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Properties and Shelf Life of Spicy Ricotta Cheese

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A NEW type of Ricotta cheese spiced using different types of spice pastes (onion, garlic or hot green pepper) and control Ricotta cheese (without spice additive) were prepared and stored up to 25 days at 5°C. The spice pastes were added at the rate of 1, 2 and 3% w/w. Physo-chemical, microbiological properties and sensory quality of Ricotta cheese samples were examined. Fortification of the Ricotta cheese curd with different spices caused a slight decrease in protein content in final product depending on the percentage of the added spices, whereas no significant differences in the acidity, yield and pH values were found among all treatment. Fortification of Ricotta cheese curd with different spicy pastes resulted in obvious differences in the texture profile parameters of the cheeses. Coliform and sporeforming bacteria were not detected in either fresh control or treatment cheese samples and during the refrigerated storage. Addition of spices during Ricotta cheese manufacture had significant effect on microbiological quality and improved the shelf life of the resultant products. Spices enhanced the flavour and total scores in resultant cheese. Generally, the titratable acidity%, dry matter, protein and ash contents gradually but slightly increased in control and all treatments during the storage period. The yield and sensory values of all the Ricotta cheese samples were decreased along cold storage period. It is recommended to add different spices in Ricotta cheese manufacture as new products and to improve its microbiological quality and shelf life.

Keywords: Sporeforming bacteria , Garlic paste , Hot green pepper paste , Onion paste

Introduction

Ricotta cheese is a dairy product of Italian origin, which means "recooked", It is manufactured by boiling acidified cheese whey (Maubois & Kosikowski, 1978), as a practical and economic way for utilization of whey. Ricotta cheese is classified as high moisture soft cheese (Modler & Emmons, 2001), which can be made using cheese whey or milk, or a mixture of both (Pizzillo *et al.*, 2005). Fresh Ricotta cheese has a mild and nuty flavor and is used as flavor enhance in different products such as Salad (Kosikowski, 1982). Ricotta cheese has limited shelf life of few days due to its high moisture content, high initial pH (above pH 6) and low salt content. Ricotta is very susceptible to spoilage by molds, yeasts and bacteria, substantially represented by Enterobacteriaceae (Fleet and Mian, 1987; Pintado *et al.*, 2001). Several researches have focused on how to improve the quality of shelf-life of Ricotta cheese. Herbs, spices, vegetables, and other condiments are essential flavouring agents added to cheese for commercial purposes. Herbal spices particularly onions; garlic and hot pepper have been added to foods since ancient times, not only as flavoring agents, but also as food preservatives. In addition to imparting its characteristic flavours, certain spices and herbs can prolong the shelf life of foods *via* their bacteriostatic, bactericidal and antioxidant activities (Wafay, 2010).

Hot green pepper (Capsicum annuum) and onion (Allium cepa) are widely used for flavoring and for nutritional purposes in different food products. In addition, recent reports state that the Capsicum genus, among other plant genera, is a good source of antimicrobial and antifungal compounds (Tajkarimi et al., 2010 and Omolo et al., 2014). Several studies have reported in vitro pharmaceutical activity of extracts of onion (Allium cepa) including anti-tumor, anti-diabetic, antioxidant, antimicrobial, anti-allergic and molluscicidal activity (Zohri et al., 1995, Lampe, 1999, Helen et al., 2000, Rose et al.,

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2005 and El-Meleig et al., 2010). Garlic is one of the oldest herbal remedies; it has been a favored food in the Old Testament and has been giving almost magical properties in various cultures, and has been employed to treat infections, wounds, diarrhea, respiratory conditions, rheumatism, diabetes, heart disease and many other disorders. Also, it is widely promoted to reduce high cholesterol and high blood pressure. On the other hand, the antibacterial properties of crushed garlic have been known for a long time. Various garlic preparations have been shown to exhibit a wide spectrum of antibacterial activity against gram-positive and gram-negative bacteria including species of Salmonella, Escherichia, Staphylococcus, Klebsiella, Streptococcus, Proteus, Clostridium and Bacillus. Garlic extracts also have a good affect against growth of fungi and inhibit the formation of mycotoxins such as aflatoxins by Aspergillus parasiticus (Lawson, 1996).

Therefore, the goal of this study was to develop a new type of Ricotta cheese spiced with different types of spice pastes and investigate the effect of those spices on the quality and shelf life of resultant product.

Materials and Methods

Materials

Fresh cow's milk was obtained from the dairy cattle at Faculty of Agriculture, Cairo University, Giza, Egypt, and skimed using a cream separator. Dried whey protein concentrate (DWPC) was purchased from Mullins Whey Company, USA origin. The chemical composition of DWPC was 95.23, 2.74, 87.21 and 0.25 % for dry matter, ash, protein and acidity contents, respectively. Commercial fine grade salt (Sodium-chloride, NaCl) was obtained from El- Nasr salines Company, Alexandria, Egypt. Citric acid was obtained from Biochem, Co., Egypt. Spices used in this study namely onion (*Allium cepa*) cultivars (Giza 6 white), garlic (*Allium sativum L.*) and hot green pepper paste (*Capsicum annuum*) were purchased from the local market at Cairo, Egypt.

Preparation of different spice pastes

Onion and garlic were shelled and hot green pepper was washed, mashed using a electric mixer (Brown, Germany) and heated in a water bath at 85˚C for 5 min then cooled before use. The chemical composition of the resulting spicy pastes is present in Table 1.

Production of Ricotta cheese containing different types of spicy pastes

Ricotta cheese fortified with different spices was made using the conventional method as described by Mahran et al. (1999), with some modification as follows:

Dried whey protein concentrate (DWPC) was reconstituted of 2% in tap water and heated up to 65˚C and then mixed with fresh cow's skim milk at the ratio of 1:1. Mixtures were heated up to 85 – 90˚C, and then acidulated with the addition of 10 % citric acid followed by the addition of 0.5 % NaCl to the mixture. The curd was left in the whey mixture for 10- 15 min before draining, using a muslin filter. The curd was divided into ten portions. The first portion was kept as control Ricotta cheese without any additives. Onion paste was added at the ratio of 1, 2 and 3% (w/w) to second, third and fourth portion and mixed well to prepare (T1), (T2) and (T3) Ricotta cheese respectively. The other three portions were used for the preparation of T4, T5 and T6 fortified with 1, 2 and 3% (w/w) Garlic paste respectively. The last three spicy Ricotta cheeses T7, T8 and T9 were fortified with 1, 2 and 3% (w/w) hot green pepper paste respectively. Three replicates were done for every treatment. All spicy Ricotta cheeses were packaged into plastic container (100 g) and held at 5±1˚C for 25 day. The samples were analyzed at fresh, 5, 10, 15, 20 and 25 days of cold storage.

TABLE 1. The chemical composition % of different spicy paste used in manufacture of spicy Ricotta cheese

spicy kind of paste			
Green pepper	Garlic	Onion	Property
6.8	36.34	18.70	Dry matter (%)
0.92	2.53	2.11	Ash (%)
0.75	7.74	1.55	Protein (%) (TN X 5.25)
1.65	2.4	2.16	Crude fiber (%)
5.42	5.75	5.58	pH value

Methods of analysis

Dry matter, ash, total protein, Titratable acidity as lactic acid (TA %) and crude fiber contents were determined according to the method described in AOAC (2012). The pH value of cheese was measured using Beckman electric pH meter type 7010; with combined glass electrode (Electric Instruments Limited).

The yield of cheese is a mathematical expression for the quantity of cheese obtained from a given quantity of raw materials as the formula given by Fox et al. (2000).

$$\text{Cheese yield} = \frac{\text{Amount of cheese (kg)}}{\text{Amount of original raw materials (kg)}} \times 100$$

The texture properties of the cheeses were evaluated with a TA-XT2 Texture Analyzer TM (Multi Test 1- *d* Systems, Mecmesin, USA) using a two-bite compression of cylindrical samples (25-mm-diameter acrylic cylindrical probe (P25), strain rate programmed to a speed of 1 mm s1 and maximum penetration of 10 mm). Hardness, springiness, adhesiveness, cohesiveness, chewiness and gumminess were measured in three replicates of each sample (Buriti *et al.*, 2005).

Total viable bacterial count (TVBC) was determined using tryptone glucose yeast agar medium according to American Public Health Association (APHA) (2004). The plates were incubated at 32°C for 48hr. Moulds and yeasts were determined on oxytetracycline–glucose-yeast extract agar (OGYE Agar) medium according to International Dairy Federation (IDF), (1990). The plates were incubated at 25-27°C for 4 days. Coliform counts were determined with Violet Red Bile Agar medium as reported by APHA (2004). The plates were incubated at 37°C for 48 h. Sporeforming bacteria were determined by heating suitable dilution to 80°C for 15 minutes, and cooling suddenly to 30°C before transfering one ml into petri dish. Plating and counting was carried out as in the total count, but nutrient Agar medium + 0.1% soluble starch was used in this determination (Murrell et al., 1950).

Different Ricotta cheese samples were organoleptically scored for appearance (10 points) and Body &Texture (50 points) and flavour (40 points) according to the score card suggested by Mahran *et al.* (1999). Samples were judged by 15 panel tests from the staff members of the Food Science Department, Faculty of Agriculture, Ain shams University and Dairy Science &Technology section, National Research Center, Dokki, Cairo, Egypt.

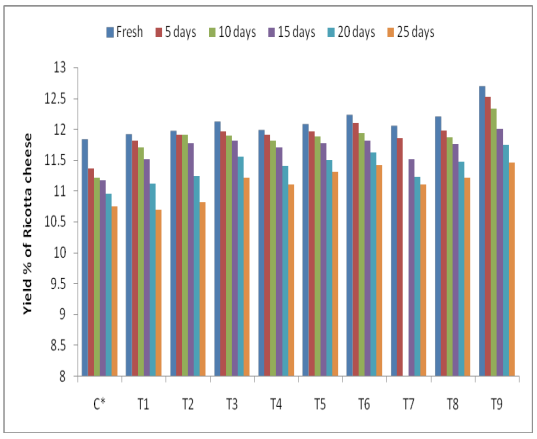
Statistical analysis was performed according to SAS (1999) using General Linear Model (GLM) with main effect of treatments. Duncan's multiple range was used to separate among of three replicates at $P \leq 0.05$.

Results nd Discussion

Yield and weight stability of Ricotta cheese during cold storage

The yield of different fresh Ricotta cheese samples ranged from 11.83 to 12.70%. Ricotta cheese fortified with 3% hot green pepper paste (T9) exhibited the highest yield while; control Ricotta cheese had the lowest one whether when fresh or during cold storage (Fig 1). The differences in the yield value were non significant among all treatments when fresh and throughout cold storage.

After the end of cold storage, yield values of various Ricotta cheese samples ranged from 10.75 to 11.46%. It could be noticed that, the cheese yield slight decreased gradually with progressed cold storage period. This slight decrease in cheese yield may be due to very slight water evaporation from different cheese samples during the storage period. Decrease in yield during cold storage in different type of cheese such as cottage cheese was reported by Aylward et al. (1980).



C*: Ricotta cheese made without any additives, T1, T2 and T3: Ricotta cheese made with 1, 2 and 3% onion paste, T4, T5 and T6: Ricotta cheese made with 1, 2 and 3% garlic paste, T7, T8 and T9: Ricotta cheese made with 1, 2 and 3 % hot green pepper paste

Fig. 1. Yield% of Ricotta cheese spiced with different types of spice pastes when fresh and during storage at 5±2°C.

Changes in dry matter, protein and ash contents:

Data presented in Table 2 show that, the dry matter content of different fresh Ricotta cheeses ranged between 25.02 to 27.75%, protein content between 18.57 to 19.04%, and the ash content between 1.40 to 1.60%. Garlic Ricotta cheeses were slightly higher in dry matter content than the control. On the other hand, addition of onion and hot green pepper pastes caused slight decreases in dry matter content of spicy Ricotta cheese compared with the control. Control Ricotta cheese had the highest protein content compared to spicy Ricotta cheeses from all treatments when fresh and during the cold storage period, which mean that, fortification the Ricotta cheese caused a slight decrease in protein content in final product. Ricotta cheese fortified with 3% hot green pepper (T9) had the lowest ash content among all treatments, while, the ash content was proportionally increased with increasing the ratio of onion or garlic paste added. The changes in dry matter, protein and ash contents among different treatments could be attributed to the differences in the chemical composition of the different spices used for fortify the Ricotta cheese curd (Table 1). These results are in agreement with Coskun & Tuncturk (2000) who found that significant differences in dry matter in spicy cheeses containing 0.5, 1, 2 and 3% wild garlic. While, Tarakci *et. al.,* (2004) reported that, increasing black cumin level in Tulum cheese had higher dry matter contents compared to the control cheese. Foda *et. al.*, (2006) found that, the dry matter content of UF soft cheese significantly increased, while the protein content was not significantly affected by addition of tow type herbs (celery and thyme).

At the end of cold storage period dry matter content of different Ricotta cheeses ranged between 25.84 to 28.33% and protein content between 18.93 to 19.59%, while, the content of ash ranged between 1.53 to 1.80%. The results showed that, dry matter, protein and ash contents were slightly increased in all in Ricotta cheeses as the refrigerated storage period progressed up to 25 days, which may be attributed to water evaporation and/ or slight wheying off during the storage period. These results agree with El-Hawary et al. (2010) and Abdel-Rafee et al. (2010), who found that the total solids of different Ricotta cheese treatments increased during storage period.

Acidity% and pH values

As shown in Table 3, fortification of the Ricotta cheese curd with different ratios of various spice pastes had no significant effect on the titratable acidity content and pH value in the resultant Ricotta cheese product. Generally, the titratable acidity % gradually increased in all treatments and control samples during cold storage period. The pH value of all treatments were correlated and in same trend as the acidity % of the treatments. Similar results were reported by (El-Hawary et al., 2010 and Abdel-Rafee et al., 2010). These results agree also with (Harby et al., 2008), who found that, addition some spices (black cumin) had no significant effect on development of acidity in all functional fermented dairy product. Foda et al. (2006) noticed that, herby cheeses celery or thyme had higher titratable acidity compared with control cheese. Kavaz et al. (2013) observed higher increase of titratable acidity in the herby cheese samples compared with the control cheese.

Texture profile of spicy Ricotta cheese

The instrumental texture profile of the spicy ricotta cheese characterized the product as easily deformable, inelastic, cohesive, soft in texture, delicate and fragile. As shown in Table 4, the textural parameter, of fresh Ricotta cheese and after 25 days of refrigerated storage were a lowest in changed except hardness which showed an increase with storage. This indicates that the cheese maintained acceptable typically texture properties for the throughout its shelf life. There were obvious differences in the hardness of cheeses from different treatments. The cheese made using hot green pepper were softer than those of other treatments, and the cheese of the onion additions exhibited intermediate values compared to the control and garlic cheese. The cohesiveness of the cheeses from the additions of garlic ratios, and onion were not significantly different, but its values were the lower than that of the control. These results show that there were no changes in the deformability of Ricotta due to changes in the chemical structure of components as before reported by Faerrandini et al. (2011). In relation to gumminess, no significant differences ($p>0.05$) observed during storage; but only among treatments. According to Fox et al., 2000 and Tunick et al., (2012), the texture profile of ricotta cheese is defined as a viscoelastic food with very soft consistency, not pasty and friable, compressible and not too cohesive, with brittle characteristics. Stable texture profile during storage is required for marketing and sensory acceptability. The springiness values observed in the present study were similar to those observed for probiotic Minas fresh cheese studied by Buriti et al. (2005).

TABLE 2. Dry matter, protein and ash contents of Ricotta cheese spiced with different types and levels pastes when fresh or during storage at 5±2°C.

Parameters	Storage period (Day)	Treatments									
		C*	T1	T2	T3	T4	T5	T6	T7	T8	T9
Dry matter %	Fresh	26.77^{Ab}	25.93^{ABb}	25.51^{ABb}	25.16^{Bb}	27.12^{Ab}	27.42^{Ab}	27.75^{Ab}	25.62^{ABb}	25.32^{Bb}	25.02^{Bb}
	5	26.89^{Aab}	25.98^{ABab}	25.60^{ABab}	25.25^{ABab}	27.43^{Aab}	27.61^{Aab}	27.90^{Aab}	25.71^{Bab}	25.39^{Bab}	25.13^{Bb}
	10	27.16^{Aab}	26.07^{ABab}	25.66^{Abab}	25.34^{ABab}	27.53^{Aa}	27.83^{Aab}	27.96^{Aab}	25.78^{Bab}	25.45^{Bab}	25.36^{Bab}
	15	27.50^{Aa}	26.23^{ABa}	25.89^{Bab}	25.68^{Ba}	27.85^{Aa}	27.90^{Aa}	28.02^{Aa}	25.93^{Bab}	25.57^{Ba}	25.42^{Ba}
	20	27.71^{Aa}	26.41^{Ba}	26.05^{Ba}	25.95^{Ba}	27.97^{Aa}	28.11^{Aa}	28.21^{Aa}	26.12^{Ba}	25.89^{Ba}	25.76^{Ba}
	25	27.89^{Aa}	26.53^{Ba}	26.19^{Ba}	26.03^{Ba}	27.99^{Aa}	28.21^{Aa}	28.33^{Aa}	26.20^{Ba}	25.97^{Ba}	25.84^{Ba}
Protein%	Fresh	19.04^{Aa}	18.97^{Aa}	18.83^{Ba}	18.70^{Bb}	19.01^{Aa}	18.87^{ABa}	18.72^{Bb}	18.90^{ABa}	18.80^{Ba}	18.57^{Ba}
	5	19.19^{Aa}	19.04^{Aa}	18.88^{ABa}	18,67^{Bab}	19.10^{Aa}	18.96^{ABa}	18.86^{ABab}	18.96^{ABa}	18.83^{Ba}	18.74^{Ba}
	10	19.34^{Aa}	19.12^{Aa}	18.94^{Aa}	18.76^{Bab}	19.18^{Aa}	19.03^{Aa}	19.02^{Aa}	19.02^{Aa}	18.89^{Ba}	18.79^{Ba}
	15	19.39^{Aa}	19.22^{Aa}	18.99^{Aa}	18.87^{Ba}	19.32^{Aa}	19.14^{Aa}	19.08^{Aa}	19.11^{Aa}	18.95^{Ba}	18.85^{Ba}
	20	19.55^{Aa}	19.36^{Aa}	19.10^{Aa}	19.00Aa	19.39^{Aa}	19.24^{Aa}	19.13^{Aa}	19.16^{Aa}	19.02^{Ba}	18.91^{Ba}
	25	19.59^{Aa}	19.38^{Aa}	19.11^{Aa}	19,07^{Aa}	19.43^{Aa}	19.28^{Aa}	19.20^{Aa}	19.21^{Aa}	19.12^{Ba}	18.93^{Ba}
Ash %	Fresh	1.51^{Bb}	1.55^{ABb}	1.60^{ABb}	1.64^{Ab}	1.58^{ABb}	1.62^{ABb}	1.67^{Ab}	1.46^{Bb}	1.43^{Bb}	1.40^{Bb}
	5	1.53^{Bb}	1.56^{Bb}	1.61A^{Bb}	1.67^{Ab}	1.61^{ABb}	1.65^{ABab}	1.71^{Aab}	1.48^{Bab}	1.46^{Ba}	1.43^{Bb}
	10	1.57^{Ba}	1.61^{ABab}	1.64A^{Bab}	1.69^{Aab}	1.64^{ABab}	1.67^{ABab}	1.73^{Aab}	1.50^{Ba}	1.49^{Ba}	1.46^{Bab}
	15	1.60^{Ba}	1.65^{ABa}	1.69A^{Ba}	1.72^{Aa}	1.69A^{Bab}	1.71^{Aa}	1.75^{Aa}	1.53^{Ba}	1.51^{Ba}	1.47^{Ba}
	20	1.63^{Ba}	1.68^{ABa}	1.71^{Aa}	1.73^{Aa}	1.73^{Aa}	1.75^{Aa}	1.78^{Aa}	1.55^{Ba}	1.53^{Ba}	1.49^{Ba}
	25	1.65^{Ba}	1.69^{ABa}	1.73^{Aa}	1.75^{Aa}	1.77^{Aa}	1.78^{Aa}	1.80^{Aa}	1.58^{Ba}	1.56^{Ba}	1.53^{Ba}

made with 1, 2 and 3% garlic puree, T7, T8 and T9: Ricotta cheese made with 1, 2 and 3 % green pepper puree
A, B, C: Means with same letter among treatments in the same storage period are not significantly different.
a, b, c : Means with same letter for same treatment during storage periods are not significantly different.
C*: Ricotta cheese made without any additives, T1, T2 and T3: Ricotta cheese made with 1, 2 and 3% onion puree, T4, T5 and T6: Ricotta cheese

TABLE 3. Acidity content and pH value of spicy Ricotta cheese fortified with different types of spices when fresh and during storage at 5±2°C.

Parameters	Storage period (Day)	Treatments									
		C*	T1	T2	T3	T4	T5	T6	T7	T8	T9
Acidity content	Fresh	0.31^{Ab}	30^{Ab}	0.31^{Ab}	0.31^{Ab}	0.32^{Ab}	0.31^{Ab}	0.32^{Ab}	0.30^{Ab}	0.32^{Ab}	0.33^{Ab}
	5	0.31^{Ab}	0.31^{Ab}	0.32^{Ab}	0.32^{Ab}	0.32^{Ab}	0.33^{Ab}	0.32^{Ab}	0.30^{Ab}	0.33^{Ab}	0.34^{Aab}
	10	0.33^{Aab}	0.32^{Aab}	0.32^{Ab}	0.33^{Aab}	0.34^{Aab}	0.33^{Ab}	0.33^{Ab}	0.32^{Ab}	0.34^{Aab}	0.34^{Aab}
	15	0.35^{Aa}	0.34^{Aa}	0.34^{Aa}	0.34^{Aa}	0.35^{Aab}	0.34^{Aab}	0.34^{Aab}	0.33^{Aab}	0.35^{Aa}	0.36^{Aa}
	20	0.36^{Aa}	0.35^{Aa}	0.36^{Aa}	0.35^{Aa}	0.36^{Ab}	0.36^{Aa}	0.35^{Aa}	0.35^{Aa}	0.35^{Aa}	0.37^{Aa}
	25	0.36^{Aa}	0.36^{Aa}	0.36^{Aa}	0.37^{Aa}	0.37^{Ab}	0.37^{Aa}	0.36^{Aa}	0.36^{Aa}	0.36^{Aa}	0.38^{Aa}
pH value	Fresh	5.88	5.89	5.87	5.85	5.88	5.86	5.86	5.86	5.85	5.84
	5	5.85	5.87	5.88	5.84	5.86	5.85	5.84	5.85	5.85	5.84
	10	5.84	5.85	5.85	5.84	5.85	5.83	5.83	5.85	5.83	5.81
	15	5.81	5.84	5.83	5.82	5.84	5.81	5.82	5.83	5.81	5.80
	20	5.80	5.84	5.80	5.80	5.81	5.80	5.80	5.81	5.79	5.79
	25	5.78	5.80	5.79	5.78	5.79	5.79	5.80	5.78	5.77	5.77

C*: Ricotta cheese made without any additives, T1, T2 and T3: Ricotta cheese made with 1, 2 and 3% onion paste, T4, T5 and T6: Ricotta cheese made with 1, 2 and 3% garlic paste, T7, T8 and T9: Ricotta cheese made with 1, 2 and 3 % green pepper paste
A, B, C: Means with same letter among treatments in the same storage period are not significantly different.
a, b, c : Means with same letter for same treatment during storage periods are not significantly different.

TABLE 4. Texture profile analysis of Ricotta cheese spiced with different types of spices when fresh and after 25 days of storage at 5±2°C

Treatment	Hardness (N)	Springiness (mm)	Cohesiveness	Gumminess (N)	Chewiness (N*mm)
		Fresh Ricotta cheese			
Control	15.20^{A}	0.62^{A}	0.71^{A}	10.77^{A}	6.63^{A}
T1	13.90^{B}	0.63^{A}	0.62^{AB}	8.56^{AB}	5.40^{B}
T2	13.70^{B}	0.61^{A}	0.65^{A}	8.91^{AB}	5.40^{B}
T3	13.60^{B}	0.61^{A}	0.67^{A}	9.07^{AB}	5.53^{B}
T4	14.80^{AB}	0.57^{B}	0.66^{A}	9.82^{AB}	5.64^{B}
T5	13.70^{B}	0.54^{B}	0.66^{A}	9.04^{AB}	4.88^{C}
T6	12.50^{C}	0.59^{AB}	0.59^{B}	7.43^{B}	4.36^{C}
T7	9.80^{D}	0.56^{B}	0.58^{B}	5.68^{C}	3.16^{D}
T8	9.40^{D}	0.59^{AB}	0.62^{AB}	5.86^{C}	3.46^{D}
T9	8.60^{E}	0.62^{A}	0.66^{A}	5.70^{C}	3.55^{D}
		After 25 day of storage			
Control	18.30^{A}	0.64^{A}	0.69^{AB}	12.54^{A}	8.06^{A}
T1	16.40^{B}	0.63^{A}	0.65^{B}	10.72^{C}	6.72^{B}
T2	15.80^{C}	0.64^{A}	0.64^{B}	10.19^{D}	6.48^{B}
T3	15.70^{C}	0.61^{A}	0.65^{B}	10.28^{D}	6.22^{B}
T4	18.20^{A}	0.57^{C}	0.65^{B}	11.90^{B}	6.82^{B}
T5	17.60^{AB}	0.58^{C}	0.59^{C}	10.39^{D}	6.04^{BC}
T6	14.90^{C}	0.58^{C}	0.62^{BC}	9.24^{E}	5.36^{C}
T7	9.00^{E}	0.60^{B}	0.77^{A}	6.97^{F}	4.18^{D}
T8	11.30^{D}	0.60^{B}	0.59^{C}	6.64^{F}	3.96^{DE}
T9	10.20^{DE}	0.57^{C}	0.57^{C}	5.81^{G}	3.29^{E}

C*: Ricotta cheese made without any additives, T1, T2 and T3: Ricotta cheese made with 1, 2 and 3% onion paste, T4, T5 and T6: Ricotta cheese made with 1, 2 and 3% garlic paste, T7, T8 and T9: Ricotta cheese made with 1, 2 and 3 % green pepper paste A, B, C: Means with same letter among treatments in the same storage period are not significantly different.

Microbiological quality

It can be seen clearly from Table 5 that, control cheese samples had the higher total bacterial and yeast & mold counts compared to all spicy Ricotta cheese treatments whither when fresh or during cold storage period. While, Ricotta cheese made with 3% garlic paste (T6) had the lowest total bacterial count compared with other

cheese treatments when fresh or along cold storage period. Yeast & mould were not detected in all fresh Ricotta cheese, while, this appeared in control cheese samples after 10 days of cold storage. In addition, yeast & mold counts were not detected in Ricotta cheese samples spiced with 3% garlic or hot green pepper pastes (T6 and T9) when fresh or during cold storage period, on the other hand control cheese samples had the higher yeast & mold counts compared with different spicy treatments at the end of cold storage. Addition of garlic and hot green pepper to Ricotta cheese curd decreased the total bacterial and yeast & mold counts at the end of cold storage compared with these spiced with onion paste.

Coliform and sporeforming bacteria were not detected in either fresh control or spiced cheese samples and during the refrigerated storage period. This may be due to the high sanitation conditions during manufacture and cold storage.

According to these results, it could be concluded that, addition of garlic, hot green pepper or onion in Ricotta cheese had a significant positive effect on microbiological quality and hence improving the shelf life of the resultant product. This could be due to the antimicrobial effectiveness of those spices which forms the major volatile components. There were many researchers reported the antioxidant and antimicrobial activities of extracts of Allium cepa (Eltaweel, 2013). Onions were reported to be rich in a wide variety of secondary metabolites, such as alkaloids tannins, terpenoids, and flavonoids, which had in vitro antimicrobial properties (Cowan, 2001) and antifungal activity (Zohri et al., 1995). Recent reports stated that the Capsicum genus is a good source of antimicrobial and antifungal compounds against numerous human pathogens (Omolo et al., 2014). Garlic extract showed strong antimicrobial activity against many strains of bacteria, fungi and viruses (Papu et al., 2014). Tsao and Yin (2001) found that, garlic extract to inhibit the growth of many strains from Gram positive and Gram negative bacteria, such as staphylococcus, klebsiella, lactobacillus, streptococcus, micrococcus, enterobacter, escherichia, proteus, pseudomonas, salmonella, shigella, and Helicobacter pylori. The antibacterial activity of garlic extract depends on the presence of allicin which considered to be the most potent antibacterial agent in crushed garlic extracts. On the other hand, ajoene is an active compound found in garlic which plays a impotant role as topical antifungal agent as reported by Ledezma andApitz-Castro (2006).

TABLE 5. Total bacteria and Yeasts & moulds counts (log cfu/ g) of Ricotta cheese spiced with different types and levels of spices when fresh and during storage at 5±2˚C.

Treatment	Cold storage period (Day)					
	Fresh	5	10	15	20	25
	Total count					
C	3.23^{Ae}	3.42^{Ad}	3.73^{Ac}	3.96^{Ab}	4.20^{Aab}	4.48^{Aa}
T1	3.10^{Ac}	3.21^{Ac}	3.45^{ABb}	$3.65A^{Bab}$	3.85^{Bab}	4.05^{Ba}
T2	2.96^{Abe}	3.05^{ABde}	3.23^{Bd}	$3.45A^{Bcd}$	3.56^{BCb}	$3.87B^{Ca}$
T3	2.87^{Bd}	2.92^{Bcd}	3.06^{Cc}	3.21^{Bb}	3.32^{Cb}	3.59^{Ca}
T4	2.90^{ABd}	2.94^{Bcd}	3.03^{Cc}	3.30^{Bb}	3.44^{Cab}	3.61^{Ca}
T5	2.81^{Bc}	2.86^{Cbc}	2.95^{Cb}	3.12^{Bab}	3.30^{Ca}	3.41^{Da}
T6	2.70^{BCc}	2.74^{Cbc}	2.79^{Db}	2.84^{Cab}	2.91^{Ea}	2.98^{Ea}
T7	2.94^{ABc}	$3.01A^{Bbc}$	3.19^{BCb}	$3.41A^{Bab}$	$3.56B^{Ca}$	3.68^{Ca}
T8	2.80^{Bd}	2.83^{Cd}	2.97^{Cc}	3.22^{Bb}	3.45^{BCab}	$3.50C^{Da}$
T9	2.65^{Cd}	2.70^{Ccd}	2.86^{CDc}	3.03^{Bbc}	3.14^{Db}	3.42^{Da}
Yeast &mould						
C	n.d	n.d	3.58	3.92	4.46	4.68
T1	n.d	n.d	n.d	2.54	3.05	4.30
T2	n.d	n.d	n.d	n.d	2.23	3.11
T3	n.d	n.d	n.d	n.d	n.d	2.10
T4	n.d	n.d	n.d	n.d	2.32	3.14
T5	n.d	n.d	n.d	n.d	n.d	2.11
T6	n.d	n.d	n.d	n.d	n.d	n.d
T7	n.d	n.d	n.d	n.d	1.85	2.50
T8	n.d	n.d	n.d	n.d	n.d	1.90
T9	n.d	n.d	n.d	n.d	n.d	n.d

C*: Ricotta cheese made without any additives, T1, T2 and T3: Ricotta cheese made with 1, 2 and 3% onion paste, T4, T5 and T6: Ricotta cheese made with 1, 2 and 3% garlic paste, T7, T8 and T9: Ricotta cheese made with 1, 2 and 3 % green pepper paste A, B, C: Means with same letter among treatments in the same storage period are not significantly different. a, b, c : Means with same letter for same treatment during storage periods are not significantly different.

Our results are in agreement the results obtained by Foda et al. (2006) who found that, increasing the herbs concentration in herby soft cheese caused a significant decrease in total bacterial count in final product. Tarakci et al. (2004) noticed that, psyrotrophic and proteo;ytic bacterial counts were decreased with increasing black cumin concentration. Also, Adriana-Lobacz et al. (2016) stated that, the use of different spices such as red garlic-pepper in the production of fresh cheeses may benefit in terms of safety of food production and distribution, contributing at the same time to limited use of food preservatives. Moreover, different natural additives used in food production may function as natural preservatives, which make a strong element of marketing strategy.

It could be seen that, the total bacterial and yeast & mold counts increased progressively during storage. These results are in agreement with the results obtained by El-Hawary et al., (2010)

Sensory Quality

As shown in Table 6, sensory evaluation results showed significant differences among sensory attributes of the Ricotta cheese samples. The highest flavour and total scores were gained by spicy Ricotta cheese that fortified with hot green pepper paste followed by Ricotta cheese containing garlic paste. On the other hand, the least flavour and total scores were recorded for control and onion Ricotta cheese samples. The Ricotta cheese samples containing each of hot green pepper and garlic paste had significantly higher flavor score, than the other treatments; this was due to coordination between hot green pepper and garlic flavor and dairy products such as Ricotta cheese. Addition of spicy pastes especially garlic paste improved the body & texture properties of final product. This Improvement could be due to the spices content of fibers (Table 1).

TABLE 6. Sensory score of spicy Ricotta cheese fortified with different types of spices when fresh and during storage at 5±2˚C.

Criteria	Storage period (day)	Treatment									
		C*	T1	T2	T3	T4	T5	T6	T7	T8	T9
Appearance (10)	Fresh	7	7	7	7	7	7	7	8	9	9
	5	7	7	7	7	7	7	7	8	9	9
	10	7	6	6	6	7	7	7	7	8	9
	15	6	6	6	6	7	7	7	7	8	8
	20	6	6	6	6	6	6	6	7	8	8
	25	6	6	6	6	6	6	6	6	7	7
Body & texture (50)	Fresh	40	41	43	45	42	43	47	43	45	46
	5	40	42	43	44	42	43	47	43	45	46
	10	40	40	43	43	40	42	47	41	45	45
	15	39	40	41	43	40	41	45	41	44	45
	20	37	38	40	41	39	40	43	40	42	44
	25	35	36	38	40	39	40	42	39	41	42
Flavour (40)	Fresh	31	31	33	33	36	37	38	37	38	39
	5	32	31	34	32	36	36	38	36	38	39
	10	31	30	33	31	36	36	38	35	38	39
	15	30	30	31	30	33	35	38	35	38	37
	20	28	29	29	28	31	34	35	32	34	35
	25	26	27	26	26	30	31	33	30	31	34
Total (100)	Fresh	78^{Fa}	79^{Fa}	83^{Ea}	85^{Da}	85^{Da}	87^{Ca}	92^{Ba}	88^{Ca}	92^{Ba}	94^{Aa}
	5	79^{Ca}	80^{Ca}	84^{BCa}	$83B^{Cab}$	85^{BCa}	87^{Ba}	92^{Aa}	87^{Ba}	92^{Aa}	94^{Aa}
	10	78^{Ca}	76^{Db}	82^{BCa}	80^{Cb}	83^{Bab}	85^{Bab}	92^{Aa}	83^{Bb}	91^{Aa}	93^{Aa}
	15	75^{Cb}	76^{Cb}	78^{BCb}	79^{BCb}	80^{BCb}	83^{Bb}	90^{Aa}	83^{Bb}	90^{Aa}	90^{Ab}
	20	71^{Dc}	73^{CDc}	75^{Cc}	75^{Cc}	76^{Cc}	80^{Bc}	84^{Ab}	79^{Bc}	84^{Ab}	87^{Ac}
	25	67^{Ed}	69^{DEd}	70^{Dd}	72^{Dd}	75^{CDc}	77^{Cd}	81^{Ac}	75^{Bd}	79^{ABc}	83^{Ad}

C*: Ricotta cheese made without any additives, T1, T2 and T3: Ricotta cheese made with 1, 2 and 3% onion paste, T4, T5 and T6: Ricotta cheese made with 1, 2 and 3% garlic paste, T7, T8 and T9: Ricotta cheese made with 1, 2 and 3 % green pepper paste A, B, C: Means with same letter among treatments in the same storage period are not significantly different. a, b, c : Means with same letter for same treatment during storage periods are not significantly different.

In general, spices additives increased the acceptability of Ricotta cheese especially hot green pepper and garlic. These results agree with Yetismeyen (1997), who reported that, Turkish herby spicy cheese with mixture herbs containing 17.5% thyme had a higher flavour and odor score. Herby *et. al.,* (2008) recommended, using 0.5% black cumin as spice to produce a healthy symbiotic dairy product with a high acceptability. Foda *et. al.* (2006) concluded that, herby spicy soft cheese made from UF-retentate with tow celery or thyme concentrations with were accepted by Egyptian expert's panelists. Hayaloglu and Farkye (2011) reported that, herbs, spices, vegetables, and other condiments are essentially flavoring agents that are added to cheese to diversify cheese flavor for commercial purposes. These additives also give cheese some color and improve presentation and attractiveness of cheese to consumers

The sensory scores of all the Ricotta cheese samples were decreased during storage period. This decrease may be due to the acidity development or the production of microbial metabolism which affect the rheological and sensory properties. These results are harmony with that data obtained by El-Hawary et al., 2010).

Conclusions

It could be recommended that, addition of spices particularly hot green pepper and garlic in Ricotta cheese manufacture could improve the microbiological quality and the shelf life in resultant product. It could be made as a new spicy Ricotta cheese with acceptability for the Egyptian consumer to introduce for our local market.

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خواص الجودة ومدة حفظ الجبن الريكوتا المتبلة

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يهدف البحث الى دراسة اثر تدعيم خثرة الجبن الريكوتا بمعجون بعض التوابل الخضراء وذلك على خواص الجودة التركيبية والفيزوكيماوية والميكروبيولوجية والحسية للجبن الريكوتا الناتج. حيث تم صناعة نوع جديد من الجبن الريكوتا المتبلة بإضافة ١ , ٢ أو٣٪ من عجينة التوابل (بصل , ثوم أوالفلفل الأخضر الحار) , كما تم صناعة جبن ريكوتا مقارنة (بدون إضافة اي توابل). و تم تخزين كافة المعاملات على درجة ٥±١٥ م لمدة ٢٥ يوم. أظهرت النتائج أن تدعيم خثرة الجبن الريكوتا ببعض التوابل يؤدي الى إنخفاض طفيف في محتوي الجبن الناتج من البروتين , ويزداد هذا الاإنخفاض بزيادة نسبة عجينة التوابل المضافة الى خثرة الجبن. بينما لم تكن هناك أختلافات معنوية في محتوي الجبن من الحموضة والاس الهيدروجيني وكذلك معدا التصافي بين الجبن الكنترول وباقي المعاملات. اثرت أضافة التوابل الى خثرة الجبن الريكوتا بشكل ملحوظ على خواص الجودة التركيبية للمنتج النهائي. ادت اضافة بعض التوابل الى خثرة الجبن الريكوتا الى أنخفاض معنوي في اعداد الخمائر والفطريات والعدد الكلي للبكتيريا في الجبن الناتج وقد زادت تلك الاعداد مع تقدم مدة التخزين. كما كانت كافة العينات خالية من بكتيريا القولون والبكتيريا المتجرثمة خلال مراحل التخزينس. أدت إضافة التوابل (خاصة الثوم والفلفل الاخضر الحار) الى تحسن في الخواص الحسية للجبن الريكوتا حيث لقت تلك المعاملات اكثر درجات في التحكيم الحسي. وقد اظهرت النتائج ان مع تقدم فترات التخزين يحدث انخفاض تدريجي في درجات الاس الهيدروجيني ومعدلات تصافي الجبن و والتحكيم الحسي كما يحدث زيادة طفيفة في محتوي الجبن الناتج من المادة الصلبة , البروتين , الرماد والحموضة.

لذلك يمكن التوصية بأستخدام عجينة بعض التوابل (خاصة الثوم والفلفل الاخضر الحار) لتصنيع نوع جديد من الجبن الريكوتا المتبلة حيث ان تدعيم الجبن الريكوتا بعجينة التوابل يؤدي الى زيادة ملحوظة في مدة حفظ الجبن وتحسن معنوي في خواصه الحسية.