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Improvement of Physicochemical Properties of Ricotta Cheese Fortified with Curcumin

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RICOTTA cheese was made from sweet whey,fortified with 1, 2, 3 and 4 % curcumin and stored at 4°C for 28 days. All cheeses were analyzed for physico-chemical, total phenol compounds, antioxidant activity, texture profiles and organoleptic properties. Results indicated that Ricotta cheese fortified with curcumin was characterized by increase in yield, total solids, protein, ash, lactose content, acidity, phenol compounds (PC), antioxidant activity%, rheological properties, shelf life and the total score points of sensory evaluation. Cheese treatment which fortified with 3% curcumin gained the highest score of organoleptic properties, total phenol compounds, antioxidant activity and shelf life till the end of storage period. Control cheese (had no curcumin) was spoiled at the day 21 of storage. These results clear that, the possibility of using the acidifiedsweet whey (by lactic acid) and fortified with curcumin to produce of functional Ricotta cheese as well as utilizing the surplus sweet whey.

Keywords: Curcumin, Ricotta cheese, Physicochemical properties, Total phenols, Antioxidants activity, Curcumin.

Introduction

"Ricotta" means "re-cooked" referring to its nation and made by acidifying and heating the sweet whey that came from another cheese-making (Kilic& Lind, 2004). Since sweet whey includes a high percentage of organic materials, its disposal poses a considerable environmental risk. Sweet whey contains whey proteins, most lactose, water-soluble minerals, and vitamins (Zall, 1992).

Making Ricotta cheese is one of the methods that have been developed to use sweet whey. During its production, the sweet whey is heated to a temperature of 90°C, and organic acid may be used to help the separating of protein from the whey. According to Modler & Emmons (2001), ricotta cheese has high moisture content and is formed from either milk or cheese whey or a combination of the two (Pizzillo et al., 2005). Fresh Ricotta cheese was used in many Italian dishes and had a mild and nutty flavor. The manufacture of ricotta cheese has been viewed as one of the more economical ways to use up excess sweet whey and generate additional income (Shukla et al., 1986). Curcumin (CCM) is a phenolic compound obtained from the rhizome of plant turmeric (*Curcuma longa*) (Li et al., 2015). It has many health promoting benefits such as antioxidant, anticancer, anti-inflammatory (Aggarwal et al., 2007; Anand et al., 2007 and Anand et al., 2008) and anticarcinogenic activities (Miller et al., 2008). The major curcuminoid compounds isolated from turmeric root are curcumin.

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Few kinds of literature were found about the use of curcumin in the field of dairy and dairy products**.** The use of curcumin in cheese production was applied by Souza et al. (2016), El-Dem (2020);and El Sayed& Shalaby (2021). Souza et al. (2016) studied the impact of the storage period (0, 24, 48, and 72 hr) of fresh Ricotta, made from sweet or acid whey, on the physicochemical parameters, color, texture, and microstructure. In comparison to control cheese, they found that Ricotta made with saved whey had an average yield of 5.33%, a lower fat content and pH, and higher acidity. There were little variations in color and texture, and their hardness and gumminess diminished, creating a compression microstructure. They came to the conclusion that producing Ricotta cheese from whey kept for 72 hours produced cheese of high quality and improved its suitability for consumption.

El-Den (2020) is studying the feasibility of improving the quality of Ricotta cheese by utilizing curcumin and adding bifidobacteria, as well as tracking changes in cheese quality and bifidobacteria survival for a 14-day storage period. According to the results, adding 2% curcumin to Ricotta cheese had a significant ($p < 0.05$) impact on the amount of total protein, titratable acidity, lactose, fat, and ash. While cheese yield decreased gradually during the storage period, these parameters were increased. Increases in phenol components (PC), antioxidant activity (AA), and scores of organoleptic properties were observed in Ricotta enhanced with curcumin. The probiotic Ricotta with curcumin treatment had the highest PC and TAA values. Curcumin could be regard as a good source of total phenolic. Furthermore, the high retention of antioxidant activity in curcumin-treated Ricotta could be attributing to the stability of the curcumin. Organoleptic properties of Ricotta cheese showed that all curcumin-treated samples gained higher scores as compared to untreated curcumin treatment (control). Additionally, it had high counts of bifidobacteria during the storage period. It could be conclude that bifidobacteria and curcumin can be added to Ricotta to make it functional and of acceptable composition and quality. Moreover, El-Sayed & Shalaby (2021); El-Sayed & Shalaby (2021) employed curcumin nanoemulsion (CR-NE) in manufacturing processed cheese as a functional and healthy substance. Curcumin nanoemulsion was added to the processed cheese formula by a ratio of 2.5% and 5% to achieve a final concentration of 25 mg and 50 mg of nano curcumin/ kg processed cheese, respectively. The results showed that adding CR-NE enhanced the physicochemical, microstructural, and textural characteristics of processed cheese during cold storage at 4°C for 60 days. Curcumin Nano emulsion decreased the loss of moisture during storage. The hardness of cheese containing CR-NE was slightly affected during storage compared with control samples. The objective of this paper was studying the effect of using different levels of curcumin in Ricotta cheese making, on the keeping quality, physicochemical, phenolic compounds, antioxidant activity and organoleptic properties of the resultant cheese made from sweet whey.

Materials and Methods

Sweet whey

Sweet whey of Mozzarella cheese processing was obtained from of Sakha Station, Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt. Lactic, acetic and citric acids were purchased from Misr Food Additives (MIFAD), Egypt.Curcumin (CCM) from *Curcum longa* (> 65% pure), was purchased from sigma (St. Louis, Mo, USA).

Preparation and storage of cheese

Experimental pilot was carried out by Basiony (2008) to select the best organic acid (citric, acetic and lactic acid) in the manufacture of Ricotta cheese and results indicated that the best one was lactic acid. So we employ it in our study. Ricotta cheese was made according to the method described by El-Sheikh et al. (2010). About 200 L. of sweet whey obtained from the processing of Mozzarella cheese was divided into fiveportions,pH was adjusted to 4.5 using lactic acid.The 1st portion without curcumin was used as control.Curcumin was added to the rest 4 portions at a level of 1, 2, 3 and 4 %, respectively.All sweet whey was heated at 90°C for 15 – 30 min. The resultant curd was left in the whey for 10 min, scooped in plastic frames lined with cheese cloth and allows toachieve complete drainage within 24 h. The curd was removed from the molds , cut into cubes (1 kg each) , packed in polyethylene bags with 10% salt whey and stored at (4°C) for 28 days. The samples were taken for analysis after 0, 7, 15, 21and 28 days for physico-chemical, texture profile,phenolic compounds, antioxidant activity and sensory properties. The whole experiment was carried out in triplicates.

Methods of analysis

Total solids, titratable acidity, PH, moisture, protein, fat and ash contents were determined according to AOAC (2007). Lactose was determined according to Barnett & Abdel-Tawab (1957).

Cheese yield

Cheese yield was calculated as kg of fresh cheese per 100 kg of sweet whey used.

Organoleptic assessment

Ricotta cheese samples were scored for organoleptic properties by a taste panel of 10 staff members of Dairy department, Food Technology Institute, Agricultural Research Center according to Mahranet al. (1998). The panelists scored the cheese for flavour (out of 40 points); body & texture (out of 50 points) and appearance (out of 10 points)

Antioxidant activity

Antioxidant activity was determined by using 2, 3-diphenyl-1-pricrl-hydrazyl (HPPH) assay (Cuendet &Potterat, 1997; Burits & Bucar, 2000). Phenolic compound was determined in the ethanolic extract of cheese according to Singleton & Rossi (1965).

Textural profile

Texture profile of Ricotta cheese was measured at 23ºC as described by Bourne (1978**)** using an Instron Universal Testing Machine model 1195, Stable Micro System (SMS) LTD., Godalming, UK, loaded with Dimension software SMS program. Likewise, Penetration values measured as mentioned by Bourne (1978).

Statistical analysis

All the data were analyzed using a factorial experiment, and the Student Newman Keuls test was used to perform the multiple comparisons (Steel & Torrie, 1980) using the Costat program. Significant differences were calculated at $p \leq 0.05$.

Results and Discussion

a-Effect of curcumin on chemical composition of fresh cheeses

Table 1 shows that the yieldof control treatment (0.0% curcumin) was 4.55%, increased by the additionof curcumin (1, 2, 3 and 4%) being 4.70, 4.86, 5.10 and 5.0 , respectively.Total solids content (%) behaved the same trend of yield so it were 23.60 for control cheese and 23.80, 23.90, 24.30 and 24.25 % forthe Curcumin cheese treatments B , C , D and E, in order .Table 1 shows, also, an increase in the total protein by the addition of curcumin being15.77, 15.78, 15.82 and15.85%, in curcumin cheeses, respectively. Cheese made by adding 4.0 % curcumin contained the highest protein content, and this might be due to the formation of a complex between curcumin and immunoglobulin (Liu et al., 2008) and β-lactoglobulin (Sneharani et al., 2010; Mohammadi & Moeeni, 2015). There were a little compositional difference in fat and ash contentsamongall treatments, compared with control one**.** Increasing ash contents in curcumin cheeses may refer to the ability of curcumin to bind with transition metals like Fe3+, Mn2+, Ni2+, Cu2+, Zn2+, Pb2+, cd2+, ru3+ and re3+ , render curcumin to be stable and functional (Zebib et al., 2010). Generally**,**we can conclude that there was a direct relationship between the percent of curcumin added and the values of the parameters mentioned before. This means that as the level of curcumin increased the values of yield, TS, protein, fat and ash were increased.

B- Effect of storage period

As the storage period progressed, the values of TS, protein, fat, and ash increased. On the other hand, the yield of all treatments gradually decreased up until the end of the storage period (28 days). This may be due to expelling the whey from the curd and decreasing moisture during storage (Kebary et al., 2018).

From the data in Table 2, it was noticed that Ricotta cheese fortified with curcumin might be regarded as a good source of total phenolic compounds and antioxidants. Total phenol (mg\100 g) increased by 20.56, 32.30, 43.83 and 52.48 % for B, C, D, and E curcumin-treated cheeses, respectively. Data also showed that Ricotta cheese fortified with curcumin had the highest value of total phenol compounds and antioxidant activity compared to the control. In addition, antioxidant capacity increased with the increasing level of curcumin (EL-DEN, 2020). This variation might be attributed to the high antioxidant capacity of curcumin, and high antioxidant activity retention in curcumin-treated cheeses might be related to the presence of polyphenolic compounds or Curcuminoids which is the major components in turmeric (Anand et al., 2008).

Textural profiles

Hardness is the amount of force needed for compression (N); cohesiveness is the ratio of force to time for the areas of two compressions (dimensionless); Springiness (mm) is a recovery measure after the first compression (dimensionless); gumminess is the result of cohesiveness by hardness (N), and chewiness is the result of gumminess (N) bySpringiness(mm)(Tunicketal., 2012).

TABLE 1. Chemical Changesof Ricotta cheese made with lactic acid andfortified by different levels of curcumin, during storage period (28day) at 4°C.

Parameters	Storage period	Treatments				
		A (control)	B	C	D	E
Yield (%)	0	4.55±0.02^{eA}	4.70±0.18^{dA}	4.80±0.02^{cA}	5.10±0.05^{aA}	5.00±0.02^{bA}
	7	4.35±0.02^{eB}	4.53±0.18^{dB}	4.71±0.02^{cB}	5.00±0.05^{aB}	4.86±0.02^{Bb}
	15	4.00±0.02^{eC}	4.18±0.18^{dC}	4.35±0.02^{cC}	4.70±0.05^{aC}	4.51±0.02^{bC}
	21	3.67±0.02^{eD}	3.94±0.18^{dD}	4.04±0.02^{cD}	4.44±0.05^{aD}	4.13±0.02^{bD}
	28	2.98±0.02^{eE}	3.21±0.18^{dE}	3.67±0.02^{cE}	4.11±0.05^{aE}	3.89±0.02^{bE}
Total solids (%)	0	23.60±0.01^{De}	23.80±0.02^{cE}	23.90 ±0.07^{b}	24.30±0.08^{aE}	24.25±0.19^{aE}
	7	24.20±0.02^{dD}	24.30±0.06^{cD}	24.50±0.02^{bD}	25.80±0.02^{aD}	25.70±0.02^{aD}
	15	25.10±0.06^{dC}	25.40±0.02^{cC}	25.70±0.09^{bC}	26.76±0.17^{aC}	26.80±0.02^{aC}
	21	26.40±0.06^{dB}	26.70±0.02^{cB}	26.90±0.09^{cB}	27.40±0.17^{aB}	27.30±0.01^{bB}
	28	27.00±0.06^{dA}	27.30±0.02^{cA}	27.60±0.09^{bA}	27.80±0.17^{aA}A	27.73±0.04^{bA}
Fat (%)	0	6.21±0.09^{cE}	6.25±0.06^{bE}	6.26±0.08^{bE}	6.28±0.15^{aE}	6.27±0.09^{aE}
	7	6.29±0.09^{cD}	6.31±0.06^{cD}	6.35±0.05^{bD}	6.38±0.15^{aD}	6.38±0.09^{aD}
	15	6.37±0.09^{cC}	6.40±0.06^{bC}	6.44±0.05^{bC}	6.47±0.15^{aC}	6.46±0.09^{aC}
	21	6.51±0.09^{bB}	6.54±0.06^{bB}	6.59±0.05^{bB}	6.61±0.15^{aB}	6.62±0.09^{aB}
	28	6.59±0.09^{cA}	6.61±0.06^{cA}	6.67±0.05^{bA}	6.70±0.15^{aA}	6.72±0.09^{aA}
Protein (%)	0	15.75±0.17^{bE}	15.77±0.15^{bE}	15.78±0.09^{bE}	15.82±0.06^{aE}	15.85±0.15^{aE}
	7	16.45±0.17^{bD}	16.48±0.15^{bD}	16.52±0.09^{bD}	16.55±0.06^{aD}	16.57±0.15^{aD}
	15	17.15±0.17^{bC}	17.19±0.15^{bC}	17.24±0.09^{bC}	17.33±0.06^{aC}	17.34±0.15^{aC}
	21	17.55±0.17^{bB}	17.59±0.15^{bB}	17.66±0.09^{bB}	17.70±0.06^{aB}	17.72±0.15^{aB}
	28	17.76±0.15^{bA}	17.76±0.15^{bA}	17.84±0.09^{bA}	17.92±0.06^{aA}	17.94±0.15^{aA}
Ash (%)	0	2.00±0.06^{cE}	2.12±0.02b^{E}	2.23±0.17^{bE}	2.37±0.02^{aE}	2.40±0.02^{aE}
	7	2.40±0.06^{bD}	2.54±0.02^{bD}	2.65±0.17^{bD}	2.79±0.02^{aD}	2.90±0.09^{aD}
	15	2.67±0.06^{cC}	2.78±0.02^{cC}	2.91±0.17^{bC}	3.03±0.02^{bC}	3.13±0.02^{aC}
	21	2.73±0.06^{cB}	2.81±0.02^{cB}	2.95±0.17^{bB}	3.13±0.02^{aB}	3.19±0.02^{aB}
	28	2.82±0.06^{cA}	2.87±0.02^{cA}	2.99±0.17^{bA}	3.21±0.02^{aA}	3.26±0.08^{aA}

A: Ricotta cheese without curcumin(control).

B: Ricotta cheesefortified by 1% curcumin.

C: Ricotta cheesefortified by 2% curcumin.

D: Ricotta cheese fortified by 3% curcumin.

E: Ricotta cheese fortified by 4% curcumin.

Different capital letters within the same column are differed significantly at $p < 0.05$.

Different small letters within the same row are differed significantly at $p < 0.05$.

TABLE 2. Changes inthe total phenol compounds and antioxidant activities of Ricotta cheese made with lactic acid and fortified by different levels of curcumin, during storage period.

Parameters %	Storage period (days)	Treatments				
		A	B	C	D	E
Total phenols (mg\ 100 g)	0	00.00	20.56d±0.02^{Da}	32.30c±0.03^{cA}	43.83±0.09^{bA}	52.48±0.12^{aA}
	7	00.00	17.91±0.02^{dB}	30.1±0.02^{cB}	42.15±0.09^{bB}	50.93±0.12^{aB}
	15	00.00	16.60±0.02^{dC}	28.06±0.02^{cC}	40.11±0.09^{bC}	49.02±0.12^{aC}
	21	00.00	16.31±0.02^{dD}	27.90±0.02^{cD}	39.09±0.09^{bD}	48.40±0.12^{aD}
	28	00.00	15.99±0.02^{dE}	26.05±0.02^{cE}	38.59±0.09^{bE}	47.87±0.12^{aE}
Anti-oxidant activity (%)	0	22.10±0.02^{eA}	42.52±0.12^{dA}	47.81±0.09^{cA}	53.23±0.02^{bA}	58.34±0.02^{aA}
	7	20.00±0.02^{eB}	37.93±0.12^{dB}	43.64±0.09^{cB}	49.77±0.02^{bB}	54.12±0.02^{Ab}
	15	17.30±0.02^{eC}	32.27±0.12^{dC}	39.66±0.09^{cC}	44.87±0.02^{bC}	51.76±0.02^{aC}
	21	16.50±0.02^{eD}	32.06±0.12^{dD}	38.99±0.09^{cD}	44.18±0.02^{bD}	51.21±0.02^{aD}
	28	16.08±0.02^{eE}	31.79±0.12^{dE}	38.11±0.09^{cE}	43.86±0.02^{b}	50.99±0.02^{aE}

See footnote Table 1.

According to instrumental texture profile analysis (TPA) of Ricotta cheese made by the addition of lactic acid and enriched with different levels of curcumin during storage at 4°C. Table 5revealed no significant differences at $p \leq 0.05$ among hardness attributes when fresh. It was (with average values) 0.88, 0.85, 0.83, 0.87, and 0.86 N, for A, B, C, D, and E, respectively. During the storage period, it differed significantly at $p \leq 0.05$ and being 1.26, 1.23, 1.20, 1.22, and 1.24 at the end of the storage period. Proteolysis and Lipolysis reactions that occurred in curcumin cheeses during storage may impact the stability of the protein matrix and emulsifying agents such as lipoproteins and play an important role in that (Pereira et al., 2002).

The averages of cohesiveness scores of Ricotta cheese did not differ significantly at ($p>0.05$) among different treatments. Borba et al. (2014) also observed near values of cohesiveness during storage in our study. These results suggest that there was no impact on the deformability of Ricotta due to changes in the chemical structure of the components (Ferrandini etal., 2011). No significant differences in springiness values were noticed between the control and other treatments of fresh cheeses. On the other hand, there were significantly differences among these treatments during the storage period. Regarding gumminess and chewiness, no significant differences ($p>0.05$) were shown in fresh cheeses and during storage or among cheese containing curcumin. The gumminess values decreased, exhibiting similar behavior comparable to that of the main attribute of hardness. Despite the chewiness attribute being secondary, derivative of hardness, it remained steady. Ciabotti et al. (2009) found that the chewiness value in Ricotta made with mozzarella cheese whey is higher.

According to the texture profile analysis, Ricotta cheese is classified as a viscoelastic food (Fox et al., 2000) with a very soft consistency, not pasty and friable, compressible and not too cohesive, with brittle properties (Tunick et al., 2012). A stable texture profile during storage is necessary for marketing and sensory acceptability. The protein matrix of Ricotta cheese loses the spongy texture and becomes more compacted. There is a decrease in hardness and gumminess among curcumin cheese treatments, indicating that the presence of protein bonds is more frequently weakened by proteases and/or irreversible denaturation. The texture of acidic coagulation cheeses is closely related to heat and acid levels used during Lower pH levels, near the isoelectric point of whey proteins, which are possibly responsible for the creation of the matrix (Tunick et al., 2012). Immunoglobulins were responsible for this structural change due

to their isoelectric point (IP), which ranges from 4.5 to 5.5, and their high heat sensitivity. They communicate with β-lactoglobulin (IP 5.2) and bovine whey albumin (IP 4.7 to 4.9) via disulfide bonds (Morr & Há, 1993). The Lacto globulin is irreversibly denatured, polymerizes, and becomes more susceptible to the action of proteases at temperatures above 70°C. α-lactalbumin (IP from 4.2 to 5.1) has high denature reversibility, around 40% following heating at 95°C due to connections with Ca2+ and Zn2+ion (Morr & Há, 1993).

Organoleptic properties

Figure 1 Presented the total score points for Ricotta cheese at the end of the cold storage period. It was observed that adding curcumin and storage period had an impact on the organoleptic properties of Ricotta cheeses. The treatment containing 3% curcumin received the highest scores for its organoleptic properties compared with control cheese and other cheeses. These results showed that all curcumin-treated samples performed better than untreated samples at the conclusion of cold storage (control).

TABLE 3. Textural profileanalysis of Ricotta cheese made with the addition of lactic acid and fortified by differentlevelsofcurcuminduring storage.

Textural profiles	Storage period (days)	Treatments				
		A(control)	B	C	D	E
Hardness (N)	0	0.88±0.02^{aE}	0.85±0.02^{aE}	0.83±0.02^{aE}	0.87±0.02^{aE}	0.86±0.02^{aE}
	7	1.02±0.02^{aD}	1.00±0.02^{aD}	0.98±0.02^{aD}	0.99±0.02^{aD}	1.03±0.02^{aD}
	15	1.08±0.02^{aC}	1.03±0.02^{aC}	1.01±0.02^{aC}	1.10±0.02^{aC}	1.11±0.02^{aC}
	21	1.13±0.02^{aB}	1.10±0.02^{aB}	1.08±0.02^{aB}	1.16±0.02^{aB}	1.18±0.02^{aB}
	28	1.26±0.02^{aA}	1.23±0.02^{aA}	1.20±0.02^{aA}	1.22±0.02^{aA}	1.24±0.02^{aA}
Cohesiveness (-)	0	0.36±0.02^{a}	0.34±0.02^{aA}	0.33±0.02^{aA}	0.36±0.02^{aA}	0.36±0.02^{aA}
	7	0.35±0.02^{aA}	0.35±0.02^{aA}	0.34±0.02^{aA}	0.39±0.02^{aA}	0.38±0.02^{aA}
	15	0.40±0.02^{aA}	0.38±0.02^{aA}	0.37±0.02^{aA}	0.41±0.02^{aA}	0.39±0.02^{aA}
	21	0.37±0.02^{aA}	0.33±0.02^{aA}	0.33±0.02^{aA}	0.38±0.02^{aA}	0.40±0.02^{aA}
	28	0.35±0.02^{aA}	0.32±0.02^{aA}	0.32±0.02^{aA}	0.36±0.02^{aA}	0.39±0.02^{aA}
Springiness (mm)	0	0.94±0.02^{aA}	0.92±0.12^{aA}	0.93±0.06^{aA}	0.95±0.02^{aA}	0.96±06^{aA}
	7	0.86±0.12^{aB}	0.88±0.02^{aB}	0.85±0.04^{aB}	0.85±0.05^{aB}	0.87±0.17^{aB}
	15	0.75±0.05^{aC}	0.83±0.06^{aA}	0.80±0.02^{aC}	0.76±0.04^{aC}	0.82±0.11^{aC}
	21	0.77±0.17^{aD}	0.89±0.05^{aB}	0.84±0.06^{aB}	0.79±0.01^{aD}	0.80±0.02^{aD}
	28	0.79±0.14^{aE}	0.83±0.02^{aA}	0.85±0.01^{aB}	0.81±0.02^{aB}	0.84±0.19^{aE}
Gumminess (N)	0	0.31±0.04^{aA}	0.28±0.09^{aA}	0.27±0.02^{aA}	0.31±0.12^{aA}	0.30±0.22^{aA}
	7	0.35±0.14^{aA}	0.35±0.14^{aA}	0.33±0.14^{aA}	0.38±0.14^{aA}	0.39±0.14^{aA}
	15	0,43±0.14^{aA}	0.39±0.14^{aA}	0.37±0.14^{aA}	0.45±0.14^{aA}	0.43±0.14^{aA}
	21	0.41±0.18^{aA}	0.36±0.18^{a}	0.35±0.18^{aA}	0.44±0.18^{aA}	0.47±0.18^{aA}
	28	0.44±0.02^{aA}	0.39±0.02^{aA}	0.38±0.02^{aA}	0.43±0.02^{aA}	0.48±0.18^{aA}
Chewiness (n/m)	0	0.39±0.02^{aA}	0.38±0.02^{aA}	0.37±0.02^{aA}	0.39±0.02^{aA}	0.36±0.18^{aA}
	7	0.32±0.02^{aA}	0.30±0.02^{aA}	0.35±0.02^{aA}	0.34±0.02^{aA}	0.35±0.02^{aA}
	15	0.29±0.02^{aA}	0.34±0.02^{aA}	0.34±0.02^{aA}	0.30±0.02^{aA}	0.32±0.02^{aA}
	21	0.30±0.02^{aA}	0.39±0.02^{aA}	0.36±0.02^{aA}	0.29±0.02^{aA}	0.30±0.02^{aA}
	28	0.32±0.02^{aA}	0.38±0.02^{aA}	0.39±0.02^{aA}	0.33±0.02^{aA}	0.28±0.02^{aA}

See footnote Table 1

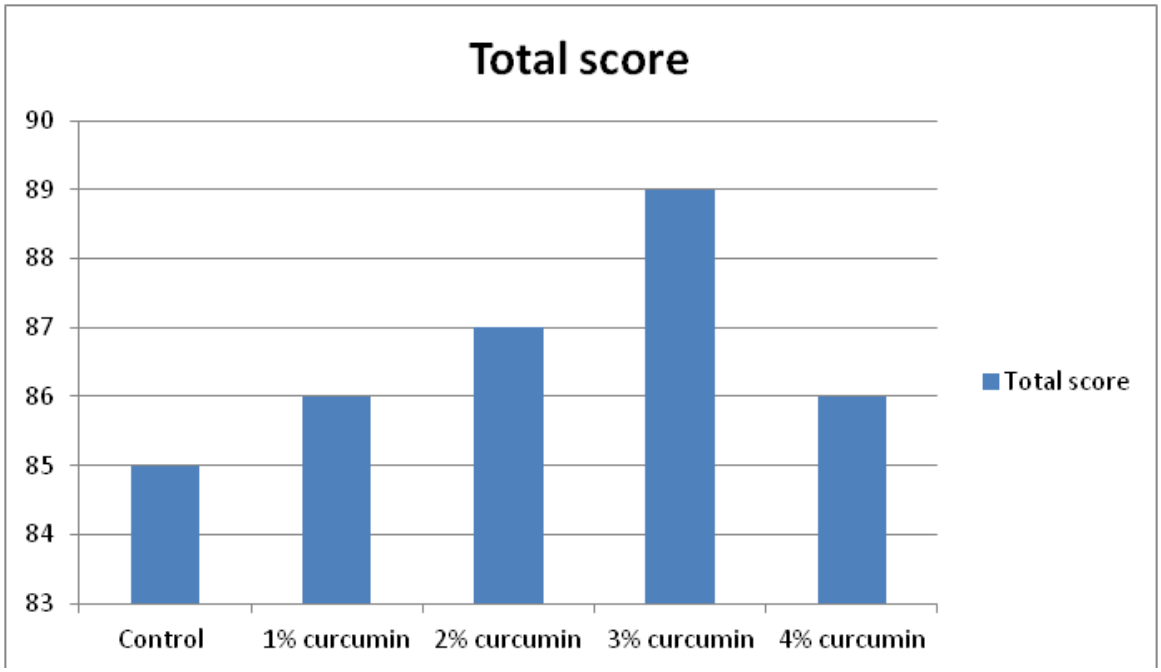

Fig. 1. Total score points for Ricotta cheese fortified with 1, 2,3, and 4% curcumin , at the end of cold storage .

Conclusion

These results demonstrated clearly that, it is possible and appropriate to use lactic acid in the manufacture of Ricotta cheese in order to obtain good curd qualities. Manufacturing Ricotta cheese may be considered one of the economical ways to use up the extra sweet whey. Fortification of Ricotta cheese with curcumin was found useful to produce long shelf-life cheese, rich in both total phenolic compounds and antioxidant activity, and had good properties. Cheese containing 3% curcumin was the superior one among the all treatments, during the storage period.

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تحسين الخواص الفيزوكيميائية لجبن الريكوتا المدعمة بالكركميين

باستخدام بعض الأحماض العضوية

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* تم تصنيع جبن الريكوتا من الشرش المُتخلف عن صناعة جبن الموزاريلا للاستفادة من القيمة الغذائية والصحية العالية له باستخدام حمض اللاكتيك (لخفض ال pH للشرش الى ٤,٥) وذلك من دراسة سابقة ل Monira,2008.

*تم تدعيم الشرش الحلو بالكركميين (قبل تحميضه بحامض اللاكتيك) بنسب ١ ، ٢ ، ٣ ، ٤ ٪ ودراسة أثر هذا التدعيم على الخواص الحسية والفيزوكيميائية والريولوجية للجبن الناتج خلال فترة التخزين لمدة ٢٨يوم على درجة حرارة الثلاجة (٤ م)...

*اظهرت النتائج زيادة كل من التصافي، البروتين، الجوامد الكلية، الرماد– مُقارنة بالكنترول مع زيادة نسب التدعيم بالكركميين ؛ كذلك لوحظ ارتفاع نسب المواد الفينولية و مضادات الأكسدة في المعاملات المدعَّمة بالكركمين

*أدي التدعيم بالكركمين بنسب مختلفة الى اطالة فترة الحفظ للجبن حتي نهاية مدة التخزين (٢٨ يوم) مقارنة بالكنترول التى تدهورت صفاتها بعد (٢١ يوم) كما حصلت الجبن المدعَّمة بنسبة ٣٪ كركميين على أعلى درجات التقييم الحسي.

*لذا نوصى باستخدام حمض اللاكتيك لتحميض الشرش المُستخدم في صناعة جبن الريكوتا لتعظيم الاستفادة الاقتصادية من الكميات الكبيرة هذا من الشرش الغير مملح – وتدعيم جبن الريكوتا المصنعة منة بالكركميين حتى نسبة ٣٪ لتحسين الخواص الفيزوكيميائية ورفع قيمتها الغذائية والصحية واطالة فترة حفظها وزيادة المركبات الفينولية والمواد المضادة للاكسدة بها، مع تخزينهاعلى درجة حرارة الثلاجة.