

EFFECTS OF ADDING DIFFERENT FORMS OF SELENIUM IN DIETS FOR FATTENING LAMBS

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Abstract: The study included lambs of Mis population, divided into two groups (experimental and control). All the animals fed with identical portions of meals consisted of alfalfa hay and fully concentrate mixtures. Meals are only different in the fact that the experimental group received organic selenium and contained 2000 mg of selenium / kg preparations, while the control group received inorganic selenium in the form of sodium selenite (Na₂SeO₃). Each animal consumed the same amount of selenium than 0.3 mg / kg of dry matter in the organic or inorganic form, which added in the mineral-vitamin premix. Diet of lambs has been ad libitum. The body weight of lambs in both (control and experimental groups), were balanced at 60 days (19.60 kg : 19.65 kg) and 100 days (31.06 kg : 32.88 kg). The result on average daily gain of the control and experimental groups were almost similar and there were no statistically significant differences ($P > 0.05$) in the measured values from 28 to 60 days (259.0 : 255.0 g), from the 60-100 days (286.0 : 330.0g), and on average from 28 to 100 days (274.0 : 297.0. g). Both treatment have no significant effect on lambs' performance (body weight and growth). The study results showed that the diet of lambs experimental group, based meal supplement organic selenium resulted in significantly higher concentration of Se in MLD, kidneys, liver and spleen, compared with the control group, which are consumed inorganic form of selenium. The differences between the Se content in MLD the experimental and control groups were on significance level $P < 0.05$, while the differences in the content of Se in kidney, liver and spleen, the aforementioned treatments were statistically highly significant ($P < 0.01$). So fattening lambs are better utilizing organic source of selenium, which is associated with better absorption of this element.

Key words: sheep, lambs, selenium, body growth, selenium content

Introduction

Selenium (Se) was discovered in 1817, and considered a toxic element for humans and animals, until *Rotruck et al. (1973)* have not yet established that it is incorporated in selenocysteine (SeCys) which is essential element for the normal life processes. Selenium (Se), in the form of selenocysteine, is the central structural component of a number of specific enzymes, and especially catalase, glutathione peroxidase, which allows the host defense against oxidative stress. An adequate intake of selenium is needed to reduce the risk of myopathy, immunodeficiency, cardiovascular disease, cancer (*Rock et al., 2001; Hartikainen, 2005*). For animals and especially lambs, selenium deficiency is associated with white muscle disease. Selenium from food mainly derived from plants, which are adopted from the soil selenium in inorganic form, and synthesize the most selenomethionine (*Mezes and Balogh, 2006*). Selenium is an essential micronutrient in sheep and the deficiency of it can limit lamb growth and survival (*Stewart et al., 2012*). Selenium has a variety of role and is an essential element in the diet of animals. Generally, there are two forms of selenium, inorganic (selenate and selenite) and organic (selenomethionine and selenocysteine), *Sunde, (2006)* and that both forms can be a good source of selenium dietary (*Terry et al., 2012*). The soils contain inorganic selenites and selenates that plants accumulate and convert to organic forms, mostly selenocysteine and selenomethionine and their methylated derivatives. Selenium is a naturally occurring metalloid element that is essential to human and animal health in trace amounts but is harmful in excess. Any deficiency or excess in the diet affected animal health, the intake of selenium being dependent on the amount of selenium taken up by plants as bioavailable selenium (*Fordyce, 2005*). While light soils and lush legume-dominant pastures are most often associated with selenium responsive conditions in animals, there are many exceptions (*Karimi-Poor et al., 2011*). Selenium behaves antagonistically with copper and sulfur in humans and animals inhibiting the uptake and function of these elements (*Khanal & Knight, 2010*). It serves as an anti-oxidant that works in conjunction with vitamin E to prevent and repair cell damage in the body, also involved in immune function and is necessary for growth and fertility (*Khanal and Knight, 2010; Karimi-Poor et al., 2011*). Moreover, Se is a component of selenoproteins and is involved in immune and neuropsychological function in the nutrition of animals (*Meschy, 2000*). Various selenium contains amino acids that occur in nature and play important physiological roles especially in grazing sheep. Selenium after absorb from plants roots transferred to tissues and milk accompanying with plasma protein. More than 80% of protein-bound Se is selenocysteine. *Ullrey, (1987)*, pointed out that the forms of Se in animal tissues have not completely understood but some is bound to protein, perhaps by a selenium-sulfide linkage, and that some had integrated into proteins. Therefore, regulation and synthesis of those proteins

and its behavior in the different organs and tissues are dependent highly on selenium supply (*Karimi-Poor et al., 2011*).

However, the content of Se in the plants in our area (experimental farm of the institute) is low and in order to alleviate the consequences of nutritional deficits, it is necessary to supplement this element in diets for feeding of lambs. As source of selenium is mainly used selenite and selenate. However, organic sources of selenium in the form of selenomethionine, has certain advantages. *Weiss (2005)* suggests that the digestibility of sodium selenite in sheep is around 50%, while the adoption of organic forms around 66%. Also well known that Se organic sources, is incorporated more efficiently into tissue than of Se inorganic sources (*Ehlig et al., 1967; Van Ryssen et al., 1989*).

The aim of this study was to compare the effects of different Se sources on growth performance of lambs and to determine the selenium content in muscles and organs of fattening lambs.

Material and methods

The study included 30 lambs of Mis population, with an average age of 28 days. The lambs were divided into two groups (experimental and control) which were completely uniform in all relevant parameters (body weight, age, sex, type of birth). All the animals fed with identical portions of meals consisted of alfalfa hay and fully concentrate mixtures containing 18% of protein. Composition of concentrate mixtures were the following (%): whole grain corn-58.4; whole soybeans -23.6; wheat bran 10%; yeast-5; minerals-2; premix-1. The mixture contained: 88.83% dry matter; 18.73% of the total protein and 1.208 NU, kg / kg. With the achieved body weight of 15 kg onward, lambs continued to feed concentrate with 16% of the total protein and alfalfa hay. The mixture contained 87.77% of dry matter of 16.47% as the total of protein and 1.198 NU, kg / kg. Meals are only different in the fact that the experimental group received organic selenium, which is a product of the American company Alltech and contained 2000 mg of selenium / kg preparations, while the control group received inorganic selenium in the form of sodium selenite (Na_2SeO_3). Each animal consumed the same amount of selenium than 0.3 mg / kg of dry matter in the organic or inorganic form, which added in the mineral-vitamin premix. Diet of lambs has been ad libitum. In addition to the meals, lambs supplied with water through automatic drinkers. The measurement of lambs was performed on 28, 60 and 100 days when they were calculated the average daily weight gain of 28 to 60 days, from 60 to 100 days and an average of 28-100 days of fattening.. The average daily intake, feed conversion and nutrient material had accompanied by the same dynamics. At the end of the experiment, animals have weighed and slaughtered seven lambs per treatment in the experimental slaughterhouse of the Institute for Animal

Husbandry. After slaughtering and primary processing, which is performed by standard methodology, the samples were taken from muscle (*Musculus longissimus dorsi*), kidney, liver and spleen in order to determine the selenium content. Statistical analysis of the obtained data was performed using the program Statistica 10.

Results and Discussion

Table 1. Body weight and growth of lambs

Treatments	Body weight, kg			ADG, g		
	Initial body weight	60 days	100 days	28-60	60-100	28-100
Control (inorganic Se)	11.30	19.60	31.06	259	286	274
Experimental (organic Se)	11.49	19.65	32.88	255	330	297

a,b - $P < 0.05$

The average body weight and average daily gain of lambs are shown above (Table 1). The body weight of lambs in both (control and experimental groups), were balanced at 60 days (19.60 kg: 19.65 kg) and 100 days (31.06 kg: 32.88 kg). The result on average daily gain of the control and experimental groups were almost similar and there was no statistically significant difference ($P > 0.05$) in the measured values from 28 to 60 days (259.0: 255.0 g), from the 60 -100.days (286.0: 330.0g), and on average from 28 to 100 days (274.0: 297.0. g). Both treatments had no significant effect on lambs' performance (body weight and growth). The result we obtained was comparable with the findings of (*Chladek et al., 1999; Antunović et al., 2009*). Likewise, in the study of *Antunović et al., (2014)*, found non-significant differences in body weights of fattening lambs depending on dietary treatments with selenium. *Vignola et al. (2009)* who tested the influence of different sources and levels of selenium in diets for feeding of lambs of the Apennine breed have stated that the treatment had no significant effect on the average daily gain. *Luthman and Lindh, (1990)*, gave their explanation to the specified results that "unless there is an evident lacking of Se, selenium supplementation does not affect the growth performance of lambs". Different result found by *Kumar et al., (2009)*, in their study, supplementation of organic as well as inorganic Se, has found to improve the growth rate, of the lambs and that between the two sources, organic Se was more effective than inorganic Se.

Table 2. Average daily intake of nutritive substances of meals and consumption of nutritive substances per kg of gain

Indicator	Average daily intake of nutritive substances of meals		Consumption of nutritive substances per kg of gain	
	Experimental	Control	Experimental	Control
	28-60			
Dry matter, kg	0.580	0.517	2.295	1.995
Total protein, g	119	109	472	420
NU, kg/kg	0.637	0.569	2.522	2.193
	60-100			
Dry matter, kg	0.790	0.814	2.390	2.855
Total protein, g	146	148	441	519
NU, kg/kg	1.014	1.024	3.070	3.593
	28-100			
Dry matter, kg	0.695	0.680	2.345	2.481
Total protein, g	134	130	452	476
NU, kg/kg	0.844	0.818	2.847	2.987

In table 2, the differences were minimal, in favor of the Experimental group in periods 28-60: 28-100 days on the Average daily intake of nutritive substances of meals on the following indicator and differences (experimental : control); Dry matter, kg-0.063:0.015; Total protein, g-10:4; NU, kg/kg-0.068 : 0.026. In favor of control group at 60 100 days with such difference on the following indicator: Dry matter, kg-0.024, Total protein, g-2, NU, kg/kg- 0.01. Concerning the consumption of nutritive substances per kilogram of gain was higher in the experimental group in period 28-60 with the following differences in the indicator: Dry matter, kg - 0.3, Total protein, g - 52, NU, kg/kg - 0,329. At 60 - 100 and 28 - 100 in favor of the control group with the following differences: Dry matter, kg - 0.465 : 0.136, Total protein, g – 78 :24, NU, kg/kg - 0.523 : 0.14.

Table 3. Selenium contents in muscle and organs

Tissue	Experimental group (organic Se)	Control group (inorganic Se)
M. longissimus dorsi, mg / kg	195.06 ^a	130.32 ^b
Kidney, µg/kg	1350.24 ^A	1131.62 ^B
Liver, mg / kg	710.22 ^A	591.13 ^B
The spleen, mg / kg	390.43 ^A	301.25 ^B

^{a,b} P<0.05 ^{A,B} P<0.01

The study results showed that the diet of lambs experimental group, based meal supplement organic selenium resulted in significantly higher concentrations of Se in MLD, kidneys, liver and spleen, compared with the control group, which are consumed inorganic form of selenium. The differences between the Se content in MLD The experimental and control groups at a significance level $P < 0.05$, while the differences in the content of Se in kidney, liver and spleen, the aforementioned treatments were statistically highly significant ($P < 0.01$). So fattening lambs are better utilizing organic source of selenium, which is associated with better absorption of this element. Previous studies in ruminants (*Aspila, 1988*) have pointed to the better absorption of organic selenium compared to inorganic selenium (65, 50). The weaker absorption of inorganic selenium is probably the result of reducing the availability of selenium from food from insoluble forms (Se element or selenides) in the rumen (*Varady et al., 2005*). As seen in table 3, can noticed that the accumulation of selenium in the internal organs significantly higher ($P < 0.01$) in comparison with that of the MLD ($P < 0.05$) at both investigated treatments and statistically significant differences ($P < 0.05$) in favor of organic selenium and indicating a better bioavailability. Organic selenium supplementation gave 49.67% higher selenium contents in lamb meat than inorganic selenium supplementations. Our result was similar with the findings of *Steen et al., (2008)*, of which they have noted that organic selenium supplementation gave 50% higher selenium concentration in lamb meat than inorganic selenium supplementation. The result obtained by *Antunović et al., (2009)* on Se content in the muscle of OS was higher than that found for the C lambs confirmed with ours. In our study, the organic selenium supplementation has higher percentages (than inorganic supplementation) of selenium acquired in internal organs: 19.32% in kidney, 20.15% in liver, 9.7% in the spleen. In both treatments has found the highest content of selenium in kidney of which is complementary with the findings of other authors. *Combs & Combs, 1986; Supczyńska et al., 2009*, reported the amount of Se in the tissues, ranked the highest in the kidney, followed by the liver and the least in skeletal muscle. The Se contents in liver in each treatment had 3 to 4 times higher than the muscle. As stated by *Lee et al. (2004)*, which indicating that “a high Se concentration in the liver compared with muscle might result from the fact that liver acts as a major pool of Se in the body”, uphold our findings. Moreover, in the studies of *Juniper et al., 2009; QIN et al., 2007; Van Ryssen et al., 1989*, in both groups, the highest Se concentration was also found in the kidneys, which is true in our results. *Pehrson, (2005)*, terminated in his study that “the supplementation of farm animal diets with organic selenium instead of inorganic selenium will increase selenium status of lambs and slaughter lambs” in accordance with the results we obtain. A different result found by *Antunović et al., (2009)*, where Se content of kidney was not significantly affected by treatment but they concluded that Se in organic form had a better bioavailability compared to the inorganic form. *Joksimović et al., (2012)*, have noted in their papers that, “In difference to

inorganic selenium, organic selenium is deposited more effectively in tissues. Several authors who conducted similar studies have expressed their views regarding their findings. *Kim and Mahan, (2001)*, informed that Selenium concentrations in tissues are affected by the dietary concentration and chemical form of Se. Whereas, *Ehlig et al., (1967)*; *van Ryssen et al., (1989)* commented in their papers that Se from organic sources is also well known as more efficiently incorporated into tissue than inorganic sources of Se. The distribution of Se in tissues was dependent upon an organically bound source of Se fed to animals, and that this could be due to the molecular forms of Se present in organic Se sources (*Lawler et al., 2004*; *Wu et al., 1997*). Furthermore, various findings from feeding of different chemical forms of dietary Se to animals showed that organic Se was more bioavailable than inorganic Se of which resulted in an increase of Se contents in tissues (*Lawler et al., 2004*; *Lee et al., 2006*). In addition to selenium enriched yeast (organic form) most occupies part of selenomethionine which must undergo enzymatic transformation to selenocysteine lyase prior to the release of specific selenium without the production of reactive intermediates (*Foster et al., 1986*). *Hakkarainen (1993)* pointed out that the microbial population of the rumen can incorporate selenomethionine from selenized yeast in their proteins and thereby reduce selenium ingested food to insoluble forms, such as elemental selenium, and thus make it less available for absorption. The content of selenium in tissues is associated with a higher metabolic activity viscelarnih organs such as; kidneys, liver, spleen and pancreas. Absolutely the greatest concentration of Se was observed in the renal cortex. The explanation for this phenomenon is based on the fact that the proximal renal tubules main site of synthesis of three specific selenoproteins: a phospholipid hydroperoxide glutathione peroxidase, type I deiodinase iodotironin -5 and plasma glutathione peroxidase (*Mony and Larras Regards, 2000*).

Conclusion

Based on the conducted research and the results obtained, we can conclude:

- Source of selenium (inorganic and organic form) in meals of lambs, did not significantly affect the production performance of fattening lambs.
- Accumulation of selenium in the internal organs of lambs was significantly higher compared with the content in MLD at both trial treatments, a statistically significant difference in favor of organically bound selenium, indicate its better bioavailability.

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Efekti dodavanja različitih oblika selena u obroke za tovnu jagnjad

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Rezime

Selen (Se) je esencijalni mikroelement za ljude i životinje i predstavlja centralnu strukturnu komponentu niza specifičnih enzima a pre svega glutathion peroksidaze. Uglavnom potiče iz biljaka, koje iz zemljišta usvajaju selen u neorganskom obliku. Sadržaj Se u biljkama na našem području je nizak. Da bi se ublažile posledice nutritivnog deficita, neophodna je dopuna ovog elementa u obrocima za ishranu životinja. U tu svrhu se koriste organska i neorganska forma selena.

Cilj ovog istraživanja je upoređivanje efekata različitih formi selena na proizvodne performanse i retenciju selena u tkivima tovne jagnjadi. Istraživanjem je bilo obuhvaćeno 30 jagnjadi Mis populacije, prosečnog uzrasta oko 28 dana, podeljenih u dve grupe. Grla su hranjena identičnim obrocima koji su se sastojali od sena lucerke i potpune smeše koncentrata. Obroci su se razlikovali u tome što je ogledna grupa dobijala organski selen koji je bio proizvod američke firme Alltech i sadržao je 2000 mg selena/kg preparata, dok je kontrolna grupa dobijala neorganski selen u obliku natrijumselenita (Na_2SeO_3). Svako grlo je konzumiralo identičnu količinu selena od 0.3mg/kg suve materije u organskom odnosno neorganskom obliku koji su dodavani u mineralnovitaminsku predmešu. Rezultati oglada su pokazali da su telesne mase jagnjadi kontrolne i ogledne grupe bile ujednačene, kako 60. dana (19.60 kg; 19.65 kg), tako i 100. dana (31.06 kg; 32.88 kg). Dnevni prirasti jagnjadi kontrolne i ogledne grupe su takođe bili slični i nije bilo statistički značajnih razlika ($P > 0.05$) u vrednostima izmerenim od 28. do 60. dana (259.0 : 255.0 g), od 60.-100. dana (286.0 : 330.0g), i prosečno od 28. do 100. dana (274.0 : 297.0. g). Izvori selena nisu značajnije uticali na prosečno konzumiranje suve materije (0.695 : 0.680 kg), ukupnih proteina (134.0:130.0 g), OHJ (0.844:0.818), kao ni na konverziju hranljivih materija: suva materija (2.345: 2.481 kg); ukupan

protein (452 :476 g), OHJ (2.847: 2.987 kg), u periodu od 28-100. dana ogleđa. Ishrana jagnjadi ogleđne grupe, obrokom na bazi suplementa organskog selena je rezultirala znatno većim koncentracijama Se u MLD, bubrezima, jetri i slezini, u poređenju sa grlima kontrolne grupe, koja su konzumirala neorgansku formu selena. Ustanovljene razlike između sadržaja Se u MLD jagnjadi ogleđne i kontrolne grupe su na nivou značajnosti $P < 0.05$, dok su razlike u sadržaju Se u bubrezima, jetri i slezini, na navedenim tretmanima, bile statistički veoma značajne ($P < 0.01$). Dakle, točna janjad su bolje iskoristila organski izvor selena, što se dovodi u vezu sa boljom apsorpcijom ovog element.

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