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Comparative Study of some Characteristics for Whey Cheese Produced by Heat Acid Coagulation

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Abstract. In the current study sweet whey obtained from white soft cheese was used for processing of Ricotta cheese using heat treatment with acid and Best Ricotta which manufactured by heating without addition of acid. Cheese samples were analyzed for some physicochemical analysis (moisture, total solids, pH, protein, yield and hardness) and organoleptic characteristics including (Appearance, texture, flavor, color, and overall acceptability) during 7 days of storage at 4±1°c. It was found that the moisture content of Ricotta cheese was76.50% which was lower than that of Best ricotta 79.266%, the total solid of Best ricotta cheese was 17.733 %, while for Ricotta cheese was 21.50 %. Ricotta cheese characterized by lower pH value of 5.48 and higher acidity, protein contain, yield and hardness 0.103 %, 14.2%, 8.7% and 6g as compared to Best Ricotta cheese which were 6.40, 0.054 %, 12.26%, 6.49% and 3.66 g respectively at the first day of cold storage. It was noted that with the prolonged of the storage time, there was an increase in the values of some characteristics, including the percentage of total solids, acidity and hardness, while there was a decrease in the values of pH, moisture and protein percentage. Ricotta cheese gets the highest score by sensory panelists for the texture and appearance and unlike for, flavors and color than the Best Ricotta. Those degrees decreased slightly during the storage period.

Keywords. Acid Ricotta, Best Ricotta, Cheese whey, Soft cheese, Whey.

1. Introduction

The reutilizing and reprocess of industrial waste have become the interest of many countries of the world because of its economic importance and it may cause environmental problem if not used correctly, in response to the growing attention for low-cost and valuable food components, food by-products are measured as excellent sources of many components that have functional and nutritional properties to improve the immune system (Chavan *et al.*, 2015). The effective use of by-products provides significant economic gains for the countries and significant reduction in environmental pollution. Nowadays, the present technologies allow the recovery of important compounds from the by-products and their recovering inside food chain as foods or functional additives in different products to increase the nutritional value and to supply food with many sensory qualities and health benefits. Such as whey powder, whey protein, whey permeates, whey cheese. baby food, sport food and probiotics (Bulut Solak and Akin 2012, Carvalho *et al*., 2013 and Pires *et al.*, 2021).

Whey is a greenish-yellowish liquid fraction that remains after milk coagulation and casein removal during the cheese-making process. This by-product contains about 55 percent of milk nutrients and accounts for 85–90% of milk weight depending on the kind of milk and cheese (Smithers, 2008). Due

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to its high BOD and COD concentrations, cheese whey is considered an environmental contaminant (Lahoue *et al*., 2016). Whey's biochemical oxygen demand (BOD) and chemical oxygen demand (COD) values are approximately 27-60 g/L and 50-102 g/L, respectively. (Carvalho et al. 2013 and Zandona et al.2021). The high organic load of whey ((lactose, proteins and vitamins) stand up from the presence of residual milk nutrients. As demand for cheese worldwide is increasing, it leads to increased production of whey, The total global production of whey is estimated at about 180 to 190 million tons/year (Mollea et al., 2013), which poses many management problems (Yadav et al. 2015 and Mann et al. 2019).

Ricotta cheese is one of the dairy products which is Italian in origin, it is a whey cheese made from sheep, cow, goat or buffalo's milk whey residues from the production of cheese by enzymatic coagulation which named as sweet whey, it can be produced using cheese whey or milk, or a mixture of both. Although it is commonly referred to as ricotta cheese, ricotta is not a cheese in the proper sense because it is not produced by coagulating casein in which the casein is filtered away from whey during cheese making. Rather, it results from heat coagulation of other milk proteins, especially albumin and globulin left behind in whey that is separated from milk during cheese production, ricotta cheese is safe for those with a casein intolerance (Modler and Emmons, 2001 and Pizzillo *et al*. 2005).

Ricotta cheese is a white un- ripened soft cheese highly perishable, has a limited shelf-life, grainy, creamy, white in appearance and slightly sweet to taste curd. The curd is accurately cooked twice hence the name "ricotta, indicates to" re-cooked process (Maubois *et al*. 2004 and Del Nobile *et al*.,2009.). Being low in fat and sugar. Ricotta is a dieter's favorite cheese where currently, there is increasing concern about the impact of diet on human health as consumers focus on reduced or low-fat and sugar, foods, which are less associated with the risk of chronic disease such as, diabetic, lactose intolerance, obesity, arteriosclerosis and coronary heart disease high (Jinjarak *et al*.2006; Akalin *et al*.,2008 and Królczyk *et al*.2016). Ricotta cheese has high nutritional value from the high-quality proteins, vitamins and minerals that it contains, the main protein in ricotta cheese is whey, which contains all the amino acids for the body and is easy to absorb and is useful in building muscle, also Whey proteins are rich in bioactive peptides, possessing bioactive properties such as being antioxidant and antihypertensive as well as having antimicrobial activities, which, when ingested, confers several health benefits. (Kumar *et al*., 2008and Minj and Anand,2020). Specific protein fractions are used to control blood pressure and to induce sleep (Korhonen, 2009; Yadav *et al*.2015), In addition, it contains some proteins and enzymes that support the immune system which includes, immunoglobulin, transferrin, lactoferrin lysozyme, and lacto-peroxidase (Brandelli *et al*.2015) . Ricotta is naturally low-fat cheese, and consuming it is preferable to that of low-fat processed cheeses, if people need to reduce the calories consumed daily, and intake cheese in general is useful for reducing cholesterol level in the body and lowering blood pressure, therefore it is possible to depend on low-fat cheeses without Concerns about being overweight. As well as Ricotta cheese is one of the cheeses with low sodium content compared to similar types, also it is cheese is an excellent source of calcium which indicates that dairy helps to reduce the risk of colorectal cancer (Thorning *et al*.2016).

Since the use of whey is economically, healthy and environmentally friendly. Thus, the objective of present study was to compare some physiochemical and microbial properties of cheese made by heat treatment (best ricotta) and heat treatment with acid (acid ricotta) during (7) days of storage at 4 ± 2 °C.

2. Materials and Methods

2.1. Materials

Fresh raw cow milk was obtained from the dairy field unit (Animal Resource Department, College of Agriculture, Salahaddin University-Erbil). Citric acid and microbial rennet were obtained from Erbil local market. Other chemicals were used for analytical grade.

2.2. Methods

2.2.1. Chemical Analyses

2.2.1.1. Determination of pH

pH values of milk, whey and whey cheese samples were determined according to the method of A.O.A.C. (2012) using digital pH meter (Wtw-pH530).

2.2.1.2. Moisture Content

The moisture content of milk, whey and whey cheese samples was determined according to AOAC (2012).

$$\% \text{ Moisture} = W1 - \frac{W2 \text{ X } 100}{W1}$$

Where, W1=initial weight of sample; W2=weight of the dried sample.

2.2.1.3. Determination of Total Solid

Total solid of samples was determined according to AOAC (2012).

2.2.1.4. Other Milk and Whey Components

The percentage of solid nonfat, fat, protein and lactose in milk and whey were measured using milko tester (Funke Gerber-Lcto star\ Germany).

2.3. Preparation of Ricotta Cheese

Sweet bovine whey was obtained from manufacturing Iraqi soft white cheese as a byproduct using method described by Al-Dhhan (1983). The milk was pasteurized to 71.8±2°C for 15 sec. and cooled to coagulating temperature of 38±2 °C, followed by the addition of microbial rennet after dissolving it with water and according to the company's instructions. Approximately 40 minutes after enzyme addition, the curd was cut with 2 cm then allowed to settle in the whey for 5 minutes with agitation to prevent curd matting. After that, the whey was drained by passing through cheese cloth.

Ricotta and Best Ricotta Cheese was made from heat-acid and heat precipitation of proteins from whey respectively according to method used by (Mahran *et al.,* 1999). During heating whey proteins begin to coagulate at about 70 ^{o} C. The rate of coagulation increases as the temperature is raised to 90 ^{o} C and a thick layer of curd forms on the surface of the whey, then citric acid solution was added for adjusting pH value to about 5.7 at this, in which the whey becomes clear. When coagulation is complete and the curd is firm (after about 20 min. at 90 ^{o} C), the curd was removed. The obtained Ricotta cheese was then transferred in small plastic containers and stored at 4±2 ^{o}C for 1, 4, and 7 days. Samples were then subjected to some chemical, physical, sensory evaluation and microbiological tests. For manufacturing of the Best Ricotta Cheese, the same procedure was applied without adding acid. The best Ricotta is made from very sweet whey (pH 6.4 - 6.5) without any addition acid.

2.4. Cheese Yield

The resulting cheese was weighed immediately. The yield of cheese was calculated as follows:

$$\text{Cheese yield} = \frac{\text{weight of cheese}}{\text{weight of cheese whey}} X\ 100$$

2.5. Gel Strength

The gel strength was determined using Texture Analyzer (Stevens-LFRA with cylindrical probe). The instrument was adjusted to the following conditions: penetration speed, 1.0mm/sec.: penetration distance, 10 mm into surface. Gel strength was determined in triplicate and expressed as g/cm^2 (Bourne, 1978).

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2.6. Determination of Acidity

The titrimetric determination of acidity of samples was accomplished according to the (AOAC 2012). 10 gm sample were taken, and then diluted in 100ml distilled water, then10ml were pipette into 100 ml conical flask. The pipettes were washed with distilled water, and six drops of phenolphthalein indicator then added. The samples then titrated with 0.1 N. NaOH until a stable pink color was formed. The titratable acidity was expressed as % lactic acid:

$$\text{Acidity \% (as lactic acid)} = \frac{0.0090\text{x volume of NaOH used x10}}{\text{Weight of the sample}} X\ 100$$

Where 90 is the amount of lactic acid reacted with 1.0ml of o.1 N NaOH.

2.7. Determination of Protein

Total nitrogen in cheese samples was measure by Kjeldahl Method (AOAC, 2012). Protein percentage was calculated by multiplying of nitrogen percentage with milk and dairy products constant factor of 6.38.

2.8. Sensory Evaluation

Sensory evaluation was conducted by using a panel of 7 members selected from the college academic staff and students at the department of Food technology, Salahadin University. Cheese samples were given codes before being tested and evaluated for appearance, texture, flavor and Color according to (Clark *et al*., 2009).

2.9. Microbiological Analysis of Cheese

Cheese samples were prepared to total count plate **(T.C.P),** total yeast and mold count. Nutrient agar and Potato dextrose agar were used for enumerating of total bacteria, yeast and molds, plates were incubated at 30 ^{o}C and 25 ^{o}C for 3 and 5days for total bacteria, yeast and molds according to (ISO NO,4833 2003 and NO,6611,2004) respectively.

2.10. Statistical Analyses

To find out the significant differences between means for each parameter Duncan multiple range tests (DMRT) was used and for the sensory evaluation all scores were analyzed by the use of (SPSS) software.

3. Results and Discussion

3.1. Milk and Whey Compositions

Table (1) shows the approximate analysis of raw milk and sweet whey obtained from soft cheese manufacturing. The percentage of (moisture, solid nonfat, fat, protein, lactose and total solid) in milk were (88, 8.18, 3.8, 3. 18, 4.86 and 12) respectively. The mean value of pH and acidity for all milk samples were found to be of 6.6 and 0. 0.17%, respectively. This table is shows that all compositions of milk samples are normal and similar to that obtained by (AL-Jumaili and Abdullah, 2019).

Table 1. Average values of chemical compositions and pH of raw milk and sweet Whey.

	Milk Compositions	**Sweet whey Compositions**
Moisture	88%	92.7%
Solids Non-Fat	8.18%	ND
Fat	3.8%	ND
Protein	3.18%	0.7%
Lactose	4.86%	4.9%
Total Solids	12%	7.1%
P H	6.6	6.41
acidity	0.17%	0.13%

ND =Not Determined.

Regarding to whey analysis, the percentage of moisture, protein, lactose and total solid were 92.7%, 0.7%, 4.9% and 7.1 % with pH and acidity values of 6.4 and 0.13**%** respectively, these results indicate to that the amount of the whey compounds analyzed agreed to the range of traditional sweet whey and are in agreement with results reported by many researchers, they analyzed the sweet cheese whey and found that moisture, protein, lactose , total solid contents , pH and acidity value of cheese whey ranged from 92 to 93, 0.64 to 0.9%, 4.9 to 5.5% , 6 to 7.1%,6·18 to and 0.09to 0.14% respectively (El-sheikh *et al*. 2010; Omole *et al*. 2012; Sulieman *et al*., 2012; Souza *et al*., 2016, Riera *et al*., 2016 and Patange *et al*., 2018).

3.2. Moisture, Total Solids and Yield of Ricotta Cheese

Moisture of cheese and total solids are a critical factor for determining cheese functionality. It is clarifying from table(2) that at first day of storage ,The moisture content of Best Ricotta cheese was79.266 ± 1.70 which was insignificantly higher than that of Ricotta cheese76.500±0.87 % , The total solid of Best Ricotta cheese was significantly lower 17.733 ± 2.17 %compared to Ricotta cheese which was 21.500 ± 0.98 % , the variations in the moisture content and total solids of Ricotta cheese which depends on the processing method and type of the whey used (Kandarakis, 1981),this variations has been attributed to acid addition because the addition of acid to ricotta cheese lead to precipitation of whey proteins that are resistant to heat treatment at normal pH of whey and cause increase in total solid and decrease in moisture. A decrease in the percentage of moisture is noted, and on the contrary, an increase in the percentage of total solids in both types of cheese with an increase in the storage time as a result of whey drainage until reached to close values are obtained. The change was significant for both characteristics on the last day compared to the first day of cold storage, Whereas, the moisture content of Ricotta cheese remained relatively constant throughout 60 days storage as observed by (Rashid, 2016). Sulieman *et al*. (2012) observed 72.89% while Najafi and Moatamedzadegan (2001) detected 76.33% moisture contents in Ricotta cheese. Madalozzo *et al.* (2015) analyzed moisture contents in commercially marketed Ricotta cheese samples in Brazil and observed that moisture content was in the range between 60.09 to 81.35%. Zinina *et al*., (2021) revelated that the moisture content of Ricotta cheese was 63.18%, (Brandelli *et al.,* (2015) found that Ricotta cheese is considered one of the cheeses it as a high moisture cheese.

Table 2. Moisture, Total solids and yield of cheese.

Cheese type	Storage time (day)	Moisture %	Total solid%	Yield%
Ricotta	1	76.500±0.87 ab	21.500 ± 0.98 bc	8.7 ±0.23a
	4	73.766 ± 0.63 bc	25.700 ± 0.51 ab	
	7	72.033 ± 0.66 c	27.100 ± 1.12 a	
Best Ricotta	1	79.266 ± 1.70 a	17.733 ± 2.17 c	6.49± 0.28b
	4	75.933 ± 1.15 abc	23.666 ± 1.17 ab	
	7	72.033 ± 1.76 c	27.366 ± 1.83 a	

[a, b, c] means within columns with different superscripts differ significantly at (P≤ 0.05).

The yield of fresh , Ricotta and Best Ricotta cheeses were presented in table (2), the percentage of yield for fresh Ricotta cheese was 8.7 ±0.23 which was significantly higher than of Best Ricotta cheese of 6.49± 0.28 this is owing to the addition of acid to whey during ricotta cheese making which increases the total solids significantly at first day of cold storage as a result of increasing the quantity of precipitated proteins in the curd by the effect of heat and acid precipitation of whey proteins as Donovan and Mulvihill (1987) reported that , thermal precipitation was found to be pH dependent with greatest aggregation occurring in the pH range 4.5-5.5. Various factors influence the yield of Ricotta cheese, also temperature is one of the most important elements among these factors. Denaturation of the whey protein determines the yield, which is affected by temperature applied during the production process. The yield of both chesses was higher than that reported by Ribeiro *et al*. (2005) who observed Ricotta cheese yield 4–6% made from cow milk whey. In general Ricotta cheese yield reported in the literature ranges from 4 to 12% which found by (EL-Sheikh *et al*. 2010; Rashid,2016 ; Shamsia and El-Ghannam 2017 and Araque *et al*. 2018) .

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3.3. Other Physiochemical Properties of Cheese

Acidity and pH are an important parameter that influences all properties of cheese including texture, flavor and appearance (Upreti and Metzger, 2007).

Table 3. Some physiochemical properties of cheese.

Cheese type	Storage time (day)	pH	Acidity%	Protein %	Hardness (gm)
Ricotta	1	5.48±0.21 b	0.103±0.01 c	14.2 ±0.17 a	6.000±0.57 c
	4	5.10±0.18 b	0.173±0.01 b	12.73 ±0.37 b	8.000±0.57 b
	7	5.08±0.14 b	0.206±0.01 a	12.52 ±0.39 b	11.00±0.57 a
Best Ricotta	1	6.40±0.01 a	0.054±0.01 d	12.26±0.33 b	3.666±0.67 d
	4	6.31±0.06 a	0.089±0.01 c	11.79±0.50 b	4.333±0.33 cd
	7	6.10±0.09 a	0.099±0.01 c	10.53±0.70 c	9.000±0.57 b

[a, b, c ,d] means within columns with different superscripts differ significantly at (P≤ 0.05).

The variation in the samples was significantly influenced cheese pH, Ricotta cheese treated with acid characterized by lower pH value of 5.48±0.21compared to 6.40±0.01 for best Ricotta at first day of storage, The results indicated that pH of samples decreased insignificantly from 5.48±0.21 and 6.40±0.01 (1day) to 5.08±0.14 and to 6.10±0.09 (7days) for Ricotta and Best Ricotta respectively during storage , The results available in table(3) shows in contrary to pH the acidity values of Ricotta cheese is significantly higher than best ricotta at first day of storage with percentage of 0.10±0.01% and 0.05±0.01%respectivly. Generally, significantly increase in acidity during cold storage of samples was observed, it was decreased at 1day to 0.20±0.01 and 0.09±0.01 at 7days of cold storage for Ricotta and best Ricotta cheese respectively. The lowest value of pH and highest acidity of Ricotta cheese attributed to addition of citric acid during it is manufacturing and the decrease in pH and increase in acidity during storage may be attributed to the increase in lactic acid due to growth of lactic acid bacterial culture as a result of lactose utilization (Gabriela *et al*., 2008 and Mancuso *et al*., 2014). Sulieman *et al*. (2012) observed pH 5.30 ± 0.23 and acidity 1.38 ± 0.06 in Ricotta cheese prepared at laboratory scale, a decreasing and increasing in pH and acidity values of Ricotta cheese samples during the period of storage was observed by (Asensio *et al*., 2014 and Rashid, 2016).

Hardness of cheese is strength required to achieve a given deformation. The hardness of cheese characterizes its chemical composition and the physicochemical state of cheese components. Hardness is also substituted by the term firmness which can be defined as the maximum peak force during the first compression (Gunasekaran and Ak, 2003). Statistical analysis of data concerning hardness of cheese table (3) showed that the effect of differences in processing conditions of cheese and storage duration was significant on cheese hardness. The hardness of Ricotta cheese was higher than Best Ricotta and the mean value for hardness of both type of cheese increased from 6.000±0.57 to 11.00±0.57 and 3.666±0.67 to 9.000±0.57 g at first day and after 7 days of storage respectively , this may be due to the fact that Ricotta cheese contained a higher percentage of total solids as a result of recovering a higher percentage of whey proteins by addition of acid and to moisture loss and an increase in total solids when cheese samples are stored for 7days , Madureira *et al.* (2007) observed during the texture profile analysis of sweet whey cheese matrices that the hardness of samples increased while softness decreased during 21 storage days, different results was mentioned by Rashid,2016 who found decreasing in hardness during storage of Ricotta samples for 60 days. The cheese texture is affected by ingredients used for its preparation, its physicochemical composition (pH, relative humidity, fat content, protein and sodium, calcium and phosphate contents) (Lucey *et al*., 2003 and Bunka *et al*., 2007).

The statistical analysis achieved on protein table (3) showed that this parameter differs significantly at first day of cold storage due to variation in cheese type. The storage periods also influenced on the protein contents, whereas a significant decrease in the percentage of protein was observed when comparing the first and last day of storage in both treatments. The result indicated that Ricotta cheese displayed the highest protein content (14.2 ±0.17%) while best Ricotta cheese contained the significantly lower protein percentage (12.26±0.33%) these differences are due to different processing conditions, Madalozzo *et al*. (2015) analyzed various samples of Brazilian Ricotta cheese and observed that protein percentage ranged from 9.94 to 16.02%. The protein contents of cheese samples

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slightly but there was non-significant decreased during storage. These results are similar to the finding studied by Mancuso *et al*. (2014), they observed the decrease in protein percentage of Ricotta cheese during 17 days of storage, Rotaru, *et al*, (2008); Hayaloglu and Karabulut, (2013) attributed that this is due to the proteolytic activities of lactic acid bacteria. The researchers Soliman et al. (2010) confirmed the occurrence of proteolysis, they were observed that non protein nitrogen content increased during storage.

3.4. Sensory Evaluation of Cheese During Storage

Sensory evaluation was explained the product acceptability by the consumer. A result was illustrated in table (4). It is noted from the table that the highest scores for appearance assessed by panelist were awarded to Ricotta cheese at 1day storge (9.4 ± 0.40) and Best Ricotta was gained the lowest score of (8 ± 0.63) at 7 days storge, however there are no significant differences for this characteristic between the two treatments and during 7 days of storage. The results of sensory evaluation regarding the texture as it is clear from table (4) indicates that Ricotta cheese prepared the liquid whey heated at 90 °C with addition of citric acid perceived the highest score throughout the storage compared to Best Ricotta .These results ensure the results gained for hardness property table (3).There was significant and insignificant statistically decrease in texture scores with an increase in the storage period from 1 day to 7 days for Ricotta and Best texture scores respectively.

Table 4. Sensory properties of cheese during storage time.

Cheese type	Storage period	Appearance (10)	Texture (10)	Color (10)	Flavor (10)	Total (40)
Ricotta	1 day	9.4 ± 0.40 a	9.2 ± 0.37 a	9 ± 0.44 a	8 ± 0.63 ab	35.6 ± 1.02 a
	4 days	9 ± 0.44 a	9.4 ± 0.40 a	9.2 ± 0.20 a	7.8 ± 0.86 ab	35.2 ± 1.31 a
	7 days	8.2 ± 0.58 a	7.8 ± 0.74 b	9 ± 0.31 a	7.6 ± 0.81 b	34.4 ± 1.36 a
Best Ricotta	1 day	8.8 ± 0.80 a	8.2 ± 0.48 ab	9.8 ± 0.20 a	9.6 ± 0.24 a	36.4 ± 1.37 a
	4 days	9 ± 0.77 a	8 ± 0.31 ab	9 ± 0.00 a	9.2 ± 0.20 ab	35.2 ± 1.16 a
	7 days	8 ± 0.63 a	7.6 ± 0.24 b	9.2 ± 0.20 a	8.8 ± 0.48 ab	33.6 ± 1.07 a

[a, b] means within columns with different superscripts differ significantly at (P≤ 0.05).

It is noted from table (4) that the scores obtained by the panelist for color indicated that those scores were similar for both types of cheese, and the cheese retained its natural color during storge, and the differences were not significant according to the type of treatment and storage period. On the contrary, concerning the properties of flavor Best Ricotta exhibited a higher score for flavor during all storage period compared to Ricotta cheese whereas the lowest value (7.6 ± 0.81) was recorded in Ricotta cheese at 7days of storge. As shown in tables (4) regarding to the total scores of sensory evaluation of cheese. Maximum score was obtained by Best Ricotta at 1day storge with insignificant differences among treatments and storage periods. The decrease in the scores given by panelists for some sensory characteristics according to different treatments and storage period for ricotta cheese was mentioned by Sulieman *et al*. (2012) and Rashid (2016), although they illustrated that the sensory analysis of Ricotta cheese was highly acceptable by panelist and they recommended introducing whey to other food industries.

3.5. Microbiological Analysis of Cheese

Microbiological analysis is important to display the shelf life and also to measure food safety because food products that are not in good sanitary condition should not be consumed(Moura et al. 2013) , shelf life of cheese is affected by its initial microflora and components of cheese ingredients mainly water activity (Erkan *et al.*, 2007) .Microbiological analyses of cheese which revealed in table (5) indicates that in first day of storge there was no presences of total bacteria count in both types of

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cheese, while after 4days of storage the total bacteria count was found to be 5 x 10^5 and 1.1 x 10^6cfu/g for Ricotta and Best Ricotta respectively. On the seventh day, the numbers increased to the level of 1.7x10^6 cfu/g for Ricotta and to 1.7x10^6 cfu/g for Best Ricotta. Concerning the cheese content of yeasts molds, it is clear from table (5) that the microbial growth wasn't observed during 1 and 4 days of storage, in 7 days of storage, their numbers was increased to 3.7 x 10^6 and 18.6 x 10^6 cfu/g for Ricotta and Best Ricotta respectively. The result of microbiological analysis was higher than that found by (Sulieman,2012 and Rashid 2016) which was 1.0×10^4 and 7.2×10^4 cfu/g with yeast and mold count of 2.0×10^2 cfu/g and 3.5×10^2 cfu/g in Ricotta cheese . Asensio et al. (2014) observed that the total viable mesophilic count in Ricotta cheese increased from 1.8×103 to 1.4×105 cfu g-1 after 30 days of storage at 23°C.

Mancuso et al. (2014) examined microbiological parameters of the Ricotta cheese under modified atmosphere packaging for 24 days of storage at 4±1°C and observed that total bacterial counts increased significantly from 6.7× 10^3 at 1st day to 3.6×10^7 cfu / g after 24 storage days.

Table 5. Microbiological analysis of ricotta and best ricotta cheese CFU/ g.

Types of cheese	Storage period(day)	Total count bacteria cfu/g	Yeast and mold
Ricotta	1	0	0
	4	5 x 10^5	0
	7	8.5x10^5	3.7 x 10^6
Best Ricotta	1	0	0
	4	1.1 x 10^6	0
	7	1.7x10^6	18.6 x 10^6

It is also noted from the table that Best Ricotta cheese have high microbial load as compared to Ricotta cheese sample which is due to low pH and low moisture content which led to displayed low microbial counts. Rashid (2016) demonstrated that Processing conditions such as high temperature, low moisture and pH, also the proper hygienic conditions of cheese production of Ricotta cheese significantly affected the microbial loads.

Conclusion

Ricotta cheese produced by addition of acid and heat treatment showed higher cheese total sold, pH, yield, protein and hardness compared with Best Ricotta cheese produced with heat treatment of whey without acid addition. The sensory evaluation of cheese indicates that ricotta cheese was more acceptable in terms of texture and appearance while Best Ricotta cheese was superior in color and flavor properties. Also, the Ricotta cheese was better from a microbiological point of view than Best Ricotta cheese.

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References

AOAC (2012). Official Method of Analysis: Association of Analytical Chemists. 19th Edition, Washington DC, 121-130.

Akalin , A.S., Karagözlü, C. and Ünal, G.(2008). Rheological properties of reduced-fat and low-fat ice cream containing whey protein isolate and inulin. European Food Research and Technology ,227(3):889-895.

Al-Dhhan, 1983. Cheese industry and its type in the world. Dar al-Hikma Press Mosul. Iraq.

AL-Jumaili, A. MS. and Abdullah, A. R. Chemical composition, sensory evaluation and microbial content of Iraqi soft white cheese: influence by whole black seeds 2019. Plant Archives, 19 (1):889-896.

Araque L. C. O., Darre ,M., Ortiz, C. M., Massolo, J. F. and Vicente, A. R. 2018. Ricotta cheese as affected by milk fat content and coagulant type. International Journal of Dairy Technology, 71(2): 340–346.

Asensio, C.M., N. Gallucci, M. M. Oliva, M. S. Demo and N. R. Grosso. 2014. Sensory and bio-chemical preservation of Ricotta cheese using natural products. International Journal of Food Science and Technology, 49(12):2692-2702.

DOI: 10.33794/qjas.2023.137549.1115

Bourne, M. (1978). Texture profile analysis. *Food Technology*, 32, 62-67 & 72.

Borba, K.K.S., Silva ,F.A., Madruga , M.S. Cassia, R. Queiroga, R. E. Leite de Souza, E. and

Brandelli, A., Daroit, D.J. and Corrêa, A.P.F., 2015. Whey as a source of peptides with remarkable biological activities. *Food Research International*, *73*, pp.149-161.

Bulut Solak ,B. and Akın N.2012. Functionality of Whey Protein. International Journal of Health and Nutrition. 3(1): 1-7.

Bunka, F., V. Pavlínek, J. Hrabe, O. Rop, R. Janis and J. Krejci. 2007. Effect of 1- monoglycerides on viscoelastic properties of processed cheese International Journal of Food Properties,10(4): 819-828.

Carvalho, F., Prazeres, A.R., Rivas, J. 2013. Cheese Whey Wastewater: Characterization and Treatment. Science of the -Total Environment, 445/446:385-396.

Chavan , R.S., Shraddha, R.C. , Kumar A. and Nalawade, T. 2015. Whey Based Beverage: Its Functionality, Formulations, Health Benefits and Applications. Journal of Food Processing and Technology, 6(10):1-8.

Clark, S., Costello, M., Drake, M., & Bodyfelt, F. W. (2009). The sensory evaluation of dairy products (2nd ed.) New York: Springer Science and Business Media, Inc.

Del Nobile, M.A., A. Conte., A.L. Incoronato and O. Panza. 2009. Modified atmosphere packaging to improve the microbial stability of Ricotta. African Journal of Microbiology Research 3 (4) : 137-142.

Donovan, M. and Mulvihill, D. M. (1987): Thermal denaturation and aggregation of whey proteins. Irish Journal of Food Science and Technology,11, (1) :87-100.

El-Sheikh, M., Farrag ,A. and Zaghloul, A. 2010. Ricotta cheese from whey protein concentrates. Journal of American Science. 6(8). 321-325.

Erkan, E. M., Ciftcioglu, G. ,Vural, A. and Aksu, H. 2007. Some microbiological characteristics of heed cheeses. Journal of Food Quality 30(2):228 – 236.

Gabriela, R., Dănuț, M., Mădălina, U. and Doina, A., 2008. Research studies on cheese brine ripening. *Innovative Romanian Food Biotechnology*, (2), pp.30-39.

Gunasekaran, S. and M.M. Ak. 2003. Cheese rheology and texture. CRC Press, London, UK.

Hayaloglu,A.A. and Karabulut,I.2013. SPME/GC-MS Characterization and comparison of volatiles of eleven varieties of Turkish cheeses. International Journal of Food Properties, 16:1630–1653.

ISO,6611(2004). Milk and milk products -enumeration of Colony-forming units of yeasts and \ or molds-Colony count technique at 25 ^{o} C.

ISO,4833(2003). Microbiology of food and animal feeding stuffs-Horizontal method for the enumeration for microorganism-Colony- count at 25 ^{o} C.

Jinjarak, S., Olabi , A. , Jimenez-Flores, R. and Walker, J. H.(2006). Sensory, Functional, and Analytical Comparisons of Whey Butter with Other Butters. Journal of Dairy Science , 89 (7): 2428–2440.

Kandarakis, 1.G. 1981. Contribution to the Study of the Technology of a Cheese Type Manouri with the Traditional Way. Use of U. F. Ph.D. Thesis, Agricultural University of Athens, Greece.

Korhonen H. 2009 Milk-derived bioactive peptides: From science to applications. Journal of Functional Foods, 1:177-187.

Królczyk1 , J.B., Dawidziuk ,T., Janiszewska-Turak, E. and Sołowiej,B . 2016. Use of Whey and Whey Preparations in the Food Industry – a Review. Polish Journal of Food and Nutrition Sciences, 66(3) : 157–165.

Kumar R., Sangwan R.B. and Mann B., Separation and application of bioactive whey proteins. Technological Advances in the utilization of dairy by-products, 22nd Short Course 2008. Available at: (http://www.dairyprocessingcaft.com/wp-content/uploads/2012/05/Byproducts-2008.pdf).

Lahouel, N. , Kheroua,O. , Saidi,D. and Yahiaoui, F.Z.2016. . Characterization and Treatment of Cheese Whey Wastewater.Research Journal of Pharmaceutical, Biological and Chemical Sciences 7(5):2456- 2462.

Lucey, J.A., M.E. Johnson and D.S. Horne. 2003. Invited review: Perspectives on the basis of the rheology and texture properties of cheese Journal of Dairy Science, 86(9): 2725-2743.

Madalozzo, E. S., Sauer, E. and Nagata , N. 2015. Determination of fat, protein and moisture in ricotta cheese by near infrared spectroscopy and multivariate calibration. International Journal of Food Science and Technology,52(3):1649-55.

Madureira, A. R., Pereira, C. I., Gomes, A. M. P., Pintado, M. E. and Malcata, F. X. 2007. Bovine whey proteins – overview on their main biological properties. Food Research International, 40(10):1197–1211.

Mahran, G.A.; Hammad, Y.A., Nawal S. Ahmed; Saged, A.F and Abd ElAziz, M. 1999. Manufacture of Ricotta Cheese from whey fortifier with skim milk powder using different acidulant . Egyptian Journal of Dairy Science 27(1): 191-203.

Mancuso, I., C. Cinzia., F.Gerlando., M. Giusi., A. Luigi., M. Viviana and L.Maria. 2014. Sensory and microbiological evaluation of traditional ovine ricotta cheese in modified atmosphere packaging. Italian Journal of Food Safety. 3:1725 (2):122-124.

DOI: 10.33794/qjas.2023.137549.1115

Mann, B., Athira, S., Sharma, R., Kumar, R., & Sarkar, P. (2019). Bioactive peptides from whey proteins. In H. C. Deeth & N. Bansal (Eds.), Whey proteins: from milk to medicine (pp. 519-547). London: Academic Press.

Maubois, P.L. H., Ottogalli, G, and Fax, P. F, 2004. Diversity of Cheese Varieties: an overview, in Cheese; Chemistry, Physics and Microbiology Vloume 2Major Cheese Group, 3rd edn, P. F.

Minj, S. and Anand,S.2020.Whey Proteins and Its Derivatives: Bioactivity, Functionality, and Current Applications. Dairy , *1*(3): 233-258.

Mollea C, Marmo L, Bosco F. 2013. Valorization of Cheese Whey, a By-Product from the Dairy Industry. In Food Industry; Intech Open: London, UK, 2013.

Modler, H.W. and Emmons, D. B. 2001. The Use of Continuous Ricotta Cheese Processing to reduce ingredient cost in further processed cheese products. International Dairy Journal 11 (4-7):517-523.

Moura, L. B., Moura, R. L., and Guimarães, F. R. (2013). Análise de Coliformes e Salmonella em leite pasteurizado no sertão central do Ceará. Higiene Alimentar, 27(216-217), 146-149.

Najafi, M.B.H. and A. Moatamedzadegan. 2001. Process optimization of Ricotta cheese according to Iranian preferences. Journal of Agricultural Science and Technology 3(3): 237-240.

Omole, J., O. Ighodaro, O. Macdosnald and M.O. Mathew. 2012. Proximate composition of whey from south west Nigeria. Advances in Bioresearch 3(1): 14-16.

Pizzillo, M., S. Claps., G.F. Cifuni., V. Fedele and R. Rubino. 2005. Effect of goat breed on the sensory, chemical and nutritional characteristics of ricotta cheese. Livestock Production Science 94(1/2): 33-40.

Pires, A.F. Marnotes, N.G. Rubio , O.D., Garcia,A.C. and Pereira, C.D.2021. Dairy By-Products: A Review on the Valorization of Whey and Second Cheese Whey. Foods 2021, 10, 1067:1-24.

Patange, D.D., Kamble ,D.K. and Ranveer, R.C. 2018. A text book on milk and milk products. Jaya publishing house. Delhi India. 251.

Rashid, A.A.2016. Impact of concentrated whey on dairy products. Ph.D. Thesis, Faculty of Food, Nutrition & Home Sciences, University of Agriculture, Faisalabad Pakistan.

Ribeiro, A.C., Marques, S.C. ,Sodre, A.F. ,Abreu, L.R. and Piccoli, R.H. 2005. Microbiological assessment of creamy ricotta during shelf-life. Ciência e Agrotecnologia,29(1): 113-117.

Riera, F., Gonzalez, P., and Muro, C. (2016). Whey cheese: Membrane technology to increase yields. Journal of Dairy Research ,83(01):96-103.

Shamsia, S. M. and El-Ghannam, M. 2017. Production and Evaluation of Processed Cheese Analogue Using Ricotta Cheese Prepared from Sweet Whey. Alex. Journal of Food Science and Technology 14(1): 1-11.

Smithers GW. Whey and whey proteins-from „gutter-to-gold". 2008.International Dairy Journal ,18(7):695-704.

Soliman, T. N., A. F. Farrag., A. Shendy and M.M. El-Sayed. 2010. Denaturation and viscosity of whey proteins solutions as affected by frozen storage. Journal of American Science ,6(12): 49- 62.

Souza,J.L.F., Silva,M.A.P. , Silva,R.C.F. , Carmo, R.M.*et al*.2016. Effect of whey storage on physicochemical properties, microstructure and texture profile of ricotta cheese. African Journal of Biotechnology, 15(47): 2649-2658.

Sulieman, A. M. E., Eljack , A. S. and Salih, Z. A. 2012. Quality evaluation of "Ricotta" cheese produced at laboratory level. International Journal of Food Science and Nutrition Engineering, 2(6): 108-112.

Thorning, T.K., Raben, A., Tholstrup, T., Soedamah-Muthu, S.S., Givens, I. and Astrup, A. 2016 Milk and dairy products: good or bad for human health? An assessment of the totality of scientific evidence. Food and Nutrition Research.;60: 32527(1):1-11.

Upreti, P. and Metzger, L.E., 2007. Influence of calcium and phosphorus, lactose, and salt-to-moisture ratio on Cheddar cheese quality: pH changes during ripening. Journal of dairy science, 90(1), pp.1-12.

Yadav, J.S.S., Yan, S., Pilli, S.r., Kumar, L., Tyagi, R.D., Surampalli, R.Y. 2015. Cheese Whey: A Potential Resource to Transform into Bioprotein, Functional/Nutritional Proteins and Bioactive Peptides. Biotechnology Advances, 33, (6) 756-774.

Zandona ,E. , Blažić, M. and Anet Režek J. 2021.Whey utilization: Sustainable uses and environmental approach. Food Technology and Biotechnology. 59 (2) 147–161.

Zinina,O., Khitsenko, A., Neverova , O., Stepanov, A. and Bykova, O.2021. Research of the Ricotta made from cheese whey enriched with citrus dietary fiber. IOP Conference. Series: Earth and Environmental Science 699, 01200.

DOI: 10.33794/qjas.2023.137549.1115