

Effect of Different Pasteurization Temperature-Time Combinations on Shelf Life of Raw Cream in Relation to its Microbiological, Chemical and Physical Properties

C.N.P. Gunawardana, D.C. Mudannayake
Uva Wellassa University, Badulla, Sri Lanka

and

M.N.P. Perera
Fonterra Brands Lanka (pvt) ltd. Biyagama, Sri Lanka

Introduction

Cream is a vital ingredient in manufacturing of many dairy products. Cream is a good substrate for microbial growth due to its high nutritional value. Generally, in dairy processing factories separated cream is held on a period of time prior to incorporation in to the dairy products. The spoilage of cream from separation till the production of dairy products has been a critical problem to producers. The treatments which are given and the conditions under which cream is held will have a direct effect on its keeping quality. Shelf life of raw cream currently produced as an ingredient for curd production at Fonterra Brands Lanka (Pvt) Ltd is estimated to be approximately four days at 4 °C. Therefore a method that could be used to extend the keeping quality of raw cream beyond four days would be a helpful and economical to the industry. Pasteurization of raw cream after separation can be done to improve the keeping quality. As there are no regulations governing heat treatment of cream in Sri Lanka, the time/temperature combinations used vary widely in practice. This investigation was undertaken to determine the effective pasteurization temperature/time combinations to improve the keeping quality of cream.

Methodology

Raw cream (60% fat) sample was obtained from the cream separator (Serial no: 95078, Frautech, Italy) in the factory. Initially the fat content of the sample was measured according to the Gerber method described in IDF 152 A: 1997.

4 kg of cream sample was divided in to 1 kg of four samples separately. Each 1 kg of cream sample was transferred in to Duran bottles aseptically and three bottles were used for each of the temperature. The cream filled Duran bottles were held in four temperatures as 72 °C (T1), 75 °C (T2), 78 °C (T3) and 81 °C (T4) for 15 seconds in the water bath (model: Wb29, Memmert, Germany). A thermometer inserted (OAKION, serial number; 2347890754, England) cream filled Duran bottle was kept along with samples in each trial to check the accuracy of the pasteurization temperature. Each temp trial was replicated. A complete randomized design was used to ensure that each temperature and time held a same position in processing in each three replicate. After heat treatment samples were cooled by immediate immersion in running cold water at about 12 °C for 10 minutes and then the samples were transferred aseptically in to cups. As the control sample other 1 kg of cream sample was used. All the cups were kept in the cold room which has a temperature of 4 ± 1 °C.

Initially microbiological (Aerobic plate count, Yeast and Moulds, Coliform), chemical (pH, titratable acidity) and physical parameters (colour, texture, odour, appearance) of cream samples were measured by getting three cups from each sample. All above

parameters were checked in 3 days interval for 30 days at temperature 4 °C. The pH and titratable acidity data were analyzed by ANOVA (Analysis of variance) and Duncan New Multiple Range Test (DNMRT) from the statistical software package SAS 9.0.

APC, Yeast and Moulds, coliforms were tested in cream processing area and handling equipments as well.

Results

As there are no regulations governing heat treatment of cream in Sri Lanka, the microbiological limits set out by the Bureau of Indian standards (2006) were used in this study; APC < 10⁷ CFUg⁻¹ (Raw Cream) and < 6 × 10⁴ CFUg⁻¹ (Pasteurized Cream), Coliforms < 100 CFUg⁻¹ (Raw Cream) and < 10 CFUg⁻¹ (Pasteurized cream), Yeasts < 1000 CFUg⁻¹ and Moulds < 10 CFUg⁻¹ (Raw cream), Yeasts < 100 CFUg⁻¹ and Moulds < 1 CFUg⁻¹ (Pasteurized cream).

APC of control sample exceeds its microbiological limit (The Bureau of Indian standards, 2006) after the 3rd day of refrigerated storage (4 °C). But APC of treatments T1, T2, T3 and T4 exceed the microbiological limit (The Bureau of Indian standards, 2006) after the 9th, 12th, 15th, 9th days respectively. T1 and T4 exceed microbiological limit at the same day (9th day) at refrigerated storage. On the 9th day APC of T1 (6.97 × 10⁴ CFUg⁻¹) was greater than T4 (6.84 × 10⁴ CFUg⁻¹).

Yeasts and Moulds were not detected in any treatment sample during the whole period of storage at 4 °C. After the 3rd day Yeasts and Moulds were increased markedly in control sample. At the end of the storage (30 days) Yeast and Mould counts detected in the control sample were 2.8 × 10² CFUg⁻¹ and 2.91 × 10² CFUg⁻¹ respectively.

Throughout the study coliforms were not detected in any of the cream samples.

Initial pH of the treatments (T1, T2, T3, and T4) 6.74, 6.73, 6.75 and 6.72 were declined with time up to 5.13, 5.79, 5.83 and 5.62. Control sample had the lowest initial pH value (6.71) compared that of pasteurized samples. pH of the treatments T1, T2, T3 and T4 decreased markedly after 9th, 12th, 15th and 9th days.

Similarly titratable acidity of the treatments T1, T2, T3 and T4 were increased markedly after 9th, 12th, 15th and 9th day respectively. Titratable acidity of control sample was rapidly increased after the 3rd day.

Colour of the T4 sample was impaired (turned to yellow colour) after pasteurization compared to other treatments. In the refrigerated storage, all the cream samples were thickened and the gelation was occurred and also slight putrefactive odour was occurred. Mould growth on the surface was observed only in the control sample at 5th day of refrigerated storage.

Discussion

Adherence to relevant regulatory requirements, not allowing microbial counts to exceed regulatory limits is important in determining the shelf life of cream. In the T4 (81 °C) APC was increased significantly after 9th day compared to other treatments. This is an agreement with Robinson (1999) who stated that a higher temperatures than 80 °C may impair cream quality, possibly through activation of bacterial spores.

Yeast and Mould colonies were not observed in treatment samples, while mold growth was started after 5th day of control sample. These results are due to destruction of Yeasts and Moulds in cream by the pasteurization.

Throughout the study coliforms were not detected in any of the cream samples. These observations can be explained by the results of microbiological evaluation of the cream separation environment and the cream handling equipments in the factory. Coliforms were not detected in the floor of the cream separation area, neither in containers used to store cream nor in the cream separator. The results indicated that a high level of hygiene is maintained throughout the cream separation and storage in the factory.

There was a significant ($P < 0.05$) difference in pH of pasteurized and the control samples that is mainly due to pasteurization. According to DNMRT the higher mean value for pH was in the T3.

After the 30 days of storage at 4 °C titratable acidity was very high in the control sample (0.297) than the treatments (T1-0.179, T2-0.169, T3-0.157, T4-0.218). The increment of titratable acidity is a reflection of souring activity due to lactic acid produced by microorganisms. According to Hammer, 1948 acid production by *S. lactis* is dominated in raw cream stored in 4 °C. The increase of titratable acidity of control samples during the refrigerated storage can be explained with this statement. There was a significant difference ($P < 0.05$) in lactic acid development during refrigerated storage of control and pasteurized cream samples. This could be due to the fact that pasteurization destroys many of the lactic acid producing microorganisms.

The yellow colour development in T4 was due to the high pasteurization temperature. According to the Robinson (1999) lipolytic enzymes produced by psychotropic bacteria can result from long refrigerated storage of pasteurized cream. Psychotroph-derived proteases may also cause spoilage involving thickening and gelation. According to the findings of Robinson (1999) the thickening was accompanied by a slight putrefactive odour.

Conclusions

Pasteurization of raw cream shows a higher shelf life than the raw cream in refrigerated storage (4 °C). pH and titratable acidity of the treatment samples were significantly differ ($P < 0.05$) compared to control sample. From mean values in DNMRT the highest pH and the lowest titratable acidity were in the sample that was pasteurized to 78 °C for 15 s. According to physical parameters minimum changes during the refrigerated storage was observed in sample pasteurized to 78 °C for 15 s. T1, T2, T3, T4 and control sample had shelf life of 9, 12, 15, 9 and 3 days respectively according to microbiological data (The Bureau of Indian standards, 2006). The highest shelf life was detected in the sample pasteurized to 78 °C for 15 s. The overall conclusion is that, it is possible to extend the shelf life of the raw cream by pasteurization process beyond four days. The best temperature time combination is 78 °C for 15 s.

References

- Bureau of Indian standards specifications, 2006. Bureau of Indian standards, New Delhi
- Codex standards for cream for direct consumption, 2003. Codex Alimentarius Commission.
- Crossley, E.L. 1948. Bacteriological flora and keeping quality of pasteurized liquid cream. Journal of Dairy Research, 15:261-276
- Robinson, R.K. 1999. Modern dairy technology, Aspen publishers, Maryland, 1:61-101.