The effect of adding sweet buttermilk and banana peels powder on the properties and quality of Ricotta cheese

تأثير إضافة اللبن الخض الحلو ومسحوق قشر الموز على خواص وجودة الجبن الريكوتا

By

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Abstract:

It was investigated how enhanced banana peel powder (BPP) affected the rheological, physicochemical, sensory assessment, and microbiological characteristics of ricotta cheese. For the purpose of producing ricotta cheese, BPP was added to the sweet butter milk used to make Ricotta cheese at 0.5% (B_1), 1% (B_2), and 1.5% (B_3). By increasing its concentration, the fortification of BPP had a major impact on the contents of Ricotta cheese, including ash, fibers, protein, moisture, pH, total phenolic content, total antioxidant activity, minerals, and vitamins. Molds and yeasts did not appear in all treatments by added BPP up to 31 days of cold storage; however, they appear in control (B) after 23 days. With a rise in BPP, there were progressive increases in TPA characteristics, WHC, OHC, total phenolic compound, antioxidant activity, minerals, and vitamins; in contrast, an inverse trend was seen in acidity and total carbs. In light of everything mentioned above, adding BPP to the Ricotta cheese is advised, particularly in amounts of 0.5 or 1%, as it demonstrated excellent sensory qualities that were both superior to and comparable to the control cheese over the course of storage. The product was well-made, hygienic, and of excellent quality.

Key words*:* banana peel powder; Ricotta cheese; sweet buttermilk; health benefit–

المستخلص:

تم دراسة تأثير تدعيم مسحوق قشر الموزBPP على الخواص الريولوجية والفيزيائية والكيميائية والحسية و الميكروبيولوجية لجبن الريكوتا ، حيث تم إضافة BPP إلى اللبن الخض الحلو المستخدم لصناعة جبن الريكوتا بنسب ٥ر. , ١ , ٥ر١ % للمعاملات B_3,B_2,B_1 على التوالى تمت زيادة محتويات الجبن الريكوتا المدعمة بمسحوق قشر الموز من البروتين والرماد والرطوبة والالياف والمركبات الفينولية الكلية ومضادات الاكسدة والمعادن والالياف بزيادة نسبة الاضافة. كما زادت

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مدة حفظ الجبن الى ٣١ يوما بدون نمو فطر اوخمائر بينما لوحظ ظهور الفطر والخمائر وفساد جبن المقارنة بعد ٢٣ يوما من التخزين البارد. أشارت النتائج إلى زيادة قوة احتفاظ الماء والدهن فى الجبن وزيادة الخصائص الريولوجية وذلك بزيادة نسبة الاضافة . يوصى باضافة BPP الى الجبن الريكوتا بنسبة حتى ١% والتى أظهرت للجبن خصائص حسية ممتازة تفوق معاملة المقارنة على مدار فترة التخزين مع اطالة مدة الحفظ وزيادة القيمة الغذائية للجبن.

INTRODUCTION

Ricotta is a soft cheese with a high moisture content Matthäus (2002). This cheese can be made from milk, whey, or a combination of the two Pintado and Malcata (2001). Since ricotta cheese is so mild, many Italian cuisines call for it. Making ricotta cheese is one of the many strategies that have been devised to make use of whey EL-Dardiry (2017); Sulieman, *et al.* (2012). Since Ricotta cheese is exposed to the air before being packaged, its shelf life is often only a few days. Furthermore, due to its high moisture content, initial pH of 6, ricotta is highly prone to spoiling by molds, yeasts, and bacteria. Enterobacteriaceae Pintado and Malcata (2001), which dominate this group, are a major contributor to this.

Buttermilk is a by-product of manufacturing butter that is liberated during the Churning of cream. It is extremely rich in milk fat globule membrane (MFGM), and it has been employed as a natural functional component in many food products. Inhibition of colon cancer, suppression of gastrointestinal infections, and potential involvement in stress responses are just a few of the positive health benefits that the MFGM fragments have been found to carry in the past by Dewettinck, *et al*.; EL-Dardiry (2017). In addition to having significant nutritional content and being thought to include components that are health-promoting, buttermilk also has a high water-holding capacity, according to Le, *et al*. (2011); Romeih, *et al.* (2014); Turcot, *et al.* (2001) which could decrease or even eliminate the whey. Also, It boosted yield, extended the shelf life of cheese El Sayed,

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et al. (2010), improved crumb texture, increased in vitro bio accessibility of bioactive, and increased yield Augustin, *et al.* (2015).

Banana peels (*Musa paradisiaca L.*) relieves intestinal lesions, diarrhoea, dysentery, ulcerative colitis, nephritis, gout, heart illness, hypertension, and diabetes.It are also quite nutritious. Emaga, *et al.* (2007); Emaga, *et al.* (2008); Imam *et al.* (2011); Wachirasiri, *et al.* (2008). Additionally, it has a lot of phenolic compounds, which are a wonderful source of antioxidants that prevent cancer and heart disease Someya, *et al. (*2002). About 40% of fresh bananas are made up of leftover banana peels from industrial procedures Anhwange, *et al.*(2008).

The goal of this study is to use by-products like sweet buttermilk and banana peel in order to increase the production of new and functional flavours of Ricotta cheese with low production costs, improve nutritional value, add numerous health and therapeutic benefits, and prolong the shelf life. Additionally, the usage of banana peel and sweet buttermilk (by-products) will lessen the load of environmental pollution.

1. MATERIALS AND METHOD

1.1. Materials

Sweet buffalo buttermilk (0.65% fat) was obtained from the Dairy Unit, Animal production Research Institute, Egypt. Citric acid, food grade sodium hydroxide solution and NaCl were obtained from Piochem, Co.,Egypt. Mature banana fruits (Musa paradisiaca L.) was purchased from the local market. Table 1, shows the chemical composition of sweet buttermilk, banana peel powder (BPP) used in the present study.

2.1. Preparation of Banana Peel powder (BPP)

Banana peel powder is prepared by washing the banana with clean water in order to get rid of the impurities stuck to the peel. Then cut the banana peel into thin slices before peeling it

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for quick steaming. Then, the slides were dried for eight hours at 65°C in order to destroy the enzymes present. Then grind it well and sift it to form fine flour, and then save it by packing it in clean, airtight plastic bags, then cooling it to room temperature until it is used for analysis and for fortifying the ricotta cheese under study Alshehry (2002).

1.2. Manufacturing Ricotta cheese fortified with Banana peel powder (BPP).

The following modifications have been made to the standard process as reported by Mahran *et al.* (1999) to produce several types of Ricotta cheeses fortified with varying levels of BPP: Sweet buttermilk was placed in a cheese vat and neutralized to an acidity of 0.13% as lactic acid by the addition of food grade sodium hydroxide solution. The mix was divided into four portions. The first portion was used for the manufacture of control Ricotta cheese made without any additives (B). The second portion was added with 0.5% BPP (B_1), and the third portion was added with 1% BPP (B_2). Finally, a portion of 1.5% BPP (B_3) was added. All mixtures were heated to 65˚C to destroy residual rennet, which would cause premature coagulation of casein. All the mixtures were heated to 88–90˚ C for 15 min. For all these treatments, we acidulate (10% citric acid) and 0.5% NaCl. (pH5.9- 6) The curd was left in the mixture of whey for 20 minutes before draining. Traditionally, the curd is ladled from the surface of the whey. This was found to be cumbersome, and it was more convenient to run off the whey. Fines were removed from the curd using a muslin filter. After draining, the curd was packaged into plastic containers (100 gm) and stored at 5±1°C for 31 days.

They were analyzed at 1, 11, 21, and 31 days.

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Physicochemical analysis of Ricotta cheese

Moisture, fat, ash, titratable acidity (TA%), dietary fiber, total protein contents and pH values (using pH meter, Jeneway) were determined in both raw materials and Kareish cheese samples according to the method described by AOAC (2016). The content of carbohydrate was calculated by the differences. The Folin-Ciocalteau method Ebrahimzadeh et al. (2008) was used to determine the total phenolic compounds. The stable 2,2-diphenyl-1-picryl-hydrazyl (DPPH, Sigma Aldrich, Germany) radical scavenging technique, as reported by Matthäus, (2002) was used to assess the antioxidant activity of JPR methanolic extract. The yield of cheese is calculated by Fox *et al.*, (2000). The loss of protein and recovery of protein content in different treatments was calculated by El-Dardiry (2017). The loss of fat and recovery of fat content in different treatments was calculated by El-Dardiry [14]. Using an atomic absorption spectrometer, the concentrations of ascorbic acid, vitamin E, B_1, B_2, A, and beta-carotene as well as minerals were measured in accordance with the procedure outlined by AOAC (2016).

2.4 Rheology analysis of Ricotta cheese

At 23^{o}C, the texture profile analysis (TPA) of Ricotta cheese was tested according to Bourne's description (1982). Stable Micro System (SMS) LTD., Godalming, UK, Instron Universal Testing Machine model 1195 that is loaded with the Dimension software SMS application. similar to the penetration values Bourne described (1982).

Water holding capacity (WHC) and oil holding capacity (OHC) in different treatments were determined by Alkarkhi et al. (2010).

2.5. Microbiological Analysis of Ricotta cheese

Cheese samples were examined for total viable bacterial count, yeasts & molds according to American Public Health Association ABHA, (2005).

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2.6.Texture profile analysis (TPA) :

Using a Universal Testing Machine (TMS-Pro) outfitted with a 1000 N (250 lbf) load cell and connected to a computer running Texture ProTM texture analysis software, texture profile analysis tests were conducted on samples of Kareish cheese (program, DEV TPA withhold). The texture profile parameters were obtained using a calculation as given by Bourne (1982).

2.7. Sensory Evaluation of Ricotta cheese

Ricotta cheese were Sensory evaluated for appearance, texture, flavor and Overall Acceptability according to scheme described by Sulieman *et al.* (2012).

2.8. Statistical Analysis

The SPSS version (10) computer application SPSS (1999) Inc., Chicago, IL, USA was used to conduct it. Results were subjected to an ANOVA and a Duncan's Test to identify differences in means that were statistically significant at the level of 0.05. The mean and SE of three replicates were used to express the data.

2. RESULTS AND DISCUSSION

The chemical composition of sweet buttermilk and Banana Peel powder were shown in Table (1).

The results in Table 1 are similar to Aly, *et al.* (2017); Khawas and Deka (2016); Wachirasiri, *et al.* (2008).

The data in Table 2 showed the chemical composition of treatments Ricotta cheese fortified with different levels of Banana peel powder (BPP) during storage at 5±1°C. It was observed that the percentages of moisture, total protein, ash, and dietary fiber were higher in the treatments supported by banana peel compared to the control. It was also significantly increased by increasing the percentage of banana peel. On the contrary, it occurred in the percentage of total carbohydrates, as it was significantly reduced by increasing the percentage of addition, and the largest percentage was in the B treatment compared to

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other treatments. This was mainly due to differences in the chemical composition of BPP and SB used materials (Table,1).

Table 2 shows an increase in ash, fat, total protein, and carbs during the storage period. With the lengthening of the storage duration up to 29 days, there were significant variations in all of the evaluated treatments for the Ricotta cheese ($P \leq 0.05$). This increase in components for all treatments is attributed to a decrease in cheese moisture with the long storage period. These results were in agreement with Aly, *et al.* (2017); Khawas and Deka (2016); Gouda, (2017).

Loss and Recovery of protein or fat and yield

Table 3 is shown loss and recovery of protein or fat in Ricotta cheese fortified with different level of banana peel powder (BPP). It was found that the B treatment had the most loss in protein (28.05) and fat (19.72) in whey. While B_3 fortified with 1.5% BPP had the least loss in protein (5.76) and fat (8.33) in the whey. There is an inverse relationship between the percentage of banana peel addition and the percentage of protein and fat loss in the whey. This could be a result of the useful functional properties that dietary fiber and starch have, such as improving crystallization, thickening texture, stabilizing, and emulsifying El-Dardiry (2021). The protein and fat in the cheese curds may be retained by BPP, which has been to be high in both starch and fiber and may prevent their release into the whey. These outcomes corroborated what El-Dardiry, *et al.* (2023).

As shown in Table 3, the yield in Ricotta cheese fortified with different level of (BPP) increased with the addition of BPP compared to the control treatment (B).

According to the data in Table (3), the B_3 treatment raised cheese yield by 54.11% in comparison to the B treatment, while the B_2 treatment increased cheese yield by 35.69%. These findings concur with those of EL-Dardiry (2017); El-Dardiry (2021). This may be due to dietary fibers advantageous

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functional properties, which include texture, gelling, thickening, emulsification, and stability in DF-enriched foods.

PH and Acidity

The results of Table 4. showed that the control (B) treatment had the highest T.A.% when fresh, while the treatment (B_3) fortified with BPP at level 1.5% had a lowest value in T.A.%. pH values were with treatments fortifieded with BPP higher than control. Moreover, the levels of acidity or pH in Ricotta cheese treatments were no significant ($p<0.05$). Generally, the prolongation of the cold storage period of Ricotta cheese treatments caused an increase ($p<0.05$) in T.A.% and an reduction ($p<0.05$) in pH value.

Minerals and Vitamins

Regarding the minerals and vitamin contents of Ricotta cheese, data were given in Table 5, which indicated that the BPP caused an increase in the Ca, K, Fe, Na, Mn, P, Cu, Mg, and Zn contents. Also, the addition of BPP led to an increase in vitamin content (C, B_1, B_6, E, A, and β-carotene). In Table 5, the increase in minerals and vitamins in the treatments fortified with BPP is attributed to the percentage of minerals and vitamins present in the banana peel powder and the percentage added from it to the buttermilk for the manufacture of ricotta cheese (Table 1). These results agreed with Ahmed, *et al.* (2021), Aly, *et al.* (2017); Khawas and Deka (2016); Zahid, *et al.* (2021).

Total phenolic content and antioxidant activity (%)

Table 6 shows that fortification of Ricotta cheese with BPP proportionally increased the total phenolic content of the resultant after day Ricotta cheese by increasing the percent of addition. The rate of increase in total phenolic content for after-day Ricotta cheese samples fortified with BPP was 34.29, 37.05, and 40.72 for Ricotta cheese samples B_1, B_2, and B_3, respectively. Also, it is noteworthy that the total phenolic content of the control cheese sample is reduced by 18.25. Ricotta cheese

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was more affected by storage than the fortified samples. After 31 days, the total phenolic content reduction of cheese samples B_1, B_2, and B_3 was significantly higher by 30.04, 32.63, and 36.58 than the corresponding value of control cheese (15.03).

The results of Table (6) showed, different significant in total phenolic content between treatments storage period. These results are agreed with those found by Ahmed, *et al.* (2021), Aly, *et al.* (2017); Khawas and Deka (2016).

Regarding antioxidant activity, it behaved the same way as the total phenolic compounds in the Ricotta cheese treatments, which shows that BPP is rich in antioxidants and total phenolic compounds. Also, their percentage increases with the increase in the percentage of fortified BPP in the ricotta cheese. These results were similar to what [Khawas and Deka (2016); Thnaa and Mahmoud (2018). found.

Microbiological quality:

Throughout the storage period or while the Ricotta cheese was fresh, no coliforms were found in any of the different treatments. This can be the result of the extremely hygienic conditions both during preparation and storage.

The results of Fig.1 indicated that there were no significant differences in TBC, mold, or yeast counts between ricotta cheese treatments after a day. While significant differences were found between treatments during the storage period. It was also noted that fortified BPP in Ricotta cheese prevented the growth of mold and yeasts throughout the storage period compared to the control treatment, in which growth appeared after 23 days (2.48 log CFU/ g).These results were similar to Ahmed, *et al.* (2021).

Water holding and oil holding capacity

The water holding capacity (WHC) and oil holding capacity (OHC) of ricotta cheese with varying BPP concentrations are listed in Fig.3,4. The higher fiber content of

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the Ricotta cheese led to an increase in WHC and OHC compared to the control. That finding indicates that when the BPP content in Ricotta cheese grew, so did the amount of water in the cheese. Fig.3,4 illustrates that Ricotta cheese exhibits the largest water absorption at the B_3 concentration. B had a WHC of 11.2 ml/g, whereas B_1, B_2, and B_3 had WHCs of 15.5, 20.2, and 20.8 ml/g, respectively. B, B_1, B_2, and B_3 had OHCs of 9.3, 12.7, 14.8, and 16.6 ml/g, respectively. This result is similar to that of Suresh,*et al.* (2014)., who found that peels increased from WHC and OHC. This could be because the peels' high WHC values were linked to the dietary fiber component, which has been demonstrated to be strongly correlated with oil holding capacity (OHC). Comparably, there was a strong association between the protein and OHC (Tables 2, 3 and Fig.3,4). This suggested that the overall amount of protein present could also affect the OHC of the fiber source samples Sharoba, *et al.*(2013).. Ferreira *et al.* (2013) found that because WHC and OHC are significant functional characteristics, there is a correlation between them and food quality. There was a lot of fruit waste flour in the WHC. These results were similar to the results Nareman (2016).

Textural profile analysis

Since Ricotta cheese's texture is a crucial component of its quality, the textures of the three BPP-fortified Ricotta cheese were compared to those of B treatment. The findings are shown in Table 7. There were considerable variations in the Ricotta cheese' texture parameters. This increase was caused by the fiber content of BPP, which affects its toughness and other structural features. Mechanical variations referred to as the fortification of BPP in Ricotta cheese are associated with an increase in crude fiber, insoluble dietary fiber, fat, and a reduction in carbohydrates.

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Dietary fibers have been positively correlated with both gumminess and hardness Gómez,*et al.* (2003); Oliveira, ,*et al.* (2015) . Furthermore, in Ricotta cheese fortified with 0.5, 1, and 1.5% BPP, cohesiveness increased from 0.46 in the control ricotta cheese to 0.0.77, 0.8, and 0.94. The insoluble dietary fibers from BPP that were added to Ricotta cheese may be the cause of this rise. The findings of the chewiness, gumminess, and springiness tests showed that the Ricotta cheese that was fortified with BPP at varying levels and had a high content of insoluble dietary fiber differed significantly from the control Ricotta cheese. These results were also consistent with what Garsa, (2022) concluded.

Sensory evaluation of ricotta cheese

Sensory evaluation results of Ricotta cheese fortified with banana peel powder (BPP) during storage are shown in Table 9. Treatment B_3 fortified with 1.5% BPP received the lowest scores. It was found that treatments B_1 or B_2 fortified with 0.5 or 1% BPP were the best treatments. It was characterized by softness and a creamy feel, while the composition was homogeneous and more flexible. According to the sensory total score of Ricotta cheese, which represents the overall organoleptic quality of the product. Overall, Ricotta cheese that had been fortified with 0.5 or 1% BPP scored higher than control cheese. BPP is a cheap material that is high in insoluble dietary fiber Angelis-Pereira, *et al.* (2016), and its addition to food items does not adversely influence organoleptic qualities such as appearance, texture, color, flavor, and overall acceptability. Eshak, (2016).

3. CONCLUSION

This study proved that functional Ricotta cheese can be produced by adding banana peel powder up to 1% to sweet buttermilk in order to enhance the health of the person consuming the product by increasing the vitamins, minerals,

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phenolic compounds, antioxidants, fiber, protein, and fat. The rheological and sensory properties also improved, in addition to extending the shelf life of the product to 31 days without the growth of mold or yeast.

List of Tables

Table (1): The chemical composition of Banana Peel powder (BPP) and sweet butter milk used in manufacture of Ricotta cheese formula.

Character assessed		Banana Peel powder(BPP)	Sweet buttermilk (SB)
Moisture	%	6.82[b]	90.40[a]
Protein	%	9.64[a]	3.56[b]
Ash	%	9.21[a]	0.73[b]
Fat	%	3.68[a]	0.67[b]
Total dietary fiber	%	31.82	-
Available Carbohydrates	%	38.83[a]	4.64[b]
TitratableAcidity	%	1.86[a]	0.18[b]
pH- value		5.66[b]	6.7[a]
Ca	(mg/100g)	20454.5[a]	169.2[b]
K	(mg/100g)	47838.2[a]	156.2[b]
Fe	(mg/100g)	270.9[a]	0.12[b]
Na	(mg/100g)	6051.3[a]	52.3[b]
Zn	(mg/100g)	1896.2[a]	0.22b
Mg	(mg/100g)	2138.68[a]	31.5[b]
P	(mg/100g)	37462.2[a]	117.4[b]
Mn	(mg/100g)	117.4[a]	0.018[b]
Cu	(mg/100g)	8.1[a]	0.045[b]
Thiamin (B_1)	(mg/g)	0.68[a]	0.051[b]
Vitamin (B_6)	(mg/g)	1.61[a]	0.023[b]
Vitamin C	PPm	127.46[a]	2.3[b]
Vitamin E	(mg/g)	0.27[b]	31[a]
Vitamin A	(µg/100g)	11.28[b]	53[a]
B- carotene	(mg/100g)	34.11	-
T. phenolic	(mg GAE/100 g DM)	835.11[a]	7.45[b]
DPPH	%	80.4[a]	18.23[b]

*Determined in 20% aqueous solution (w/v).

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Table (2): The chemical composition of Ricotta cheese fortified with different
Levels of Banana Peel powder (BPP) during storage at 5±1˚C

Component (%)	Storage (day)	Treatments			
		B	B_1	B_2	B_3
Moisture (%)	1	66.6300± 0.05^{Ac}	67.5200 ± 0.05^{Ab}	68.1300 ± 0.05^{Aa}	68.8400 ± 0.01^{Aa}
	11	65.2700± 0.05^{Bd}	66.0900 ± 0.01^{Bc}	67.2100 ± 0.05^{Bb}	68.5967 ± 0.33^{Aa}
	21	64.1800± 0 .05^{Cd}	65.3700 ± 0.05^{Cc}	66.5133 ± 0.07^{Cb}	67.1100 ± 0.01^{Ba}
	31	63.3900 ± 0. 05^{Dd}	64.5700± 0.05^{Dc}	65.7300 ± 0.01^{Db}	66.4800 ± 0.01^{Ca}
Fat (%)	1	9.80 ± 0.05^{Ac}	10.50± 0.05^{Bb}	10.80 ± 0.05^{ABa}	10.80 ±c0.05^{ABa}
	11	10.00 ± 0.57^{Aa}	10.60 ± 0.05^{Ba}	10.80 ± 0.05^{ABa}	10.60 ± 0.25^{Ba}
	21	10.37 ± 0.26^{Ab}	10.60 ± 0.25^{Bab}	10.90 ± 0.25^{Bab}	11.37 ± 0.26^{Aa}
	31	10.20 ± 0.05^{Ab}	11.37 ± 0.26^{Aa}	11.20 ± 0.05^{Aa}	11.20 ± 0.05^{ABa}
Total Protein (%)	1	9.66 ± 0.005^{Dc}	11.43 ± 0.05^{Bb}	13.31 ± 0.5^{Aa}	13.39 ± 0.5^{Aa}
	11	10.15 ±0.05^{Cb}	11.99 ± 0.5^{ABab}	13.19 ± 0.5^{Aab}	13.82 ± 0.5^{Aa}
	21	11.12 ± 0.05^{Bb}	12.24 ± 0.5^{ABab}	13.16 ± 0.5^{Aa}	13.74 ± 0.5^{Aa}
	31	12.29 ± 0.05^{A}	13.21 ± 0.5^{Aab}	14.36 ± 0.5^{Aa}	14.66 ± 0.5^{Aa}
Fiber (%)	1	-	0.16 ± 0.005^{Cc}	0.33 ± 0.005^{Bb}	0.48 ± 0.005^{Aa}
	11	-	0.18 ± 0.005^{Cc}	0.35 ± 0.005^{Bb}	0.50 ± 0.005^{Aa}
	21	-	0.20 ± 0.005^{Cc}	0.38 ± 0.005^{Bb}	0.53 ± 0.005^{Aa}
	31	-	0.23 0.005^{Cc}	0.41 ±0.005^{Bb}	0.55 ± 0.005^{Aa}
Ash (%)	1	1.01 ± 0.005^{Ad}	1.07 ± 0.005^{Cc}	1.1007 ± 0.005^{Ab}	1.15± 0.005^{Ca}
	11	1.02 ± 0.005^{Ad}	1.08 ± 0.005^{BCc}	1.1010 ± 0.005^{Ab}	1.17 ± 0.005^{Ba}
	21	1.02 ± 0.005^{Ac}	1.09± 0.005^{Bb}	1.1083 ± 0.005^{Ab}	1.18± 0.005^{Ba}
	31	1.03 ± 0.005^{Ac}	1.11 ± 0.005^{Ab}	1.1087 ± 0.005^{Ab}	1.20± 0.005^{Aa}
Carbohydrates (%)	1	9.32 ± 0.01^{Da}	7.43 ± 0.01^{Cb}	7.43 ± 0.01^{Ab}	5.34 ± 0.01^{Bc}
	11	10.06 ± 0.01^{Ba}	7.45 ± 0.01^{Bb}	7.45 ± 0.01^{Ab}	5.68 ± 0.01^{ABc}
	21	10.30 ± 0.01^{Aa}	8.02 ± 0.01^{Ab}	8.02 ± 0.01^{Ab}	6.0067 ± 0.01^{Ac}
	31	9.78 ± 0.01^{Ca}	6.92 ± 0.01^{Db}	8.93 ± 0.01^{Aa}	5.81 ± 0.01^{ABb}

C_1:The control with without additives.
$T_{1,2,3,}$;The treatments with fortified Banana Peel powder (BPP) 0.5, 1and 1.5% respectively.

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a,b,c,…. : Means with same capital letter in same character assessed for between treatments are not significantly different ($p>0.05$). A,B,C,…. : Means with same letter in the same character assessed among treatments in the same storage period are not significantly different ($p>0.05$).

Table (3): Loss and recovery of protein or fat and yield in Ricotta cheese fortified with different level of banana peel powder (BPP).

Property	Treatments			
	B	B_1	B_2	B_3
Protein loss %	28.05^{a}	20.31^{b}	11.20^{c}	5.76^{d}
Recovery of protein%	71.95^{d}	79.69^{c}	88.8^{b}	94.24^{a}
Fat loss %	19.72^{a}	13.81^{b}	10.26^{c}	8.33^{d}
Recovery of fat%	80.28^{d}	86.19^{c}	89.74^{b}	91.67^{a}
Yield%	25.5^{d}	29^{c}	34.6^{b}	39.3^{a}
Increment with C%	-	13.73^{c}	35.69^{b}	54.11^{a}

Table (4) the PH and Acidity of Ricotta cheese fortified with banana Peel powder (BPP) during storage at 5±1°C .

Component (%)	Storage (day)	Treatments			
		B	B_1	B_2	B_3
PH	1	6.05 ± 0.005^{Aa}	6.06 ± 0.005^{Aa}	6.07 ± 0.005^{Aa}	6.07 ± 0.005^{Aa}
	11	5.98 ± 0.005^{Bb}	$5.99 \pm .005^{Bb}$	6.01 ± 0.005^{Ba}	6.02 ± 0.005^{Ba}
	21	5.93 ± 0.005^{Cd}	5.95 ± 0.005^{Cc}	5.97 ± 0.005^{Cb}	5.99 ± 0.005^{Ca}
	31	5.87 ± 0.005^{Dc}	5.90 ± 0.005^{Db}	5.94 ± 0.005^{Da}	5.95 ± 0.005^{Da}
Acidity	1	1.15 ± 0.005^{Ca}	1.101 ± 0.005^{Ab}	1.07 ± 0.005^{Cc}	1.01 ± 0.005^{Ad}
	11	1.17 ± 0.005^{Ba}	1.102 ± 0.005^{Ab}	1.08 ± 0.005^{BCc}	1.02 ± 0.005^{Ad}
	21	1.18 ± 0.005^{Aba}	1.11 ± 0.006^{Ab}	1.09 ± 0.005^{Bb}	1.05 ± 0.005^{Ac}
	31	1.197 ± 0.003^{Aa}	1.13 ± 0.005^{Ab}	1.11 ± 0.005^{Ab}	1.09 ± 0.005^{Ac}

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See details Table 2.

Table (5): Minerals and Vitamins of Ricotta cheeses fortified with different levels of Banana peel powder (BPP)

Properties	Treatments			
	B	B_1	B_2	B_3
Minerals (mg/100g cheese)				
Ca	572.12^{d}	674.81^{c}	789.15^{b}	898.23^{a}
K	617.04^{d}	858.05^{c}	1106.08^{b}	1340.11^{a}
Fe	0.47^{d}	1.82^{c}	3.22^{b}	4.63^{a}
Na	204.13^{d}	234.26^{c}	264.27^{b}	295.04^{a}
Zn	0.72^{d}	10.20^{c}	19.681^{b}	29.17^{a}
Mg	125.02^{d}	135.69^{c}	145.38^{b}	157.09^{a}
P	456^{d}	643.32^{c}	829.64^{b}	1014.03^{a}
Mn	0.63^{d}	1.22^{c}	1.78^{b}	2.34^{a}
Cu	0.15^{b}	0.19^{b}	0.24a	0.28^{a}
Vitamins (mg/100g cheese)				
Thiamin (B_1)	0.1908^{b}	0.1934^{b}	0.2001^{a}	0.2036^{a}
Vitamin (B_6)	0.091^{a}	0.104^{a}	0.112^{a}	0.118^{a}
Vitamin C PPm	7.2105^{c}	7.8421^{c}	8.4773^{b}	9.1168^{a}
Vitamin E	123.002^{a}	123.012^{a}	123.026^{a}	123.038^{a}
Vitamin A (µg/100g)	212.08^{a}	212.056^{a}	212.110^{a}	212.179^{a}
B- carotene	-	0.17^{a}	0.35^{a}	0.51^{a}

See details in Table 2.

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Table (6): Total phenolic content (equivalent mg Gallic acid/100gm) and antioxidant activity (%) of ricotta cheeses fortified with different levels of Banana peel powder (BPP) during storage at 5±1°C

Storage by day	Treatments			
	B	B_1	B_2	B_3
Total phenolic content (equivalent mg Gallic acid/100gm)				
1	18.25^{Ad}	34.29^{Ac}	37.05^{Ab}	40.72^{Aa}
31	15.03^{Bd}	30.04^{Bc}	32.63^{Bb}	36.58^{Ba}
Antioxidant activity % (DPPH : 2,2-dihpenyl-1-picrylhydrazyl)				
1	31.24^{Ad}	40.76^{Ac}	48.91^{Ab}	56.08^{Aa}
31	28.72^{Bd}	38.11^{Bc}	46.45^{Bb}	52.39^{Ba}

See details in Table 2.

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Table (7) : Textural profile analysis of Ricotta cheeses fortified with different Level of Banana Peel powder (BPP) during storage at 5±1°C.

Component (%)	Storage/ day	Treatments			
		B	B_1	B_2	B_3
Hardness (N)	0	0.40 ± 0.05^{Aa}	0.45 ± 0.02^{Ca}	0.50 ± 0.05^{Aa}	0.7 ± 0.05^{Ca}
	10	0.60 ± 0.05^{Aa}	0.90 ± 0.05^{Ba}	0.80 ± 0.05^{Aa}	1.20 ± 0.05^{Ba}
	20	1.10 ± 0.05^{Ab}	1.30 ± 0.05^{Ab}	1.20 ± 0.05^{Ab}	2.10 ± 0.05^{Aa}
	30	1.00 ± 0.05^{Aa}	1.10 ± 0.05^{ABa}	1.00 ± 0.05^{Aa}	1.30 ± 0.05^{Ba}
Cohesivenes s(-)	0	0.46 ± 0.005^{Dc}	0.77 ± 0.00^{Ab}	0.80 ± 0.005^{Ab}	0.94 ± 0.005^{Aa}
	10	0.58 ± 0.005^{Cd}	0.72 ± 0.005^{Bc}	0.78 ± 0.005^{Ab}	0.87 ± 0.005^{ABa}
	20	0.63 ± 0.005^{Bb}	0.71 ± 0.005^{Bab}	0.74 ± 0.005^{Aa}	0.80 ± 0.05^{BCa}
	30	0.73 ± 0.005^{Ac}	0.65 ± 0.005^{Cb}	0.72 ± 0.005^{Ab}	0.75 ± 0.005^{Ca}
Springiness (mm)	0	5.0 ± 0.05^{Ad}	9.06 ± 0.005^{Ac}	11.01 ± 0.05^{Ab}	13.04 ± 0.005^{Aa}
	10	4.3 ± 0.05^{ABd}	8.58 ± 0.005^{Bc}	10.76 ± 0.005^{Bb}	$12.470 \pm .005^{Ba}$
	20	4.0 ± 0.05^{ABd}	7.37 ± 0.05^{Cc}	10.42 ± 0.005^{Cb}	12.08 ± 0.005^{Ca}
	30	3.2 ± 0.05^{Bd}	6.92 ± 0.005^{Dc}	10.05 ± 0.005^{Db}	11.82 ± 0.005^{Da}
Gumminess (N)	0	0.184 ± 0.005^{Db}	0.462 ± 0.005^{Da}	0.40 ± 0.05^{Dab}	0.658 ± 0.005^{Dab}
	10	0.348 ± 0.005^{Ca}	0.675 ± 0.01^{Ca}	0.624 ± 0.005^{Cb}	1.044 ± 0.005^{Cc}
	20	0.693 ± 0.005^{Aa}	0.9227 ± 0.008^{Ab}	0.888 ± 0.005^{Ac}	1.68 ± 0.005^{Ac}
	30	$0..730 \pm 0.005^{Ba}$	0.715 ± 0.005^{Bc}	0.72 ± 0.005^{Bc}	0.975 ± 0.005^{Bb}
Chewiness (n /m)	0	0.92 ± 0.0005^{Dc}	4.186 ± 0.0005^{Db}	4.404 ± 0.0005^{Db}	8.580 ± 0.0005^{Da}
	10	1.496 ± 0.0005^{Cc}	5.559 ± 0.0005^{Bb}	6.714 ± 0.0005^{Ca}	13.019 ± 0.0005^{Ca}
	20	2.772 ± 0.0005^{Ad}	6.803 ± 0.0005^{Ac}	9.253 ± 0.0005^{Ab}	20.294 ± 0.0005^{Aa}
	30	2.336 ± 0.0005^{Bd}	4.948 ± 0.0005^{Cc}	7.236 ± 0.0005^{Bb}	11.524 ± 0.0005^{Ba}

See Table 2.

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Table (8) Sensory evaluation of of Ricotta cheese fortified with banana peel powder (BPP) during storage at 5±1°C .
See details Table 2

	Storag	Treatments			
		B	B_1	B_2	B_3
Appearan (10)	0	10	10	10	9
	11	10	10	10	10
	21	9	9	10	9
	31	7	8	8	7
Texture (10)	0	9	10	10	10
	11	9	10	10	10
	21	9	10	10	10
	31	9	9	9	9
Color (10)	0	10	9	9	7
	11	10	9	9	7
	21	10	9	9	7
	31	9	9	9	7
Flavor (10)	0	9	10	10	8
	11	9	10	10	7
	21	9	10	10	8
	31	8	9	9	7
Overall Acceptabi liy(10)	0	10	10	10	7
	11	10	10	10	7
	21	10	10	10	7
	31	8	9	8	6
Total	0	48^{Ab}	49^{Aa}	49^{Aa}	41^{Ac}
	11	48^{Ab}	49^{Aa}	49^{Aa}	41^{Ac}
	21	47^{Bc}	48^{Bb}	49^{Aa}	41^{Ad}
	31	41^{Cc}	44^{Ba}	43^{Bb}	36^{Bd}

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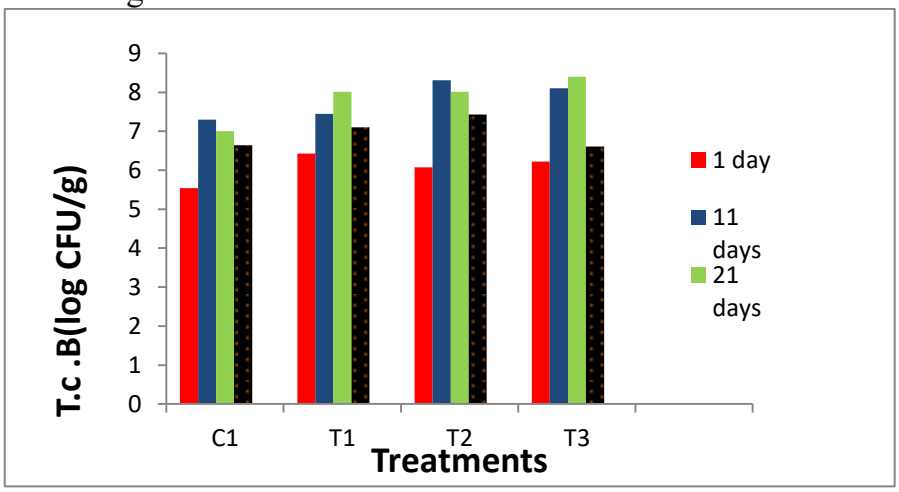

Fig. 1: Microbiological counts (log CFU/ g) of Ricotta cheeses fortified with different levels of Banana peel powder (BPP) during storage at 5±1°C.

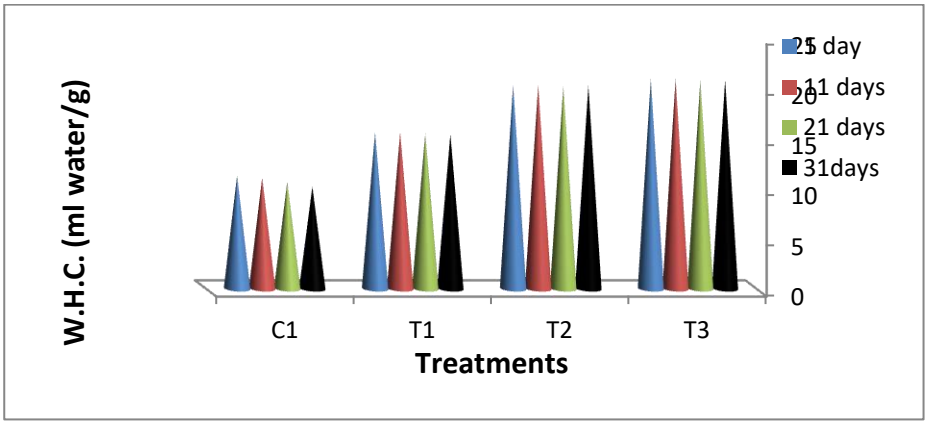

Fig.2 Water holding capacity of Ricotta cheese fortified with different levels of Banana peel powder (BPP) during storage at 5±1°C.

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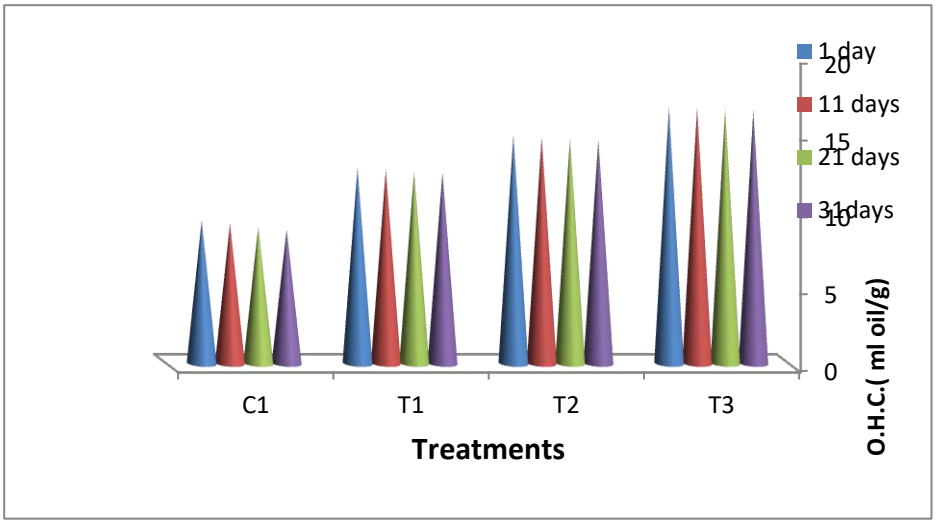

Fig.3 Oil holding capacity of Ricotta cheese fortified with different levels of Banana peel powder (BPP) during storage at 5±1°C.

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