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Mineral Profile of Camel (*Camelus dromedarius*) Milk under Pastoral Production System in Katsina State, Nigeria

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Abstract

The most important factor in camel milk for people living in dry zone is its water and mineral contents. Camels provide food and other means of livelihood in the pastoral communities of Northern Katsina State. However, the composition of camel milk provides essential mineral and nutrients to the humans. This study was designed to investigate the mineral composition of camel milk under the pastoral production system. Randomly, twelve (12) lactating camel cows at parities one, three and five were used for milk collection. Results obtained from this study across the seasons with respect to parities indicated significant (P<0.05) difference from Zinc (562.40µg/100g) in parity three, Copper (138.25µg/100g), Iron (269.65µg/100g), Sodium (58.33 mg/100g), Potassium (149.10mg/100g), Calcium (114.91mg/100g), Magnesium (12.79 mg/100g) from parity five and Phosphorous (88.51 mg/100g) from parity one respectively. From the results, it is concluded that higher concentrations of mineral elements were reported from parity five as the quantity of milk produced also increases as parity advanced.

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Nijerya, Katsina Eyaletinde Pastoral Üretim Sistemi Altında Deve (*Camelus dromedarius*) Sütünün Mineral Profili

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Öz

Kurak bölgelerde yaşayan insanlar için deve sütündeki en önemli etken içerdiği su ve minerallerdir. Develer, Kuzey Katsina Eyaletinin pastoral topluluklarında yiyecek ve diğer geçim kaynakları sağlar. Bununla birlikte, deve sütünün bileşimi, insanlar için gerekli mineral ve besin maddelerini sağlar. Bu çalışma, pastoral üretim sistemindeki deve sütünün mineral bileşimini araştırmak için tasarlanmıştır. Rastgele, bir, üçüncü ve beşinci paritelerde on iki (12) emziren deve ineği süt toplama için kullanıldı. Paritelere göre mevsimler boyunca bu çalışmadan elde edilen sonuçlar, üçüncü paritede Çinko (562.40µg/100g), Bakır (138.25µg/100g), Demir (269.65µg/100g), Sodyum (58.33mg/100g), Potasyum (149.10mg/100g), Kalsiyum (114.91mg/100g), Magnezyum (12.79 mg/100g) beşinci pariteden ve Fosfor (88.51 mg/100g) birinci pariteden. Elde edilen sonuçlardan, parite ilerledikçe üretilen süt miktarı da arttığından, beşinci pariteden daha yüksek mineral element konsantrasyonlarının rapor edildiği sonucuna varılmıştır.

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Introduction

Milk from camel is a complex mixture of various nutrients such as protein, fat, lactose, minerals and vitamins (Schwartz and Dioli, 1992). The composition and properties of camel milk are described based on different production systems and highlight the special properties of camel milk. The composition of camel milk differs significantly from that of other ruminants (Elamin, 1999; Elamin and Wilox, 2002; Dell'Orto et al., 2001; Wang'ang'a, 2002; El Hag et al., 2003; Nabag et al., 2006). The general composition of camel milk varies in different parts of the world and its range also varies. (Gnan and Sheriha, 1996). Large differences in milk composition can be due to factors such as age, parity, management, stage of lactation and sampling technique used (Salah, 2011) and feed quality (Yagil, 1992; Parraguez et al., 2003). One of the most important products from camel is milk. It's being characterized as a valuable food for people living on marginal land of both Asia and Africa. Pastoralists from around the world cherish and utilize camel milk as a main food. However, camels have an outstanding milk production in harsh environmental conditions in which they are kept (Mohammad and Eliman, 1998; Venbert et al., 2003; Ramat et al., 2014). Milk yield of camels compared to cows, sheep, and goat under the same harsh environmental conditions has recorded a significant variation and its lactation lasts well into the dry season and rarely stops, even during prolonged droughts (Muliro, 2007; Salah et al., 2011). However, there are no experimental studies conducted or available literature on mineral composition from camel cows in the study area. Therefore, the purpose of this study was to evaluate the mineral status and constituents of camel milk in order to create a database and an awareness in people about its usefulness.

Materials and Methods

Herd structure, selection and management of the lactating camel cows

An inventory of the herds was carried out and information on parity was recorded. A total of twelve (12) lactating camels were selected and used for the study. The selection was based on 3 parity levels (i.e. 1st, 3rd and 5th parities) in which four (4) animals were selected in each stage of parity. Camel management is similar because their grazing and watering areas are the same. Camels were grazed on natural grasses and were offered mineral (potash) supplementation periodically.

Experimental design

The experiment was conducted using a 3 x 3 factorial method in a completely randomized fashion to determine mineral status of camel milk. The parities were 1 (one), 3 (three), and 5 (five) and four camel cows were used within each parity and each camel cow used as a replicate. The data were sorted out into the seasons and then analyzed. The seasons were Wet Season (June-October), Cold Dry Season (November–February) and Hot Dry Season (March–May) respectively.

Milking procedure

In all camels selected for experiments, calves were nursed first to trigger the milk ejection reflex. After a few seconds (5–10) the calf was moved aside and the camel cow was milked by two men standing on opposite sides of the animal. A container was used to collect the milk as soon the milking started.

Sample collection, handling and laboratory analysis

Samples of milk from 12 lactating camels at various stages of lactation were collected. Milk samples (300 ml each) were collected in the sterilized bottles and kept in the ice bags and then transported to the laboratory for analysis. Concentration of Zinc, Copper, Iron, Sodium, Potassium, Calcium, Magnesium

and phosphorus were determined. Minerals were extracted from the milk samples and analyzed according to the methods and procedures described by AOAC (2000).

Data analysis

The obtained data were imported into Microsoft Excel (2007) and analyzed using the Statistical Analysis System (SAS, 2002).

Results

Mineral profile of camel milk was affected by the seasons in parity one (Table 1). The results revealed that values (562.81, 138.46 and 269.84 µg/100g) of zinc, copper and iron were significantly (P<0.05) higher in cold dry and hot dry seasons respectively. Sodium and Potassium values (58.68 and 149.28 mg/100g) were significantly (P<0.05) higher in hot dry seasons. Values (115.07 and 12.61 mg/100g) of calcium and magnesium were significant (P<0.05) in hot and cold dry seasons while significant (P<0.05) difference also exist in phosphorous in cold dry season respectively.

Table 1. Mineral Profile of Camel Milk Affected by Seasons in Parity One

Parameters	**Seasons**		
	Wet	**CDS**	**HDS**
Zn (µg/100g)	561.03^{c}	562.81^{a}	561.34^{b}
Cu (µg/100g)	137.73^{b}	137.21^{c}	138.46^{a}
Fe (µg/100g)	268.51^{a}	268.11^{c}	269.84^{a}
Na (mg/100g)	57.42^{b}	57.05^{c}	58.68^{a}
K (mg/100g)	148.73^{b}	147.21^{c}	149.28^{a}
Ca (mg/100g)	114.86^{b}	114.21^{c}	115.07^{a}
Mg (mg/100g)	11.88^{c}	11.91^{b}	12.61^{c}
P (mg/100g)	88.74^{b}	88.83^{a}	87.64^{c}

Means with different letters in the same row are significantly different (P<0.05), Zn=Zinc, Cu=Copper, Fe=Iron, Na=Sodium, K=Potassium, Ca=Calcium, P=Phosphorous

Table 2 presents the results of mineral composition of camel milk as influenced by the seasons in parity three. Significantly (P<0.05), there were higher values (563.14 µg/100g) of zinc in the cold dry season followed by Cupper (138.89 µg/100g) in the hot dry season. Also, values (269.97µg/100g; 58.51 and 149.61 mg/100g) of Iron, Sodium and Potassium contents were higher (P<0.05) in a cold dry season. However, there were no significant (P>0.05) difference observed from calcium values. Magnesium and phosphorous recorded (12.94 and 88.76 µg/100g) values in hot dry and wet seasons respectively.

Mineral profile of camel milk as influenced by the seasons in parity five were presented in Table 3. Results of Zinc (562.75 µg/100g) followed by copper (138.52 µg/100g) and iron (269.98 µg/100g) revealed a significant variation (P<0.05) in cold and hot dry seasons respectively. Sodium values (58.64 mg/100g) and potassium (149.51 mg/100g) were significant (P<0.05) in hot dry seasons. However,

calcium values were (114.93 mg/100g) in a cold dry season. Significant variations (P<0.05) existed from magnesium (12.96 µg/100g) and phosphorous (88.82 µg/100g) in cold dry season respectively.

Table 2. Mineral Profile of Camel Milk Affected by Seasons in Parity Three

Parameters	**Seasons**		
	Wet	**CDS**	**HDS**
Zn (µg/100g)	562.74[b]	563.14[a]	562.26[c]
Cu (µg/100g)	137.78[b]	137.16[c]	138.89[a]
Fe (µg/100g)	268.54[b]	269.97[a]	269.13[b]
Na (mg/100g)	57.05[c]	58.51[a]	57.66[b]
K (mg/100g)	147.12[c]	149.61[a]	148.52[b]
Ca (mg/100g)	114.78	114.83	114.84
Mg (mg/100g)	12.73[b]	11.96[c]	12.94[a]
P (mg/100g)	88.76[a]	87.61[c]	88.51[b]

Means with different letters in the same row are significantly different (P<0.05), Zn=Zinc, Cu=Copper, Fe=Iron, Na=Sodium, K=Potassium, Ca=Calcium, P=Phosphorous

Table 3: Mineral Profile of Camel Milk as affected by Seasons in Parity Five

Parameters	**Seasons**		
	Wet	**CDS**	**HDS**
Zn (µg/100g)	561.81[b]	561.24[c]	562.75[a]
Cu (µg/100g)	137.42[b]	138.52[a]	137.41[b]
Fe (µg/100g)	269.14[b]	268.15[c]	269.98[a]
Na (mg/100g)	57.85[b]	57.20[c]	58.64[a]
K (mg/100g)	148.52[b]	147.61[c]	149.51[a]
Ca (mg/100g)	114.15[c]	114.93[a]	114.82[b]
Mg (mg/100g)	11.78[c]	12.96[a]	12.81[b]
P (mg/100g)	88.02[b]	88.82[a]	87.97[c]

Means with different letters in the same row are significantly different (P<0.05), Zn=Zinc, Cu=Copper, Fe=Iron, Na=Sodium, K=Potassium, Ca=Calcium, P=Phosphorous

Mean mineral compositions of camel milk as affected by three parities were presented in Table 4. The mineral composition of camel milk was influenced by three parities indicated significant differences (P<0.05) from zinc (562.40 µg/100g) followed by copper (138.25 µg/100g) both in parities three and

five and iron (265.65 µg/100g) in parity five respectively. Higher values were significantly (P<0.05) observed from Sodium (58.33 mg/100g), potassium (149.10 mg/100g) and calcium (114.91 mg/100g) both in parity five among the parity levels. Magnesium (12.79 mg/100g) and phosphorous (88.51 mg/100g) were both significant (P<0.05) in parities five and one respectively.

Table 4: Mineral Profile of Camel Milk as Affected by Three Parities

Parameters	**Parities**		
	1	**3**	**5**
Zn (µg/100g)	561.86^{c}	562.40^{b}	562.12^{a}
Cu (µg/100g)	137.64^{b}	137.63^{c}	138.25^{a}
Fe (µg/100g)	268.73^{b}	268.74^{b}	269.65^{a}
Na (mg/100g)	57.44^{c}	57.59^{b}	58.33^{a}
K (mg/100g)	148.12^{b}	148.14^{b}	149.10^{a}
Ca (mg/100g)	114.60^{c}	114.66^{b}	114.91^{a}
Mg (mg/100g)	12.13^{c}	12.28^{b}	12.79^{a}
P (mg/100g)	88.51^{a}	88.42^{b}	88.04^{c}

Means with different letters in the same row are significantly different (P<0.05), Zn=Zinc, Cu=Copper, Fe=Iron, Na=Sodium, K=Potassium, Ca=Calcium, P=Phosphorous

Discussion

Mineral content of camel milk revealed high concentrations in parity five and during hot dry season; with the exception of Phosphorus in parity one and Zinc in parity three across the seasons of the year respectively. Milk is the best source of essential minerals (Cu, Zn, Fe, Na and K) required for human health (Yagil, 1992). The composition of camel milk from a nutritional standpoint, despite it is being described as not easily fermented still exploits the essential nutrients present. Sodium and potassium are considered together because they are electrolytes that play an important role in maintaining the osmotic pressure in the extracellular and intracellular fluids and in maintaining the acid-base balance of milk. Values of sodium from the present study were within the normal range and in agreement with the reports of El-Amin and Wilcox (2002). The levels of sodium may probably be affected by the seasonal heat, vegetation and environment (Alkali, 2015). Differences in the level of Iron could be attributed due the wide range of vegetation utilized by the camels in the area (Alkali *et al.*, 2016). This is similar to the result reported by Ali–Gorban and Izzeldin (1997).The higher zinc content is directly attributed to the composition of the soil. Although, there was no study that correlates the nature of soil and the zinc content of milk in the study area (Ghude, 2017). Therefore, the result presented indicated that camels try to prevent the loss of some of these elements in hot dry season as this period is critical in terms of water availability for camels. The result is in agreement with reports of Underwood (1981); Yagil (1992); Elamin and Wilox (2002); Wango (1993); Zia Ur Rahman et al. (1994); Al–Awadi and Srikumar (2001); Dell'Orto et al.(2001); Wernery (2003); Khan and Al-Bukhari (2004); Al–Attas (2008); Hassan et al.

(2009); Konuspayeva et al. (2009); Al Haj and Al Kanhal (2010); Raziq et al. (2011) and Riyadh et al. (2012) who reported higher mineral concentrations in camel milk as parity advances and also during hot dry season of the year.

Conclusion

Parities strongly influence the concentration of mineral in the milk. Also, seasons, feed and water availability increase the quantity of milk produced as parity advance. However, the results of the current study shall contribute to the knowledge about the mineral composition of camel milk from the study area.

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