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EFFECT OF COAGULANTS ON PREPARATION OF CAMEL MILK PANEER

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ABSTRACT

The study was aimed at preparation of camel milk paneer by using different coagulants and evaluation of organoleptic characteristics of camel milk paneer prepared from different coagulants. Different percentages of citric acid and $CaCl_2$ were used. The paneer made from whole camel milk and precipitated with 0.5-1.0% citric acid along with 0.1-0.2% $CaCl_2$ effectively increased the binding of camel milk coagulum and the yields were found to vary between 9.0-10.0%. Highest taste and overall acceptability scores were observed for the paneer prepared by using 1.0% citric acid+0.1% $CaCl_2$. The moisture and fat content in camel milk paneer were 51.24±5.21% and 18.52±3.40%, respectively. Camel milk paneer can be stored upto 28 days at 4°C without any colour change.

Key words: Camel milk, coagulants, evaluation, paneer

The camel is an important component of the dry land and desert ecosystem. It is not only an important economical means of short distance transport to the rural and urban societies inhabiting arid and semi-arid zones; but also serves as a source for milk in some segments of the camel rearing society namely "Raikas/ Rabaris" since centuries. Camel milk is supposed to have nutritive (Knoess, 1984) as well as medicinal properties (Yagil, 2000).

Indian camel can produce milk up to 6.73±0.27 kg/day (Sahani *et al,* 1998) most of which is utilised fresh. Value additions of camel milk can be an alternative to enhance its utility and bye-products can be prepared to prolong its shelf life and facilitate transportation. Camel milk is reported to be difficult for processing into cheese (Yagil, 2000). As such, processing as paneer acquires greater relevance in the Indian context. The objective of this study was to standardise and characterise the manufacturing procedure for the preparation of paneer from camel milk and its sensory evaluation.

Materials and Methods

Experiments were carried out for the preparation of camel milk paneer and the protocol for making camel milk paneer (Ramasamy *et al,* 1999) was standardised with slight modifications. Each observation was repeated three times to get a definite conclusion. Fresh whole camel milk was obtained from NRCC dairy farm and was stored at refrigeration until use. Milk samples were filtered and heated to 82°-85°C for 5 minutes and cooled to 70°C. Different concentrations of citric acid and $CaCl_2$ solutions were added to the camel milk as coagulants. $CaCl_2$ was always added prior to citric acid as established (Mohamed *et al,* 1989). Four methods were used to manufacture paneer from whole camel milk (Table 1). One method utilised whole milk in 4 aliquots with addition of 0.5, 1.0, 1.5 and 2.0% citric acid. The second method utilised camel milk+cow milk in the ratios of 4:1, 3:1, 2:1 and 1:1 containing 0.5, 1.0, 1.5 and 2.0% citric acid. In the third method, whole camel milk was allowed to coagulate with 0.5% citric acid with different proportions of $CaCl_2$ varying from 0.01%, 0.02%, 0.04%, 0.08%, 0.10% and 0.20%. In fourth method, whole camel milk was allowed to coagulate with 1.0% citric acid with different proportions of $CaCl_2$ as described for third method. The milk was kept on continuous agitation for 15 minutes and allowed to settle down for 2-3 h without agitation. The coagulated material was collected in four layered muslin cloth and pressed by placing a suitable weight for 30 minutes. Afterward, weight was removed and immersed in chilled water. After draining the water, the coagulated product, paneer was weighed and stored at refrigerated temperature for further evaluation.

Milk samples were analysed for pH (Systronic pH System 361). Moisture and fat per cent were determined as per AOAC (1980). Sensory evaluation of paneer was done after one day of storage and

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Table 1. Observations on texture and recovery of paneer from camel milk using different combinations/concentrations of coagulants.

Source	Coagulants	Texture of the final product	Observations
Whole camel milk	citric acid 0.5%, 1.0%, 1.5%, 2.0%	Loosely bound	Recovery: 6.4-6.8%Turning yellow after 15 days at 4°C
Camel milk+ cow milk (4:1, 3:1, 2:1, 1:1)	citric acid 0.5%, 1.0%, 1.5%, 2.0%	Loosely bound	Recovery: 6.5-8.0% Turning yellow after 15 days at 4°C
Whole camel milk	citric acid+$CaCl_2$ 0.5%+0.01%, 0.5%+0.02%, 0.5%+0.04%, 0.5%+0.08%	Loosely bound	Recovery: 7.5-8.5%No colour change up to 21 days at 4°C
	0.5%+0.10%,	Good binding	Recovery: 9.3-9.5%No colour change up to 28 days at 4°C
	0.5%+0.20%	Good binding	Recovery: 9.5-10.0%No colour change up to 28 days at 4°C
Whole camel milk	citric acid+$CaCl_2$ 1.0%+0.01%, 1.0%+0.02%, 1.0%+0.04%, 1.0%+0.08%	Loosely bound	Recovery: 7.5-8.5%No colour change up to 21 days at 4°C
	1.0%+0.10%	Good binding	Recovery: 9.0-9.5%No colour change up to 28 days at 4°C
	1.0%+0.20%	Good binding	Recovery: 9.5-9.8% No colour change up to 28 days at 4°C

evaluated by 7 people who were familiar with paneer. Sensory attributes of smell, color, body, taste and overall acceptability were recorded by using hedonic scale (Larmond, 1977). Sensory attributes were analysed statistically by using t-test for significance (Snedecor and Cochran, 1994).

Results and Discussion

Different concentrations of coagulants used for the preparation of camel milk paneer are given in Table 1. The process of making paneer from the camel milk by using citric acid and $CaCl_2$ for the coagulation is shown in Fig 1 (A-F). When 0.5% citric acid used for the coagulation, coagulum retains the higher amount of whey as evident from Fig 1A. The coagulated mass was found to be loosely bound even after increasing the concentration of citric acid from 0.5%-2.0% with pure camel milk (Fig 1B). By using camel and cow milk mixed in different proportions along with varying concentrations of citric acid, the coagulum still remained loosely bound (Fig 1C). But, an increase in the yield of coagulated product was observed i.e. 6.5-8.0% with camel+cow milk versus 6.4-6.8% with whole camel milk alone (Table 1). Further, for coagulation, along with 0.5% citric acid, 0.01-0.2% $CaCl_2$ was used. No significant effect was observed on the binding of coagulated product after addition of various percentages of $CaCl_2$ from 0.01-0.08%. It was noticed that the addition of 0.5% citric acid+ 0.1 or 0.2% $CaCl_2$, whey separated clearly and coagulum settled to bottom as shown in Fig 1D. It was also found that 0.1-0.2% $CaCl_2$ along with 0.5% citric acid effectively increased the binding of camel milk coagulum and it can be cut into blocks (Fig 1E). No effect of $CaCl_2$ up to the levels of 0.01-0.08% added was observed on binding, despite increasing the concentration of citric acid from 0.5 to 1.0%. When 1.0% citric acid was used in combination with 0.1 or 0.2% $CaCl_2$, again good binding was observed (Fig 1F). However, a slight decrease in recovery was observed with 1.0% citric acid+ 0.1-0.2% $CaCl_2$ in comparison to 0.5% citric acid+ 0.1-0.2% $CaCl_2$ (Table 1), which was found to range between 9.0-9.8% and 9.3-10.0%, respectively. Initial pH of the whole camel milk cooled to 70°C was 6.4-6.6, after addition of 0.1-0.2% $CaCl_2$, pH reduced to 5.8-6.0 and it further came down to 4.0-4.5 when 0.5-1.0% citric acid was added.

This study revealed that the concentration of Ca played a pivotal role for the effective coagulation and preparation of paneer from the camel milk. The main role of calcium in milk clotting process may be due to the fact that camel milk supplemented with calcium salts significantly decreases the clotting time and increases gel strength of the casein micelle network (Ould Eleya and Ramet, 1994). The presence of soluble calcium such as $CaCl_2$ is essential to complete the secondary phase of the coagulation process that leads to curd formation (Ramet, 1994).

The yield of paneer also depends upon the fat content in the milk. As camel milk contains 2.60-3.20% fat (Mal *et al,* 2007), so the yield of paneer is less. A yield of 19.78% was observed from buffalo milk having 6% fat (Kumar *et al,* 2008). The $CaCl_2$ along

Fig 1. (A) Precipitation of whole camel milk with 0.5% citric acid (B) Whole camel milk paneer coagulated with 1% citric acid (C) Camel and cow milk (1:1) paneer coagulated with 1% citric acid (D) Precipitation of whole camel milk with 0.5% citric acid+ 0.2% $CaCl_2$ (E) Whole camel milk paneer prepared with 0.5% citric acid+ 0.2% $CaCl_2$ and (F) Paneer from whole camel milk prepared with 1.0% citric acid+0.2% $CaCl_2$.

with citric acid as a coagulants gave better yield than the citric acid alone. This may be due to the fact that the $CaCl_2$ because of its chemical nature interacted better with the proteins in camel milk than citric acid alone used in terms of its proteins precipitating and coagulating ability.

Sensory evaluation was carried out for the paneer prepared from camel milk using four different proportions of citric acid and $CaCl_2$ (Table 2), as these combinations gave highest recovery of the product [0.5% citric acid+0.1% $CaCl_2$ (T_1), 0.5% citric acid+0.2% $CaCl_2$ (T_2) and 1.0% citric acid+0.1% $CaCl_2$ (T_3), 1.0%

Table 2. Average score in points of sensory evaluation of paneer made from camel milk using hedonic scale (9: most desirable, 5: optimum, 1: most undesirable); a, b: P< 0.05; T= treatment.

Coagulants	Smell	Body and texture	Taste	Overall acceptability
0.5% citric acid+0.1% $CaCl_2$ (T_1)	7.00^a±0.31	7.57^a±0.20	5.86^a±0.26	7.18^a±0.18
0.5% citric acid+0.2% $CaCl_2$ (T_2)	8.14^b±0.26	7.86^a±0.14	6.86^a±0.34	7.83^b±0.15
1.0% citric acid+0.1% $CaCl_2$ (T_3)	8.00^b±0.31	8.14^b±0.14	7.43^b±0.37	8.06^b±0.17
1.0% citric acid+0.2% $CaCl_2$ (T_4)	6.71^a±0.36	7.28^a±0.36	6.64^a±0.28	7.32^a±0.13

citric acid+0.2% $CaCl_2$ (T_4)]. The mean score for smell was 7.00±0.31, 8.14±0.26, 8.00±0.31 and 6.71±0.36 for the samples under T_1, T_2, T_3 and T_4, respectively. Sensory score for smell under T_1 and T_4 differed significantly (P<0.05) compared to T_2 and T_3 and the values for paneer prepared with T_2 and T_3 were at par. It is observed that the average score for body and texture of camel milk paneer was 7.57±0.20, 7.86±0.14, 8.14±0.14 and 7.28±0.36 for the samples under T_1, T_2, T_3 and T_4, respectively. Paneer prepared with T_3 differed significantly (P< 0.05) in body and texture compared to others. The mean score for taste was 5.86±0.26, 6.86±0.34, 7.43±0.37 and 6.64±0.28 for the samples under T_1, T_2, T_3 and T_4, respectively. Paneer prepared with T_3 differed significantly (P< 0.05) in taste compared to others. Overall acceptability was 7.18±0.18, 7.83±0.15, 8.06±0.17 and 7.32±0.13 for the samples under T_1, T_2, T_3 and T_4, respectively. Overall acceptability scores were significantly higher (P<0.05) for T_2 and T_3 compared to T_1 and T_4. Highest scores for body and texture, taste and overall acceptability were observed for the paneer prepared by using 1.0% citric acid+0.1% $CaCl_2$ (T_3) and sensory score for smell was almost similar to that of the paneer made with 0.5% citric acid+0.2% $CaCl_2$ (T_2).

The moisture and fat content of the paneers were 51.24±5.21% and 18.52±3.40%, respectively. Camel milk and milk products are gaining an escalated popularity and acceptance for human consumption (Wernery, 2006; Goyal and Bishnoi, 2007).

The results of the present investigation apparently lead to the conclusion that 0.5-1.0% citric acid along with 0.1-0.2% $CaCl_2$ yields a good quality and acceptable paneer with a recovery of 9-10%. Camel milk paneer can be kept for 28 days at refrigerated temperature. However, more research is needed to improve the yield of camel milk paneer.

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