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SELENIUM- HEALTH, PRODUCTIVE AND REPRODUCTIVE TRAITS OF FARM ANIMALS

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This study is a review of a previous research on the effects of selenium on health, productive and reproductive traits of farm animals. The interest for research on selenium has originated from the knowledge that this nutrient has a distinctive antioxidant role in cells, thus preventing tissue damages mediated by free radicals. By performing different biological activities in the organism, selenium becomes an essential element for preserving health and improving productive and reproductive characteristics. It has a very important role in the functions of immune system, so that during deficiency its feed supplementation in suitable quantities results in improving immune response. A supplemented level of selenium into feeds of farm animals can provide adequate basal concentrations necessary for the protection both against oxidative activities of free radicals created during physiological processes and external harmful factors.

Key words: organic and inorganic selenium, gluthathione-peroxidase, deficiency

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INTRODUCTION

Selenium performs its biological role through the enzyme gluthathione peroxidase (GSH-Px) which contains selenium in its nexus (ROTRUCK, *et al.*, 1973). Together with catalysis, superoxide dismutase and vitamin E, it protects cell system against peroxidative damages. Selenium, through Se GSH-Px decreases peroxidase of lipids and transforms H_2O_2 into water. Otherwise, H_2O_2 would react with numerous cell ingredients and build free radicals, which can be multiplied by chain reactions and lead to structural changes and cross section binding of lipids and proteins. This all results in both membrane damages and creation of lesions, characteristics of selenium deficiency (MIHAILOVIĆ, 1996).

Gluthathione peroxidase

Besides the level of Se in blood plasma, the activity of glutathione peroxidase GSH-Px is also a reliable indicator of bioavailability of selenium. Activity of this enzyme depends on the level of intaken selenium (HASSAN, 1987). Feeding optimal and suboptimal levels of Se (0.5 and 1 mg Se/kg diet) results in linear increase of GSH-Px in the plasma of small turkeys (MIHAILOVIĆ *et al.*, 1991). However, at certain concentrations of selenium, the level of GSH-Px reaches plateau, so that further increase of the level of selenium does not lead to the increase of the activity of this enzyme. Also, addition of high levels of inorganic (Na_2SeO_3) and organic selenium (selenized yeast) above 5 mg Se/kg diet for broilers does not result in linear increase of the activity of this selenoenzyme. In the first days, the activity of selenoenzyme increases in blood plasma of trial animals, but is followed by a significant decrease of activity only 10 days later (JOKSIMOVIĆ-TODOROVIĆ and JOKIĆ, 2005 a,b). At the end of fattening period (42 days) the activity of enzyme was three times lower in relation to the initial value, especially at extremely high levels of selenium in diet (10 and 15 mg Se/kg).

High levels of selenium, more than 5 mg Se/kg diet in the beginning, lead to the increasing activity of GSH-Px, but after 10 days, the cells that synthesize this enzyme are so damaged that the synthesis is considerably reduced or even interrupted.

Selenium deficiency

Selenium deficiency leads to a number of diseases in farm animals (nutritive muscular dystrophy, hepatosis dietetic, mulberry heart disease, mastitis in dairy cows) and in poultry, there occurs encephalomalacia, exudative diathesis, fibrosis of pancreas.

Mastitis is a frequent disease among dairy cows, especially in those high-productive ones. In our country, the frequency of the occurrence of mastitis ranges from 30-50% depending on the application of the programme for preventing and controlling this phenomenon (HRISTOV *et al.*, 2000). These measures are not conducted systematically and the greatest importance is given to the administration of antibiotics; while in the nutrition of cows during the different periods of lactation, little attention is paid to the ration composition in regard to the quantity of micronutrients. Numerous studies have confirmed a Se stimulative effect on immunological status, including the activity of neutrophillic granulocytes as well. Selenium, as a natural antioxidant, plays an important role in preserving the sound condition of mammary gland. It increases the activity of neutrophilic granulocytes, improving their haemostatic effect and phagocytosis opsonizated pathogenic microorganisms (JOKSIMOVIĆ-TODOROVIĆ *et al.*, 2006a). A supplementation of 0.2 mg Se/kg feed for dairy cows prevents the occurrence of mastitis and results in successful curing of already present disease (MALBE *et al.*, 2003).

Besides the diseases provoked by Se deficiency in farm animals, it also causes a retarded growth, reduced egg laying in poultry, an increase of embryo mortality, etc. Se-supplemented diets for small turkeys in the quantity of 0.5 and/or 1 mg Se/kg diet has led to considerably higher weight gain in relation to birds receiving none of the supplement (MIHAILOVIĆ *et al.*, 1991). The results of our research show that adding Se in broiler diets also has a positive effect on weight gain. The birds were fed with feed containing 0, 0.3, 0.6 and/or 0.9 mg Se/kg , feed in the form of selenized yeast. At the end of fattening (42 days) the highest body weight gain was found at birds fed with 0.6mg Se/kg diet and somewhat lower, broilers fed 0.3 and 0.9 mg Se/kg diet. Birds that did not receive Se-supplement in diet (0 mg Se/kg) had significantly lower body weight gain in relation to those fed with Se-supplemented diets (JOKIĆ *et al.*, 2005).

Inadequate levels of selenium in farm animals' food often result in sterility, abortions, occurrence of ovary cysts, retained placenta in dairy cows, disorder of spermatogenesis and reduced spermatozoa viability (SURAI, 2002). The retained placenta represents a post-partum disease in diary cows having a harmful effect on reproduction (decreased rate of conception, occurrence of abortions and ovary cysts), milk yield and mammary gland. This disease is characterized by multi-factorial etiology-physiological, pathological and nutritive factors. It occurs due to either abnormal physiological processes during liberating fetal membrane or the influences of pathological factors leading to the loss of the mechanism of ejecting placenta. The ratio among antioxidative nutrition, oxidative stress and phenomenon of retained placenta in dairy cows is a well-known one. Nevertheless, pathogenesis of this disease connected with Se deficiency is not completely clear, but a participation of oxidative stress in

etiology of this syndrome indicates decreased occurrence after the application of selenium (JOKSIMOVIĆ-TODOROVIĆ *et al.*, 2006b). Moreover, selenium deficiency effects adversely a function of polymorphonuclear neutrophiles and the change in levels of GSH-Px (TURNER and FINCH,1990). The absence of white cells in placenta results in retained placenta in 100% of dairy cows (PUTNAM and COMBEN, 1987). Selenium increases the number of white cells in placenta, white cell haemotaxis -- causes the weakening of the bonds at a fetal-maternal juncture and consequently the ejecting of placenta. Increased cortisol concentrations in this ailment represent a stress response and an inflammation of pregnant uterus. The cortisol decreases the function of neutrophiles and therefore can completely prevent their activity thus resulting in development of this disease.

The advantage of organic selenium in relation to inorganic one

Recently, the organic Se forms, which have greater bio-utility, have been increasingly in use as the sources of trace elements for animals. Inorganic forms can satisfy the needs of the organism although most of them are difficult to absorb and can produce ions that react with other feed ingredients or trace elements.

Recent research work has shown that organic selenium is more and more used instead of inorganic selenium (MAHAN, 1999; SURAI, 2000). Metabolic pathways of organic and inorganic selenium are different. Organic selenium is present in cereals, animal feed and certain feeds, mostly in the form of selenomethionine, so its pathway is the same as that of methionine. It represents an active means of transport through intestinal membrane together with an active accumulation in target organs. Inorganic selenium is briefly retained by tissues, a small part of it is built into selenoproteins, while greater part is secreted by urine. An animal organism has adapted itself to organic selenium which is a feed incorporating part, while inorganic Se is not a natural source (SURAI, 2000). During the transport of proteins and during stress the selenomethionine is liberated into free amino acid depots and can be used for the synthesis of selenoenzymes, GSH-Px. It means that animals under stress and in incubation period have an adequate antioxidative protection, which prevents a decrease in productive characteristics. Moreover, organic selenium is less toxic than inorganic one (TODOROVIĆ *et al.*, 1999; TODOROVIĆ *et al.*, 2004), it is more rapidly deposited and longer retained in tissues. Tissues show different affinity for selenium and are retaining it in different degrees, depending on a quantity of chemical form, time of consuming and animal species.

Our research into depositing of selenium in individual tissues of gilts fed 0, 0.3 and/or 0.6 mg Se/kg diet in the form of selenized yeast has shown that the concentration of Se was the highest in kidneys, liver and heart and lowest in thigh and neck musculature in all trial animals. The Se concentration in examined

internal organs was not significantly different between studied trial groups. However, the level of Se in thigh and neck musculature was 2, that is, 3 times higher in animals fed 0.3 and 0.6 mg Se/kg feed in comparison with animals not receiving the Se supplement (JOKSIMOVIĆ-TODOROVIĆ *et al.*, 2006c).

Selenium-immunological status

Selenium deficiency results in a decrease in number and disorder of function of almost all cells of immunosystem. The activity of neutrophile granulocytes is decreased, the same happens to T cells, NA cells and production of antibodies of IgM class. The maturing of limphocytes and function of mature forms of these cells is disturbed.

CONCLUSION

An adequate use of nutrients of selenium is significant for preserving health and improving productive and reproductive characteristics in farm animals. This can be attained by feed supplementation by certain levels of selenium, primarily those in organic form. The use of animal products enriched by selenium has a beneficial effect on a human health as well.

REFERENCES

HASSAN, S. (1987): Bioavailability of selenium in feedstuffs as studied in the chick. Swedish University of Agricultural Science: 1-67.

HRISTOV, S., TODOROVIĆ, M. and NEŠIĆ, K. (2000): The most important aspects of the programme of preventing the occurence and removing the mastitis in cows. Arhive for Agricultural Sciences 61: 135-146.

JOKIĆ, Ž., JOKSIMOVIĆ-TODOROVIĆ, M. and DAVIDOVIĆ, V. (2005): Organic selenium in nutrition of chicken in fattening. Biotechnology in Animal Husbandry 21: 79-89.

JOKSIMOVIĆ-TODOROVIĆ, M. and JOKIĆ, Ž. (2005a): Influence of high levels of inorganic selenium on activity of glutathione-peroxidase (GSH-Px) in blood plasma of chickens. Biotechnology in Animal Husbandry 21: 125-131.

JOKSIMOVIĆ-TODOROVIĆ, M. and JOKIĆ, Ž. (2005b): Effect of high levels of organic selenium on glutathione-peroxidase (GSH-Px) activity in blood plasma of broilers. Veterinary Messenger 59: 383-390.

JOKSIMOVIĆ-TODOROVIĆ, M., DAVIDOVIĆ, V., HRISTOV, S., STANKOVIĆ, B. and RELIĆ, R. (2006a): The effect of selenium and vitamin E on the health condition of mammary glands in cow. Proceedings of the 6. Symposium "Live Stock Production, Veterinary and Agronomy in Transition Processes" with international participation. Book of Abstracts, Herceg Novi, p.157.

JOKSIMOVIĆ-TODOROVIĆ, M., HRISTOV, S., DAVIDOVIĆ, V., STANKOVIĆ, B. and RELIĆ, R. (2006b): Role of selenium and vitamin E on incidence of retained placenta in dairy cows. Proceedings of the 8th Symposium of Clinicle Pathology and Therapy Animals, with international participation improvement, Neum, June 26-30.

JOKSIMOVIC-TODOROVIĆ, M., JOKIĆ, Ž. and HRISTOV, S. (2006c): The effect of different levels of organic selenium on body mass, bodyweight gain, feed conversion and selenium concentration in some porcine tissues. Acta Veterinaria, No 5-6 (In Press).

MAHAN, D. (1999): Organic selenium: using natures model to redefine selenium supplementation for animals. In: Biotechnology in the Feed Industry. Proceedings of 15th Alltechs Annual Symposium, eds. by LYONS, T.P. and JACQUES, K.A., Nottingham University Press, Nottingham, U.K. p.p. 523-535.

MALBE, M., KLAASSEN, E., KAARTINEN, L., ATTILA, M. and ATROSHI, F. (2003): Effects of oral selenium supplementation on mastitis markers and pathogens in Estonian cows. Vet. Ther. 4: 145-154.

MIHAILOVIĆ, M. (1996): Selenium in the nutrition of people and animals. Monograph.

MIHAILOVIĆ, M., TODOROVIĆ, M. and ILIĆ, V. (1991): Effects of dietary selenium of glutathione peroxidase activity and body weight of growing turkeys. Acta Veterinaria 23: 75-80.

PUTNAM, M.E. and COMBEN, N. (1987): Vitamin E. Vet. Rec. 121: 541-545.

ROTRUCK, J.T., POPE, A.L., GANTHER, H.E., SWANSON, A.B., HAFEMAN, D.G. and HOEKSTRA, W.G. (1973): Selenium: Biochemical Role as a Component of Glutathione Peroxidase. Science 179: 588-590.

SURAI, P.F. (2000): Effect of the selenium and vitamin E content of the maternal diet on the antioxidant system of the yolk and the developing chick. British Poultry Science 41: 235-243.

SURAI, P.F. (2002): Selenium in poultry nutrition: a new look at on old element. Antioxidant properties, deficiency and toxicity. Worlds Poultry Sci. J. 58: 333-347.

TODOROVIĆ, M., MIHAILOVIĆ, M. and HRISTOV, S. (1999): Effects of excessive levels of sodium selenite on daily weight gain, mortality and plasma selenium concentration in chickens. Acta Veterinaria 49: 313-320.

TODOROVIĆ, M., JOVANOVIĆ, M., JOKIĆ, Ž. HRISTOV, S. and DAVIDOVIĆ, V. (2004): Alterations in liver and kidneys of chickens fed with high rates of sodium selenite or selenized yeast. Acta Veterinaria, 54: 191-200.

TURNER, R.J. and FINCH, J.M. (1990): Immunological malfunction associated with selenium-vitamin E diets in lambs. J. Comp. Pathol. 102: 1044-1049.

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SELEN-ZDRAVLJE, PROIZVODNE I REPRODUKTIVNE KARAKTERISTIKE FARMSKIH ŽIVOTINJA

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I z v o d

U ovom radu dat je pregled dosadašnjih istraživanja uticaja selena na zdravlje, proizvodne i reproduktivne karakteristike farmskih životinja. Interesovanja za izučavanje selena proizašla su iz saznanja da ovaj nutricijent ima izraženu antioksidativnu ulogu u ćelijama, čime sprečava tkivna oštećenja posredovana slobodnim radikalima. Selen je esencijalni element za očuvanje zdravlja, poboljšanje proizvodnih i reproduktivnih karakteristika, ostvarivanjem različitih bioloških aktivnosti u organizmu. Selen, takođe, ima veoma značajnu ulogu u funkcijama imunološkog sistema, tako da njegovo dodavanje u hranu u odgovarajućim količinama kod deficita, rezultira u poboljšanju imunološkog odgovora. Dodati nivoi selena u hranu za životinje obezbeđuju adekvatne bazalne koncentracije neophodne za odbranu od oksidativnih delovanja slobodnih radikala nastalih u toku fizioloških procesa i spoljnih štetnih faktora.

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