

The Effect of Colloid and Micelles vs. Inorganic Forms of Nano-Selenium on Performance, Health, Growth Factors, and Some Blood Parameters of Holstein Calves

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Abstract

This study aimed to investigate the effect of different forms of selenium in the nutrition of Holstein suckling calves. This study was performed using 40 male and female Holstein calves with an average age of 1 to 8 days and an average weight of 39 ± 6 kg with 4 treatments and 10 replications as a completely randomized block design. Experimental treatments include: 1) Selenium-free base diet (control), 2) Basic diet with 3 mg/kg nano-selenium micelles, 3) Basic diet with 3 mg/kg nano-selenium colloid, and 4) Basic diet with 3 mg/kg sodium selenite. During the experimental period, the starter diet was given to the calves freely as well as chopped dried hay from the age of 20 days. The results showed that using different forms of selenium could not significantly affect feed intake, daily weight gain, and feed conversion ratio during periods. Also, various forms supplementation of selenium did not significantly affect blood metabolites including glucose, cholesterol, triglycerides, urea, albumin, total protein, and beta-hydroxybutyrate in suckling calves. The blood concentrations of aspartate aminotransferase, alanine aminotransferase, and superoxide dismutase could not make a significant difference by adding different forms of selenium in the suckling calves diet, while blood concentrations of glutathione peroxidase and catalase were significantly increased by adding nano-selenium micelles and selenium mineral form, respectively ($P < 0.05$). Different forms of selenium did not change the withers height, in contrast to the heart girth and body length. It is generally concluded that nano-selenium micelles can improve the immune status of suckling calves.

Keywords: Dairy calves, Different selenium forms, Growth performance, Health.

Research Highlights

The suckling calves that make up the next generation of the herd are the largest capital of dairy cattle breeders. Traditionally, farmers do not use any

mineral supplements for their calves. The need for minerals during the rearing period in calves increases for calves' development as alternative heifers. Low-consumption mineral elements such as

selenium can be included in the diet from various sources (organic, mineral, and nano). This study aimed to investigate the effect of various sources of selenium, including in the form of micelles and colloids on performance, health, growth factors, and some blood parameters of dairy calves. Using emulsion technology to deliver essential nutrients to the calf and increase its efficiency is beneficial in improving and enhancing health.

Introduction

The future of any dairy farm depends on its success in rearing calves and alternative heifers. With the availability of facilities, the most economical way to provide the heifers needed by the herd is to raise dairy calves. The suckling calves that make up the next generation of the herd are the largest capital of dairy cattle breeders. Respiratory diseases, diarrhea, and other gastrointestinal problems have been identified as the most common diseases of suckling calves and any action to reduce the above problems will be effective in increasing the efficiency of suckling calves [1]. Nutritional manipulation as one of these appropriate management measures is important to reduce the incidence of disease and also reduce calf mortality. Due to the high nutritional needs of young calves, limited nutrient reserves in the body, and the ability to digest nutrients, this stage of feeding is very critical for calves. The body's requirements for minerals vary according to age, size, physiological states (pregnancy, milk production, and growth), action, animal species, and genetics [2].

Selenium is a micronutrient that plays a key role in animal health and function. Because the immune systems in suckling calves are not developed and mature. Therefore, supplementing the diet with selenium is especially important in the feeding of new-born calves. Selenium

deficiency in the diet of dairy cows can lead to ovarian cysts, heat stress damage, the birth of weak calves, and susceptibility to disease with poor immunity and whitening muscle disease [3]. Low-consumption mineral elements such as selenium can be included in the diet from various sources (organic, mineral, and nano). Organic selenium is a component of selenocysteine. Selenocysteine is an amino acid that plays an important role in cellular function and the immune system [4]. The two most common forms of oral selenium (sodium selenite and selenium-rich yeast) are additives in the diet of farm animals. Selenomethionine and selenocysteine are the major constituents of selenium-containing organic compounds in selenium-rich yeast, which makes a difference in its metabolism in the body compared to mineral selenium [4]. Micelles are used as encapsulating and carrier structures for different hydrophobic molecules such as essential oils, flavors, antioxidants (polyphenols, carotenoids, coenzyme Q10), vitamins, minerals, proteins, nutrients, and nutraceuticals [5]. These micelles act as liquid carriers, allowing encapsulation of different bioactive components (vitamins, minerals, and phytosterols). The micelles are added to the food products to improve the bioavailability of the bioactive, being able to pass through the digestive system effectively, without breaking up, and thus effectively reaching the absorption site [6]. A study by Asghari *et al.* [7] is an attempt to show that using emulsion technology to deliver essential nutrients such as essential oils to an animal (calf) and increase its efficiency is beneficial in improving and enhancing health.

However, little or no studies have been performed to determine the effect of nano-selenium in the form of micelles and colloids on calf nutrition. Therefore, this study aimed to investigate the effect

of various sources of selenium, including in the form of micelles and colloids on performance, health, growth factors, and some blood parameters of dairy calves.

Materials and Methods

Preparation of Nano Colloid, Nano Micelles, and Mineral Selenium Forms

In this study, different forms of selenium were in the form of three forms nano-selenium micelles (emulsion), colloid-nano-selenium, and inorganic selenium, sodium selenite. To prepare nano micelles, six materials were used: Acacia, flaxseed oil, nano-selenium (Nano Se), whey, and benzoate, the values of which are presented in Table 1. Briefly, 25 g of lecithin was dissolved in 25 g of flaxseed oil by heating to 60 °C and mixing using a magnetic stirrer (magnet) for 10 minutes to prepare the lipid phase. The aqueous phase was dissolved by mixing 4 g of Acacia, 5 g of whey, and 0.2 g of benzoate (as a preservative) in 250 ml of distilled water, previously heated with an electric heater to 60 °C, by gentle mixing using a magnetic stirrer on an electric heater, it was prepared for one hour. They were then mixed in a blender for 15 minutes by adding 30 ml of nano-selenium to the oil phase. The aqueous phase was then slowly added to them

and mixed for 20 minutes in a blender. Finally, by adding the required amount of distilled water, the final volume of the emulsion (nano-selenium micelles) reached 1000 ml.

The prepared nano-selenium micelles were stored in a dark 1-liter polyethylene bottle until use. The prepared nano-selenium micelles were examined under an atomic force microscope to obtain a microscopic image of the size of the nano-selenium micelle droplets along with their distribution (Figure 1). In addition, the charge density assessment of the Z potential (Table 2) of nano-selenium micelle droplets prepared was measured using an electrophoretic light scattering method (NanoPartica SZ-100 V2 Series, Horiba Scientific Instrument, Japan). Before measurement, the prepared nano-selenium micelle sample was diluted with distilled water in a ratio of 100: 2 (taking into account the optimal range of equipment detection and avoiding multiple scattering effects) [8]. Sample measurements were repeated three times after three weeks of storage at room temperature as an indicator of nano-selenium micelle stability [9]. The droplet size distribution of nano-selenium micelles was between 100-300 nm based on AFM results (Figure 1).

Table 1 Nano-micelles compounds (emulsion)

Material type	Amounts L ⁻¹
Acacia	4 g
Lecithin	25 g
Oil	25 g
Nano Se	30 ml
Whey powder	5 g
Benzoate	0.2 g

Table 2 Evaluation of nano-selenium

Samples	Mean (nm)	SD (nm)	Mode (nm)	Z-Average (nm)	PI	Zeta Potential(mv)
1	386.4	97	376.5	459.3	0.377	-83.1
2	512.9	127.2	482.9	811	0.41	-78.5
3	263.4	68	233.8	713.6	1.049	-81.2

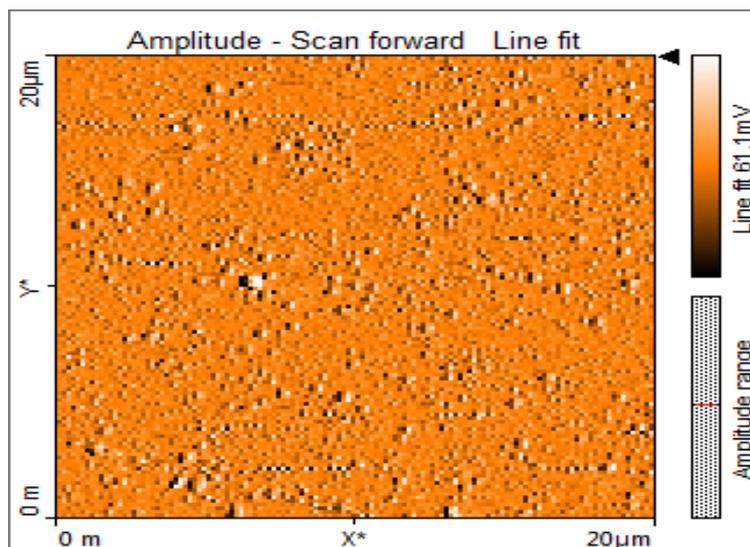


Figure 1 Atomic force microscope image (AFM) of the prepared emulsion sample (after dilution 2: 100 v/v)

The Z potential of nano-selenium micelle droplets was determined in three replications of -83.1, -78.5, and -81.2, respectively (Table 2). Because emulsion systems with a Z potential greater than -60 mV are considered excellent stable emulsions and systems with a Z potential greater than -30 mV are considered physically stable systems. Therefore, the study sample had a Z potential of more than -60, and then the study sample as a natural emulsion sample can be mentioned as a completely stable and excellent emulsion system. To prepare nano-selenium colloid, 60 ml of nano-selenium was dissolved in one liter of distilled water, and to prepare mineral selenite (sodium selenite), 0.5 g of sodium selenite was dissolved in one liter of distilled water.

Experimental Design and Animal Management

In this study, 40 male and female Holstein calves with a mean age of 1-8 days and a mean body weight of 39 ± 6 kg were selected. The experiment was performed in the animal husbandry unit of Pars Agro-industry and Animal Husbandry Company from the end of

November to the end of January 2016. Four treatments of 10 heads (equal numbers of both sexes) were: 1) Selenium-free base diet, 2) Basic diet with nano-selenium micelles, 3) Basic diet with nano-selenium colloid, and 4) Basic diet with inorganic selenium, sodium selenite. Except for the control treatment [1], other treatments had the same selenium concentration of 0.3 mg/kg in the diet. The calves were separated from the mothers immediately after birth and transferred to individual pens. The pens were cleaned of all bedding and fecal material once daily before noon and replaced with new bedding material (straw). During the first 12 hours of life and 3 days later, based on 10% of body weight, the calves received 4 kg of colostrum. After that, the calves were fed 4 kg of milk per day until the age of 40 days and 6 kg of milk per day from 41-60 days. This operation was performed at 8 am, 4 pm, and 12 pm, and the milk volume decreased from 61 days and was weaned at 65 days of age. To ensure that the calves receive the full amount of sodium selenite (1.5 ml) colloidal nano-selenium (5 ml) and nano-selenium micelles (10 ml), the prescribed amount (morning meal) to calf milk was

added. Drinking water was provided to the calves freely, except for one hour before and after milk feeding. From the fourth day after birth, the starter diet was freely given to the calves to consume based on appetite, and their daily intake was recorded. The rest of the feed was collected and weighed every morning, the next morning, and then the fresh feed was poured into the feed bucket. The nutrients and components of the test diets and their chemical composition are reported in Table 3. Experimental diets were adjusted using the NRC [10] software of dairy cows and based on the nutritional needs of a 42 kg calf and according to the chemical composition of the available feed.

Data Collection, Sampling Procedure, and Chemical Analysis

The chemical composition of feed (crude protein, NDF, ADF, crude ash, calcium, and phosphorus) used in the setting of experimental diets was determined in the standard laboratory.

Calves were measured individually every 10 days with a digital scale for weighing calves. Body growth parameters including withers height,

body length, and heart girth were recorded at the beginning and end of the experiment. At the end of the experiment, blood was drawn from the jugular vein 3-4 hours after feeding in the morning. Blood samples were collected. At 3500 rpm, they were centrifuged at 4 °C for 15 minutes, and the plasma and serum samples were stored for -20 days at -20 °C until chemical analysis. On the day of chemical analysis, the samples are melted at room temperature and the concentrations of glucose, cholesterol, triglycerides, total protein, catalase, albumin, beta-hydroxybutyrate, blood urea, and the activity of liver enzymes such as aspartate aminotransferase, alanine aminotransferase were evaluated and analyzed by commercial laboratory kits (Pars Azmoun, Tehran, Iran) with autoanalyzer system (Biotechnica Targa 3000, Rome, Italy).

Statistical Analysis

Data related to blood and enzyme parameters were analyzed by GLM procedure and repeated data analysis (body weight, average daily weight gain and feed efficiency) by mixed procedure and using SAS software [11].

Table 3 The components of the basic diet and its chemical composition

Feed items	%	Chemical composition	%
Corn grain	39.1	Dry matter	88.10
Barley grain	20	Protein	22.12
Soybean meal	30	Neutral detergent fiber	7.31
Wheat bran	5.5	Acid detergents fiber	17.25
Salt	1	Ether extract	2.28
Oyster powder	1	Calcium	0.55
Bentofid	1	Phosphorus	0.23
Binder Magnetotox	0.1		
Fish meal	1.5		
Vitamin E	0.2		
Vitamin A	0.1		
Mineral supplement without selenium	0.5		

Vitamin supplement composition: Vitamin A: 500,000 international units per kilogram, Vitamin E: 100 mg/kg, Vitamin D3: 100,000 international units per kg, Mineral supplement composition: Calcium 195,000 mg, Phosphorus 90,000 mg, Magnesium 90,000 mg, Sodium 55,000 mg, Zinc 3000 mg, Manganese 2000 mg, Copper 280 mg, Cobalt 100 mg, and Antioxidant 400 mg.

For repeated data, the comparison of least square means at the 5% level was done by Tukey's test. The statistical model used was as follows:

$$Y_{ij} = \mu + T_i + e_{ij} \quad (1)$$

Where,

Y_{ij} : the dependent variable, μ : average of each of the observations, T_i : treatment effect, and e_{ij} : the effect of experimental error.

Results

Feed Intake and Growth Performance

The results related to the effect of different forms of selenium on feed intake and growth performance of suckling calves are indicated in Table 4.

The addition of different forms of selenium (nano micelles, colloids, and mineral form) did not have a significant effect on daily weight gain in the first, second, third, fourth, and total rearing periods compared to the control group. The mean daily weight gain over the

entire rearing period in the calves receiving nano-selenium micelles had a significant increase compared to other treatments. Likewise, adding different forms of selenium during this experiment did not affect the feed intake of suckling calves in the first, second, third, fourth, and whole rearing periods, but numerically, in the whole rearing period, feed intake was higher as daily weight gain in the groups receiving nano-selenium micelles. The results showed that the groups receiving nano-selenium micelles and the mineral form of selenium had a lower feed conversion ratio (FCR) compared to other treatments. Increased body weight and feed efficiency of calves using different forms of selenium did not change significantly (Table 4).

Skeletal Growth Function

The results of different forms of selenium on the skeletal growth performance of suckling calves are shown in Table 5. Withers height was not affected by the addition of various forms of selenium.

Table 4 The effects of different forms of selenium on the growth performance of Holstein calves (g/ day)

Items	Basic diet				SEM	P-value
	Control (Selenium-free)	With nano-selenium micelles	With nano-selenium colloid	With sodium selenite		
Daily weight gain						
First period	434	440	445	435	36.01	0.99
The second period	744	850	725	780	70.11	0.61
Third period	824	810	810	950	57.36	0.25
Fourth period	856	1000	880	905	54.14	0.26
The whole period	690	755	715	676	25.24	0.07
Feed intake						
First period	155	134	124	137	22.80	0.81
The second period	372	365	307	326	28.14	0.32
Third period	684	700	643	681	59.41	0.92
Fourth period	982	1092	1057	1020	78.97	0.78
The whole period	548	582	533	543	39.40	0.83
Feed conversion ratio	0.751	0.734	0.743	0.711	0.04	0.94

Table 5 The effects of different forms of selenium on the skeletal growth performance of Holstein calves (cm)

Items	Basic diet				SEM	P-value
	Control (Selenium-free)	With nano-selenium micelles	With nano-selenium colloid	With sodium selenite		
Withers height						
First day	82.50	84.25	85.35	83.00	0.80	0.08
The end of the period	95.20	95.20	97.40	96.80	0.82	0.33
Changes	12.75	13.15	12.05	13.80	0.61	0.23
Heart girth						
First day	81.75	81.75	74.40	80.50	0.84	0.84
The end of the period	98.12	98.12	99.00	98.30	0.91	0.91
Changes	16.37 ^b	18.55 ^{ab}	19.60 ^a	18.10 ^{ab}	0.71	0.71
Body length						
First day	94.00	94.20	96.10	94.50	1.61	0.80
The end of the period	108.10	113.70	114.10	117.60	1.41	0.01
Changes	14.12 ^b	19.50 ^a	18.00 ^a	19.80 ^a	1.21	0.01

Means without a common letter within the same row differ (P < 0.05).
SEM standard error of the mean.

Heart girth was affected by the use of different forms of selenium so that the groups receiving selenium colloid could have the most changes in heart girth among the experimental groups (P < 0.05). The body length of suckling calves was also affected by adding various forms of selenium so that the groups receiving nano-selenium micelles and the mineral form of selenium caused the most changes throughout the body. The results related to skeletal growth showed that the addition of different forms of selenium could not have a significant effect on the withers height while the heart girth and body length were affected.

Blood Parameters

The results of the study of the effects of different forms of selenium on blood parameters, hepatic enzymes, and the immune system of suckling calves are listed in Table 6. Supplementation of diet with different forms of selenium could not have a significant effect on blood parameters of glucose, cholesterol,

triglyceride, urea, albumin, total protein, beta-hydroxybutyrate, and malondialdehyde in suckling calves. Furthermore, blood concentrations of liver enzymes such as superoxide dismutase, aspartate aminotransferase, alanine aminotransferase, and total antioxidant capacity were not affected by different forms of selenium. The concentrations of glutathione peroxidase and catalase showed a significant increase using different forms of selenium. The use of different forms of selenium caused a significant difference in the blood concentration of selenium so that the group receiving nano-selenium micelles had the highest concentration of blood selenium. Blood concentrations of glutathione peroxidase increased in selenium-receiving calves. Meanwhile, the group that received nano-selenium micelles had higher concentrations of glutathione peroxidase compared to other treatments.

Discussion

Feed intake and Growth Performance

The recommendation for adding selenium to the diets of suckling calves is 0.3 mg/kg of dietary dry matter [10].

However, at this early stage in the life of suckling calves, dry matter intake is very low and milk is the source of almost all nutrients, but only contains an average of 0.02 to 0.15 mg of selenium per kg of dry matter. Many studies do not observe significant effects of selenium on calf performance under normal conditions. According to the findings of Juniper et al. [12], oral supplements with a source of selenium yeast or organic form (1.2 to 3.19 mg of selenium per kg of dry matter) did not affect calf performance. In this regard, research results reported the positive effects of nano-selenium on daily weight gain in sheep [13] and in goats [14]. However,

there are reports that the addition of different levels of selenium and different sources of selenium does not have a significant effect on the growth performance of cows [15] and lambs [16]. Shi et al. [17] observed a positive effect on growth performance by feeding selenium to goats. The researchers attributed this growth to higher dietary selenium and increased absorption. In another study, El-Shahat and Abdel Monem [18] reported that supplementing the diet with vitamin E and selenium in ewes' diets increased the growth performance of newborn lambs. Kafilzadeh et al. [19] did not observe any effect on birth weight, daily weight gain, and weaning weight in newborn calves by injection and oral methods of vitamin E and selenium.

Table 6 The effects of different forms of selenium on blood parameters, hepatic enzymes and immune system of Holstein's calves

Items	Basic diet			SEM	P-value	
	Control (Selenium-free)	With nano-selenium micelles	With nano-selenium colloid			
Glucose (mg / dL)	94.4	106.1	102.6	92.8	6.51	0.42
Cholesterol (mg / dL)	92.5	79.3	89.4	91.9	5.52	0.31
Triglycerides (mg / dL)	32.7	27.5	33.8	29.9	2.83	0.43
Blood urea (mg / dL)	12.6	14.3	14.1	14.4	1.41	0.80
Protein (g / dL)	5.0	5.1	5.3	5.2	0.11	0.38
Albumin (g / dL)	2.9	4.01	4.0	4.06	0.10	0.79
BHBA (mmol / L)	0.254	0.220	0.233	0.213	0.02	0.74
Malondialdehyde (mmol/L)	2.07	1.81	2.01	1.93	0.12	0.42
Selenium (µg/L)	18.0	28.5	19.0	25.0	1.76	0.01
Aminotransferase aspartate (u/ml)	56.5	58.9	59.4	56.5	0.83	0.56
Alanine aminotransferase (u/ml)	20.2	21.6	19.5	21.1	0.71	0.22
Glutathione peroxidase (u/gHB)	49.9 ^b	125.8 ^a	114.0 ^a	122.1 ^a	4.6	0.01
Superoxide dismutase (u/gHB)	1280.0	1340.4	1300.0	1268.6	27.6	0.28
Total antioxidant capacity (mmol/l)	0.189	0.178	0.187	0.198	0.01	0.60
Catalase	50.2 ^b	69.3 ^a	67.1 ^a	71.8 ^a	3.2	0.01

Means without a common letter within the same row differ (P < 0.05).

SEM standard error of the mean.

BHBA: β-Hydroxybutyric acid.

Also, in another study, Droke *et al.* [20] did not observe a positive effect on growth performance in calves, and as well as, Voudouri *et al.* [21] used vitamin E and selenium. Other studies have emphasized the lack of effect of selenium sources on growth performance [22]. Kumar *et al.* [23] examined different levels of sodium selenite in the diet of suckling lambs and reported that the use of 0.15 and 0.3 ppm did not affect growth performance. In another study, Najafnejad *et al.* [24] examined the effects of different sources of selenium in diets rich in unsaturated fatty acids and reported that their weight gain was not affected by experimental treatments.

Skeletal Growth Function

In this regard, Zarei *et al.* [25] reported that the use of different sources of selenium affected the body length and heart girth of suckling calves. Gunter *et al.* [15] showed that supplementing the diet with selenium did not improve growth parameters. Sasani *et al.* [26] reported that injections of vitamin E and selenium in suckling calves did not cause a significant difference in skeletal growth indices (heart girth, withers height, pelvic height, body length, and distance between two hip bones). Changes in skeletal growth are affected by herd growth status and health, genetics, feed intake, and feed conversion ratio. Khoshgoftar *et al.* [27] by examining the effects of selenium supplementation on the skeletal growth of suckling calves reported that the use of this supplement could not have a significant effect on skeletal growth parameters such as withers height, body length, hip distance, and withers height. Kumar *et al.* [23] suggested that adding 0.3 mg/kg sodium selenite had no significant effect on skeletal growth rate in growing lambs.

Blood Parameters

There are reports that glucose concentration in nano-selenium-receiving calves is higher than that in the sodium-selenite-receiving group [28]. Juniper *et al.* [16] further stated that selenium intake did not affect blood albumin concentration in dairy cows. Qin *et al.* [29] reported that adding selenium supplements to the lambs' diets lowered cholesterol. In another study, Ebrahimi *et al.* [30] reported that the use of selenium yeast in calves' diets reduced blood cholesterol levels and attributed it to improved thyroid efficiency in fat metabolism. Haidari *et al.* [31] showed that intramuscular injection of 1 ml of vitamin E and selenium in Baluchi ewes showed that blood triglyceride and cholesterol levels could not be significantly affected. Zarei *et al.* [25] by examining the effects of selenium supplementation in the diet of suckling calves showed that selenium supplementation increases glucose concentration. In another study, Asadi *et al.* [32] showed that injection of vitamin E selenium in lambs increased blood glucose and triglyceride parameters. Slavik *et al.* [33] showed that the use of selenium does not affect blood protein concentration. Singh *et al.* [34] and Kumar *et al.* [23] also reported that supplementing the diet with selenium did not affect globulin concentration. Hisham *et al.* [35] reported that taking vitamin E and selenium supplements did not affect blood glucose concentrations. Calamari *et al.* [36] found that the use of vitamin E and selenium injections or the use of sodium selenite or vitamin E did not have a significant effect on blood glucose, cholesterol, and triglyceride concentrations. In contrast to the results of this study, Falkowska *et al.* [37], and Ziaei *et al.* [38] suggested that supplementing the diet with selenium had a significant effect on blood

triglyceride concentration. Glutathione peroxidase is a selenium-containing antioxidant enzyme with a direct relationship between increased activity of this enzyme and serum selenium concentration. Following the results of this study, Kaneko *et al.* [39] (using 0.1 ppm selenium to a diet containing 0.06 ppm selenium organically and inorganically in fattening periods and using 0.26 ppm selenium in calves reported an increase in glutathione peroxidase activity. The study of Ali Arabi and Fadaifar *et al.* [40] showed that the use of selenium supplementation as a slow-release bolus in pregnant ewes and lambs born from them increased glutathione blood concentration. Mousavi *et al.* [41] also stated that injection of vitamin E and selenium solution in transition cows did not affect the concentration of glutathione peroxidase in calves. In another study, Mousavi *et al.* [41] reported that selenium injection in dry cows increased the concentration of blood glutathione peroxidase on calving day. In the study of Balicka Ramisz *et al.* [42], the effect of mineral supplementation including selenium had no significance on days 230 and 260 of pregnancy, 6 days before parturition, and 3, 7, 14, and 25 days after parturition on serum glutathione peroxidase activity. Abdolmaleki *et al.* [43] reported that injections of vitamin E and selenium in dry cows could not have a significant effect on malondialdehyde concentration in cows and calves born from them. Gunter *et al.* [15] reported that selenomethionine consumption in near-calving cows increased the concentration of glutathione peroxidase in calves born to them. The researchers stated that selenomethionine increased blood selenium levels more than sodium selenite. Huang *et al.* [44] reported that nano-selenium has a higher ability to trap free radicals produced in response to the oxidation of unsaturated fats in the

body, thus protecting body tissues against oxidative damage.

Conclusion

Low-consumption mineral elements such as selenium can be included in the diet from various sources (organic, mineral, and nano). It is generally concluded that the use of nano-selenium micelles can improve the immune status of suckling calves. As a result, Using emulsion technology to deliver essential nutrients to the calf and increase its efficiency is beneficial in improving and enhancing health.

Ethics approval

Animal studies have been approved by the Animal Ethics Committee of the University of Mohaghegh Ardabili, (Ardabil, Iran). The present work was performed in accordance with the ethical standard laid down in the 1996 declaration of Helsinki and its later amendments and were under the academy's guidelines for animal research and a written informed consent was obtained from the owners for the participation of their animals in this study.

Conflict of Interest

The authors declare that there is no conflict of interest in this study.

Authors' Contributions

Naser Gavidel conceived and designed the experiment; Jamal Seifdavati supervised the student thesis; Jamal Seifdavati, Hossein Abdibenemar and Sayad Seifzadeh conducted the experiment; Jamal Seifdavati and Hossein Abdibenemar supervised the experiment; Jamal Seifdavati, Hossein Abdibenemar, and Naser Gavidel prepared the manuscript. Reza SeyedSharifi

contributed data or analysis tools. All authors approved the manuscript.

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Availability of Data and Materials

All data and materials are available.

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