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Full length Research paper

Nutritional effect of different forms of selenium additive on productive performance of dairy Zaraibi goats and their suckling kids

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Fifty Zaraibi goats with average body weight of 42.45±1.25 kg and aged 3-5 years after kidding were divided into five similar groups (10 in each). All goats were fed the basal diet consisted of 50% concentrate feed mixture + 31% berseem hay + 19% wheat straw. The goats in the first group (control) were fed the basal diet without supplement (G1). The goats in the first group (control) were fed the basal diet without supplement (G1). The other groups were supplemented with 0.3 mg Se/kg DM intake as inorganic selenium (sodium selenite, SS) in G2, organic selenium (yeast selenium, YS) in G3, biological organic selenium (BOSe) in G4 or biological nano-selenium (BNSe) in nano-selenium (NSe) in G5. Results showed that G5 showed significantly (P<0.05) the higher values nutrients digestibility, feeding values and feed intake followed by G4 and G3 then G2, whereas G1 had the lower values. Group 5 showed significantly (P<0.05) the highest yield of actual milk and 3.5% fat corrected milk (FCM) and the contents of fat, protein, lactose, solids not fat (SNF) and total solids (TS) followed by G4 and G3 then G2, while G1 had the lowest yield. Group 1 (control) showed significantly (P<0.05) the highest amounts of DM, TDN, CP and DCP per kg 3.5% FCM followed by G2 and G3, then G4, while G5 had the lowest values. Feed cost per 1 kg 3.5% FCM was higher in G1 followed by G2, then G3 and G4, but G5 had the lower cost. On the other side, G5 recorded significantly (P<0.05) the highest output of 3.5% FCM yield, net revenue and economic efficiency followed by G4 and G3, then G2, however G1 had the lowest values. Number of weaned kids was significantly (P<0.05) higher in G5 followed by G3 and G4 then G2, but was lower in G1. No death kids in G5 received BNSe and moreover mortality rate was the least with G3 and G4, followed by G2, but was the highest in G1 (P<0.05). Weaning weight, total weight gain and average daily gain were significantly (P<0.05) higher in G5 followed by G4 and G3, then G2, but were lower in G1. Suckled milk and the cost of suckled milk per kg weight gain were significantly (P<0.05) higher in G1 followed by G2 then G3 and G4, but G5 had the lowest values. Output of ADG, net revenue and economic efficiency were significantly (P<0.05) higher in G5 followed by G4 and G3, then G2, while G1 had the lowest values.

Keywords: Economic efficiency, Digestibility, Milk yield and composition, Selenium additive

INTRODUCTION

The biological functions of selenium (se) in living organisms are mediated through various selenium proteins. Some selenoproteins have enzymatic functions (glutathione peroxidase, iodothyronine deiodinase, etc.) and are very important for key biological functions (antioxidant activity, thyroid function, immunity, cancer prevention, mammary gland health, reproduction etc. Mala et al., 2009). Se bioavailability is influenced by many factors, including se status, amount of the element

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in the diet, form of the element (inorganic or organic), development of rumen fermentation, type of diet, hostility to other elements or food components, and others factors. Major pathways of se loss from the organism include urine, feces, milk, and possibly exhaled air Pavlata et at., 2005). The organic sources of Se are seleno-amino acids [eg, selenomethionine (Se Met) and selenocysteine (SeCys)], which are found in Se yeast or in forages grown in selenium-rich soil (Stewart et al., 2012). Nano-Se (nano-elemental Se) is another form of inorganic Se. It is bright red, highly stable, and of nanosize in the redox state of zero (Se0). 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 (Shoeibi et al., 2017). (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 se as sodium selenite. Added selenium yeast at the rate of 0.3 ppm to diets of cross bred calves improved their disease resistance (Vinu et al., 2012) Se keeps the animal in a good health condition and right growth performance Nampoothiri et al., 2017 Organic se (OSe) and nano se (NSe) produced by lactobacillus bacteria supplemented for suckling Friesian calves improved growth performance and health status (Shams et al., 2020) This study evaluated the effects of adding different forms of se (inorganic, organic and biological) to dairy Zaraibi goats on feed intake, digestibility, milk production and composition, feed conversion ratio and economic efficiency as well as the growth performance of their kids.

MATERIALS AND METHODS

Experimental procedures used in this study were conducted at Sakha Animal Production Research Station, belonging to Animal Production Research Institute (APRI), Agriculture Research Centre (ARC), Ministry of Agriculture, Egypt.

Experimental animals and rations

Fifty Zaraibi goats with average body weight of 42.45±1.25 kg and aged 3-5 years after kidding were divided into five similar groups (10 in each). All goats were fed the basal diet consisted of 50% concentrate feed mixture + 31% berseem hay + 19% wheat straw to cover their recommended requirements according to NRC (2017) (Table 1). The goats in the first group (control) were fed the basal diet without supplement (G1). The other groups were supplemented with 0.3 mg Se/kg DM intake as inorganic selenium (sodium selenite, SSe) in G2, organic selenium (yeast selenium, YSe) in G3, biological organic selenium (BOSe) in G4 or biological nano-selenium (BNSe) in G5. Ingredients and chemical composition of basal diet used in feeding goats are presented in Table (1).

Table 1: Ingredients and chemical composition of the basal diets.

Ingredients	% on DM basis	Chemical composition	% on DM basis
Concentrate feed mixture	49.97	DM	90.46
Berseem hay	30.98	OM	89.78
Wheat straw	19.05	CP	12.58
Total	100	CF	21.59
		EE	2.55
		NFE	53.06
		Ash	10.22

Experimental procedures

Animals in all groups were fed in group feeding, and the tested diets were offered in equal amounts for all groups twice daily at 8 a.m. and 3 p.m., while fresh water was available at all times.

Digestibility trails

Five digestibility trails were conducted during the feeding period using 3 lambs from each group to determine the nutrients digestibility and feeding values of the experimental rations. Each digestibility trial consisted of 15 days as preliminary period followed by 7 days as collection period. Acid insoluble ash was used as a natural marker (Van Keulen et al., 1977) Feces samples were taken from the rectum of each goat twice daily with 12 hrs interval during the collection period. Samples of feedstuffs were taken at the beginning, middle and end of the collection period. Chemical analysis of samples of feedstuffs and feces were carried out according to the methods of **AOAC (2005).** Nutrient digestibility was calculated (Schneider et al., 1975) as follows:

$$\text{DM digestibility \%} = 100 - \left[100 \text{ x } \frac{\text{AIA\% in feed}}{\text{AIA\% in feces}} \right]$$

Nutrient digestibility % = $100 - \left[100 \text{ x } \frac{\text{AIA\% in feed}}{\text{AIA\% in feces}}\right] \text{x} \left[\frac{\text{Nutrient \% in feces}}{\text{Nutrient \% in feed}}\right]$

Where, AIA is acid insoluble ash.
Total digestible nutrients (TDN) and digestible crude protein (DCP) were calculated (McDonald et al., 1995).

Milk yield and composition

The milk production was recorded biweekly using the manual milking technique and the udder was stripped completely and corrected for 4% fat corrected milk (4% FCM) calculated (Parekh et al., 1986) 3.5% FCM = Actual milk yield (kg) x 0.35 +18.57 x fat yield (kg). Milk samples were analyzed for fat, protein, lactose, solids not fat (SNF) and total solids (TS) using Milkoscan, model 133 B. Ash was determined by the difference.

Feed conversion

Feed conversion efficiency in terms of DM, TDN and DCP required for one kg 4% FCM yield were calculated for every goat.

Economic efficiency

Cost of feed, feed cost /kg 4% FCM and the price of 4% FCM were calculated for every goat according to the prices of year 2020. Additionally, economic efficiency expressed as the ratio of price of 4% FCM yield and feed cost were calculated. Prices of concentrate feed mixture = 5000 LE/ton, barley grains = 4200 LE/ton, fresh berseem = 600 LE/ton, wheat straw = 1500 LE/ton, sodium selenite = 200 LE/kg, selenium yeast = 150 LE/kg, organic selenite = 100 LE/kg, nano-selenium = 150 LE/kg, goat's milk = 6 LE/kg and weigh gain of kids 80 LE/kg.

Suckling kids

Total of 90 born kids produced from three experimental groups (18 in each) suckled their dams until weaning at 90 days of age (normal weaning). Kids were weighed weekly from birth until weaning and total weight gain, average daily gain and mortality rate were calculated.

Statistical analysis:

Data were analyzed by least square means analysis of variance using General Linear Models (GLM) procedure of IBM SPSS Statistics (2020) for one-way ANOVA. The model used to analyze the different treatments studied for lambs was as follows:
$Y_{ij} = \mu + T_i + e_{ij}$
Where: Y_{ij} = Observation, μ = Overall mean; T_i = Effect of ith treatments and e_{ij}= Experimental error.

Duncan's Multiple Range test was used to detect differences between means of the experimental groups (Duncan et al., 1955)

RESULTS AND DISCUSSION

Nutrients digestion and feeding values

Nutrients digestion and feeding values for different groups are presented in Table 2. There were significant differences ($P<0.05$) in nutrients digestibility coefficients of DM, OM, CP, CF, EE and NFE as well as feeding values of TDN and DCP among the different groups. Which, G5 showed significantly ($P<0.05$) the higher values followed by G4 and G3 then G2, whereas G1 had the lower values. These results might be due to increase the availability of Se in the form of BNSe, BOSe and YSe. In the current study, the finding that supplemental BNSe was the more efficient form in enhancing nutrients digestibility and nutritive values. When Se was supplemented at 0.4 ppm, Se yeast was more effective than sodium selenite to increase ($P<0.05$) digestibility of DM, OM, CP, NDF and ADF in sheep (Alimohamady et al., 2013). In addition, dietary supplementation of SY at high levels (150 and 300 ppm) was also efficient to enhance digestibility of DM and CP in lactating dairy cows (Wang et al., 2009) They concluded that organic Se seems to be a better choice, considering the nitrogen and energy available for metabolism. Ibrahim and Mohamed (Ibrahim et al., 2018) found that digestibility of OM, CP, CF, EE, NFE and the values of DCP and TDN were increased ($P<0.05$) for lambs fed SY compared with those fed SS or control. It has been reported that groups received OSe and NSe recorded significantly ($P<0.05$) the highest digestibility of all nutrients and feeding values compared to the control group (Shams et al., 2020)

Feed intake

Feed intake by goats in different groups is shown in Table (3). Data showed that average daily intake of DMI and CPI were the same for the different groups. Meanwhile, the average daily intake of TDN and DCP were greater ($P<0.05$) for goats in G5 (BNSe) compared with G1 (control) with insignificant ($P<0.05$) differences with the other groups (G2, G3 and G4. The increases in the intake of TDN and DCP might be attributed to increase TDN and DCP values with selenium supplementation. In goats, the dry matter, organic matter and crude protein intake significantly increased with organic Se than inorganic one (Zohreh et al., 2016). Ibrahim and Mohamed (Ibrahim et al., 2018) found insignificant differences in the intake of DM and CP, but

Table 2: Nutrients digestion, feeding values and feed intake of different groups.

Item	Experimental groups					SEM
	G1	G2	G3	G4	G5	
Nutrients digestion coefficients %						
DM	65.59^{c}	67.34^{bc}	69.53^{ab}	69.92^{ab}	71.85^{a}	0.65
OM	66.84^{c}	68.63^{bc}	70.29^{b}	70.90^{ab}	73.17^{a}	0.65
CP	62.52^{c}	64.26^{bc}	66.35^{ab}	66.89^{a}	68.29^{a}	0.62
CF	62.48^{c}	64.15^{bc}	66.39^{ab}	66.78^{a}	68.29^{a}	0.62
EE	72.37^{c}	75.25^{b}	76.73^{b}	77.77^{ab}	79.92^{a}	0.75
NFE	68.00^{c}	69.51^{bc}	71.14^{ab}	71.80^{ab}	73.01^{a}	0.56
Feeding values %						
TDN	61.59^{c}	63.13^{bc}	64.83^{ab}	65.39^{ab}	66.66^{a}	0.55
DCP	7.86^{c}	8.08^{bc}	8.35^{ab}	8.42^{a}	8.59^{a}	0.08
Feed intake on DM basis (g/head/day)						
DMI	1447.40	1447.40	1447.40	1447.40	1447.40	6.32
TDNI	891.45^{b}	913.74^{ab}	938.37^{ab}	946.45^{ab}	964.84^{a}	10.64
CPI	182.08	182.08	182.08	182.08	182.08	0.79
DCPI	113.77^{b}	116.95^{ab}	120.86^{ab}	121.87^{ab}	124.33^{a}	1.44

a, b, c: values in the same row with different superscripts differ significantly at P<0.05.

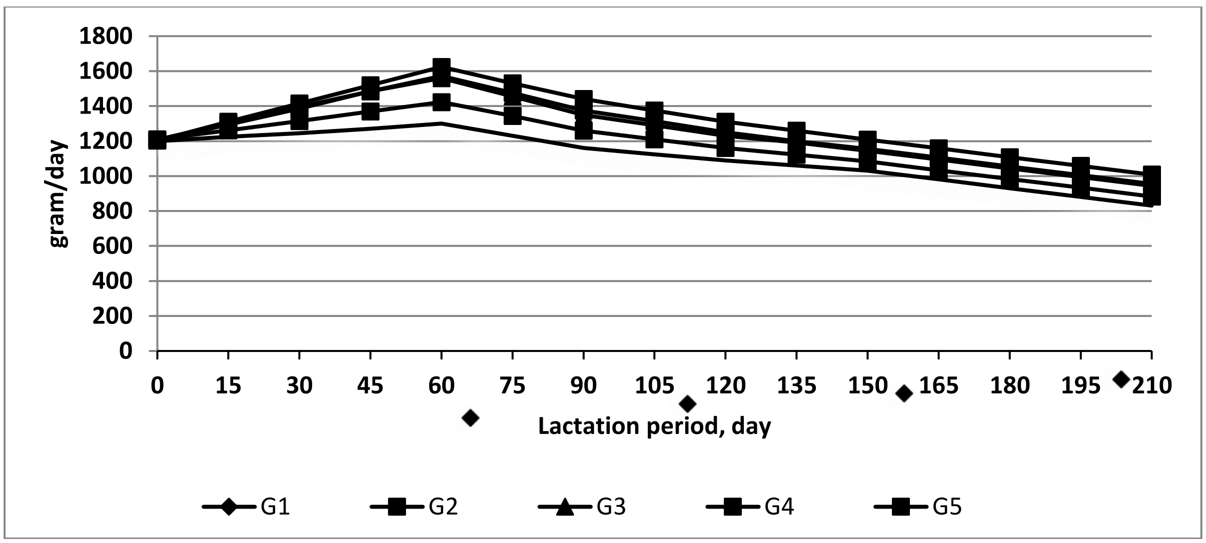

Figure1: Milk yield of Zaraibi goats during lactation period**.**

found significant (P<0.05) increase in the intake of TDN and DCP with selenium supplementation. Shams et al. (Shams et al., 2020) reported that DM intake was the same for different groups. Whereas, TDN and DCP intake tended to increase with OSe and NSe supplementation than those of control group.

Milk yield and composition

Milk yield, composition and constituent's yield of goats in different groups are shown in Table 3 and Figure 1. Milk yield and composition revealed significant differences (P<0.05) among the different groups. Group 5 showed significantly (P<0.05) the highest yield of actual milk and 3.5% fat corrected milk (FCM) and the contents of fat, protein, lactose, solids not fat (SNF) and total solids (TS) followed by G4 and G3 then G2, while G1 had the lowest yield. Yield of actual milk of G2, G3, G4 and G5 increased by 6.31, 12.80, 13.89 and 17.85% compared to G1, respectively. The corresponding values of 3.5% FCM were 8.69, 18.40, 19.41 and 28.19%, respectively. In the present study, yield of milk and composition were emphasize the benefits of supplementation of goats with BNSe, BOSe and YSe. Supplementing buffalo ration with 10 mg/h/d selenized yeast or 10 mg/h/d organic Se improved milk production and composition (Kholif et al., 2008). Organic se (Se-yeast) supplementation has considerable influence on the production traits of dairy goats (Bagnicka et al., 2017). Milk yield and contents of fat, protein, casein, lactose, total solids and non-fat solid

Table 3: Milk yield and composition of dairy goats during suckling and lactation periods

Item	Experimental groups					SEM
	G1	G2	G3	G4	G5	
Milk yield g/day)						
Actual milk	1109^{c}	1179^{bc}	1251^{ab}	1263^{ab}	1307^{a}	23.94
3.5% FCM	1185^{c}	1288^{bc}	1403^{ab}	1445^{ab}	1519^{a}	37.58
Milk composition %						
Fat	3.86^{c}	4.00^{bc}	4.15^{ab}	4.27^{a}	4.37^{a}	0.06
Protein	3.29^{c}	3.36^{bc}	3.41^{abc}	3.44^{ab}	3.49^{a}	0.02
Lactose	4.21^{c}	4.27^{bc}	4.33^{ab}	4.36^{ab}	4.43^{a}	0.02
SNF	8.31^{c}	8.45^{bc}	8.56^{abc}	8.62^{ab}	8.73^{a}	0.05
TS	12.17^{c}	12.44^{bc}	12.71^{ab}	12.89^{ab}	13.10^{a}	0.10
Ash	0.81	0.82	0.82	0.82	0.82	0.002

a, b, c: values in the same row with different superscripts differ significantly at P<0.05.

Table 4: Feed conversion ratio and economic efficiency of dairy goats.

Item	Experimental groups					±SE
	G1	G2	G3	G4	G5	
Feed conversion						
DM (kg/kg 3.5% FCM)	1.23^{a}	1.13^{ab}	1.04^{ab}	1.01^{ab}	0.96^{b}	0.04
TDN (kg/kg 3.5% FCM)	0.76^{a}	0.72^{ab}	0.68^{ab}	0.66^{ab}	0.64^{b}	0.02
CP (g/kg 3.5% FCM)	155.15^{a}	142.75^{ab}	131.09^{abc}	127.20^{bc}	120.80^{c}	4.75
DCP (g/kg 3.5% FCM)	96.94^{a}	91.69^{ab}	87.02^{abc}	85.14^{bc}	82.49^{c}	2.64
Economic efficiency						
Feed cost (LE/day)	5.950	5.951	5.951	5.951	5.951	0.001
Feed cost (LE/kg 3.5% FCM)	5.07^{a}	4.66^{ab}	4.28^{bc}	4.16^{bc}	3.95^{c}	0.16
Milk output (LE/day)	7.11^{c}	7.73^{bc}	8.42^{ab}	8.67^{ab}	9.11^{a}	0.29
Net revenue (LE/day)	1.16^{c}	1.78^{bc}	2.47^{ab}	2.72^{ab}	3.16^{a}	0.29
Economic efficiency[1]	1.20^{c}	1.30^{bc}	1.41^{ab}	1.46^{ab}	1.53^{a}	0.05
Economic efficiency[2]	19.50^{c}	29.89^{bc}	41.43^{ab}	45.73^{ab}	53.14^{a}	5.80

a, b, c, d: values in the same row with different superscripts differ significantly at P<0.05.
[1] Economic efficiency = output of 4% FCM yield/ feed cost.
[2] Economic efficiency = net revenue x 100/ feed cost.

increased significantly with organic Se supplementation (Reczyńska et al., 2019) Milk yield of dairy cows fed diets were supplemented by 6 g of Se-yeast per d per cow was higher in the organic Se treatment group vs. the inorganic one (Bagnicka et al., 2017). It has been found that milk yield was the highest with selenium yeast followed by sodium selenite and lastly the control for both breeds of Farafra and Saidi ewes, but the differences were significant only between selenium yeast and control (P<0.05) (Saba et al., 2019).

Feed conversion ratio

Feed conversion ratio of goats in different groups is shown in Table (4). Inorganic, organic and biological selenium supplementation led significant (P<0.05) improvements in feed conversion ratio compared to control group. Group 1 (control) recorded significantly (P<0.05) the higher amounts of DM and TDN per kg 3.5% FCM compared to G5 with insignificant differences with G2, G3 and G4. Also, G1 showed significantly (P<0.05) the highest amounts of CP and DCP per kg 3.5% FCM followed by G2 and G3, then G4, while G5 had the lowest values. The improvements in feed conversion could be attributed the increase of 3.5% FCM yield with selenium supplementation. These results agreed with those obtained by Ibrahim and Mohamed (Ibrahim et al., 2018) found that feed conversion of DM, DCP and TDN were improved (P<0.05) for Ossimi lambs fed SS and SY vs. those fed control.

The feed conversion efficiency by sheep was increased with selenium yeast (P<0.01) (Xun et al., 2012) (Shams et al., 2020) reproted 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.

Economic efficiency

Economic efficiency of goats in different groups is shown in Table (4). Average daily feed cost was nearly similar for the different groups, while feed cost per 1 kg 3.5% FCM was the highest in G1 followed by G2, then G3 and G4, but G5 had the lowest cost. On the other side, G5 recorded significantly (P<0.05) the highest output of daily

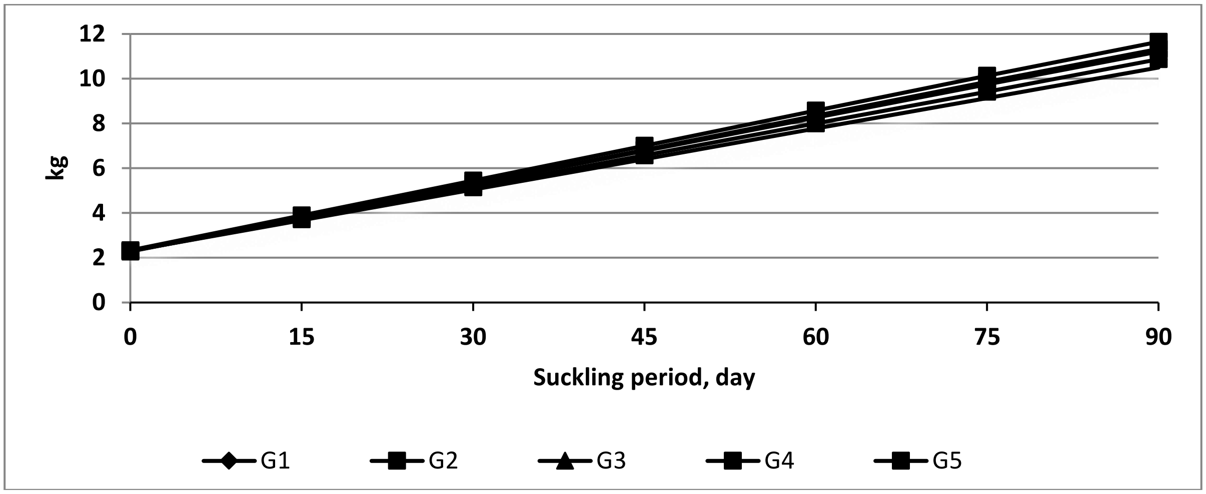

Figure 2: Body weight of suckling kids.

3.5% FCM yield, net revenue and economic efficiency followed by G4 and G3, then G2, however G1 had the lowest values. These results are confirmed with the increase of 3.5% FCM yield with selenium supplementation. Economic efficiency expressed as the ratio of output of 3.5% FCM yield to feed cost of G2, G3, G4 and G5 increased by 8.33, 17.50, 21.67 and 27.50% compared to G1, respectively. The corresponding values of economic efficiency expressed as the percentage of net revenue to feed cost were 53.28, 112.46, 134.51 and 172.51%, respectively. (Eulogio et al., 2012) stated that the economic feasibility of the use of selenium allowed obtaining a profit margin. Dietary Se supplementation did not show any effect on feed cost of Nellore ram lambs (Sushma et al., 2015) (Kumar et al., 2008) reported that cost of feed per kg weight gain were less by about 11% and 17% in groups supplemented with Se at 0.15 and 0.30 ppm levels, respectively, as compared to control group.

Growth performance of suckling kids

Growth performance of suckling kids in different groups is presented in Table (5). Number of weaned kids was significantly ($P<0.05$) higher in G5 followed by G3 and G4 then G2, but was lower in G1. No death kids in G5 received BNSe and moreover mortality rate was the least with G3 and G4, followed by G2, but was the highest in G1 with significant differences ($P<0.05$). Moreover, it was noticed that losses was concentrated among twins while no losses among single born kids. The mortality rate presented in this study did not exceed normal rate stated by (Abdelhamid et al., 1999) **w**ho stated that mortality of born kids did not exceed 18% in Zaraibi goats.

Body weight progress of suckling kids from birth to weaning at 90 days for the different groups is shown in Figure 2. Weaning weight, total weight gain and average daily gain were significantly ($P<0.05$) higher in G5 followed by G4 and G3, then G2, but were lower in G1. Average daily gain of kids in G2, G3, G4 and G5 increased by 4.17, 8.03, 10.02 and 13.25% compared to G1, respectively. In other comparative study by (Abdelhamid et al., 1999) who found that the total weight gain was 9.27 kg in Zaraibi kids. In the same way, Average daily gain was enhanced with supplemental selenium sources in goats (Yue et al., 2009) Kumar et al. (Kumar et al., 2008) opined that supplemental organic selenium was more effective than inorganic in improving growth performance in male lambs. Shi et al. (Shi et al., 2011) found that FBW of growing male goats increased ($P<0.05$) in different se sources supplemented bucks compared with control, and the ADG was greater ($P<0.05$) with feeding Nano-selenium and selenium yeast than sodium selenite. (Shams et al., 2020) reported that weaning weight, total weight gain and average daily gains were significantly ($P<0.05$) higher for OSe and NSe groups than untreated group.

Suckled milk as g per kid per day and the cost of suckled milk as LE per day were nearly similar for the different groups. While, suckled milk and the cost of suckled milk per kg weight gain were significantly ($P<0.05$) higher in G1 followed by G2 then G3 and G4, but G5 had the lowest values. Output of ADG, net revenue and economic efficiency were significantly ($P<0.05$) higher in G5 followed by G4 and G3, then G2, while G1 had the lowest values. Shams et al. (Shams et al., 2020) found that the feed cost for producing one kg weight gain was significantly ($P<0.05$) lower for OSe and NSe groups compared to control group. 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.

Table 5: Growth performance of suckling kids in different groups.

Item	Experimental groups					±SE
	G1	G2	G3	G4	G5	
No. of born kids	18	18	18	18	18	0.08
No. of weaned kids	15^{c}	16^{bc}	17^{ab}	17^{ab}	18^{a}	0.28
Mortality rate (%)	16.67^{a}	11.11^{b}	5.56^{c}	5.56^{c}	0.00^{d}	1.51
Birth weight (kg)	2.31	2.30	2.32	2.28	2.33	0.01
Weaning weight (kg)	10.54^{c}	10.87^{bc}	11.21^{ab}	11.33^{ab}	11.65^{a}	0.12
Total weight gain (kg)	8.23^{c}	8.57^{bc}	8.89^{ab}	9.05^{ab}	9.32^{a}	0.11
Average daily gain (g)	91.44^{c}	95.25^{bc}	98.78^{ab}	100.60^{ab}	103.56^{a}	1.20
Suckled milk (g/head/day)	736	733	732	739	723	6.52
Cost of suckled milk (LE/day)	4.42	4.40	4.39	4.43	4.34	0.03
Suckled milk (kg/kg gain)	8.05^{a}	7.70^{ab}	7.41^{bc}	7.35^{bc}	6.98^{c}	0.09
Cost of suckled milk (LE/kg gain)	48.34^{a}	46.19^{ab}	44.44^{bc}	44.04^{bc}	41.91^{c}	0.05
Output of ADG (LE/day)	7.32^{c}	7.62^{bc}	7.90^{ab}	8.05^{ab}	8.28^{a}	0.10
Net revenue (LE/day)	2.90^{c}	3.22^{bc}	3.51^{ab}	3.62^{ab}	3.94^{a}	0.08
Economic efficiency[1]	1.66^{c}	1.73^{bc}	1.80^{ab}	1.82^{ab}	1.91^{a}	0.02
Economic efficiency[2]	65.61^{c}	73.18^{bc}	79.95^{ab}	81.72^{ab}	90.78^{a}	1.58

a, b, c, d: values in the same row with different superscripts differ significantly at $P<0.05$.
[1] Economic efficiency = price of ADG/ cost of suckled milk.
[2] Economic efficiency = net revenue x 100/ cost of suckled milk

The results of this study showed that inorganic selenium (sodium selenite) and organic selenium (selenium yeast) supplementation for dairy Zaraibi goats at the level of 0.3 mg Se/kg DM intake has led to significant improvement in digestibility, feed intake, milk yield and composition, feed conversion and economic efficiency as well as growth performance of their suckling kids.

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REFERENCES

Abdelhamid AM, EI Shehata, ME Ahmed (1999)**.** Physio-nutritional studies on pregnant and lactating goats fed on rations differing in roughage /concentrate ratio at different feeding levels and/or not supplemented with bentonite. 3- Effects on productivity, reproductivety and metabolic disturbances. J. Agric. Sci., Mansoura Univ., 24 (9): 4637.

Alimohamady R, H Aliarabi, A Bahari, AH Dezfoulian (2013). Influence of Different Amounts and Sources of Selenium Supplementation on Performance, Some Blood Parameters, and Nutrient Digestibility in Lambs. Biol. Trace Elem. Res., 154: 45–54.

AOAC. *Official method of Analysis*. [Association of Officiating Analytical Chemists, Washington DC, USA. 18th Edition, 2005]

Bagnicka E, EM Kościuczuk, J Jarczak, A Jóźwik, N Strzałkowska, D Słoniewska, J Krzyżewski (2017). The effect of inorganic and organic selenium added to diets on milk yield, milk chemical and mineral composition and the blood serum metabolic profile of dairy cows. Anim. Sci. Papers Rep., 2017, 35: 17–33.

Bagnicka E, J Jarczak, J Kaba, EM Kościuczuk, M Czopowicz, J Krzyżewski (2016). Effect of organic vs. Inorganic selenium supplementation on the milk production traits of polish dairy goats. In Kukovics S. (ed.), Sustainable Goat Breeding and Goat Farming in Central and Eastern European Countries. [Rome, Italy: Food and Agriculture Organization of the United Nations, pp. 237–241.

Duncan DB (1955). Multiple range test and multiple F-test. Biometrics, 11: 1-42.

Eulogio GLJ, CV Hugo, CN Antonio, CI Alejandro, MQ Juan (2012). Effects of the selenium and vitamin E in the production, physicochemical composition and somatic cell count in milk of Ayrshire cows. J. Anim.Vet. Adv., 11: 687–691.

Guyot H, P Spring, S Andrieu, F Rollin (2007). Comparative responses to sodium selenite and organic selenium supplements in Belgium Blue cows and calves. Livest. Sci., 111: 259–263.

IBM SPSS Statistics (2020). Statistical package for the social sciences. [Release 27, SPSS INC, Chicago, USA., 2020]

Ibrahim EM, MY Mohamed (2018). Effect of different dietary selenium sources supplementation on nutrient digestibility, productive performance and some serum biochemical indices in sheep. Egyptian J. Nutr. Feeds,

21: 53-64.
Kholif AM, SM Kholif (2008). Effect of selenium enriched yeast supplementation on the productive performance of lactating buffaloes. Egypt. J. Nutr. Feeds, 11: 187-200.
Kumar N, AK Garg, V Mudgal, RS Dass, VK Chaturvedi, VP Varshney (2008). Effect of different levels of selenium supplementation on growth rate, nutrient utilization, blood metabolic profile, and immune response in lambs. Biol. Trace Elem. Res., 126: S44–S56.
Mala S, F Kovaru, L Misurova L Pavlata, R Dvorak, M Ciz (2009). Influence of selenium on innate immune response in kids. Folia Microbiologica, 54: 545–548.
McDonald P, RA Edwards, JFD Greenhalgh, CA Morgan (1995). Animal nutrition. [Copyright licensing LTD., London., 5th Ed., 1995]
Nampoothiri V, P Ganga Devi 2017). Selenium for calf growth and health: Mini review. Int. J. Livestock Res., 7: 1–10.
NRC. Nutrient requirements of small ruminants: sheep, goats, cervids and new world camelids. [National Academies Press: Washington, DC, USA., 2007]
Parekh HK (1986). A new formula for 3.5% fat-corrected milk. Indian J. Anim. Sci. 56, 608–609.
Pavlata L, S Slosarkova, P Fleischer, A Pechova (2005). Effects of increased iodine supply on the selenium status of kids. Veterinarni Medicina, 50: 186–194.
Quintana M, Haro-Poniatowski E, Morales J, Batina N (2002). Synthesis of selenium nanoparticles by pulsed laser ablation. Appl. Surf. Sci., 195: 175–186.
Reczyńska D, B Witek, J Jarczak, M Czopowicz, M Mickiewicz, J Kaba, L Zwierzchowski, E Bagnicka (2019). The impact of organic *vs.* inorganic selenium on dairy goat productivity and expression of selected genes in milk somatic cells. J. Dairy Res. 86: 48-54.
Saba Fatma E, AAK Saleh, AA Al Moafy (2019). Effect of supplementation with different types of selenium on lactation performance and some blood parameters of Farafra and Saidi ewes and performance of their lambs. Egyptian J. Sheep & Goat Sci., 2019, 14: 19 – 30.
Schneider BH, WP Flat (1975). The evaluation of feeds through digestibility experiments. [Athens: The University of Georgia Press, pp. 423,]
Shams Ash, MA Zommara, ME Sayed-Ahmed, MM El-Nahrawy (2020). Growth performance and immunity response of suckling Friesian calves fed on ration supplemented with organic or nano selenium produced by lactic acid bacteria. Egyptian J. Nutr. Feeds, 23: 205-217.
Shi L, W Xun, W Yue, C Zhang, Y Ren (2011). Effect of sodium selenite, Se-yeast and nanoelemental selenium on growth performance, Se concentration and antioxidant status in growing male goats. Small Ruminant Res., 96: 49-52.
Shoeibi S, M Mashreghi (2017). Biosynthesis of selenium nanoparticles using Enterococcus faecalis and evaluation of their antibacterial activities. J. Trace. Elem. Med. Biol., 39:135–139.
Stewart WC, G Bobe, GJ Pirelli, WD Mosher, JA Hall (2012). Organic and inorganic selenium: III. Ewe and progeny performance. J. Anim. Sci., 90: 4536-4543.
Sushma K, Y Ramana Reddy, N Nalini Kumari, P Baswa Reddy, T Raghunandan, K Sridhar (2015). Effect of selenium supplementation on performance, cost economics, and biochemical profile of Nellore ram lambs. Vet. World, 8: 1150-1155.
Van Keulen J, BA Young (1977). Evaluation of acid insoluble ash as a natural marker in ruminant digestibility studies. J. Anim. Sci., 44: 282.
Vinu MN, P Gangadevi, AD Mercy, KS Anil, K Shyama (2012). Effect of dietary supplementation of organic selenium on growth performance and nutrient utilization in crossbred calves. J. Vet. Anim. Sci., 43:36-40.
Wang C, Q Liu, WZ Yang, Q Dong, XM Yang, DC He, P Zhang, KH Dong, YX Huang (2009). Effects of selenium yeast on rumen fermentation, lactation performance and feed digestibilties in lactating dairy cows. Live Sci., 126: 239–244.
Xun W, L Shi, W Yue, C Zhang, Y Ren, Qiang (2012). Effect of High-Dose Nano-selenium and Selenium-Yeast on Feed Digestibility, Rumen Fe mentation and Purine Derivatives in Sheep. Liu Biol. Trace Elem. Res., 150: 130–136.
Yue WB, CX Zhang; LG Shi, YS Ren, YS Jiang, DO Kleemann (2009). Effect of supplemental selenomethionine on growth performance and serum antioxidant status in Taihang black goats. Asian-Aust. J. Anim. Sci., 22: 365–370.
Zhang SY, Zhang J, Wang HY, Chen HY (2004). Synthesis of selenium nanoparticles in the presence of polysaccharides. Mater Lett., 58: 2590–2594.
Zohreh T, S Karimi, H Mehrban, Moharrery A (2016). Supplementation of different selenium sources during early lactation of native goats and their effects on nutrient digestibility, nitrogen and energy status. J. Applied Anim. Res., 46: 1-5.