Influence of type of culture on compositional, physico-chemical, rheological and sensory attributes of Processed Cream Cheese based (PCCB) spread

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Abstract

Cream cheese is one of the most popular soft cheese products in North America. It is used as a spread on bread, as a salad dressing, in sandwiches and as an ingredient for making several kinds of desserts, such as cheesecake. Cream cheese is a soft, mild, rich, unripened cheese and is a creamy white, slightly acidic product with a diacetyl flavor. Starter culture plays an important role in sensory and also the textural characteristics of cheese. Hence, for development of technology for Processed cream cheese based (PCCB) spread manufacture, different type of culture i.e. (i) FD-DVS R-704 (Lactococcus lactis subsp. lactis; Lactococcus lactis subsp. cremoris), (ii) FD-DVS YF-3331 (Lactobacillus delbrueckii subsp. bulgaricus; Streptococcus thermophilus) and (iii) FD-DVS YF-3331 and FD-DVS ST-BODY-4 (Streptococcus thermophilus) (combination of two culture) were studied so that an optimum level yielding best organoleptic characteristics in final product could be selected. Final cost for production of 1 kg PCCB spread was computed ₹ 284.47. Based on the results obtained, a combination of two culture YF-3331+ STB-4 for coagulation of cheese milk has been selected considering the economic point of view and sensory quality.

Key words: Processed cream cheese based (PCCB) spread; starter culture; physico-chemical properties; sensory attributes

Introduction

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. The production of fresh acid-curd cheese generally involves milk pre-treatments, slow acidification via in situ conversion of lactose to lactic acid by added starter, whey separation and/or curd treatment. Thus, processing factors influence the coagulum structure and hence the rheological and physico-chemical stability of the product (Guinee et al., 1993). Mesophilic culture, Thermophilic culture or combination of starter cultures is reported to be used for manufacture of cream cheese. It is used widely as a spread to replace butter. Butter is high fat spread containing 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. According to a report (Anon, 2014), the world demand for cheese is expected to grow at a CAGR (Compound Annual Growth Rate) of 7.3 per cent in terms of revenue from the year 2013 to 2019 and the world cheese market which was valued at USD 72.45 billion in the year 2012 is expected to reach USD 118.44 billion by 2019. Although, there has been quite extensive study about cream cheese, very little work has been published and most of the information is kept secret exclusively within certain food companies, and most of the research works are registered as United States patents (Han, 2002). Today’s trend of consumer is to purchase newer food products which provide acceptable properties including nutrition. Hence, there is a need to explore the possibility of development of technique of Processed cream cheese based (PCCB) spread with certain additives which improve its taste, functionality and better texture than cheese spread available in market (traditionally cream cheese milk is also added with rennet but in this product rennet is totally eliminated).

Materials and Methods

To develop a technology and standard formulation, the study involved several phases; one of them is the selection of starter culture to be used for coagulation of cheese milk for PCCB spread.
Materials used

The milk and cream used for manufacturing PCCB spread was procured from Anubhav Dairy of AAU, Anand. Culture was procured from a supplier of M/S. Chr-Hansen, Denmark. The cultures were (i) FD-DVS R-704 (Lactococcus lactis subsp. lactis; Lactococcus lactis subsp. cremoris), (ii) FD-DVS YF-3331 (Lactobacillus delbrueckii subsp. bulgaricus; Streptococcus thermophilus) and (iii) FD-DVS YF-3331 and FD-DVS ST-BODY-4 (Streptococcus thermophilus).

Whey protein concentrate 70% (WPC 70) was procured from M/S. Mahaan Protein Ltd., Kosi Kalan, Mathura, U.P. One citrate salt viz., tri-sodium citrate (TSC), dehydrate and one phosphate salt viz., di-sodium hydrogen orthophosphate (DSP), dehydrate 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 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 4 per cent fat and pasteurized at 73°C for 16 sec. Then the temperature of milk was lowered to coagulation temperature 42°C as per the starter culture requirement. Rate of culture inoculation was used as prescribed by the manufacturer and time for coagulation was decided based on gel formation of milk at pH 4.8. The milk was poured into S.S. cheese vat in batches of 50 kg. At this stage, three different Starter cultures i.e. R-704, YF-3331 and YF-3331+ STB-4 (combination of two culture) activated in skim milk were added to the milk and kept undisturbed for setting. At pH 4.8, the curd was cut with cheese knife into 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 blend of TSC and DSP @ 0.8 & 1.5 % respectively, WPC and guar gum @ 0.4 percent each, salt @ 1.0 percent and cream (45% fat) @ 45 percent of curd before starting the Stephan kettle. Cheese curd mix was then processed in Stephen Kettle Blender. The PCCB spread is unloaded, weighted and hot packed.

The final products obtained as above were evaluated for their proximate composition, physico-chemical properties, Rheological attributes, microbiological and organoleptic characteristics. Based on the above analysis, the type of culture used for coagulation of cheese milk which resulted in the best product was selected.

Analysis

Compositional attributes

The TS of the PCCB spread samples was determined by standard procedure using Mojonnier Milk Tester Model-D (Laboratory Manual, 1959). Fat extraction was determined as per the procedure described in IS: 2311-1963. Total nitrogen/protein of spread was determined by Semi-Microkjeldahl method (IS: 1479-Part-II, 1961), using Kjel-plus Digestion System (Model-KPS 006L, M/s. Pelican Instruments, Chennai) and Kjel-plus Semi-Automatic Distillation System (Model-Distil M, M/s. Pelican Instruments, Chennai). The ash content of the cheese samples 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 component 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 during Systronic digital pH meter, Model 335 using the method described by Franklin and Sharpe (1963). The water activity (a_w) of spread samples tempered at 25°C temperature, were measured using Rotronic Hygrokop Model: Hygrolab-3 (M/s. Rotronicag, Switzerland). The method prescribed by Deeth et al., (1975) was used to estimate the FFA content – a measure of rancidity of PCCB spread.

Texture profile

Four samples from each of the experimental PCCB spread were subjected to uniaxial 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 Back Extrusion 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 S.S. cylinder for texture analysis of semi solid products.

Sensory evaluation

For the organoleptic evaluation of PCCB spread, 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 (YM C) by the methods as described in IS: 5550 (2005).
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. The statistical model of Steel and Torrie (1980) was used.

Results and Discussion

The influence of type of culture was studied to arrive at a recipe for PCCB spread to standardize the process of its manufacture amenable to industrial application. For selection of type of culture for coagulation of cheese milk R-704, YF-3331 and YF-3331+ STB-4 (combination of two cultures) were selected so that the quality of final product would be compatible and well preferred over the market samples by the sensory panel.

Influence of type of culture used for coagulation of cheese milk on the average proximate composition of Processed cream cheese based (PCCB) spread

The values in Figure 1 show that there was a proportionate significant (P≤0.05) increase in percent of fat and total solids content whereas, protein, total carbohydrate and ash content increased but non-significantly (P≥0.05) and also non-linearly in all the experimental samples with changes in the type of starter culture used in order R-704, YF-3331 and YF-3331+ STB-4 respectively.

The fat content of prepared PCCB sample increased from initial content of 26.80±0.41 per cent in R-704 sample to 29.11±0.47 per cent in YF-3331+ STB-4 sample. It was also observed that all the three culture treatments differed significantly (P≤0.05) with respect to their total solids contents as shown in Table 1.

Influence of type of culture used for coagulation of cheese milk on the Rheological properties of Processed cream cheese based (PCCB) spread

The results depicted in Figure 2 clearly show that type of culture used for coagulation of cheese milk had a significant (P≤0.05) influence on the hardness and cohesiveness properties whereas there was no statistically significant (P≥0.05) influence on all other properties such as springiness, gumminess, chewiness, adhesiveness and stiffness of the final PCCB spread samples.

In case of hardness (N) of the PCCB spread samples, it was observed that the values shown different trend from R-704 to YF+STB. It significantly (P≤0.05) increased from initial 8.64±4.46 N in samples having culture R-704 to 22.51±7.98 N in samples having culture YF in cheese milk and then declined significantly (P≤0.05) to 13.21±1.59 N in samples having culture YF+STB. However, the values of R-704 and YF+STB samples were statistically at par with each other. Whereas the cohesiveness of the PCCB spread samples was significantly (P≤0.05) decreased from initial 0.62±0.08 in samples having culture R-704 to 0.45±0.08 in samples having culture YF in cheese milk and then

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Type of culture used for coagulation of milk</th>
<th>R-704</th>
<th>YF-3331</th>
<th>YF-3331+ STB-4</th>
</tr>
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<tr>
<td>Physico-chemical Character</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Acidity (%LA)</td>
<td></td>
<td>0.98± 0.02</td>
<td>1.12± 0.02</td>
<td>1.15± 0.02</td>
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<tr>
<td>pH</td>
<td></td>
<td>6.192± 0.10</td>
<td>5.500± 0.09</td>
<td>5.644± 0.03</td>
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<tr>
<td>FFA (µ eq/g)</td>
<td></td>
<td>1.792± 0.32</td>
<td>1.824± 0.41</td>
<td>1.968± 0.26</td>
</tr>
<tr>
<td>Water Activity (aw)</td>
<td></td>
<td>0.976± 0.01</td>
<td>0.972± 0.01</td>
<td>0.962± 0.01</td>
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<tr>
<td>Microbial Count</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>SPC (log_{10} cfu/g)</td>
<td></td>
<td>4.118 ± 0.11</td>
<td>4.056 ± 0.27</td>
<td>4.046 ± 0.25</td>
</tr>
<tr>
<td>Yeast &amp; mould (log_{10} cfu/g)</td>
<td></td>
<td>0.577± 0.17</td>
<td>0.595± 0.16</td>
<td>0.631± 0.24</td>
</tr>
<tr>
<td>Curd and Whey Properties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield of curd (% w/w)</td>
<td></td>
<td>14.98± 1.12</td>
<td>16.67± 0.48</td>
<td>18.30± 0.33</td>
</tr>
<tr>
<td>Time for coagulation (min)</td>
<td></td>
<td>381± 25.10</td>
<td>193± 12.04</td>
<td>198± 11.51</td>
</tr>
<tr>
<td>Fat of whey (% w/w)</td>
<td></td>
<td>0.92± 0.13</td>
<td>0.60± 0.16</td>
<td>0.62± 0.08</td>
</tr>
<tr>
<td>TS of whey (% w/w)</td>
<td></td>
<td>7.12± 0.51</td>
<td>5.68± 0.32</td>
<td>6.13± 0.29</td>
</tr>
<tr>
<td>pH of whey</td>
<td></td>
<td>4.822± 0.07</td>
<td>4.778±0.06</td>
<td>4.738±0.08</td>
</tr>
</tbody>
</table>

1. Each observation is a mean ± SD of five replicate experiments (n=5)
2. Each mean 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)
Figure 1: Influence of type of culture used for coagulation of cheese milk on composition of Processed Cream Cheese Based (PCCB) Spread

Figure 2: Influence of type of culture used for coagulation of cheese milk on rheological characteristics of Processed Cream Cheese Based (PCCB) Spread
increased significantly (P ≤ 0.05) to 0.54±0.08 in samples having culture YF+STB. However, the values of YF and YF+STB samples were statistically at par with each other.

Influence of type of culture used for coagulation of cheese milk on physico-chemical and microbial characteristics of processed cream cheese based (PCCB) spread

The values presented in Table 1 show that except for acidity and pH, no other physico-chemical property was influenced significantly (P ≤ 0.05) by type of culture used for coagulation of cheese milk used for the manufacture of PCCB Spread. In case of acidity (%LA) values, it significantly (P ≤ 0.05) increased from initial value of 0.98±0.02 % LA to 1.15±0.02 % LA as culture used was R-704 and YF+STB respectively. However, the values for treatment YF and YF+STB were found statistically at par with each other. It was observed from experimental results that the pH of cheese spread manufactured using culture R-704 was significantly (P ≤ 0.05) higher than that from use of culture YF as well as YF+STB also. Singh and Tewari (1990) reported the values for Acidity (% LA) and pH of Cream Cheese as 0.80 and 4.60 respectively. Phadungath (2005) and Lucey (2002) also reported the pH value of 4.6 in Cream Cheese whereas Karin et.al (2000) reported the pH 4.7 for Cream Cheese. On the other hand Buriti et al. (2007) observed pH 5.05±0.21 and a_w 0.979±0.03 in Fresh Cream Cheese.

All the samples of PCCB Spread were subjected to microbiological analysis for standard plate count (SPC), coliform count and yeast and mold count (YMC).However, the microbial counts of both these attributes were statistically non-significantly influenced. The coliform counts were absent in all the samples of PCCB Spread studied and hence not reported.

Influence of type of culture used for coagulation of cheese milk on sensory attributes of processed cream cheese based (PCCB) spread

The results depicted in Figure 3 clearly show that type of culture used for coagulation of cheese milk had a significant (P ≤ 0.05) influence on all the sensory parameters.

The values of flavour (out of 50), body and texture (out of 20), spreadability (out of 10), colour and appearance (out of 15) and total score (out of 100 including 5 score given to package), show the increasing trend with the cultures, R-704 to YF+STB. The values of all sensory attributes significantly (P ≤ 0.05) increased from initial 40.04±3.93; 14.12±1.49; 6.36±1.25; 11.48±1.03 and 77.00±7.31 in culture R-704 samples to 45.48±1.35; 17.42±0.95; 8.73±0.33; 13.76±0.48 and 90.39±1.02 in culture YF+STB samples respectively for flavour, body and texture, spreadability, colour and appearance and total score.

![Figure 3: Influence of type of culture used for coagulation of cheese milk on Sensory attributes of Processed Cream Cheese Based (PCCB) Spread](image-url)
Preparation of *PCCB Spread* samples in relation to culture selection is very important for deciding the quality of the product. The sensory panel observed that samples having culture R-704 in cheese milk had less lactic flavour as compared to both other samples having YF and YF+STB cultures added in cheese milk respectively. Culture R-704 samples were observed to have very soft body and were more liquid to spread. The YF and YF+STB samples had excellent lactic and cheesy flavour with richness of fat and gave good mouth feel. However, YF cheese samples were having comparatively higher sour flavour and were not liked by judges. The YF cheese samples also had smooth body and good spreadability but had a grainy texture which was not liked by sensory panel. On the other hand, YF+STB cheese spread samples had good soft and smooth body and texture with better spreadability. It was observed that all the three treatment cheese spread samples had good acceptability with regard to their colour and appearance.

Influence of type of culture used for coagulation of cheese milk on cheese curd and whey

The results depicted in Table 1 clearly show that treatments from R-704 to YF+STB had a significant (P \leq 0.05) influence on the cheese curd and whey i.e. yield of curd, Time for coagulation, Fat loss in whey and TS of whey but no significant (P > 0.05) influence was observed on pH of whey. The treatments from R-704 to YF+STB in cheese milk showed significantly (P \leq 0.05) increased values of the yield of curd. The values were highest in samples having culture combination YF+STB in cheese milk. Because of the higher moisture content, it resulted in the maximum yield of curd which was 18.30±0.33 per cent (w/w). The time required for coagulation (min) of cheese milk decreased significantly (P \leq 0.05) from 381±25.10 min in R-704 to 198±11.51 min in YF+STB which was statistically at par with that of YF having 193±12.04 min coagulation time. Similar behavior was also observed in case of % fat of whey and % TS of whey. The % fat of whey observed in R-704 sample was 0.92±0.13 which significantly (P \leq 0.05) decreased to lowest level of 0.60±0.16 in YF samples. However the value was statistically at par with that of YF+STB sample having fat % of 0.62±0.08. The TS in whey (% w/w) was highest 7.12 ±0.51 in whey from R cheese samples which was significantly (P \leq 0.05) higher than those of YF as well as YF+STB having values at par with each other. The pH of cheese whey also differed with each other but non-significantly.

Chen *et al.* (2013) while studying the cream cheese manufactured with different coagulating methods, observed that cheese produced by acid induced coagulation showed the significant increase in cheese curd yield and decrease in its pH towards the iso-electric point of milk.

Conclusions

Based on the findings of experimentation in this study, it was observed that effect of culture R-704 in coagulation of cheese milk tended to produce soft curd which was very difficult to handle and it required highest time for coagulation as compared to cultures YF as well as YF+STB. Because of the softness of the curd observed, higher losses of fat and TS was reported in treatment cheese having culture R-704 which is also reflecting in hardness values. In case of YF and YF+STB samples, it was observed that the curd was firmer and had a lesser fat and TS loss in whey and these samples scored highest organoleptically. The YF+STB samples also scored the highest organoleptic score as compared to R-704 and YF samples of *PCCB Spread*. However, effect of culture i.e. YF and YF+STB on values of coagulation time (min), Fat loss in whey (% w/w) and TS lost in whey (%w/w) were statistically at par with each other but the yield of curd (% w/w) was observed highest in case of treatment YF+STB and thus it was considered as best culture which can be selected for coagulation of cheese milk for *PCCB Spread*. Thus, considering the observations and the economic point of view (₹ 284.47 per kg) along with the sensory perception of *PCCB Spread*, treatment having culture combination of YF+STB was considered optimum for manufacture.

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References


