

Development of Ricotta cheese spread by using basket centrifuge

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Abstract: Maximum whey drainage is an important criterion in development of Ricotta cheese spread (RCS) as it ensures maximum removal of lactose from the cheese curd. Mechanization at small scale for preparation of RCS from Mozzarella cheese whey has been investigated by intervention in the whey drainage process using basket centrifuge. In the present study conventional method of whey drainage was replaced with basket centrifuge where whey drainage was carried out at different rpms (i.e., 1000, 1500, 2000 and 2500) for different time periods (i.e., 1, 2, 3, 4 and 5 min) and then moisture content in the curd was determined. The results indicated that with increase in centrifugal speed (from 1000 to 2500 rpm) and time period (from 1 to 5 min) there was a significant reduction in moisture content of the curd. The percentage reduction in the moisture content of cheese curd after centrifugation at 1000, 1500, 2000 and 2500 rpm for 5 min was observed to be 1.68%, 5.78%, 7.28% and 8.72% and corresponding yields of the curds were 7.2%, 6.33%, 5.86% and 5.13%, respectively. Curds obtained from basket centrifuge (at 2500 rpm for 5 min) and conventional methods were used to prepare the RCS and both the products were equally acceptable based on sensory evaluation. Use of basket centrifuge showed substantial attainment in reduction of time for the process of drainage of whey which is otherwise a time and capital intensive process.

Keywords: Ricotta Cheese Spread; Basket Centrifuge; Whey Drainage; Moisture Content

Cheese is emerging as a fastest growing segment in dairy in India. The cheese market in India has been reported to reach a value of INR 56.7 billion in 2021 and expected to reach INR 211.5 billion by 2027 at CAGR of 24.3% during 2022-2027 (IMARC, 2022). Varieties of ripened and fresh cheeses are now being manufactured and sold in India viz. Cheddar, Mozzarella, Swiss, Gouda, etc. Whey, which is the major by-product of the cheeses, is known to be a nutritionally rich, containing large amount of organic matter such as whey proteins, lactose, minerals, etc. The gross composition of cheese whey on the basis of dry matter has been observed as 45-50 per cent total milk solids, 70-80 per cent lactose, 9-20 per cent proteins (mainly whey proteins), 8-20 per cent minerals (Kinsella and Morr, 1984; Hortan, 1995). Conversion of whey into nutritionally rich value added products can provide good opportunity to cheese entrepreneurs and consumers.

Whey cheeses are one such category which can be explored from the perspective of Indian consumers and cheese entrepreneurs and can be promoted both from commercial and nutritional point of view. Ricotta Cheese is a soft Italian unripened whey cheese known for its yellowish-white color and has a compact mass and granular texture (Ortiz Araque et al. 2018; Rubel et al. 2019). Ricotta cheese can be prepared with whey, milk, or milk/whey mixtures. The process of Ricotta cheese making involves co-precipitation of whey proteins and casein using suitable coagulant at suitable time-temperature combination and pH (Shelke et al. 2022; Lucey 2022). It is consumed fresh due to its susceptibility to microbial spoilage even under refrigeration condition, probably due to its high pH, high moisture content, low salt content, and water activity very close to unity (Martins et al. 2010). Bhatti et al. (2021) developed the probiotic Ricotta cheese in which limitations of Ricotta cheese developed from whey were discussed with special emphasis on prolonged time taken during drainage of whey from cheese curd and whey syneresis during storage of Ricotta cheese. To overcome the issue of whey syneresis in Ricotta cheese, hydrocolloids were added into the cheese followed by thorough blending and the cheese was converted into a spread like product known as Ricotta cheese spread (RCS). The overall process of making RCS takes

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approximately 12-18 hours in which a major share of time was consumed during the whey drainage carried out under refrigerated conditions which makes it a time and capital intensive process as well as product becomes more susceptible to microbial growth. Therefore, in the present study, attempts have been made to use basket centrifuge as a whey drainage mechanism for cheese curd preparation for making RCS.

Mozzarella cheese whey (fresh and sweet) was collected during Mozzarella cheese preparation from the Experimental Dairy Plant (EDP) of the College of Dairy Science and Technology, Ludhiana. Standardized mixed milk (4.5% fat and 8.5% SNF) was also procured from the EDP of the college. Good quality common salt and citric acid were obtained from the local market for the preparation of RCS. Guar gum used as hydrocolloid was procured from HiMedia Laboratories, Mumbai, India. Total solids, fat, protein content and % titratable acidity of Mozzarella cheese whey and mixed milk samples were analyzed by method described in IS (1981). pH of the samples was determined by using digital calibrated hand pH meter (pH5, Cole Parmer, Mumbai, India).

Conventional method of Ricotta cheese was prepared as per the method described by Bhatti (2021). Sweet Mozzarella cheese whey was heated to 50°C to stop the growth of starter culture followed by addition of standardized mixed milk (4.5% fat and 8.5% SNF) with whey/milk mixtures of 80:20. The whey/milk mixture was heated to 90°C and when the temperature was attained, citric acid (5%, w/v) was added into it to acidify the mixture to pH 5.4. The flocculated protein rises to the surface and the curd along with Ricotta cheese whey (scotta) was allowed to rest for 20 minutes to complete the coagulation process. Later, curd was recovered and whey (also called scotta) was drained. In conventional method, curd obtained was hung overnight (14-15 h) for drainage using a clean muslin cloth under refrigerated condition (4°C).

Mechanized method for the manufacturing of Ricotta cheese was almost same as conventional except the whey drainage. Here whey drainage using muslin cloth was replaced with basket centrifuge with perforated cylindrical bowl (Deepali United Manufacturing Pvt. Ltd., Mumbai, India; capacity 200-500 g) carried out at different rpms (i.e., 1000, 1500, 2000 and 2500) for different time periods (i.e., 1, 2, 3, 4 and 5 min). Prior to use, the basket centrifuge and polypropylene bag which was fitted in the perforated cylindrical basket were cleaned with hot water at 80°C and dried. Moisture content of Ricotta cheese curd was analyzed as per the method described for cheese in IS (1981).

Ricotta cheese samples prepared by conventional and mechanized method were analyzed for its moisture content. The final moisture content of Ricotta cheese was adjusted to 75% for making RCS by using the formula given below.

$$X = (M_2 - M_1 / 100 - M_2) \times G$$

Where,

M_1 = % Moisture present in Ricotta cheese curd

G = Weight of cheese in gram

M_2 = % moisture required in RCS (75%)

X = Amount of water in gram to be added in Ricotta cheese curd

For the preparation of RCS, calculated amount of previously boiled water along with mixture of guar gum (0.4%) and common salt (1.5%) was added to the Ricotta cheese and further homogenized by using hand blender to produce smoother consistency. RCS was hot packed in pre-sterilized polypropylene cups (50 ml capacity) and stored at 4°C until further analysis.

A selected sensory panel assessed the coded RCS samples at random, according to the methodology described in Indian standards (IS, 1971). Sensory evaluation of samples was carried out with a 6-member panel who were scientists and students of College of Dairy Science and Technology, Ludhiana. The panelists had a good knowledge on the sensory evaluation of dairy products and participated previously in such evaluations. Samples were first prepared and then kept in a refrigerator at 4°C

Table 1 Effect of centrifugal speed and time on moisture content of Ricotta cheese curd prepared by basket centrifuge

Centrifugal speed (rpm)	Time (min)	Moisture content (%) in Ricotta cheese curd
1000	1	73.16±0.09 ^a
	2	73.12±0.06 ^a
	3	72.08±0.09 ^c
	4	71.83±0.11 ^d
	5	71.47±0.04 ^e
1500	1	72.83±0.07 ^b
	2	70.55±0.08 ^f
	3	68.94±0.05 ^h
	4	67.73±0.04 ^j
	5	67.49±0.05 ^k
2000	1	71.48±0.05 ^e
	2	68.42±0.06 ⁱ
	3	67.19±0.06 ^l
	4	65.72±0.02 ^m
	5	64.87±0.06 ^o
2500	1	70.05±0.06 ^g
	2	65.32±0.07 ⁿ
	3	62.62±0.08 ^p
	4	60.93±0.05 ^q
	5	59.74±0.09 ^r

Data are presented as Mean ± SD, n =3. Means with different lowercase superscripts are significantly different (P < 0.05) from each other.

Table 2 Effect of centrifugal speed on per cent moisture reduction and yield (%) of Ricotta cheese curd obtained by using basket centrifuge

Centrifugal speed (at different rpm for 5 min)	Moisture reduction (%) in cheese curd	Yield (%)
1000	1.68±0.03 ^d	7.20±0.02 ^a
1500	5.78±0.01 ^c	6.33±0.02 ^b
2000	7.28±0.04 ^b	5.86±0.02 ^c
2500	8.72±0.04 ^a	5.13±0.07 ^d

till sensory evaluation by panel. Each RCS sample was presented in a polypropylene cup filled with 20 g sample and labeled with a 3-digit code. Sensory evaluation of the samples was carried out in the sensory evaluation room under appropriate fluorescent lighting. Each panelist was asked to taste the samples and rate the sensory parameters on a 9-point hedonic scale and the acceptance test was carried out for the attributes of flavour, mouthfeel, colour and appearance, spreadability and overall acceptability. For spreadability parameter, panel members were provided with a spatula and bread and they were asked to spread the samples on the bread to evaluate the parameter.

Mean values and standard deviations (SD) of triplicate determinations were calculated using Microsoft excel (Microsoft office, 2010). All statistical analyses were performed using SPSS 16. One way analysis of variance (ANOVA) was used to determine differences among treatment means at 95% confidence interval.

Mozzarella cheese whey and mixed milk were used as raw materials at the ratio of 80:20 for preparation of Ricotta cheese curd followed by RCS. Mozzarella cheese whey contained 7.01% total solids, 0.78% fat and 0.9% protein whereas mixed milk contained 13.57% total solids, 4.5% fat and 3.52% protein. Higher titratable acidity (0.15% lactic acid) and lower pH (6.32) values were observed in Mozzarella cheese whey compared to full fat milk (0.13% lactic acid and pH 6.66).

Conventional method of whey drainage was replaced with basket centrifuge where whey drainage was carried out at different rpms (i.e., 1000, 1500, 2000 and 2500) for different time periods (i.e., 1, 2, 3, 4 and 5 min). The moisture content of Ricotta cheese was observed to be 70.94% when prepared by conventional method of whey drainage. On the other hand, with the use of basket centrifuge at different rpms, the moisture contents observed at 1000, 1500, 2000 and 2500 rpm at different time periods (from 1 to 5 minutes) were in the range of 73.16-71.47%, 72.83-67.49%, 71.48-64.87% and 70.05-59.74%, respectively (Table 1). The results indicated that with increase in centrifugal speed (from 1000 to 2500 rpm) and time period (from 1 to 5 min) there was a significant reduction in moisture content of the curd.

The percentage reduction in moisture content in Ricotta cheese curds after centrifugation for 5 min at different rpms using basket centrifuge is shown in the Table 2. The results clearly showed

that with increase in centrifugation speed and time period, percentage reduction in moisture content of Ricotta cheese curd increased significantly ($p < 0.05$). The Ricotta cheese curd obtained after centrifugation at 2500 rpm for 5 min showed maximum moisture reduction of 8.72%. On the other hand, the lowest moisture reduction of 1.68% was observed in the cheese curd after centrifugation at 1000 rpm for 5 min. Time taken for the process of removal of whey for the batch of 200-500 g using basket centrifuge was only up to 5 min. However, in conventional method, for the same process of whey removal it took up to 14-15 h for the same batch.

The yield of the Ricotta cheese obtained after centrifugation for 5 min at different rpms using basket centrifuge is shown in the Table 2. The per cent decrease in the yield of Ricotta cheese was observed with increase in the centrifugal speed from 1000 to 2500 rpm. The maximum yield (7.2%) in Ricotta cheese was observed at centrifugal speed of 1000 rpm whereas lowest yield (5.1%) at 2500 rpm. The difference in the yield percentages might be due to difference in the moisture contents of the curds obtained. Yield of ricotta cheese curds obtained are in agreement with the yield of ricotta cheese curd obtained with hanging method at same moisture content.

The study showed that basket centrifuge is an effective way of drainage of whey as we can achieve maximum reduction in moisture in the cheese curd with substantial reduction in time from hours to minutes. It is imperative to mention here that for preparation of RCS from Ricotta cheese maximum drainage of whey is an essential step as it ensures maximum removal of lactose from the cheese curd. Thus the product will be less susceptible to microbial spoilage and more it is suitable for lactose intolerant patients.

Sensory scores of RCS prepared by conventional method for flavour, mouthfeel, colour and appearance, spreadability and overall acceptability were 8.10±0.68, 8.15±0.74, 8.16±0.53, 7.48±0.70 and 8.13±0.57, respectively, whereas sensory scores of RCS prepared by mechanized method were 8.27±0.88, 8.30±0.57, 8.23±0.50, 7.51±0.48 and 8.23±0.47, respectively. The spread prepared with the Ricotta cheese curd obtained from basket centrifuge had no significant difference in the scores of all the sensory parameters and was identical to the spread prepared with Ricotta cheese curds obtained from conventional method.

The study concluded that the mechanization of the process can be adopted without affecting the sensory properties of the product.

Conclusions

Cheese industry is an emerging enterprise in India where varieties of cheeses are venturing into the market. RCS prepared from Ricotta cheese is one such novel product which has potential to be introduced in the upcoming market. New product development takes a lot of consideration when introduced into the market in terms of flavor, acceptability, cost, shelf life and ease of mechanization at large scale. One such step of mechanization at small scale at initial stages of study for RCS has been investigated by intervention in whey drainage process using basket centrifuge. Study showed that considerable amount of whey drainage from Ricotta cheese curd was possible at centrifugation of 2500 rpm for 5 minutes which showed some promising results. This study was carried out with a small batch of 10 liters of whey-milk mixture. An elaborative study may be taken up to standardize the process of Ricotta cheese and RCS in terms of microbiological, compositional, varying batch size, textural, cost and viability of this technology which might help in reducing the cost of the product and even help in designing the continuous production of Ricotta cheese and spreads.

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