EFFECT OF DIETARY SODIUM SELENITE AND SE-ENRICHED YEAST ON EGG-SHELL QUALITATIVE PARAMETERS OF LAYING HENS EGGS

VPLYV SELENIČITAMU SODNÉHO A SELÉNOM OBOHATENÝCH KVASNÍC NA KVALITATÍVNE PARAMETRE ŠKRUPINY VAJEC ZNÁŠKOVÝCH SLIEPOK

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ABSTRACT

The experiment was designed to investigate the effects of feed supplementation with selenite or selenized yeast on eggs quality of laying hens. Hens of laying breed Isabrown were randomly divided at the day of hatching into 4 groups (n=12) and fed ad libitum for 9 months on diets which differed only in amounts or forms of selenium supplemented. Hens were fed from 1st day by standard feed mixture. Control group get only native dose of selenium (0.1 mg/kg) naturally presented in feed mixtures. First experimental group get selenium addition 0.4 mg/kg in a form of sodium selenite, second one the same dose of 0.4 mg/kg but in organic form of Se-yeast. The diet for the fourth group was supplemented with Se-yeast at Se dose 0.9 mg/kg DM. The both doses of organic selenium had significantly ($P<0.05$) beneficial influence on the egg weight (g±SD) (60.45 ± 3.87^a; 60.81 ± 5.63^a; 62.41 ± 3.72^b; 62.15 ± 3.16^b). Significantly lower values of egg shell weight and egg shell ratio were found out in experimental group with sodium selenite only. The significantly lower egg shell strength (N/cm^2) was in the experimental groups with supplementation of Se in both forms. Average egg shell thickness (μm) were not significantly affected ($P>0.05$) by the supplementation of Se into the feed mixture for laying hens.

Key words: laying hens, sodium selenite, Se-yeast, egg weight, egg shell

SÚHRN

Pokus bol uskutočnený s cieľom sledovania vplyvu prídavku anorganického selénu (Se) alebo selenizovaných kvasníc na kvalitu vajec znáškových sliepok. Kurčatá znáškového hybrida Isabrown boli náhodne rozdelené do 4 skupín (n = 12) a od 1.dňa života kŕmené po dobu 9 mesiacov kŕmnou zmesou s prídavkami rozdielnych množstiev alebo foriem Se. Sliepky boli kŕmené štandardnými kompletnými kŕmnymi zmesami pre odchov a neskôr v chove zmesou pre vajcia produkujúce nosnice ad libitum. Sliepky v kontrolnej skupine prijímali kompletnú kŕmnu zmes s natívnou dávkou Se, v prvej experimentálnej skupine bol prídavok Se vo forme seleničitanu sodného v množstve 0,4 mg/kg sušiny, v druhej experimentálnej skupine bola zmes obohatená o Se v dávke 0,4 mg/kg sušiny, ale vo forme organickým Se obohateného kvasničného extraktu, v tretej experimentálnej skupine dostávali sliepky zmes obohatenú o selenizované kvasnice v dávke 0,9 mg/kg sušiny, teda nad limit povolený EÚ. V pokuse boli sledované ukazovatele: hmotnosť vajec (g), merná hmotnosť vajec (g/cm^3), hmotnosť škrupiny (g), merná hmotnosť škrupiny (g/cm^3), percentuálny podiel škrupiny (%), pevnosť škrupiny (N/cm^2) a priemerná hrúbka škrupiny (μm). Pri hmotnosti vajca sa štatisticky významne ($p<0,05$) prejavil priaznivý vplyv oboch dávok organickej formy Se. Štatisticky nižšia pevnosť škrupiny bola v experimentálnych skupinách s prídavkom Se v oboch formách, pri priemernej hrúbke škrupiny boli rozdiely medzi jednotlivými skupinami štatisticky nevýznamné ($p>0,05$).

Kľúčové slová: sliepky, seleničitan sodný, selenizované kvasnice, hmotnosť vajca, škrupina

DETAILNÝ ABSTRAKT

V súčasnosti sa venuje zvýšená pozornosť vplyvu výživy na zdravie v súvislosti s príjmom antioxidantov zabraňujúcich tvorbe škodlivých oxidačných procesov v organizme, ako sú vitamíny (A, E, C), fenolové zlúčeniny, taníny, flavonoidy aj množstvo ďalších rastlinných antioxidantov a esenciálnych stopových prvkov ako zinok (Zn), meď (Cu), selén (Se), ktoré sú súčasťou antioxidačných enzýmov. Vzhľadom na zákaz antibiotík a chemoterapeutík pri výrobe hydinového mäsa a vajec, zvyšuje sa potreba hľadať vhodnú a hlavne bezpečnú alternatívu. Preto najmä výživa musí byť tou zložkou, ktorá svojím množstvom, kvalitou a koncentráciou všetkých potrebných zložiek pri ich vysokej utilizácii bude zabezpečovať optimálny prejav úžitkových vlastností. Jednou z možností je suplementácia kŕmnych zmesí organickými formami stopových prvkov. V posledných rokoch sa značne používal ako prídavok do kŕmnych zmesí hospodárskych zvierat práve anorganický Se. V tejto súvislosti sa dostala do popredia otázka výhodnosti doplňovania kŕmnych zmesí pre hospodárske zvieratá prípravkami s organickou formou Se namiesto doposiaľ užívaného anorganického seleničitanu sodného. Prirodzené pozadie Se tvorené Se - metionínom a Se - cysteínom bielkovín jednotlivých komponentov našich kŕmnych zmesí je na úrovni len asi 0,03 až 0,12 mg/kg sušiny (skôr sa pohybuje v oblasti nižších hodnôt), čo by znamenalo jeho výraznú deficienciu so všetkými následnými zdravotnými problémami. Preto sú v súčasnosti kŕmne zmesi u nás dotované seleničitanom sodným v množstve asi 0,2 mg Se na kg sušiny krmiva, čím sa dosahuje jeho takmer optimálny príjem. Organický Se vo forme selénových kvasiniek podáva nový prístup vo výžive hospodárskych zvierat. Keďže má dôležitý význam pre produkciu a kvalitu v živočíšnej výrobe, môže nepriamo cez tieto produkty znížiť chorobnosť tak v chove zvierat, ako i u ľudskej populácie. Biovyužiteľnosť Se prijímaného z jeho organických zdrojov je vysoko signifikantne vyššia zvieratami aj ľuďmi, Se-Met je nešpecificky zabudovaný najmä do bielkovín svalovej hmoty, ale aj iných orgánov, kde vytvára významné telové zásoby Se, inkorporuje sa aj do bielkovín živočíšnych produktov, ako sú napr. vajcia a mlieko. Selénové vajcia so zvýšeným obsahom prírodného Se znamenajú aj jeho podstatne vyšší príjem v metabolicky najvhodnejšej forme ľudskou populáciou na Slovensku. Škrupine vajca, jej vlastnostiam a významu sa venuje zvýšená pozornosť a nemôžeme ju už považovať len za odpad, ale naopak, za zdroj významných biologicky dôležitých látok. Jej kvalita je významným faktorom ovplyvňujúcim celkovú hodnotu konzumného vajca aj efektívnosť jeho výroby. Straty spôsobené nekvalitnou škrupinou sú stále vysoké, čo má nepriaznivý dopad na ekonomiku výroby vajec. Cieľom nášho príspevku bolo sledovať vplyv anorganickej aj organickej formy selénu v rôznych hladinách na zmeny ukazovateľov kvality škrupiny a hmotnosti vajec prebiehajúcou znáškou. Suplementácia organického Se do kŕmnej zmesi signifikantne ovplyvnila hmotnosť vajec. V priemernej hmotnosti analyzovaných vajec v jednotlivých skupinách za celé sledované obdobie (60.45 ± 3.87^{a}; 60.81 ± 5.63^{a}; 62.41 ± 3.72^{b}; 62.15 ± 3.16^{b}) bol štatisticky signifikantný rozdiel ($p<0,05$) medzi kontrolnou skupinou a experimentálnymi skupinami s organickým Se v oboch dávkach. Signifikantne nižšie hodnoty hmotnosti vaječnej škrupiny a percentuálneho podielu škrupiny boli len v experimentálnej skupine so seleničitanom sodným. Pevnosť vaječnej škrupiny ($28,85\pm6,31^{a}$; $25,63\pm6,84^{b}$; $26,03\pm5,02^{b}$; $27,20\pm5,90^{b}$) bola signifikantne nižšia v skupinách s oboma formami selénu. Priemerná hrúbka vaječnej škrupiny, špecifická hmotnosť vajca a špecifická hmotnosť škrupiny neboli prídavkom selénu do kŕmnej zmesi signifikantne ovplyvnené.

INTRODUCTION

At present it is very important to increase the quality of compound feed supplements with various feed additives (probiotics [3], phytobiotics, enzymes and minerals in organic form) in connection with increased attention to the impact of nutrition on animal health and production.

Selenium is an essential trace element with many vital functions in humans and animals. Apart from supplementation, farm animals receive selenium mainly in the form of selenoamino acids (selenomethionine) in vegetable feed ingredients [10]. Inadequate selenium (Se) supply often in combination with low vitamin E status causes deficiency symptoms in many species [16]. Although inorganic Se is absorbed as a mineral, little is retained in the tissue and much of the Se is excreted via the feces in ruminants and urine in the non-ruminant animals. Very little of the inorganic Se was incorporated into body proteins [15]. Inorganic form of selenium can cause toxicity, interaction with other minerals, low ability to penetrate into the products as well as weak ability to keep selenium supplies in body.

Selenium in the form of another amino acid, selenocysteine, is the central structural component of specific selenoenzymes including glutathione peroxidases, iodothyronine deiodinases, thioredoxin reductases, selenophosphate synthetase and many others. The best understood selenoenzyme is cytosolic glutathione peroxidase (cGPx), which works as the antioxidant by removing reactive oxygen species [6].

Eggs are a good source of nutrients. With a moderate enrichment of nutrients according to the recommendations for fortification of foods, eggs could play an important role as a functional food [13]. Increase of selenium content in the eggs of commercial laying hens express in stronger antioxidant protection of yolk, prolonged stability and nutrition value of eggs [5]. Organic selenium increases egg production, improves fertility, antioxidant status, accelerating of feathers growth after feather loosing of layers at saddle and back sections [4] and has positive influence on storage ability of eggs. Selenium concentration in eggs according to many authors was markedly higher in groups with organic selenium [7, 14, 11, 12]. In experiment of [2] human volunteers receiving multiple-enriched eggs improved the blood concentration of omega-3 fatty acids, HDL cholesterol, LDL cholesterol and triglycerides. [1] recorded significant to very high significant influence of laying hens individuality on content of macroelements and microelements in fresh yolk of eggs.

The aim of this study was to compare the effects of feed supplemented with sodium selenite and Se-yeast on egg weight and egg shell quality.

MATERIAL AND METHODS

Animal, diets and treatments

Forty-eight hens of the laying breed Isabrown were randomly divided at the day of hatching into 4 groups (n=12) and fed for 9 months on diets which differed only in amounts or forms of selenium supplemented. For period rearing and breeding hens consumed ad libitum appropriate diets for development of laying hens. Feedstuff HYD-04 for period 0 – 6 weeks, HYD-05 for period 7 – 16 weeks and HYD-06 from 17 to 22 weeks were given. The composition of the last basal diet HYD-10 fed to the hens from the 23rd week up to the age of 36 weeks is presented in Table 1.

Hens in control group were fed the basal diet with native Se content 0.1 mg/kg dry matter (DM). First and second experimental groups were fed the basal diets supplemented with equivalent Se dose 0.4 mg/kg DM of either sodium selenite or Se-yeast (Sel-Plex, Alltech Inc., USA), respectively. The basal diet for third experimental group was supplemented with Se-yeast at Se dose 0.9 mg/kg DM. The diets for groups 1, 2 and 3 were fortified with corresponding amounts of the yeast extract without Se (NUPRO, Alltech, USA) to obtain the same final levels of yeast extract as in the diet for group 4 (81.9 g

Table 1 The composition of the basal diet (feedstuff HYD – 10) fed to hens for breeding
Tabuľka 1 Zloženie bazálnej diéty (kŕmnej zmesi HYD -10) skrmovanej nosnicami počas chovu

Component Komponent	g/kg
Wheat, (10.5 % of crude protein (CP)) Pšenica (10,5 % obsah hrubého proteínu (HP))	366
Soyabean oil Sójový olej	7
Maize (8.3 % CP) Kukurica (8,3 % HP)	50
Soyabean meal (45 % CP, 1.5 % fat) Sójový extrahovaný šrot (45 % HP, 1,5 % tuk)	90
Limestone Vpenec dolomitický	82
Premix HYD-10	35
Barley (12 % CP) Jačmeň (12 % HP)	200
Pulverized soya fat, Soyax-FORTA (35% CP, 20 % fat) Soyax-FORTA (35 % HP, 20 % tuk)	170

1kg of basal diet containing: IU: vit. A, 13469; vit. D3, 3106; mg: vit. K, 2.49; thiamine, 5.6; riboflavin, 6.6; pyridoxine, 6.1; niacin, 59; panthothenic acid, 13.86; biotin, 0.09; folic acid, 0.86; Se, 0.1; Zn, 64.2; I, 0.77; Co, 0.06; Mn, 100.13; Cu, 13.96; Fe, 192.55; µg: cyanocobalamin, 0.35; g: lysine, 8.7; methionine, 4.267

1kg bazálnej diéty obsahuje: IU: vit. A, 13469; vit. D3, 3106; mg: vit. K, 2.49; thiamin, 5.6; riboflavin, 6.6; pyridoxin, 6.1; niacin, 59; kyselina pantoténová, 13.86; biotin, 0.09; kyselina listová, 0.86; Se, 0.1; Zn, 64.2; I, 0.77; Co, 0.06; Mn, 100.13; Cu, 13.96; Fe, 192.55; µg: kyanokobalamin, 0.35; g: lyzín, 8.7; metionín, 4.267

per 100 kg of feed).

During the rearing chicks were stabled in one-storey cage technology in groups, trough-manger tables as well as founts were located in the cage with possibility of free access to the feed and water. The powdery feed mixture was given to feed manger manually. In the hall of 4.5×3.6m was natural lighting, from the first day of experiment the constant light regime was used.

Young hens at the age of 17 weeks were transferred to the breeding place to adapt to conditions where they were housed during the laying period. The experimental layers were stabled individually in three-etage cage batteries. The front cage panel was mobile in order to allow manipulation with layers. The manger tables were placed out of the cage with the possibility of free access to feed. The powdery feed mixture was given to the feed manger manually. The founts were dropping and they were placed in the centre of battery etage, which enables free access to water from both sides of cage battery. The layer hens were kept in the standard bioclimatic conditions.

The eggs were collected daily by hand. Immediately after collection they were marked with the date, number of group, number of hen and weighed by using of laboratory balance OWA Labor with precision of 0.01 g.

Sample analysis

Eggs for analysis were collected regularly twice a month (30 from each group). Five analyses were done in total. Weights of eggs (g) and egg shell (g) were determined by analytical balance with the accuracy of 0.01g. The percentage of egg shell (%) was calculated as a proportion of shell weight from the weight of whole egg. Specific egg weight (g/cm^3) was expressed as a ratio between the egg weight on the air and egg weight on the water. The strength of egg shell (N/cm^2) was determined by an electronic device, egg crusher (12.99 version Cz). Thickness of egg shell (μm) was measured on both poles and in the centre of the egg. Average egg shell thickness was set as an average of these 3 values.

Statistical analysis

The differences among various parameters within the frame of monitored groups were tested using single-factor analysis of single-stage sorting variant with identical number of observation. Duncan's test was used to test the significance between any two means.

RESULTS AND DISCUSSION

The weight of eggs (g), the egg shell weight (g) and the percentage ratio of egg shell (%) are presented in Figure 1. The average weight of analyzed eggs in individual groups during the whole observed period was 60.45±3.87; 60.81±5.63; 62.41±3.72 and 62.15±3.16 g, respectively, in the order of the groups. Experimental groups with Se-yeast (at the dose of 0.4 mg/kg and 0.9 mg/kg DM) differed significantly from the control group ($P<0.05$). Similar increase of eggs weight after administration of selenium, especially in the form of Se-yeast, was reported also by other authors [7, 11]. Beneficial effect of inorganic selenium with the supplement of vitamin E on the egg weight was reported [9]. In our experiment, the weight of eggs in the group with inorganic selenium was slightly higher in comparison with the control group, but the differences were not significant. Similar report was given by [14].

The weight of egg shell was in the sequence of 5.69±0.63; 5.56±0.46; 5.74±0.40; 5.72±0.39 g (Figure 1). Significant difference ($P<0.05$) was recorded between the experimental group with sodium selenite and all other groups.

In the parameter of egg shell ratio, significant difference ($P<0.05$) occurred just between the control group and the group with sodium selenite.

The specific egg weight, specific egg shell weight, egg shell strength and average egg shell thickness are presented in Table 2. In the specific egg shell weight only minimal non-significant differences were found (2.00±0.14; 2.01±0.11; 2.01±0.11; 2.00±0.10 g/cm^3). Egg shell strength reached significantly higher values in the control group compared with selenium enriched groups. In contrast to that, other authors found out positive effect of selenium additives in organic and inorganic form on egg shell strength [8]. Also, another study reports egg shell strength improved by the organic bound selenium [11]. Higher percentage of dirty and cracked eggs of hens fed with Se-yeast compared with those fed with sodium selenite was also reported [7]. Thickness of egg shell among the groups in our experiment differed non-significantly ($P>0.05$), however some authors report positive influence of selenium supplemented diet [9].

CONCLUSION

Both doses of organic selenium had beneficial influence on the egg weight. Significantly lower values of egg shell weight and percentage of egg shell weight were found in the experimental group with sodium selenite only. Significantly lower egg shell strength was found in the experimental groups with Se supplementation in both forms. Average egg shell thickness was not significantly affected by the supplementation of the feed mixture for laying hens with Se.

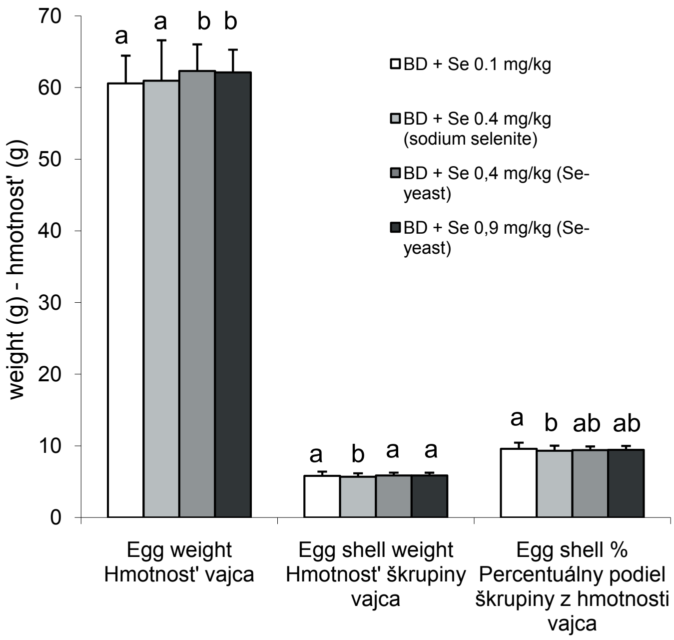

Figure 1 The effect of basal diet (BD) supplementation with selenium in the form of selenite or Se-yeast on Isabrown hybrid egg weight, egg shell weight and egg shell percentage ratio. Values are means±SD (n=150).
Obrázok 1 Efekt suplementácie bazálnej diéty (BD) selénom vo forme seleničitanu sodného alebo selenizovaných kvasníc na hmotnosť vajca, hmotnosť škrupiny vajca a percentuálny podiel škrupiny vajca sliepok znáškového hybridu Isabrown. Hodnoty sú priemery±SD (n=150).

Table 2 The effect of basal diet (BD) supplementation with selenium in the form of selenite or Se-yeast on Isabrown hybrid egg shell quality (mean±SD) (n=150).
Tabuľka 2 Efekt doplnku selénu vo forme seleničitanu sodného a selenizovaných kvasníc do kŕmnej zmesi (KZ) na kvalitu škrupiny vajec sliepok znáškového hybridu Isabrown (priemer±SD) (n=150).

Parameter Ukazovateľ	BD 0.1 mg Se per kg DM KZ + natívny Se 0,1 mg/kg sušiny	BD + Se 0.4 mg/kg[1] DM Selenite KZ +seleničitan sodný 0,4mg/kg sušiny	BD + Se 0.4 mg/kg[1] DM Se-yeast KZ + selenizované kvasnice 0,4 mg/kg sušiny	BD + Se 0.9 mg/kg[1] DM Se-yeast KZ + selenizované kvasnice 0,9 mg/kg sušiny
Specific egg weight (g/cm^3) Špecifická hmotnosť vajca (g/cm^3)	1.09±0.007	1.09±0.008	1.09±0.004	1.09±0.005
Specific egg shell weight (g/cm^3) Špecifická hmotnosť škrupiny (g/cm^3)	2.00±0.14	2.01±0.11	2.01±0.11	2.00±0.10
Egg shell strength (N/cm^2) Pevnosť škrupiny (N/cm^2)	28.85±6.31^a	25.63±6.84^b	26.03±5.02^b	27.20±5.90^b
Average egg shell thickness (µm) Priemerná hrúbka škrupiny (µm)	379.90±37.5	371.15±36.87	374.97±32.72	379.82±34.37

Distinct letters in superscripts within a row mean significant differences (P<0.05). Values are means±SD n=150.
Rozdielne písmená v indexoch v riadku znamenajú signifikantné rozdiely (p<0.05). Hodnoty sú priemery±SD n=150.

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