Dynamics of IgG in the blood serum of sheep with different selenium intake

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ABSTRACT: An experiment was conducted to study the effect of supplementation of ewes with selenium in an inorganic and organic form on the level of IgG during infertility, pregnancy and lactation and in their offspring until two months of age. Control Group C (n = 5) was without Se supplementation. Experimental groups: E1 (n = 5) was supplemented with 180 µg Na_2SeO_3 per ewe/day, E2 (n = 5) received 180 µg Se per ewe/day organically bound in the biomass of an alga of the genus *Chlorella*. The average number of newborn lambs per lambing ewe was 1.0, 1.0 and 1.8 in Group C, E1 and E2, respectively. The supplementation did not influence either weight or growth of lambs. The content of IgG increased significantly in ewes in the last third of pregnancy regardless of Se supplementation while their postpartal decrease ($P < 0.01$) followed only in Group C. Lambs in Group C had a significantly lower level of IgG on Day 30 ($P < 0.05$) and 60 ($P < 0.01$) after birth especially in comparison with Group E2. The results document a lower level of immunity in the postpartal period of lambing ewes without Se supplementation and enhancement of postnatal proteosynthesis in the offspring of lambing ewes supplemented with the organic form of Se.

Keywords: selenium; *Chlorella*; Na_2SeO_3; lambing ewes; lambs

In connection with a wide range of knowledge of selenium indispensability in biochemical processes (Kim and Mahan, 2001; Underwood and Suttle, 2001; Boldizarova et al., 2005) its general dietary supplementation has become in sheep a condition of its supplementation in mineral feed additives in order to provide for the complete saturation of animals with trace elements. In the Czech Republic the consequence of Se deficiency and the efficiency of different methods of Se supplementation in ruminants were studied by Kursa (1969), Pavlata et al. (2001a) and Travnicek et al. (2007).

Deficiency of selenium is reflected in the immunity capacity of animals (Turner and Finch, 1990). Larsen (1993) reported a decrease in immunoglobulins G and M in the blood plasma at its deficiency. According to Jukola et al. (1996) resistance to infections caused by *Staphylococcus aureus*, *Actinomyces pyogenes* and *Corynebacterium* increases at an optimum selenium level in the blood. Turner and Finch (1990) and Hidiroglou et al. (1992) stated that the formation of antibodies was satisfactory even at a low dietary content of Se if a sufficient amount of vitamin E was applied. Pavlata et al. (2004) concluded that the parallel application of Se and vitamin E to pregnant dairy heifers increased colostral concentrations of Se, vitamin E and immunoglobulins.

The chemical form of dietary Se affects its metabolism. In nonruminants Se from selenomethionine is incorporated more into tissue proteins, and selenite is better available for GPX synthesis (Butler et al., 1991). According to Pavlata et al. (2001b) the organic form of Se is also better utilisable in metabolic processes when selenised yeasts were supplemented to calves. The dynamics of IgG in lambs in the first days after birth is related mainly to IgG concentration in ewes' colostrum because

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the syndesmochorial placenta of ruminants does not allow the transfer of high-molecular-weight proteins. Ruminants suffer from a gammaglobulinaemia immediately after birth before the first intake of colostrum (Aldridge et al., 1992).

Immunoglobulins G in the blood serum of lambs increase significantly after colostrum intake. According to Barta (1993) the concentration of IgG 0.04 g/l of blood serum on the day of birth steeply increases in lambs after colostrum intake until the second day to the maximum value 19.56 g/l and then it decreases to 8.37 g/l until Day 16. This decrease continues until Day 60 to the minimum value 5.52 g/l. In the subsequent period until Day 180 after birth a recurrent increase to 11.24 g/l follows, but this value does not reach the level of adult individuals yet – 20.95–30.52 g/l. Similar dynamics was observed by Maden et al. (2003). The value 2 g/l on the day of birth increased in lambs to 32 g/l on Day 1 after birth and it dropped to 13 g/l until Day 15 after birth. Changes in IgG concentration in the peripartal period were also determined in lambing ewes. According to Maden et al. (2003) IgG concentration in the blood serum dropped from 18.97 g/l at parturition to 14.8 g/l on Day 1 *post partum*. It increased again to 20.7 g/l until Day 15 *post partum*.

The objective of the present paper was to evaluate the efficiency of supplementation of an organic form of selenium in the biomass of an alga of the genus *Chlorella* and of an inorganic form (Na_2SeO_3) in relation to IgG concentration in the blood serum of lambing ewes and their lambs.

MATERIAL AND METHODS

Fifteen primiparous ewes of Sumavka sheep breed were included in an experiment at the age of 18 months, and they were divided into these groups by five animals: control C and experimental ones E1 and E2. After parturition the number of animals in the groups increased by lambs of lambing ewes. Table 1 shows the weight of lambing ewes and lambs during the whole experiment.

The formulation of feed ration during the experiment (Table 2) differed only in the amount and form of supplemented selenium.

The technology of controlled cultivation in solar bioreactors of the Microbiological Institute of the Academy of Sciences of the Czech Republic in Trebon according to the Doucha and Livansky (1999) patent was used for the production of algal biomass. Selenium content in 1 kg of dry matter of algal biomass was 255 mg.

The experiment was conducted from July 2005 to March 2006. The mating of ewes by the ram of Sumava sheep breed started in September 2005. The ewes were in the stage of non-pregnancy, pregnancy and lactation during the experiment. All ewes conceived and parturitions took place within six weeks. Blood for the selenium analysis was collected in monthly intervals approximately until four weeks before the expected parturition. After parturition blood samples were taken in lambing ewes and newborn lambs on Day 1, 3, 10, 30 and 60.

To determine IgG concentration in the blood serum an ELISA (enzyme-linked immunosorbent assay) technique of the Immunotech – Beckman Coulter Company was used.

Statistical processing of data included the calculation of mean values ($\bar{x}$) and standard deviations (SD); statistical significance was determined by ANOVA – Tukey's test.

RESULTS AND DISCUSSION

There were no significant differences in the weight of sheep (Table 1) between the experimental groups. Its insignificantly lower level in comparison with Group E1 and E2 persisted in Group C for the whole duration of the experiment although no twins occurred in the latter group contrary to 80% of twins in Group E2. The weights of primiparous

Table 1. Live weight of ewes, number of lambs born and litter weight

Group	Live weight of ewes at the beginning of experiment	Live weight of ewes 2 months after parturition	Number of lambs born per ewe	Average live weight of lambs born (kg)	Average live weight of the litter (kg)
C	37.0 ± 2.6	50.0 ± 2.7	1	4.6	4.6
E1	40.0 ± 3.6	52.8 ± 3.9	1	4.7	4.7
E2	39.3 ± 6.0	52.3 ± 3.6	1.8	4.4	7.7

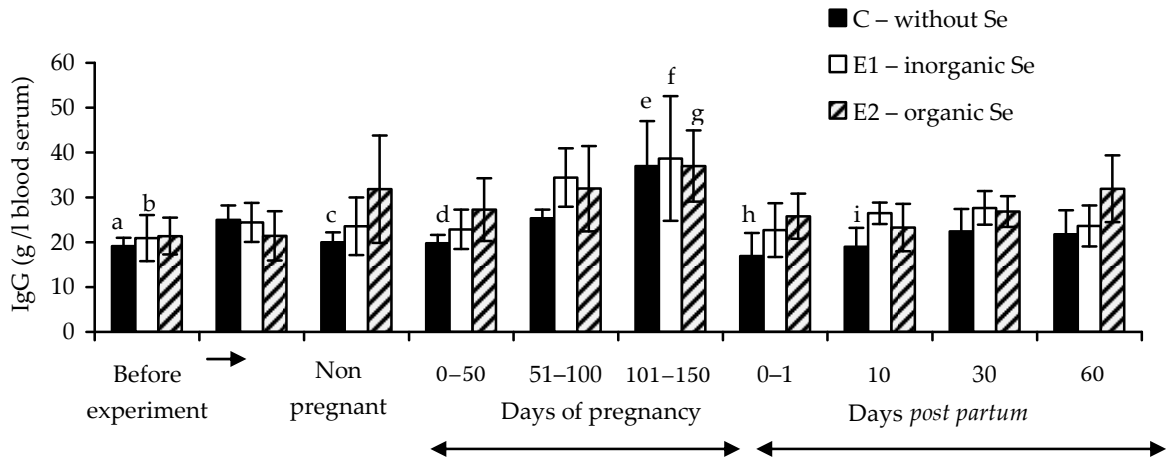

Figure 1. Immunoglobulins G in blood serum of ewes with different Se-supplementation

a:e; b:f; c:f; d:f; e:i; g:i $P < 0.05$; e:h; f:h; g:h; f:i $P < 0.01$

ewes at the beginning of the experiment until two months *post partum* corresponded to reference values for the Sumavka sheep breed. The differentiated intake of selenium by pregnant primiparous ewes did not influence the weight of newborn lambs significantly. Similar conclusions were reported by Awadeh et al. (1998) in the offspring of cows receiving selenite and selenised yeast during pregnancy. An abortion occurred in one ewe from Group C at the end of pregnancy. The cause of this abortion was not explained.

A statistically significant increase in the content of immunoglobulins G in the blood serum of primiparous ewes was recorded in the last third of pregnancy regardless of Se intake (Figure 1). This finding documents the activity of the complex of humoral changes, especially an increase in oestrogens in the period of high pregnancy (Toman et al., 2000). IgG of the blood serum of lambing ewes (Figure 1) are their crucial source for colostrum and newborn young. Mainly the isotype IgG1 is present in ovine colostrum (Barta, 1993). The decrease in IgG in the blood of lambing ewes on Day 1 *post partum* was statistically significant ($P < 0.01$) only in Group C without selenium supplementation. This group had a significantly lower selenium level in the blood serum (68.8 µg/l) (Travnicek et al., 2007) compared to group E1 (114.2 µg/l) and E2 (103.1 µg/l). There was only a statistically insignificant decrease in IgG in blood serum in Group E1 and E2 (E1 $P < 0.11$; E2 $P < 0.77$) although the lambing ewes in Group E2 receiving the organic form of selenium bore mostly twins. The good prosperity of twins can be explained on the basis of the observations of Lacetera et al. (1996) about increased colostrum production when the organic form of selenium is applied. The statistically significantly lower ($P < 0.01$; $P < 0.05$) level of IgG in Group C

Table 2. The composition of the daily ration and selenium intake per ewe

Component	Group								
	C			E1			E2		
	amount (g)	DM (g)	Se (µg)	amount (g)	DM (g)	Se (µg)	amount (g)	DM (g)	Se (µg)
Hay	1 180	1 010	40	1 180	1 010	40	1 180	1 010	40
Lucerne	240	218	6	240	218	6	240	218	6
Scraped oat	270	236	9	270	236	9	270	236	9
Mineral mixture	6	6	0	6	6	180	6	6	180
Total	1 696	1 470	55	1 696	1 470	235	1 696	1 470	235
Selenium content (µg/kg DM)			37			160			160

Table 3. Immunoglobulins G (g/l blood serum) in lambs 1–60 days after birth

Group	Sex	Days after birth				
		1	3	10	30	60
C	F	–	28.8	19.5	8.0	–
	M	0.1	> 30	> 30	17.9	9.3
	M	13.7	10.4	9.4	4.8	–
	F	14.3	11.0	7.8	3.7	9.3
E1	M	> 30	> 30	> 30	14.3	18.0
	M	–	> 30	21.7	–	–
	F	24.5	25.5	20.6	10.2	12.5
	M	> 30	> 30	> 30	19.6	12.7
	M	16.7	24.4	13.5	–	–
E2	F	> 30	> 30	29.0	–	–
	F	19.7	10.1	25.2	–	–
	M	> 30	> 30	7.0	–	–
	F	0.4	1.0	1.6	19.4	29.8
	M	14.5	18.6	18.7	20.6	16.9
	F	> 30	> 30	> 30	28.4	16.1
	F	> 30	> 30	> 30	22.8	> 30
	M	20.7	19.0	24.8	18.0	19.3
	M	6.7	6.8	5.7	7.6	17.9

F = female, M = male

twins

persisted until Day 10 *post partum* while in the group with the organic selenium intake and 80% of twins the increase in IgG was more marked until Day 60 after parturition. A tendency of the persistence of a higher level of immunoglobulins G and M and Se in the blood of lambing ewes receiving the

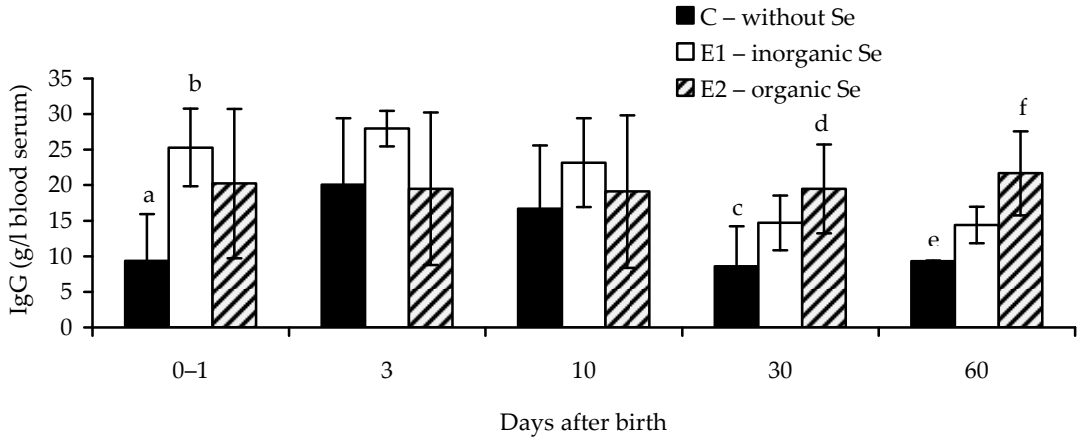

Figure 2. Immunoglobulins G in blood serum of lambs with different Se-supplementation

$^{a:b; c:d}P < 0.05$; $^{e:f}P < 0.01$

organic form of selenium after parturition was also reported in cows by Awadeh et al. (1998).

Changes in the content of immunoglobulins G in the blood of lambs are characterised by high individual variability conditioned by the amount of ingested colostrum (Table 3). In the control group (C) the level 15 g IgG/l of blood serum was not exceeded on Day 1 after birth. In both groups of lambs from selenium-supplemented ewes the values above 20 g/l of blood serum were recorded also in twins, documenting the importance of selenium supplementation of ewes regardless of the form of its application. A significantly higher value was transiently measured on Day 1 after birth in Group E1 receiving sodium selenite. The average values of immunoglobulins G in lambs did not show any statistically significant differences between the groups from Day 3 to Day 10 after birth (Figure 2). In this period the content of IgG in the blood serum of lambs is parallelly influenced by their intake from colostrum and by the onset of own proteosynthesis (Barta, 1993; Maden et al., 2003). Following this period, the level of IgG on Day 30 and Day 60 after birth remains statistically significantly lower in Group C compared to Group E2 receiving the organic form of Se in the alga of the genus *Chlorella*. The permanently higher value of IgG in Group E1 supplemented with sodium selenite did not reach statistical significance (Day 30 $P < 0.85$; Day 60 $P < 0.90$). The results of the dynamics of immunoglobulins G in lambs within two months after birth prove a marked improvement of the immunity of lambs from day 30 after birth when the lambing ewes are supplemented with selenium in an organic form (Figure 2).

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