant			
	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	
Yolk (%)	$\bar{x} \pm Sx$	24.63 <sup>a</sup> ±0.336	23.17 <sup>a</sup> ±0.570	23.37 <sup>a</sup> ±0.525
	CV	3.57	6.27	5.75
Albumen (%)	$\bar{x} \pm Sx$	63.34 <sup>a</sup> ±0.531	64.20 <sup>a</sup> ±0.539	64.62 <sup>a</sup> ±0.621
	CV	3.18	3.20	3.67
Shell (%)	$\bar{x} \pm Sx$	12.04 <sup>a</sup> ±0.333	12.64 <sup>a</sup> ±0.256	12.10 <sup>a</sup> ±0.510
	CV	5.15	3.89	7.95
Yolk/albumen ratio	$\bar{x} \pm Sx$	0.389±0.014	0.363±0.018	0.364±0.018
	CV	11.90	15.91	15.87
	Percentage difference	<b>100</b>	<b>93.31</b>	<b>93.57</b>

According to the data presented in table 4, we may draw the following:

- the yolk percentage of total egg presented values between 23.17±0.57% (V<sub>2</sub>) and 24.63±0.336% (V<sub>1</sub>) we did not record any statistically significant differences (p>0.05). This index's variability is reduced (max. 6.27%);
- the albumen percentage is comprised between 63.34±0.521 % (V<sub>1</sub>) and 64.62±0.621% (V<sub>3</sub>), with insignificant difference between the experimental variants (p>0.05); this index's variability is reduced (max. 3.67%);
- regarding the proportion of egg shell, we may remark the experimental variant V<sub>2</sub> with 12.64±0.256%, at a difference of 0.60% compared with the experimental variant V<sub>1</sub> (variant without micromineral supplementation); the differences are insignificant, too (p>0.05);
- the ratio yolk/albumen has similar values in the mineral-supplemented variants V<sub>2</sub>, respectively V<sub>3</sub> (0.636±0.018; respectively 0.364±0.018), smaller with approximately 6.5% than the reference experimental variant (V<sub>1</sub>); the differences are statistically insignificant (p>0.05).

#### 4. Conclusions

- The combined feed ingestion ranged between 117 g/hen/day and 119 g/hen/day; this intake may be classified in the standard of these hybrids, and the percentage differences between groups, of 1.68% in V<sub>2</sub>/V<sub>1</sub> and respectively 0.84% in V<sub>3</sub>/V<sub>1</sub> show that the different microelement levels from

egg-laying poultry feed do not influence the CM intake;

- The experimental variant V<sub>2</sub> was observed with the most reduced specific intake, of 187.57 g CM/piece egg, respectively 3.34 kg CM/kg egg-mass, and the biggest specific intake was recorded in V<sub>1</sub> (234.73 g CM/egg, respectively 4.31 kg CM/kg egg-mass), a variant whose micromineral participation was given by the CM structure;
- The number of eggs produced by the hens in this experiment was influenced by the level of micromineral supplementation; this increased the egg production with 22% in V<sub>2</sub> (with micromineral premix adapted to the extensive poultry breeding), compared with the reference variant (V<sub>1</sub>) and with 16%, in the variant supplemented with premix adapted to the intensive poultry breeding;
- The mean egg weight is not influenced by feed's microelement level and the differences between groups are not statistically assured;
- The egg-mass index determined in V<sub>2</sub>, whose micromineral supplementation dose was of 50%, was of 0.245± 0.018kg/hen/week, 27% bigger than the mean value in V<sub>1</sub>; this percentage difference was statistically assured (p<0.05). In V<sub>3</sub>, too, the percentage difference of 15% compared with the reference variant is statistically assured (p<0.05);
- Regarding the indices % yolk, % albumen and % shell in total egg, the differences between the experimental variants are not significant (p>0.05), so that we may conclude that the mineral

supplementation levels do not exert any influence on these indicators.

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