REVIEW

THE IMPORTANCE, UTILIZATION AND SOURCES OF SELENIUM FOR POULTRY: A REVIEW*

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Selenium remains one of the most discussed elements. Selenium is on one hand toxic at high doses. On the other hand, Se deficiency is a global problem related to an increasing susceptibility of animals and humans to various diseases. The main objective of this paper is to estimate the importance of selenium for poultry, its use in organic and inorganic forms and as nutrition supplements, the benefits and risks of its use and suggestions of new possible ways of using selenium and its sources, e.g., the freshwater alga Chlorella. Optimisation of Se nutrition of poultry will result in increased quality of poultry products. From the data presented in the review, the effort to replace inorganic forms of selenium with organic forms in the poultry nutrition is clear especially in the recent time. The review shows that organic selenium is better absorbed from gastro-intestinal track then inorganic selenium. One possibility is Selenium – enriched yeast (Sel-Plex). Another source of organic forms of selenium might be Se – enriched freshwater alga Chlorella. The main advances in Se status assessment and Se requirements were established based on the activity of glutathione peroxidase (GSH-Px). Se research and practical applications are developing quickly, and they are very exciting and promising.

poultry; inorganic form; organic form; Sel-Plex; alga Chlorella; GSH-Px

INTRODUCTION

Nowadays because of considerable changes in our environment, excessive haste and other factors such as poor nutrition, an increase in various diseases being is recorded. All these factors cause an increase in reactive free radicals in an organism, against which it tries to protect itself by its own mechanisms. For improvement of the ability of the organism to protect itself, intake of the necessary quantity of anti-oxidants is very important, especially vitamins C and E, carotenoids, flavonoids, glycosides, amines, phenol acids, etc., and among the trace elements, for example, selenium which has been ignored for decades. In low concentrations it can be considered an essential element, but in high concentrations it is very toxic.

Selenium is the only trace element that is necessary for the growth and efficiency of animals. It is an important essential mineral for the health of people and animals and one of the anti-oxidants, which improve the ability of the organism to protect itself. In addition, it protects some ingredients of food, primarily lipids and vitamins, from undesirable oxidation. Along with vitamin E, it has a positive influence on the technological characteristics of meat thanks to its anti-oxidation properties. The element was discovered in 1817 or 1818 by the Swede Jöns Jacob Brezelius during his study of sludge in the lead chambers of a factory producing sulphuric acid. He described it as an element similar to sulphur and tellurium. Selenium exists naturally in various degrees of oxidation (–1, 0, +4, +6) and is a component of many organic and inorganic compounds. It is one of the rarer elements and usually occurs in nature together with sulphur. Although it is frequent, it occurs mostly in small quantities. Scientists have been concerned merely with its toxic characteristics for many years. Its influence on the nutrition of animals was discovered in 1957. While it occurs in food only in its organic form, in dietary supplements it occurs both in organic and inorganic ones. The soil and plants in the Czech Republic have a low concentration of selenium, and therefore its percentage in food is low as well and does not meet the recommended daily dietary dosage. The percentage of selenium in food of animal origin depends on the nutrition of the respective animals and its percentage in their diets.

THE IMPORTANCE OF SELENIUM IN GENERAL

Selenium is a semi-metal present in all the cells and tissues of animal and human body (Ortman, 1999), but its biological importance remained unknown until the year 1957, when Schwarz, Foltz (1957) found out that

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selenium shortage could cause necrotic degeneration of the liver.

Selenium (along with vitamin E) is one of the essential nutritional elements whose main function consists of the protection of cells and tissues from oxidation damage (Schwarz, Foltz, 1957; Burk, 1997; Pavlata et al., 2002). It is an anti-oxidant which protects the organism against the formation of lipid peroxides in cells and subsequent damage to cells and distances the process of pathological aging (Kvasničková, 1998). It also has some anti-cancer effects (Clark et al., 1993; Ip, 1998; Brigelius-Flohé, 1999; Schrauzer, 2000, 2003) and influences immunity as a component of selenium proteins and enzymes. In addition, it influences sperm, their reproduction, and fertility (Surai, 2002; Ševčíková et al., 2006). It is likewise important for the activity of the brain and the thyroid (Rayman, 2008). Its primary physiological function is mediated by GSH-Px, an integral part of which is selenium (Mills, 1957; Flohe et al., 1973). The structure of this enzyme was described by Rotruck et al. (1973). The basic function of GSH-Px is to remove excess hydrogen peroxide (H_2O_2) from the cytoplasm of cells (Burk, 1997; Pavlata et al., 2002). Mammalian GSH-Px includes four selenoproteins: cellular, extra cellular, phospholipid and gastro-intestinal GSH-Px (Ursini et al., 1995). Low concentration of selenium in blood is being connected with increased mortality within cardiovascular disorders. It can be a consequence of suboptimal activity of glutathion-peroxydase in preventing LDL (low density lipoprotein) oxidation with subsequent absorption by endotheliocytes and macrophages in heart vessels (Brown, Arthur, 2001). The activity of GSH-Px is dependent on the selenium in tissues. Selenium in diets increases the activity of GHS-Px in the bodies of various animals including sewer rats, mice, chickens, quail, sheep, cows, horses, pigs, salmon etc. (Brigelius-Flohé, 1999). Another selenium protein is iodothyronin deiodinaze (ID), which regulates the conversion of thyroxin (T4) to the biologically active form of the hormone of thyroid 3,3′,5-tri-iodotyronin (T3) (Arthur et al., 1990; Salvatore et al., 1995; Larsen, Berry, 1995; Pavlata et al., 2002). The activation of the thyroid hormone is necessary for the growth of the organism and its adaptability to cold. Other important selenium proteins are mention P, W, thio-redoxine reductase, selenium which binds selenium proteins (58, 56 and 14 kDa) in the sperm capsule, and protein in the glandular epithelial cells of the prostate of sewer rats whose biologic functions have been explained (Burk, Hill, 1993; Pavlata et al., 2002). About 30 selenium proteins were described so far, the exact function of most of them is not known yet (Arthur, 1997; Behne, Kyriakopoulos, 2001).

Selenium prevents the formation of blood clots because it inhibits the concentration of blood platelets. It is important for the metabolism of prostaglandins which function as important blood regulators. Some prostaglandins have negative effects (for example, arthritis). Selenium seems to help in the production of useful prostaglandins and decrease the formation of harmful ones. The low percentage of selenium is one of the probable reasons for myocardium infarct and arteriosclerosis (Kvasničková, 1998).

Selenium also retains a reserve of vitamin C, glutathione and vitamin E. In the form of selenium cystein it slows down the biochemical process of the aging of tissues or even prevents it. It can protect against the toxic effects of heavy metals and of other substances. Thus it helps the synthesis of proteins, growth, development and fertility, especially in the case of males, by improving the production and motility of sperm. It also seems to stimulate the formation of antibodies as a reaction to vaccination (Nyam News, 2005).

Selenium supplementation stimulates the function of neutrophiles, production of antidotes, proliferation of T and B lymphocytes, function of NK cells, etc. (Kiremidjian-Schumacher, Stoltzky, 1987).

THE IMPORTANCE OF SELENIUM FOR POULTRY

The influence of selenium on poultry takes place in many ways. Scott et al. (1967) found that in young turkeys selenium can prevent stomach and heart myopathy. Schwarz et al. (1957) and Schwarz, Foltz (1957) found that selenium in yeast can protect geese from hepatic necrosis and broiler chickens from exudative diathesis. Another article was published in 1957 which demonstrated that selenium is the main factor in prevention of chicken exudative diathesis (Patterson et al., 1957), which was confirmed by Nouguchi et al. (1973) and Barthlomew et al. (1998). The symptoms of this disease are sore oedemas induced by increased permeability of capillary combined with low content of blood albumins (Kristiansen, 1973). In the case of very severe Se deficiency, the chicken develops pancreatic fibrosis (Thompson, Scott, 1970), a condition that reduces the secretion of pancreatic digestive enzymes. In cases of milder deficiency of selenium, where it is used only as a supplement to feed mixtures, the development of the immune system of young chickens can be retarded, their feathers grow poorly, and they lose energy. In addition, the mortality of chicken embryos can increase and the production of eggs decrease (Finch, Turner, 1996; Edens, 2002).

It was determined that a shortage of selenium has – in addition to the fact that it can cause a decrease in the number of eggs laid by chickens and turkeys – a significant impact on total hatchability (Cantor, Scott, 1974; Latshaw, Osman, 1974; Cantor et al., 1978, 1982). Ratcliff (2001) states that organic selenium in poultry is characterised by the body's higher "bioactivity" and better retention of selenium in meat and eggs.

The effects of selenium are similar to those of vitamin E. The importance of selenium and vitamin E consists above all in the protection of tissues against oxidation (Gerloff, 1992). Edens (1996) found that the meat drip loss of chickens fed organic selenium is lower than that of chickens fed selenite. This fact was confirmed by D o w n s et al. (2000), N a y l o r et al. (2000), E d e n s (2002), C h o c t, N a y l o r (2004), C h o c t et al. (2004), as well as U p t o n et al. (2008). E d e n s (1997) determined a mutual relationship between vitamin E and organic selenium when he monitored the improved growth of chickens.

C a n t o r et al. (1982), C h o c t et al. (2004) and P a y n e, S o u t h e r n (2005) found that the body weight and breast musculature of chickens which received organic selenium during their dietary regime was higher.

An experiment of Š e v č í k o v á et al. (2006) demonstrated that the organic form of selenium increases the concentration of intramuscular fat in the breast musculature by almost 12%, especially within the group of chickens administered selenium from Chlorella in addition. Concerning the group fed yeast enriched with selenium such an increase was not as pronoviced. Only small differences were registered in the femoral musculature. The concentration of intramuscular fat in the femoral musculature was four – five times higher than that in the breast (a maximum of 50.8 $g.kg^{-1}$). Although chicken meat is recommended in diets because of its low percentage of fat, this percentage in the femoral musculature is debatable because it can reach values as high as those in pork. Therefore, the breast musculature is more suitable for the human diet. S k ř i v a n et al. (2008) confirm that any selenium supplement increases the percentage of intramuscular fat but does not compare the state after supplement with selenium methionine and Na_2SeO_3 to that during the control. He only states that Na_2SeO_3 can increase this percentage by as much as 32%. D l o u h á et al. (2008) found that such supplementation with influences neither ($P < 0.05$) protein nor fat in the breast musculature, although supplementation with Se-Chlorella increased the percentage of fat by as much as 21%.

Supplementation with Se-Chlorella increased the weight of chickens at 21 and 42 days ($P < 0.05$) in comparison with that in the control group. On the contrary, due to the supplementation of Na_2SeO_3, the weight in both cases was lower than that in the control group. Supplementation of Se-Chlorella increased the concentration of selenium in the breast musculature, but no difference was found between the control group and the group in which Na_2SeO_3 was added to the diets. Both supplements of selenium increased ($P < 0.05$) its concentration in the excrement. Weight increase in the group where Na_2SeO_3 was added was greater than that in the group given Se-Chlorella (D l o u h á et al., 2008).

A r p á š o v á et al. (2009b) studied the effect of supplement the diet for laying hens with sodium selenite (SS) or selenized yeast (SY) on the quality and content of some minerals of eggs. The results showed that supplementation of SY to the diet significantly affected egg weight, egg yolk weight, egg albumen weight and Haugh units. Significantly lower egg shell weights and egg shell ratios were found in the experimental group with sodium selenite. Also, the concentration of Se in blood as well as that of some trace- and macroelements in eggs of laying hens appeared to be significantly influenced by selenium supplementation.

S k ř i v a n et al. (2008) investigated the influence of different forms of dietary selenium (Se) on vitamin E (α-tocopherol) and Se contents of egg yolk and chicken meat. Dietary Se supplementation increased the α-tocopherol content of egg yolks from 297 $mg.kg^{-1}$ dry matter in treatment without supplementation to 311 $mg.kg^{-1}$ when selenium was supplemented as selenite, and to 370–375 $mg.kg^{-1}$ when organic supplements were used. The Se and α-tocopherol contents of breast and thigh meat in broilers were significantly increased by organic dietary Se supplementation.

Utilization of selenium was examined in slow-growing laying-type chickens (SG) and in fast-growing broiler hybrids (FG). Coefficients of selenium retention and retention per unit of body gain were higher in SG chickens. The influence of age on selenium content in body weight gain of birds was evident ($P < 0.01$) (Z e l e n k a, F a j m o n o v á, 2005).

The study of dietary supplementation with either Na_2SeO_3 or yeast enriched with selenium (K u r i c o v á et al., 2003; C h o c t et al., 2004; P a y n e, S o u t h e r n, 2005) demonstrated that the organic form of selenium is concentrated in the breast musculature more effectively than is the inorganic one. S k ř i v a n et al. (2008) confirm that the source of selenium determines the increase in its percentage in the breast musculature. The organic form of selenium from seleno-methionine is more concentrated than the inorganic one.

Dietary supplement with selenium from selenomethionine increased the weight of chickens, but only by 3% (S k ř i v a n et al., 2008; A r p á š o v á et al., 2009a). N i u et al. (2009) induced non-significant influence body weight and feed intake by dietary Se, while feed conversion was significantly improved by a Se supplementation of 0.2 mg/kg. Alike results were in the experiment of P e t r i c et al. (2007). Y o o n et al. (2007) showed a non-significantly improved by a Se-supplementation of 0.2 mg/kg. Whatever the origin of Se supplementation, no significant effect on body weight, body weight increase and feed intake was observed in the experiment of D e n i z et al. (2005), or F e r n a n d e s et al. (2008).

Dietary supplementation of selenium increases its percentage in eggs (L a t s h a w, O s m a n, 1975; S t i b i l j et al., 2004; B e n k o v á et al., 2005; S k ř i v a n et al., 2006), Dietary Se significantly increased the vitamin E contents of egg yolk (S u r a i, 2000), and vitamin E concentrations in plasma of chickens (T h o m p s o n, S c o t t, 1970), rats (S c o t t et al., 1977) and ducklings (D e a n, C o m b s, 1981). Supplementation with organic vs. inorganic selenium resulted in a higher concentration of selenium in eggs. This was confirmed by a several studies (L a t s h a w, 1975; H a s s a n, 1990; K u r i c o v á et al., 2003; K e n y o n, S p r i n g, 2003; S k ř i v a n et al., 2006) dealing with the supplementation of yeast enriched with selenium and Na_2SeO_3. The organic, as opposed to the inorganic, form of selenium also improves the morphology of sperm (E d e n s, 2002; E d e n s, S e f t o n, 2003), along with the duration of fertility (A g a t e et al., 2000). It likewise improves fertility (E d e n s , 2002) and decreases mortality (L a n n i n g et al., 2000). In addition, it improves feathering (E d e n s , 1996), growth (V l a - h o v i c et al., 1998; E d e n s , 2002; S t o l i c et al., 2002; A n c i u t i et al., 2004; E d e n s , G o w d y, 2004; S r i m o n g k o l et al., 2004), eviscerated weight and breast yield (N a y l o r et al., 2000), the freshness of eggs during storage (W a k a b e , 1998, 1999; P a n , R u t z , 2003), and the quality of eggshells (K l e c k e r et al., 1997, 2001; P a t o n , C a n t o r , 2000; R u t z et al., 2003). It also decreases the formation of ascites (R o c h et al., 2000).

The data collected indicate the positive effect of organic selenium on the reproduction of poultry (S u r a i , 2006).

The organic form of selenium increases the concentration of this element in the musculature of chickens more than the more frequently used inorganic one (L e n g et al., 2003; Š e v č í k o v á et al., 2006; S k ř i v a n et al., 2008; D l o u h á et al., 2008; Y o o n et al., 2007).

The inorganic form of selenium is concentrated in excrement three times more than the organic one (S k ř i v a n et al., 2008; D l o u h á et al., 2008).

In poultry nutrition, selenium as an essential microelement is necessary for normal growth and higher yield. The nutrition need of selenium in feeding compounds for broiler chickens is between 0.1 (M a h a n , 1995) and 0.15 $mg.kg^{-1}$ (NRC, 1994). The maximum permissible quantity of selenium is 0.3 $mg.kg^{-1}$ (FDA, 2004). In the EU, including the Czech Republic, the maximum quantity of selenium in poultry diet is 0.5 $mg.kg^{-1}$ (Š e v č í k o v á et al., 2007; EU Directive, 2004).The safe quantity of selenium for poultry with regard to its insufficiency and toxicity is in the range of 0.15–4.0 $mg.kg^{-1}$ of the diet (NRC, 1994).

The amount of Se available for assimilation by poultry tissues depends on the form and concentration of the element in the diet (A r n o l d et al., 1974; L a t s h a w, 1975; L a t s h a w, B i g g e r t , 1981; C a n t o r et al., 1982; D o w n s et al., 2000; C h o c t et al., 2004; P a y n e et al., 2005; P e t r o v i c et al., 2006). Higher bioavailability of organic Se (C a n t o r et al., 1982) has resulted in the use of organic sources such as Se-enriched yeast as an alternative to inorganic Se supplementation in poultry nutrition (H o l o v s k á et al., 2003; U t t e r b a c k et al., 2005).

The influence of selenium and vitamin E dietary supplementation on to the efficiency of broiler chickens and the oxidation stability of fat was studied by P r a k a s h et al. (2000) and R y u et al. (2005). S w a i n et al. (2000) reported the maximum daily weight gain and highest feed conversion in chickens, which received 0.50 mg $Se.kg^{-1}$ and 300 $IU.kg^{-1}$ of vitamin E.

SOURCES OF SELENIUM

The most prevalent selenium compound existing in an organism is selenium cystein. Along with other organic selenium compounds, it originates in plants and is transferred to animal organisms through diet.

The selenium cycle in the food web begins in the soil, which is its main source for plants, and thereby for animals and humans. The content of selenium in the soil is various (R e i l l y, 1996). Its accessibility for plants depends on many factors including pH, oxidative-reduction potential and soil structure, fertilization, precipitation and above all the chemical form of selenium (S u r a i , 2006)

Both inorganic and organic forms of selenium can be used as a dietary supplement (Na_2SeO_3, selenide, selenane, yeast enriched with selenium, algae enriched with selenium – alga Chlorella, selenium methionine) (M a c h á t et al., 2005). Inorganic selenium has been added since 1960 in the form of Na_2SeO_3 to dietary doses of both animals and food. Na_2SeO_3 is absorbed in limited quantities and is toxic in higher doses (R a t c l i f f , 2001).

In 1974 the US Food and Drug Administration (FDA) approved the selenium supplements for poultry and pigs in the form of Na_2SeO_3 or selenane.

NATURAL SOURCES

The basic natural source of selenium is the crust of the earth, where 0.05–0.09 $mg.kg^{-1}$ of this element occurs (O r t m a n , 1999). Another source is represented by plants in soil rich in selenium. However, the soil in European countries is not rich in selenium, and therefore plants are not an important source of this element. Some Asian countries and areas rich in vanadium-uranium rocks where the quantity of selenium can reach 2.6 $mg.kg^{-1}$ are the only exception (R o s e n f e l d , B e a t h , 1964).

F o x et al. (2003) researched the evolution and transformation of selenium in soil and plants. Plants absorb selenium from the soil in the form of selenide or selenane and synthesize selenium-amino acids including selenium methionine, which represents more than 50% of selenium in grain (O l s o n , P a l m e r , 1976) and along with Se-methyl-selenium-methionine, selenium cystein and Se-methyl-selenium cystein creates a group of selenium compounds occurring in plants (B r o d y, 1994). Biosynthesis of selenium methionine in plants was researched by S c h r a u z e r (2003). Plants can also obtain selenium from the soil in organic forms. They accumulate various amount of selenium. Some of them cumulate selenium proportionally to its amount in the soil, while the others can cumulate selenium in concentrations multiply higher (F i n l e y, 2005).

Selenium is highly concentrated in brewer's yeast and wheat germ as well as in liver, most fish, butter and lamb. Other sources rich in selenium are vegetables, nuts (primarily brazil nuts), whole grains, molasses, brown rice and some sea food – scallops, lobster, shrimp, clams, crabs and oysters (Nyam News, 2005).

Wheat however, is very sensitive to the loss of selenium during its utilisation (75%). In the case of animal products the loss of selenium during its utilisation is lower (Nyam News, 2005).

Table 1. The richest natural sources of selenium in food products µg/kg (Germany)

Brazil nuts	2000–5000
Kidney	500–2000
Cheeses	20–2000
Fish and molluscs	200–500
Cereals	10–500
Eggs	100–200
Liver	50–200
Nuts	20–200
Pork	50–150
Chicken meat	30–100
Mushrooms	20–100
Beef	20–80
Vegetables (potatoes, legumes, celery)	10–30
Milk	5–20
Fruits (apples, bananas, oranges)	< 10
Vegetable oils	< 5

(S u k o v á , 2008)

Selenium gets into animal bodies through plants most often in the form of selenium methionine and selenium cystein (C o m b s , C o m b s , 1986). The recommended selenium intake for adult humans is 55 µg/day, with a tolerable maximum intake level of 300 µg/day (R a y m a n , 2004).

ARTIFICIAL SOURCES

Inorganic compounds

Inorganic compounds include oxides that react chemically with water and create acids. There are also salts with electro-positive elements – especially selenanes, selenite alkaline metals (Li, Na, K, etc.).

Na_2SeO_3 is the most current additive to diets. Although it is the most frequent additive to the diet of animals, its use is limited. The limited use of inorganic selenium is well known, Organic selenium is toxic, and it is not effectively transferred to milk, meat and eggs. In addition, it is not able to maintain its percentage in the organism (K i m , M a h a n , 2003).

Inorganic selenium is absorbed as minerals by passive diffusion. Only its small part is deposited in tissues and the majority is excluded with excrements in ruminants or with urine in non-ruminant species (W o l f f r a m , 1999).

It is a "pro-oxidant" (compounds which take part in respective chemical reactions during which toxic forms of oxygen are produced). In combination with iron and zinc it can stimulate the formation of lipid peroxidant (a chemical compound in which toxic forms of oxygen are included), destroy enterocytes and consequently decrease the absorption of nutrients including anti-oxidants (compounds which prevent the formation of toxic forms of oxygen) (L y o n s et al., 2007). There is equilibrium between pro-oxidants and anti-oxidants in organisms. If it is interrupted – for example due to a shortage of anti-oxidants or the use of some medications- so-called oxidation stress can occur. Moreover, if this persists for a long time, it can have serious consequences (B l a c h e et al., 1999).

Organic compounds

The organic compounds of selenium have similar chemical and biochemical characteristics those of sulphur. However, the compounds of selenium are less stable in reaction to light and heat than their sulphur counterparts. As for nutritional aspects, selenium amino acids, peptides which contain selenium, selenium derivatives of nucleoacids (F u s s , G o d w i n , 1975), alga-Chlorella, selenium methionine (Se-Met), selenium cystein and Sel-Plex are the most frequent additives to organic selenium.

The utilisation efficiency of selenium from organic compounds is likely to be influenced by the selenomethionine content. Se-Met can be the major selenocompound in selenium-enriched yeast (W h a n g e r , 2002). According to the data in literature, selenium yeast contains 54–74% of Se-Met and R a y m a n (2004) reported 60–84% of Se-Met and 0.1–15% of selenite.

In June 2000 the FDA approved selenium yeast (Sel-Plex®, Alltech Inc.) as an organic source of selenium supplement to the diet of broiler chickens (Federal Register, 2000). In the EU Sel-Plex as a source of such a supplement was approved in November 2006. It is still the only permissible source of the organic form of selenium which is approved within the EU for all kinds of animals.

Chlorella is a freshwater alga containing a twofold amount of proteins (60%) compared to all species of legumes, 20% of polysaccharides and 10% of fats. It does not produce any toxic metabolites, and its biomass contains many biologically active compounds. Little information on the form of selenium form in Se-enriched Chlorella is available for the time being. Selenium is assumed to be built into the protein structure in a similar way to that of Se-enriched yeast (M a c h á t et al., 2005). Selenium-enriched Chlorella may be used as a new source of selenium supplementation of feed mixtures for poultry. Š e v č í k o v á et al. (2006) state that this alga does not form toxic metabolites and its biomass contains many biologically active substances.

The Se-Met contained in Sel-Plex is accessible normally. It is absorbed in the bowels through the same mechanism as methionine via the Na^+ dependent neutral amino acid transporter, while selenite is absorbed passively (S c h r a u z e r , 2000). This form of selenium is metabolized immediately. It is transferred to and absorbed in the organs responsible for the creation of proteins, i.e., skeletal muscles, erythrocytes, pancreas, liver, kidneys, etc. These proteins containing selenium are a source of selenium for the synthesis of selenium proteins. Metabolized selenium changes into selenium cystein that breaks down in liver to serine and selenide. Selenide is used for the formation of selenium proteins or it is secreted by through urine or faeces (M o e s g a a r d , 2008).

In comparison with the inorganic form of selenium, the organic one is absorbed better and much more quickly in the bowel micro-flora (Reasbeck et al., 1981; Daniels, 1996).

Organic selenium is absorbed as an amino acid similar to methionine. One part of it is utilised for the immediate synthesis of selenium proteins, and the other is included in new proteins formed by this synthesis. Therefore, it is concentrated in muscles or eggs, and due to this process selenium reserves in the body are ensured. These reserves are important in situations when the need for selenium increases (Arpášová et al., 2005).

CONCLUSIONS

In spite of long history, knowledge of the molecular mechanism of the activity of selenium in the bodies of animals and people is still inadequate. The main reason for the use of selenium as an additive to the diet of animals is the attempt to eliminate its deficiency caused by the low percentage of selenium in both soil and plants.

It is possible to use organic selenium as a supplement to the organic source of selenium in the form of Sel-Plex, but this form is almost one hundred times more expensive than an additive in the form of Na_2SeO_3.

The high reproduction ability, intensive growth, profitability, the percentage of nutrients and the optimal dietary characteristics of poultry meat and eggs indicate them as a food of the future.

Meat and egg products are important with regard to both biological and economic aspects.

The optimisation of the selenium nutrition of poultry will result in higher quality of eggs and meat.

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Význam, využití a zdroje selenu u drůbeže: revue.

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Selen je stále jedním z velice diskutovaných prvků. Na jedné straně je ve vysokých dávkách toxický, a celá řada prací se též zabývá problematikou, která se týká znečišťování životního prostředí selenem. Na druhé straně se však řeší otázka nedostatku selenu ve výživě, který se projevuje sníženou odolností a vyšší vnímavostí k různým onemocněním zvířat i člověka a negativně také působí na reprodukční schopnost. Hlavním cílem příspěvku je zhodnocení významu selenu ve výživě drůbeže, seznámení s jeho anorganickými a organickými formami a doplňky, charakteristikami kladů a rizik při využívání obou forem selenu a návrh některých méně známých možností využití selenu a jeho zdrojů, jakou je např. sladkovodní řasa Chlorella. Optimalizace výživy drůbeže selenem by měla přispět ke zkvalitnění drůbežích produktů. Z prací četných autorů shromážděných v tomto příspěvku vyplývá, že zvláště v poslední době je vyvíjena snaha o náhradu anorganické formy selenu, kterou je nejčastěji seleničitan sodný (selenit) ve výživě drůbeže, jejíž účinnost není dostačující, některou z organických forem selenu, získanou z přírodních zdrojů. Jednou z možností je selenem obohacená kvasnice (Sel-Plex). Dalším možným zdrojem organické formy se ukazuje být i selenem obohacená sladkovodní řasa Chlorella, která podle některých autorů netvoří toxické metabolity a která též obsahuje řadu biologicky aktivních látek. Jako určitá překážka se zatím ukazuje cena těchto zdrojů, která značně převyšuje náklady na anorganickou formu doplňků. Zvýšený zájem o využití selenu ve výživě nastal především v souvislosti se zjištěním aktivity glutation peroxidázy (GSH-Px), především její všudypřítomné cytosolické formy (GSH-Px1), která byla po řadu let považována za hlavní selenoprotein. Teprve v nedávné době však bylo zjištěno, že je pouze jedním z přibližně 30 různých selenoproteinů. Význam selenu je široký a jeho využití ve výživě zvířat a člověka rychlé a účinné, což naznačuje značné perspektivy.

drůbež; anorganická forma; organická forma; Sel-Plex; Chlorella; GSH-Px

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