Organic and inorganic selenium supplementation on the productive and reproductive performance of hair ewes

Suplementación con selenio orgánico e inorgánico sobre el comportamiento productivo y reproductivo de ovejas de pelo

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Abstract

The objective of this study was to evaluate the effect of supplementation with organic and inorganic selenium on the productive and reproductive performance of ewes and their offspring. Selenium (Se) is an essential mineral for sheep, studies have found its intestinal absorption and biodisponibility in the animal is greater when it comes from an organic source. A total of 18 multiparous and 22 nulliparous ewes Pelibuey breed were used in this study, averaging 54.8 ± 9.4 kg and 39.7 ± 5.6 kg of body weight (BW). The experimental units were blocked by the number of parturitions (none or more than one). Then randomly assigned to one treatment: basal diet +1.2 ppm of organic Se (OSe, Sel-Plex®) or basal diet +1.2 ppm inorganic Se (ISe). Using the linear model PROC MIXED, BW changes were measured in ewes and average daily gain (ADG) in offspring. Fisher's test, chi-squared test and *t* test were used for analyzing reproductive rates and production efficiency. No differences (P > 0.05) were found for BW changes, productive efficiency, and pregnancy rate between treatments. Prolificacy was higher (P < 0.05) for primiparous ewes in the OSe group vs the ISe group (66.7 vs 18.2%). No differences (P > 0.05) were found for birth weights of lambs. The ADG was higher (P < 0.05) for the offspring of ISe vs OSe ewes. This indicates that the OSe supplementation improves reproductive parameters, but not the productive such as ADG.

Keywords: organic e inorganic selenium sources, performance, hair sheep.

Resumen

El objetivo de este estudio fue evaluar el efecto de la suplementación con selenio orgánico e inorgánico sobre el desempeño productivo y reproductivo en ovejas de pelo. El selenio (Se) es un mineral esencial en ovinos; estudios han encontrado que su absorción intestinal y biodisponibilidad dentro del animal es mayor cuando proviene de una fuente orgánica (EFSA, 2014). Dieciocho ovejas multíparas y 22 nulíparas de raza Pelibuey con 54.8 ± 9.4 kg y 39.7 ± 5.6 kg de peso vivo fueron utilizadas para formar bloques, considerando número de partos (0 o 1 en adelante); luego asignadas aleatoriamente a un tratamiento: dieta basal +1.2 ppm Se orgánico (OSe, Sel-Plex®) o dieta basal +1.2 ppm Se inorgánico (ISe). Fue usado un modelo lineal PROC MIXED para cambios de peso en ovejas y ganancia diaria de peso (GDP) en crías; y las pruebas de Fisher, chi-cuadrada y *t* para parámetros reproductivos y eficiencia de producción. No se encontraron diferencias (P > 0.05) para cambios de peso, eficiencia productiva, porcentaje de preñez entre tratamientos. La prolificidad fue mayor (P < 0.05) para nulíparas bajo OSe vs ISe (66.7 vs 18.2%). No se encontraron diferencias (P > 0.05) para pesos al nacimiento en corderos. La GDP fue mayor (P < 0.05) para corderos hijos de borregas bajo ISe vs OSe. Es concluyente que el OSe mejora parámetros reproductivos, pero no los productivos como las GDP.

Palabras clave: selenio orgánico e inorgánico, comportamiento en ovinos.

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Introduction

Selenium (Se) is an essential trace mineral for living organisms, and its importance is mainly related to the glutathione peroxidase enzyme (Libién-Jiménez *et al*., 2015). This element could be an effective strategy to improve animal performance and reduce the negative effects of nutrient restriction to improve oxidative stress (Mousaie *et al*., 2017).

Selenium supplementation has been reported to enhance productive and reproductive ewe lamb performance (Mousaie *et al*., 2014). In general, Se fed diet has a positive effect for growth, reproduction, milk synthesis, and immune system functions in sheep. The Food and Drug Administration (FDA) regulations of the EU had authorized the Sel-Plex as a nutritional additive; produced by *Saccharomyces cerevisiae* cultures (EFSA, 2014). The FDA recommend that Se be supplemented in feed by 0.3 mg/kg (Hall *et al*., 2012). However, this recommendation does not consider the Se source, which is usually classified as inorganic and organic. The inorganic element is typically administered through commercial mineral premixes or injected as Na-selenite or Na-selenate. Organic Se is associated with the amino acids methionine and cysteine, which are found in Se-yeast and make it highly digestible (Stewart *et al*., 2012; EFSA, 2014). Therefore, new alternatives for the supplementation of this mineral are being studied to improve and enhance animal performance. Sel-Plex (*Saccharomyces cerevisiae* cultures) has been demonstrated to have a higher digestibility compared with inorganic selenium as feeding additive in animal performance. However, these are still contradictive results because the accelerated lambing system demands high nutritional levels and also the ewes are under continuing nutritional and management stress. The objective of this study was to evaluate the effect of feeding inorganic and organic Se on the productive and reproductive performance of hair ewes and their offspring's.

Materials and methods

All procedures involving animals were approved by local official techniques for animal care (NOM-051-ZOO-1995: Humanitarian care of animals during mobilization of animals; NOM-024-ZOO-1994: Animal health stipulations and characteristics during transportation of animals). Forty Pelibuey non-pregnant ewes were used in the study (n = 22 nulliparous ewes, and n = 18 multiparous, with one or more parturitions; averaging 39.7 ± 5.6 and 54.8 ± 9.4 kg of initial body weight [BW], respectively). Prior to the start of the experiment, all sheep received 1 mL/50 kg BW of Dectomax (0.2 mg/kg BW of doramectin; Zoetis) and 2.5 mL of Bobact-8® (MSD). All experimental units were blocked by the number of parturitions and randomly assigned to one of two treatments, resulting in two groups of nulliparous and multiparous ewes. Doses of 1.2 ppm of inorganic Se (ISe) or organic Se (OSe) Sel-Plex50^{MR} were added to the basal diet of each group. The basal diet was prepared every week and consisted of 57% forage (alfalfa hay and oat hulls) and 43% concentrate composed of mainly alfalfa and steam-rolled corn grain to cover nutritional requirements (NRC, 2007; Table 1).

Table 1. Composition of experimental diets and chemical analysis.

Ingredients	Gestation	Lactation
Corn flakes, kg	21.3	18.2
Oat hulls, kg	17.4	18.5
Alfalfa hay, kg	57.2	57.4
Soybean meal, kg	–	3.0
Molasses, kg	3.6	2.5
Mineral premix[1], kg	0.3	0.3
Salt, kg	0.1	0.1
OSe or ISe, ppm	1.2	1.2
Chemical analysis (kg kg^{-1})		
DM	93.4	93.4
OM	89.7	89.6
CP	14.7	15.6
ADF	29.4	28.9
NDF	36.6	46.1
EE	6.3	7.2

[1] Commercial mineral premix, each 100 g contains: 1.4% Mg, 0.26% S, 0.12% Fe, 0.048% Cu, 0.003% Co, 0.072% Mn, 0.42% K, 0.12% Zn, 0.003% I, 3.936% Na, 6.064% Cl, 14% Ca, and 8% P. DM = dry matter, OM = organic matter, CP = crude protein, ADF = acid detergent fiber, NDF = neutral detergent fiber, EE = ether extract.
Source: Author´s own elaboration.

The study was performed at the Facultad de Zootecnia of the Universidad de Chihuahua, from July 1st of 2006 through April 30th of 2007. It began with the selenium supplementation to the ewes; six weeks before the breeding season, all through the gestation period and continued 90 days postpartum until weaning time. Pregnancy rate, prolificacy, production efficiency, and postpartum BW changes were evaluated for the ewe lambs and ewe groups. The average daily gain (ADG) of the offspring was also estimated. The pregnancy rate was determined by ultrasound imaging using an Aloka SSD-500V with a 3.5 MHz transabdominal probe 60 days after the end of the breeding period. Prolificacy was determined after lambing was completed by dividing the total number of offspring born per group by the number of ewes lambed within each treatment group. Productive efficiency was measured by the formula: (weaned lamb kg/ewe kg) * 100. Body weight changes in ewes were determined from the beginning of the experiment using an electronic scale to weigh individuals every 14 days. The offspring were also weighed every 14 days from birth to weaning day (at 90 days of age).

Continuous variables of BW changes in ewes and ADG in offspring were analyzed with PROC MIXED using a linear model that included treatment, age, treatment by age, type of lambing, and type of birth by age (SAS®). The random effects in the model were the ewes, lambs within treatments, and rams. Fisher's and Chi-square test were used to analyze pregnancy rates and prolificacy, respectively. A *t* test for independent samples was used for production efficiency to observe the effect of treatment on these variables.

Results and discussion

Pregnancy rate was not different (P > 0.05) by treatment (OSe vs ISe) among the four groups (81.8% vs 77.7%; and 72.7% vs 66.6%, nulliparous and multiparous, respectively). Although it can observe a higher pregnancy rate for OSe of nulliparous ewe compare to the multiparous group. Even when no significant differences were found between organic or inorganic Se source. Hall *et al.* (2012) demonstrated high bioavailability of OSe in supplemented ewes. For other way, Awawdeh *et al*. (2019) recently found that multiple injections of vitamin E and Se improve the pregnancy rate but no the fertility of the ewes. Then our results are some similar to these studies; where has been demonstrated that both Se sources (organic and inorganic) have positive effects on reproductive performance in ewes. Been numerically higher when in nulliparous fed with Ose.

The prolificacy rate was higher (P < 0.05) for the nulliparous OSe group compared with the nulliparous ISe group (66.7% vs 18.2%, respectively; Table 2). These results are similar to those of Davis *et al*. (2006) and Steen *et al*. (2008), who reported that organic Se supplementation increased Se concentrations in blood and organ tissues. With positive effects in tissue metabolism that consequently could enhance the pregnancy rate and prolificacy. Sanchez *et al*. (2008) found a positive effect with Se supplementation on estrous synchronization inside and outside the breeding season. However, Sánchez *et al.* (2008) reported high embryonic mortality caused by Se supplementation of the dam previous mating period. Contrary to our findings fed diet OSe increases the number of lambs per lambing in the nulliparous ewes. There were also no differences (P > 0.05) found between OSe and ISe treatments in the multiparous groups. These results can be support with Awawdeh *et al*. (2019), whom reported increase in prolificacy in ewes with multiple injections of vitamin E and Se, pre- and post-mating. Showing that inorganic or organic Se have a positive effect on prolificacy rate.

No differences (P > 0.05; Table 2) in BW changes were found between treatments for nulliparous and multiparous groups. Similarly, Awawdeh *et al*. (2019) reported no positive BW changes in ewes and their lambs under multiple injections of vitamin E and Se. Kumar *et al*. (2009) reported a positive effect on ADG in feed lot lambs supplemented with Se, been higher for those receiving organic Se compare to the inorganic fed. Also, Awadeh *et al*. (1998) reported that cows supplemented with Se did not increase their BW during the experimental period. Most studies report OSe benefits for reproduction parameters and immune system, but no improvement in ADG. All these studies support our results with no positive effect of Se fed diet on BW changes.

Table 2. Productive and reproductive performance in Pelibuey ewes supplemented with organic selenium (OSe) or inorganic selenium (ISe).

	Nulliparous		Multiparous	
Parameter	**OSe**	**ISe**	**OSe**	**ISe**
Production efficiency (%)	68.3 ± 6.8	65.3 ± 4.5	72.0 ± 7.7	77.6 ± 5.6
Prolificacy (%)				
Lambing singles	33.3[a]	72.7[b]	11.1	33.3
Lambing twins	66.7[a]	18.2[b]	55.6	66.7
Lambing triplets	0.0[a]	9.1[b]	33.3	0.00
Pregnancy (%)*	81.8	72.7	77.7	66.6

[a,b] Different literals between columns indicate differences (P < 0.05) between treatments.
* Evaluated within the time of the experiment. OSe = basal diet plus 1.2 ppm organic selenium (Sel-Plex), ISe = basal diet plus 1.2 ppm inorganic selenium.
Source: Author´s own elaboration.

Offspring birth weights were not different (P > 0.05) between treatments. However, ADG was higher (P < 0.05) for the offspring of nulliparous supplemented with ISe compared with those receiving OSe (Figure 1) with regression coefficients of 3.68 ± 0.75 and 3.21 ± 0.72, respectively. While no differences (P > 0.05) were found by ADG for the offspring of multiparous ewes. We believe that the maximum ADG present in the offspring of ISe nulliparous group was because had a higher of single births. Due to the fact that single birth lambs have a greater advantage (P < 0.05) over twins because they do not have competition for suckling milk, which usually results in better performance during the lactation period. Davis *et al*. (2006) reported Se placental transfer from the ewe to the fetus, and Stewart *et al*. (2012) reported benefits in ADG for the offspring of ewes supplemented with supranutritional Se concentrations. Also, Hefnaway *et al*. (2008) reported that subcutaneous or oral sodium selenite have a positive relationship between maternal plasma, milk and lamb plasma; improving the body weight gain of the newborn lambs. Kumar *et al*. (2009) reported improved growth rate of lambs fed Se supplemented diets; being higher when lambs were under OSe fed diet. Fed Se supplementation diets has been demonstrated to improve weight gain and gain:feed (Mahima, 2006). Studies have shown that OSe is better absorbed and utilized in ruminants when compared to ISe source (Kumar *et al*., 2009). These studies reported a positive effect over ADG of new born lambs from organic and inorganic Se supplemented ewe's pre-parturition and post-partum. The results for the present study is similar body weight gain; although single births could have a potential effect for this rate.

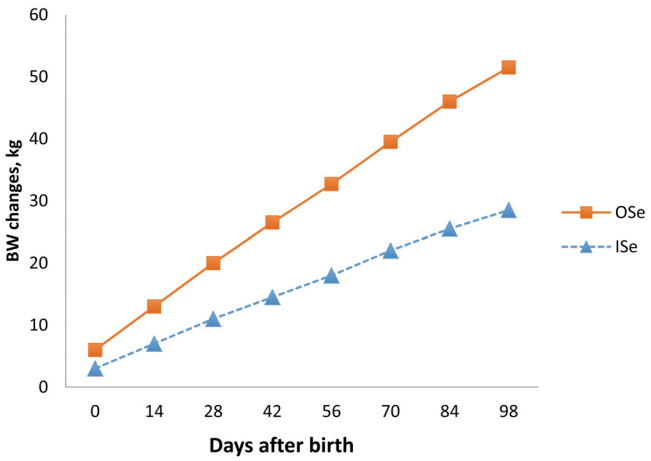

Figure 1. Body weight (BW) changes of the offspring from nulliparous ewes.
Source: Author´s own elaboration.

Conclusions

Supplementation of 1.2 ppm of OSe at least six weeks before the breeding season had favorable effects on pregnancy rates and prolificacy in nulliparous Pelibuey ewes. However, no beneficial effects were found on postpartum BW changes. More studies about OSe supplementation are therefore recommended because even though there have been some reports, the results remain inconsistent. Probably due to the way OSe is supplied, the doses and source of Se supplementation. We also recommend measurement of glutathione peroxidase activity, which is the best indicator of Se metabolic status which could be associated with animal performance results.

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