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Effect of calcium chloride on the preparation of paneer from goat milk

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Abstract
The present study was conducted on goat milk paneer using $CaCl_2$ to estimate the effect of $CaCl_2$ in term of quantity of coagulant (1% citric acid solution) used and quantity of whey received during preparation of goat milk paneer and on sensory quality (General appearance, Taste and flavour, Body and texture and Overall acceptability) and yield of goat milk paneer. Different levels of calcium chloride in goat milk for preparation of paneer were used like C_0 (control), C_1 (0.08%), C_2 (0.10%) and C_3 (0.12%). The statistical analysis of data revealed significant ($P<0.05$) effect on quantity of coagulant used during preparation of paneer and sensory quality of paneer due to treatment in all group. Quantity of whey received during preparation of paneer and yield of paneer ($P>0.05$) were not affected by $CaCl_2$. A level of calcium chloride 0.10 percent was found to be best suited, because it resulted in good quality goat milk paneer.

Keywords: Goat milk, calcium chloride, paneer, yield, sensory quality

1. Introduction
Livestock sector plays an important role in India economy. Goats are important part of livestock industry and play a crucial role in the socio-economic structure of marginal farmers in India. India possess 148.88 million goats and is ranked second in the world in terms of goat population (Basic Animal Husbandry Statistics, 2019) [6]. Total milk production in India is 187.7 million tone and goat milk contribution is 3 percent of total milk production in India (Basic Animal Husbandry Statistics, 2019) [6]. Goat milk has been recommended as an ideal substitute for cow and human milk (Zenebe *et al.*, 2014) [15].Goat milk can be used to prepare a wide variety of dairy products as paneer, cheese, butter, ice-cream, butter milk, condensed milk, yoghurt, flavoured milk, sweets and candy (Fazilah *et al.*, 2018) [4]. The growing consumer interest in goat's milk and its dairy products is related to the nutritional benefits offered by these products (Clark & Gacia, 2017) [2]. Good quality paneer is characterized by a marble white color, sweetish, mildly acidic taste, nutty flavour, spongy body and closely knit smooth texture (Patel, 1991) [9]. Enriching milk and dairy products with calcium is a common practice today. Calcium supplementation of milk is usually achieved by adding soluble calcium salts such as calcium chloride, calcium lactate and calcium gluconate, or less-soluble calcium salts like calcium carbonate and calcium citrate (Singh et al. 2007; Omoarukhe et al. 2010) [12, 8]. The present research work was carried out as an attempt to utilize goat milk for the preparation of paneer, a value added product. In order to estimate the effect of $CaCl_2$ in term of quantity of coagulant used and quantity of whey received during preparation of goat milk paneer and on sensory quality and yield of goat milk paneer, different level of calcium chloride were used for its preparation and better suited level of calcium chloride are selected for paneer preparation from goat milk.

2. Materials and Methods
2.1 Procurement of milk: Goat milk was procured from livestock research station, Bojunda, Chittorgarh and standardized to 5 percent fat for preparation of paneer.

2.2 Additives used: Different levels of calcium chloride in goat milk were used as additives like C_1 (0.08%), C_2 (0.10%) and C_3 (0.12%) to preparation of paneer. The product was prepared by the process suggested by Sachadeva and Singh (1988) [10]. The standardized goat milk was added with calcium chloride and heated to 90 °C than subsequently cooled to 85 °C

and add 1 percent citric acid solution as coagulant slowly with continuous agitation till clear whey separated out. The curd was left for 5-10 minutes in the whey and then drained through muslin cloth and pressed in a hoof at 2-3 kg/cm2 pressure. Paneer block was dipped in chilled water for 5-10 minute and packaged in pre-sterilized LDPE pouches and stored at 5 °C.

2.3 Yield of goat milk paneer: The yield of goat milk paneer obtained was weighed and recorded as per cent yield of the milk used for preparation of goat milk paneer in each treatment.

2.4 Sensory analysis of paneer: The paneer prepared under different treatments during the course of the investigation was subjected to the sensory evaluation by a panel of five judges from the Department of Livestock Products Technology and Department of Veterinary Public Health by using the procedure described in IS 6273 (Part II) (1971) [7]. The product was judged for different quality attributes by 9 point Hedonic scale (Amerine *et al*., 1967) [1] with suitable modifications.

2.5 Statistical analysis: Data were statistically analyzed by using the method described by Snedecor and Cochran (1989) [14].

3. Results and Discussion

To study the effect of calcium chloride, paneer was prepared from goat milk added with variuos level of calcium chloride using 1 percent citric acid solution as coagulant at 85 °C coagulation temperature.

3.1 Effect of calcium chloride on quantity of 1% citric acid solution used and quantity of whey received during preparation of paneer and yield of paneer.

The results of mean values of effect of calcium chloride on quantity of 1% citric acid solution used and quantity of whey received during preparation of paneer and yield of paneer are presented in Table 1

In control (C_0) values for quantity of citric acid (ml/L milk) used were differed significantly (p<0.05) with other level like C_1, C_2 and C_3. The C_0 value for quantity of citric acid (ml/L milk) used was significantly higher as compared to C_1, C_2 and C_3. However values for C_1 and C_2 treatments for quantity of citric acid (ml/L milk) used were non-significant. Values for C_3 treatment for quantity of citric acid used had the lowest value than C_1, C_2 and C_0. The present findings are similar to those reported by Dybing and Smith (1998) [3] for the effect of ability of calcium compounds during cheese manufacturer.

The difference in values of C_0, C_1, C_2 and C_3 for quantity of whey received were non-significant but all the values of a calcium chloride levels were more than control.

The yield of a paneer made using different calcium chloride fortification levels was comparable with one another but they had higher values than control. The present findings are in agreement with those of Singh and Kanawjia (1988) [13] who reported calcium helps in building the cross linkages during the formation of curd and thus helps in increasing the recovery of milk solids, yield and improves body and texture and overall acceptability scores of paneer. Hill *et al.* (1982) [5] recommended use of high temperature and $CaCl_2$ for getting better yield through co-precipitation of casein and whey proteins.

Table 1: Effect of calcium chloride on quantity of 1% citric acid solution used and quantity of whey received during preparation of paneer and yield of paneer.

Parameter	Quantity of citric used (ml/L milk)	Quantity of whey received (ml/L milk)	Yield (%)
C_0	106.40 a ±1.00	674.66±14.3	14.68±0.42
C_1	57.60 b ±2.46	706.00±5.6	16.89± 0.82
C_2	30.40b±3.10	701.33±2.88	16.09±0.48
C_3	22.66 c ±3.50	700.33±29.3	15.65±0.75

Each observation is a mean ± SE of three replicate experiment (n=3)
Mean in column bearing a common superscripts do not differ significantly (p<0.05).
Control (C_0): Without calcium chloride
C_1: With 0.08 % calcium chloride
C_2: With 0.10 % calcium chloride
C_3: With 0.12 % calcium chloride

3.2 Effect of calcium chloride on sensory quality of paneer prepared from goat milk

The results obtained are presented in Table 2 which represents the influence of various level of calcium chloride on the sensory attributes of experimental goat milk paneer *viz.* general appearance, taste and flavour, body and texture and overall acceptability.

3.2.1 General appearance: The mean value for general appearance for control (C_0) was 6.23±0.16 and for treatments group C_1, C_2 and C_3 were 7.00±0.02, 7.93±0.04 and 7.33±0.15 respectively. It is revealed that the score for general appearance with different level of calcium chloride differed significantly (p<0.05). The general appearance score for C_2 group was observed to be significantly higher than C_1 and C_0 while C_2 and C_3 were non-significant to each other.

3.2.2 Taste and flavor: The mean value for taste and flavor for control (C_0) was 6.00±0.16 and for treatments group C_1, C_2 and C_3 were 6.70±0.08, 7.50±0.01 and 6.86±0.16 respectively. It is revealed that the score for taste and flavour with different level of calcium chloride differed significantly (p<0.05). The taste and flavor score for C_2 group was observed to be significantly higher than all groups while group C_1 and C_3 were non-significant to each other and group C_0 and C_1 were non-significant to each other.

3.2.3 Body and texture and overall acceptability: The mean value body and texture for control (C_0) was 6.00±0.28 and for treatments group C_1, C_2 and C_3 were 7.03±0.13, 7.70±0.06 and 7.30±0.20 respectively. The mean value for overall acceptability for control (C_0) was 6.00±0.15 and for treatments group C_1, C_2 and C_3 were 7.06±0.07, 7.76±0.05 and 7.23±0.22 respectively. The score for body and texture and overall acceptability of a goat milk paneer treated with calcium chloride levels differed significantly (p<0.05). It is further noticed that values for body and texture and overall acceptability of all treatment significantly higher than C_0 but other levels i.e C_1, C_2, C_3 were non-significant to each other.

These above findings for general appearance, taste and flavor, body and texture and overall acceptability are in accordance with the observations of Singh and Kanawjia (1988) for the use of 0.10 percent calcium chloride in the manufacture of paneer from cow milk. Sachdeva *et al.* (1991) [11] observed that incorporation of 0.08% $CaCl_2$ in manufacture of cow milk paneer helped in improving the sensory score for appearance, flavour, body and texture compared to milk without added calcium salt.

On the basis of the study, it can be seen that sensory quality of paneer was affected significantly ($P<0.05$) by $CaCl_2$ and C_2 was preferred the most with respect to all the attributes studied from amongst all the experimental samples. A level of calcium chloride 0.10 percent was found to be best suited, because it resulted in good quality goat milk paneer (Table 2).

Table 2: The Effect of calcium chloride on sensory quality of goat milk paneer

Sensory attributes				
Parameter	**General appearance**	**Taste and flavor**	**Body and texture**	**Overall acceptability**
C_0	6.23 ^{c} ±0.16	6.00 ^{c} ±0.16	6.00 ^{b} ±0.28^{b}	6.00 ^{b} ±0.15
C_1	7.00 ^{b} ±0.02	6.70^{bc} ±0.08	7.03 ^{a} ±0.13	7.06 ^{a} ±0.07
C_2	7.93 ^{a} ±0.04	7.50 ^{a} ±0.10	7.70 ^{a} ±0.06	7.76 ^{a} ±0.05
C_3	7.33 ^{ab}±0.15	6.86 ^{b} ±0.16	7.30 ^{a} ±0.20	7.23 ^{a} ±0.22

Each observation is a mean ± SE of three replicate experiment (n=3)
Mean in column bearing a common superscripts do not differ significantly ($p<0.05$).
Control (C_0): Without calcium chloride
C_1: With 0.08 % calcium chloride
C_2: With 0.01 % calcium chloride
C_3: With 0.12 % calcium chloride.

4. Conclusion

On the basis of the results obtained in the experiment, it is concluded that Quantity of whey received during preparation of paneer and yield of paneer (P>0.05) were not affected by $CaCl_2$. Quantity of coagulant used during preparation of paneer and sensory quality of paneer were significantly ($P<0.05$) affected by $CaCl_2$. A level of calcium chloride 0.10 percent was found to be best suited, because it resulted in good quality goat milk paneer**.**

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