UDC: **636.46:636.087.7:636.46/637.42**
Shortended report of master's thesis

Acta Agriculturaae Serbica, Vol. III, 5 (1998) 3-16

Acta Agriculturae Serbica
FACULTY OF AGRONOMY • CACAK •

Influence of Zeolites Used in Diet of Laying Hens Isabrown ssl on egg Production and Quality

Vera A. Radovic

Faculty of Agronomy, Cacak, Yugoslavia

Abstract: During a 7- month survey of the influence of diets containing zeolites (clinoptilolite) for laying hens Isabrown SSL, the results were obtained on egg production and quality for consumption. The experiment was conducted on the farm near Cacak.

Zeolites (clinoptilolite) were added to diets for laying hens in different levels: the experiment included 1000 hens divided into 4 groups: K-group, with no addition of zeolites to diet, O-I group with 0.2, O-II group with 0.3 and O-III group with 0.5% zeolites. Each group counted 250 hens held in cages, 4 hens each.

The obtained data showed significant differences in egg production, daily feed utilization, feed conversion and egg quality. Thus, the best results were obtained in O-III group with 0.5% of zeolites, with an average rate of laying 88.6%; 12.352 kg egg weight per hen housed egg production, the best food utilization 2.306; 0.433 kg of egg weight/kg of food. The highest average egg weight was in O-II group (with 0.3% zeolites) 69.72 g, measured by the method of Haught - 69.36 HJ. The lowest mortality was found in the hens of O-III group, with the biggest body weight accomplished at the end of egg production.

During the experiment, the samples of red and white meat, liver and eggs contained neither zeolite nor mycotoxin remainders, although the presence of aflatoxinG_2 and ochratoxin was enhanced in diets. These results confirm chemi-sorptive influence of zeolites in mycotoxin used in hen diets.

Key words: laying hens, diet, zeolites (clinoptilolite), egg production, eggs, quality, mycotoxin, remainder.

Introduction

There are works about using zeolites (clinoptilolite) in foreign and domestic references, such as those on additives, animal husbandry on the basis of zeolites in cattle breeding. Use of zeolites refers to improving microclimatic conditions (soil), facilities for animals, manure, body weight, then, to less using of feed, diarrhea prevention, as well as to upgrading an overall health condition Although there are so many works about the influence of zeolites in breeding broiler chickens, little information about the influence of zeolites on egg quality is provided. In zeolites, such an influence benefits from antimycotoxical additive, which indirectly improves egg quality and chicken meat, since it is free from mycotoxins.

Oliver (1983) fed the chickens (Hy-line Line) with diet containing 16 proteins or 13.5%. He carried out 4 breeding experiments. The chickens were divided into 4 groups. In the diet of control group, no zeolites (clinoptilolite) were added and, in that of experimental groups, 5% zeolites were added. He concluded that zeolites caused no significant differences in the average body weight, nor those in egg quality, as measured by Haugh. However, he determined certain differences in the day of laying, number of produced eggs, daily diet consumption, conversion of diet, meaning that this diet was used to produce 1 kg of eggs.

Ingram et al. (1987) determined a positive influence of synthetic hydrated sodium calcium aluminun-silicate on zeolites, added to diet for laying hens and roosters in the amount of 0,5 and 1% for body growth and specific egg weight ($P<0,05$).

Kasumov et. al., fed the laying hens with diet to which 3, 5 and 6% of clinoptilolite was added. The results confirmed that clinoptilolite had immensely contributed to a better production profitability.

Kalyzhanov et al. (1988) claimed that the zeolites added to chicken diets, increased egg production by 3-6% and growth of feeding chickens, as well.

Bunger (1982) fed broilers with diet to which 0,25-9% of zeolites (four feeding mixture) was added in different amounts, being of Sheaville-Oregon origin. He found out that body weight was higher and feed conversion lower in by 1-3% in the groups under surveyed.

Phillips et al. (1988) claimed that HSCAS (hydrated aluminonsilicate) significantly weakened the effect of aflatoxin B_1 in the chickens.

Phillips, et. al.. (1990), in their work on aflatoxicosis prevention in cattle with selective chemisorption aflatoxins, claimed that more recent studies had immensely contributed to new approaches to aflatoxin control using mineral absorbers (zeolites), which leads to aflatoxin immobilization in the digestive system of the cattle and poultry. The selective chemosorption of aflatoxin was performed in water conditions including milk. The level of aflatoxin in the blood was decreased and its transport to the organs, such as liver, too.

Palic et al. (1993) stated that natural zeolites, added to chicken's diet had increased body weight and growth, but decreased conversion and mortality of the chickens.

Cheng Jeong-Hsiang et. al., (1995) confirmed that the addition of 2% HSCAS (hydrated aluminosilicate) to duck's diet containing 400 µg aflatoxins B_1 had lowered its growth, but increased GOT activity (glutamic oxaloacetix transaminoze) and GPT (glutamic pyruvic transaminoze) while preventing aflatoxicosis in the ducks which behaved excellently, since the remains of aflatoxin B_1 were not found in their breast muscles.

Phillips et al. (1995) gave a comprehensive information considering details on the mechanisms of selective chemisorption and detoxification of aflatoxins, natural zeolites and HSCAS.

The main objective of the present study was, therefore, to scientifically check the findings on the influence of natural zeolites (clinoptilolite), added to full feeding mixture for laying hens SSL, in concentrations 0.2, 0.3 and 0.5%, which would, as such, help better production and egg quality, then, conversion and feed utilization, in this case, zeolite remains in red and white meat, liver and eggs.

The obtained results served as an answer to the question if the addition of zeolites to full feeding mixtures for laying hens had medical and producing usefulness.

The present study is referred to three parts:

1. egg production
2. testing egg quality, and
3. chemical surveys of feeding mixtures for eggs white and red meat and liver.

In order to increase the influence of zeolite and thus enable higher egg producing and its quality, the major task was: to organize experiment on feeding laying hens, consuming eggs, full feeding mixtures, with or without zeolites. This experiment has to fully comply with requirements needed for its appropriate performance and full lasting for 7 months, too.

Materials and methods

The experiment, was arranged as a group-control system. The hens, hybrid laying hens Isabrown SSL were studied. During the investigation period, the conditions of holding, feeding and watering were equal for all the groups of laying hens. Feeding of laying hens was followed for 210 days. At the moment of setting up of the experiment; laying hens were 46 weeks old and 26 weeks lapsed from the beginning of their production.

There were 1000 hens in the experiment divided into four groups. Control K-group 250; O-I group 250; O-II group 250 and O-III group 250 hens.

According to the objective of this study, the experiment of feeding hens was organized in such a way that all the differences in the amount of added zeolites could be established, the obtained results explained and relevant conclusions drawn.

The hens of the control and of all the three test groups were fed with full feeding mixture containing the same raw sources (Tab. 1). The only difference was that the hens of the control group didn't receive zeolites by diet, being the case with the experimental group O-I 0,2; O-II 0,3; O-III 0,5% zeolites. (The zeolites produced under the name "Min-a-zel" in ITNMS, Belgrade were used for the experiment).

Table. 1. Composition of full feeding mixture for laying hens (%)

Food	% of Participation	Groups of hens			
		K	O-I	O-II	O-III
1. Corn		55,5	55,3	55,2	55,0
2. Wheat bran		9,0	9,0	9,0	9,0
3. Cattle yeast		3,0	3,0	3,0	3,0
4. Soybean grits		13,0	13,0	13,0	13,0
5. Sunflower grits		2,0	2,0	2,0	2,0
6.Fish flour		3,0	3,0	3,0	3,0
7. Lucerne flour		5,0	5,0	5,0	5,0
8. Cattle shalk		7,0	7,0	7,0	7,0
9. $CaHPO_4$		1,2	1,2	1,2	1,2
10. NaCl		0,3	0,3	0,3	0,3
11. Premix		1	1	1	1
12. Zeolites		-	0,2	0,3	0,5
Entirely	100	100,0	100,0	100,0	100,0

Food utilization: During the experiment, feed utilization was surveyed by the groups of laying hens.

On the basis of feed used, the number of feeding days and that of produced eggs, we came to the following results

- feed used for one egg per g
- number of produced eggs per 1 kg of feed
- daily consumption of feed per g.

Egg production: On the basis of daily evidence on produced eggs, for each group of hens during the experiment and the number of feeding days were found:

- the average production per average hen
- the average number of eggs per average hen
- the average number of egg per hen housed
- cumulative number of eggs per hen housed.

Chemical analyses of feeding mixture on the primary chemical composition, and micro-toxicological analyses, were done three times: at the start, in the middle and at the end studies. Chemical analyses were done by the method of Wende, and micro-toxicological, using Slender-layer chromatography.

Egg quality: During the experiment, the samples of eggs were taken five times, at 46 (September), 54 (November), 60 (December); 65 (January) and at the end of studies, being 72 weeks of age (March). From each group, 15 eggs were randomly sampled. Surveys included 300 eggs.

The data regarding each egg were, as follows: egg weight, egg width, egg shape index, shell color, albumen height, haugh units, yolk color, shell thickness, shell weight, albumen weight, yolk weight, share of egg white in egg weight (by calculation) share of yolk in egg weight (by calculation), white yolk ration in egg categories.

At the end of feed experiment, bio-mechanic properties of layer bones were determined from 8 hens of each hen group sacrificed. From the bodies of each group were taken tibia and humerus, with breaking of strength bones (kg) determined.

Remainders of zeolites could be seen at the end of experiment after sacrificing hens by means of x-ray of red and white meat, liver and eggs of hens up to their last presence.

Chemical features of an egg shell were analyzed twice. At the beginning of the experiment (38 days) all through its end (198 days) were established contents, as follows

$$Ca^{2+}, Mg^{2+}, Fe^{2+}, K^{+}, Na^{+}, Zn^{2+}, Mn^{2+}, Cu^{2+}, P.$$

Remainders of myco-toxins were established after sacrificing hens, testing red and white meat, liver and eggs up to their eventual presence, using Slender-layer chromatography method.

The analysis of variance was used for statistical analysis of the obtained data. Statistically significant differences between mean values ($\bar{x}$) established for some feeding ways, were determined by F test. LSD test was employed for individual comparisons with 5 and 1% threshold of differences found in both tests.

Results and discussion

During the investigation period, indices of laying hens with feeding hens with no addition of zeolites and with different concentrations of zeolites added to diet, were demonstrated (Tab. 2) and (Graph. 1).

Table. 2. Laying of the hen during the examined period

Traits	Groups of hens			
	K	O-I	O-II	O-III
Hen housed-at the beginning of experiment	250	250	250	250
Average number of hens	245	246	247	247,5
Total egg production	43826	43908	44299	45034
Hen housed egg production	175,30	175,60	177,19	180,14
Hen/day egg production	178,88	178,48	179,06	181,95
Rate of laying % (average)	85,20	84,90	85,40	88,60
Eggs produced/hen/day	0,852	0,849	0,854	0,886

The best rate of laying was in O-III group (180,14 eggs, 12,352 kg egg weight per hen housed, average laying 88,6%) and the worst one in K-group (173,30 eggs, 11,761 kg egg weight per hen housed, average laying 85,2%).

The results on zeolite influence on the rate of laying comply with those of Oliver (1983) who claimed that a larger rate of laying might be exerted by the use of zeolites in the amount of 5% by Hy-line hens. Kasumov et. al., (1988) added 3; 5 and 6% zeolites to laying hens and, thus, increased egg production.

LSD test enabled us to establish a statistical significance of feeding (P<0,05) by months and, a big statistical one (P<0,01) among hen groups, in favor of K group receiving zeolites in its diet.

Feed utilization: Given in absolute and relative indices by months and overall experimental period, the average daily feed utilization shows that hens of examined groups consumed less food than those of the control group. Hens of O-I group consumed food less by 1,55, O-II group by 2,16 and O-III group by 3,15% (Tab. 3, Graph 2).

Table. 3. Daily feed utilization, (g) in absolute and relative indices

Months of feeding		Groups of laying hens			
		K	O-I	O-II	O-III
I September	$\bar{x}$	135,50	131,50	130,97	129,80
index		100,00	97,05	96,66	95,79
II October	$\bar{x}$	128,75	129,55	130,10	128,70
index		100,00	100,62	101,05	99,96
III November	$\bar{x}$	130,25	130,60	128,85	126,17
index		100,00	100,27	98,92	96,87
IV December	$\bar{x}$	145,20	140,95	138,20	136,50
index		100,00	97,07	95,18*	94,01**
V January	$\bar{x}$	165,00	162,30	160,70	160,15
index		100,00	98,36	97,39	97,06
VI February	$\bar{x}$	145,12	141,50	143,12	142,85
index		100,00	97,50	98,62	98,43
VII March	$\bar{x}$	140,80	138,70	137,15	135,12
index		100,00	98,51	97,41	95,96
General average	$\bar{x}$	*141,49*	*139,30*	*138,43*	*137,04*
index		*100*	*98,45*	*97,84*	*96,85*
Difference			*-1,55*	*-2,16*	*-3,15*

- These data indicate a positive influence of zeolites on the feed economical use in hen diet

All the differences between the mean values of the study groups were significant (P<0,05) an highly significant (P<0,01) except 6^{th} period of feeding (February), with no statistically significant differences found between K-group and the examined ones. The obtained results are in agreement with those obtained by Oliver (1983) benefiting the fact that the addition of 5% zeolites to hen diet led to less feed consumption. Velikanov et al. (1983) also found out that daily feed was utilized less by provided zeolites were added to the laying hens.

Food conversion: Feed utilization proved to be the most best in O-III group (2,306; 0,433 kg egg weight/kg of food), and the worst in K-group (food conversion being 2,476; 0,404 kg egg weight/kg of food).

The obtained results comply with those obtained by Palić et. al., (1993) who emphasized that feed conversion had been reduced in fattening chickens with addition of zeolites to food: Andronikašvili et. al., (1994) claimed that clinoptilolite, added to food, held back passing of the diet through the digestive tract for 2-2,5 hours, just as being with ameliorate absorption of the feeding ingredients.

Significant (P<0,05) and highly significant (P<0,01) differences were noticed in the mean values for all the periods between the examined groups and K-group, except the second period of feeding (October).

Graph 3 shows an ordinary feed conversion, i.e. the relation between the used diet and produced egg weight, kg/kg, while graph 4 shows the relation between the produced egg weight and used diet, kg/kg, complying with new methodical requirements +++ 1989.

A reciprocal value of the usual feed conversion is found. A rapid jump (fall) of curvature (December and January) is accounted for by a very low t^{o} during the period in question.

Body weight of sacrificed hens: At the end of the period of laying, the highest EW of hens was established in O-III group (2140,0) and the lowest one in the K-group (1896,25 g).

Many authors believe that the addition of zeolites to diet improve feed utilization and increase body weight. Thus, Bunger (1982) claimed that the addition of zeolites increased BW, but decreased feed conversion by 1-3%. Similar results were obtained by Palić et al., (1993), Andronikošvili et al., (1994) and many others.

These results were also obtained in the present study so that hens of O-III group were completely feathered at its end (0,5% zeolites was taken up by hens through feeding).

Mortality of hens: The lowest mortality applied to the O-III group hens (2%) and the highest one to the K-group hens (4%). Currently obtained results are in full agreement with those of Palić et. al., (1993), who pointed out that zeolites added to chicken diet lowered their mortality.

Bio-mechanical traits of the examined bone layers: Breaking strength, spec. breaking strength, were the most favourable in O-III group for humerus and in the O-II group for tibia. However, the differences between control and examined groups were not significant (P>0,05).

It was found that the presence of zeolites in the diet of laying hens had no negative effect on the bone strength. Some positive effect was manifested during feeding with 0,3 and 0,5% zeolites. Chung et al., (1990) found that the broiler feeding with HSCAS had no effect on both, organic and inorganic phosphorus). Hossain et al., (1994) also confirmed that zeolites, added to chicken diet, increased Ca and tibia, but didn't P.

Remainders of zeolites: After sacrificing hens at the end of experiment, the study on the white and red meat specimens, liver and eggs of hens, yeolite remainders , was performed. Examinations of x-ray fraction samples did not give any zeolite mineral.

Thus, it was confirmed that zeolites were neither resorption nor digestive organs of the animals under way.

Remainders of mycotoxins: After sacrificing hens at the end of experiment, the analyses of mycotoxin remains were made on the samples of: red and white meet, liver and eggs of the control group and O-III group which gained 0,5% mynazel through diet.

It was also found that neither aflatoxin G_2 nor ochratoxin existed in the samples studied:

The presence of two mycotoxins was observed in the hen diet in all the three periods of food sampling: at the start of experiment, aflatoxin G_2 2,67, ochratoxin 0,32; at its middle, aflatoxin G_2 1,60, ochratoxin 0,27; and its end, aflatoxin G_2 5,30, ochratoxin 0,13 mg/kg VSM (air.... food matter).

Chemi-adsorptive influence of zeolites on mycotoxins, was revealed by many authors, such as Phillips et. al., (1990) who claimed that the influence of zeolites held back and immobilized aflatoxins in the digestive tract of animals. Kubena et al. (1990) also concluded that HSCAS prevented many adverse effects of aflatoxins, present in the diet for chickens.

Table 4. Feed conversion and production of egg weight per unit of diet used for the whole feeding period

Traits	Groups of hens							
	K	index	O-I	index	O-II	index	O-III	index
Total feed utilization for whole feeding period (kg)	7279,66	100	7227,23	99,28	7180,36	99,63	7122,65	97,84
Total number of produced eggs	43826,00	100	43908,00	101,19	44299,00	101,08	45034,00	102,76
Average weight of examined eggs (g)	67,08	100	68,03	101,42	69,73*	103,95	68,57	102,22
Total produced egg weight (kg)	2940,02	100	2987,06	101,61	3088,97	105,07	3087,98	105,03
Feed conversion food egg weight kg/kg	2476,00	100	2419,00	97,70	2324,00	93,86	2306,00	93,13*
Produced egg weight/feed utilization kg/kg	0,404	100	0,413	101,22	0,430	106,43	0,433	107,18*

Egg Quality

Egg weight: The highest average egg weight was in O-II group (69,72 g), and the lowest in the K-group (67,09 g). (Tab. 5)

Table 5. Egg Weight, g (15 egg per survey)

Period of survey-	Week of age	Groups of hens							
		K		O-I		O-II		O-III	
		$\bar{x}$	index	$\bar{x}$	Index	$\bar{x}$	index	$\bar{x}$	index
1.	46.	65,83	100	64,42	97,86	68,61	104,22	66,43	100,91
2.	54.	65,83	100	68,50	104,05	69,24	105,18	66,45	100,94
3.	60.	67,67	100	67,23	99,35	69,97	103,40	67,51	99,76
4.	65.	64,41	100	68,01	105,59	68,18	105,85	71,31	110,48*
5.	72.	71,73	100	71,98	100,35	72,60*	101,21	71,16	99,82
Total average:		*67,09*		*68,02*		*69,72*		*68,57*	
Index		*100,00*		*101,39*		*103,92*		*102,21*	
Difference				*+1,39*		*+3,92*		*+2,21*	

Present results show that the hens of the groups that had zeolites in diet, achieved bigger egg weight. However, the differences in the mean values between the groups were insignificant (P>0,05).

Little information is provided about the influence of zeolites added to diet for hens and the average egg weight. Still, Velikanov et al. (1983) stressed that zeolites added to diet might increase the average egg weight to a great extent

Classes of eggs: The data obtained on the share of egg classes of high commercial (SU", "S", "A") value, are given in tables 6 and 7.

Table 6. Egg classes of the high commercial value, (%)

Group of hens	"SU" EU 1 +70 g	"S" EU 2 65-70 g	"A" EU 3 60-65 g	Total %	Total index
		September, 46. week of age			
K	26,67	26,67	40,00	93,34	100,00
O-I	13,33	33,33	40,00	86,67	92,85
O-II	53,33	20,00	13,33	86,66	92,84
O-III	6,67	60,00	33,33	100,00	107,13
		November, 54 weeks of age			
K	20,00	53,33	6,67	80,00	100,00
O-I	33,33	40,00	26,67	100,00	125,00
O-II	46,67	20,00	33,33	100,00	125,00
O-III	20,00	42,86	33,33	96,19	120,23
		December, 60. Week of age			
K	26,67	40,00	33,33	100,00	100,00
O-I	26,67	33,33	33,33	93,33	93,33
O-II	53,33	20,00	26,67	100,00	100,00
O-III	26,67	46,67	26,67	100,00	100,00
		January, 65 weeks of age			
K	35,71	42,86	14,28	92,86	100,00
O-I	42,86	21,43	28,57	92,86	100,00
O-II	28,57	42,86	28,57	100,00	107,68
O-III	60,00	33,33	6,67	100,00	107,68
		March, 72 weeks of age			
K	53,33	33,33	6,67	93,33	100,00
O-I	53,33	26,67	20,00	100,00	107,14
O-II	66,67	13,33	20,00	100,00	107,14
O-III	60,00	20,00	13,33	93,33	100,00

The total average shows that O-I group had 2,89%, O-II group 5,91% and O-III group 6,52% more highly commercial valuable than K-group had. Egg classes of a medium commercial value ("B" and "C") had the average for all the periods studied, with K-group 67,5%; O-I 6,75%; O-II 2,67% and O-III group 2,67% of the total eggs considered. Egg classes of the low commercial value ("D", "E") were not revealed in the eggs examined.

No data on the influence of zeolites on this trait are available in literatire

Egg shape index: The highest egg shape index (relation between egg length and egg width in %) was found in the eggs of O-III group 75,60%, and the lowest one in the O-II group 75,43% (P>0,05). (Eggs with smaller shape index are more resistant to breaking).

Table 7. Egg classes of the high commercial value
(absolute and relative indices)

Months of examination	Groups of hens K	O-I	O-II	O-III
	September, 46. week of age			
Σx	93,34	86,67	86,66	100,00
index	100,00	92,85	92,84	107,13
	November, 54. week of age			
Σx	80,00	100,00	100,00	96,19
index	100,00	125,00	125,00	120,23
	December, 60. week of age			
Σx	100,00	93,33	100,00	100,00
index	100,00	93,33	100,00	100,00
	January, 65. week of age			
Σx	92,86	92,86	100,00	100,00
index	100,00	100,00	107,68	107,68
	March, 72. week of age			
Σx	93,33	100,00	100,00	93,33
index	100,00	107,14	107,14	100,00
	For whole period of examination			
average $\bar{x}$	91,91	94,57	97,33	97,91
index	100,00	102,89	105,91	106,52
difference		*+2,89*	*+5,91*	*+6,52*

Deformation of egg's shell: The least egg's shell deformation was detected in the O-III group (26,15) and the highest in the O-II group (27,83), (Tab. 8).

It is doubtless that the addition of 0.5% zeolites to laying hen diet had an excellent effect on the egg's shell quality (O-III group had the smallest deformation (P>0,05)).

Haugh units (HJ): Quality of albumen were the best in O-II group (69,36 HJ), and the worst in O-I group (68,48 HJ). Thus, we estimated that the groups which gained 0,3 and 0,5% zeolites through food, had a higher average value HJ than the O-I (0,2% of zeolites) and K-group, with no zeolites added. Differences between the mean values were not significant (P>0,05), (Tab. 9).

Tab 8. Egg deformation, 0.01mm

Traits: period	week of age	Groups of hens: K n=15	O-I n=15	O-II n=15	O-III n=15
1.	46.	26,67	26,00	26,40	27,00
2.	54.	25,33	28,28	27,40	22,21
3.	60.	28,38	27,73	29,43	26,53
4.	65.	27,07	30,57	26,14	26,40
5.	72.	26,13	25,14	29,78	28,61
average $\bar{x}$		26,72	27,54	27,83	26,15
index		100,00	103,07	104,15	97,87
difference			*+3,07*	*+4,15*	*-2,13**

Table 9. Haugh-units, HJ

Traits		Groups of hens			
period	week of age	K n=15	O-I n=15	O-II n=15	O-III n=15
1.	46.	81,40	77,53	83,40	83,07
2.	54.	68,87	79,45	72,07	73,00
3.	60. .	69,28	69,13	65,53	67,43
4.	65.	70,50	67,15	64,62.	71,40
5.	72.	54,64	49,14	61,36	51,87
average $\bar{x}$		68,86	68,48	69,36	69,35
index		100,00	99,45	100,73	100,71
difference			*-0,55%*	*+0,73%***	*+0,71%**
$Lsd_{0,01}$ = 21.681 $Lsd_{0,05}$ = 15.735			-0,38	0,5	0,49

Conclusion

Studying 1000 hens Isabrown SSL, divided into 4 groups, K-group 250 laying hens, O-I group 250 laying hens, O-II group 250 and O-III group 250 laying hens over the 28-week period of laying with equal food (feed mixture), the only differences found were the levels of zeolites (clinoptilolite) added to the groups under study: O-I 0,2; O-II 0,3 and O-III group 0,5% of zeolites, and K-group fed without any zeolites added. Several conclusions deserve mention

- the best egg production was reached in O-III group (180,14 eggs 12,352 kg egg weight per hen housed, average laying 88,6%), and the poorest one in K-group (173,30 eggs 11,761 kg egg weight per hen housed, average laying 85,2%);

-the best feed utilization was in O-III group (2,306; 0,433 kg egg weight/kg of diet), and the worst one in the K-group (feed conversion 2,476; 0,404 egg weight/kg of diet);

- body weight was the largest at the end of laying period in O-III group (214,0 g), and the smallest in K-group (1896,25 g);

-the least mortality was established in the hens of O-III group (2%), and the highest one in those of K-group (4%);

-the biggest average egg weight was reported for the O-II group hens (69,72 g) and the smallest one for the K-group ones (67,09 g);

-the highest egg shape index was found in the eggs of O-III group (75,60%), with the darkest egg shell color (3,13points) and the smallest egg shape index in the O-II group (75,43%) and, the palest egg shell color (2,96 points);

- albumen quality was the best in O-II group (69,36 HJ), but the worst in O-I group (68,48 HI);

-the colour of yolk was the most intensive in K-group (9,84 points Roche), and the palest in O-I group (9,54 points Roche);

-the percentage of meat and blood spots in eggs was the least in O-I group (16,00%), and the highest in O-III group (26,67%);

-relation between albumen/yolk was the best in O-II group (0,94), and the worst in O-I group (0,907);

- egg shell was deformed least in O-III group (26,15) and most in the O-II group (27,83);

-bio-mechanical traits (breaking strength, spec. breaking stength) of bones were the best in O-III group for humerus, and in O-II group for tibia;

-the best production value per hen housed was that of O-III group, which through diet gained 0,5% of zeolites

-zeolites (clinoptilolite) are not resorptive, and do not leave remainders in white and red meat, liver and eggs;

In conclusion, the application of zeolites to hen diet, consume eggs, may outstandingly increase hen economical value and, is widely used in practice.

References

Aguillard C.D., Ingram D.R., Herbert J.A. (1989): White Leghorn production and blood parameters as affected by Ethacal feed component. Nutrition Reports International 39 (2) 219-224.

Andronikashvili T.O., Tsereteli B.S., Dolidze V.K., Iremashvili N.G. (1984): Zeolite supplements in diets for birds. Zootekhnija No. 5, 17-18.

Abo Norag M., Edrington S.T., Kubena F.L., Phillips D.T., Harvey B.R. (1995): Influence of a Hydrated Sodium Calcium Aluminosilicate and Virginamycin on Aflatoxicosis in Broiler Chicks. Poultry Science 74: 626-632.

Bunger F.L. (1982): Use of zeolites in the feeding of Turkyes and broiles. Simp. Zeo Agriculture Rochestar, New-York.

Cornejo V.S., Klohn E.A., Hidalgo O.H., Pokniak R.I. (1995): [Inclusion of nautral chilcan zeolite (clinoptilolite) in diets for broiler chickens]. Incorporacion de una zeolita natural chilena (clinoptilolita), a diets de pollos broiler. Avances en ciencias Veterinarias 10 (1) 32-37.

Chung K.T. Erdman W.I., JR., Baker H.D. (1990): Hydrated Sodium Calcium Aluminosilicate: Effects of Zinc, Magnese, Vitamin A, and Riboflavin Utilization. Poultry Science 69: 1364-1370.

Chung K.T., Baker H.D. (1990): Phosphorus utilization in chicks fed Hydrated Sodium Calcium Aluminosilicate. J.Anim. Science 68: 1992-1998.

Cheng Jeong-Hsiang., LinJuAn., Lee Der Nan., Wu Fu Ju. (1995): Efficacy of hidtated sodium calcium aluminosilicate against the aflatoxicosis of mul duck lings. Journal of the Chinese Society of Animal Science 24 (1) 9-18.

Dumić M., Vukićević Olivera (1990) Prirodni zeoliti, upotreba u stočarstvu, Institut za tehnologiju nuklearnih i drugih mineralnih sirovina, Beograd.

Dobiec M. (1994): (Influence of clinoptilolites on chicken growth) Učinak klinoptilolita na uzrast pilića. Veterinarska stanica 25 (6) 323-332.

Dobrzanski Z., Trzinska T., Jamroz D., Mazurkiewicz M. (1994): [Effect of supplementary aluminosilicate in layer feeds on some indicators of egg quality]. Wplyw dodatku glinokrzemianów do paszy dla niosek na niektore, cechy jakosciowe jaj. Roezniki Naukowe zootechnici 21 (1/2) 195-203.

Phillips T.D., Sarr A.B, Grant P.G (1995): Selective chemisorption and detoxification of aflatoxins by phyllosilicate clay. In Micotoxins and toxic plant components. International worshop held in Lisabon. Natural Toxicns 3 (4) 204-214. USA.

Gibson R.M., Bailey A.C., Kubena F.L., Huff E.W., Harvey B.R. (1990): Impact of L-Phenylalanine Supplementation on the Performance of Three- Week-Old Broilers Feed Diets Containing Ochratoxin A. Effects on Body Weight, Feed Conversion, Relative Organ Weight, and Mortality.Poultry Science 69: 414-419.

Hossain S., Bertechini A.G., Nobre P.T.C. (1994): [Effect of natural zeolit and amounts of calcium on performance and tibia of broiler fowes]. Efeito da zeolita natural e niveis de calcio no desempenho e caracteristicas do plasma e tibia de frangos de corte. Arguivo Brasileiro de Medicina Veterinaria e Zootecnia 46 (5) 545-552.

Jones F.T., Wineland M.I., Parsons I.T., Hagler W.M.JR., (1996): Degradation of aflatoxin by poultry litter. Poultry Science 75(1) 52-58.

Kubena F.L., Harvey B.R., Huff E.W., Corrier E.D., Phillips D.T., Rottinghaus E.G. (1990): Efficacy of a Hydrated Sodium Calcium Aluminosilicate to Reduce the Toxity of Aflatoxin and T-2 Toxin. Poultry Science 69: 1078-1086.

Kubena F.L., Harvey B.R., Huff E.W., Elissalde M.H., Yersin G.A., Phillips D.T., Rottinghaus E.G. (1993): Efficacy of a Hydrated Sodium Calcium Aluminosilicate to Reduce the Toxicity and Diacetoxyscirpenol. Poultry Science 72: 51-59.

Kalyuzhnov V.T., Zlobina I.E., Nikulina L.G. (1988): In ispol'zovanie tseolitov Sibiri i Dalnego Vostoka v sel'skom khozyaistve. Referativny žhurnal 2.58.95. (Prema: Nutrition Abstracts and Reviews, Series B, 1989, vol 59, No. 11).

Lon-Wo. E., Zaldivan V., Margolles E. (1993): Effects of natural zeolites o poultry feeding with diferent nutritional levels or ligh mycotoxin contamination. Cuban Journal of Agricultural Scince 27 (2) 199-204.

Lon Wo. E., Cardenas M. (1995): New natural Cuban zeolite deposits for broiler feeding. Cuban Journal of Agricultural Acience., 29 (1)85-90.

Mumpton S. (1976) Natural Zeolites, Occurrence, Properties, MSA.

Oliver M.D. (1983): The efect of feeding clinoptilolite (zeolite) to laying hens. Sauth African Journal of Animal Science 13 (2), 107-110

Vest Larry, Schutie John V. (1982): Influence of feeding zeolitis to poultry under feed conditions. Simp. Zeo-Agriculture. Rochester, New-York.