International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(3): 5012-5015

Received: 07-03-2019
Accepted: 09-04-2019

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Effect of neutralization of milk on sensory, color, yield and textural characteristics of cow milk paneer

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Abstract
Paneer is used as a base material for the preparation of a large number of culinary dishes and snacks in almost all parts of the country. *Paneer* was prepared by standardized method. Efforts of the industry are always top make *paneer* production a profitable venture for which maximum amount of *paneer* needs to be produced from a given amount of milk. Increased yield of *paneer* and at the same time production of whiter *paneer* using cow milk seems to be the primary requirement of *paneer* manufacturers in the country. The common neutralizers which are added to milk are caustic or sodium hydroxide, baking soda or sodium bicarbonate and washing soda or sodium carbonate. The type and quality of milk used for preparation of *Paneer* affects the quality, sensory, colour and textural changes in the product. Textural attributes are significantly affected by neutralization of milk, resulting in lower values of hardness, cohesiveness, springiness, chewiness and gumminess in *paneer* manufactured using neutralized milk and higher values in *paneer* manufactured using fresh milk. *Paneer* manufactured by using neutralized milk due to higher yield and whiteness as compared to fresh milk *paneer*.

Keywords: Cow milk, neutralization, sensory, colour, textural attribute, whiteness

Introduction
An estimated 5% of milk produced in India is converted to *paneer* (Chandan, 2007b [6]. *Paneer* of good quality can be produced from cow milk as well as buffalo milk, but buffalo milk *paneer* has superior quality attributes like whiter and marble coloured appearance, spongy and chewy body and texture and pleasing nutty flavour. Whereas cow milk *paneer* has sensory attributes of creamy yellowish white colour, closed and compact body and texture, and nutty flavour with a bland note. The attributes of buffalo milk *paneer* have better consumer acceptance because of sensory attributes as described above (Kumar *et al*., 2008 [16]. Further, it is also economical to produce *paneer* from buffalo milk because of higher yields which is from 17-20%. Many *paneer* makers want to produce same quality of *paneer* using cow milk, which seems to be a difficult proposition owing to compositional differences in protein make up of both the milks. Dairy industry always strives for profitable *paneer* production for which primary factor responsible is the yield which has to be maximum from a given quantity of milk to get better returns. Increased yield of *paneer* as well as whiter *paneer* using cow milk seems to be the primary requirement of *paneer* makers in dairy industry. Several factors affect yield and colour of *paneer* prepared from cow milk. The textural characteristics of a dairy product is always influenced by its composition, type and quality of raw materials used. Adhikari *et al.* (1993 [1] reported coalesced, compact casein micelles with associated fat globules in *chhana* and numerous small voids interspersed throughout the matrix. Rapid development of natural acidity in milk at ambient temperature is a common problem in India. Historically, such type of milk with developed acidity is not suitable for sweets preparation, as heating of milk with developed acidity resulted in coagulation of milk proteins. Therefore, addition of neutralizer to such milk is a common and ancient practice. Manufacture of traditional dairy products adds value to milk as it preserves milk solids for longer time at room temperature and hence increases the shelf life of milk solids. *Paneer* contains all the milk constituents except for loss of some soluble whey proteins, lactose and minerals (Singh and Kanawjia, 1988 [29]. *Paneer* has a fairly high level of fat (22–25%) and protein (16–18%) and a low level of lactose (2.0-2.7%) (Kanawjia and Singh, 1996 [15]. *Paneer* must be uniform and have a pleasing white appearance with a greenish tinge when made from buffalo milk and light yellow when made

from cow milk. *Paneer* is characterized by a mild acidic flavour with slightly sweet taste and a soft, cohesive and compact texture. It is an excellent substitute for meat in Indian cuisine. There is hardly any information on the yield, colour and textural changes as affected by quality of milk. This was essential, since it largely determines the material and rheological behaviour of the product. Therefore, an attempt has been made to determine the effect of developed acidity and subsequent neutralization of milk to recognize the interrelation among sensory, texture and microstructure changes of *paneer*. Hardness, gumminess and chewiness are negatively correlated with moisture and fat content, but positively with protein, lactose, added carbohydrates, ash and calcium content (Adhikari *et al*. 1994 [2]. *Paneer* production is the easiest way of preserving rurally produced milk, the size and hardness of grains increased with the increase in acidity. As a result of complex interactions occurring among the individual milk components like casein, whey protein, lactose and fat globules in addition to additives such as acidulants, enzymes and thickening agents added during the production of milk products results in changes in microstructure. Keeping this in view, a present study is undertaken to see the effect of use of milk neutralised with addition of caustic and acidic milk on the quality attributes of *paneer*.

Material and methods

Fresh cow milk was procured from Livestock Research Centre of ICAR- National Dairy Research Institute, Bengaluru, filtered, standardized to approximately 4.5% fat and 8.5% SNF by mixing required quantity of skim milk and cream (De, 1980 [8].

Preparation of samples: Fresh milk samples were incubated at 30ºC in an incubator (Narang Scientific Works Pvt. Limited, Delhi, India) for rapid development of acidity up to 0.25% lactic acid. Acidity of milk was evaluated hourly until it reaches up to 0.25% LA. Developed acidity was neutralized with the addition of calculated amount of neutralizer (sodium bicarbonate) at required rate to adjust the acidity to 0.15% acidity of fresh milk. The fresh and neutralized cow milk samples were used for manufacture of *paneer*.

Preparation of *paneer*: The standardized cow milk was heated up to 90 °C with 5 min holding, cooled to 85 °C and coagulated using citric acid with gentle stirring till clear greenish yellow whey was separated from the coagulated mass. The coagulum thus obtained was left undisturbed for approximately 5 min and the temperature of the contents was not allowed to drop below 60 °C at this stage. Whey was drained by filtering contents through a fine muslin cloth. The coagulum was then filled in wooden hoops with holes on the all sides and bottom to facilitate quick and efficient expulsion of whey. The hoops were lined with strong and clean muslin cloth from inside and the whole mass was then pressed in hoops by applying pressure of 0.07kg/cm^2 on the lid of the hoop for approximately 15min. The pressed block of curd was cut into pieces of suitable size (7.5×7.5×7.5 cm) and the pieces were immersed in chilled water (4 °C) for 1h. The *paneer* was then taken out of water, drained well, wiped clean and weighed to obtain final *paneer* yield.

Sensory evaluation: A panel of 7-10 semi-trained judges evaluated different sensory parameters of the *paneer* by 9-point hedonic scale (Peryam and Pilgrim, 1957 [20].

Textural analysis: Texture profile analysis (TPA) parameters namely hardness, cohesiveness, springiness and chewiness were determined using the Stable Microsystems TA-XT plus Stable Micro System Texture Analyzer (UK) fitted with 5kg load cell by two-bite linear compression of *paneer* samples (Bourne, 1978 [5].

Colour characteristics: Colour of the *paneer* samples was measured by Scanner-Adobe Photoshop (SAP) method (Vyawahare and Rao, 2011 [33].

Statistical analysis: Data obtained during the study were subjected to statistical analysis by one way ANOVA using SPSS Software 20 [31]. The comparison between treatment means was done for statistical significance by Turkey's test. The analysis of variance of group mean was computed and significance of means tested by using Least Significant Difference test at 5% level of significance. The tested means were compared when the interaction was found to be significant. In the absence of such significance the overall means, wherever significant were compared (Snedecor and Cochran, 1994 [30].

Result and discussion

Sensory evaluation: Sensory attributes viz. colour and appearance, body and texture, flavour and overall acceptance of cow milk *paneer* prepared using fresh, neutralized and acidic milk are given in Table-1.

Paneer prepared from fresh milk possessed the characteristic flavour and secured significantly higher average scores, while in case of *paneer* prepared from neutralized milk, Bland taste resulted in lowest flavour scores. However, in case of *paneer* prepared from neutralized milk, the increase in moisture content which resulted in soft body and loose texture hence lower body and texture score. The colour and appearance scores of fresh milk *paneer* had less white with comparison to neutralized milk *paneer* samples prepared cow milk, exhibited significant difference. However, neutralized samples had significantly higher scores, due to whiter appearance. These neutralizers shifted the pH towards alkaline value and thus resulting in more pronounced colour in *paneer* prepared from neutralized milk (Rajorhia *et al*. 1990 [21]. Significant difference was observed in overall acceptance sensory scores of *paneer* prepared from fresh and neutralized milk. Total scores significant differences were observed between the colour and appearance, flavour, body and texture and overall acceptability of *paneer* from fresh and neutralized milk.

Table 1: Effect of neutralizer on sensory acceptance score of *paneer*

Type of milk	Sensory attribute			
	Colour and appearance	Body and texture	Flavour	Overall acceptability
Fresh milk	8.50±0.35	8.65±0.43	8.65±0.45	8.50±0.83
Neutralized milk	8.70±0.52	8.00±0.51	8.35±0.26	8.15±0.63

Textural analysis: *Paneer* has a compact to slightly open texture with some porosity and sponginess (springiness) the extent of which depend on type of milk from which it is made. The body and textural characteristics of *paneer* depend on several factors viz. type of milk, quality of milk, extent of heat treatment given to milk, temperature coagulation, amount of coagulant used, type of coagulant used, temperature and extent of pressing applied, temperature of chilled water, period of storage at retail selling pint and temperature of storage.

Texture is an important attribute in *paneer* as it decides the ultimate acceptability of a product by the consumers. The changes in the textural attributes viz: hardness, springiness, cohesiveness, chewiness, gumminess of *paneer* measured using Texture Profile Analyser, Stable Micro Systems, UK. Changes in these textural attributes directly affected the quality of *paneer* e.g. higher hardness in *paneer* will result in less moisture, low yield. Similarly, higher gumminess and springiness will result in elastic and gummy texture of *paneer*.

Table 2: Effect of neutralized milk on textural properties of *paneer*

Type of milk	Hardness (N)	Cohesiveness	Springiness	Chewiness (N)
Fresh milk	34.88±0.50	0.52±0.02	0.82±0.02	14.75±0.36
Neutralized milk	25.81±0.96	0.50±0.03	0.83±0.01	10.91±0.15

Development of typical rheological characteristics of *paneer* could be due to preponderant and intensive heat induced protein-protein interactions (Richert, 1975 [22]. The β-lactoglobulin and κ-casein interact by sulphydryl disulphide interchange when heated together (Sawyer, 1969 [28]. Interaction between heated κ-casein and β-lactoglobulin as evidenced by electrophoretic changes is initiated at about 65 °C, increasing to a maximum of 83% at 85 °C and decreasing to 76% at 99 °C (Long *et al.,* 1963 [17]. However, there are reports that α-lactalbumin and β-lactoglobulin also do interact (Hunziker and Tarassuk, 1965 [13] and the complex so formed appears to be able to interact with κ-casein (Baer *et al.*, 1976; Elfagm and Wheelock, 1977 [4, 11].

Yield and colour parameters: Various factors such as temperature of coagulation, period of storage of milk and use of food additive etc. have been found to influence the yield and quality of *paneer*. The yield mainly depends on the solids losses into whey. The higher yields obtained seems to be from lower losses into whey as also shown by clear transparent whey obtained by neutralized milk. This may be result of different coagulation mechanisms of these coagulants.

The minimum losses of protein content in whey could be due to the adherence of Ca^{2+} ions on the alpha casein particles which results in reduction of negative electric charge and creates additional reaction sites through which aggregation may takes place between casein micelles by virtue of cross linkages by divalent calcium ions thus leads to more protein retention in the coagulum (Dalgleish and Parker, 1980; Sachdeva *et al*., 1991; Joshi *et al.* 2004 [7, 26, 14] and due to increased recovery of whey protein by the addition of calcium phosphate as it also induces the precipitation of whey protein thus they are recovered along with casein (Dybing and Smith, 1998; Guo *et al.*, 2003 [10, 12].

Table 3: Effect of neutralized milk on yield and colour parameters of *paneer*

Type of milk	Yield (g per lit of milk)	Colour parameter		
		L*	a*	b*
Fresh milk	158.71±0.56	91.27±0.37	-0.75±0.04	13.43±0.37
Neutralized milk	165.83±0.59	96.31±0.55	-0.83±0.04	15.73±0.15

Heat treatment of milk is also essential to denature whey proteins and reduce solubility of colloidal calcium phosphate, thus co-precipitating them along with the casein upon acidification of milk. These constituents increase the yield of curd, which are otherwise lost in whey. Sachdeva and Singh (1995 [27] observed higher *paneer* yield by coagulation at 90^0C temperature.

The coagulation of milk takes place when milk is acidified because calcium from colloid state goes into solution destabilising the casein moieties. The mechanism of coagulation is different when calcium lactate is added. Co-precipitation of casein and whey protein through acidification in presence of calcium chloride (0.15%) led to enhanced yield of *paneer* (Makhal and Kanawjia 2005 [18]. The moisture and fat content of the *paneer* which decide the yield are influenced by several factors such as composition of milk, temperature of coagulation (Vishweshwaraiah and Anantakrishna, 1986; Singh and Kanawjia, 1988; Roy and Singh, 1994 [32, 29, 23] and type of coagulant.

Higher the L* value, the whiter is *paneer*. A value of zero indicates complete dark (black) colour whereas 100 indicate complete white. The colour parameters are an important factor of *paneer* which contributes for the consumer appeal. The L*, a* and b* values of *paneer* prepared from different coagulants delineated in Table 3. The wide variation in values of L* score of samples prepared from neutralized milk due to variation in reflection of light, calcium ion content and casein protein interaction between milk protein.

Table 4: Proximate Composition of *Paneer*

Parameter (%)	Fresh milk	Neutralized milk
Total solids	46.68 ± 0.77	45.53±0.51
Fat	23.04±0.41	22.58±0.42
Protein	20.01±0.15	22.25±0.17
Lactose	2.11±0.05	2.55±0.07
Ash	1.50±0.38	1.64±0.42

Conclusions

From the present study, it was concluded that the type and quality of milk used for preparation of *paneer* produced noticeable changes in sensory, textural, colour and yield in the product. Neutralization of milk resulted in *paneer* with soft and smooth texture and comparatively higher moisture retention, higher yield and blind taste and whiter appearance. Textural attributes such as hardness, cohesiveness, springiness, chewiness and gumminess were significantly affected by neutralization of milk, indicating lower values for hardness, cohesiveness, springiness, chewiness and gumminess in *paneer* manufactured using neutralized milk and higher values in *paneer* manufactured using fresh milk.

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