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Effect of different temperatures on cream separation

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Abstract

Cream is a valuable dairy product used in the production of butter, ghee, ice cream, and other dairy-based items. This study aims to evaluate the yield of cream from milk containing 6% fat at different temperatures using a centrifugal cream separator. The data were compared to ascertain the influence of temperature on cream yield, and statistical analysis was conducted to contrast the findings. The findings indicated that cream yield improved with increasing temperatures up to an optimum point, after which excessive heat lowered efficiency as a result of fat globule stability changes. The maximum cream yield occurred at 25 and 35°C, being 38-39%, suggesting that these temperatures offer the optimum separation conditions. The results identify the optimum range of temperature for maximum cream yield as 30⁰-35⁰C.

Keywords: Cream separation, Milk fat (6%), Centrifugal cream separator, Separation efficiency, Temperature effect, Fat globule stability

Introduction

Milk is a multi-component emulsion of globules of fat suspended in an aqueous medium of proteins, lactose, minerals, and other vital nutrients. Cream separation takes place on the basis of the principle of density difference between milk fat and the surrounding skim milk. Effective cream separation is very important in the dairy industry because it has a direct bearing on product yield, quality, and economic returns Tamime, (2009)^[12], Deosarkar, *et al.*, (2016)^[3]. Among the various factors affecting cream separation, temperature is important as it changes the physical properties of fat globules such as size, stability, and aggregation behaviour. Cream is an important dairy product employed in butter making, ghee production, ice cream manufacture, and other dairy products. The effectiveness of cream extraction not only affects the quantity but also the quality of the end product (Fox and McSweeney, 2006^[8], Lampert, 2010)^[7]. Conventional cream separation techniques involve gravity creaming and centrifugal separation, with the latter used extensively in the dairy industry because of its speed and efficiency. But the efficiency of cream separation is influenced by numerous factors such as fat content, temperature, centrifugal force, and processing time. Temperature exerts a great influence on the viscosity of milk, globule aggregation of fat, and the overall efficiency of cream separation. At reduced temperatures, fat globules aggregate, making the milk more viscous, which may interfere with efficient separation (Chandan and Kilara, 2013)^[1]. When temperatures are increased, viscosity decreases, and fat becomes mobile, enhancing separation. When temperatures are too high, however, they destroy the structure of fat globules, causing emulsification and decreasing the efficiency of separation (Walstra and Jenness (1984)^[14]. The aim of this research is to assess the cream yield from milk containing 6% fat at various temperatures. Through knowledge of the influence of temperature on cream separation, dairy processors can fine-tune their processes to attain maximum cream yield with preservation.

2. Materials and Methods

The experiment was carried out to assess the yield of cream from 6% fat milk at various temperatures by the use of a centrifugal cream separator in the laboratory of Dairy Science at Chhatrapati ShivajiRaje Mahavidyalaya, Udgir. The milk samples were prepared at different temperatures prior to separation, and the yield of cream for each temperature treatment was noted.

Fresh milk containing a standard fat content of 6% was purchased from local market and split into four equal samples. Each of the samples was heated or cooled to one of the temperatures listed below:

5°C (Cold Condition),

15°C (Slightly Cold Condition),

25°C (Room Temperature Condition)

35°C (Warm Condition), A water bath was employed to set the temperature of each milk sample accurately. A thermometer was used to monitor the temperature continuously to ensure accuracy.

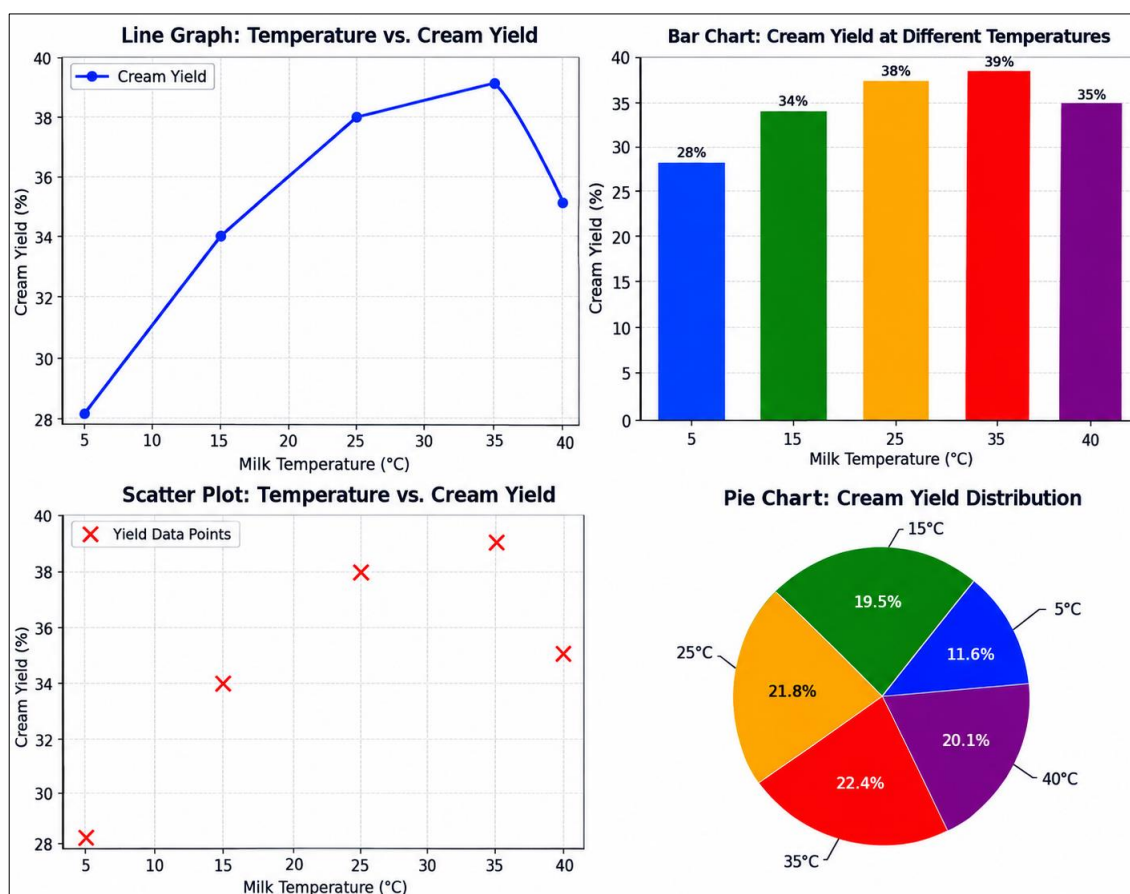
The centrifugal cream separator was assembled and cleaned based on the instructions of the manufacturer. The milk

sample in the required temperature was filled into the feeding bowl of the separator. The separator was run at a fixed speed to provide a uniform separation for all experiments. Cream and skim milk were separately collected in measuring graduated cylinders. The separation process was performed for a constant time for maintaining consistency. The yield of cream from each sample was weighed and noted. Cream yield was reported as a percentage of the volume of milk treated. The experiment was repeated three times for each temperature to get precise and reproducible data. The data were examined to check the influence of temperature on cream yield, and statistical analysis was carried out to compare the data.

Results and Discussion

Table 1: Influence of Temperature on Cream Yield from 6% Fat Milk

Milk-Temperature (°C)	Total Milk Processed (L)	Cream Yield (L)	Cream Yield (%)	Observations
5°C(Cold Condition)	10	2.8	28%	Thick, high viscosity, slow separation.
15°C(Slightly Cold)	10	3.4	34%	Moderate viscosity, improved separation.
25°C(Room Temp.)	10	3.8	38%	Good separation, optimum yield.
35°C(Warm Condition)	10	3.9	39%	Maximum yield, smooth separation.
40°C(High Temperature)	10	3.5	35%	Slight emulsification, decreased yield.-



As the milk temperature increased from 5°C to 35°C, the yield of cream enhanced. At 5°C, the separation rate was slow under high milk viscosity, which produced lower cream recovery (28%). A research by McCarthy, *et al.*, (1997)^[8], Sharma, *et al.* (2017)^[10] studied the influence of temperature and centrifugal force on cream recovery from standardized milk. Their findings indicated maximum cream

yield to occur at 30°C to 35°C, wherein fat globules were intact, and viscosity was low enough for successful separation. Outside this range, extreme heating caused emulsification, which compromised the efficiency of cream recovery. The present investigation corroborates with Brook (2014)^[2] and Singh and Patel (2020)^[11] they also recommended in their study that warming milk beforehand

to between 25–35°C prior to centrifugal separation led to an additional 15% increase in cream yield as compared to non-heated milk or overheated milk. At 15°C, the cream recovery enhanced to 34%, owing to decreased viscosity, facilitating freedom of movement in fat globules. At 35°C and 25°C, the maximum cream yield was found to be 38–39%, proving the best temperature condition for separation. Above 35°C (40°C), the cream yield decreased slightly to 35%, which might have resulted from partial emulsification and fat globule instability, degrading the separation efficiency. The presentation relates with Mehta and Deeth (2016)^[9], and Kumar *et al.* (2019)^[6] who examined cream separation efficiency in milk with varying fat contents (3%, 4.5%, and 6%). Their findings confirmed that higher fat content milk (6%) yielded more cream, but the efficiency was highly dependent on processing temperature (Wijesundera and Shen, 2016)^[15]. At lower temperatures, fat retention in skim milk increased, reducing cream recovery. With low temperatures, fat globules agglomerate, resulting in increased viscosity, hindering cream separation. Increasing the temperature decreases viscosity and fat globule mobility, which enhances separation efficiency. Temperatures above 40°C, however, lead to partial homogenization, which decreases separation efficiency. At lower temperatures (5°C, 15°C), the cream was thicker, with a higher viscosity, making it harder to separate. At 25°C–35°C, the cream had a smooth and consistent texture, ideal for processing. At 40°C, the cream started showing signs of partial emulsification, which affected separation efficiency. Similar results have been reported by Hussain (2017)^[5] and Singh and Patel, (2020)^[11] and Vekariya, *et al.*, (2024)^[13].

Conclusion

From the present investigation it is concluded that the cream yield increased with rising temperatures up to an optimal level. Above this level, excessive heat reduced efficiency because of changes in fat globule stability. The maximum cream yield occurred at 25 and 35°C, reaching 38-39%. This indicates that these temperatures offer the best conditions for separation. The optimal temperature range for maximum cream yield is 30°-35°C.

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