RESEARCH ARTICLE

Effect of level of fat on compositional, physico-chemical, rheological and sensory attributes of processed cream cheese based (PCCB) spread

Krupa Hirpara, HG Patel, AJ Gokhale and AM Patel

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Abstract There are many varieties of cheese with differing characteristics, appeal and associated uses. *Cream cheese* is one such product which has potential of gaining popularity among the Indian consumers. *Cream cheese* is a soft, mild, rich, unripened cheese and is a creamy white, slightly acidic product with a diacetyl flavor. It is usually manufactured by the coagulation of cream or mixture of milk and cream by acidification with starter culture. Fatcontent plays an important role in physico-chemical, sensory and also the textural characteristics of cheese. Hence, for development of technology for *Processed cream cheese based* (PCCB) *spread* manufacture, different levels of fat in milk (2, 4 and 6%) were studied so that an optimum level yielding best organoleptic characteristics in final product could be selected. The better quality product was made from milk standardized to 4 per cent fat and added with cream (45 percent fat) @ 45 per cent of cheese curd at the time of mixing in Stephan kettle. Final cost for production of 1 kg PCCB spread was computed ₹ 284.47. Based on the economic as well as sensory quality obtained, a level of 4 percent fat for standardization of cheese milk has been selected.

Key words: Processed cream cheese based spread, fat level, physico-chemical properties, sensory attributes

Krupa Hirpara, HG Patel (✉), Gokhale AJ and Patel AM
Department of Dairy processing & Operations, Sheth M.C. College of Dairy Science, Anand Agricultural University, Anand-388 110,
H.G. Patel
Department of Dairy processing & Operations,
Sheth M.C. College of Dairy Science,
Anand Agricultural University, Anand-388 110,
e-mail: hgpatel311@gmail.com

Introduction

Cream cheese is one of the most popular soft cheeses in North America. *Cream cheese* is a soft, mild, rich, unripened cheese and is a creamy white, slightly acidic product with a diacetyl flavor. It is usually manufactured by the coagulation of cream or mixture of milk and cream by acidification with starter culture. *Cream cheese* is one such product which has potential of gaining popularity among the Indian consumers. It is used widely as a spread to replace butter which contain ~80 percent fat. The high fat level not only increases its cost but also makes it unsuitable for those who are fat conscious. In *cream cheese*, the presence of non-fat solids makes it nutritionally more balanced (Singh and Tewari, 1990). Because of its lower cost of production and better nutritional value, there is a need to popularize the use of *cream cheese.* The Indian cheese market was estimated to be of ₹ 1250 crores is exhibiting a growth rate of ~ 20.0 percent per annum. The Indian organized cheese market including its variants like processed cheese, mozzarella, cheese spreads, flavored and spiced cheese, is valued at around ₹ 4.5 billion. Processed cheese value at 60.0 per cent of the overall market is ₹ 2.7 billion. The next most popular variant is cheese spread claiming a share of around 30.0 per cent of the total processed cheese market. The market for cheese cubes, slices and tins is growing (Jayadevan, 2013). Although, there has been quite extensive study about *cream cheese*, very little work has been published and most of the information is patented (Han, 2002). Today's trend of consumer is to purchase newer food products which provide acceptable properties with nutrition as well. Hence, there is a need to explore the possibility of development of technique of *Processed cream cheese based* (PCCB) *spread* with certain additives which helps to improve its taste, functionality and better texture compared to cheese spread available in Indian market.

Materials and Methods

To develop a technology and standard formulation, the study involved several phases; one of them is the selection of levels of fat in cheese milk for processed cream cheese based spread. The *processed cream cheese based* (PCCB) *spread* samples thus manufactured were analyzed for their chemical composition, physico-chemical attributes, texture profile, sensory and microbial quality.

Materials used

The milk and cream used for manufacturing *Processed cream cheese based* (PCCB) *spread* was procured from Anubhav Dairy of AAU, Anand. Culture was procured from a supplier of M/S. Chr-Hansen, Denmark.Whey protein concentrate (WPC 70) was procured from M/S. Mahaan Protein Ltd., Kosi Kalan, Mathura, U.P.Tri-sodium citrate (TSC)and Di-sodium hydrogen orthophosphate (DSP) both of LR grade were procured from M/S. Loba Chemie Pvt. Ltd., Mumbai.Guar gum was procured from M/S. Hi Media Laboratories Pvt. Ltd., Mumbai and common salt of 'TATA' brand was procured from the local market of Anand.

Process for *Processed cream cheese based* (PCCB) *spread* making

Fresh high quality raw milk was procured from Anubhav Dairy. It was filtered and standardized to required fat of three different levels viz. 2, 4 and 6 percent as per requirement and pasteurized at 73°C for 16 sec. The temperature of milk was lowered to coagulation temperature of 42 °C. The milk was poured into S.S. cheese vat in batches of 50 kg. At this stage, Starter culture combination activated in skim milk was added to the milk@ 10 U/ 50 kg and kept undisturbed for setting of curd up to pH 4.8. At pH 4.8, the curd was cut with cheese knife in to 1 cubic cm size. After 10 min, the cooking was started to raise the temperature to 46°C within 15 min. The coagulated curd was strained and whey was separated. The curd was transferred into the Stephan kettle for further processing. Curd was mixed with accurately weighted emulsifying salts TSC and DSP @ 0.8 & 1.5 per cent respectively, WPC and guar gum @ 0.4 percent each, salt @ 1.0 percent and cream (45 per cent fat) @ 45 percent of curd before the processing started. Cheese curd mix was then processed in Stephen Kettle Blenderat 78.7 °C, unloaded, weighed and hot packed.

The final product obtained as above was evaluated for its proximate composition, physico-chemical properties, Rheological attributes, microbiological and organoleptic characteristics.Based on the above analysis, the level of fat in cheese milk which resulted in the optimum quality product was selected.

Analysis

Compositional attributes

The TS of the *Processed cream cheese based* (PCCB)*spread* samples was determined by standard procedure using Mojonnier Milk Tester Model-D (Laboratory Manual, 1959).Fat extraction of samples was determined as per the procedure described in IS: 2311-1963.Total nitrogen/protein was determined by Semi-Microkjeldahl method (IS: 1479-Part-II, 1961), using Kjel-plus Digestion System (Model-KPS 006L) and Kjel-plus Semi-Automatic Distillation System (Model-Distil M) of M/s. Pelican Instruments, Chennai. The ash content was determined using 3.0 g of sample and following the standard method (IS: 1479-Part-II, 1961).The total carbohydrate content was obtained by difference of other components viz., fat, protein, ash and moisture content.

Physico-chemical quality attributes

Titratable acidity of PCCB Spread was determined by the procedure as described by Singh and Tewari (1990). The pH was measured using Systronic digital pH meter, Model 335 using the methoddescribed by Franklin and Sharpe (1963). The water activity (a_w) of samples, tempered at 25°C temperature, was measured using Rotronic Hygroskop Model: Hygrolab-3 (M/s. Rotronic ag, Switzerland).The method prescribed by Deeth *et al.,* (1975) was used to estimate the FFA content.

Texture profile

Four samples from each of the experimental PCCB *spread* were subjected to back extrusion to 50 per cent of the initial sample height, using a Food Texture Analyzer of Lloyd Instruments LRX Plus Material Testing Machine, England; fitted with 50 Newton (N) load cell. The force-distance curve was obtained employing a Cross Head speed of 50 mm/min, Trigger 10 gf and 50 per cent compression of the samples to determine various textural attributes of PCCB *spread* held for 1 h at 23±1°C and 55 per cent RH filled in specific S.S. cylinder for texture analysis of semi solid products.

Sensory evaluation

For the organoleptic evaluation of PCCB s*pread*, 8 judges were selected on the basis of duo-trio test. The samples were evaluated using 100 point scale as per the score card reported by Singh and Tewari (1990).

Microbiological analysis

All the PCCB *spread* samples were analyzed for the Standard Plate Count (SPC), Coliform count and Yeast and Mold count (YMC) by the methods as described in IS: 5550 (2005) with slight modification.

Statistical Analysis

The mean value of each attribute under study obtained from duplicate samples of five replications (three treatments) were subjected to statistical analysis using 'Completely Randomized Design' (CRD) with equal number of observations (Steel and Torrie, 1980).

Results and Discussion

The influence of level of fat was studied to arrive ata recipe for *Processed cream cheese based (PCCB) spread* and standardize the process of its manufacture amenable to industrial application. For standardizing the level of fat in cheese milk 2, 4 and 6 percent (w/w of milk) were selected based on the preliminary trials so that the fat content in the final product would be in the vicinity of average value of fat well preferred in the market samples by the sensory panel.

Influence of level of fat in cheese milk on the average proximate composition of PCCB *spread*

The values in Figure 1 show that due to progressive increase in level of fat in cheese milk, the content of all the compositional attributes except ash and total solids content such as Fat, protein and total carbohydrate of PCCB *spread* manufactured were affected significantly (P≤0.05).It was found that on increase of fat level in cheese milk from 2 per cent to 6 per cent, there was a significant(P≤0.05) increase in fat content of PCCB *Spread* which increased from initial content of 13.14±0.69 per cent in 2 percent fat milk to 22.13±0.66 per cent in 6 percent fat milk samples. It is also evident from Figure 1 that there was a proportionate significant (Pd"0.05) decrease in per cent of protein and total carbohydrate but ash and total solids content declined non-significantly (P≤0.05) in all experimental samples with increasing level of fat in cheese milk. Phadungath (2005) also made an observation that an increase in the level of fat in cheese milk from 9 percent to 15 percent significantly (P≤0.05) increased the percent fat in cream cheese from 33 percent to 35.7 percent respectively.

Influence of level of fat in cheese milk on the Rheological properties of PCCB *spread*

The results depicted in Figure 2 clearly show that increasing the level of fat in cheese milk had a significant (P≤0.05) influence on the textural parameters as determined by Texture Profile Analysis such as hardness, cohesiveness, gumminess, and stiffness whereas there was no statistically significant (P≤0.05) influence on other properties of the final PCCB *Spread* samples.

In case of hardness (N) of the PCCB *Spread* samples, it was observed that the values showed different trend as the fat level was increased. It significantly (P≤0.05) increased from initial 11.26±0.92 N hardness in samples having minimum 2 per cent fat level to 15.30±1.54 N in samples having 4 per cent fat in cheese milk and then declined significantly (P≤0.05) to 8.95±1.50 N in samples having highest level 6 per cent of fat content.

The increased fat level in cheese mix was found to increase significantly (P≤0.05) the values of cohesiveness from 0.42±0.07 to 0.63±0.11 in experimental samples of PCCB *Spread.* Covacevichl and Kosikowski (1977) also reported that the textural properties such as hardness, cohesiveness and adhesiveness are important parameters for control of the texture of the cream cheese and it could be controlled by composition of cheese milk.

Influence of level of fat in cheese milk on physico-chemical and microbial characteristics of PCCB spread

The values presented in Table 1 show that except for Acidity and FFA, no other physico-chemical property was influenced significantly (P≤0.05) by changes in the levels of fat of cheese milk used for the manufacture of Processed Cream Cheese Based Spread.

In case of Acidity (% LA) values, it was observed that the values showed a irregular trend as the fat level increased. The value was significantly (P≤0.05) increased from initially 1.10±0.03 % LA to 1.14±0.02 % LA when fat content in cheese milk was increased from 2 per cent to 4 percent and thereafter it significantly (P≤0.05) decreased to 1.09±0.01% LA when fat content in cheese milk was kept to 6 per cent. However, the values

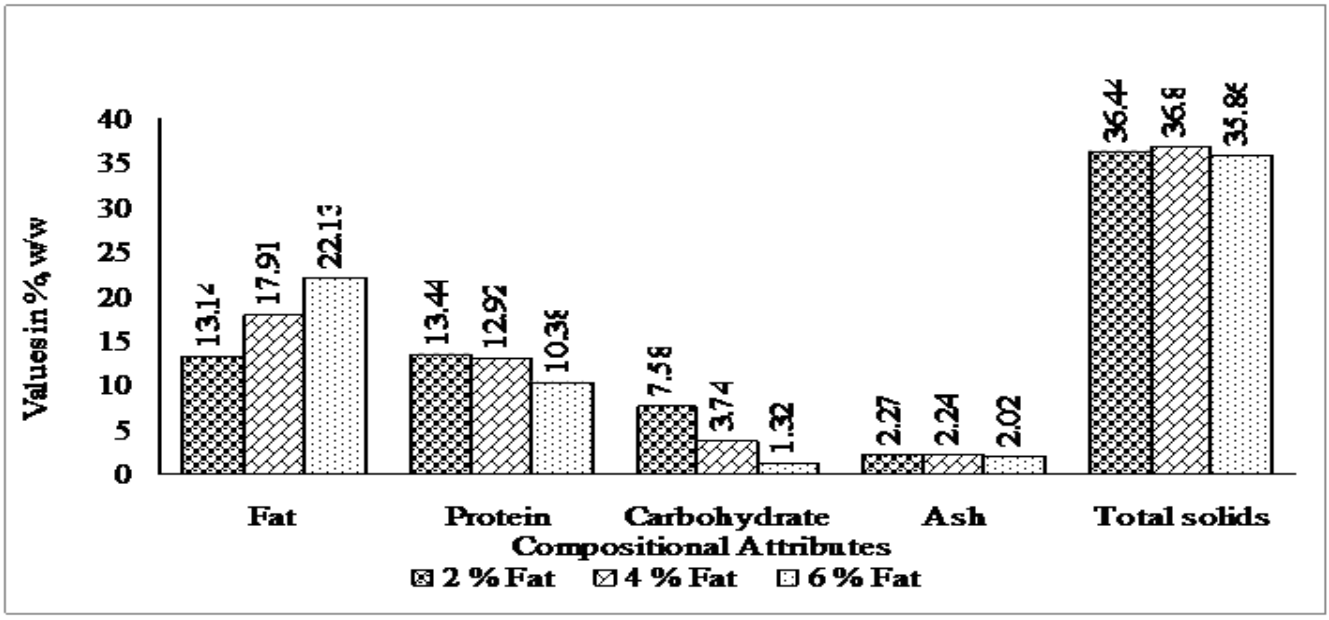

Figure 1: Influence of level of Fat in cheese milk on compositional attributes of *Processed Cream Cheese Based (PCCB) Spread*

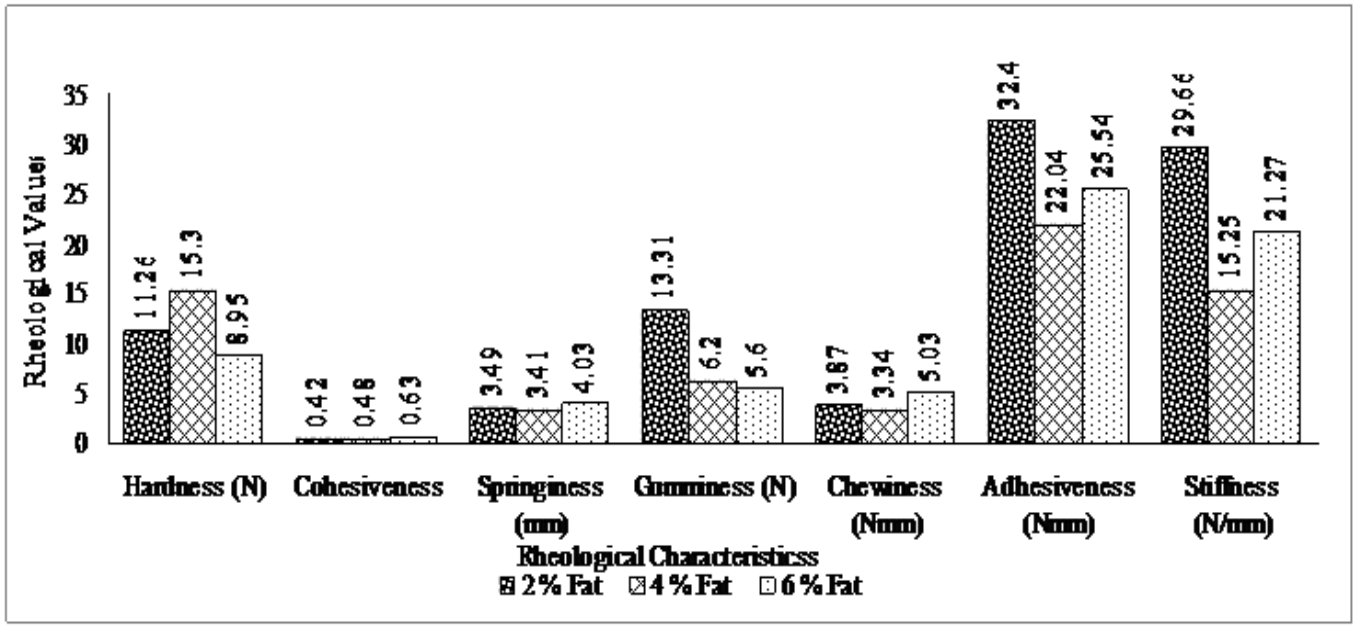

Figure 2: Influence of level of fat in cheese milk on rheological characteristics of *Processed Cream Cheese Based (PCCB) Spread*

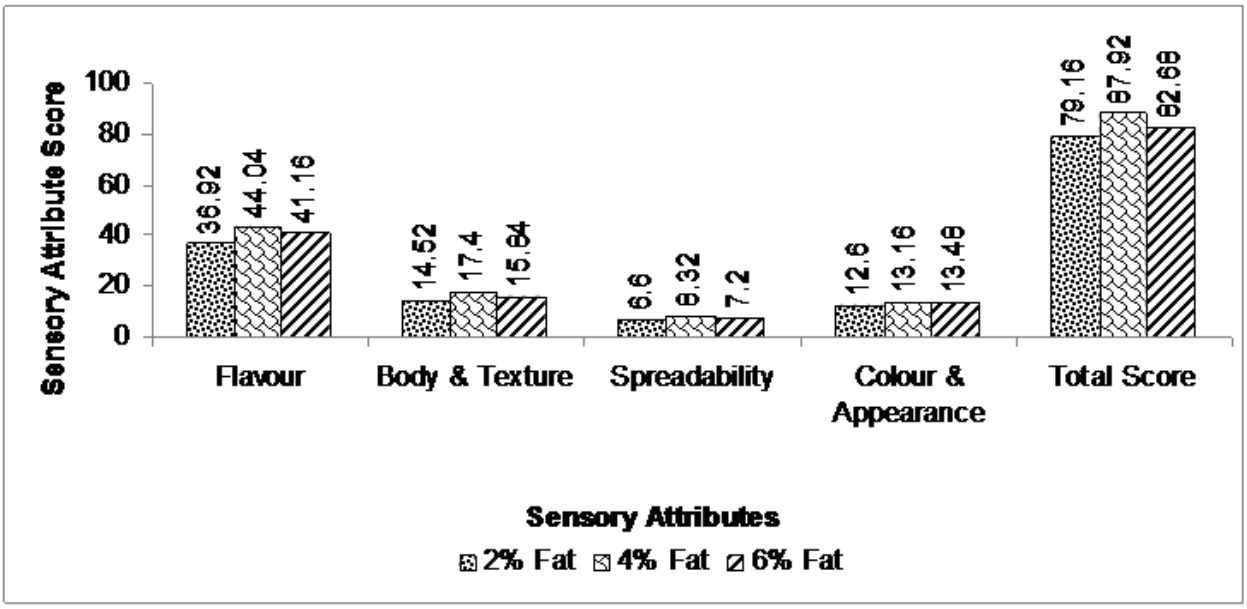

Figure 3: Influence of level of Fat in cheese milk on Sensory attributes of *Processed Cream Cheese Based Spread*

Table 1: Influence of levels of fat in cheese milk on different properties of *PCCB Spread*

Attribute	Level of fat (% w/w) in cheese milk		
Physico-chemical Characteristic	2 percent	4 percent	6 percent
Acidity (%LA)	1.10 ± 0.03 [a]	1.14 ± 0.02 [b]	1.09 ± 0.01 [ac]
pH	5.644 ± 0.03 [a]	5.656 ± 0.05 [a]	5.674 ± 0.05 [a]
FFA (μ eq/g)	1.072 ± 0.07 [a]	1.376 ± 0.10 [b]	1.632 ± 0.09 [c]
Water Activity (a_w)	0.968 ± 0.01 [a]	0.964 ± 0.01 [a]	0.97 ± 0.00 [a]
Microbial Count			
SPC ($\log_{10}$ cfu/g)	4.118 ± 0.11 [a]	4.056 ± 0.27 [a]	4.046 ± 0.25 [a]
Curd and Whey Properties			
Yield of curd (% w/w)	13.53 ± 0.53 [a]	16.55 ± 0.99 [b]	20.03 ± 2.01 [c]
Time for coagulation (min)	186 ± 6.52 [a]	196 ± 4.18 [ab]	218 ± 20.49 [c]
Fat of whey (% w/w)	0.46 ± 0.05 [a]	0.54 ± 0.09 [ab]	0.96 ± 0.11 [c]
TS of whey (% w/w)	4.51 ± 0.01 [a]	5.34 ± 0.04 [b]	6.46 ± 0.09 [c]
pH of whey	4.810 ± 0.10 [a]	4.764 ± 0.09 [a]	4.736 ± 0.13 [a]

1. Each observation is a mean ± SD of five replicate experiments (n=5)
2. Each pair of means is compared using CD values obtained from statistical analysis of data
3. Numbers in each labeled data superscripted with the same alphabet are not significantly different (P<0.05)

for samples having 2 percent and 6 percent milk fat were found statistically at par with each other.

The increased fat level in cheese milk resulted into the Processed Cream Cheese Based Spread having a significantly (P≤0.05) higher FFA content which increased from initial content of 1.072±0.07 µ eq/g in 2 percent fat milk samples to 1.632±0.09 µ eq/g in 6 percent fat milk samples of Processed Cream Cheese Based Spread.

The increased fat level in cheese milk was found to have significant(P≤0.05) decreaseof SPC (log_{10} cfu/g) values from initial 4.118±0.11 in 2 percentfat samples to 4.046±0.25log_{10} cfu/gin 6 percent fat samples. Yeast and mould as well as coliform counts were absent in all samples hence, not reported.

Influence of level of fat in cheese milk on sensory attributes of PCCB spread

The results depicted in Figure 3 clearly shows that increased level of fatin cheese milk had a significant (P≤0.05) influence on all the sensory attributes except for colour and appearance scores which also increased but non-significantly.

The values of flavour, body and texture, spread ability and total score, show the increasing and then decreasing trend as the fat level was increased. The values of flavour score out of 50 significantly (P≤0.05) increased from initial 36.92±3.93 in 2 percent fat to 44.04±2.41 in samples containing 4 percent milk fat samples; body and texture score out of 20 from initial 14.52±1.25 in 2 percentfat to 17.4±1.52 in 4 percent fat samples; spread ability score out of 10 from initial 6.60±1.03 in 2 percentfat to 8.32±0.63 in 4 percent fat and total score out of 100 from initial 79.16±4.18 in 2 percentfat to 87.92±4.66 in 4 percent fat containing samples which were at peak and then declined significantly (P≤0.05) to 41.16±1.81, 15.84±1.68, 7.20±1.14 and to 82.68±3.81 in 6 percent milk fat containing samples respectively. Organoleptic scores in cream cheese as observed by Singh and Tewari (1991) were 39.5 for flavour, 27 for body and texture, 11 for spread ability and 7.5 for colour and appearance. Spread ability was considered as the most important property for cream cheese by Breidinger and Steffe (2001) which they found was influenced by fat content as well as additives in cheese.

Observations given by sensory panel were very important for deciding the quality of the product. The sensory panel observed that samples having 2 per cent milk fat in cheese milk had less cheesy flavour as compared to samples having 4 and 6 per cent milk fat in cheese milk respectively. They also had excellent lactic flavour with richness of fat and gave good mouth feel. However, samples prepared from milk having 6 percent fat had high flavour with very weak body and spread ability were not liked by sensory panel. Samples prepared from 2 percent milk fat were observed to have hard body and were difficult to spread. On the other hand, samples prepared using 4 percent milk fat had good soft and smooth body and texture with better spread ability.

Influence of level of fat in cheese milk on cheese curd and whey

The results depicted in Table 1 clearly shows that increasing the level of fat in cheese milk had a significant (P≤0.05) influence on the cheese curd and whey i.e. yield of curd, Time for coagulation, Fat in whey and TS of whey but no significant (P≤0.05) influence was observed on pH of whey.

The increasing fat level in cheese milk showed significantly (P≤0.05) increased values of the yield of curd, Time for coagulation, Fat in whey and TS of whey. The values were highest in samples having 6 per cent milk fat in cheese milk. The maximum values were 20.03±2.01 per cent (w/w) for yield of curd; 218±20.49 min coagulation period; 0.96±0.11 per cent (w/w) fat in whey and 6.46±0.09 per cent (w/w) TS going in whey for samples prepared using 6 percent fat cheese milk.

While experimentation, it was observed that the increased fat level in cheese milk tend to produce soft curd which was very difficult to handle. Because of softness of the curd, higher losses of fat and TS was observed in samples prepared from cheese milk having highest (6 per cent) level of milk fat. It also required higher time for coagulation of cheese milk and had higher retention of moisture and fat content in the curd which may be a probable reason for softness and weak body of the curd. In case of samples prepared from cheese milk containing 4 per cent milk fat, it was observed that the curd was firm and had a lesser fat and TS loss in whey. Singh and Tewari (1990) also recommended that low fat milk could be used to manufacture a spreadable cheese of creamy consistency.

Conclusions

Based on the findings of experimentation, it is observed that the 4 percent milk fat level was more convenient for manufacture of processed cream cheese based (PCCB) spread and hence this level was selected for product. As reported in the literature, the cream cheese has fat content as low as 10 per cent to as high as 33 per

cent. Therefore, to improve the flavour and spread ability of PCCB spread, cream having 45 per cent milk fat is added @ 45 per cent by weight of curd. Addition of cream in cheese curd instead of in cheese milk also prevents the loss of milk fat in whey during the whey removal step. *PCCB Spread* prepared using cheese milk containing 4 per cent milk fat was more economical and had optimum sensory quality. The higher levels of milk fat in cheese milk resulted in increase in yield of curd, fat going in whey and TS loss in whey. Based on these findings, it is concluded that the 4 percent fat level was more convenient for manufacture of PCCB *spread.* To improve the flavour and spread ability of PCCB *spread*, cream having 45 per cent milk fat is to be added @ 45 per cent by weight of curd.

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