Chemical composition of camel (*Camelus dromedarius*) milk as affected by parity and seasons under pastoral production systems in north-west, Nigeria

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Abstract

One hundred and seven camels and twelve lactating camel cows were used in a study comprising three seasons (wet, cold–dry and hot–dry) and three parities (one, three and five). The study was conducted using a 3 x 3 factorial in a completely randomized design. Four animals were selected in each parity level and were at early stage of lactation. The calving time and health status of the animals were carefully examined before selection. Milk samples were analyzed for chemical composition. The mean chemical composition of the milk obtained indicated significantly (P<0.05) higher total solids, solid non fat, fat, ash and viscosity in hot–dry season, however no significant (P>0.05) difference existed in the pH and density while lactose level of milk was significantly (P<0.05) higher in cold–dry season respectively. It is concluded that there is lower fat content in camel milk compared to other dairy animals despite the feed and water challenges during hot season.

Key words: camels, milk, chemical composition, parity, seasons

Introduction

Camels are found in Africa and Asia and are kept mostly by nomads (FAO, 2006). People living in Africa and Asia depend on camels to supply most of their daily needs. In arid and semi-arid lands (ASALs), camels pull ploughs, turn water wheels to irrigate fields, and carry agricultural products to market places (Shuiep *et al.,* 2008). In the deserts, camels are almost the only source of transportation and food. In turn, camels need people to fetch water for them from wells if they are to survive the hot dry season (Yagil, 1990). Milk is the only food that provides a well-balance array of sufficient nutrients including protein, fat, carbohydrate, vitamins and minerals which is palatable, digestible and absorbable (Abdel–Rahim *et al.* 2014). There are two species of camels: one-humped Arabian camels or dromedaries (*Camelus dromedarius*) – the camels of the plains; and two-humped Bactrian camels (*Camelus bactrianus*) – the camels of the mountains (Yagil, 1990; Wilson, 1998a; Wilson, 1998b and 1998c; Ibrahim *et al.,* 2000 and FAO, 2004). The composition of camel milk varies with seasons, quality and availability of feed as well as parity differences (Abu–Shloue *et al.,* 1998 and Bekele *et al.,* 2002). Camel sustains its productivity in difficult conditions and comparatively less affected by water deficit, high ambient temperature and quality/scarcity of feed (Gabans *et al.,* 2002). However, some factors such as type of feed, age, seasons and parity have been reported to affect the quantity and composition of camel milk (Mehaia *et al.,* 1995; Khaskheli *et al.,* 2005; Haddadin *et al.,* 2008; Shuiep *et al.,* 2008; Konuspayeva *et al.,* 2009 and Omer and Eltinay, 2009). However, data on camel milk composition under pastoral production system in arid and semi arid lands (ASALs) are scanty and this necessitated the design and conduct of this study.

Materials and methods

Location of the study area

The study was conducted at Gana Jigawa, Mashi Local Government Area, Shirinya, Mani LGA and Sharawar Bugaje, Daura LGA in Katsina State, North-West, Nigeria.

Experimental design

The experiment was conducted using a 3 x 3 factorial in a completely randomized design to evaluate the effect of parities and seasons on camel milk and its chemical composition. The parities were one (1), three (3) and five (5) and within each parity four camel cows were used and each camel cow serving as replicate. The data collected were sorted out into seasons and analyzed. The seasons were wet (June–October), cold–dry (November–February) and hot–dry (March– May) respectively.

Pastoral system and herd structure

Pastoralists managed the camels under extensive system of management (Ghude *et al.,* 2013). During rainy season, they migrated to a nearby uncultivable land for grazing to avoid damaging crops. The camel herd used for the experiment composed of 107 camels out of which 43 were lactating camel cows at different stage of lactation and parity levels. The animals were carefully examined before selection and the calving range was noted.

Milking Procedure

In all the camel cows selected for the experiment, the calf was allowed to suckle 5–6 seconds to elicit the milk let-down reflex after which the calf was moved aside and the camel cow was milked by two men standing on opposite sides of the animal. As soon the milking started, a container was used to collect the milk. About 300ml were collected per animal for the chemical analysis.

Sample Collection and handling

Milk samples were collected on monthly basis with respect to three seasons of the year. The samples were collected between June, 2015–May, 2016. Samples of milk collected at the point of milking were preserved in flask containing ice pack which was transported immediately to the laboratory for analysis.

Laboratory analysis

Chemical composition of camel milk was analyzed using the procedures described by AOAC (1990). Other parameters such as solid non fat were calculated by subtracting fat content from total solid content. Lactose content was calculated by subtracting the sum of protein and ash contents from solid non fat content. Total Milk Solids were calculated by adding the fat and solid non fat (SNF) contents. However, the density of the milk depended on fat content and its type while specific gravity is a composition of relative density. Viscosity is an important physical property of dairy products and for evaluation of various processing characteristics.

Data analysis

Records collected were entered into SPSS version 16.0 thereafter imported into the SAS version 9.1 and analyzed. Duncan multiple range test (DMRT) were used to separate the means.

Results and discussion

Results

The results on chemical composition of camel milk as influenced by parity in wet season are presented in Table I. Highest value (13.36%) of Total solid were significant ($P<0.05$) in parity five followed by solid non fat (SNF) values (9.38%) in parity five respectively. Fat content (3.98) were significant ($P<0.05$) in parities five. Protein values (3.52%) were also significant ($P<0.05$) in parity five. Significantly ($P<0.05$), values (1.34%) of density presented was significant ($P<0.05$) in parity five respectively. Values of ash composition presented were 0.90% and 0.88% in parity five and one. Lactose in parity five and three had similar values (4.96%) while parity one had 4.90%. However, pH values were 6.54% in parity three and five and 6.36% in parity one. Values (27.92%) of Viscosity were significant (P<0.05) in parity three.

Table 1: Chemical Composition of Camel Milk as affected by Parity in Wet Season

Parameters	Parities		
	1	3	5
Total solid (%)	13.15[b]	13.18[b]	13.36[a]
SNF (%)	9.21[b]	9.24[b]	9.38[a]
Fat (%)	3.94[b]	3.94[b]	3.98[a]
Protein (%)	3.43[c]	3.46[b]	3.52[a]
Density (%)	1.03[b]	1.04[b]	1.34[a]
Ash (%)	0.88[b]	0.82[c]	0.90[a]
Lactose (%)	4.90[b]	4.96[a]	4.96[a]
pH	6.36[b]	6.54[a]	6.54[a]
Viscosity (%)	24.75[b]	27.92[a]	25.75[ab]

Means with different letters in the same row are significantly different (P<0.05), SNF=Solid Non Fat

Table 2 presented the results of chemical composition of camel milk as influenced by parity in cold dry season. Values of Total solid were significant (P<0.05) across the parity levels while Solid non fat (SNF), Fat and Protein followed the same trend. Values (1.20%) of Density were significantly (P<0.05) higher in parity three. There was significant (P>0.05) difference in ash composition (0.78, 0.73 and 0.70%) presented across the parities respectively. Parity three had 4.90% from lactose which showed a significant (P<0.05) difference among the parity levels. However, the pH values were 6.58 in parity three and five and 6.30 in parity one. Values (27.08%) of viscosity were significant (P<0.05) in parity five respectively.

Table 2: Chemical Composition of Camel Milk as affected by Parity in Cold Dry Season

Parameters	Parities		
	1	3	5
Total solid	13.09[c]	13.16[b]	13.32[a]
SNF (%)	9.18[a]	9.11[b]	9.20[a]
Fat (%)	3.91[c]	4.05[b]	4.12[a]
Protein (%)	3.44[c]	3.48[b]	3.58[a]
Density (%)	1.01[b]	1.20[a]	1.01[b]
Ash (%)	0.70[b]	0.73[b]	0.78[a]
Lactose (%)	4.14[c]	4.90[a]	4.84[b]
pH	6.30[c]	6.56[b]	6.58[a]
Viscosity (%)	24.75[c]	26.58[b]	27.08[a]

Means with different letters in the same row are significantly different (P<0.05), SNF=Solid Non Fat

Table 3 presented the results of chemical composition of camel milk as influenced by parity and season (hot dry). Higher values (13.26%) of total solid presented were significant (P<0.05) while solid non fat (SNF) followed the same trend. Significant (P<0.05) difference exists from values of Fat and Protein across the three parity levels. Values (1.36) of density presented were significantly (P<0.05) different in parity three. Ash compositions presented were 0.94, 0.88 and 0.87% in parity five, three and one, respectively. Significant (P<0.05) different was observed in parity three from lactose content. However, pH values were 6.52 in parity five and 6.37 in parity one. Higher values (28.02) of viscosity were also significant in parity three, respectively.

Table 3: Chemical Composition of Camel Milk as affected by Parity in Hot Dry Season

Parameters	Parities		
	1	3	5
Total solid (%)	12.86 ^{c}	13.01 ^{b}	13.26 ^{a}
SNF (%)	9.22^{c}	9.40^{b}	9.50^{a}
Fat (%)	3.64^{c}	3.69^{b}	3.76^{a}
Protein (%)	3.31^{b}	3.33^{b}	3.49^{a}
Density (%)	1.03^{c}	1.36^{a}	1.12^{b}
Ash (%)	0.87^{b}	0.88^{b}	0.94^{a}
Lactose (%)	5.02^{a}	5.40^{b}	5.07^{c}
Ph	6.37^{c}	6.55^{a}	6.52^{b}
Viscosity (%)	25.01^{b}	28.02^{a}	26.05^{ab}

Means with different letters in the same row are significantly different (P<0.05), SNF=Solid Non Fat

Presented in Table 4 is the mean chemical composition of camel milk as influenced by seasons. Mean values of total solid, solid not fat showed significant (P<0.05) difference. Meanwhile values of fat and protein followed the same trend. Values (1.17%) of density presented were significantly (P<0.05) higher in wet and hot–dry seasons. Ash compositions were 0.87% in hot–dry season and 0.82% for both wet and cold–dry seasons. However, values (5.09%) of lactose were significantly (P<0.05) higher in cold dry season. Values of pH were similar (6.48) across the seasons. However, values (26.36%) of viscosity were higher in hot dry season and similar (26.14%) in wet and cold–dry seasons, respectively.

Table 4: Mean Chemical Composition of Camel Milk as affected by Three Parities across the Seasons (Wet, Cold Dry and Hot Dry)

Parameters	Seasons		
	Wet	Cold Dry	Hot Dry
Total solid (%)	13.03^{c}	13.12^{b}	13.31^{a}
SNF (%)	9.20^{c}	9.25^{b}	9.36^{a}
Fat (%)	3.83^{c}	3.89^{b}	3.95^{a}
Protein (%)	3.39^{b}	3.42^{b}	3.53^{a}
Density (%)	1.02^{c}	1.20^{a}	1.17^{b}
Ash (%)	0.82^{b}	0.81^{b}	0.87^{a}
Lactose (%)	4.99^{c}	5.09^{a}	4.96^{b}
pH	6.34^{b}	6.55^{a}	6.55^{a}
Viscosity (%)	24.83^{c}	27.51^{a}	26.29^{b}

Means with different letters in the same row are significantly different (P<0.05), SNF=Solid Non Fat

Discussion

Total solid values were higher in hot–dry season. This might be attributed to the reasons that during hot season camel provides milk with lower total solids because of variations in breeds, feeding system and stage of lactation. However, milk solids are the non-water components of milk–protein, lactose, and minerals (Abdel–Rahim *et al.,* 2014). Sometimes the combination of protein, lactose and minerals is called the solids not fat content, and when the fat is included it is called total solids content. The total solid of milk may change due to differences in relative rates of synthesis and secretion of milk components by the mammary gland. Variations are due to differences among species, between individuals within a strain, and between conditions affecting an individual. Conditions affecting the cows may include the weather or seasons and the stage of lactation. This is in harmony with the reports of El-Agamy *et al.* (2007).

Values of solid not-fat (SNF) were higher in hot dry season. This might be attributed to the reasons that during hot season camel provides milk with lower total solids because the calves need more fluids. However, on the basis of seasonal variations, the highest solid non–fat value was obtained in hot dry season. This is an indication that camel produces better quality milk for production of various products during this period which is the most difficult period for other milk producing animals. Various authors (Dell'Orto *et al.,* 2001; Iqbal *et al.,* 2001; Wang'ang'a, 2002 and Nabag *et al.,* 2006) confirmed the findings with similar trends.

Higher values from fat content were obtained in hot dry season and the trend goes on with the lowest value in wet season. This is in agreement with the reports of Shueip *et al.* (2008) while Ramet (2001) reported a higher value in fat content with respect to seasons as parity advances. However, Ebsa *et al.* (2002) reported higher fat content from camel milk under traditional pasture as parity advances compared to fat content of camel milk under farming system. However, Zeleke (2007) Omer and Eltinay (2009) also reported that seasonal variation does not significantly affect fat composition of camel milk. In another report, Yagil and Etzion (1980) also revealed that fat contents could be reduced in the milk of thirsty camels. Variations in camel milk fat may be attributed to the methods employed to determine yield, high genetic variation between individuals, breed, feeding and management conditions, type of work, milking frequency, age of animal, persistency of lactation, lactation number and stage of lactation. This is in conformity with the report of Kamoun and Jemmali (2012).

Protein content follows similar trend with fat content in a reverse way in which fat and protein in camel milk are inversely related which is the normal trend. FAO (2006) and Khan *et al.* (2011) reported similar values on protein content of camel milk irrespective of parity and season but Dell'Orto *et al.* (2001) and Nabag *et al.* (2006) reported lower values in parity one and higher values as parity advances. Abdel–Rahim *et al.* (2014) reported that protein content under traditional pasture ranged from 3.34 to 4.08% and decreases as parity advances while values from farming system are slightly lower than in traditional pasture production. Al–Attas (2008) reported that this trend might be due to the feeding habit, which resulted in production of milk richer in protein content.

The density of the camel milk did not follow any particular trend based on seasons. However, the highest value was reported for both in wet and hot dry seasons, respectively. Lower values were reported by Al–Attas (2008) from camels kept in Arabian Peninsula. The Density of camel milk was found to be different in some aspects from milk of other animal species, such as bovine milk. Variations observed in the density of camel milk were attributed to several factors, such as different analytical procedures, geographical locations, seasonal variations, feeding conditions and breed of camel. This is in harmony with the reports of Khaskheli *et al.* (2005) and Al–Attas (2008).

Lactose content was higher in cold dry season. This study reported values within the range compared to many authors (Nabag *et al.,* 2006; Khan *et al.,* 2011; Kamoun and Jemmali, 2012). However, Zeleke (2007) reported similar values across the seasons of the year. This may be as a result of analytical procedure, stage of lactation, diet, physiological status and sample handling. Dehydration of the animals may lead to a decline in milk lactose content to as low as 2.9%. The higher value of Lactose in cold dry season might be attributed to the feeding habit of the animal. Accordingly, changes in lactose concentration would account for the milk being described sometimes as sweet and other times as bitter. This report is in harmony with the reports of Khaskheli *et al.* (2005); El–Agamy (2007); Konuspayeva *et al.,* (2009) and Getachew *et al.* (2013). However, Iqbal *et al.* (2001) also reported that these differences in chemical composition of camel milk may be due to factors such as stage of lactation, age, number of calving, nutritional state and water intake.

Values of pH were similar across the seasons of the year. However, the values reported from this experiment are within the normal range reported by several authors (Abu–Taraboush *et al.,* 1998; Ebsa *et al.,* 2002; El–Agamy 2007; Khan *et al.,* 2011).

Viscosity content was higher in hot dry season and similar values in wet and cold dry seasons. Jumah *et al.* (2001) reported similar trend and the values are within the range of these findings. Change in the apparent viscosity with the increase in the thermal treatment of camel milk, where the highest treatment (95°C/30 min) increase in the solids concentration led to highest apparent viscosity (Mohammed *et al.,* 2004).

Conclusion

In this study, it is concluded that lactating camel cows under pastoral production system provide substantial quantity of milk for pastoral consumption and nourishment of the calves. Without intervention in feeding and watering regimes, camel milk composition and its constituents fall within the normal range. However, variations in some milk constituents may be attributed to the methods of milking, physiological status, seasons, parity levels and feed availability.

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