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Comparative growth response related to hair mineral analysis in dromedary camel calves

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Abstract

Background: The dromedary camel plays a significant role in supporting the livelihood of pastoral and agropastoral systems, as well as a source of income for the national economy in arid regions.

Aim: The current study was executed to check the comparative growth response in relation to hair mineral status in Marecha camel calves reared under an intensive management system and an extensive management system in Thal desert Punjab, Pakistan.

Methods: Twelve male and female *Camelus dromedarius* calves of almost the same weight and age were divided into two groups of 6 each (3 male and 3 female). The calves of the first group were maintained at the Camel Breeding and Research Station, Rakh Mahni, in a semi-open housing system, while the second group was maintained in available housing under field conditions. Calves in the first group were fed concentrate at the rate of 1 kg/head/day along with gram straw (*Cicer arientinum*) *ad libitum*, while calves in the second group were allowed to graze/browse for 10 hours daily along with household refusals, including kitchen wastes. Water was provided twice a day. Impressum's digital weighing scale was used for fortnightly weighing. Data collected on different parameters were subjected to statistical analysis with 2 × 2 factorial arrangements of treatments under a completely randomized design.

Results: After the 120-day trial period, the mean body weight and average daily gain of male and female calves were significantly increased ($p < 0.05$) in IMS as 80.8 ± 2.7, 77.8 ± 2.7 kg and 0.67 ± 0.02, 0.65 ± 0.02 kg/days than EMS as 64.5 ± 2.6, 52.9 ± 2.6 kg and 0.54 ± 0.02, 0.44 ± 0.02 kg/days. Intake of crop residues ($p < 0.05$) was found to be 6.9 ± 0.45 and 6.4 ± 0.45 kg/days for male and female calves in IMS, respectively, and 3.5 ± 0.23 for male and female calves in EMS, respectively. The conversion index g/kg average daily intake was 97.1, 101.5 and 154.3, 125.7 for male and female calves in IMS and EMS, respectively. Regarding hair mineral status, Ca, Mg, Cu, Zn, Fe, and Mn concentrations were found to be significantly different ($p < 0.05$) among calf groups in IMS and EMS.

Conclusion: This study indicates that wool analysis and management of weight gain in camel calves should be further explored to support increased meat supply in arid regions.

Keywords: Camel, Growth, Management, System, Wool.

Introduction

Food security is a challenging issue in the current days for developing countries due to the rapid increase of growth and limited resources, and exploration of new resources is the need of the hour. In this context, the indigenous sources are of keen interest. The camel is the future hope in this regard (Faraz *et al*., 2019a), which is an important source of food subsistence and income for pastorals, arid, and semiarid people (Faye, 2016). A camel can survive and produce in severe, hot, and hostile environments with equally good potential as other domestic animals in favorable environments. It is the best food source for dry areas, which nourishes the Bedouins, nomads, and pastoralists since centuries (Faraz, 2020a). Dromedary camel is one of the most important domestic animals in desert regions, as it is equipped to produce milk, meat, and wool at comparatively low costs and in extremely harsh conditions (Mustafa *et al*., 2015).

A camel can utilize poor quality forages with much more efficiency, as it retains fiber in its fore stomach for as long as 70 hours (Von Engelhardt *et al*., 2006). It reutilizes urea for microbial protein synthesis and can use water economically for almost all metabolic functions. With 1.1 million heads (FAOSTAT, 2019; GOP, 2019-20), the camel population in Pakistan is enough to contribute to food security in the national economy and for diverse ecozones.

However, for contributing to this, improvement of meat productivity in the camel herd is necessary. One way could be more intensive feeding to increase the growth of young camels. Mineral estimation in camel hair is a relatively newer concept in Pakistan. It could be an interesting tool for monitoring the general

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health status of camel calves (Faraz *et al*., 2019b). However, in Pakistan, camel hairs have not been taken up for mineral estimation so far. Hence, this study was planned to evaluate the growth potential related to hair mineral status in Marecha camel calves under an intensive management system (IMS) and an extensive management system (EMS) in its natural habitat.

Materials and Methods

Study area and meteorological conditions

This study was conducted at the Camel Breeding and Research Station (CBRS), Rakh Mahni, Tahsil Mankera, District Bhakkar. The CBRS is located in Thal area between 31°10′ and 32°22′ north latitude and 70°47′ and 72° east longitude. Most of the area lies in the desert plain of Thal. This area is included in the agro-ecological zone-III A and B (sandy desert area), having narrow strips of sand ridges and dunes. The climate is arid to semiarid, subtropical, and continental and the mean monthly highest temperature goes up to 45.6°C, while in winter it goes from 5.5°C to 1.3°C. The mean annual rainfall in the region ranges from 150 to 350 mm, increasing from south to north (Rahim *et al.*, 2011).

Animal management

Marecha camel calves were maintained at the CBRS, Rakh Mahni, Tahsil Mankera, District Bhakkar, and the nearby field was used for this experiment to compare the efficiency of body weight gain and hair mineral status in camel calves raised under an IMS and an EMS. Twelve Marecha calves (*Camelus dromedarius*) aged around 330 ± 30 days and having group weight of 1350 and 1340 kg, respectively, were used in the 120-day trial, with additional 15 days adaptation period. Of these, six (three male and three female) belonged to the CBRS and were reared under IMS and the other six calves (three male and three female) were owned by private farmers and reared under EMS. The experiment was conducted during the months of March to August 2014. Before the start of the experiment, all the camel calves were marked for identification and dewormed to reduce the parasitic load. Calves were housed in semi-open pens throughout the trial at a farm in IMS and under available housing in EMS. Initial body weights of the camel calves were recorded before shifting these calves to the respective treatment groups, and thereafter all the experimental calves were weighed fortnightly on a digital weighing scale (Impressum, Pakistan) before morning feeding.

Experimental feeding plan

Water was provided twice a day in both the systems. The animals in the first group were fed concentrate at the rate of 1 kg/head/day along with gram straw (*Cicer arientinum*) *ad libitum* in IMS. While in EMS, the calves were allowed to graze/browse for 10 hours (as per prevailing practice) along with feeding of households (kitchen waste, house refusals, and some grains). The ingredients and the chemical composition of the experimental ration are given in Table 1, while the compositions of gram straw and different grazing/browsing species are given in Table 2.

Data collection

Daily growth rate average daily gain (ADG) was calculated by fortnightly weighing as follows: Current weight−previous weight/15. The feed intake of crop residues was calculated as the difference between the residual amount of feed and the amount offered. The average dry matter values of feed were measured and the dry matter intake (DMI) was then determined.

Laboratory analysis

The concentrate, crop residues, and herbage samples of the grazing/browsing material were analyzed for percent dry matter, crude protein, crude fiber, ether extract, and ash (AOAC, 1990). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were also determined (Van Soest *et al*., 1991).

Hair collection, digestion, and analyses

Hair samples were collected from shoulder, neck, hump, and mid region of the body of camel calves. The hair was cut with stainless steel scissors into pieces of about 1 cm length from each region and mixed well to ensure homogeneity. The skirting of the sample was carried out properly. Samples were washed with acetone and were filtered and rinsed with plenty of water. They were dried in a hot air oven and 0.5 g of dried mass was taken for further processing. Digestion of hair samples was carried out at the Animal Nutrition Lab, Faculty of Animal Husbandry, University of Agriculture Faisalabad. Concentrated nitric acid (2 ml) was added to each hair sample and was kept at 100°C until half of the total volume evaporated. The samples were taken out and cooled. Concentrated perchloric acid (2 ml) was added and again the sample was kept until half of the total volume evaporated. After this procedure, distilled water was added to give a total volume of 10 ml (Bhakat *et al*., 2009). The solution was used for

Table 1. Ingredients of experimental ration and chemical composition of experimental ration.

Ingredients (%)	Ration	Parameters (%)	Ration
Maize grain	9	DM	90.32
Wheat bran	24	CP	18.06
Cottonseed cake	25	NDF	29.09
Rapeseed cake	6	ADF	14.41
Corn gluten (30%)	20	TDN	70
Molasses	14	ME (Mcal/kg DM)	2.41
DCP	1		
Salt	1		

DM = Dry matter; CP = Crude protein; NDF = Neutral detergent fiber; ADF = Acid detergent fiber; TDN = Total digestible nutrients; ME = Metabolizable energy.
Adapted from Faraz *et al*. (2018).

the determination of important macrominerals and microminerals. The concentrations of macrominerals (Ca and Mg) and microminerals (Cu, Fe, Mn, and Zn) were determined by the atomic absorption spectrophotometer (Method 965. 09A; AOAC, 1990) at the Hi-Tech Lab, University of Agriculture Faisalabad.

Statistical analysis

Data collected on different parameters were analyzed statistically by using Fisher's analysis of variance technique having 2 × 2 factorial arrangements of treatments under completely randomized design (CRD) (Steel *et al*., 1997) using generalized linear model (GLM) of Statistical Package for the Social Sciences software (SPSS, 2008). Tukey's test at 0.05 levels of significance was used to compare the differences among the treatment means.

Ethical approval

In the current study, camels were fed according to the farm routine practices having grazing/browsing and stall feeding available. They were provided fresh, clean water and salt loops. Camels were vaccinated and dewormed according to scientific recommendations. All institutional and national guidelines for the care and use of experimental animals were followed (ethical committee approval number: DGS No/19457-62).

Results

Calves of almost similar weights were selected in both management systems for this study. After the 120-day trial period, the overall weight gain and daily weight gain (DWG) (growth rate) were 80.8 ± 2.7, 77.8 ± 2.7 kg and 670, 650 g/days for male and female calves in IMS, respectively, and 64.5 ± 2.6, 52.9 ± 2.6 kg and 540, 440 g/days for male and female calves in EMS, respectively (Table 3).

The daily feed intake (DFI) of crop residues was found to vary significantly ($p < 0.05$) among calf groups

Table 2. Proximate analysis (%) of crop residue and different grazing/browsing species.

Feed/Forage Species	DM	CP	EE	CF	NDF	ADF	Crude Ash
Gram straw (*Cicer arietinum*)	93.53	9.72	2.60	44.4	68.7	47.6	7.83
Kikar (*Acacia nilotica*)	28.5	16.71	1.79	25.08	55.4	25.4	5.94
Phulai (*Acacia modesta*)	53.4	13.23	2.21	35.40	46.6	28.78	6.94
Beri leaves (*Ziziphus mauritiana*)	40.2	15.52	5.77	28.02	48.3	26.9	8.48
Siras (*Albizia lebbeck*)	37.3	16.17	6.58	27.25	43	29	16.33
Jand (*Prosopis cineraria*)	46.15	16.86	6.52	19.14	47.5	29	4.95
Khagal (*Tamarix aphylla*)	31.9	12.81	3.25	17.32	42.4	31.6	13.03
Dhaman (*Cenchrus ciliaris*)	31.9	14.69	3.94	26.51	38.53	18.15	15.71
Persain (Suaeda fruticosa)	30.3	10.57	5.52	33.14	48.7	27.6	7.54
Khawi (*Cymbopogon schoenanthus*)	34.6	9.53	2.01	35.67	62.1	43.5	7.14
Kali bui (*Kochia indica*)	33.78	10.80	4.91	27.61	58.6	39.76	13.32
Bhakra (*Tribulus terrestris*)	32.1	8.76	4.58	32.63	46.7	35.4	9.64
Kari (*Capparis spinosa*)	36.7	17.84	1.18	30.75	51.8	33.5	6.97
Laana (Haloxylon salincornicum)	34.2	15.85	3.09	32.33	51.34	37.5	11.93
Phog (*Calligonum polygonoides*)	34.7	8.95	4.82	23.42	49.6	31.9	8.76
Karir (*Capparis decidua*)	49.4	16.75	1.52	24.64	53.6	37.8	14.76
Khar laana (*Haloxylon recurvum*)	47.9	12.36	3.32	24.95	49.2	31.3	12.15

DM = Dry matter; CP = Crude protein; EE = Ether extract; CF = Crude fiber; NDF = Neutral detergent fiber; ADF = Acid detergent fiber.
Adapted from Faraz *et al*. (2018).

Table 3. Overall weight gain (kg) and growth rate (kg/day) of male and female camel calves in IMS and EMS.

Parameter	IMS		EMS	
	Male ($n = 3$)	Female ($n = 3$)	Male ($n = 3$)	Female ($n = 3$)
Growth at 30 days	21.7 ± 0.9^{ax}	20.3 ± 0.9^{ay}	17.7 ± 1.0^{ax}	14.6 ± 1.0^{by}
Growth at 60 days	20.2 ± 0.6^{ax}	19.7 ± 0.6^{ay}	16.4 ± 0.8^{ax}	14.3 ± 0.8^{by}
Growth at 90 days	19.7 ± 0.7^{ax}	19.2 ± 0.7^{ay}	15.4 ± 0.7^{ax}	12.5 ± 0.7^{by}
Growth at 120 days	19.3 ± 0.6^{ax}	18.7 ± 0.6^{ay}	15.0 ± 0.6^{ax}	11.5 ± 0.6^{by}
Overall weight gain	80.8 ± 2.7^{ax}	77.8 ± 2.7^{ay}	64.5 ± 2.6^{ax}	52.9 ± 2.6^{by}
DWG	0.67 ± 0.02^{ax}	0.65 ± 0.02^{ay}	0.54 ± 0.02^{ax}	0.44 ± 0.02^{by}

Means having different superscripts in columns are significantly different ($p < 0.05$).
IMS = Intensive management system; EMS = Extensive management system.
Adapted from Faraz *et al*. (2017, 2018).

between IMS and EMS, with IMS being higher than EMS. The intake of crop residues was found to be 6.9 ± 0.45 and 6.4 ± 0.45 kg/days in male and female calves in IMS, respectively, and 3.5 ± 0.23 for male and female calves in EMS, respectively. The weight gain for 1 kg intake of crop residues in the conversion index is 97.1 and 101.5 g/kg average daily intake (ADI) for males and females in IMS, respectively, and 154.3 and 125.7 g/kg ADI for males and females in EMS, respectively (Table 4).

The mean values of macro (Ca and Mg) and trace elements (Cu, Zn, Fe, and Mn) of male and female camel calves in the different farming systems were found to be significantly different ($p < 0.05$) for calcium, magnesium, copper, zinc, iron, and manganese between male and female calves, the values being higher in males than females in both systems (Table 5).

Discussion

Sex effect on growth

In the present study, male calves attained higher weights in both the systems, which may be due to the reason that more receptors are present on muscle cells for androgens that accelerate the growth (Hossner, 2005). The highest growth of young males is a common feature in most of the farm animals and is widely reported in the literature. In camels, for example, similar observations were realized in Pakistan by Knoess (1977) and Qureshi (1986), who reported the average DWG as 1,400 g in male and 950 g in female camel calves and 1,500 g in male and 1,000 g in female camel calves, respectively. Ouda *et al*. (1992) studied the production performance of Somali and Rendille camels in northern Kenya and observed that sex and year significantly affect growth after 2 years of age. Kurtu (2004) reported that mature male calves were heavier than female calves by 38% in Ethiopia. Reported weight gain in calves was 411 g/days in males and 380 g/days in females, while weight gain after sexual maturity was 120 g/days in males and 60 g/days in females in northern Kenya (Musavaya, 2003).

Sahani *et al*. (1998) in India reported the ADG in 0–3 (630, 580 g); 3–6 (640, 620 g); 6–9 (370, 390 g); 9–12 (230, 230 g); 18–24 (160, 200 g); 24–30 (160, 170 g), and 30–36 months (180, 140 g) in male and female calves, respectively. Khanna *et al*. (2004) reported the ADG as 700 and 770 g in Jaisalmeri and Bikaneri Indian camel breeds from birth to 3 months of age, respectively.

Table 4. Average male and female camel calves' intake of crop residues (kg) and conversion index (g/kg ADI) on DM basis in IMS and EMS.

Parameter	IMS		EMS	
	Male (n = 3)	Female (n = 3)	Male (n = 3)	Female (n = 3)
ADI in 30 d	6.5 ± 0.44^{ax}	5.9 ± 0.44^{ay}	3.3 ± 0.22^{bx}	3.3 ± 0.22^{by}
ADI in 60 d	6.9 ± 0.45^{ax}	6.4 ± 0.45^{ay}	3.5 ± 0.23^{bx}	3.6 ± 0.23^{by}
ADI in 90 d	7.5 ± 0.46^{ax}	6.8 ± 0.46^{ay}	3.8 ± 0.24^{bx}	3.8 ± 0.24^{by}
ADI in 120 d	7.9 ± 0.45^{ax}	7.4 ± 0.45^{ay}	4.0 ± 0.25^{bx}	4.0 ± 0.25^{by}
DFI/animal	6.9 ± 0.45^{ax}	6.4 ± 0.45^{ay}	3.5 ± 0.23^{bx}	3.5 ± 0.23^{by}
Conversion index	97.1	101.5	154.3	125.7

Means having different superscripts in columns are significantly different ($p < 0.05$).
ADI = Average daily intake; IMS = Intensive management system; EMS = Extensive management system.
Adapted from Faraz *et al*. (2017, 2018).

Table 5. Wool mineral analyses of male and female camel calves in IMS and EMS.

Parameter (mg/dl)	IMS		EMS	
	Male (n = 3)	Female (n = 3)	Male (n = 3)	Female (n = 3)
Calcium	685.0 ± 25.3^{ax}	595.7 ± 38.0^{ay}	529.8 ± 15.9^{bx}	498.7 ± 23.2^{by}
Magnesium	104.3 ± 2.0^{ax}	101.2 ± 0.9^{ay}	87.8 ± 3.4^{bx}	83.5 ± 4.0^{by}
Copper	7.0 ± 0.4^{ax}	6.7 ± 0.4^{ay}	5.7 ± 0.4^{bx}	4.5 ± 0.1^{by}
Zinc	65.3 ± 2.9^{ax}	59.3 ± 3.0^{ay}	59.3 ± 2.4^{bx}	46.9 ± 1.8^{by}
Iron	322.2 ± 6.3^{ax}	311.1 ± 6.3^{ay}	300.6 ± 3.1^{bx}	242.3 ± 4.7^{by}
Manganese	46.5 ± 1.7^{ax}	40.7 ± 0.3^{ay}	32.5 ± 2.4^{bx}	27.0 ± 1.6^{by}

Means having different superscripts in columns are significantly different ($p < 0.05$).
IMS = Intensive management system; EMS = Extensive management system.

However, no significant difference was found between male and female calves regarding their DWG. Bakheit *et al*. (2012) studied the effect of management systems on growth rate of calves in North Kordofan, Sudan, and found no significant difference between male and female calves regarding their DWG. Faraz *et al*. (2017, 2018, 2019b) compared the growth performance of camel calves in different management systems and found higher weight gain in male calves than female calves.

Diet effect on growth

The ADGs significantly varied between groups, with IMS being higher than EMS. These findings are in line with that of Bhakat *et al*. (2008), who studied the effect of management systems on growth performance of dromedary camel calves in India. They used 10 camel calves aged between 7 and 10 months in their study and divided them randomly into two comparable groups of five each. The average initial body weight of both groups was almost similar. The groups were of hetero breed and sex combinations, each group contained three Jaisalmeri, one Bikaneri, and one Katchi breed, and four males and one female. At the end of the trial, the average total gain was almost double in the IMS than the semi-intensive management system (SIMS) group. The average growth rate was significantly higher in IMS (611 g/days) than SIMS.

Contrary to our observations, Bhakat *et al*. (2009) reported that the ADG (g/day) differed significantly among two systems, with SIMS being higher (325 and 476 g/days) than IMS (278 and 331 g/days) with guar phalgati (*Cyamopsis tetragonoloba*) and moth chara (*Phaseolus aconitifolius*) feeding, respectively. In another context, in Sudan, Bakheit *et al*. (2012) studied the effect of management systems on the growth rate of calves and reported that daily growth rate was 534 and 316 g/days in semi-intensive and traditional management systems, respectively.

Dabiri *et al*. (2003) reported that the average DWG as 700 g in camels aged 1–2 years in a traditional management system. In Kenya, under proper nutrition, the reported average DWG in camel calves was 870 and 570 g from birth to 30 days and from birth to 180 days, respectively (Wilson, 1992), while in Egypt, El-Badawi (1996) reported 830–970 g DWG from birth to 180 days in dromedary calves.

Saini *et al*. (2014) also reported a higher total and ADG (kg) in stall-fed pre-pubescent camels as compared to the grazing group. In Sudan, Mohamedain *et al*. (2015) studied the growth performance in dromedary camels under two feeding regimens. First was the zero browsing group (15 Darfuri and 10 Butana) fed complete ration (sorghum 50%, groundnut cake 15%, wheat bran 5%, molasses 10%, dura husk 5%, bagasse 12%, urea 2%, and common salt 1%) to provide metabolizable energy (ME) at the rate of 11 MJ/kg dry matter (DM) and 16% crude protein (CP). Second was the free browsing group with same breeds without any supplement. The trial was for 120 days with 2 weeks as adaptation period. The average total weight gain was almost double in the zero browsing group (96 ± 17.3 kg) than in the free browsing group (42 ± 19.5 kg). ADG was 800 g in the zero browsing group as compared to 350 g in the free browsing group, while in present study, a lower DWG was observed in IMS due to the limited supply of concentrate.

Faraz *et al*. (2018), comparing the IMS with the SIMS regarding growth rate of camel calves, found a higher growth rate in male calves under IMS than SIMS. The values of the present study are very close to other study reported in which higher growth rates were achieved in EMS than SIMS (Faraz *et al*., 2017). The current findings are also in agreement with our former study (Faraz *et al*., 2019b) in which we compared the growth performance and hair mineral status of Marecha calves in different management systems and found a significant increase in the ADG of male and female calves being higher in IMS than SIMS. Faraz *et al*. (2020) compared the growth rate of weaned growing camel calves of almost 1 year of age reared under an open grazing/browsing and stall-fed system and found that the average DWG as 480 and 520 g/days ($p < 0.05$), respectively, under open grazing and stall-fed system, while feed conversion index (quantity of fodder/kg of gain) was found to be 14.42 in stall-fed animals. The values of DWG (g) and feed conversion index (g/kg average daily intake) of male and female weaned dromedary calves around 1 year of age were found to be 670, 97.1 g; 650, 101.5 g, and 540, 154.3 g; 440, 125.7 g reared under intensive and extensive feeding management systems, respectively (Faraz, 2020b).

Feed intake

In the study of Bhakat *et al*. (2008), regarding the effect of management systems on growth performance of Indian camel calves, it was reported that the crop residue intake significantly varied between two groups, 5.53 versus 4.37 kg/calf/days in ISM and SISM, respectively. Moreover, Saini *et al*. (2014) reported a higher DMI (kg/day) in stall-fed pre-pubescent camels as compared to the grazing group.

In the study of Bhakat *et al*. (2009), who determined the growth characteristics of Indian camel calves under IMS and SIMS, a non-significant intake was found by using Guar phalgati chara (*C. tetragonoloba*) (6.02 *vs.* 5.14 kg/calf/days), but a significance was found with moth chara (*P. aconitifolius*) (7.91 *vs.* 6.24 kg/calf/days), respectively. Furthermore, in the study of Tandon *et al.* (1993), dry fodder and water intake positively correlated with the growth of weaned calves. Moreover, DMI was also found to be positively correlated in Indian camel calves (Singh *et al.*, 2000).

The findings of the present study confirmed the values reported by Faraz *et al*. (2019b) who compared the IMS with SIMS and found a higher crop residues intake in male and female calves under IMS than SIMS. In another study, Faraz *et al*. (2017) compared the growth performance of dromedary calves reared under EMS and SIMS and found a higher feed intake in EMS than SIMS. Such differences in feed intake could be due to the higher part of cellulose in the grazing diet. It is linked also to the time spent for grazing. In all intensive systems, animals in closed pens do not spend time for grazing, hence no energy loss for walking, and consequently their feeding capacity increases.

Wool mineral status

Determination of mineral hair composition could be an indirect tool for assessing the general health status of the animal as it is an accumulative mineral nutrition witness. The observed differences reflect better mineral nutrition in the intensive system compared to the other. To our knowledge, no work has been reported on wool mineral analysis of camel calves in Pakistan as yet. Faraz *et al*. (2019b) studied the growth performance and hair mineral status of Marecha camel calves in different management systems and reported a higher weight gain and mineral concentrations in calves in IMS than SIMS.

Bhakat *et al*. (2009) in India determined the hair mineral status of camel calves reared under different management systems and reported higher concentrations of macrominerals and microminerals in calves in SIMS. They reported calcium as 549.6 ± 74.5, 434.4 ± 60.2 mg/dl and 719.7 ± 78.6, 476.0 ± 128.0 mg/dl, magnesium as 88.9 ± 2.4, 67.6 ± 6.3 mg/dl and 77.5 ± 3.7, 69.8 ± 3.2 mg/dl, copper as 6.7 ± 0.7, 4.3 ± 0.4 mg/dl and 7.4 ± 0.7, 5.7 ± 1.0 mg/dl, zinc as 66.0 ± 4.4, 57.6 ± 2.3 mg/dl and 64.3 ± 2.0, 54.8 ± 1.5 mg/dl, iron as 285.7 ± 26.6, 216.0 ± 30.9 mg/dl and 319.4 ± 27.9, 261.9 ± 33.4 mg/dl, and manganese as 21.6 ± 3.7, 20.6 ± 1.0, and 45.8 ± 1.8 mg/dl, 32.9 ± 4.4 mg/dl in calves reared under semi-intensive and IMS with guar phalgati (*C. tetragonoloba*) and moth chara (*P. aconitifolius*) feeding, respectively.

Moreover, the relationship between physical, chemical, and industrial characteristics of different dromedary camel's hair types was studied by Helal (2015), who reported higher concentrations of B, Cd, Co, Cr, Fe, Mn, Ni, and S in fine hairs of Maghrebi camels, while Mo, Pb, and Zn were higher in coarse fibers. Furthermore, similar studies carried out on horses (Or *et al*., 2004) and yaks (Chatterjee *et al*., 2005) revealed that the level of some mineral elements was affected by nutritional differences in horses and yaks, respectively.

Conclusion

The current research findings confirmed higher gains in male calves in IMS. It is of the opinion that Pakistani camel calves have greater production potential that could be exploited by modern husbandry techniques on scientific lines. Definitely, it will be a useful addition to the food chain. Male calves should be utilized for meat production, while the higher growth rate of females should be utilized to achieve a more precocious reproduction age for heifers. Constituents entering into the body are accumulated in hairs and also reflect the nutritional status of the animal. These levels could be used in the diagnosis of various diseases and metabolic disorders of the animal. This article describes the growth rate and hair mineral status of young calves reared under two management systems in desert conditions and could be used as a primary database for future studies in this field.

Significance of the study

The role of camels in the economy of marginal areas of the world and society is well documented, but it is still one of the most ignored species in Pakistan. Being a valuable genetic resource, initiatives have been taken to illustrate production potential and related parameters of camels under natural milieus. Previous studies did not validate penetrating requirements of the subject; hence extensive studies of Pakistani camels under different management systems are desired. The current study covers the growth parameters and hair mineral analysis of camel calves reared in IMS and EMS and provides comprehensive material about these parameters lacking in previous studies. This study will not only condense the thirst of the scientific community by plotting footprints to develop a database for camel production and reproduction but it will also go a long way to reconnoiter novel and unmapped areas of camel production to provide solid recommendations for the camel farming community.

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Conflict of interest

The authors declare that there is no conflict of interest.

Authors' Contributions

All authors contributed to make the completion of this manuscript possible. AF conducted the research and wrote the article; AW helped in the analysis, NAT and ABM helped in writing the article, and AOA helped in analyzing and reviewing the article.

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