Effect of Different Coagulants on the Quality of Paneer Made from Cow Milk

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Abstract- This study was carried out to develop paneer with four different coagulants (Lime juice, Vinegar, Curd and Citric acid) using cow milk. Developed paneer were stored at 4 ^{0}C for 5 days and titratable acidity and pH were tested during the storage. Nutritional composition and microbial counts of paneer were analysed. Sensory evaluation was done for fresh paneer samples using five point hedonic scale. Titratable acidity and pH of paneer became significantly different *(p<0.05)* with storage time and they were in acceptable range, up to 4 days of storage at 4^{0}C. Moisture, total solids, fat and ash contents of paneer did not significantly differ *(p>0.05)* with different coagulants. However, yield of paneer was significantly affected *(p<0.05)* by the coagulant and paneer prepared with curd reported the highest yield. Developed paneer was negative for pathogenic micro-organisms. According to the sensory evaluation, coagulants significantly influenced *(p<0.05)* the sensory attributes and paneer produced from citric acid received a higher rank for overall acceptability. Results of this study indicated that, paneer produced from cow milk with citric acid can be recommended as the best product.

Index Terms- Coagulants, Cow milk, Paneer, Storage, Whey

I. INTRODUCTION

Cow milk plays an important role in human nutrition since milk is one of the primary sources of nutrients in diets. In addition, milk contains various properties, which make it easy to convert into different milk products or to use it as an ingredient for other food items [1]. Various human cultures have their own traditional ways of using milk and preparing different milk products. Paneer is a popular Indian soft cheese variety and nutritious and indigenous, dairy products, which occupy a prominent place among traditional milk products. According to the PFA [2], paneer means "product obtained from cow or buffalo milk or combination thereof, by precipitation with sour milk, lactic acid or citric acid". Paneer has a fairly high levels of fat, moisture, protein and low levels of lactose and minerals [3]. It is used as the base material for the preparation of a large number of culinary dishes and it is a popular food product at the household level. Paneer is a rich source of animal protein available at a comparatively lower cost and forms important source of animal protein for vegetarians. Over and above its high protein content and digestibility, the biological value of protein in paneer is in the range of 80 - 86% [4].

Whey is a valuable by-product obtained during manufacture of paneer. It contains precious nutrients like lactose, whey protein, minerals and vitamins. These nutrients have an indispensable value in human dietary requirement [5]. Consumption of the whey can supplement much of the lost organic and inorganic nutrients to the extra cellular fluid and utilization of these fluids can be targeted to the people working with strenuous occupation like sportsman, body builders, competitive athletes, exercising for pleasure and other people with similar kind of activity [6].

Paneer is a vegetarian food item and there is a growing demand in the world for vegetarian food items at present. Even though paneer is highly nutritious with low production cost, it is not popular among Sri Lankans. Paneer can be easily manufactured using locally available coagulants at household level. Normally, buffalo milk is used to produce paneer and several researchers worked on producing paneer with cow milk. Therefore, aim of this study was to develop paneer with locally available coagulants such as lime juice, vinegar, curd and citric acid using cow milk and to evaluate the chemical composition of paneer whey.

II. METHODOLOGY

Raw materials

Fresh cow milk was obtained from the Livestock Farm, Veterinary Research Institute, Gannoruwa, Peradeniya, Sri Lanka. Four different coagulants; lime juice (citric acid), vinegar (acetic acid), curd (lactic acid) and citric acid were purchased from a local market.

Preparation of paneer

The average amount of coagulants required for coagulation was calculated from a preliminary study. Four replicates of paneer were prepared with each coagulant following the paneer production steps reported by Rao, et al. [7]. One litre of fresh cow milk was used in each replicate.

Milk was heated separately up to 90^{0}C for 10 min in a stainless steel vat. The heated milk was allowed to cool to 70^{0}C and hot solutions of coagulants were added for each litre of milk with continuous stirring until there was a complete coagulation with clear whey separation. The coagulant curd was allowed to settle down for 5 min and the whey was allowed to drain using a

muslin cloth. The curd was transferred to hoops lined with muslin cloth and pressed (40 g / cm^2 for 10 min) to obtain a compact block of paneer. Then the yield of paneer was measured. The pressed block of curd was immersed in chilled water (4 - 5^0C) for about 2 hrs. Then the product was removed from the chilled water and allowed to drain out the excess water. The paneer blocks were wrapped in polythene sheets and stored in the refrigerator at 4^0C.

Each replicate was divided into equal portions (25 ± 3 g) and used for the evaluation of sensorial, physico-chemical, and microbial properties and shelf life.

Sensory evaluation

Prepared paneer samples were stored in a refrigerator and used for sensory evaluation in the next day. Each fresh paneer sample was evaluated using 30 non-trained (age = 22 – 25 yrs., sex = male and female) panellists for appearance, flavor, taste, texture and overall acceptability using a five-point hedonic scale.

Physico-chemical analysis

Paneer samples and whey were analyzed for various physico-chemical parameters viz., moisture, total solids and ash by gravimetric method, fat by Gerber method, pH by digital pH meter and titrable acidity by standard procedure described in AOAC [8]. Paneer was evaluated for moisture, fat and ash as described in AOAC [8]. The pH of paneer was determined by using a pH meter as the method described by Arora and Gupta [9].

Shelf Life and microbiological analysis

The developed paneer was stored in the refrigerator and analysed for changes in titratable acidity and pH immediately after preparation and at regular intervals in storage up to 5 days. Further, fresh paneer samples were analysed for desirable and undesirable (*E. coli*, yeast and mould counts) microorganisms by agar plate methods to assess the shelf life of the developed paneer.

Required amount of culture media (MPCA for bacteria, PDA for Yeast and mould, McConkey agar for *E. coli*) was taken according to the prescription and sterilized by autoclaving at 121^0C for 15 min. Fifteen millilitres of prepared media were poured into petri dishes and allowed to solidify at ambient temperature. One gram of paneer sample was added into 9 mL peptone solution and mixed up (10^{-1} dilution). One millilitre from 1st dilution was transferred into the tube with 9 mL peptone solution and 2nd dilution was obtained (10^{-2} dilution). Then, 0.1 mL of samples from each and every dilution were poured into the petri dishes and spread. After that, dishes were transferred into the incubator and kept for overnight at 37^0C and colonies were counted. Amount of colonies in 1 g of sample was reported.

Statistical analysis

Parametric data were analysed by one way Analysis of Variance (ANOVA) in Statistical Analysis Software [10]. Means were separated by Tukey's Studentized Range Test (TSRT). Sensory data were analysed by Friedman non-parametric test in MINITAB 16.1.0 software package [11] with 95% confidence interval.

III. RESULTS AND DISCUSSION

pH of coagulants

Several coagulants for making paneer; namely lemon juice, citric acid, tartaric acid, lactic acid, malic acid, hydrochloric acid, phosphoric acid, acetic acid, fermented milk, sour/cultured whey, yoghurt, and lactic cultures have been tested successfully by Kumar, et al. [12] and Sachdeva and Singh [13]. In this study, lime juice, vinegar, curd, and citric acid were used as coagulants to produce paneer and their pH were 2.21 ± 0.001 , 2.72 ± 0.001, 4.01 ± 0.002 and 1.25 ± 0.001 , respectively. Accordingly, citric acid was more acidic compared to the curd. Khan and Pal [14] reported that the strength of coagulant has an effect on the body and texture of paneer. Low acid strength results in soft body and smooth texture, while high acid strength results in hard body. Confirming their findings, paneer developed with curd yielded a soft body and a smooth texture due to the low acid strength of curd and paneer developed with citric acid showed a hard body texture due to the high acid strength of citric acid [14].

Nutritional composition of fresh cow milk

Total solid (11.4 ± 1.4%), fat (2.65 ± 0.35%) and ash (0.52 ± 0.01%) contents of cow milk used in this study were in line with the findings of Enb, et al. [15]. Further, moisture content, pH and titrable acidity in cow milk used in this study were observed as 88.6 ± 1.7%, 6.63 ± 0.02 and 0.16 ± 0.001, respectively.

Sensory qualities of paneer

Paneer made with four types of coagulants showed a significant difference *($p < 0.05$)* for sensory attributes such as flavour and overall acceptability while appearance, taste and texture did not significantly different *($p>0.05$)*. Paneer developed with citric acid in this study also obtained better preferences (Figure 1). Rajashekar, et al. [16] reported that, paneer developed with citric acid yield superior paneer. Milk fat exerts significant effect on the organoleptic qualities of paneer. Hence, quality of paneer depends upon the quality of milk from which it was made. Though cow milk was used in our study, it contained 2.65% milk fat in average. The developed paneer with citric acid gave highest acceptable organoleptic qualities. However, Arya and Bhaik [17], observed less softness and flavour in paneer made from cow milk (2.2% fat).

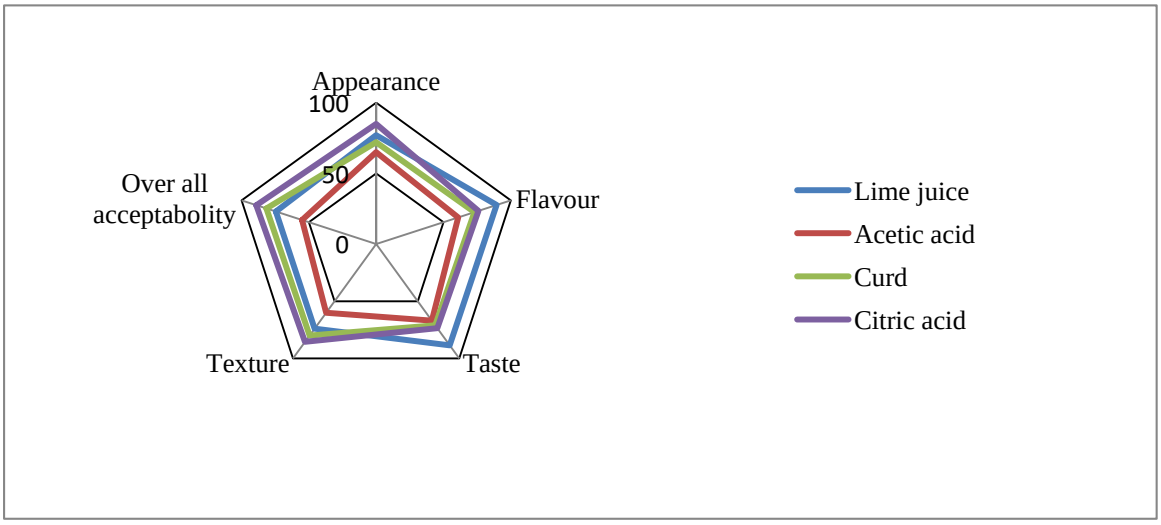

Figure 1: Sensory qualities of paneer developed with different coagulants

Yield and nutritional composition of developed paneer

Yield of paneer developed from cow milk with different coagulants was significantly different *(p > 0.05*, Table 1). Paneer developed with curd had a significantly higher yield compared to those developed with other three coagulants. Yield of paneer is dictated by the composition of milk, given heat treatment, type and strength of coagulant, losses incurred after coagulation (based on pH and temperature of coagulation), and moisture content of resultant paneer after pressing [13, 18]. Therefore, observed differences in yield could be due to type and strength of coagulants used in the present study.

Moisture content, total solids, and fat content of paneer did not significantly differ *(p > 0.05)* with the type of coagulant used (Table 1). With contrast to our findings, Arya and Bhaik [17] reported that the fat content of paneer changes with different coagulants. Further, the observed total solids, fat and ash contents of paneer in the study were little less compared to the values reported by Masud, et al. [19] who prepared paneer using cow milk in which lactic acid was used as the coagulant.

Table 1: Yield and nutritional composition of paneer developed with different coagulants

Parameter	Treatments				SE*
	Lime juice	Vinegar	Curd	Citric acid	
Yield (g)	132^{b}	134^{b}	166^{a}	120^{b}	18
Nutritional composition (%)					
Moisture	55.93	64.15	54.30	52.68	8.77
Total solids	44.07	44.29	45.69	47.32	4.3
Fat	19.83	20.00	21.88	21.63	4.83
Ash	1.58	1.79	1.91	1.23	0.54
Microbial counts (cfu)					
Total plate count	42×10^{3}	5×10^{3}	40×10^{2}	57×10^{2}	
Yeast & mould count	7×10^{1}	-	2×10^{2}	1×10^{2}	
E. coli	-	-	-	-	

^{a,b} means within the same row with different superscripts are significantly different *(p< 0.05)*
* Standard error of means

Physico-chemical changes in developed paneer

The pH and titratable acidity of developed paneer were significantly affected *(p<0.05)* by different coagulants (Figure 2 and 3). Further, there might be an interactive effect of treatments and storage time on pH and titratable acidity and they were within the acceptable range up to 4 days of storage at 4^{0}C. In most of the developed paneer, pH decreased with storage time. In general, microbial count increases with the time and these microbes ferment lactose in to acid [20]. Therefore, with the time, acidity level increases and pH decreases.

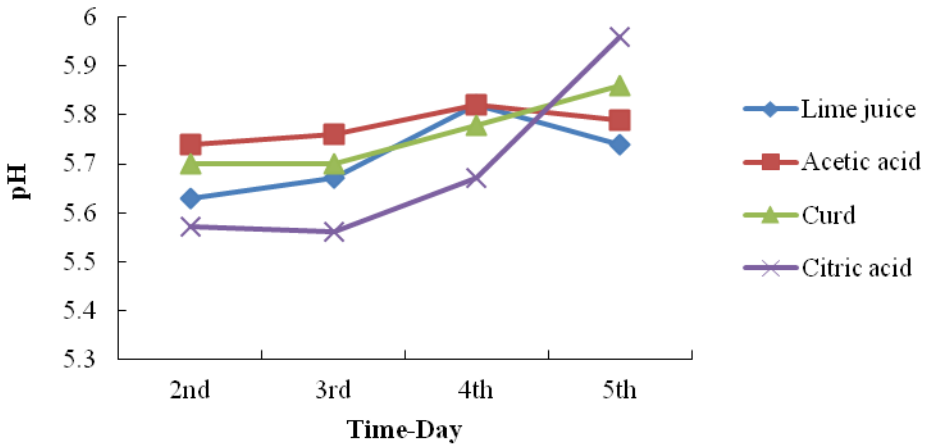

Figure 2: Change of pH in paneer with the storage

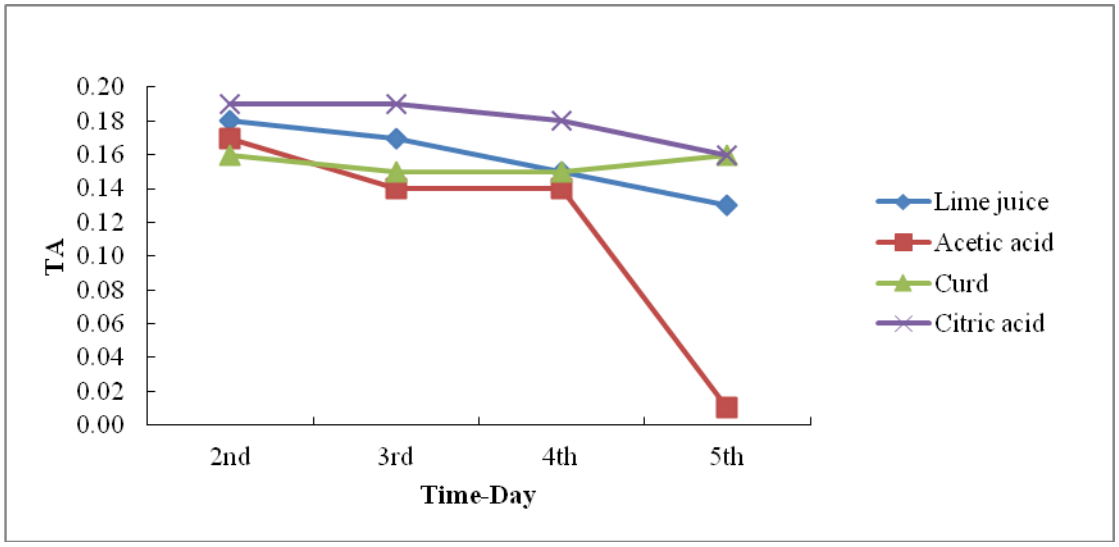

Figure 3: Change of titrable acidity in paneer with the storage

Microbiological changes in paneer

According to IS: 10484 (1983) standards, the recommended total plate count, yeast and mould count and *E. coli* were < 5 x 10^5, < 250 and < 90, respectively. The developed paneer was negative for pathogenic microorganisms (Table 1). Aggarwal and Srinivasan [21] reported that microorganisms such as coliforms, yeasts and moulds that might be present in raw milk, get destroyed completely when milk is heated at 82^0C for 5 min. However, these microbes may contaminate the product through a number of sources; air, water, equipment, knife, muslin cloth, and persons handling the products. If microbes can cause proteolytic and lipolytic changes, discolouration and other defects in the products would be possible [22]. Hence, it is very important to check the microbial counts in the developed product after preparation and during the storage.

Yield and nutritional composition of paneer whey

Yield and nutritional composition of paneer whey was not significantly affected *($p > 0.05$)* by different coagulants used (Table 2). In contrast, pH and titrable acidity were significantly different *($p < 0.05$)* when different coagulants were used and pH was significantly greater (acidity was lower) in whey resulted from paneer developed with vinegar and curd compared paneer developed with citric acid.

Table 2: Yield and nutritional composition of paneer whey

Composition	Treatments				SE*
	Lime juice	Vinegar	Curd	Citric acid	
Yield (g)	651	653	764	646	134
Nutritional composition (%)					
Moisture	91.88	92.21	92.31	91.63	1.52
Total solids	8.12	7.79	7.69	8.37	1.51
Fat	0.68	0.74	1.35	1.14	1.23
Ash	0.98	0.66	0.91	1.14	0.54
pH	5.36^{ab}	5.48^{a}	5.48^{a}	5.28^{b}	0.1
TA	0.29^{a}	0.21^{b}	0.20^{b}	0.27^{a}	0.04

^{a,b} means within the same row with different superscripts are significantly different *($p< 0.05$)*
* Standard error of means

IV. CONCLUSIONS

Different coagulants such as lime juice, vinegar, curd, and citric acid with cow milk can be used to prepare paneer with acceptable sensory qualities and nutritional compositions without any quality defects under refrigerated condition. However, overall acceptability of paneer and whey is greater when citric acid is used as the coagulant.

REFERENCES

[1] Haug A, Høstmark AT, Harstad OM. Bovine milk in human nutrition – A review. Lipids in Health and Disease. 2007, 6:25-25.

[2] PFA. Prevention of food adultration rules, 1954 (amended up to 2009) In. New Delhi, Universal Law Publishing Company Pvt Ltd. 2010, 165–166.

[3] Singh S, Kanawjia SK. Development of manufacturing technique for paneer from cow milk. Indian J. Dairy Sci. 1988, 41:322–325.

[4] Shrivastava S, Goyal GK. Preparation of Paneer - A review. Indian J. Dairy Sci. 2007, 60:377-388.

[5] Mathur BN, Hashizume K, Musumi S, Nakazawa Y, Watanabe T. Traditional cheese 'paneer' in India and soyabean food 'tofu' in Japan. Jap. J. Dairy Food Sci. 1986, 35(4):A137–A141.

[6] Kumar Singh A, Sinha S, Singh K. Study on Galactosidase isolation, purification and optimization of lactose hydrolysis in whey for production of instant energy drink, Int. J. Food Eng. 2009, 5(2).

[7] Rao KVSS, Zanjad PN, Mathur BN. Paneer technology, A review. Indian J. Dairy Sci. 1992, 45(6):281–291.

[8] AOAC. Association of official analytical chemists. Official methods of analysis (18th ed.). In. Washington DC, USA. 2003.

[9] Arora VK, Gupta S. Effect of low temperature storage on paneer. Indian J. Dairy Sci. 1980, 33:374-380.

[10] SAS. Statistical Analysis System. Users Guide Statistics. SAS Institute Inc. Cary, North Carolina, USA. 2002.

[11] Minitab. Minitab, version 16.1.0. In. Minitab Inc., State College, Pennsylvania, USA. 2010.

[12] Kumar HA, Ramanjaneyulu G, Venkateshaiah BV. Comparison of three coagulants in the preparation of paneer. Tropical Agric. Res. 1998, 10:407-412.

[13] Sachdeva S, Singh S. Use of non-conventional coagulants in the manufacture of paneer. J. Food Sci. Technol. 1987, 24:317-319.

[14] Khan SU, Pal MA. Paneer production: A review. J. Food Sci. and Technol. 2011, 48(6):645-660.

[15] Enb A, Donia MAA, Abd-Rabou NS, Abou-Arab AAK, El-SenaityEnb MH. Chemical composition of raw milk and heavy metals behavior during processing of milk products. Global Veterinaria. 2009, 3(3):268-275.

[16] Rajashekar G, Kempanna C, Brunda SM, Roopa OM. Influence of different coagulation temperature and coagulants on chemical and sensory qualities of paneer. Int. J. Agric. Sci. and Res. 2016, 6(3):7-12.

[17] Arya SP, Bhaik N. Suitability of crossbred cow's milk for paneer making. J. Dairying Food Home Sci. 1992, 11:71-76

[18] Sharma RB, Kumar M, Pathak V, Kumar M. Effect of different seasons on cross-bred cow milk composition and paneer yield in sub-himalayan region. Asian-Australasian J. Anim. Sci. 2002, 15:528-530.

[19] Masud T, Athar IH, Shah MA. Comparative Study on Paneer Making from Buffalo and Cow milk. Asian-Australian J. Anim. Sci. 1992, 5(3):563-565.

[20] Pal MA, Yadav PL, Sanyal MK. Effect of paraffining on the physico-chemical, microbiological and sensory characteristics of low fat paneer at low temperature storage. Indian J. Dairy Sci. 1993, 46:519-524.

[21] Aggarwal PK, Srinivasan RA. Mould contamination from dairy and farm environment. Indian J. Dairy Sci. 1980, 33:117-119.

[22] Thakral S, Gupta M, Ghodekar DR. Microbiological quality of paneer. Indian Dairyman. 1986, 38:388-390.

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