Physiological indicators and live weight gain of camel calves as influenced by selenium source supplementation

Gamal Ashour[1], Faten Fahmy Abou-Ammou[2], Sherif Mohamed Dessouki[1], Hossam Khaled Saad El-Deen[2]

[1]Department of Animal Production, Faculty of Agriculture, Cairo University, 12613 Giza, Egypt.

[2] Camel Research Department, Animal Production Research Institute, 12611 Dokki, Giza, Egypt.

Received: April 26, 2021; Accepted: November 12, 2021; Published: March 18, 2022

Abstract

This study was carried out to investigate the impact of selenium source (i.e organic and inorganic) given at 8 mg/head/d on the antioxidant capacity of camel calves and their growth performance. Seventeen camels at 18 months of age with an average body weight of 172.47±10.56 kg (mean±SE) were randomly divided into 3 groups: group 1 (organic selenium, n=6), group 2 (inorganic selenium, n=6) plus vitamin E (15 IU/kg DM) and a control group (control, n=5). The three groups were housed in three semi-opened and shaded pens and fed the experimental diets for 115 days.

A significant increase (P<0.05) in blood plasma metabolites including glucose, total protein, albumin, and total lipids was observed. Also, the concentration of triiodothyronine was higher (P<0.05) in both Se supplemented groups while the concentration of alkaline phosphatase was higher (P<0.05) only in the organic Se group. The values for alanine aminotransferase, aspartate aminotransferase, blood urea nitrogen, and creatinine were similar across treatments and remained within the normal range. A significant improvement of antioxidant status was clearly reflected by the significant increase (P<0.05) in glutathione peroxidase, catalase, total antioxidant capacity, and a decrease in malondialdehyde for supplemented groups *vs* control group. The concentrations of plasma selenium, calcium and potassium were higher (P<0.05) in treated groups. Sodium concentration was similar (P>0.05) across treatments.

Average daily gain (g/d) was higher (P<0.05) in the Se supplemented groups with a clear difference between the organic selenium group compared with the others.

It has been concluded that the supplementation of selenium to growing camel diets by (8 mg/head/d) improved growth performance and reduced oxidative stress without any adverse effect on animals. In addition, organic source showed a better effect than the inorganic source.

Keywords: Camel calves, growth, selenium, blood metabolites, enzymes, hormones.

Corresponding author: Hossam Khaled Saad El-Deen, Email: negomzeraa_2007@yahoo.com

Introduction

The Arabian camel (*Camelus dromedarius*) is most widely distributed in the hot arid areas of the Middle East and Africa. They are very important in many countries as they are used as meat, milk and draft animals. They survive in an arid environment where the supply of good quality forages is limited. Most camels are raised under a true nomadic husbandry system (Tibary and El Allali, 2020)

In Egypt the daily per capita share of animal protein is 18.9 g (El-Badawi, 2018) which is lower than the recommendations of FAO 1989 for the minimum level of animal protein per

capita (29.3 g protein/capita/day). The contribution of camels in meat production in Egypt is 23,500 tons/year which is about 8% of total meat production (CAPMS, 2018). One hundred forty thousand heads formed less than 1% of the total animal population in Egypt (FAO, 2018). So that, the low contribution in camel meat production is due to their small population Therefore, increasing the contribution of camels to meat production needs the development of fattening operations in order to improve productivity and the quality of the product.

Generally, camels are economic meat producers. This is because of their ability to utilize fiber-rich diets and changing their feeding behavior according to seasson, as well as their relatively low maintenance enery requirements (Al Jassim 2019). An average daily gain (ADG) of 557 g/d was reported by Farghaly (2009) for 2-3 years old calves fed a concentrated mixture at 1% bodyweight rate plus molasses treated rice straw. Higher ADG of 819 g/d was earlier reported by Yacout and El-Badawi (2001) feeding concentrated diets containing graded levels of crude protein (10 to 18%) under stall-feeding conditions. Camel calves have also performed well and are comparable to Sudanese Baladi steers under feedlot conditions (El-Badawi and Yacout, 1999).

Egyptian Maghrebi camel is a dual-purpose animal reared for meat and milk production. It is medium in size but relatively has a relatively high growth rate. It could increase about 700-1000 g/d during the first year under intensive (Wardeh, 2004) and fattening conditions (Saad El-Deen 2013). In addition, ADG of camel calves less than tow years did not affected by sex (Saad El-Deen 2013, and Bakheit et al., 2017)

Generally, the trace minerals requirement should be covered due to their importance in body biological functions . These trace elements are necessary for enzymes and hormones which control the live processes (Soetan et al., 2010; Hennigar and McClung, 2015). In concern, selenium (Se) is an essential trace element in animal nutrition, because it plays an important role in the prevention of fertility disorders, oxidative stress, and cell membrane damage. More than 30 selenoenzymes have been described in a hierarchy process. It is critical to feed metabolism due to its role in converting T4 (thyroxin inactive form) to T3 (active form) (Hefnawy and Tortora-Perez, 2010; Shi et al., 2011).

In Egypt, most of the live stock holders did not distribute oral selenium supplementation for their adult animals or newborns. But they are using an inorganic or multi-nutrient solution by injection at the final stage of pregnancy or as a medical treatment for deficiency on a formula prepared for cattle and small ruminants. Although, (Faye et al., 2014a; Faye et al., 2014b) reported that this unique method is quite insufficient for Se status improvement.

Many studies focused on the role of Se supplementation on the adult camels under different conditions (Al-Qarawi et al., 2001), levels (Seboussi et al., 2009), sources (Faye et al., 2014b), and physiological status (Faye et al., 2011) but in growing camel, information is rarely available. Therefore, this study aimed to assess and evaluate the effect of Se source on blood metabolites, thyroid hormones, antioxidant status, and blood minerals as physiological indicators of growth performance of Maghrabi camel calves raised in the north coastal zone of Egypt.

Materials and Methods

This experiment was conducted in Camel Studies and Production Development Center in Matrouh governorate which is located in the hot dry area of the North-Western Coastal Zone of Egypt (Latitude: 31°21′00″ N, longitude: 27°13′59″ E and elevation: above sea level 41 m). The

laboratory work carried out at biochemical analysis lab, both of them are belong to Camel Research Department, Animal Production Research Institute, Agricultural Research Center, Giza, Egypt. This study was lasted continuously for 115 days from May to August.

Experimental animals and management

Seventeen healthy and growing Maghrabi camels (9 males and 8 females) with average body weight (BW) of 172.47 ± 10.56 kg and at the age of 18 months were used. The calves were bloched according to sex then randomly divided into 3 groups (6 in each treated group OSG: organic Se group and ISG: inorganic Se group and 5 in CG: control group). Groups OSG and ISG contained equal nomber of males and females (3 of each) while the control group contained 3 males and 2 females. Early work showed that sex does not affect ADG at this stage (Saad El-Deen 2013, and Bakheit et al., 2017). The three groups were housed in three semi-opened and shaded pens. According to farm protocol, all calves were fed individually the same basal complete rations at 2% of body weight (on a dry matter basis) and adjusted weekly. Diet was composed of alfalfa hay, concentrate feed mixture, and rice straw with (40% roughage – 60% concentrate). The chemical composition of the experimental feeds is shown in Table 1. Feed intake was measured daily and feed offered was adjusted weekly.

Table 1. Chemical composition of camel calves feedstuffs (% dry matter basis).

Item	Alfalfa	Concentrated mixture	Rice straw
Dry matter (DM)	89.96	89	89.25
Organic matter (OM)	90.00	87.64	86.33
Crude protein (CP)	13.76	13.48	4.92
Crude fibers (CF)	36.20	9.00	37.87
Ether extract (EE)	1.28	2.81	1.03
Ash	10.00	12.35	13.67

Selenium supplementation

Before the start of the experiment, blood, feeds and water samples were taken to assess Se's concentration to determine the dose to be used. The overall mean of whole blood Se was 18.43 ng/ml. the normal concentration mean reported by (Fay and Bengoumi, 2018) which was around 100 ng/ml. So that The maximal tolerable dose as recommended by (Faye and Seboussi, 2009) (8 mg/head/d) was used in the form of selenomethionine as organic source and sodium selinate as inorganic source to cover the requirements of animal to achieve the optimum health and productivity compared with the control group without any addition. The Se addition was provided by Premex Inc. Company, United States of America. The Se from two sources were in powder form and given daily by putting the dose in a date according to Faye et al., (2014b).

Rations were offered twice daily at 8.00 and 14.00 hours. Chemical composition for experimental feed stuffs on dry matter basis (%) is shown in Table (1). The dietary ingredients consisted of alfalfa, rice straw, and the commercial concentrate feed mixture (25% yellow corn, 25% wheat bran, 20% barley, 15% rice bran, 9% cotton earn peeled, 3% molasses, 2% limestone and 1% salt). Water was allowed free choice all day.

Colorimetric methods were adopted for the determination of glucose (Glu), total protein (TP), albumin (Alb), total cholesterol (TC), triglyceride (TG), total lipids (TL), alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), blood urea nitrogen (BUN) and creatinine (Crt). Antioxidant biomarkers; glutathione peroxidase (GSH-Px), catalase (CAT), malondialdehyde (MDA), and total antioxidant capacity (TAC) were measured by manufactured locally kits of Bio Diagnostic Company (Dokki, Giza, Egypt). Globulin concentration (Glob) was calculated by the difference between TP and Alb.

Blood samples (about 10 ml) were collected monthly, from the Jugular vein into clean, dry test tubes containing heparin as an anti-coagulant. Plasma was separated by centrifugation at 3000 rpm for 20 minutes and then stored at -20º C for later analysis. The red blood cells were washed three times with an isotonic solution of NaCl (0.9%) and centrifuged for 4 minutes at 4,000×g. The supernatant was immediately collected for the determination of glutathione-peroxidase (GSH-Px). The preparation of samples was carried out according to the procedure supplied with kit manufactured locally by Bio Diagnostic Company (Dokki, Giza, Egypt).

Plasma metabolic hormones, including triiodothyronine (T3) and thyroxine (T4), were quantified by radioimmunoassay (RIA) method using commercial kits supplied by Siemens Medical Solutions Diagnostics (Los Angeles, CA 90045-6900. USA).

The blood selenium concentration was measured using a GC (spell out as gas chromatograph at first mention) (Agilent technologies 7890A) interfaced with a polar Agilent HP-5ms (5%-phenyl methyl polysiloxane) capillary column (30m × 0.25 mmi. d. and 0.25 µm film thickness). Sodium (Na), potassium (K), and calcium (Ca) were measured in plasma by using kits manufactured locally by Bio Diagnostic Company (Dokki, Giza, Egypt).

Total body gain (TBG, kg), and average daily gain (ADG, g/head/d) were estimated as good indicators of growth performance. Changes in live BW were recorded individually using digital platform balance at biweekly intervals before morning feeding and after fasting overnight. TBG was calculated as the differences between the final body weight (FBW) and the initial body weight (IBW), then these values were divided by period in days to get the average daily weight (ADG) for each animal. Feed conversion ratio (FCR) was calculated as g feed/g gain.

Ethics Statement

The study was conducted after obtaining the needed permits and approvals from Institutional Animal Care and Use Committee (CU- IACUC), Cairo University, Egypt., (Approval number CU II F 25 18, dated October, 2018).

Statistical Analysis

Data analysis was carried out by applying General Analysis of Linear Model (GLM) Procedure (SAS, 2008) with the following model used: $Y_{ij} = \mu + T_i + e_{ij}$.

Where, Y_{ij}= observed parameters, μ = Overall mean, T_i= Effect of selenium source (I = 1-3, 1= CG, 2 = OSG, 3 = ISG) and e_{ij}= Experimental error. Significant differences among means were detected by using Duncan's multiple range test (Duncan, 1955).

Results and Discussion

Blood parameters

All studied blood biochemical parameters Glu, TP, Alb. Glob, TG, TC, and TL are presented in Table (2).

Table 2. Biochemical parameters of growing Maghrabi camels as affected by different sources of selenium supplementation. (LSM ±SE)

Traits	CG	OSG	ISG
Glucose (mg/dl)	115.33^{b} ±4.13	130.83^{a} ±3.77	130.97^{a} ±3.77
Total Protein (g/dl)	6.76^{b} ± 0.18	8.12^{a} ±0.17	7.98^{a} ±0.17
Albumin (g/dl)	3.92^{b} ±0.19	4.87^{a} ±0.18	4.80^{a} ±0.18
Globulin (g/dl)	2.84^{b} ±0.12	3.25^{a} ±0.11	3.18^{a} ±0.011
Triglycerides(mg/dl)	62.00 ±3.25	55.77±2.97	62.07±2.97
Cholesterol mg/dl	61.20±2.47	65.89±2.26	67.33±2.26
Total lipids (mg/dl)	365.56^{b} ±18.35	457.87^{a} ±17.75	450.93^{a} ±17.75

$^{a-b}$ Least square means with different superscripts differ significantly (P<0.05). CG control group without any supplementation, OSG organic source group, and ISG inorganic source group.

Blood Glu increased significantly (P<0.05) by about 13% in supplemented groups (OSG and ISG) more than CG. This result is contrary to Alhidary et al. (2016a) who found that trace elements supplementation including Se does not affect Glu level. Although, the shortage of papers which studied the direct effect of Se on Glu. However, AL–Suhaimi et al. (2009) reported that the high Glu level was due to the camel's ability to store water during summer conditions with similarity to these experimental conditions. Previously, Elmahdi, et al., (1997) pointed that hyperglycaemia in camels could be due to higher gluconeogenic activity in the liver with lower cell response to insulin. Recently, Alim et al., (2019) studied the neural adaptation of the dromedary camel to hot arid conditions and found that the camel genotype is markedly affected by water preservation throughout high water reabsorption rate by kidney and Glu may help as a carrier of reabsorbed water.

On the other hand, the interaction between Se and Glu in other species was mentioned. For example, contrary to our findings, Singh et al. (2002) reported a decrease in Glu levels in the blood of buffalo calves fed on wheat straw with high Se (8.54 mg/kg DMI). In contrast, Nayyar et al. (2003) found that blood Glu level in buffalo heifers supplemented with vitamin E+Se was significantly more than the control group. Kamada (2017) also observed no significant increase in plasma Glu concentration in Holstein cows which were given yeast-based Se at the rate of 0.3 mg/kg DMI. The discrepancy in the results may be due to Se source, dose, duration, and other experimental protocols.

In the same line, TP increased significantly (P<0.05) by 20% for OSG and 18% for ISG more than CG . However, the variation between both treated groups was negligible. For Alb concentration the obtained values showed the same trend 24% higher in OSG than CG and 22% higher in ISG than CG. The same results were observed in Glob which increased from 2.84 g/dl in CG to 3.25g/dl in OSG by about 14%, and increased to 3.18 g/dl in ISG by about 12%. According to Hefnawy and Tortora-Perez (2010) who reviewed that most Se in the animal is tied with proteins with selenocysteine form and it is mostly involved in enzymes formation. So that, the increase in TP values may be due to the influence of protein synthesis which is

confirmed by the significant increases in studied enzymes (ALP, GSH-Px, and CAT).

To maintain the colloidal osmotic pressure and water preservation camel has a great ability to synthesize and store protein (Zongping, 2003). Connecting to our results the higher levels of Alb in the supplemented groups may be reflect that Se has a positive role in enhancing mechanisms of water preservation especially our study was conducted in the summer.

The other studied component of blood proteins was Glob which is related to immunity. Immunological parameters were not studied. But according to literature increasing concentration of IgG in serum in cows, which associated with higher blood Se levels **(**Hefnawy and Tortora-Perez, 2010) In the same line in camels, Kamal (2008); Karimi et al. (2015); and Hussain et al. (2016) found a significant decrease in blood proteins due to low immunity caused by Trypanosoma infection. So that, the increase of Glob may be due to the influence of immune response by Se supplementation.

On the other hand, blood proteins are affected by feeding conditions. So, this result is confirmed by Osman and Al-Bosadah (2000) for high feed quality and availability feeding resources in green season cause increase blood protein levels. In addition, Amin et al. (2007) observed a high level of Alb in the green season, while higher Glob in summer. Delvaud et al. (2013) studied the effect of prolonged underfeeding periods and found that Glob level is positively correlated with feed intake. These results are in agreement with Badawy et al. (2008) in Egypt, Bargaâ et al. (2016) in Morocco, and also in Algeria Aichouni et al. (2013), which reported an increase in plasma Glob concentration during winter (rainy season).

For studying lipid profile, TG, TC, and TL were assessed. The observation was no significant variation (P>0.05) among the three groups in TG and TC, but a slight increase in treated groups with priority in ISG. The similarity in age and physiological stage of the experimental animal may be the reason for low differences in TG and TC among groups because these parameters did not affect by age or sex as found by Saeed et al. (2004); Ali et al. (2008); Mohamed (2008). In addition, Yousif et al. (2016), and Ali et al. (2008) reported that also season has no effect.

Total lipids were significantly higher (P<0.05) in treated groups OSG and ISG than CG. An increase by about 25.25% was observed in OSG more than CG and by 23.35% in ISG, which gives superiority to Se addition regardless of the source. These results may be due to the antioxidant role played by Se in protecting lipids from peroxidation. Moreover, Adel and El-Metwaly (2012) mentioned that TL could be modulated by dietary energy levels. In addition, Nazifi et al. (2000) and Asadi et al. (2009) reported an increase in TL values during the increase of camel's age.

Liver and kidney functions

A slight increase (P>0.05) in ALT and AST activities with non-significant differences (P>0.05) in OSG more than the other two groups were observed during this study (Table 3). However, their values are within the normal range, which indicates that no harmful effect is caused by supplementation. On the other hand, ALP activity showed a significant increase (P<0.05) in OSG higher than CG, and the other ISG was intermediated between them. The higher activity in AST, ALT, and ALP were attributing it to the positive correlation with thyroid hormones and high metabolic rate (Aichouni et al., 2013; Faye and Bengoumi, 2018). These findings are confirmed by our result for growth performance. In addition, the plasma activity of the ALP in camel is mostly affected by age with higher values in young camels than adults and the increase is related to the osteogenesis action of osteoblasts, which is

very active in growing young camels, and it continues beyond 18 months in this species as reported by Faye and Bengoumi (2018). This information is also confirmed by our results and the significant increase in ALP activity may be due to influencing in growth rate and skeletal conformation on animals.

Table 3. Thyroid, liver and kidney functions in growing Maghrabi camels as affected by different sources of selenium supplementation. (LSM ±SE)

Traits	CG	OSG	ISG
Liver function			
ALT (IU/L)	11.94 ±0.59	12.10 ±0.54	11.25 ±0.54
AST (IU/L)	25.49 ±1.94	27.85 ±1.77	25.54 ±1.77
ALP (IU/L)	114.29^{b} ±7.30	138.72^{a} ±7.24	134.33^{ab} ±7.24
Kidney function			
BUN (mg/dl)	20.17 ±1.46	20.85±1.33	18.51±1.33
Crt (mg/dl)	1.55±0.12	1.48±0.11	1.58±0.11
Thyroid function			
T3 (ng/ml)	9.42^{b}±0.29	10.31^{a}±0.28	9.95^{a}±0.28
T4 (ng/ml)	108.23±17.21	112.74±15.17	96.26±15.17

[a-b] Least square means with different superscripts differ significantly (P<0.05). CG control group without any supplementation, OSG organic source group, and ISG inorganic source group. ALT: Alanine aminotransferase, AST: aspartate aminotransferase, ALP: alkaline phosphatase, BUN: blood urea nitrogen, Crt: creatinine, T_3: Triiodothyronine, T_4: thyroxine.

The values of BUN and Crt were found to be non-significant (P>0.05) among the three groups which means that kidney functions were not affected by treatment. Moreover, these values in the normal range were recorded by other previous studies reviewed by Faye and Bengoumi (2018)

BUN and Crt can be taken as an indicator for Kidney efficiency, (Kamili et al., 2013). Whereas hyperuremia is observed during renal failure. Furthermore, BUN levels and metabolism in camels are more comparable than other ruminant animals because high reabsorption rate to use it as a non-protein nitrogen source (Faye and Bengoumi, 2018). From previous literature, BUN concentration is mostly affected by diet and dehydration. This reflects that our results were due to supplement and avoiding other management and feeding conditions

Thyroid hormones

The level of T3 revealed a significant response to selenium supplementation and the highest value was recorded in the organic group. T4 showed insignificant differences among the three groups as shown in Table 4.

A significant increase (P<0.05) in T3 levels was recorded in the supplemented groups compared with the control group. These results may due to the sensitivity of the thyroid gland to blood Se level because it plays a very important role in its activity**.** Moreover, selenoenzymes have a significant effect on the activation of T3 from T4. In the same line, a significant reduction in T3 level was recorded under Se deficiency conditions and a high concentration of T3 was found in

calves supplemented with selenium (Hefnawy and Tortora-Perez, 2010).

Antioxidant biomarkers

The impact of Se supplementation from different sources on GSH-Px, MDA, CAT, and TAC, in growing camels are presented in Table 4. All plasma oxidative biomarkers were affected significantly ($p<0.05$) by treatment. The Se supplemented camels recorded better resistance against oxidative stress when compared with those in the control group.

Table 4. Antioxidant biomarkers of growing Maghrabi camels as affected by different sources of selenium supplementation. (LSM ±SE).

Traits	CG	OSG	ISG
GSH-Px (IU/g Hb)	39.94^{b} ± 1.61	48.61^{a} ±1.47	48.05^{a} ±1.47
MDA (nmol /ml)	30.31^{a} ±0.97	18.70^{b} ±0.88	21.22^{b} ±0.88
CAT (U/L)	0.518^{b} ±0.021	0.634^{a} ±0.019	0.657^{a} ±0.019
TAC (mM/L)	0.729^{b} ±0.013	0.870^{a} ±0.012	0.884^{a} ±0.012

$^{a-b}$ Least square means with different superscripts differ significantly ($P<0.05$). CG control group without any supplementation, OSG organic source group, and ISG inorganic source group. GSH_Px: glutathione peroxidase, MDA: malondialdehyde, CAT: catalase, and TAC: total antioxidant capacity.

The GSH-Px activity was higher by 22 % in OSG and 20% in ISG than in control. Similarly, an increase by 22.4 and 26.8 % in CAT activity was observed in the treated groups (OSG: and ISG) than CG. But the highest concentration was achieved by inorganic supplementation. Moreover, TAC took the same trend, OSG raised by about 11% and ISG was 21% (OSG and ISG) compared with control CG. MDA decreased significantly ($P<0.05$) in treated groups by about 38% for OSG and by about 29% for ISG lower than control CG. All results clearly indicated that an improvement of antioxidant status was achieved by Selenium addition in growing camel diets.

GSH-Px is mostly affected by Se supplementation and its values varied according to intake (Alhidary et al., 2016 b; Kamada, 2017; Faye and Bengoumi, 2018). Improving GSH-Px level helps in controlling hydrogen peroxide and lipid peroxide produced by normal metabolic processes. MDA is a stable by-product of the cell membrane's lipid peroxidation. So, it is widely used as a stress marker and reactive oxygen species (ROS) detector (Gawel *et al*., 2004; Dedar and Patil, 2013). The reduction of MDA reflects the enhancement of the antioxidant ability of the body. This finding clarifies our results which showed a reduction by about 29 - 38% in supplemented groups. In addition**,** Fararh et al., (2016) found that reduction in MDA concentration in Se supplemented camels**.** Furthermore, Cao et al. (2014) concluded that organic supplementation seemed to be more effective and advantageous. This result is in agreement with Saleh et al., (2009). In addition, CAT had the same trend. The catalytic activity of catalase allows the transformation of superoxide anion into hydrogen peroxide (H_2O_2) and water and inactivates large amounts of oxidants (Mates, 2000). The improvement of antioxidant status causes an increase in TAC levels in the blood (Alhidary et al., 2016b).

Mineral profile

Mineral values are presented in Table (5). These results indicated that all assessed minerals (Na, K, and Ca) had a significant response ($P<0.05$) to selenium

supplementation from both sources. Moreover, OSG was higher, but insignificant except for sodium the differences were non-significant but took the same trend. The blood Se concentration in the supplemented groups was higher by about two folds than in the control group. For all studied minerals, addition of Se resulted in a significant change regardless of its source. Furthermore, non-significant differences were observed between the two groups OSG and ISG. Animals in OSG showed the highest values for Na, K, and Ca which ingested organic Se *Vs* inorganic in ISG.

Table 5. Mineral elements of growing Maghrabi camels as affected by different sources of selenium supplementation. (LSM ±SE)

Elements	CG	OSG	ISG
Se (µmol/L)	0.14 ±0.009	0.26±0.008	0.22±0.008
Na (mmol /L)	128.52 ±3.85	138.91 ±3.51	131.99 ±3.51
K (mmol /L)	3.94^{b} ±0.25	4.92^{a} ±0.22	4.87^{a} ±0.22
Ca (mmol/L)	2.30^{b} ±0.23	2.58^{a} ±0.22	2.55^{a} ±0.22

[a-b] Least square means with different superscripts differ significantly (P<0.05). CG control group without any supplementation, OSG organic source group, and ISG inorganic source group. Se: selenium, Na: sodium, K: potassium, Ca: calcium

According to Faye and Seboussi (2009), the high value of camel blood Se in treated groups was the result of the high sensitivity of camel to Se intake, and organic Se is more efficient than inorganic. Our findings were similar to several studies on the effect of supplementation by Se to different physiological stages calves and adult camels which done by Seboussi et al. (2009); Faye et al (2014b) and in other species in cattle Gunter et al. (2013), in goat Kachuee et al. (2013), and sheep Davis et al. (2006). Na plasma concentration is the main indicator of plasma osmolarity, blood pressure, kidney performance, and some hormones such as antidiuretic hormone (ADH), aldosterone, and the renin-angiotensin system. The insignificant variation among the three groups in Na value may be due to no negative effect of supplementation on kidney function. This observation is confirmed by our BUN and Crt results discussed previously. Potassium has an important role in cell membrane potential, nervous system, acid-base balance, and muscular activity, and cardiac functions (Faye and Bengoumi, 2018). The significant increase in the treated groups in plasma K concentration may result from the improvement of the antioxidant system which protects cell membranes from oxidative stress caused by ROS. Calcium is a macromineral which plays a very an essential role as an electrolyte in muscular contraction, nerve conduction, blood clotting, skeleton building, and some metabolic reactions (Faye and Bengoumi, 2018). Al-Busadah (2010) noticed that a hypercalcaemia was found in young camel calves compared to adult camels. On the other hand, Saeed, et al. (2004) reported that camel age did not affect Ca levels. The obtained Ca values are within the normal range as referenced by (Faye and Bengoumi, 2018).

Growth performance

The growth performance of the experimental camel calves is shown in Table (6). All groups were almost similar in their initial body weight. But, by the end of the experiment, TBG, and ADGshowed significant differences (P<0.05) among experimental groups with superiority in OSG.

Meat production is the main target of the fattening process which appeared through ADG. The growth rate of young animals mainly depends on management practices and feed quality and quantity. But in general camel's growth curve is similar to other farm animals (Kadim et al., 2013). The calculated values for ADG followed the pattern of the other domestic farm animals at the same age which recorded by Kadim et al. (2008). Moreover, they reported that the growing camel has a sensitive response to any improvement in managerial condition at this age, which was 260 g/d for non-supplemented animals up to 550 g/d for animals fed a high-quality diet. Generally, Se plays an indirect role in growth-promoting in calves. Its effect is done by removing all constraints that may inhibit growth (Mehdi and Dufrasne, 2016).

Table 6. Growth performance of growing camels supplemented with organic and inorganic selenium (LSM ±SE).

Item	CG	OSG	ISG
Initial body weight (kg)	174.6 ± 11.2	173.2 ±10.2	170.0±10.2
Final body weight (kg)	226.5^{c} ±11.6	251.6^{a} ±10.6	238.5^{b} ±10.6
Total body gain (kg)	51.87^{c}	78.43^{a}	68.54^{b}
Average daily gain (g)	451^{c}	682^{a}	596^{b}
Dry matter intake (DMI,kg d^{-1})	4.01	4.24	4.08
Feed conversion ratio, FCR (kg feed/ kg gain)	8.89^{b}	6.21^{a}	6.85^{a}

$^{a-b}$ Least square means with different superscripts differ significantly ($P<0.05$). CG: control group without any supplementation, OSG: organic Se source group, and ISG: inorganic Se source group.

A variable effect of Se on the growth performance of animals was observed by many studies. Alhidary et al. (2016a) reported an improvement of growth of growing camel by 14.4% as a result of trace minerals supplementation. Concerning with the finding of the current study, the improvement in growth performance may be due to the great activity of antioxidants of the body which led to more energy and nutrient availability for tissue accretion (Russel et al., 2016). Moreover, Mehdi and Dufrasne (2016) reviewed that the regulation of adipose tissue metabolism by T3 hormone which is a seleno-dependent hormone.

In addition to the beneficial effect of Se supplementation, several studies mention that a great effect on meat quality and characteristics like: color, flavor, texture, and nutritive value (Sun, et al., 2002). This effect is related to GSH-Px, which protects lipid peroxidation. Furthermore**,** Khan et al. (2015) reported that meat cholesterol content was affected by Se addition. The reduction of cholesterol is a health benefit because Cholesterol oxidation products cause atherosclerosis, cytotoxic, mutagenic, and carcinogenic. Several studies cited that a positive effect on the immune system and productivity by regulating antioxidant balance. Even though, the obtained result showed an increase in lipid profile. but also, Raiymbek et al. (2015) demonstrated that camel meat is comparable to beef meat especially in cholesterol which has a small amount of it in intramuscular tissue. This difference between blood and meat may be due to the variation in fat metabolism and fat mobilization in camel to transfer it to the hump.

Conclusion

Se supplemented diets for growing and fattening camel, especially from organic source has a positive effect on growth performance and antioxidant responses via the recoded increases in ADG, TBG, FBW especially in the OSG. In addition, the recoded enhancement on blood total protein, albumin, globulin, which were higher in treated groups (with especial reference to OSG) than the control one but still within normal physiological range and metabolic hormones (T3 and T4). Furthermore, increase the antioxidant enzymes activity and the noticeable reduction in MDA in the treated groups than control group. Therefore, further studies are required to define the effects of Se supplementation and to quantify interactions between other not studied physiological responses of pre-puberty camels. The level, source, and synergistic combinations of other trace mineral supplementation should be considered when determining the most beneficial effect for productive and reproductive performance and the health of camels at the early stage of age.

References

Adel E.M. and El-Metwaly H. 2012. Effect of feed additive “exogenous enzymes” on growth performance of Maghraby camels. *Life Sci. J.,* 9(4):4830–4835.

Aichouni A., Belhadia M., Kebir N. and Aggad H. 2013. Season influence on serum organic parameters of dromedarius (*Camelus dromedarius*) in Algeria. *Biochem. Biotechnol. Res.,*1(1):8–12.

Al-Busadah K.A. 2010. Serum concentration of aluminum, calcium, magnesium and phosphorous in camels. *Sci. J. King Faisal Univ. (Basic Appl. Sci.).,* 11(1):161–167.

Alhidary I.B., Abdelrahman M. and Harron R. 2016a. Effects of a long-acting trace mineral rumen bolus supplement on growth performance, metabolic profiles and trace mineral status of growing camels. *Trop. Anim. Health Prod.,* 48:763–768.

Alhidary I.B., Abdelrahman M., Khan R.U. and Harron R. 2016b. Antioxidant status and immune responses of growing camels supplemented a long-acting multi-trace minerals rumen bolus. *Italian J. Anim. Sci.,* 15(2):343–349.

Ali S., Ahmad N., Akhtar N. and Zia-ur-Rahman N.D.E. 2008. Metabolite contents of blood serum and fluid from small and large sized follicles in dromedary camels during the peak and the low breeding seasons. *Anim. Reprod. Sci.,* 108:446–456.

Alim F.Z.D., Romanova E.V., Tay Y.L, Rahman, A.Y.b.A., Chan K.G. and Hong K.W. 2019. Seasonal adaptations of the hypothalamoneurohypophyseal system of the dromedary camel. *PLoS ONE*., 14(6):e0216679. https://doi.org/ 10.1371/journal.pone.0216679.

Al Jassim R. 2019. Metabolisable energy and protein requirements of the Arabian camel (*Camelus dromedarius*). *J. Camelid Sci*., 12: 33-45.

Al-Qarawi A.A., Abbas B., Haroun E.M., Mahmoud O.M. and Al-Hawas A. 2001. Clinicopathological investigation of selenium responsive myopathy in young adult camels. *J. Camel Pract. Res.,* 8:23-27.

AL–Suhaimi E., Abu-se’da K. and Akbar A. 2009. Relationship of leptin hormone with insulin and glucose in arabian camel (*Camelus dromedarius*). *J. Camel Pract. Res.,* 16(2):201-207.

Amin A.S.A., Abdoun K.A. and Abdelatif A.M. 2007. Seasonal variation in blood constituents of one-humped camel (*Camelus dromedarius*). *Pak. J. Biol. Sci.,* 10(8):1250–1256.

Asadi F., Shahriari A., Asadian P., Pourkabir M., Sabzikar A. and Ojaghee R. 2009. Serum

lipid, glucose, free fatty acids and liver triglyceride in sub-adult and adult camels (*Camelus dromedarius*). *Rev. Med. Vet.,* 160(12):552–556.

Badawy M.T., Gawish H.M., Khalifa M.A., El-Nouty F.D. and Hassan G.A. 2008. Seasonal variations in hemato-biochemical parameters in mature one humped she-camels in the north-western coast of Egypt. *Egypt J. Anim. Prod.,* 45(2):155–164.

Bakheit S.A., Faye B., Ibrahim I. E. and Idris A. O. 2017. Effect of management system on camel calves growth rate and daily gain. *J. Sci, Eng. Res.,* 4(2):41-47.

Bargaâ R., Lektib I., Farh M., El Abbadi N., Belhouari A. and El Khasmi M. 2016. Seasonal variations of biochemical profile and its correlations with thyroid and adrenal gland hormones in Moroccan camel (*Camelus dromedarius*). *Int. J. Agric. Environ. Res.,* 2(6):1858–1872.

Cao J., Guo F., Zhang L. and Dong B. 2014. Effects of dietary selenomethionine supplementation on growth performance, antioxidant status, plasma selenium concentration and immune function in weaning pigs. *J. Anim. Sci. Biotechnol.,* 5:46-52.

CAPMS 2018. Statistical Yearbook. Central Agency for Public Mobilization and Statistics, Arab Republic of Egypt.

Davis P.A., McDowell L.R., Wilkinson N.S., Buergelt C.D., Van Alstyne R., Weldon R.N. and Marshall T.T. 2006. Effects of selenium levels in ewe diets on selenium in milk and the plasma and tissue selenium concentrations of lambs. *Small Rumin. Res.,* 65:14–23.

Dedar R.K. and Patil N.V. 2013. Oxidative stress in pregnant and lactating camels. *J. Camel Prac. Res.,* 20(1):1-4.

Delavaud C., Bengoumi M., Faye B., Levieux D. and Chilliard Y. 2013. Plasma leptin, glucose and non-esterified fatty acid variations in dromedary camels exposed to prolonged periods of underfeeding or dehydration. *Comp. Biochem. Physiol. A.,* 166:177–185.

Duncan D.E. 1955. Multiple range and Multiple F test. *Biometrics,* 11:1-42.

El-Badawi A.Y. 2018. The present situation of animal protein in Egypt and the role of camels in providing cheap and healthy meat for people in poor greenery lands. I*nt. J. Avian Wildlife Biol.,* 3(4):319–322.

El-Badawi A.Y. and Yacout M.H.M. (1999). Comparative study on growth performance of camel (*Camelus dromedarius*) calves and cattle steers in the feedlot system. *Egyptian J. Nutr. Feeds*, (2): 319- 330.

Elmahdi B., Sallmann H., Fuhrmann H., Engelhardt W. and Kaske M. 1997. Comparative aspects of glucose tolerance in camels, sheep, and ponies. *Comp. Biochem. Physiol.,* 118(1):147-151.

FAO 2018. http://www.fao.org/faostat/en/#data/EK.

Fararh K.M., Farid A.S., Abdalla O.A. and Algharib S.A. 2016. Antioxidant effect of selenium and its Nano form on oxidative stress induced by iron overload. *Benha.Vet.Med.J.,* 31(1): 96-102. (http://www.bvmj.bu.edu.eg).

Farghaly M.S. 2009. Productive performance of fattening Sudanese camel calves under different feeding regimes. *J. Agric. Sci. Mansoura Univ.,* 34 (8): 8719 – 8726.

Faye B., Althamma O., Musaad A., Konuspayeva G. and Bengoumi M. 2014a. Effect of selenium injection in pregnant camels on selenium status of their new-born and milk. *Emir. J. Food Agric.,* 26 (4): 342-348.

Faye B. and Bengoumi M. 2018. Camel Clinical Biochemistry and Hematology. Springer Nature Switzerland. 352pp.

Faye B., Saleh S.K., Konuspayeva G., Musaad A., Bengoumi M. and Seboussi R. 2014b. Comparative effect of organic and inorganic

selenium supplementation on selenium status in camel. *J. King Saud Uni. – Sci.,* 26:149–158.

Faye B. and Seboussi R. 2009. Selenium in camel – a review. *Nutrients*, 1:30–49.

Faye B., Seboussi R. and Alhadrami G. 2011. Maternal transfer of selenium by blood and milk in camels. *J. Camelid Sci.,* 4:30-39.

Gawel S., Wardas M., Niedworok E. and Wardas P. 2004. Malondialdehyde (MDA) as a lipid peroxidation marker. *Wiad Lek*, 57:453–455.

Gunter S.A., Beck P.A. and Hallford D.M. 2013. Effects of supplementary selenium source on the blood parameters in beef cows and their nursing calves. *Biol. Trace Elem. Res.,* 152:204–211.

Hefnawy A.E.G. and Tórtora-Pérez J.L. 2010. The importance of selenium and the effects of its deficiency in animal health. *Small Rumin. Res.,* 89:185–192.

Hennigar S. R. and McClung J. P. 2015. Homeostatic regulation of trace mineral transport by ubiquitination of membrane transporters. *Nutr. Rev.,* 74(1):59–67.

Hussain M., Saeed Z., Gulsher M., Shaikh R.S., Ali M., Ahmad A.N., Hussain I., Akhtar M. and Iqbal F. 2016. A report on the molecular detection and seasonal prevalence of *(Trypanosoma bruceiin)* dromedary camels from Dera Ghazi Khan District in southern Punjab (Pakistan). *Trop. Biomed.,* 33(2):268–275.

Kachuee R., Moeini M.M. and Souri M. 2013. The effect of dietary organic and inorganic selenium supplementation on serum Se, Cu, Fe and Zn status during the late pregnancy in Merghoz goats and their kids. *Small Rumin. Res.,* 110:20–27.

Kadim I.T., Mahgoub O., Fay B. and Farouk M.M. 2013. Camel Meat and Meat Products. CABI, Oxfordshire, UK. 256pp.

Kadim I.T., Mahgoub O. and Purchas R.W. 2008. A review of the growth, and of the carcass and meat quality characteristics of the one-humped camel (*Camelus dromedarius*). *Meat Sci.,* 80:555–569.

Kamada H. 2017. Effects of selenium-rich yeast supplementation on the plasma progesterone levels of postpartum dairy cows. *Asian-Austral. J Anim. Sci.,* 30:347-354.

Kamal A.M. 2008. Some biochemical, hematological and clinical studies of selected ruminal and blood constituents in camels affected by various diseases. *Res. J. Vet. Sci.,* 1(1):16–27.

Kamili A., Bengoumi M., Oukessou M., Faye B. and Lefebvre H.P. 2013. Assessment of glomerular filtration rate in normally hydrated and dehydrated dromedary camel by plasma exogenous creatinine clearance test. *Emir. J. Food Agric.,* 25(4):314–319.

Karimi A., Rahbari S. and Yousefi A. 2015 Blood parasites of camels from central regions of Iran: comparative evaluation of various detection techniques and serum protein components. *J. Adv. Parasitol.,* 2(1):1–4.

Khan M.I., Min J.S., Lee S.O., Yim D.G., Seol K.H., Lee M. and Jo C. 2015. Cooking, storage, and reheating effect on the formation of cholesterol oxidation products in processed meat products. *Lipids in Health and Disease,* 14:89-98

Mates J.M. 2000. Effects of antioxidant enzymes in the molecular control of reactive oxygen species toxicology. *Toxicol*., 153: 83-104.

Mehdi Y. and Dufrasne I. 2016. Selenium in cattle: A review. *Molecules*, 21:245-257.

Mohamed H.E. 2008. Factors affecting the plasma lipid status in camels (*Camelus dromedarius*). *Res. J. Biol. Sci.,* 3(4):444–445.

Nayyar S., Gill V.K., Malik V.S., Roy K.S. and Singh R. 2003. Vitamin E and selenium improve the blood biochemical composition

of anoestrous buffalo heifers. *Indian J Anim Sci.*, 73: 654–656.

Nazifi S., Gheirsari H.R., Abbasali Poorkabir M. and Saadatfar S. 2000. Serum lipids and lipoproteins in clinically healthy male camels (*Camelus dromedarius*). *Vet. Res. Communi.,* 24: 527-531.

Osman T.E.A. and Al-Busadah K.A. 2000. Effects of age and lactation on some biochemical constituents of camel blood in Saudi Arabia. *J. Camel Pract. Res.,* 7(2):149–152.

Raiymbek G., Kadim I., Konuspayeva G., Mahgoub O., Serikbayeva A. and Faye B. 2015. Discriminant amino-acid components of Bactrian (*Camelus bactrianus*) and Dromedary (*Camelus dromedarius*) meat. *J. Food compos. anal.,* 41:194-200.

Russel J.R., Sexten W.J., Kerley M.S. and Hasen S.L. 2016. Relationship between antioxidant capacity, oxidative stress, and feed efficiency in beef steers. *J. Anim. Sci.,* 94:2942-2953.

Saad El-Deen, H.Kh. (2013). Growth performance of Maghrabi camel calves under different managerial conditions. Fac. Agric. Cairo Univ., pp 138.

Saeed A., Hussain M.M., Khan I.A. and El-Yousuf R.J. 2004. Effect of age on some serum constituents of camels in United Arab Emirates. *Indian J. Anim. Sci.,* 74(3):278–280.

Saleh M.A., Al-Salahy M.B. and Sanousi Samera A. 2009. Oxidative stress in blood of camels (*Camelus dromedaries*) naturally infected with *Trypanosoma evansi*. *Vet. Parasitol.*, 162:192–199.

SAS 2008. SAS/STAT ® 9.2 User's Guide. Cary, NC: SAS Institute Inc.

Seboussi R., Faye B., Alhadrami G., Askar M., Ibrahim W., Hassan K. and Mahjoub B. 2009. Effect of different selenium supplementation levels on selenium status in camel. *Biol. Trace Elem. Res.,* 123:124-138.

Shi L., Xun W., Yue W., Zhang C., Ren Y., Shi L., Wang Q., Yang R. and Lei F. 2011. Effect of sodium selenite, Se-yeast and nano-elemental selenium on growth performance, Se concentration and antioxidant status in growing male goats. *Small Rumin. Res.,* 96:49–52.

Singh R.A., Randhawa S.S. and Dhillon K.S. 2002. Changes in blood biochemical and enzyme profile in experimental chronic selenosis in buffalo calves (*Bubalus bubalis*). *Indian J .Anim. Sci.,* 72:230–232.

Soetan K.O., Olaiya C.O. and Oyewole O.E. 2010. The importance of mineral elements for humans, domestic animals and plants: A review. *Afr. J. Food Sci.,* 4(5): 200-222.

Sun Q., Senecal A., Chinachoti P., Faustman C. 2002. Effect of water activity on lipid oxidation and protein solubility in freeze-dried beef during storage. *J. Food Sci.,* 67, 2512–2516.

Tibary A. and El Allali K. 2020. Dromedary camel: A model of heat resistant livestock animal. *Theriogenology,* 154:203-211.

Wardeh M.F. 2004. Classification of the dromedary camels. *J. Camel Sci.,* 1:1-7.

Yacout M.H.M. and El-Badawi A.Y. 2001. Effect of dietary protein level on fattening performance of camel calves. *Egyptian J. Nutr. Feeds,* 4:545-556.

Youssef S.Y., Yasien S., Mousa A.W.H., Nasr S.M., El-Kelesh E.A.M., Mahran K.M. and Abd-El-Rahman A.H. 2016. Vector identification and clinical, hematological, biochemical, and parasitological characteristics of camel (*Camelus dromedarius*) theileriosis in Egypt. *Trop. Anim. Health Prod.,* 47:649–656.

Zongping L. 2003. Studies on the hematology and trace elements status of adult Bactrian camels (*Camelus bactrianus*) in China. *Vet. Res. Commun.,* 27:397-405.