

A study on microbial contaminations, sources and preventive measures in salted butter production in a commercial dairy plant

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Introduction

Dairy fat spreads are milk products relatively rich in fat in the form of a spreadable emulsion principally of the type of water-in-milk fat that remains in solid phase at a temperature of 20 °C (Codex Standard for Dairy Fat Spreads, 2006). There are two kinds of butter as sweet cream and ripened-cream. Sweet cream butter may or may not contain salt (Fernandes, 2008). To overcome the high demand of butter, a reputed dairy company in Sri Lanka engages in manufacturing salted butter. However, finish product frequently contain high microbial load before releasing to the packing which leads to quick rancidity. Consequently, it has become a problem to the company to obtain a profit. Therefore, this research was carried out to assess microbiological quality at different production steps to determine the sources of microbial contamination in salted butter production.

Methodology

A preliminary study was carried out to identify possible sample collection points including swab sampling points during production process. Samples were collected from raw cream, before and after pasteurization, after aging, during churning, final product, and wash water of butter granules and the churner. Swab samples were collected from cream and aging vats, hands of permanent workers (randomly), and inside and outside of the churner. Time and temperature during storage of cream in the cream vat, pasteurization and aging were recorded. Sample collection procedure was repeated for every batch up to identification of the contamination points. Quality of samples was evaluated by performing microbiological tests (total colony count, Coliform and fecal Coliform). According to the test results, contamination points were identified and microbiological (*E. coli*, yeast, and moulds), chemical (free fatty acid level of the final products) and physical (foreign matter observed from naked eye) properties were further analyzed. Entire tests were conducted in triplicate according to the analytical testing procedure of company. Data were finally analyzed by mean value comparison using Microsoft Excel 2013. Further, analyzed data were compared with the standards (SLS 279:1988).

Results and Discussion

According to the preliminary analysis, raw cream was stored for 4-5 hours at 7-8 °C in a cream vat. Mean total colony count in raw cream of seven batches was ranged from 110×10^6 to 127×10^6 cfu/g and Coliform and fecal Coliform bacteria were detected in all samples tested. After pasteurization (95 °C, 20 minutes), mean total colony count of all samples were lower than 10^4 cfu/g and after aging (5-7 °C, 12 hours) (Table 01). *Coliform* and fecal *Coliform*

bacteria were detected in all samples tested however, after pasteurization and aging, *Coliform* and fecal *Coliform* bacteria were not detected in any of the samples.

Table 01: Average total colony counts (cfu/g) of raw cream

Batch no.	B. P ($\times 10^6$)	A.P ($\times 10^3$)	A.A ($\times 10^3$)
A	111 \pm 9.07	66 \pm 7.37	65 \pm 3.21
B	124 \pm 7.00	49 \pm 14.98	52 \pm 5.69
C	129 \pm 2.52	49 \pm 16.29	52 \pm 9.50
D	131 \pm 3.05	57 \pm 8.39	59 \pm 2.00
E	118 \pm 12.34	41 \pm 8.19	44 \pm 3.05
F	119 \pm 2.08	34 \pm 3.00	40 \pm 2.08
G	126 \pm 3.00	46 \pm 3.51	53 \pm 6.03

B.P-Before Pasteurization, A.P-After Pasteurization, A.A-After Aging

Before churning, the mean total colony counts in aged cream were ranged from 44×10^3 to 67×10^3 cfu/g in all samples. However, after washing, the mean total colony count was decreased to a range of 19×10^3 to 53×10^3 cfu/g. Before churning, *Coliform* bacteria were not detected in samples tested (except B). However, “before washing” *Coliform* bacteria were detected in the four samples (A, C, D and G). Furthermore, products after washing and final products from these four batches contained *Coliform*. *Coliform* bacteria were not detected in chilled pasteurized water samples (0-2 °C). However, *Coliform* was detected in swabs taken from inside of churner in A, B, C, D and G batches. Swabs obtained from outside of churner and random swab samples of the permanent workers’ hands were negative for *Coliform*. Thus, churning process was identified as the contamination point of *Coliform* during salted butter production and samples collected from contamination points from new four batches were further analyzed.

The mean total colony counts in four batches were ranged between 30×10^3 – 64×10^3 cfu/g. During churning, the mean yeast counts ranged from 137 to 670 cfu/g and mould counts ranged between <10 and 50 cfu/g in samples of tested batches. However, before washing, *Coliform* bacteria were detected in the samples of A1, B1, D1 batches. Further, *Coliform* was detected after washing and in final product of same batches. *Coliform* bacteria were not detected in chilled pasteurized water samples (0-2 °C) used to wash the butter granules in all four batches during churning. In swabs analysis; *Coliform* was detected in swabs taken from inside of churner in A1, B1, D1 batches. However, swabs obtained from outside of the churner were negative for *Coliform*. This confirms the results of the preliminary analysis which was due to improper sanitary conditions of the churner inside. Hence, water used to wash the churner (before production) was also analyzed. Results showed that this water (27-30 °C) contained *Coliform* in batch A1, B1, and D1.

To prevent the contamination, hot water and steam cleaning implementation was done during washing. According to the Robinson and Tamime (2002), hot water and steam were the best sanitizers against gram-positive and gram-negative bacteria and yeast. Cords and Dychdala (1993) reported that combination of hot water and steam are more efficient than dry heat. Therefore, samples from four batches; A2, B2, C2, and D2 of salted butter were analyzed after the implementation of hot water (70-75 °C, 15 minutes) and steam (80-85 °C, 5 minutes)

cleaning. Further, samples from six batches; A3, B3, C3, D3, E3, and F3 of salted butter were analyzed after implementation of hot water and steam treatment as above. In wash water analysis; Coliform bacteria was not detected in both samples. In swabs analysis; Coliform bacteria was not detected in swabs taken from the inside and outside of churner. With the increasing water temperature, the mean total colony count was reduced in both tested batches. Yeast and moulds counts were within the standard level except B2. After implementation of hot water and steam treatments, samples of tested batches were within the standard level. Coliform were not detected in all samples tested. White (1996) stated that, Coliforms were destroyed by pasteurization therefore according to the analysis; product had not been contaminated after pasteurization, due to implementation of hot water and steam.

In chemical analysis; before implementation of the hot water and steam, the mean free fatty acid level of the final products were ranged between 0.22 and 0.52 and only one batch was within the standard level among the tested batches. After implementation of hot water (70-75 °C) and steam, it was ranged between 0.29 and 0.40 and after implementation of 75-80 °C hot water and steam; it was ranged between 0.24 and 0.30. Accordingly eight batches (among ten batches) were within the standard level. Moreover, with the temperature increment of the wash water, free fatty acid level of the final product was lower than the previous. Furthermore, no physical contaminants were observed in all tested batches.

Conclusion

Water used to wash churner was the main contamination source of Coliform in salted butter production. Microbiological and chemical quality of salted butter can be improved by using hot water (75-80 °C, 15 minutes) and steam (80-85 °C, 5 minutes) for cleaning the churner.

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