INFLUENCE OF DIFFERENT OILS, ORGANIC AND INORGANIC SELENIUM AND VITAMIN E ON LAYING HENS' PRODUCTIVITY AND BLOOD PARAMETERS

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Abstract. In this study, effects of using different oil sources (sunflower oil, rapeseed oil and linseed oil), organic and inorganic selenium and vitamin E on laying hens' productivity and blood parameters of 22−30 weeks of age were evaluated. A total of 60 Lohmann Brown laying hens, which were 22 weeks old, were assigned to 6 treatment groups (10 hens per each treatment group) and fed experimental diets for 8 weeks. They were fed diets containing 5% sunflower oil + 0.5 mg Na_2SeO_3 + 40 mg/kg vit. E (Control group 1), 5 % rapeseed oil + Na_2SeO_3 0.5 mg + 40 mg/kg vit. E (Control group 2), and linseed oil 5% + Na_2SeO_3 0.5 mg + vitamin E 40mg/kg (Control group 3). Diet in Experimental group 1 was supplemented with 5% sunflower oil + Alkosel®R397 0.5 mg + 40 mg/kg vit. E, Experimental group 2 – rapeseed oil 5% + Alkosel®R397 0.5 mg + 40 mg/kg vit. E, and Experimental group 3 – linseed oil 5% + Alkosel®R397 0.5 mg + 40 mg/kg vit. E. Laying hens were kept in similar conditions. They were fed with 125 g of compound feed per day. All eggs were calculated and weighed daily, and every 14 days feed conversion ratio, egg production intensity and egg numbers dynamics were calculated. Cholesterol, HDL-cholesterol, triglycerides, GOT and GPT amount in the blood were determined by analyser INTEGRA 400/700/800.

No statistically significant effect was observed on productive performance of laying hens at the trial period (P>0.05). Egg production capacity of laying hens during the whole trial period (22−29 weeks) did not differ significantly; only in Group 1, it increased by 4% (P>0.05) compared with Control group 1. The average egg weight of the whole period (22−29 weeks) increased by 1% in Group 1 and by 3% in Group 2 but decreased by 1% in Group 3 compared with the control groups (P>0.05). In the last period (28−29 weeks), the food consumption ratio per 1 kg of egg weight gain decreased by 8% in Group 3 compared with Control group 3 (P>0.05). In other groups, this parameter did not differ significantly.

According to our results, the amount of cholesterol in the laying hens' blood increased from 13% to 27% (P<0.05) in all the experimental groups compared with the control groups. The use of selenomethione in compound feed increased HDL-cholesterol concentration in the blood from 4% to 16% (P>0.05) compared with the control group. The triglycerides concentration also had a tendency to increase from 11% to 37% compared with the control group. The GOT amount in the laying hens' blood had a tendency to decrease by 14% and 3% (P>0.05) in Groups 1 and 3, but in Group 2 it increased by 31% (P<0.05) compared with the control group. The GPT amount in the blood increased in all the experimental groups from 7 to 11 times (P<0.05) compared with the control groups; only in Group 1, this parameter decreased by 33% (P<0.05) compared with the control group.

Keywords: organic and inorganic selenium, laying hens productivity, blood parameters

Introduction. In modern poultry production, fat is the natural component of feed mixtures, an additive increasing the energy value and effect improving consistency and tastiness of feed. Vegetable fats, such as soybean and sunflower oil, as well as animal fats, such as beef tallow, bone and poultry fat, are commonly used (Burlikowska et al., 2010; Saraee et al., 2014). The fat type in diet affects not only the blood biochemical traits but also the organs' metabolic processes, particularly in the liver (Krasnodębska-Depta and Koncicki, 2000). Advantages of utilising oils in poultry diet include decreased feed dust, increased absorption and hydrolysis of lipoproteins supplying essential fatty acids, (Nobakht et al., 2011) and improved absorption of vitamin A, vitamin E and Ca (Leeson and Atteh, 1995). However, the chemical structures of fats and oils are extremely variable and, therefore, the metabolizability and response of the animal to the type of oil may be affected by its source (Sanz et al., 2000).

Feed additives have been widely used to increase the performance of animals and are now used in poultry feeding practices extensively (Collington et al., 1990; Khan et al., 2007) not only to stimulate the growth and feed efficiency but to improve health and performance of birds (Scott et al., 1982; Fadlalla et al., 2010; Abouelfetouh and Moussa, 2012; Gopi et al., 2014). Vitamin E (α-tocopherol acetate) is a fat-soluble vitamin as well as an effective antioxidant that can protect cells from oxidative damage (Bautista-Ortega and Ruiz-Feria, 2010; Xiao et al., 2011). Selenium (Se) is an essential trace mineral that is important for growth as a component of poultry nutrition (Surai, 2002; Selle at al., 2013). Se supplementation to animal feeds enhances the immune status of the animal and the ability of the immune system to respond to disease challenges (Tayeb & Qader, 2012).

Vitamin E plays an important role in various biochemical and physiological processes, including antioxidant activity (Litta et al., 2014). Numerous nutritional and physiological studies have shown that vitamin E supplementation is beneficial for growth performance in various animal models (Colnago et al., 1984; Gao et al., 2010). Oxidative stress, imbalance between production of free radicals and their clearance by antioxidant defences, causes tissue damage, compromised health of birds and economic losses (Opara, 2006; Panda and Cherian, 2014). Antioxidants have been reported to influence both lipid and protein oxidation, and Vit E (α-tocopherol) has been extensively documented to minimise lipid oxidation (Ponnampalam et al., 2012; Suman et al., 2014).

There are no data about how different oils, organic and inorganic selenium affect GPT (glutamatpiruvattransaminase) and GOT (glutamatoksaloacetattransaminase) blood parameters of laying hens. The enzymes of blood are protein catalysts that accelerate the body's physiological effect. The liver in a chicken broiler performs many vital features. In order to evaluate the condition of the liver, GPT and GOT in the blood of laying hens were determined according to the blood serum biochemical test results. The aim of this study was to investigate the effects of dietary supplementation with different oils (as sunflower, rapeseed and linseed oils) and vitamin E (as anti-oxidant agent) on egg production performance and blood parameters in laying hens.

Material and Methods. The feeding trial was conducted on 60 laying hens of *Lohmann Brown* strain at the age of 22 weeks. The birds were divided into 6 groups, 10 chickens in each group. Control group 1 was added sunflower oil 4.5%+0.5 mg Na2SeO3 + 40 mg vit. E/kg; Control group 2 was added rapeseed oil 4.5 %+0.5mg Na2SeO3 + 40 mg vit. E/kg; and Control group 3 was added linseed oil 4.5%+0.5mg Na2SeO3 + 40 mg vit. E/kg. Compound feed of laying hens in Experimental group 1 was supplemented with sunflower oil 4.5%+0.5 mg Alkosel®R397 + 40 mg vit. E/kg; rapeseed oil 4.5 %+0.5mg Alkosel®R397 + 40 mg vit. E/kg was added in Experimental group 2; and linseed oil 4.5%+0.5mg Alkosel®R397 + 40 mg vit. E/kg was added in Experimental group 3. During the feeding trial, laying hens were held in individual cages with a stationary drinking-bowl and a feed box under the same feeding and holding conditions. Laying hens were fed with compound feed (125 g) per day. All eggs were calculated and weighed daily, and every 14 days feed conversion ratio, egg production intensity and egg numbers dynamics were calculated. Cholesterol, HDL-cholesterol, triglycerides, GOT and GPT amount in the blood were determined by analyser INTEGRA 400/700/800.

Statistical Analysis

The data of the experiment were analysed using 1-way ANOVA test, and significant differences between groups were determined by Duncan's multiple range test. The software package Statistica 8.0. for Windows^{TM} was used. Differences were considered significant at $P<0.05$.

Results and discussions

Selenium (Se) is a trace mineral that is essential for human and animal nutrition, as it is a component of at least 25 selenoproteins that participate in the regulation of various functions of the body, including redox balance maintenance and antioxidant defences (Surai and Fisinin, 2014). No statistically significant effect was observed on productive performance of laying hens during the period of trial ($P>0.05$). It has been reported that dietary supplementation with vitamin E and selenium did not have a significant effect on egg production of laying hens (Mohiti asli et al., 2007; 2010; Osman et al., 2010).

Table 1. **Composition of compound feed, %**

Component	Composition
Wheat	60.38
Soy meal	12.89
Wheat flour	10.00
Limestone	8.22
Sunflower meal	5.00
Monocalcium phosphate	0.98
Premix *HENS*	0.50
NaCl	0.21
Methionine	0.16
Pentacid liquid	0.10
Natrium sulphate	0.06
L-Lysine sulphate	0.04
Quality parameters, 1kg	
Metabolic energy MJ/kg	11.40
Protein*	17.07
Crude fat*	3.12
Crude fibre*	3.28
Crude ash*	11.95
Ca*	3.45
P (total)*	0.67
P (dig.)	0.42
Na	0.13
Mg	0.12
K	0.72
Cl	0.17
NaCl	0.22
Lysine	0.71
Methionine	0.39
Methionine+cystine	0.70
Tryptophan	0.22
Threonine	0.55
*-analysed value	

Intensity of egg laying is presented in Table 3. On weeks 22−23, it increased by 5% in Experimental group 1; however, in other groups, it did not change significantly ($P>0.05$). When the data were analysed during weeks 24−25, it increased from 2% to 5% in Groups 1 and 2, and decreased by 1% in Group 3 compared with the control group ($P>0.05$). Later, this parameter had a tendency to increase: by 6% in Group 1 and by 2% in Group 2 compared with the control groups ($P>0.05$). In the last period (28−29 weeks), intensity of egg laying had a tendency to decrease by 2%; only in Group 1, it increased by 1% ($P>0.05$). Finally, over the entire period (weeks 22−29), it did not change significantly. Only in Group 1, it increased by 4% compared with the control group ($P>0.05$).

Table 2. **Influence of different oils, selenium and vitamin E on egg production capacity of laying hens, pcs. (Number of produced eggs within the trial period per initial laying hen, pcs.)**

Laying hens' age (weeks)	Group					
	Control 1 (sunflower oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Control 2 (rapeseed oil+ 0,5 mg Na2SeO3 + 40 mg vit. E/kg)	Control 3 (linseed oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Experimental 1 (sunflower oil+ Alkosel®R397 0.5 mg + vit. E 40 mg/kg)	Experimental 2 (rapeseed oil+0.5 mg Alkosel®R397 + vit. E 40 mg/kg)	Experimental 3 (linseed oil+ 0.5 mg Alkosel®R397 + vit. E 40 mg/kg)
22−24	12±0.91 100	12±0.78 100	13±0,63 100	13±0.29 108	13±0.47 108	11±1.17 85
24−26	12±1.12 100	13±0.37 100	14±0.24 100	13±0.66 108	14±0.17 108	12±0.96 86
26−28	13±1.38 100	14±0.45 100	14±0.44 100	14±0.44 108	15±0.24 107	14±0.32 100
28−30	12±0.40 100	13±0.17 100	12±0.33 100	12±0.26 100	13±0.28 100	13±0.28 108
22−30	49±0.95 100	52±0.44 100	53±0.41 100	52±0.41 106	55±0.29 106	50±0.68 102

The data analysis of laying of hens demonstrated that there was an increase by 1 egg in Groups 1 and 2 but a decrease by 2 eggs in Group 3 ($P<0.05$) compared with the control groups. The same tendency remained in the later periods. It was noticed that during the whole trial period (22−29 weeks) the laying of hens increased by 1 egg in Group 1 and Group 2, but remained the same in Group 3 compared with the control group ($P>0.05$).

Table 3. **Influence of different oils, selenium and vitamin E on the laying rate, %**

Laying hens' age (weeks)	Group					
	Control 1 (sunflower oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Control 2 (rapeseed oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Control 3 (linseed oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Experimental 1 (sunflower oil+ Alkosel®R397 0.5 mg + vit. E 40 mg/kg)	Experimental 2 (rapeseed oil+0.5 mg Alkosel®R397 + vit. E 40 mg/kg)	Experimental 3 (linseed oil+ 0.5 mg Alkosel®R397 + vit. E 40 mg/kg)
22−24	82.54±6.53	84.69±5.57	83.93±5.80	87.30±6.71	84.29±6.72	84.41±3.57
24−26	87.31±7.97	92.86±2.66	90.06±4.79	88.89±6.95	97.14±1.23	89.29±6.49
26−28	92.86±9.89	93.57±8.21	98.62±3.17	98.57±3.13	95.64±1.68	98.41±2.31
28−30	92.31±3.06	96.92±1.32	94.87±2.56	93.16±2.00	94.62±2.11	93.27±2.14
22−30	88.76±6.86	92.01±4.44	91.87±4.08	91.98±4.70	92.92±2.94	91.34±3.63

Table 4. **Influence of different oils, selenium and vitamin E on egg mass, g**

Laying hens' age (weeks)	Group					
	Control 1 (sunflower oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Control 2 (rapeseed oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Control 3 (linseed oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Experimental 1 (sunflower oil+ Alkosel®R397 0.5 mg + vit. E 40 mg/kg)	Experimental 2 (rapeseed oil+0.5 mg Alkosel®R397 + vit. E 40 mg/kg)	Experimental 3 (linseed oil+ 0.5 mg Alkosel®R397 + vit. E 40 mg/kg)
22−24	55.04±0.93 100	53.28±1.36 100	55.39±1.21 100	56.13±0.87 102	55.69±1.06 105	54.43±8.81 98
24−26	59.57±1.07 100	61.49±1.33 100	61.43±1.23 100	59.94±0.92 101	62.29±1.16 101	58.92±1.03 96
26−28	58.68±0.77 100	57.54±2.15 100	58.53±0.96 100	58.30±0.96 99	59.86±1.06 104	59.08±1.08 101
28−30	59.72±1.17 100	59.34±1.41 100	58.91±1.32 100	59.84±1.42 100	60.88±1.39 103	59.08±0.91 100
22−30	58.25±0.99 100	57.91±1.56 100	58.57±1.18 100	58.55±1.04 101	59.68±1.17 103	57.88±2.96 99

The data about the average egg weight is presented in Table 4. In the first period (weeks 22−23), the average egg weight had a tendency to increase from 2% to 5%, but in Experimental group 3, it decreased by 2% compared with the control group (P>0.05). During weeks 24−25, this parameter decreased by 4% in Experimental group 3, but increased by 1% in Experimental groups 1 and 2 compared with the control groups (P>0.05). When the data were analysed during weeks 26−27, it had a tendency to decrease by 1% in Experimental group 1, and in the other experimental groups it increased from 1% to 4% compared with the control groups (P>0.05). In the last period, this parameter increased by 3% in Experimental group 2; however, in Control group 1 and Experimental group 1, it remained the same (P>0.05). When the average egg weight was analysed for the whole period (weeks 22−29), it increased by 1% in Group 1 and by 3% in Group 2, but decreased by 1% in Group 3 compared with the control groups (P>0.05).

Table 5. **Influence of different oils, selenium and vitamin E on feed conversion ratio to produce 1 kg of eggs, kg**

Laying hens' age (weeks)	Group					
	Control 1 (sunflower oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Control 2 (rapeseed oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Control 3 (linseed oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Experimental 1 (sunflower oil+ Alkosel®R397 0.5 mg + vit. E 40 mg/kg)	Experimental 2 (rapeseed oil+0.5 mg Alkosel®R397 + vit. E 40 mg/kg)	Experimental 3 (linseed oil+ 0.5 mg Alkosel®R397 + vit. E 40 mg/kg)
22-23	2.37±0.12 100	2.34±0.11 100	2.21±0.23 100	2.33±0.05 98	2.38±0.14 102	2.14±0.07 97
24-25	2.19±0.11 100	2.08±0.04 100	2.18±0.16 100	2.25±0.14 103	1.94±0.08* 93	2.20±0.19 101
26-27	2.06±0.04 100	2.04±0.12 100	2.03±0.07 100	2.17±0.08 105	1.95±0.05 96	1.92±0.04* 95
28-29	2.15±0.10 100	2.09±0.07 100	2.24±0.13 100	2.14±0.05 99	2.12±0.07 101	2.05±0.10 92
22-29	2.19±0.09 100	2.14±0.09 100	2.17±0.15 100	2.22±0.08 101	2.10±0.09 98	2.08±0.10 96
* − data statistically significant at P<0.05						

Table 6. **Influence of different oils, selenium and vitamin E on laying hens' blood parameters**

Parameter	Group					
	Control 1 (sunflower oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Control 2 (rapeseed oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Control 3 (linseed oil+ 0.5 mg Na2SeO3 + 40 mg vit. E/kg)	Experimental 1 (sunflower oil+ Alkosel®R397 0.5 mg + vit. E 40 mg/kg)	Experimental 2 (rapeseed oil+0.5 mg Alkosel®R397 + vit. E 40 mg/kg)	Experimental 3 (linseed oil+ 0.5 mg Alkosel®R397 + vit. E 40 mg/kg)
Cholesterol (μmol/l)	2.74±0.09	4.00±0.20	2.71±1.07	3.49±0.28*	4.52±0.81	3.24±0.49
HDL-cholesterol (μmol/l)	0.22±0.01	0.26±0.02	0.19±0.05	0.23±0.02	0.27±0.04	0.22±0.01
LDL-cholesterol	0.01±0.01	0.01±0.01	0.01±0.01	0.01±0.01	0.01±0.01	0.01±0.01
Triglycerides (μmol/l)	15.43±1.22	26.63±0.92	14.47±8.47	21.07±3.86*	29.47±7.32*	18.93±4.09*
GOT (U/l)	187.95±11.96	164.90±13.77	206.63±27.12	161.12±14.32	279.48±92.17*	201.00±28.46
GPT (U/l)	1.00±0.07	0.30±0.14	0.13±0.16	0.33±0.29*	2.07±1.08*	1.40±0.57*
*− data statistically significant at P<0.05						

The data about the feed consumption ratio per 1 kg of egg weight gain are presented in Table 5. In the first period, this parameter had a tendency to decrease from 2% to 3%; however, in Group 2, it increased by 2% compared with the control group (P>0.05). During weeks 24−25, it decreased by 6% in Group 2; however, it increased from 1% to 3% compared with the control group (P>0.05). When the data of weeks 26−27 were analysed, this parameter had a tendency to decrease from 4% to 5%; in Group 1, it increased by 5% (P>0.05). In the last period (weeks 28−29), the feed consumption ratio per 1 kg of egg weight gain decreased by 8% in Group 3 compared with the control group (P>0.05). In other groups, this parameter did not change significantly.

Selenium is a constituent of cellular and plasma glutathione peroxidase and is an essential enzyme in nutrient metabolism and cellular function (Perez et al., 2010). Moreover, it is well known that selenium can be stored in the tissues, and in periods of insufficient intake can be released by normal metabolic processes and used by the organism (Rayman, 2005).

In addition, Narimani Rad et al. (2011) indicated that dietary selenium supplementation did not have any significant effect on blood levels of glucose and cholesterol in laying hens. Kanchana and Jeyanthi (2010) found that, in laying hens, vitamin E did not have a significant effect on the serum level of cholesterol, triglycerides and LDL, but dietary supplemental selenium decreased the blood level of cholesterol. Our results demonstrate that the amount of cholesterol in the laying hens' blood increased from 13% to 27% in all the experimental groups (P<0.05) compared with the control groups. The use of selenomethionine in compound feed increased HDL-cholesterol concentration in the blood from 4% to 16% (P>0.05) compared with the control group. Triglycerides concentration also had a tendency to increase from 11% to 37% compared with the control group. The GOT amount in the laying hens' blood in Group 1 and Group 3 had a tendency to decrease by 14% and 3% (P>0.05), but in Group 2 it increased by 31% (P<0.05) compared with the control group. The GPT amount in the blood increased in all the experimental groups from 7 to 11 times more (P<0.05) compared with the control groups; however, in Group 1 this parameter decreased by 33% (P<0.05) compared with the control group.

Conclusions

It may be concluded that dietary supplementation of 4.5% of different oils, natrium selenite and selenomethionine (0.5 mg/kg) and vitamin E (40 mg/kg) increased cholesterol, HDL-cholesterol, triglycerides and GPT concentration, decreased GOT concentration in the laying hens' blood, but did not affect the laying hens' productivity parameters.

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