

Production of Traditional Indian Butter (*Makkhan*): Process Improvement and Quality Assessment

ABSTRACT

Makkhan is a very popular, widely consumed, and commercially important traditional cultured fat rich milk product of the Indian subcontinent. Conventional production practices of products from fermented whole milk or *malai* (i.e. clotted cream) lead to products of variable qualities, greater amount of fat loss in buttermilk (i.e. *chhach*) with low volume of *makkhan* production. Since the inception, rarely any scientific study is conducted either on improvement in the characteristics of product or the production process of *makkhan*. The present research was designed to study the characteristics of available *makkhan*, to improve the process for production of *makkhan* from creams with size differentiated milk fat globules (MFGs), and to study its impact on quality characteristics and storage properties of the product for large scale production. A comparative study was made between fresh cow and buffalo milk *makkhan* samples procured from households at different locations of India in terms of physico-chemical and sensory characteristics. To produce creams with size differentiated MFGs, the inside geometry of a commercial small scale cream separator was modified. To achieve MFGs above a size of 3 μm (i.e. cut-off diameter, d_c) in cream by modified separator, the combined influence of different levels of disc spacing (1, 1.5 and 2 mm), bowl speed (3500 4000, 4500 and 5000 rpm), and feed rate (650, 700, 750, 800, and 850 $\text{mL}\cdot\text{min}^{-1}$) were tested by a mathematical model and experimental validation processes. A two-stage modified separation approach was further adopted to minimize MFGs with diameter less than 3 μm in creams and compared with cream produced using the unmodified cream separator in relation to MFGs size, fat content, fatty acid composition and thermal properties. Then fermentation of standardized and processed cream samples was done with an activated mesophilic lactic acid bacteria at 30°C for 10 h. Churning was conducted at two temperatures i.e. 13°C and 19°C. Impact of process improvement was evaluated in terms of quality attributes of *makkhan*. The *makkhan* samples produced with improved properties stored for one month at refrigeration (5°C) and frozen (-18°C) storage, and samples were evaluated for physico-chemical properties, oxidative stability and sensory characteristics at 15 days interval. There were slight variations (not significant) between cow milk *makkhan* (CMM) and buffalo milk *makkhan* (BMM) samples. CMM samples were found to contain higher amount of saturated fatty acids (SFA), while BMM samples were found to contain higher proportion of conjugated linoleic acid (CLA). Both *makkhan* samples showed solid-like behaviour at 22°C. For production of cream with size differentiated MFGs in the modified separator, the final experimental validation indicated that combined influence of 1.5 mm disc spacing, 700 $\text{mL}\cdot\text{min}^{-1}$ feed rate, and either 4000 or 4500 rpm bowl speed was found most suitable to achieve the d_c . In two-stage cream separation process, cream samples from second stage contained MFGs of higher average size, higher proportion of large milk fat globules (LMFGs), solid fat and SFA. The fermentation characteristics were found comparable in all samples. Churning of each fermented cream at 13°C was observed to take slightly longer time. Churning of fermented cream samples from second stage prevented fat loss in buttermilk significantly, *makkhan* produced with significantly higher yield and increased fat recovery, improved proximate composition, microbiological properties, acceptable amount of flavour, higher amount of CLA, lower amount of SFA, and the samples possessed good spreadability at 22°C. *Makkhan* samples produced with improved characteristics didn't show any significant change in physico-chemical and microbial properties during storage, but titratable acidity, oxidative stability in the samples stored at 5°C were found to increase at relatively faster rate. More amount of flavour was accumulated in the samples stored at -18°C. The present study validated the few important claims made earlier regarding characteristics of *makkhan*. The developed process for production of *makkhan* from cream samples with higher average size and higher proportion LMFGs brought significant improvement in quality attributes of *makkhan*, and that process could be recommended for large scale production of *makkhan*.

Keywords: Whole milk, modified centrifugal separation, cream, *makkhan*, milk fat globules size, quality attributes, storage properties