International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(5): 720-725

Received: 06-07-2019
Accepted: 10-08-2019

Sunil Sakhala
Dairy Technology Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Sangita Ganguly
Dairy Technology Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India

PN Raju
Dairy Technology Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Yogesh Khetra
Dairy Technology Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Shelke Prashant Ashok
Dairy Technology Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Correspondence
Sangita Ganguly
Dairy Technology Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Effect of packaging materials on quality parameters of buffalo milk ricotta cheese

Sunil Sakhala, Sangita Ganguly, PN Raju, Yogesh Khetra and Shelke Prashant Ashok

Abstract
Whey is the largest by-product of the dairy industry in terms of volume and total solid content, which is mainly disposed off even in most organized dairy sector. Among the whey cheeses, Ricotta is the most popular and oldest variety of cheese, which is primarily as a co-precipitate of protein. Ricotta cheese developed from buffalo milk has good nutritional quality, but the product has a limited shelf life due to its inherent properties like higher moisture content, low salt concentration, higher pH and high nutrient density, leading to quicker microbial contamination. Packaging material plays a very vital role in the shelf life of soft cheeses. The study revealed that packaging materials were having significant effect on moisture content, titratable acidity, pH and total sensory score and non-significant effect on water activity. The sensory quality of the product deteriorated during refrigerated storage as observed by declined score of overall acceptability. Maximum overall acceptability score was obtained for Ricotta cheese packed in Glass jar followed by Polypropylene cups.

Keywords: packaging materials, quality parameters, milk ricotta

1. Introduction
Whey is the largest by-product of the dairy industry in terms of volume and total solid content. Recent statistics suggests that nearly 180-190 million tonnes of whey is produced worldwide yearly, out of which only 50% is processed (Baldasso *et al.*, 2011) [2]. In India one million tonnes of whey is produced annually and it corresponds to approximately 70,000 tonnes of whey nutrients (Parekh, 2007) [11]. Historically, whey has been considered a waste stream, and is mostly drained off, leading to environmental concerns due to its high BOD and COD values (27-60 kg m^{-3} and 50-102 kg m^{-3} respectively).

Among the whey cheeses, Ricotta is the most popular and oldest variety of cheese, which is primarily as a co-precipitate of protein. It is a high moisture, cream-colored, unripened cheese with a sweet-cream and nutty or caramel flavor and a delicate aerated texture (Borba *et al*., 2014) [3]. The Ricotta cheese having a physico-chemical properties midway between those of channa and khoa, due to which Ricotta cheese in the fresh form is quite suitable and can be used in the manufacture of sweets and Indian culinary dishes (Mathur and Prajapati, 1981) [12].

Ricotta is originally prepared from small ruminants' milk. Ricotta cheese (RC) preparation from small ruminant's milk restricts its availability. Factors such as higher price, lower availability and lower production of small ruminant's milk limit the production and availability of Ricotta cheese. India represents 56.5% of the world buffalo population. Buffalo milk shows 49% of India's total milk production. As the market of Mozzarella cheese is growing in India, the resultant volume of whey is also increasing, leading to an increased interest in Ricotta cheese production from buffalo milk.

However, the shelf life of Ricotta cheese is low upto 7 to 10 days due to its inherent properties like higher moisture content, low salt concentration, higher pH and high nutrient density, leading to quicker microbial contamination. Packaging material plays a very vital role in the shelf life of soft cheeses. Efficient packaging leads to the enhancement of the shelf life and also preserve its natural flavour and taste. Ricotta cheese developed from buffalo milk has good nutritional quality, but the product has a limited shelf life. Further, a systematic shelf life study using various packaging materials had not been applied in this product. Hence, in this study an attempt had been taken to study the effect of various packaging materials on quality characteristics of buffalo milk Ricotta cheese.

2 Material and methods

2.1 Materials

Fresh, chilled, raw buffalo milk (Total solids 16-17%, fat 7.6-8.4% and protein 3.3-4.0%) was obtained from the Experimental Dairy, National Dairy Research Institute, Karnal, India. All other ingredients (salt and citric acid) were purchased from standard manufacturers.

2.2 Packaging materials

Polystyrene cups, Glass bottle, Pet Jar and Poly Propylene sample containers were procured from local market of Karnal.

2.3 Preparation of buffalo milk Ricotta cheese (BMRC)

Procedure followed for preparation of probiotic Ricotta cheese is given in Fig. 1. Good quality Mozzarella cheese whey was taken in a vat and heated to 70°C for 5 minutes. Buffalo milk (1% fat) was pasteurized and mixed at the ratio of whey: buffalo milk: 80:20. The mixture was given heat treatment of 90°C for 15 minutes followed by cooling to coagulation temperature 75ºC. Citric acid (1%) was used for the coagulation (5.4 pH ined).

(Insert Fig.1)

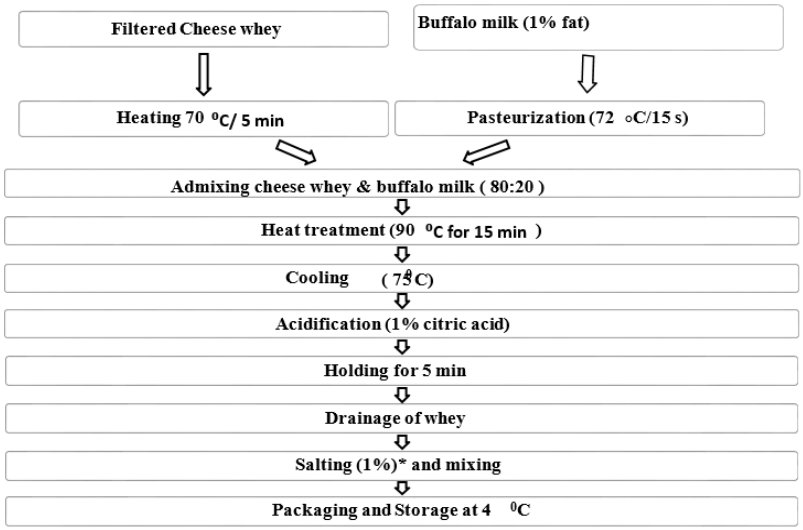

Fig 3.1: Flow diagram for manufacture of Ricotta cheese from buffalo milk

2.4 Storage study of ricotta cheese

Ricotta cheese was packaged in four packaging materials (Glass, PP, PS and PET) and stored at refrigerated temperature (7 ˚C) and the best two packaging materials were selected.

2.5 Physico-chemical analysis of Ricotta Cheese

2.5.1 Moisture

Moisture content of cheese was determined gravimetrically using as per the method described in AOAC (2005) [1] and calculated as per the given procedure

Calculation

$$\text{Moisture (\% by weight)} = \frac{\text{Loss in weight}}{\text{Weight of the sample}} \times 100$$

2.5.2 Titratable acidity

The titratable acidity of the cheese was determined by the method recommended by the AOAC (2005) [1]. Ten g grated cheese sample was weighed accurately. To this distilled water at 40°C was added to make up a volume of 100 ml. Contents were then shaken vigorously and filtered through Whatman No. 1 filter paper. Twenty five ml filtrate representing 2.5 g sample was titrated against 0.1 N NaOH using phenolphthalein as indicator.

Calculation

$$\text{Lactic acid (\% by weight)} = \frac{0.09 \text{ X } 100 \text{ X } V}{25}$$

V= volume, in ml of standard NaOH solution used for the titration

2.5.3 pH

pH was determined using microprocessor controlled pH Analyser (Labindia, New Delhi, Version I) with combined glass electrode. The pH meter was first calibrated at pH 9.20 and 4.0 and standardized at pH 7.0 using buffer solutions.

2.5.4 Water Activity (a_w)

The water activity of Ricotta cheese was measured by using Aqua Lab aw meter (Decagon Devices Inc., Washington, USA).

2.6 Rheological analysis of buffalo milk Ricotta Cheese

Ricotta cheese was evaluated for its rheological attributes using a controlled stress rheometer (MCR52, Anton Paar, GmbH, Germany)

Software: (Rheoplus/32, ServiceV.3.61)

Parallel plate geometry: PP-50 (1.002º inclination) with a gap of 1.5 mm was used for the rheological measurements.

Frequency Range: 100Hz to 0.01Hz

Temperature: 20 °C

The temperature was controlled by Peltier control system. The volume of the prepared Ricotta sample placed on the plate was covered completely and excess sample was trimmed off. The experiment was carried out using frequency sweep test. Frequency sweeps were conducted by applying frequencies in

descending order from 100 Hz to 0.01 Hz at 25°C using 0.1% strain amplitude.

2.7 Sensory evaluation of buffalo milk Ricotta *cheese*

The experimental Ricotta cheese at different stages of development and during storage was evaluated by a panel of trained judges selected from the faculty of Dairy Technology Division, NDRI, Karnal, for sensory characteristics, using Ricotta Cheese Score Card (Total Score-100).

3. Results & Discussion

3.1 Monitoring of changes during storage of buffalo milk ricotta cheese in four different packaging material

Ricotta Cheese is a soft variety of cheese with a moisture content of more than 70 %. The acidity of this cheese is 0.145%LA and pH is above 6.0 (Hough *et al*., 1999), which provides favorable conditions for microbial growth and leads to less shelf life. In this study four packaging materials were used on basis of availability. Glass jar, PP jar, PET jar and PS jar were selected as packaging material for study.

3.1.1 Changes in moisture content

The moisture content of BMRC was found out to be 75%. High moisture content is attributed to having high denatured whey protein content hence higher the hydration. Moisture was evaluated at every 3 day of storage period to last day of acceptable quality. In this study, it is found that the moisture content of PS jar and PET jar was significantly ($P<0.05$) reduced from 75.20 at first day of storage to 72.89 and 73.12% respectively at the end of the storage period (12^{th} day) and this may be due to the loose lead of the jars and also due to the high vapor permeability. Moisture vapor transmission rate (MVTR) for PP is 0.5, PET is 2.0, and PS is 10.0 g-mil/100 in (www.alphap.com/bottle-basics/plastics-comparison-chart.php). (Insert Figure 2)

The moisture content of glass and pp was none significantly decreased from 75.20 on the first day of storage to 75.10 and 74.8 respectively. Glass and PP jars were completely air tight so this moisture loss may be due to gradual and slow release of whey during storage period.

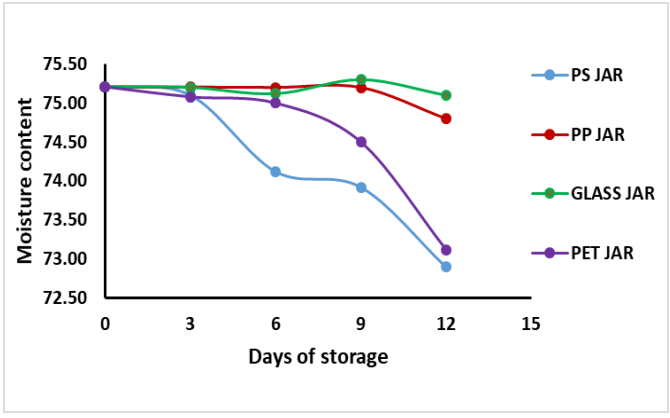

Fig 2: Trend of moisture content during storage period

3.1.2 Changes in water activity

Water activity is the measure of free water which is available for the biochemical and microbiological activity. Ricotta Cheese has a water activity (aw) of 0.993±0.002, which shows that Ricotta cheese is highly susceptible to microbial and biochemical spoilage. Water activity of Ricotta cheese remain more or less constant at 0.993 during the storage period in all packaging materials (figure 3).

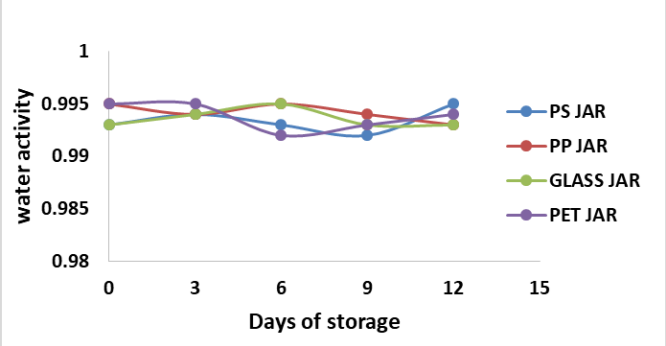

Fig 3: Changes in Water activity during storage

3.1.3 Changes in titratable acidity

Lactic acid content of Ricotta cheese can be taken as quality parameter as it shows degree of fermentation (Rodrıguez-Alonso *et al*., 2011). It was found that acidity of fresh Ricotta cheese was 0.14±0.002% LA. The acidity increased gradually during storage reducing the sensory acceptability. It was observed in this study that maximum acidity increased from initial level 0.144 %LA to 0.288% LA in PS packaging material. Minimum increment was observed in Glass packaging material from 0.144% LA to 0.216% LA, followed by PP (0.144%LA to 0.228 %LA) and PET (0.144%LA to 0.240). It may be due to the reason that PS packaging material had a loose lid as compared to other packaging materials. Glass and PP were the air tight containers as compared to PS and PET. So the increment in acidity might be due to air contamination of the cheese leading to acidity development at higher rate, due to growth of spoilage organisms. Trends are shown in figure 4. (Insert fig 4)

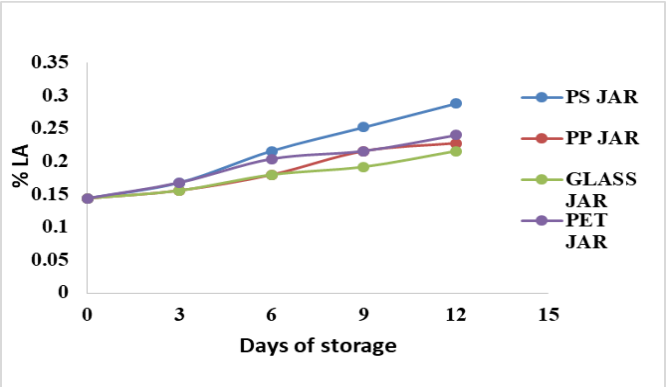

Fig 4: Changes in Titratable acidity during storage

3.1.4 Changes in pH

pH of the Ricotta cheese was around 6.18 and this pH is suitable to microbial and other spoilage related changes in BMRC. In this study pH of all the samples had equal initial pH (6.18) and with storage time it decreased. Maximum reduction in pH was observed in PS jars (6.18 to 5.11) followed by 5.3, 5.6 and 5.7 in PET, PP and Glass jar respectively. This change in pH is attributed to growth of lactic acid bacteria in the BMRC as it contains around 4.80 % of lactose. Trends of pH change are shown in figure 5. An increment in pH during storage had been observed in creamy Ricotta due to hydration of protein (Borba *et al*., 2014) [3]. However a declining, although irregular trend of commercial

Ricotta cheese had been reported by Hough *et al*., 1999. (Insert fig 5)

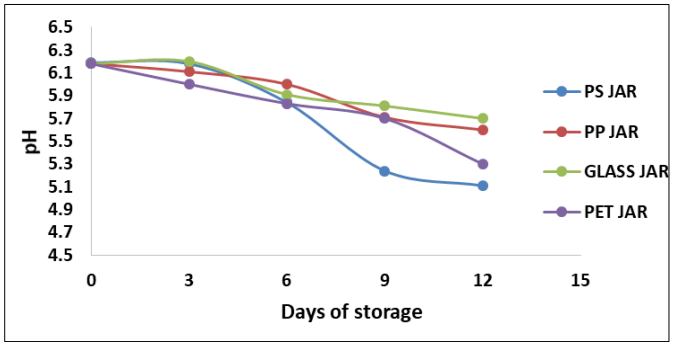

Fig 5: Changes in pH during storage

3.2 Changes in sensory attributes

The sensory quality of the product deteriorated during refrigerated storage as observed by declined score of overall acceptability. Overall acceptability was checked for all four combination and it was found that overall acceptability score was decreased during 12 days of storage. The initial overall acceptability score for all samples were 84.14, which declined during storage periods. Maximum overall acceptability score was obtained for BMRC packed in Glass (78.2) followed by PP (75.4) and least scores were obtained for PET (70.8) and PS (68.1) at the end of storage period. A considerable decrease in sensory quality had been reported in functional Ricotta cheese due to excessive acidity (Niro *et al*., 2013). Lower scores for all the sensory parameters had been reported during storage of Brazilian probiotic Coalho cheese (Espirito *et al*., 2011). The trend in overall acceptability has shown in Fig 6. All the sensory score reduced during storage in all packaging materials. The body and texture score reduced during storage the product became harder. The decrease in body and texture score of product at the end of the storag may be attributed to slow whey release from the cheese matrix making protein clusters stiffer than earlier. Additionally, yeasty and mouldy flavour was detected due to growth of yeasts and psychrotrops at the end of the refrigerated storage, decreasing flavour score of the product, leading to decreased overall acceptability of product. Similar incidence of reduction of flavor score had been reported in creamy Ricotta (Borba *et al*., 2014) [3]. The reduced colour and appearance score might be attributed to change in colour of Ricotta cheese during storage as reported by other researchers (Dantas *et al*, 2016; Verruck *et al*., 2015). The decrease of lightness value during storage has been reported for Ricotta cheese which might be probably due to higher hydration of proteins, leading to a reduced degree of light scattering. (Insert fig 6)

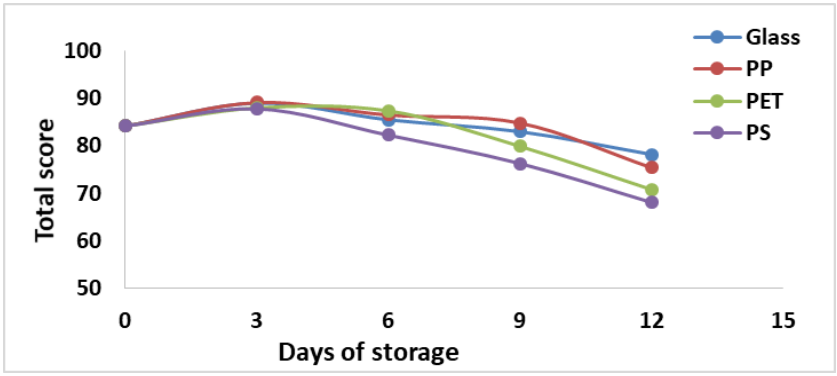

Fig 6: Change in Overall acceptability score

3.3 Changes in rheological parameters (G' and G")

Rheological parameters storage modulus (G') and loss modulus (G") were observed during storage period for all the combinations of BMRC and packaging material. It was found that value of G' and G" for all four samples were increased during the time of storage. Increment was almost equal in all four combinations. It may be attributed to slow whey release from the cheese matrix making protein clusters stiffer than earlier. Change in the values of G' and G" are shown in the Fig 7 to Fig 10. Similar incidents of increment in hardness during storage were reported in probiotic goat Ricotta cheese (Meira *et al*., 2016) [10], probiotic whey cheese (Madureira *et al*., 2011) [9], Minas-frescal cheese (Buriti *et al*., 2005) [4]. The degree of cross linking in between the proteins and formation of three-dimensional network increased the hardness of product during the storage (Lobato-Calleros *et al*., 2007; Espirito *et al*., 2011; Meira *et al*., 2016) [8, 10]. The Firmer matrices formed by acid generation during storage can be correlated to hardness of product, pH affects reactivity of the binding site if the casein molecule and therefore influences the matrix structure (Rowney *et al*., 1999). The lactic acid production enhances the protein coagulation turning matrices into harder entities and making more susceptible to fracture, which aid in filling spaces with water or residual whey, for this reason Ricotta cheese matrices exhibited higher values for hardness beside being more adhesive in texture (Madureira *et al*., 2011) [9].

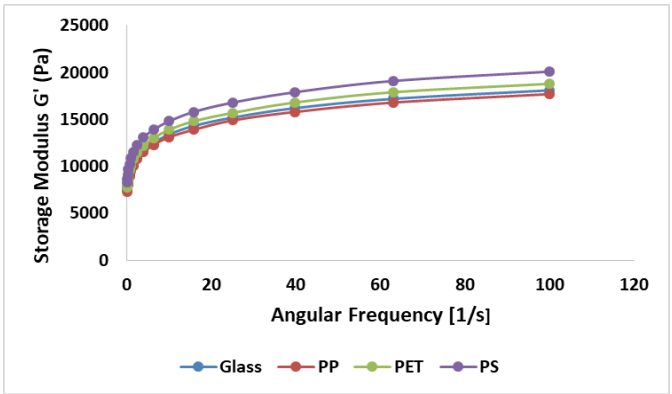

Fig 7: Storage modulus (G') values of BMRC on 1st day of storage

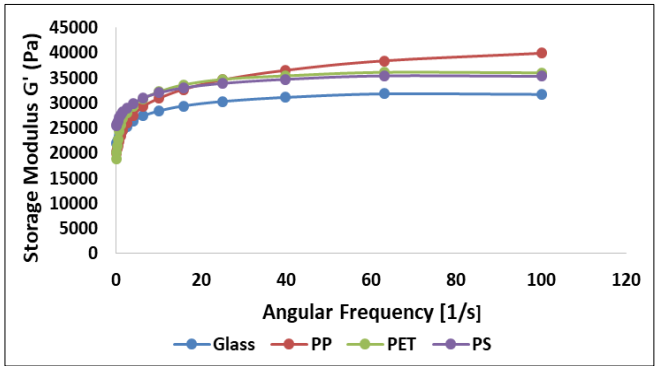

Fig 8: Storage modulus (G') values of BMRC on day 12th day of storage

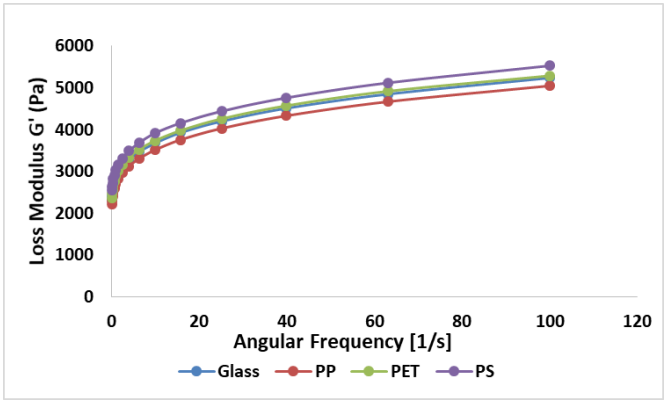

Fig 9: Loss modulus (G") values of BMRC on 1st day of storage

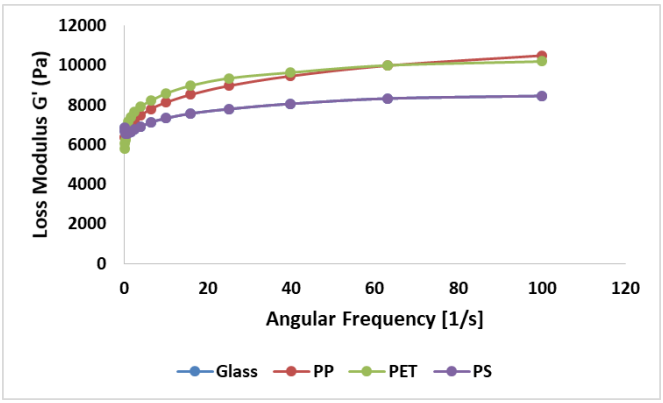

Fig 10: Loss modulus (G") values of BMRC on 12th day of storage

3.4 Statistical analysis of buffalo milk ricotta cheese packed in four different packaging material

The statistical analysis revealed that packaging materials were having significant effect on moisture content, titratable acidity, pH and total sensory score and non-significant effect on water activity (Table 1). The day of storage had significant effect on all the parameters except water activity. The interactive effect of packaging materials and day were non-significant for water activity and total sensory score and significant for moisture content, titratable acidity and pH.

Table 1: ANOVA table for BMRC and Packaging material

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F – Value
PM	Moisture content	9.054	3	3.018	22.788***
	Water activity	5.25E-06	3	1.75E-06	0.714NS
	Titratable acidity	0.011	3	0.004	21.125***
	pH	0.578	3	0.193	203.081***
	Total sensory score	201.746	3	67.249	3.949***
Day	Moisture content	11.611	4	2.903	21.918***
	Water activity	1.05E-05	4	2.63E-06	1.071NS
	Titratable acidity	0.083	4	0.021	120.535***
	pH	5.034	4	1.258	1326.939***
	Total sensory score	2191.392	4	547.848	32.171***
PM*Day	Moisture content	8.531	12	0.711	5.368***
	Water activity	4.35E-05	12	3.63E-06	1.48NS
	Titratable acidity	0.007	12	0.001	3.312***
	pH	0.813	12	0.068	71.483***
	Total sensory score	256.608	12	21.384	1.256NS

4. Conclusion

Ricotta is a high moisture, cream-colored, fresh, whey cheese having limited shelf life. The study revealed that packaging materials were having significant effect on moisture content, titratable acidity, pH and total sensory score and non-significant effect on water activity. The sensory quality of the product deteriorated during refrigerated storage as observed by declined score of overall acceptability. The overall acceptability score was decreased during 12 days of storage. Maximum overall acceptability score was obtained for Ricotta cheese packed in Glass jar followed by Polypropylene cups. Hence, glass was found as most suitable packaging material followed by PP cups for buffalo milk Ricotta cheese.

5. Acknowledgment: Authors are thankful to ICAR-NDRI, Karnal Haryana

6. References

1. AOAC. Official Methods of Analysis, 18th ed. Gaithersburg, MD: AOAC Intl, 2005.
2. Baldasso C, Barros TC, Tessaro IC. Concentration and purification of whey proteins by ultrafiltration. Desalination. 2011; 278(1-3):381-6.

3. Borba KK, Silva FA, Madruga MS, de Cássia Ramos do Egypto Queiroga R, de Souza EL, Magnani M. The effect of storage on nutritional, textural and sensory characteristics of creamy ricotta made from whey as well as cow's milk and goat's milk. International Journal of Food Science & Technology. 2014; 49(5):1279-86.
4. Buriti FC, da Rocha JS, Assis EG, Saad SM. Probiotic potential of Minas fresh cheese prepared with the addition of *Lactobacillus paracasei*. LWT-Food Science and Technology. 2005; 38(2):173-80.
5. Dantas AB, Jesus VF, Silva R, Almada CN, Esmerino EA, Cappato LP, Silva MC, Raices RS, Cavalcanti RN, Carvalho CC, Sant'Ana AS. Manufacture of probiotic Minas Frescal cheese with Lactobacillus casei Zhang. Journal of Dairy Science. 2016; 99(1):18-30.
6. Espírito Santo AP, Perego P, Converti A, Oliveira MN. Influence of food matrices on probiotic viability–A review focusing on the fruity bases. Trends in Food Science & Technology. 2011; 22(7): 377-85.
7. Hough G, Puglieso ML, Sanchez R, da Silva OM. Sensory and microbiological shelf-life of a commercial Ricotta cheese. Journal of Dairy Science. 1999; 82(3):454-9.
8. Lobato-Calleros C, Reyes-Hernández J, Beristain CI, Hornelas-Uribe Y, Sanchez-Garcia JE, Vernon-Carter EJ. Microstructure and texture of white fresh cheese made with canola oil and whey protein concentrate in partial or total replacement of milk fat. Food Research International. 2007; 40(4):529-37.
9. Madureira AR, Amorim M, Gomes AM, Pintado ME, Malcata FX. Protective effect of whey cheese matrix on probiotic strains exposed to simulated gastrointestinal conditions. Food research international. 2011; 44(1):465-70.
10. Meira SM, Zehetmeyer G, Scheibel JM, Werner JO, Brandelli A. Starch-halloysite nanocomposites containing nisin: Characterization and inhibition of Listeria monocytogenes in soft cheese. LWT-Food Science and Technology. 2016; 68:226-34.
11. Parekh JV. Small Scale Utilization of Whey. Dairy India Year Book, Sixth Edition, Published by Dairy India Year Book, New Delhi. 2007:245-6.
12. Prajapati PS, Mathur BN. Manufacture of Ricotta cheese from different whey systems and its utilization for Indian varieties of sweets. Indian journal of dairy science. 1981; 34(2), 140-147.
13. Rodríguez-Alonso P, Centeno JA, Garabal JI. Biochemical study of industrially produced Arzúa-Ulloa semi-soft cows' milk cheese: Effects of storage under vacuum and modified atmospheres with high-nitrogen contents. International dairy journal. 2011; 21(4):261-71.
14. Rowney MK, Roupas P, Hickey MW, Everett DW. Factors affecting the functionality of Mozzarella cheese. Australian journal of dairy technology. 1999; 54(2):94.
15. Verruck S, Prudêncio ES, Vieira CR, Amante ER, Amboni RD. The buffalo Minas Frescal cheese as a protective matrix of Bifidobacterium BB-12 under in vitro simulated gastrointestinal conditions. LWT-Food Science and Technology. 2015; 63(2):1179-83.