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RESEARCH ARTICLE

Inter-Relationship between some Trace Elements during Pregnancyand Newborn Birth Weight in Dromedary Camels

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Abstract

The current study aimed to determine the changes in concentrations of iron (Fe), zinc (Zn), copper (Cu), magnesium (Mg), selenium (Se), and manganese (Mn) in pregnant camels during different durations of pregnancy and to examine the relationship between these trace elements and calf birth weights. Serum samples were collected from 30 apparently healthy pregnant dromedary camels in Daraw Village, Aswan Governorate, Egypt, during the initial (2- 5th month), middle (6-9th month), and late (from 10th month to parturition) pregnancy. Serum levels of selected minerals were evaluated by using an atomic absorption spectrophotometer. The concentrations of Fe, Mg, and Se varied significantly (*P*-value < 0. 0001) during gestation. Through proceeding gestation, Fe, Zn, Cu, Mg, and Se blood levels decreased then were significantly elevated (*P*-value < 0. 0001) through delayed gestation. No significant association was found between the concentrations of serum trace elements and birth weight (*P*-value > 0.05). Blood Fe has significant associations with Zn (r = 0.65, *P*-value = 0. 0001), Cu (r = 0.26, *P*-value = 0. 01), Mg (r = 0.52, *P*-value = 0. 0001), and Se (r = 0.57, *P*-value = 0. 0001). Moreover, Zn serum concentrations have significant relationships with Mg (r = 0.25, *P*-value = 0.01), Se (r = 0.53, *P*-value = 0.0001), Mn (r = 0.23, *P* -value= 0.02). There was significant associations between serum levels of Mg and Se (r = 0.31, *P*-value = 0.003). Also, Cu serum concentrations revealed significant correspondences with Mg (r = 0.24, *P*-value = 0.02) and Se (r = 0.37, *P*-value = 0. 0004). In conclusion, the concentrations of serum trace elements changed during gestation. Evaluation of serum levels of Fe, Zn, Cu, Mg, Se, and Mn in pregnant dromedary she-camel in addition to many factors, acting additively or synergistically, can affect birth weight.
Keywords: Calf birth weight, Dromedary camel, Pregnancy, Serum minerals.

Introduction

Family Camelidae, (the extant members of this group are: dromedary camels, Bactrian camels, wild Bactrian camels, llamas, alpacas, vicuñas, and guanacos) remain the principal livestock species in desert and semi-desert areas of the earth owing to their noteworthy acclimatization to strict ecological disorders. The dromedary camel is characterized by delayed maturity and long pregnancy period, and on some occasions, it may experience reproductive problems as cyclicity and low conception rate [1-3]. Consequently, full investigations of the previous topics remain important to improve the reproductive performance of this species. Furthermore, family Camelidae remains vital livestock for reasonable generative biology. Several topographies of the propagative anatomy and physiological nature of camels are similar to those in ruminants (i.e. ovarian morphology and follicular development) or those in equidae (i.e. placentation and delivery), whereas, additional features are noticeably distinctive (i.e. procedure of induced ovulation). According to many reports, the neonatal weight of camel's newborn ranged from 20 to 50 Kg, and mean weight remained amongst 20.5 to 44.5 kg [4-6]. Numerous

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variables such as breed, body score condition (BCS) of the dame, parity, season of parturition, sex of the newborn, and sire breed may be associated with the variation in the newborn weight [4,6-9]. During the last 5 years, we noticed that a high proportion of camel newborns that were delivered in Aswan Governorate experienced a low birth weight. The pathological reasons behind the increased incidence of low birth weight are unknown. Fetal size may depend on two factors: the genotype of the fetus [10, 11] and the nutritional state of the dam [12]. The fetus depends on maternal-derived nutrients that include important trace minerals [13]. Insufficient transmission of these vital trace minerals consequences in an element insufficiency in the fetus, producing compromised fetus growing furthermore abnormal organ developments [14]. Deficiency in some trace elements as selenium (Se), copper (Cu), ferrous (Fe), and zinc (Zn) have been associated with a reduced birth weight of the newborn in different species [15-17]. The importance of minerals balance during pregnancy in camel is still underestimated.

Pregnancy is a period of increased metabolic demands with changes in the pregnant animal's physiology and fetus development is influenced by many nutrients especially trace elements [18]. A few scientific studies have shown that camels are sensitive to trace element disorder like other ruminants [19, 20] and their incidence and importance are probably underestimated. Faye and Bengoumi [21] reported that element supplementation with twice the estimated requirements of Cu, Zn, cobalt, and Mn increased Cu levels in the blood, milk, and liver of dromedaries. Numerous studies have estimated the serum concentration of several hematological parameters, hormones, enzymes, and electrolytes in pregnant and non pregnant She-camel [22-24]. The estimation of the serum level of trace minerals in pregnant and non-preganant she-camels and investigating the association between the concentration of trace elements and the weight of the newborns could be of practical importance.

To our knowledge, there is scanty information about the microelements status during pregnancy in camels and the pathological reasons behind the increased incidence of newborn weakness and low birth weight are unknown. Therefore, the present study aimed to estimate serum levels of trace minerals during different stages of pregnancy and to study the association between the serum concentration of trace minerals and the birth weight of newborns.

Materials and Methods

Ethics Statement

This study was performed according to the ethics and guidelines approved by the Ethics Committee of the Faculty of Veterinary Medicine, Aswan University, Aswan, Egypt.

Study area and animals

The present study was carried out on 30 pregnant she-camels that were reared in the traditional system by pastoralists in Daraw Village, Aswan Governorate, Egypt, during the period from September 2018 to March 2020. All the investigational dams were free from brucellosis and tuberculosis with an age 8–12 years. The age of the pregnant animals was determined according to the time of clinical eruption and replacement of teeth [25] and had variable parities (1–4), weight 400–650 kg, and BCS were ≥ 3 on the scale of 1 to 5 [26]. The animals had been vaccinated against Camel pox, Brucella (vaccination of calves at 4 to 8 months of age using S19 vaccine that were obtained from Veterinary Serum and Vaccine Research Institute, Abbassia, Egypt) and Rift Valley Fever (VACSERA, Agouza, Giza, Egypt). All the animals are upraised underneath the semi-intensive method in which they were fed barley and alfalfa hay with extremely restrained grazing besides elements additions. They were watered ad libitum. Camels were housed in an open yard.

The pregnant camels were selected in consultation with the cameleer who recorded their mating history and the pregnancy was confirmed by rectal palpation. In camels the parturient season occurred between December and February, so all the dams were approximately at a similar phase of the reproductive cycle.

Blood samples were collected from all dams at the initial (1–5th month), middle (6–9th month), and late (10 month to parturition) pregnancy. Ten mL of blood was collected in sterile glass test tubes without anticoagulant through puncture of the jugular vein using a sterile 18-gauge needle. The collected blood samples were let to coagulate, and centrifuged at 3000 rpm for 20 min. The harvested serum was kept at – 20°C until evaluation. Following delivery, the camel calves were weighed before colostrum was taken. The drinking water was analysed before conducting the experiment [27].

Analysis of trace elements

The analysis of selected trace elements required wet digestion of the samples to destroy proteins and amino acids to release the molecules of trace elements related to proteins. The serum samples were processed by mixing 1mL of each sample with 10 mL nitric acid (HNO3) then 5 mL perchloric acid (HClO4, Fisher Scientific, Waltham, Massachusetts, U.S.). The tubes were placed in the rotator then introduced into the microwave digestion system using Milestone MLS-1200 MEGA, Sorisole, Italy. After cooling, the digested sample was transferred to a volumetric flask and stored in the refrigerator until analysis [28]. Serum Fe, Zn, Cu, Mg, and Mn were determined using an atomic absorption Spectrophotometry (Shimatzu, Model 6601, Japan). Selenium was also determined with an inductively coupled argon plasma (ICP) atomic emission spectrometer (Varian Vista MPX-CCD).

Data analysis

The results were expressed as means (± SE). The normality of the distribution of variables was verified using the Shapiro-Wilk test. The data were analyzed by using the statistical package SPSS 23. To determine the significant variations among different groups (initial, middle, and late pregnancy), Pearson correlation coefficient, analysis of variance (ANOVA) by general linear model, and regression analysis were employed. Statistical significance was stated at the p-value ≤ 0.05.

Results

Serum profile of Fe, Zn, Cu, and Mg, Se, and Mn levels of the pregnant she-camels during pregnancy was given in Table 1.

Table 1: Trace elements levels in maternal serum of 30 pregnant camels during the early, mid, and late pregnancy

Elements (ppm)	Pregnancy		
	Early	Mid	Late
Fe	2.98 ± 0.09^a	1.24 ± 0.09^b	0.66 ± 0.09^c
Zn	1.08 ± 0.03^a	0.86 ± 0.03^b	0.78 ± 0.03^b
Cu	0.89 ± 0.02^a	0.84 ± 0.02^a	0.75 ± 0.02^b
Mg	8.42 ± 0.13^a	7.71 ± 0.13^b	7.21 ± 0.13^c
Se	1.06 ± 0.03^a	0.89 ± 0.03^b	0.79 ± 0.03^c
Mn	0.28 ± 0.02^a	0.25 ± 0.02^a	0.27 ± 0.02^a

Data are expressed as mean values ± Standard error; 30 samples were analyzed in each stage of gestation. Values with different superscripts are significantly different at $p \leq 0.05$.

Mean serum Fe, Mg, and Se levels varied significantly (P-value = 0. 0001) during the initial, middle, and late gestation. In comparison with the values in initial pregnancy, serum Fe, Mg, and Se levels during the late pregnancy were significantly lower (P-value = 0. 0001). The mean serum Mn levels varied non-significantly (P-value = 0.5279) between initial, middle, and late pregnancy. Zinc concentrations decreased significantly (P-value = 0. 0001) from early to middle-pregnancy whereas there were non-significant decreases in Zn levels from middle to late gestation. In comparison with the values in early pregnancy, serum Zn concentration was lower during late pregnancy. The Cu concentration reported during late pregnancy was significantly lower than that found during early and mid-pregnancy, but there was no difference between the Cu concentration during the early and mid-gestation.

Table 2: Correlation coefficient and elements significance between serum of camel and newborn birth weight

parameters	Fe	Zn	Cu	Mg	Se	Mn
Zn	**0.654****	**-**				
Cu	**0.263***	**0.132**	**-**			
Mg	**0.518****	**0.252***	**0.237***	**-**		
Se	**0.567****	**0.525****	**0.366****	**0.306****	**-**	
Mn	**0.180**	**0.234***	**0.125**	**-0.018**	**0.063**	**-**
Calf weight	**-0.015**	**-0.007**	**-0.109**	**0.206**	**-0.027**	**0.183**

*P < 0.05; **P < 0.01

As presented in Table 2, there was no significant correlation between the serum Fe, Zn, Cu, Mg, Se, and Mn concentration and the newborn weight (*P*-value = 0.8904, 0.9456, 0.3074, 0.0519, 0.8001, and 0.0838, respectively).

These were a significant correlation between Fe and Mg, Cu, Zn, and Se, between Zn and Mg, Se and Mn, between Cu and Mg, and Se, also between Mg and Se (Table 2).

Discussion

To the best of our knowledge, no previous study had investigated the association between the serum concentration of trace minerals and weight of newborns in dromedary camel. Evidence indicates that the growing fetus depends on the maternally derived trace elements completely for normal growth and development [13]. The mean serum Fe concentration differed significantly among the three stages of pregnancy. There was a decreasing tendency of Fe towards labor. During pregnancy, Fe needs are usually very high to meet the requirements for the fetus, placenta, and utilization of Fe by the mammary gland. Decrease in serum Fe concentration during pregnancy from 68.0 mg/100 mL at the beginning to 64 mg by the end of gestation has also been reported by Eltohamy *et al.* [29]. Similar findings were reported in Baladi goat and buffaloes [30, 31].

The serum Zn concentration decreased significantly (*P*-value< 0.05) before parturition, because of an active transfer of Zn from the dam to the fetus in the last part of parturition. These results corroborate with previous studies [32-34]. There was a correlation between plasma Zn status and events occurring during gestation and parturition [35]. In cows, the Zn levels decreased during parturition while the Cu levels remain elevated [36]. The reported decrease in Zn concentration in the present study might be occurred as a result of Zn intestinal absorption inhibition by the Cu [20, 36, 37].

The mean serum Cu concentration showed a significant decreasing trend (*P*-value = 0.0005) during pregnancy from the first to the third trimester. These findings are inconsistent with the results of Tartour and Idris [38]. This may be due to an active transfer of Cu stored in the dam's liver to the fetus [37]. Contrary to these findings, a significant increase in Cu serum levels during late gestation had been reported for cows [31-33], buffaloes [39], and ewes [40].

As shown in the present study, the Mg level decreased significantly during late pregnancy. A similar result was reported in buffalo [39]. Generally, the lower serum Mg during late gestation may associate renal clearance throughout gestation and utilization of elements via a developed fetus [41]. Eltohamy *et al*. [29] observed no variation in Mg concentrations during pregnancy in she-camels.

There was a significant decrease in serum Se concentrations during late pregnancy and this may be due to the maternal transfer of selenium to the growing fetus and the milk Se excretion. Those results were in accordance with those reported in the study on pregnant and lactating camels [28] and in ruminants [42]. Seboussi *et al*. [28] reported that GSH-Px activity decreased during the last month of pregnancy in she- camel. Indeed, GSH-Px, as antioxidant enzyme protects the cells from damage by free radicals and was considered as an indicator of selenium status in livestock.

Mn levels in maternal serum varied non-significantly during pregnancy. The observations of the serum Mn in the present investigation are in accordance with Akhtar *et al*. [31]. A former study demonstrated that Mn crosses the placenta to the fetus [43]. Indeed, the blood Mn level is not a good reflection of nutritional and deficiency status for this trace element. The rise in Mn concentration may be related to the glucose level. The amount of Mn transferred across the placenta is related to the content of Mn in the basal diet [13].

Newborn weight is one of the essential issues toward judge the management of pregnant camel in addition to expect the possibility of newborn illness or death [10]. Therefore, it has been a topic of various preceding studies [4-7]. The mean weight of newborn in our study is lower than that had been reported (from 25.8 to 40.5 kg) in numerous previous studies [4-7]. Furthermore, we confirmed that newborn weight did not significantly associate with dam serum levels of the various minerals under study. The neonatal weight in our investigation varied from 18 to 38 kg, in addition to the non-significant relationship between trace mineral levels and newborn weight suggesting that the levels of these minerals in dam serum are not valuable markers for the evaluation of fetal growth and development. It is probably true that other factors have a more potent effect on the weight of the newborn. Amongst the factors, body score of the dam, breed, parities, sire, and season of birth comprised to affect birth weight appreciably [4,7-9]. The newborn weight and intra-uterine growing level in camels appear to be significantly inferior compared to other large livestock species (bovine and equine). The evaluation with equine is exceptionally exciting owing to the analogous nature of the diffused type of placenta [44,45]. Nevertheless, an extended pregnancy episode linked with inferior newborn weight is liable to be due to involvement of the mechanisms of exactly how dromedary camels modified to restricted nutrition bases in arid and semi-arid regions of the world [10].

We established a substantial association amongst blood levels of Fe and Zn ($r = 0.65444$, *P*- value < 0.0001), Fe and Cu ($r = 0.26294$, *P*-value < 0.05), Fe and Mg ($r = 0.51780$, *P*-value < 0.0001), and Fe and Se ($r = 0.51780$, *P*-value < 0.0001). Some Cu containing proteins, such as ceruplasmin and hephaestin are involved in Fe transport [46]. Also, Zn includes production protein responsible for intestinal Cu absorption [47]. Fe and Zn contents of the gastrointestinal tract affect the availability and absorption of Se in dairy cows [48]. Also, the correlation between Zn and Mg ($r = 0.25217$, *P*-value < 0.05), Zn and Se ($r = 0.52523$, *P*-value < 0.0001), Zn and Mn ($r = 0.23435$, *P*-value < 0.05), Cu and Mg($r = 0.23714$, *P*-value < 0.05), Cu and Se ($r = 0.36569$, *P*-value < 0.05) were significant.

The correlation between Mn and Fe($r = 0.18018$, *P*-value > 0.05), Cu and Zn($r = 0.13150$, *P*-value > 0.05), Cu and Mn ($r = 0.12526$, *P*-value > 0.05), and Mn and Se ($r = 0.06318$, *P*-value > 0.05) were non-significant. On the other hand, there might be other reasons for these changes in camels. Unfortunately, there are no many previous studies reported regarding this aspect. Eltahir *et al*. [49] reported a significant correlation between serum Cu and Zn in racing camels which differed from our findings. Baig *et al*. [50] reported a significant positive correlation between Zn and Mg (*P*-value < 0.01) and Zn and Cu (*P*-value < 0.006) in human. Also, the correlations between Fe and Cu (*P*-value < 0.05), Fe and Zn (*P*-value < 0.001), Fe and Se (*P*-value < 0.06) and serum Zn had significant correlations with Cu (*P*-value < 0.05) and Se (*P*-value < 0.05) in buffalo [51].

Trace elements act as co-factors of enzymes [52] and act as an antioxidant [53] and prevent oxidative stress by neutralizing oxidants produced under different stresses like environmental stress. Trace elements play a vital role in many physico-biochemical processes such as protein, enzyme, and hormone synthesis [54]. Clinical trace element deficiencies in camel were defined [19, 20, 55] and must be investigated thoroughly. Further studies will be needed to explain why the camel is able to survive under desert conditions.

Conclusion

This investigation demonstrated that serum levels of Fe, Zn, Mg, Se, and Cu varies significantly between different stages of gestation So their evaluation in pregnant dromedary she-camel alone does not give the impression to be valuable in the evaluation of fetus growth and development. It is undoubtedly true that many factors, acting additively or synergistically, can affect birth weight of newborn.

Authors' contribution

All authors conducted the study equally, analyzed and discussed the results, wrote and approved the final manuscript.

Conflicts of interest

The authors have no conflict of interest.

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الملخص العربى

العلاقة بين بعض العناصرالنادرة اثناء فترات الحمل و وزن المواليد فى الإبل

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هدفت الدراسة الحالية إلى قياس التغيرات في تركيزات عنصر الحديد (Fe)، الزنك (Zn)، النحاس (Cu)، المغنيسيوم (Mg)، السيلينيوم (Se) والمنجنيز (Mn) فى الأبل العشارخلال فترات الحمل المختلفة وإلى فحص العلاقة بين العناصر النادرة في الدم وأوزان المواليد.تم تجميع عيانت مصل من 30 من الإبل العشار الأصحاء خلال فترة الحمل الاولى (الشهر الثانى – الخامس) ، المنتصف (الشهر السادس- التاسع) و المتأخر(من الشهر العاشر إلى الولادة) في قرية دراو ، بمحافظة أسوان ، مصر. تم قياس تركيزات العناصر المختارة فى المصل بواسطة مقياس طيف الامتصاص الذري. تفاوت متوسط تركيزكلا من الحديد والمنجنيز والسيلينيوم في الدم بشكل ملحوظ أثناء الحمل.مع تقدم الحمل انخفض تركيز الحديد، الزنك، النحاس ، والمنجنيز والسيلينيوم بشكل ملحوظ خلال أواخر الحمل.لايوجد ارتباط كبير بين العناصر النادرة في الدم ووزن المواليد (P> 0.05). كان لتركيزالحديد فى المصل ارتباطات مهمة مع الزنك (r = 0.65, P-value = 0. 0001) ، النحاس (r = 0.26, P-value = 0. 01)، المنجنيز (r = 0.52, P-value = 0. 0001) والسيلينيوم (r = 0.57, P-value = 0. 0001). علاوة على ذلك، كان لتركيزات الزنك فى الامصال علاقات مهمة مع المغنيسيوم (r = 0.25, P-value = 0.01) ، السيلينيوم (r = 0.53, P-value = 0.0001)، المنجنيز(r = 0.23, P -value= 0.02). كانت هناك ارتباطات مهمة بين مستويات المصل من المغنيسيوم و السيلينيوم (r = 0.31, P-value = 0.003). أيضا كان هناك ارتباطات معنوية بين تركيزات النحاس فى الامصال والمنجنيز(r = 0.24, P-value = 0.02) و السيلينيوم.(r = 0.37, P-value = 0. 0004)

في الختام ، تم تغيير تركيزات العناصر النادرة فى المصل أثناء الحمل. يمكن أن يؤثر تقييم مستويات العناصر النادرة Fe، Zn، Cu، Mg، Se ، و Mn في الإبل العشار بالإضافة إلى العديد من العوامل ، التي تعمل بشكل إضافي أو تآزري ، على أوزانِ المواليد.