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EVALUATION AND COMPARISON OF CAMEL MILK WITH COW MILK AND BUFFALO MILK FOR GROSS COMPOSITION

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ABSTRACT

The study was conducted to collect camel milk available nearby Anand-Kheda and Kutchh district and analyse for gross chemical composition. The average total solids (TS) content in camel (Anand and Kheda), camel (Kutchh), cow and buffalo milk was 11.97%, 9.95%, 13.07% and 15.57%, respectively. The average fat content in camel (Anand and Kheda), camel (Kutchh), cow and buffalo milk was 4.43%, 2.90%, 4.68% and 6.38%, respectively. The average solid not fat (SNF) content in camel (Anand and Kheda), camel (Kutchh), cow and buffalo milk was 7.56%, 7.04%, 8.39% and 8.97%, respectively; average protein content in camel (Anand ad Kheda), camel (Kutchh), cow and buffalo milk was 3.00%, 2.66%, 3.32% and 3.87%, respectively. The average lactose content in camel (Anand and Kheda), camel (Kutchh), cow and buffalo milk was 4.25%, 3.77%, 4.42% and 4.70% whereas ash content was 0.71%, 0.84%, 0.68% and 0.69%, respectively. Moreover, camel milk content higher amount of chloride and it was 0.20%, 0.25%, 0.11% and 0.12%, respectively.

Key words: Camel milk, cow and buffalo milk, gross chemical composition

In arid and semi-arid areas where cows are affected by the heat and lack of water and feed, Camelids play a major role in supplying milk in these areas. Camel milk is an important source of proteins for the people living in the arid lands of the world. Camel milk is also known for its medicinal properties, which are widely exploited for human health, as in several countries from the ex-Soviet Union (Kenzhebulat *et al,* 2000) and developing countries (Mal *et al,* 2006). In the western world, camel milk is experiencing a novel awareness in these days and even the FAO has stepped in promoting camel milk (Ramet, 2001).

In this context camel milk needs to be further investigated. There are only a few references on camel milk, whether they concern production (Konuspayeva *et al,* 2009) or composition aspects (Farah, 1993; Ramet, 1993).

The present study was planned to study the gross composition of dromedary camel milk (collected from Anand, Kheda and Kutchh districts of Gujarat) and its comparison was carried out with cow and buffalo milk.

Materials and Methods

The samples of camel milk were collected from Anand and Kheda districts (34) and from Kutchh district (34) and cow (34) and buffalo milk (34) samples were collected from the herd of cows and buffalos from Gopalpura village, Anand district). The samples were kept in ice and transported to the laboratory, where these were stored at 4°C. Milk samples were collected in clean and dry sample bottles and kept at refrigeration temperature before its analysis. Total 136 samples (34 each) were analysed for gross composition *viz*. fat, SNF, protein, lactose, ash and chloride.

The camel, cow and buffalo milk samples for chemical analysis were prepared as per the method described in BIS Handbook (SP 18: 1981).

Gross chemical composition of milk

Total solids in all the milk samples were determined gravimetrically by the procedure as described in BIS Handbook (SP 18: Part XI, 1981). The milk fat content in all the milk samples were estimated by following the Gerber method as described in BIS Handbook (SP 18: Part XI, 1981).

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SNF content of camel, cow and buffalo milk were calculated by gravimetric method. The lactose content of all the milk sample of milk was determined using Lane Eyon Method described in BIS Handbook (SP 18: part XI, 1981). The milk protein content of all the milk sample of milk was determined using micro-Kjeldahl method of nitrogen estimation as described in BIS Handbook (SP 18: part XI, 1981). The per cent total protein was obtained multiplying the per cent nitrogen by a factor of 6.38. The ash content of all the milk sample of milk was determined using gravimetric method (SP 18: part XI, 1981). Chloride content was determined by Mohr's method (SP 18: part XI, 1981).

Statistical analysis

The data obtained during investigation were subjected to statistical analyses using completely randomised design (Snedecor and Cochran, 1967).

Results and Discussion

Total Solids

The average data obtained for TS content of camel, cow and buffalo milk are presented in Table 1.

Table 1. TS content of camel, cow and buffalo milk.

Type of milk	Total Solids content (%)
Camel (Anand and Kheda)	11.97±0.15
Camel (Kutchh)	9.95±0.25
Cow	13.07±0.13
Buffalo	15.57±0.14
SEM	0.175
CD (0.05%)	0.488
CV%	8.06

SEM: Standard error of mean; CD: Critical difference (5% level significant); CV: Coefficient of variance

The range (not shown in Table 1) of TS content in camel milk (Anand and Kheda) was 9.70 to 13.48% and mean value was 11.97%. Moreover, TS content in camel milk (Kutchh) was 7.16 to 12.73% and mean value was 9.95%. Similarly, in cow milk, the TS content varied from 10.82 to 14.57% and mean value was 13.07%; whereas in buffalo milk, the TS content varied from 14.25 to 16.92% and mean value was 15.57%. Thus, buffalo milk had the highest TS content, which was followed by cow milk and camel milk. Among camel milk, milk collected from Anand and Kheda has more TS than that of Kutchh camel. The difference in TS content of camel milk (Anand and Kheda and Kutchh) and that of the cow milk was statistically significant. Moreover, the TS contents both the camel milks and cow milk were also significantly lower than that of the buffalo milk. The difference in TS content of both the camel milk i.e. Anand Kheda and that of the Kutchh camel was statistically significant.

Sankhla *et al* (2000) has analysed the camel milk produced in south Rajasthan and found the average total solids of 12.10%. Raghvendar *et al* (2004) observed 8.0 to 11.0% TS in Indian camel milk. Karim and Gooklani (1987) found 12.38% TS in Turkman Sahara camel milk. Indra (2003) reported the dry matter of 15.54% in camel milk in Mongolian bactrian. Kouniba *et al* (2005) observed that dry matter was 10.80% in Morocco. Attia *et al* (2001) found that the dry matter content of camel milk in Tunisia was 9.61%.

Total solids content in milk of various species of cow like Ayrshire, Brown Swiss, Guernsey, Holstein, Jersey, Zebu were found to be 13.1%, 13.3%, 14.4%, 12.2%, 15.0%, 14.7%, respectively (Altman and Dittmer 1961). Ceballos *et al* (2009) reported 11.36% total solids in cow milk. Han *et al* (2012) reported an average content of total solids as 16.39-18.48% in buffalo milk.

The data obtained in present study for average per cent TS content of camel milk were well within the range reported in the literature for milk obtained from dromedary camel in India. The data on TS content of camel milk in this study are also in general agreement with those reported for camel milk from exotic dromedary camel at abroad. Similarly, the data obtained for average TS per cent TS content of cow and buffalo milk were also in general agreement with those reported in the literature for cow and buffalo milk, respectively.

Fat

The average data obtained for fat content of camel, cow and buffalo milk are presented in Table 2.

Table 2. Fat content of camel, cow and buffalo milk.

Type of milk	Fat content (%)
Camel (Anand & Kheda)	4.43±0.11
Camel (Kutchh)	2.90±0.17
Cow	4.68±0.08
Buffalo	6.38±0.21
SEM	0.118
CD (0.05)	0.329
CV%	14.78

SEM: Standard error of mean; CD: Critical difference (5% level significant); CV: Coefficient of variance

Among camel milk, milk collected from Anand and Kheda has more fat than that of Kutchh. The

difference in fat content of camel milk (Anand and Kheda) and that of the cow milk was statistically non-significant, whereas fat content of camel milk (Kutchh) and that of the cow milk was statistically significant. The difference in fat content of both the camel milks i.e. Anand and Kheda and that of the Kutchh was also statistically significant.

Khanna and Rai (1993) reported 2.9 to 5.5% fat in Indian camel milk. Raghvendar *et al* (2004) observed 1.5 to 3.1% fat in Indian camel milk. The milk of Somalian and Kenyan dromedaries' camel contained 2.9 to 5.2% fat. Serikabeva and Toktamysova (2000) observed 5.17% fat in Kazakhstan camel milk. Attia *et al* (2001) reported 1.20% fat in Tunisia camel milk. Indra (2003) found 5.45% fat in Mongolian bactrian camel milk. Sela *et al* (2003) observed 2.61% fat in Israel camel milk.

Fat content in milk of various species of cow like Ayrshire, Brown Swiss, Guernsey, Holstein, Jersey, Zebu are found to be 4.1, 4.0, 5.0, 3.5, 5.5 and 4.9% respectively (Altman and Dittmer, 1961). Park *et al* (2007) reported 3.6% fat and Menard *et al* (2010) reported 4.13% in cow milk.

In the study performed by Asker *et al* (1974), fat content of buffalo milks ranged from 6.9% to 8.5%. Varrichio *et al* (2007) reported that the fat content in buffalo milk average 8.3% but reached 15% under favourable conditions. Han *et al* (2012) reported an average content of fat was 6.57-7.97% in buffalo milk.

The data obtained in present study for average fat% fat content of camel milk was in general agreement with those reported in the literature for milk obtained from dromedary camel in India. The data are also in general agreement with those reported for camel milk obtained from exotic dromedary camel at abroad fat content in camel milk. Similarly, the data obtained for average fat% fat content of cow and buffalo milk were also in general agreement with those reported in the literature for cow and buffalo milk, respectively.

Solids Not Fat

There are 2 parameters, *viz* fat and SNF usually form the basis pricing of milk to make payment to milk producers. The SNF largely consists of proteins, lactose and minerals. In the present investigation, the average data obtained for SNF content of all types of milk along with their statistical analysis are presented in Table 3.

Among camel milk, milk collected from Anand and Kheda has more SNF than that of Kutchh. The difference in SNF content of camel milk (Anand and Kheda) and that of the cow milk was statistically significant. Moreover, the SNF content of camel milk (Kutchh) and that of the cow milk was also statistically significant. The difference in SNF content of both the camel milks i.e. Anand and Kheda and that of the Kutchh was statistically significant.

Table 3. SNF content of camel, cow and buffalo milk.

Type of milk	SNF content (%)
Camel (Anand and Kheda)	7.56±0.09
Camel (Kutchh)	7.04±0.14
Cow	8.39±0.07
Buffalo	8.97±0.08
SEM	0.100
CD (0.05)	0.280
CV%	7.32

SEM: Standard error of mean; CD: Critical difference (5% level significant); CV: Coefficient of variance.

Sankhla *et al* (2000) reported 9.1% SNF in Indian camel milk. Raghvendar *et al* (2004) observed 7 to 8% SNF in camel milk. Khanna (1986) found 8.9% SNF in Indian camel milk.

Park *et al* (2007) reported 9.0% SNF in cow milk. The average SNF per cent of buffalo milk from different countries like Bulgarian, Carabaos, Caucasian, Chinese, Egyptian, Hungarian, Italian, Murrah (Indian), Rumanian, Russian, Sichun are known to be 9.9, 11.2, 9.8, 10.6, 10.0, 9.0, 10.2, 10.0, 10.0, 10.5 and 12.1%, respectively (Rao and Nagarcenkar, 1977).

The data obtained in present study for average SNF content of camel milk was in general agreement with those reported in the reviewed literature. Similarly, the data obtained for average SNF content of cow and buffalo milk were also in general agreement with those reported in the literature for cow and buffalo milk, respectively.

Protein

Milk protein varies considerably among species but as not as much as milk fat. Generally, percent protein content of milk is positively correlated with its per cent fat content. In the present investigation, protein content of camel, cow and buffalo was determined by Kjeldahl method. The average data obtained for protein content of all types of milk along with their statistical analysis are presented in table 4.

Among camel milk, milk collected from Anand and Kheda has more protein than that of Kutchh. The difference in protein content of camel milk (Anand

and Kheda) and that of the cow milk was statistically significant with cow milk. Moreover, the protein content of camel milk (Kutchh) and that of the cow milk was also statistically significant with cow milk. The difference in protein content of both the camel milks i.e. Anand and Kheda and that of the Kutchh was statistically significant.

Table 4. Protein content of camel, cow and buffalo milk.

Type of milk	Protein content (%)
Camel (Anand and Kheda)	3.00±0.06
Camel (Kutchh)	2.66±0.07
Cow	3.32±0.04
Buffalo	3.87±0.06
SEM	0.059
CD (0.05)	0.164
CV%	10.67

SEM: Standard error of mean; CD: Critical difference (5% level significant); CV: Coefficient of variance.

Khanna (1986) reported 2.0 to 5.5% protein in Indian camel milk. Sankhla *et al* (2000) observed 3.4% protein in Indian milk. Raghvendar *et al* (2004) found 2.1 to 2.5% protein in Indian camel milk.

The milk of Somalian and Kenyan dromedaries contained 2.7 to 4.5% protein (Schwartz, 1992). Serikabeva *et al* (2000) observed total protein was 4.45% in Kazakhstan. Attia *et al* (2001) observed that total protein 2.81% in Tunisia camel milk.

Protein content in milk of various species of cow like Ayrshire, Brown Swiss, Guernsey, Holstein, Jersey, Zebu were found to be 3.6, 3.6, 3.8, 3.1, 3.9 and 3.9%, respectively (Altman and Dittmer, 1961).

The average protein% of buffalo milk from different countries like Bulgarian, Carabaos, Caucasian, Chinese, Egyptian, Hungarian, Italian, Murrah (Indian), Rumanian, Russian, Sichun, are known to be 4.3, 6.0, 4.0, 6.0, 4.2, 3.6, 4.3, 4.1-4.5,4.8, 4.8 and 5.2%, respectively (Rao and Nagarcenkar, 1977).

The data obtained in present study for average protein content of camel milk was in general agreement with those reported in the literature for milk obtained from dromedary camel in India. The data are also in general agreement with those reported for camel milk obtained from exotic dromedary camel at abroad protein content in camel milk. Similarly, the data obtained for average protein content of cow and buffalo milk were also in general agreement with those reported in the literature for cow and buffalo milk, respectively.

Lactose

The average data obtained for lactose content of all types of milk along with their statistical analysis are presented in Table 5.

Among camel milk, milk collected from Anand and Kheda has more lactose than that of Kutchh camel. The difference in lactose content of camel milk (Anand and Kheda) and that of the cow milk was statistically significant with cow milk. Moreover, the lactose content of camel milk (Kutchh) and that of the cow milk was also statistically significant with cow milk. The difference in lactose content of both the camel milks i.e. Anand and Kheda and that of the Kutchh camel was statistically significant.

Table 5. Lactose content of camel, cow and buffalo milk.

Type of milk	Lactose content (%)
Camel (Anand and Kheda)	4.25±0.05
Camel (Kutchh)	3.77±0.06
Cow	4.42±0.03
Buffalo	4.70±0.05
SEM	0.050
CD (0.05)	0.139
CV%	6.746

SEM: Standard error of mean; CD: Critical difference (5% level significant); CV: Coefficient of variance.

Sankhla *et al* (2000) has analysed the camel milk produced in south Rajasthan and found the average percentage of lactose 4.62%. Raghvendar *et al* (2004) observed 3.8-4.3% lactose in camel milk. The milk of Somalian and Kenyan dromedaries camel contained 5.5% lactose (Schwartz, 1992).

Lactose content in milk of various species of cow like Ayrshire, Brown Swiss, Guernsey, Holstein, Jersey, Zebu are found to be 4.7, 5.0, 4.9, 4.9, 4.9 and 5.1%, respectively (Altman and Dittmer, 1961).

The average lactose content of buffalo milk from different countries like Bulgarian, Carabaos, Caucasian, Chinese, Egyptian, Hungarian, Italian, Murrah (Indian), Rumanian, Russian, Sichun, are known to be 4.8, 4.3, 5.2, 3.7, 4.9, 4.6, 5.0, 5.1, 4.5, 4.8 and 6.1% respectively (Rao and Nagarcenkar, 1977).

The data obtained in present study for average lactose content of camel milk was in general agreement with those reported in the literature for milk obtained from dromedary camel in India. The data are also in general agreement with those reported for camel milk obtained from exotic dromedary camel at abroad lactose content in camel milk. Similarly, the data obtained for average lactose content of cow milk were

also in general agreement with those reported in the literature for the cow. In the literature lactose content in buffalo milk is reportedly higher than that in camel milk as well as cow milk. However, in present study, buffalo milk was found to contained lower lactose compared to camel milk as well as cow milk. In fact the pattern of low lactose in buffalo milk compared to cow milk is also generally observed during the practical classes conducted in this laboratory.

Ash

The average data obtained for ash content of all types of milk along with their statistical analysis are presented in table 6.

Table 6. Ash content of camel, cow and buffalo milk.

Type of milk	Ash content (%)
Camel (Anand and Kheda)	0.71±0.01
Camel (Kutchh)	0.84±0.02
Cow	0.68±0.01
Buffalo	0.69±0.01
SEM	0.014
CD (0.05)	0.040
CV%	11.353

SEM: Standard error of mean; CD: Critical difference (5% level significant); CV: Coefficient of variance.

The camel milk had the highest ash content, which was followed by buffalo milk and cow milk. Among camel milks, milk collected from Kutchh has more ash content than that of Anand and Kheda camel. The difference in ash content of camel milk (Anand and Kheda) and that of the cow and buffalo milk were statistically not significant. The difference in ash content of camel milk (Kutchh) and that of the cow and buffalo milk were statistically significant. The difference in ash content of both the camel milks i.e. Anand and Kheda and that of the Kutchh camel was statistically significant.

Khanna and Rai (1993) reported 0.35 to 0.95% ash in Indian camel milk. Sankhla *et al* (2000) observed that 0.78% ash in Indian camel milk. Serikabeva *et al*(2000) reported that ash was 0.68% in Kazakhstan camel milk. Attia *et al* (2001) observed that ash was 0.99% in Tunisia camel milk. Sela *et al* (2003) observed that ash was 0.78% in Israeal camel milk. Kouniba *et al* (2005) found 0.83% ash in Morocco.

Ash content in milk of various species of cow like Ayrshire, Brown Swiss, Guernsey, Holstein, Jersey, Zebu are found to be 0.7, 0.7, 0.7, 0.7, 0.7 and 0.8% respectively (Altman and Dittmer, 1961). Park *et al* (2007) reported 0.7% ash in cow milk.

The average ash content of buffalo milk from different countries like Bulgarian, Carabaos, Caucasian, Chinese, Egyptian, Hungarian, Italian, Murrah (Indian), Rumanian, Russian, Sichun , are known to be 0.8 , 0.8, 0.7, 0.9 , 0.8, 0.8, 0.8, 0.8, 0.8, 0.9 and 0.8% respectively (Rao and Nagarcenkar, 1977)

The data obtained in present study for average ash content of camel milk was in general agreement with those reported in the literature for milk obtained from dromedary camel in India. The data are also in general agreement with those reported for camel milk obtained from exotic dromedary camel at abroad ash content in camel milk. Similarly, the data obtained for average ash content of cow and buffalo milk were also in general agreement with those reported in the literature for cow and buffalo milk respectively.

Chloride

The average data obtained for chloride content of all types of milk along with their statistical analysis are presented in table 7.

The camel milk had the highest chloride content, which was followed by buffalo milk and cow milk. Among camel milks, milk collected from Kutchh has more chloride content than that of Anand and Kheda. The difference in chloride content of camel milk (Anand and Kheda) and that of the cow and buffalo milk were statistically significant. The difference in chloride content of camel milk (Kutchh) and that of the cow and buffalo milk were statistically significant. The difference in chloride content of both the camel milks i.e. Anand and Kheda and that of the Kutchh was statistically significant.

Table 7. Chloride content of camel, cow and buffalo milk.

Type of milk	Chloride content (%)
Camel (Anand and Kheda)	0.20±0.00
Camel (Kutchh)	0.25±0.01
Cow	0.11±0.00
Buffalo	0.12±0.00
SEM	0.004
CD (0.05)	0.010
CV%	12.83

SEM: Standard error of mean; CD: Critical difference (5% level significant); CV: Coefficient of variance.

The variations observed in camel milk composition could be attributed to several factors such as analytical measurement procedures, geographical locations, feeding conditions and samples being taken from different breeds, in addition

to other factors including stage of lactation, age, and calving number (Khaskheli *et al,* 2005). Geographical origin and seasonal variations were found to be the most effective factors in camel milk composition. Konuspayeva *et al* (2009) have studied the effect of geographical origin on camel milk composition and shown that the milk composition from camels living in East Africa have higher fat content than the milk from camels living in Africa and western Asia. Variation in camel milk composition was also observed for camels from the same species but domesticated in different parts of the world (Mehaia *et al,* 1995).

Seasonal variations were also found to play a role in camel milk composition even for camels from the same species and regions (Bakheit *et al,* 2008). An inverse relationship was found between total solids in camel milk and water intake by camels. In one study, all components except lactose reached their maxima in mid-winter and were lowest in summer. For example, total solids were 13.9% in December and January, and 10.2% in August due to availability of drinking water (Haddadin *et al,* 2008). In another study, the fat content of camel milk was reported to decrease from 4.3 to 1.1% due to the increase in water content of milk produced by thirsty camels (Yagil and Etzion, 1980). The increase in water content could be attributed to the decrease in total solids produced by the thirsty camels.

Conclusion

The present study entailed to conclude that the camel milk has lower TS, fat, SNF, protein and lactose content as compared to cow and buffalo milk, except that its lactose content is higher as compared to buffalo milk. The camel milk was high in ash content compared to cow milk and buffalo milk. The camel milk had the highest chloride content than other milk. Among camel milk, milk collected from Kutchh has more chloride content than that of Anand and Kheda.

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