SHORT COMMUNICATION

Effect of different coagulants on the quality of paneer made from buffalo milk

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ABSTRACT

Effect of different coagulants on nutritional, sensorial, physico-chemical and microbial properties of paneer were evaluated. Paneer developed with different coagulants showed no significant difference ($P>0.05$) for sensory attributes. Paneer developed with curd had the significantly higher ($P<0.05$) yield. Moisture content, total solids and fat content of paneer did not significantly differ ($P>0.05$) with the type of coagulant used. pH and titratable acidity of paneer were significantly affected ($P<0.05$) by different coagulants and changed with storage time. Paneer developed in this study was negative for pathogenic microorganisms and can be acceptable up to 4 d of storage at 4 °C. In conclusion, four different coagulants; lime juice, vinegar, curd and citric acid with buffalo milk can be used to prepare paneer with acceptable sensory qualities and nutritional compositions without any quality defects under refrigerated condition.

Keywords: *Buffalo milk, coagulants, lime, paneer, whey*

INTRODUCTION

Paneer is a popular Indian soft cheese variety, which is prepared by high heat treatment and direct acidification of milk. It occupies a prominent place among traditional milk products (Khan and Pal, 2011). Paneer is used as the base material for preparation of a large number of culinary dishes and is a popular food product at household level. Paneer contains a fairly high level of fat and proteins as well as some minerals, especially calcium (Ca) and phosphorus (P). Since it is a rich source of animal protein available at a comparatively lower cost, it forms important source of animal protein for lactovegetarians (Kumar *et al.*, 2014). Paneer has a reasonably long shelf life under refrigeration. Conversely, whey is a by-product obtained during manufacture of paneer and it contains valuable nutrients such as lactose, whey proteins, minerals, and vitamins. These nutrients have a vital value in human dietary requirement (Mathur *et al.*, 1986).

Good quality paneer is characterised by a marble white color, sweetish mildly acidic taste, nutty flavour, spongy body, and closely knit smooth texture. The type and strength of coagulants are major factors that affect on the quality of

paneer. The concentration of coagulant has a profound effect on the body and texture of paneer. Further, temperature and pH of coagulants have a significant effect on the body, texture, total solids recovery, and yield of paneer (Khan and Pal, 2011). Paneer can be easily manufactured using locally available coagulants at household level though exact amount needed for whey separation is yet to be defined. Paneer manufacturing process is not much popular among Sri Lankans. Therefore, aim of this study was to develop paneer using buffalo milk with locally available coagulants such as lime juice, vinegar, curd, and citric acid and to evaluate the chemical composition of paneer and paneer whey, which can be used to produce value added beverages.

MATERIALS AND METHODS

Raw materials

Fresh buffalo 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*. (1992). One liter of fresh buffalo milk was used in each replicate.

Milk was heated separately up to 90 °C for 10 min in a stainless steel vat. The heated milk was allowed to cool to 70 °C and hot solutions of coagulants were added for each liter 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 °C) for about 2 h and thereafter the product was removed from the chilled water and allowed to drain out the excess water. The paneer blocks were wrapped with polythene sheets and stored in the refrigerator at 4 °C. 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 refrigerator and used for sensory evaluation in the next day. Each fresh paneer sample was evaluated using 30 non-trained (age = 22 – 25, sex = male and female) panelists for appearance, flavor, taste, texture and overall acceptability using a five-point hedonic scale.

Physico-chemical analysis

Paneer made from buffalo milk 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 Association of Official Analytical Chemists (AOAC, 2003). Paneer was evaluated for moisture, fat and ash as described in AOAC (2003). The pH of paneer was determined by using a pH meter as the method described by Arora and Gupta (1980).

Shelf Life and microbiological analysis

The developed paneer was stored in refrigerator and analysed for changes in titratable acidity and pH immediately after preparation and at regular intervals in storage up to 5 d. 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 sterilised by autoclaving at 121 °C for 15 min. 15 mL 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 mL from the 1st dilution was transferred into the tube with 9 mL peptone solution and the 2nd dilution was obtained (10^{-2} dilution). Then, a 0.1 mL of samples from each and every dilution was poured into the petri dishes and spread. After that dishes were transferred into the incubator and kept for overnight at 37 °C 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 (SAS, 2002). Means were separated by Tukey's Studentised Range Test (TSRT). Sensory data were analysed by Friedman non-parametric test in MINITAB 16.1.0 software package (Minitab, 2010) with 95% confidence interval.

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*. (1998) and Sachdeva and Singh (1987). In this study, lime juice, vinegar, curd, and citric acid were used as coagulants to produce paneer and their pH were 2.21, 2.72, 4.01 and 1.25, respectively.

Accordingly, citric acid was more acidic compared to the curd. Khan and Pal (2011) report 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 (Khan and Pal, 2011).

Nutritional composition of fresh buffalo milk

As reported by Soliman (2005), buffalo milk contains comparatively higher amount of total solids and fat than cow milk. Total solid (13%) and fat contents (5.27%) of buffalo milk used in this study were higher than cow milk and the results are in line with the findings of Enb *et al*. (2009). Further, buffalo milk has been found to contain more minerals than cow milk and observed ash percentages in buffalo milk (0.69±0.01%) was similar with the values reported by Khan *et al*. (2007). Further, moisture content, pH and titrable acidity in buffalo milk used in this study were observed as 87±1.8%, 6.84±0.02 and 0.16±0.001, respectively.

Sensory qualities of paneer

Paneer made with four types of coagulants showed no significant differences ($P>0.05$) for sensory attributes such as appearance, flavour, taste, texture, and overall acceptability. Pal *et al*. (1991) reported that, paneer developed with citric acid yield superior paneer. Paneer developed with citric acid in this study also obtained better preferences (Figure 1). The quality of paneer depends upon the quality of milk from which it was made. Milk fat exerts significant effect on the organoleptic qualities of paneer. Yield of paneer developed from buffalo 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 (Sachdeva and Singh, 1987; Sharma *et al.*, 2002). Therefore, observed differences in the yield could be due to the 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). Further, observed moisture contents and total solids of paneer were similar to the findings reported by Syed *et al*. (1992) and Masud *et al*. (2007), respectively. In contrast to our findings, Arya and Bhaik (1992) reported that the fat content of paneer changes with different coagulants. Ash content of paneer was different among the treatments and a higher ash content was observed in paneer developed with vinegar compared to citric acid ($P<0.05$).

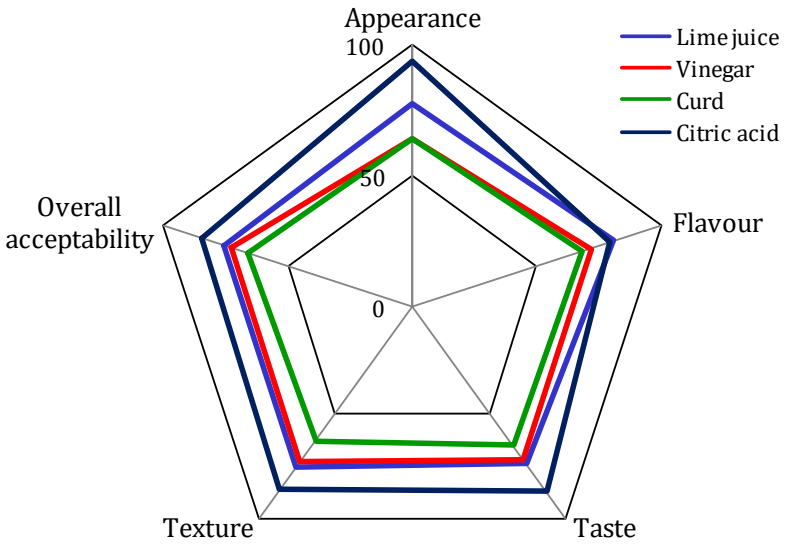

Figure 1: Sensory qualities of paneer developed with different coagulants: Yield and Nutritional Composition of Paneer**.**

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

Parameter	Treatment				SE*
	Lime juice	Vinegar	Curd	Citric acid	
Yield (g)	139^{a}	147^{a}	178^{b}	139^{a}	14
Nutritional composition					
Moisture (%)	54.93	49.73	48.28	51.06	7.43
Total solids (%)	45.07	50.27	51.72	48.94	7.43
Fat (%)	32.00	31.63	31.00	31.63	3.33
Ash (%)	1.79^{ab}	2.24^{a}	1.75^{ab}	1.48^{b}	0.43
Microbial counts (cfu)					
Total plate count	47 x 10^{3}	7 x 10^{2}	22 x 10^{2}	8 x 10^{2}	
Yeast & mould count	1 x 10^{2}	1 x 10^{2}	-	-	
E. coli	-	-	-	-	

Means within the same row with different superscripts are significantly different (P<0.05)
*Standard error of means

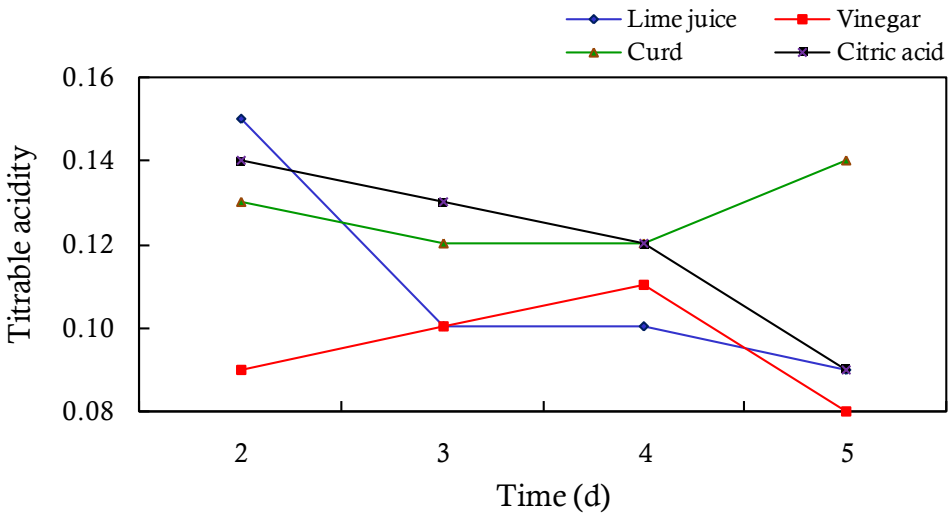

Figure 2: Change of pH in paneer in storage.

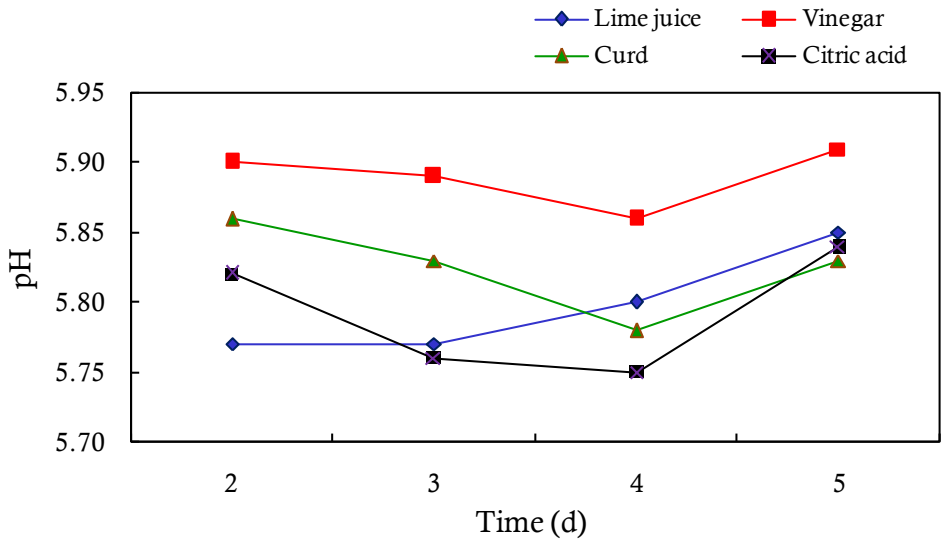

Figure 3: Change of titratable acidity in paneer in storage.

Physico-chemical changes in paneer

The pH and titratable acidity of developed paneer were significantly affected (P<0.05) by different coagulants (Figure 2 and 3). Further, there was an interactive effect of treatments and storage time on pH and titratable acidity and they were within the acceptable range up to 4 d of storage at 4 °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 (Pal *et al.*, 1993). Therefore, with the time, acidity level increases and pH decreases.

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. Paneer developed were negative for pathogenic microorganisms (Table 1). Aggarwal and Srinivasan (1980) 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 °C 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, discoloration and other defects in the products would be possible (Thakral *et al.*, 1986). 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 of paneer whey were significantly affected (P<0.05) by different coagulants used (Table 2). Whey resulted from paneer made with curd caused significantly higher yield compared to other coagulants. However, nutritional composition of paneer whey did not significantly differ (P>0.05) among treatments. In contrast, pH and titratable acidity were significantly different when different coagulants were used and pH was significantly greater (acidity was lower) in whey resulted from paneer developed with lime juice compared paneer developed with vinegar.

Table 2: Yield and nutritional composition of paneer whey.

Parameter	Treatment				SE*
	Lime juice	Vinegar	Curd	Citric acid	
Yield (g)	670[a]	663[a]	804[b]	701[ab]	86
Nutritional composition					
Moisture (%)	92.30	92.87	92.79	87.65	5.25
Total solids (%)	7.70	7.13	7.21	7.13	1.24
Fat (%)	0.93	1.05	1.45	0.90	0.97
Ash (%)	0.84	0.81	0.78	0.75	0.39
pH	5.25[a]	5.43[b]	5.41[ab]	5.30[ab]	0.11
Titrable acidity	0.24[a]	0.19[b]	0.19[b]	0.22[ab]	0.03

Means within the same row with different superscripts are significantly different (P<0.05)
* Standard error of means

CONCLUSIONS

Different coagulants including lime juice, vinegar, curd, and citric acid with buffalo milk can be used to prepare paneer with acceptable sensory qualities and nutritional compositions without any quality defects under refrigerated condition. However, yield of paneer and whey is greater (P<0.05) when curd is used as the coagulant.

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