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GROWTH PERFORMANCE AND IMMUNITY RESPONSE OF SUCKLING FRIESIAN CALVES FED ON RATION SUPPLEMENTED WITH ORGANIC OR NANO SELENIUM PRODUCED BY LACTIC ACID BACTERIA

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SUMMARY

Eighteen suckling Friesian calves with average live body weight of 32.70±0.79 kg were divided into three comparable groups based on sex and birth weight. All calves were fed on a whole milk, starter and berseem hay without supplement in the control group or supplemented with 0.3 mg Se/kg DM intake as organic selenium (OSe) or nano selenium (NSe) for 2nd and 3rd groups. The results showed that organic-and nano selenium groups recorded significantly ($P<0.05$) higher digestibility of DM, OM, CP, CF, EE and NFE as well as TDN, DE and DCP compared to the control group, Plasma total protein concentration was not significantly ($P>0.05$) affected by selenium additives. While, albumin concentration and albumin to globulin ratio were significantly ($P<0.05$) decreased, however, globulin concentration in plasma of calves supplemented with OSe and NSe was significantly ($P<0.05$) higher than that of control group, Organic and nano selenium supplementation significantly decreased ($P<0.05$) the activity of AST and ALT enzymes and creatinine concentration in plasma compared to that of the control group. The concentrations of IgA and IgG in plasma were increased significantly ($P<0.05$) with OSe and NSe supplementation compared to the control group, The IgM concentration was comparable among all groups. The percentages of various disease incidence decreased significantly ($P<0.05$) in OSe and NSe supplemented groups than those of the control group, Morality rate was higher in the control group than that of OSe group, however no mortality was observed in calves of NSe group. Dry matter intake values were the same for different groups, whereas, values of TDN and DCP intake tended to increase with OSe and NSe supplemented diet than those of the control group. Birth weight was comparable among all groups. While, weaning weight, total weight gain and average daily weight gain were significantly ($P<0.05$) higher for OSe and NSe groups than to the control. Supplementation with OSe and NSe improved feed conversion ratio, which significant decreased ($P<0.05$), where the amounts of DM, TDN and DCP per one kg weigh gain were less than those of control group. Daily feed cost was comparable among all groups, where feed cost per kg gain was significantly ($P<0.05$) lower for OSe and NSe groups than control group. The cost price of daily weight gain and net revenue as well as economic efficiency were significantly ($P<0.05$) higher for OSe and NSe groups compared to those of control group.

Keywords: *Nano selenium, Organic selenium, suckling calves, digestibility, blood biochemical, immunity response, mortality rate, weight gain, feed conversion and economic efficiency.*

INTRODUCTION

Selenium (Se) is a trace mineral found in the soil. It appears naturally in water and some feeds. Although people need a very small amount of selenium, it plays one of a key role in the metabolism, It plays on important role in reproduction, thyroid hormone metabolism, synthesis of DNA, and protection from infectious diseases and oxidative damage (Sunde, 2012, Terry and Diamond, 2012). The recommended daily allowance of Se for adult male and female is about 55 µg (FNB, 2000). Selenium exists in two forms, inorganic and organic (selenomethionine and selenocysteine) (Sunde, 2012). Both of two forms are good dietary sources of selenium (Terry and Diamond, 2012). Soils contain inorganic selenites and selenates that plants accumulate and converted to organic forms, mostly selenocysteine and selenomethionine and their methylated derivatives (Ježek, *et al*., 2012).

Nano-Se (nano-elemental Se) is another form of inorganic Se. It is bright red, highly stable, and of nano-size in the redox state of zero (Se^0). There are several methods to obtain selenium nanoparticles (SeNPs). It can be chemically synthesized (Zhang *et al*., 2004) or through physical procedures (Quintana *et al*., 2002) or by biological way, this so-called green synthesis, using microorganisms or plant extracts, (Prokisch and Zommara, 2011, Ramamurthy *et al*., 2013, Shoeibi and Mashreghi, 2017). The green synthesis of SeNPs using microorganisms takes more attention for its simplicity, high purity, producing of a uniform and stable SeNPs.

Adding 0.8 mg of organic Se to suckling calves increased the serum levels of this trace mineral in the animals and enhances their immune systems at 30 days of age. A superior immune parameter response was observed in calves supplemented with Se to the abomasum. In addition, Se supplementation maintained the performance of animals that had a diagnosis of diarrhea. Selenium supplementation did not act as a growth promoter but improved immune system function during this phase of compromised health (Salles *et al.*, 2013).

Supplementation of selenium nanoparticles gave the best performance in terms of increasing serum globulin level, reducing A:G ratio, and improving humoral immune status in male Wistar rats at the level of 150 ppb (Bunglavan *et al*., 2014).

Selenium has attracted much attention recently in human and animal food. Even though selenium in high level is toxic, in trace amounts it exerts various beneficial effects in vivo. Selenium supplementation was found to enhance muscle development and the growth rate. Selenium influences the immune response by the activation of phagocytosis, increasing antibody production and enhancing lymphocyte proliferation. Supplementation of selenium on buffalo calves diet at 8 to 9 months of ages had increased the blood globulin which led to improved immunity status (Mudgal *et al.*, 2008).

Guyot *et al.* (2007) found that calves fed diets with yeast rich organic selenium (Y-Se) located higher growth rate when given at the rate of 0.5 ppm compared with calves fed diets containing inorganic selenium as sodium selenite. Lambs fed diet with 0.15 ppm selenium as organic selenium (Jevsel-101) or sodium selenite recorded humoral immune response, antioxidant and improved growth rate, compared with control group without supplementation (Kumar *et al.*, 2009) while, the effect was higher for organic selenium group than those fed inorganic selenium supplemented diet.

Vinu *et al.* (2012) indicated that added selenium yeast at the rate of 0.3 ppm to diets of cross bred calves improved their disease resistance. Selenium was first given importance attention because of its toxicity, later selenium known as an important element for animals for developing proper immune mechanism against the invaders and for various life activities. There is only a narrow gap between dietary essential dose and toxic dose. Exceed of selenium are toxicity and leads to alkali disease while, deficiency of selenium leads to white muscle disease in calves. So, FDA (Food and Drug Administration) recommended (0.3 ppm) supplementation of selenium in the diet. Recent research indicated that organic form of selenium is more efficiency than inorganic Selenium. (Nampoothiri and Gangadevi, 2017) found that support animals with right amount of Selenium keep the animal in a good health condition and right growth performance.

The objective of the current work was to investigate the effect of nano and organic selenium supplementation on nutrient digestibilities, some blood biochemical changes, immunity response, health status, mortality rate, growth performance, feed conversion and economic efficiency of suckling Friesian calves fed on ration supplemented with organic or nano selenium produced by lactic acid bacteria.

MATERIALS AND METHODS

The current work was carried out at El-Karda Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, during year 2017/2018.

Production of organic nano-selenium (NSe):

Organic selenium (OSe) was produced by lactic acid bacteria as described by Zommara and Prokisch (2015). The ability of yoghurt culture to completely uptake and bio-convert 1 ppm of the inorganic selenium to organic form in the cultured media, suggested applied, as indicative of a real opportunity to produce fortified yoghurt with organic selenium.

Also, nano selenium spheres (NSe) were produced by lactic acid bacteria as described by Prokisch *et al*. (2008). Pure yoghurt culture was obtained from Microbiological Resource Centre, Ain Shams University (MIRCEN), Cairo. Yoghurt culture (*Lactobacillus delbrueckii subsp. bulgaricus* and *Streptococcus thermophilu*) were mixed (1:1, w/w) and cultivated in whey yeast extract media as described by Kar and Misra (1999) fortified with 1% yeast extract and 0.1% skim milk powder (Parente and Zottola, 1991). The media were amended with 100 ppm of filter sterilized (Sartorius AG, Germany) selenium Se (IV) (sodium selenite, Na_2SeO_3. $5H_2O$, Sigma-Aldrich, Switzerland) and incubated at 40°C up to 24 h. According to the electronmicroscopy pictures, the size of spheres was in the range of 50-100 nm

Animals and diets:

Eighteen suckling Friesian calves with average live body weight of 32.70±0.79 kg were divided into three comparable groups based on sex and birth weight. All calves were fed on a whole milk, starter and berseem hay without supplement in first group (Control) or supplemented with 0.3 mg Se/kg DM intake as organic selenium (OSe) in the second group or 0.3 mg Se/kg DM intake as NSe in the third group Water and diets were provided ad libitum. Calves were removed from their dams after having their colostrums for 3 days and artificially fed whole milk in plastic bucket twice daily at 7 a.m. and 6 p.m. From the beginning of the third week, calves were given the starter feed once daily at 9 a.m. and berseem hay once time at 11 a.m. Selenium additives was supplemented in the whole milk during the morning suckling and water was freely provided during the experimental period, (105 days)

Calves were fed according to the recommended requirements of Animal Production Research Institute (1997) as shown in Table (1). Chemical composition of tested feedstuffs is presented in Table (2).

Table (1): Average daily feedstuffs intake (kg/head/day) during suckling period.

Feedstuff*	Age (week)							
	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15
Whole milk	3.5-4.0	4.5-5.0	5.0-4.5	4.0-3.5	3.0-2.5	2.0-1.75	1.5-1.25	1
Calf starter	-	0.25	0.50	0.75	1.00	1.25	1.50	1.75
Berseem hay	-	0.1	0.2	0.3	0.4	0.5	0.6	0.7

** As fed.*

Table (2): Feedstuffs composition during suckling period.

Item	DM %	Composition of DM %					
		OM	CP	CF	EE	NFE	Ash
Whole milk	11.80	93.80	23.95	00.00	29.30	40.55	6.20
Calf starter*	91.45	91.75	17.90	5.95	3.35	64.55	8.55
Berseem hay	88.65	90.75	12.50	27.35	2.40	48.50	11.35

** Starter consisted of 15% soybean meal, 10% linseed cake, 34% ground yellow corn grain, 20% wheat bran, 15% rice bran, 3% molasses, 2% limestone and 1% common salt.*

Nutrients Digestibility:

Digestibility trial was conducted in the last week of the experiment using all animals to determine nutrients digestibility coefficients and nutritive values using acid insoluble ash as a natural marker (Van Keulen and Young, 1977). Feces samples were taken from the rectum of each calf twice daily with 12 hours interval for seven days collection period. Samples of whole milk, starter and berseem hay were taken at the beginning, middle and end of the collection period. The samples of starter, berseem hay and feces were composted and representative samples were dried in a forced air oven at 65 ^{o}C for 48 hours, ground and analyzed DM, CP, EE, CF, NFE, according to AOAC (1990). Whole milk samples were analyzed using Milko-Scan (133 B Foss Electric).

DM digestibility % = 100 – [100 × (AIA % in feed / AIA % in feces)]

Nutrient digestibility % =

100 – [100 × (AIA % in feed / % feces) × (nutrient % in feces / nutrient % in feed)]

Animal growth parameters:

Calves were weighed weekly in the morning before drinking and feeding to the nearest 0.1 kg for each animal during the suckling period and average daily body weight gain was calculated. Feed efficiency was calculated as the amounts of DM, TDN and DCP per kg body weight gain. The occurrence of diarrhea, respiratory, septicemia, navel and general weakness diseases as well as the mortality was observed and recorded daily for calves in each group.

Blood analysis:

At end of the feeding period blood samples were taken from the jugular vein of each calves by clean sterile needle in clean dry glass tubs using heparin as an anticoagulant and centrifuged for 15 minutes at 4000 rotations per minute to obtain plasma. Plasma samples were kept in deep freezer at -20 °C till chemical analysis was carried out. Total protein and albumin concentrations were determined using commercial kits supplied by Randox (Randox Laboratories Ltd, Crumlin, Co, Antrim, UK) according to Henry *et al.* (1974). Globulin concentration was estimated by subtracting the values of albumin from the corresponding values of total protein per sample. Activities were detrmined plasma aspartate amino transferase (AST) and alanine amino transaminase (ALT) according to Hafkenscheid and Dijt (1979) and creatinine concentration according to Chasson *et al.* (1961) using commercial kits (Bio-Merieux Laboratory Reagents and Products, France) according to the manufacturer procedure. The concentrations of immunoglobulins IgG, IgM and IgA concentrations in blood plasma were measured using the quantitative ELISA Bovine (IgG, IgM and IgA), ELISA Quantitation Kit, Bethyl laboratories, UK.

Economic efficiency:

Economic efficiency was calculated as the ratio between the income of the average daily body weight gain and the cost of average daily feed cost as follows:

Economic efficiency = output of daily weight gain/ cost of daily feed consumed

Where, the price of 1 kg was 4.50 LE for the whole milk, 5.45 LE for the starter, 3.00 LE for berseem hay and 85 LE for body weight gain throughout year 2018.

Statistical analysis:

The data were analyzed using the general linear model procedure adapted by IBM SPSS Statistics (2014) for user's guide with one-way ANOVA. Significant differences in the mean values among dietary treatments were analyzed by Duncan's tests within SPSS program set at the level of significance P<0.05.

RESULTS AND DISCUSSION

Nutrients digestibility and nutritive values:

Digestibility coefficients and nutritive values of the experimental rations by experimental suckling Friesian calves are presented in Table (3). Groups received OSe and NSe recorded significantly (P<0.05) the highest digestibility of DM, OM, CP, CF, EE and NFE as well as total digestible nutrients (TDN), digestible energy (DE) and digestible crude protein (DCP) compared to the control group. Selenium is an important dietary micronutrient required for metabolism of animals and the normal body functions, it plays a significant role in the catalytic processes within the enzyme system that consist of a variety of enzyme activities linked with the metabolic, endocrine, and immune systems (Keen *et al.*, 2004). Serra *et al.* (1994) showed that addition of 4 g/kg dietary dry matter, nano-selenium (NS) could significantly increase growth and activity of cellulolytic bacteria compared to selenium yeast (YS) and thus enhance fermentation in the rumen. This helped us to clarify the different metabolic ways that taken place for inorganic Se and organic Se in rumen. Xun *et al.* (2012) found that DM, organic matter (OM), crude protein (CP), ether extract (EE), NDF, and ADF digestibility in the total tract of sheep were lower in in control non supplemented sheep than Se supplemented animals at level of (P<0.01), and also with significantly (P<0.01) higher values in NS group compared to SY group. Ibrahim (2017) stated that nutrient digestibility of DM, OM, EE and NFE increased (P<0.05) for lambs of supplemented with selenium and vit. E than untreated (control). Abd El-Hafez *et al.* (2016) found that vitamin E plus Se supplement improved (P<0.01) digestibility coefficients of DM, OM, CP, EE, NFE and feeding values (TDN and DCP) in Sohagi lambs. These findings explained by the fact that vitamin Se and E, as necessary elements of the antioxidant defense system, play a complementary role in metabolism through their participation in critical enzymes and enzyme reactions (Willshire and Payne, 2011).

Table (3): Digestion coefficients and nutritive values of the experimental rations by suckling Friesian calves.

Item	Treatment			SEM
	Control	OSe	NSe	
Digestibility coefficients %				
DM	69.60^{b}	74.16^{a}	72.85^{a}	0.79
OM	71.30^{b}	75.43^{a}	74.27^{a}	0.81
CP	68.35^{b}	73.49^{a}	71.59^{a}	0.86
CF	55.25^{a}	58.29^{a}	57.87^{a}	0.58
EE	77.90^{b}	80.91^{a}	79.20^{a}	0.63
NFE	75.60^{b}	78.98^{a}	77.47^{a}	0.66
Nutritive values				
TDN %	76.21^{b}	79.34^{a}	78.35^{a}	0.70
DE (Mcal/kg DM)	3.36^{b}	3.52^{a}	3.45^{a}	0.03
DCP %	12.51^{b}	13.46^{a}	13.11^{a}	0.16

a, b: Means in the same row with unlike superscripts are significantly different (P<0.05).

Blood plasma biochemical Changes:

Values of blood plasma biochemical of suckling Friesian calves as affected by selenium supplementation are presented in Table (4). Total protein concentration of plasma was not shown different affect at the level of (P>0.05) when added selenium. While, albumin concentration and albumin to globulin (A:G) ratio in blood plasma of control group were significantly (P<0.05) higher compared to OSe and NSe groups. However, globulin concentration in plasma of calves supplemented with OSe and NSe was significantly (P<0.05) higher than that of control group. Moreover, OSe and NSe supplementation improved liver and kidney functions, where the activity of AST and ALT enzymes and creatinine concentration of calves in control group were significantly (P<0.05) higher than those of OSe and NSe groups. These results agreed with those obtained by Bunglavan *et al*. (2014) who found that supplementation of Se nanoparticles reduced A:G ratio and improved the mean serum globulin level, but not affected total protein level in serum. Ibrahim (2017) reported that lambs fed on selenium had higher (P<0.05) concentrations of serum total protein and globulin vs. control or vit. E supplemented diet.

Table (4): Blood plasma biochemical and immunity response of suckling Friesian calves.

Item	Treatment			SEM
	Control	OSe	NSe	
Plasma biochemical				
Total protein (g/dl)	6.72	6.74	6.70	0.12
Albumin (g/dl)	3.47^{a}	2.99^{b}	2.97^{b}	0.11
Globulin (g/dl)	3.25^{b}	3.75^{a}	3.73^{a}	0.11
Albumin: globulin ratio	1.06^{a}	0.80^{b}	0.80^{b}	0.07
AST (IU/l)	31.83^{a}	24.50^{b}	25.67^{b}	1.97
ALT (IU/l)	20.50^{a}	9.00^{b}	11.67^{b}	1.59
Creatinine (mg/dl)	0.97^{a}	0.81^{b}	0.80^{b}	0.08
Immunity response				
IgA (mg/dl)	27.00^{b}	33.35^{a}	31.67^{a}	1.04
IgM (mg/dl)	10.13	8.48	8.87	0.54
IgG (mg/dl)	137.05^{b}	161.00^{a}	157.75^{a}	2.79

a, b: Means in the same row with unlike superscripts letters are significantly different (P<0.05).

Immunity response:

Results of immunity response in Table (4) revealed that the concentrations of IgA and IgG fractions increased significantly ($P<0.05$) with OSe and NSe supplementation compared to non-supplemented group (control). Whereas, IgM fraction was not significantly ($P>0.05$) affected by selenium supplementation and tended to increase in control group. Reffett *et al.* (1988) clarified that supplemented diet with selenium stimulated primary and secondary immune response in calves challenged with infectious bovine rhinotracheitis virus. They indicated that selenium supplemented group at (0.2 mg/kg diet) increase whole blood and plasma GSH-Px activity. Gill and Walker (2008) stated that elaborated spleen lymphocyte were proliferated indicating improved immune response of selenium fed rats fed selenium diet at (121 µg/100g feed) for forty nine days compared with control rats fed selenium at (18 µg/100g feed) Vinu *et al.* (2012) found that crossbred calves fed selenium yeast at the rate of 0.3 ppm reduced the chance of getting sick. It was olsonoted that selenium is important for the regulation of immunity functions (Köhrle and Gärtner, 2009), plays an essential role in non-specific immune response (Dercksen *et al.*, 2007) and its low level is related to weakened immune system (Effraimidis and Wiersinga, 2014).

Health status and mortality rate:

Data of health status of experimental suckling Friesian calves shown in Table (5) revealed that the percentages of various disease incidence decreased significantly ($P<0.05$) in OSe and NSe supplemented groups than those of control group. The percentage of total calves infection decreased significantly ($P<0.05$) from 70.50% in control group to 42.10% in OSe group and 37.30% in NSe group. The diseases infection showed that diarrhea and respiratory diseases recorded the highest percentages of infections followed by septicemia. The high percentages of diseases incidence presented in this study might be attributed to the repeat infection of calves. Moreover, the high incidence of diseases was reflected in the high mortality rate in the control group. Morality rate was higher in control group being 33.33% than that of OSe group being 16.67%, without no calves mortality in NSe group. The reduced diseases infection and mortality rate with organic and nano selenium supplementation could be attributed to the improvement in immunity response. Selenium (Se) is an essential trace element (Lu and Holmgren, 2009; Rayman, 2000) that evinces antioxidant activity (Abuelo *et al.*, 2016; Dkhil *et al.*, 2016; Lu *et al.*, 2017; Ju *et al.*, 2017), anti-inflammatory (Aaseth *et al.*, 2016; El-Ghazaly *et al.*, 2017; Liu *et al.*, 2017; Malhotra *et al.*, 2016; Speckmann and Steinbrenner, 2014), antimutagenic (Peng *et al.*, 2016; Schrauzer, 2008), anticarcinogenic (Ahmad *et al*., 2015; Hassan and Webster, 2016; Tran *et al.*, 2010) or chemopreventive (Rao *et al*., 2001), antiviral (Hefnawy and Tórtora-Pérez, 2010) antibacterial (Cihalova *et al.*, 2015; Guisbiers *et al.*, 2016; Chudobova *et al.*, 2014; Wang *et al.*, 2015), antifungal (Guisbiers *et al*., 2017; Shakibaie *et al.*, 2015) and antiparasitic effects (Beheshti *et al*., 2013; Dkhil *et al*., 2016; Mahmoudvand *et al*., 2014). Furthermore, it is an integral component of selenoproteins participating in a whole series of physiologically important processes (Pascual and Aranda, 2013). The first proven selenoenzyme was glutathione peroxidase (GPx) (Hefnawy and Tórtora-Pérez, 2010), which is an indispensable component of the antioxidant system in the organism (Arthur, 2000). In inflammatory diseases, the selenium concentration declines and the biosynthesis of selenoproteins is disturbed (Schomburg, 2012). The application of selenium decreases is the indices of inflammatory activity (Köhrle and Gärtner, 2009). Selenium is very important for chemotactic and phagocyte activity and respiratory burst activities. Selenium deficiency leads to decrease of GPx enzyme activity and drop in neutrophil activity as well as making the body cells more susceptible to oxidative damage. (Radostits *et al*., 2007)

Table (5): The percentages of various diseases infection and mortality rate of suckling Friesian calves.

Item	Treatment			SEM
	Control	OSe	NSe	
Incidence (%)				
Diarrhea	24.80^{a}	14.90^{b}	13.45^{b}	1.60
Mortality rate %	(2 / 6) 33.33^{a}	(1 / 6) 16.67^{b}	(0 / 6) 00.00^{c}	2.35

a, b, c Means in the same row with unlike superscripts letter are significantly different (P<0.05).

Feed intake:

Data in Table (6) revealed that the intake of whole milk, calf starter and berseem hay as well as dry matter intake (DM) were the same for different groups. Whereas, TDN and DCP intake tended to increase with OSe and NSe supplementation than those of control group. The slight increase in TDN and DCP intake may be attributed to the increase of TDN and DCP values of experimental rations with selenium supplementation. Ibrahim (2017) found significant improvement (P<0.05) in feed intakes (DCPI and TDNI) for lambs received vit. E and selenium when compared to control.

Table (6): Average daily feed intake by experimental suckling calves (during the experimental period, 105 days).

Item	Treatment			SEM
	Control	OSe	NSe	
As fed (kg/day):				
Whole milk	3.03	3.03	3.03	
Calf starter	0.82	0.82	0.82	
Berseem hay	0.33	0.33	0.33	
As DM (kg/day)				
DM	1.40	1.40	1.40	0.05
TDN	1.07	1.11	1.10	0.04
DCP	0.175	0.188	0.184	0.01

Live body weight and weight gain:

Results in Table (7) showed that birth weight was neatly similar for the different groups without significant differences. While, weaning weight, total weight gain and average daily gains were significantly (P<0.05) higher for OSe and NSe groups than untreated group. Average daily gain of OSe and NSe supplemented groups increased by 125 and 119 g/day or by 27.13 and 25.83% compared to control group. Selenium affect the formation and activation of thyroid hormones which consequently the growth performance. Wichtel *et al.* (1996) recoded that Frisian calves fed ration as pellets supplemented with selenium increased the average body weight gain than calves fed ration without selenium additive (control group). Spears *et al.* (1986) noticed that calves injected with 5.5 mg selenium and 75 IU Vitamin E /100 kg live body weight at sixty days intervals from 1st to 5th or 7th increased weaning weight in calves compared with un-treated calves. Reffett *et al*. (1986) found that calf weight gains increased in first 14 days after weaning with selenium injection at 15 mg/head. Same result were obtained on goats by Yuhua *et al.* (1996)

Table (7): Body weight and weight gain of suckling calves.

Item	Treatment			SEM
	Control	OSe	NSe	
Birth weight (kg)	29.50	30.06	28.94	0.67
Weaning weight (kg)	77.88^{b}	91.56^{a}	89.81^{a}	2.93
Total weight gain (kg)	48.38^{b}	61.50^{a}	60.87^{a}	2.46
Average daily gain (g)	460.71^{b}	585.71^{a}	579.71^{a}	23.41

a, b Means in the same row with unlike superscripts letters are significantly different (P<0.05).

Castellan *et al.* (1999) indicated that inserted selenium in to maternal diet at the level of 0.05 mg/kg within 2 days of after giving birth and on 70, 114 and 149 led to higher mean daily gain compared with control group. Selenium is available in inorganic and organic forms. Common inorganic forms include sodium selenite and selenate. Organic form exists as seleno methionine. Selenium yeast as organic form is higher digestible compared with inorganic form (sodium selenite) (Pagan *et al.,* 1999). Guyot *et al.* (2007) indicated that calves fed ration including seleno-yeast (y-Se) at the level of 0.5 ppm reached higher growth performance compared with calves fed diets containing sodium selenite as inorganic selenium. Lambs achieved humoral immune response, enhanced growth performance, and antioxidant situation when they fed diet with 0.15 ppm selenium as sodium selenite or selenium (Jevsel-101) as marketing name compared with lambs fed diets without selenium additive control (Kumar *et al.*, 2009) and the effect being lower for inorganic selenium animals than those fed organic selenium supplemented ration.

Feed conversion:

Feed conversion in Table (8) revealed that OSe and NSe supplementation improved feed conversion ratio, which led to significant decrease (P<0.05) in the amounts of DM, TDN and DCP required for producing one kg weight gain compared to control group. Ibrahim (2017) found that feed conversion (FCR, DCPI and TDNI) improved (P<0.05) for lambs received vit. E and selenium compared to control. In case of Se supplementation, the beneficial effects on animal performance were detected in studies on sheep (Kumar *et al.*, 2009) and goats (Kamdev *et al*., 2015).

Economic efficiency:

Results of economic efficiency (Table 8) showed that the cost of feed intake was the same for different groups, which the cost of OSe and NSe was negligible due to the less amount of Se additive 0.42 mg/day. The feed cost for producing one kg weight gain was significantly (P<0.05) lower for OSe and NSe groups compared to control group, being 41.46, 32.61 and 32.95 LE/ kg weight gain for control, OSe and NSe groups, respectively. However, the price of daily weight gain and net revenue as well as economic efficiency expressed as the ratio between price of daily weight gain and daily feed cost were significantly (P<0.05) higher for OSe and NSe groups compared to control group. Economic efficiency improved significantly (P<0.05) by 27.32 and 25.85% for OSe and NSe groups compared to control group, respectively. In cattle, selenium deficiency can have economically significant impacts such as reduced fertility, placental retentions, and the incidence of mastitis and merits (Spears and Weiss, 2008; Hefnawy and Tórtora-Pérez, 2010; Sordillo, 2013). According to Eulogio *et al.* (2012) the performance and economic feasibility of the use of selenium and vitamin E allowed to obtain a profit margin of 0.21 $US per animal per day.

Table (8): Feed conversion and economic efficiency of suckling calves.

Item	Treatment			SEM
	Control	OSe	NSe	
Feed conversion				
DM (kg/kg gain)	3.04^{a}	2.42^{b}	2.42^{b}	0.11
TDN (kg/ kg gain)	2.33^{a}	1.92^{b}	1.90^{b}	0.08
DCP (g/kg gain)	380.29^{a}	325.20^{b}	317.40^{b}	13.03
Economic efficiency				
Daily feed cost LE	19.10	19.10	19.10	0.07
Feed cost LE/kg gain	41.46^{a}	32.61^{b}	32.95^{b}	1.50
Price of daily gain LE	39.16^{b}	49.79^{a}	49.28^{a}	1.99
Net revenue LE	20.06^{b}	30.69^{a}	30.18^{a}	1.95
Economic efficiency	2.05^{b}	2.61^{a}	2.58^{a}	0.10
Economic improvement %	00.00^{b}	27.32^{a}	25.85^{a}	1.36

a, b Means in the same row with unlike superscripts are significantly different (P<0.05).

Economic improvement % = $\frac{OSe-control}{control*100}$

CONCLUSION

From the present study it could be concluded that organic selenium (OSe) and nano selenium (NSe) supplementation for suckling Friesian calves has led to significant improvement of feed digestibility, blood biochemical measurement, immunity response, health status, growth rate, feed conversion and economic efficiency as well as reduce mortality rate.

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أداء النمو والإستجابة المناعية للعجول الفريزيان الرضيعة مع إضافة السيلينيوم العضوى و النانو المنتج بواسطة بكتيريا حامض اللاكتيك

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تم إجراء هذا البحث على عدد ١٨ عجل فريزيان رضيع متوسط وزنها ٣٢,٧٠ ± ٠,٧٩ كجم قسمت إلى ثلاثة مجموعات متماثلة طبقا للجنس ووزن الميلاد. غذيت جميع العجول على اللبن كامل الدسم، علف بادئ ودريس برسيم وكانت المجموعة الأولى بدون إضافة (مجموعة الكنترول) أو مع إضافة ٠,٣ ملجم سيلينيوم / كجم مادة جافة مأكولة فى صورة سيلينيوم عضوى فى المجموعة الثانية أو في صورة نانو سيلينيوم فى المجموعة الثالثة .

أظهرت النتائج تحسن معنوى مع إضافة السيلينيوم العضوى أو النانو للمجموعتين الثانية والثالثة في معاملات هضم المركبات الغذائية وكذلك القيم الغذائية مقارنة بمجموعة المقارنة. فى حين لم يتأثر تركيز البروتينات الكلية فى بلازما الدم بإضافة السيلينيوم الا أن تركيز الألبيومين ونسبة الألبيومين إلى الجلوبيولين انخفضت معنويا بينما ارتفع تركيز الجلوبيولين معنويا فى مجموعتى السيلينيوم العضوى و النانو مقارنة بمجموعة المقارنة. كما لوحظ انخفاض نشاط إنزيمى الكبد وتركيز الكرياتنين معنويا فى مجموعتى السيلينيوم مقارنة بالكنترول. أدت إضافة السيلينيوم الى حدوث زيادة معنوية فى تركيز شقى المناعة IgA ، IgG عنه فى مجموعة الكنترول، بينما كان تركيز IgM متماثل تقريبا فى المجموعات الثلاثة.

انخفضت معنوياً نسبة الإصابة بالأمراض المختلفة فى مجموعتى السيلينيوم مقارنة بالكنترول، وارتفع معدل النفوق فى مجموعة المقارنة عن مجموعة السيلينيوم العضوى، بينما لم يحدث نفوق فى مجموعة النانو سيلينيوم .

تماثلت كمية المادة الجافة المأكولة تماما فى المجموعات الثلاثة، فى حين زادت كميات المركبات الكلية المهضومة والبروتين الخام المهضوم فى مجموعتى السيلينيوم مقارنة بالكنترول. حدثت زيادة معنوية فى وزن الفطام ومعدل النمو اليومى خلال فترة الرضاعة فى مجموعتى السيلينيوم العضوى و النانو مقارنة بمجموعة المقارنة.

تحسن معدل التحويل الغذائى معنويا فى مجموعتى السيلينيوم مقارنة بالكنترول حيث انخفضت كميات المادة الجافة والمركبات الكلية المهضومة والبروتين الخام المهضوم اللازمة لكل واحد كجم نمو معنوياً مقارنة بالكنترول. كانت تكلفة التغذية اليومية متماثلة تقريبا للمجموعات الثلاثة، بينما انخفضت تكلفة التغذية لكل واحد كجم نمو فى مجموعتى السيلينيوم مقارنة بالكنترول، كما لوحظ زيادة معنوية فى العائد الكلى للنمو اليومى والعائد الصافى وكذلك الكفاءة الإقتصادية فى مجموعتى إضافة السيلينيوم مقارنة بالكنترول.

نستخلص من هذه الدراسة أن إضافة السلينيوم العضوى أوالنانو سيلينيوم للعجول الرضيعة بمعدل ٠,٣ مجم سيلينيوم/ كجم مادة جافة مأكولة أدت الى تحسن معنوى فى الهضم وبعض قياسات الدم وتركيز شقى المناعة (IgA ، IgG) مع انخفاض الإصابة بالآمراض ومعدل النفوق. كما أدت إلى تحسن معنوى فى معدل النمو و معدل التحويل الغذائى والكفاءة الاقتصادية.