Impact of some Salting Methods on the Quality of Ras Cheese

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ABSTRACT

In this study, five trials of Ras cheese were made from cow's milk using different methods of salting; control (C) Ras cheese- was salted by adding salt (5%) to the curd after draining half to two-thirds whey then further by dry salting, (T1) Ras cheese was salted by adding salt (5%) to the curd after drained whole whey without dry salting, (T2) Ras cheese was salted by adding salt (5%) to the curd after drained half to two-thirds whey without dry salting, (T3) Ras cheese was salted in a brine solution (24%) for 24 hours without dry salting; and (T4) Ras cheese salting by brine solution (24%) for 12 hours then dry salting. The cheeses were allowed for ripening under the controlled conditions of temperature (13 ± 2°C) and relative humidity (about 85%). The chemical, rheological properties, sensory evaluation, and microstructure of Ras cheeses were studied. The results indicated that the trials (T2, T3, and T4) of full ripened Ras cheese had the highest grade in texture; T2 and T4 had the highest overall grade of acceptability. Trials 3 and 4 had low salt contents with acceptable flavor and texture, so Ras cheese could be produced by salting in the brine solution for 12 h with further dry salting or with salting in the brine solution for 24 h without further dry salting, so they obtained sweet whey could be used in some application.

Key Words: Microstructure, Ras cheese, rheological properties, ripening, sensory evaluation.

INTRODUCTION

Ras cheese is one of the most famous hard cheeses in Egypt. It is widely consumed by Egyptian and Arab consumers. Ras cheese is made from cow's milk or a mixture of cow and buffalo milk. Ras cheese is usually consumed after 3 to 6 months of ripening period. Which gives a perfectly ripe product. Ras cheese is placed in natural caves in the production area, where ripening takes place at approximately constant relative humidity (90% - 95%) and temperature (9° C - 12° C) (Abd-Ellah *et al*., 2017).

Sodium chloride is widely used as a preservative and taste-forming agent in dairy products, especially cheese. It is claimed that a high intake of sodium mainly contributes to high blood pressure and cardiovascular disease (Abernathy, 1979). Institute of Food Technologists, (1980) has been recommended to reduce the risk of high blood pressure, reduce daily NaCl intake.

Salt is an indispensable ingredient because it is necessary to improve the safety and quality of cheese. Salt improves the texture of the cheese through the hydration state into a viscous texture and regulates the chemical activity of microorganisms. Salt acts as a flavor enhancer and contributes to the development of the cheese flavor (Guinee, 2004 and Johnson *et al*., 2009). Cheese is viewed as products with high levels of sodium, many consumers consider cheese as a diet, and most will choose products with lower salt content (Johnson *et al*., 2009).

The Demands to reduce salt content in processed foods by health advisors and wholesalers have led to increase research on salt substitutes and innovative production techniques to reduce the amounts of salt in food. It is particularly difficult to reduce the sodium content of some cheeses, such as artisanal and raw milk cheeses. A proper understanding of the effect of salt on the properties of these cheeses is essential for developing strategies for producing low-sodium cheeses that meet consumer requirements. Regardless of the stage at which salt is added, salt has at least six roles in making and ripening artisanal cheese. This includes enhancing the syneresis of whey and controlling the final moisture content, controlling the metabolism and viability of the cheese starter culture, influencing secondary microorganisms that may proliferate and producing volatile compounds during the aging process, and controlling the enzyme activity and body of the final cheese products. When NaCl is replaced by Ca in the cheese matrix, it improves the flavor and taste of the cheese (El-Bakny, 2011).

Salting in the brine is a slow process, it takes several days for the salt to be uniformly distributed within the cheese mass. It should be noted that cheese loses its moisture in conjunction with the salt intake. The salt and moisture gradients in a cheese during salting are opposite of each other. The gradations of salt and moisture in cheese during salting interfere with each other (Walstra *et al*., 1999 and Fox *et al*., 2000). Although brine salting is the traditional method, mozzarella can also be salted by adding salt directly to the curd before stretching, during stretching, or between stretching and molding. Such direct salting reduces the time of subsequent fermentation; Another major difference is surface salting, salt is rubbed directly on

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the surface of the cheese (for example, Romano and Gorgonzola). This is repeated for several days so that the salt spreads throughout. In many other cheeses, both surface salting and brining are used (for example, Gruyere and Emmental). Regardless of the method used, salting is a vital step in cheese making because unsalted cheese is almost tasteless (Olson, 1995).

The rheological characteristics of cheeses in general and especially Ras cheese are important as a means of defining body and texture in terms of quality and identity as well as a means of studying its structure as a function of composition and storage conditions, which was also commonly used to characterize many types of cheese. The texture of cheese is a determinant of public opinion and consumer preference (Wendin *et al*., 2000 and Foegeding *et al*.,2003). Ripening is a natural process for most types of cheese includes microbiological and biochemical changes. Glycolysis pathway, the hydrolysis of lipids and breakdown of protein are involved and formulate the flavor, texture and appearance of the mature cheese. The flavor of cheese is determined by the balance between the many volatile and non-volatile components that formed during ripening (Lazzi *et al*., 2016).

The markets demanded that Ras cheese is low salt and acceptable in texture, and flavor. The current study was undertaken to determine the quality characteristics of the ripened Ras cheese with different salting techniques and their effect on the properties of texture, microstructure, and sensory acceptability.

MATERIAL AND METHODS

MATERIALS

Cow's milk was obtained from the Farm of Faculty of Agriculture, Alexandria University. Starter cultures, Freeze-dried lactic culture (YF-L904) for direct vat set (DVS) consists of *Streptococcus thermophilus* and *Lactobacillus delbreuckii* subsp. *bulgaricu*s was btained from Chr. Hansen Lab., Denmark. Liquid chymosin was obtained from Chr. Hansen Lab., Denmark. Calcium chloride was obtained from EL-Nasr Company, Alexandria.

METHODS

Ras cheese manufacture:

Ras cheese was made in the dairy pilot plant, Department of Dairy Science and Technology, Alexandria University. Raw cow's milk (3.5% fat) was pasteurized at 63˚C for 30 min and cooled to 38 ˚C, then the milk was transferred to cheese vat.

Five treatments of Ras cheese were made according to Awad (2006) with modifications in salting process; Control(C): Ras cheese was salted by adding salt (5% of milk) to the curd after the half to two-thirds whey drainage then dry salting, Treatment 1 (T1): Ras cheese was salted by adding salt (5% of milk) to the curd after the whole whey drainage without dry salting, Treatment2 (T2): Ras cheese was salted by adding salt (5% of milk) to the curd after the half to two-thirds whey drainage without dry salting, Treatment 3 (T3): Ras cheese was salted by immersing in a brine solution (24%) for 24 hours without dry salting, Treatment 4 (T4): Ras cheese was salted by immersing in a brine solution (24%) for 12 hours then dry salting. Was applied.

A commercial starter culture (5 unit/100 kg), $CaCl_2$ at level 0.012% (w/w) were added to the milk. Incubation at 35 ˚C, the rennet was added to clot the milk in 45 min, then cutting the curd with longitudinal and transverse knives, then scalding over (60 min) and hold at this temperature for 15 min. Whey was drained and salting was done to each treatment. After that, the curd was moulded and pressed for 24 h then the wheals were turned up and pressed for 24 h more. The cheeses were allowed to ripen under controlled condition of temperature (13±2ºC) and relative humidity (about 85%). Cheeses were sampled and analyzed at 1, 30, 60, 120 and 180 days of ripening.

Cheese yield

The yield is recoded at the third day of manufacturing (after salting some of treatments in brine solution). Actual cheese yield was expressed as the ratio between the curd mass obtained after 1stsalting stage and the weight of milk. *Adjusted* cheese yield was modified yield as the moisture 40% in all treatments.

Chemical analysis

According to (AOAC, 2012), cheese was analyzed for fat by Gerber method, total protein by macro-Kjeldahl, moisture content was determined by drying methods, salt content was determined using Volhard method. Titratable acidity was determined by titration methods using NaOH 0.1 N and phenolphthalein. The pH was measured in slurry prepared by macerating 20 g of grated cheese in 20 ml of deionized water using (pH meter Mi 151 PH / ORP / Temperature Bench Meter).

Textural analysis:

Samples for texture profile analysis (TPA) were obtained from the middle of the whole cheese block. Cheese samples were cut to cubes (5 cm^3) and kept at 12 ± 0.5 ˚C prior to analysis. A two-bite penetration test was performed using the texture analyzer (A. XT plus Texture Analyzer, Stable Micro Systems, UK) with the probe (50mm diameter) and operated at a crosshead speed of 1 mm/ s and deformation distance of 10 mm. The software permits the automatic calculation of sample: firmness, springiness, adhesiveness, cohesiveness, gumminess, chewiness, and resilience

The following texture profile parameters were obtained and calculated as describe by (Awad, 2011).

Sensory evaluation:

Sensory evaluation of Ras cheese samples was conducted by panel lists. Panelists were asked to evaluate the color, texture and flavor (odor and taste). For assessment of flavor and color, the following scales were used: 1, bad; 2, sufficient; 3, good; 4, very good. The scale for texture was: 1, soft; 2, normal; 3, hard; 4, very hard. The graders were asked to give the cheese an overall grade out of (100), when fresh, after 1, 2, 4 and 6 months of storage. The sensory evaluation procedure was modified from the method described by (Ayad *et al*., 2004).

Scanning electron microscopy:

Cheese microstructure was studied by Scanning Electron Microscope (SEM) after 6 months, according to(McClements,2007). Images of typical structures at 1000×magnification were recorded using a Scanning Electron Microscope (JEOI JSM- I T 200 SCANNING MICROSCOPE).

Statistical analysis:

Analysis of variance and Duncan's test as well as average and standard deviation (SD) were carried out using SPSS computer program.

RESULTS AND DISCUSSION

Cheese Composition

Results showed that there were significant differences between the treatments in the yield values. T1 and T2 had the highest yield, while control Ras cheese had the lowest one comparing with the other treatments (Table 1). The yield of cheese is directly proportional with moisture content of cheese. The control cheese recorded a lower moisture content comparing with all cheese treatments. These results are in agreement with Abou-Donia (2002), El-fadaly *et al.* (2015c) and Hamad *et al.* (2020). The salting in brine solution has affected the cheese yield, as low yield is recorded in T3 and T4. The *Adjusted* cheese yield is affected by salting methods; it was lower in T3 and T4 when compared with T2 and T1.

The obtained results of Cheese Composition (Table 2) indicated that there are significant differences in Ras cheese composition as a function of different salting methods for all parameters except in fat % (Table 2). There were no significant differences in fat content among all treatments, while results showed that there were significant differences between all treatments in moisture content as moisture residues in the final cheese were affected by the salting methods. Treatment 1 and T2 had the highest moisture content compared with other treatments in fresh cheese. During the progress of the ripening period, moisture content decreased in all treatments which led to increasing the fat, protein, ash and salt content (Awad, 2006; Awad *et al*., 2007; and Ahmed *et al.*, 2020).

There were significant differences between treatments in total nitrogen content, the control sample had the lowest protein content comparing with the other treatments. However, there were no significant differences between treatments (T2, T3, and T4). During the ripening period, total nitrogen content increased significantly in all cheese treatments (Table 2). The average of protein content in all treatments was within the range of traditional Ras cheese (Awad *et al*., 2003 and Ibrahim *et al*., 2017). Data in Table 2 also indicated that the salt content of cheese samples was significantly affected by the salting method. From the obtained results it can be observed that T2 had the highest salt content comparing with other treatments, while (T3) had the lowest salt content. The high salt in T2 is due to a high moisture level, while the low salt in T3 is related to the salting method.

Table 1. Effect of different methods of salting on the yield (%) of Ras cheese

Treatments	C	T1	T2	T3	T4
Actual Yield %	10.47^{c}	11.29^{A}	11.22^{A}	11.09^{b}	10.95^{b}
Adjusted Yield %	10.63	11.63	11.83	11.27	11.10

Values are mean of three replicates. Numbers with different superscript are significantly different (P <0.05).
C:Control Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage then dry salting.
T1:Ras cheese was salted by adding salt (5% of the milk) to the curd after the whole whey drainage without dry salting.
T2:Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage without dry salting.
T3:Ras cheese was salted by brine solution (24%) for 24 hours without dry salting.
T4:Ras cheese was salted by brine solution (24%) for 12 hours then dry salting.

Table 2. Effect of different methods of salting on the physicochemical properties of Ras cheese during ripening period

Component	Treatments	Ripening period **(days)**					Mean
		1	**30**	**60**	**120**	**180**	
Moisture %	C	41.50±.43	44.86±.72	42.13±.03	37.31±.53	35.33±.62	40.23^{A}
	T1	43.05±2.01	41.00±.04	40.21±1.01	38.33±1.27	37.31±.30	39.98^{A}
	T2	45.42±.26	42.09±.24	37.96±2.28	32.38±.84	31.25±.65	37.82^{B}
	T3	41.64±1.48	43.98±.08	38.09±1.27	34.80±.41	33.18±1.15	38.34^{B}
	T4	41.40±.82	40.50±.45	39.82±1.09	36.01±.65	33.71±.27	38.29^{B}
	Mean	42.60^{a}	42.48^{a}	39.64^{b}	35.77^{c}	34.15^{d}	
Protein %	C	21.24±.08	20.22±.25	20.61±.06	23.48±.21	24.18±.17	21.94^{C}
	T1	22.20±.05	23.16±.07	23.16±.05	24.75±.30	25.90±.12	23.79^{B}
	T2	22.46±.11	22.78±.030	24.82±.06	25.65±.04	26.41±.05	24.43^{AB}
	T3	22.78±.04	23.41±.11	24.18±.18	25.07±.07	25.84±.05	24.24^{AB}
	T4	23.35±.04	23.61±.07	24.49±.16	25.71±.08	26.09±.09	24.62^{A}
	Mean	22.41^{d}	22.63^{d}	23.45^{c}	24.93^{b}	25.68^{a}	
Fat %	C	25.53±1.70	24.03±.15	27.06±.20	28.46±1.76	29.30±1.47	26.88^{A}
	T1	24.13±.23	25.70±.43	26.13±2.50	28.30±2.35	29.40±2.00	26.73^{A}
	T2	24.63±.47	24.03±.15	26.16±.37	26.90±2.27	28.83±2.05	26.11^{A}
	T3	27.76±.92	21.83±.28	28.10±1.50	28.26±2.41	29.26±2.11	27.04^{A}
	T4	27.73±1.07	25.90±.45	26.43±2.30	27.40±2.26	28.76±1.70	27.24^{A}
	Mean	25.96^{c}	24.30^{d}	26.78^{bc}	27.86^{b}	29.11^{a}	
Salt %	C	2.19±.02	2.25±.04	2.28±.03	2.31±.02	2.41±.06	2.29^{A}
	T1	1.62±.06	1.71±.07	1.81±.10	2.01±.05	2.12±.12	1.85^{C}
	T2	2.12±.06	2.28±.07	2.35±.05	2.33±.10	2.38±.10	2.29^{A}
	T3	1.54±.06	1.66±.07	1.75±.11	2.05±.03	2.20±.07	1.84^{C}
	T4	1.76±.10	1.96±.15	2.16±.09	2.20±.11	2.26±.17	2.07^{B}
	Mean	1.84^{e}	1.97^{d}	2.07^{c}	2.18^{b}	2.27^{a}	
Ash %	C	5.15±0.32	7.02±0.14	7.49±0.39	7.81±0.49	8.14±0.69	7.12^{A}
	T1	3.74±0.14	4.84±0.82	4.53±0.38	5.10±0.24	5.30±0.28	4.70^{E}
	T2	5.31±0.37	6.01±0.25	6.33±0.11	7.03±0.14	7.12±0.13	6.36^{B}
	T3	4.11±0.14	4.76±0.21	4.97±0.18	5.52±0.36	5.69±0.31	5.01^{D}
	T4	5.15±0.58	4.81±0.35	5.22±0.29	5.68±0.41	5.85±0.27	5.34^{C}
	Mean	4.69^{c}	5.48^{b}	5.71^{b}	6.22^{a}	6.42^{a}	
Titratable acidity %	C	.83±.01	.86±.01	.89±.01	.91±.01	.93±.01	$.88^{B}$
	T1	.94±.002	.97±.01	.98±.02	.99±.01	1.01±.01	$.98^{A}$
	T2	.85±.01	.85±.01	.86±.01	.88±.02	.90±.01	$.87^{C}$
	T3	.97±.03	.96±.01	.98±.01	1.00±.01	1.01±.01	$.98^{A}$
	T4	.86±.002	.87±.01	.90±.01	.91±.01	.92±.01	$.89^{B}$
	Mean	$.89^{d}$	$.90^{d}$	$.92^{c}$	$.94^{b}$	$.95^{a}$	
pH	C	5.98±.01	5.89±.06	5.85±.08	5.81±.07	5.71±.07	5.85^{A}
	T1	5.78±.03	5.69±.05	5.57±.03	5.48±.05	5.32±.10	5.57^{C}
	T2	5.94±.08	5.82±.03	5.74±.09	5.65±.08	5.45±.10	5.72^{B}
	T3	5.66±.03	5.45±.13	5.39±.09	5.31±.10	5.19±.06	5.40^{E}
	T4	5.78±.01	5.56±.14	5.47±.08	5.43±.14	5.20±.21	5.49^{D}
	Mean	5.83^{a}	5.68^{b}	5.60^{c}	5.54^{c}	5.37^{d}	

Values are expressed as mean ± SD (n=3). Numbers with different superscript are significantly different (P <0.05).
C:Control Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage then dry salting.
T1:Ras cheese was salted by adding salt (5% of the milk) to the curd after the whole whey drainage without dry salting.
T2:Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage without dry salting.
T3:Ras cheese was salted by brine solution (24%) for 24 hours without dry salting.
T4:Ras cheese was salted by brine solution (24%) for 12 hours then dry salting.

Table 3. Effect of different methods of salting on the soluble nitrogen (%) of Ras cheese during ripening period

Treatments	Ripening period (days)		Treatment Overall mean
	1	180	
C	0.26±0.01	0.64±0.05	0.45^{D}
T1	0.31±.01	0.77±.02	0.54^{B}
T2	0.32±0.00	0.71±.02	0.52^{BC}
T3	0.30±.01	0.71±.03	0.51^{C}
T4	0.33±.01	0.80±.01	0.56^{A}
Ripening period Overall mean	0.30^{b}	0.72^{a}	

Values are expressed as mean ± SD (n=3). Numbers with different superscript are significantly different (P <0.05).
C:Control Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage then dry salting.
T1:Ras cheese was salted by adding salt (5% of the milk) to the curd after the whole whey drainage without dry salting.
T2:Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage without dry salting.
T3:Ras cheese was salted by brine solution (24%) for 24 hours without dry salting.
T4:Ras cheese was salted by brine solution (24%) for 12 hours then dry salting.

There was a significant increase in salt content in all treatments during the ripening period, which resulted from a reduction in moisture, while the significant increase of salt was in samples that received the second salting stage by applying dry salt. The salt levels in Ras cheese in this study are much lower than that in traditional Ras cheeses (Awad *et al*., 2003).

There were significant differences between treatments in titratable acidity, where T3 had the lowest values comparing to the other cheese treatments; this is due to the low levels of salt content in the water phase, which affected the growth of lactic acid bacteria during the ripening period (Osman *et al*., 2011). Acidity was significantly increased during the ripening period in all treatments. These due to the development of acidity that is a direct response for converting the residual lactose in cheese into lactic acid by the viable microflora (Mehanna *et al*., 2002 and Elewa*et al*., 2009). The pH values were antiparallel to the titratable acidity when fresh and during the ripening period. pH values of cheese samples were significantly decreased gradually during the ripening period, this was reported in previous studies (Awad, 2006 and Awad *et al*., 2007). Moreover, the lowest pH value was noticed in T3 compared with control and other treatments. The soluble nitrogen content (S.N) is taken as an index for cheese protein proteolysis during the ripening period. It can be noted that the S.N content increased significantly throughout the ripening period for all cheese treatments (Table 3). This was also reported by other researchers (Awad, 2006 and Ibrahim *et al*., 2017). Data showed that (T4) cheese had the highest S.N content, while control cheese had the lowest S.N content compared with other cheese treatments. So, the high proteolysis in T4 is related to low salt in this cheese.

Texture analysis:

There was a variation in textural parameters among all treatments (Table 4). Data illustrated that values of hardness, adhesiveness, gumminess, and chewiness have been increased after 2 months of ripening period that is related to losing of moisture in all cheese samples (Awad, 2006). Values of cohesiveness tented to decrease during ripening period in all cheese treatments. This might be due to decreasing in moisture content which acts as plasticizer in the protein matrix making cheese less elastic and more susceptible to fracture upon compression (Fox *et al.*, 2000 and Awad, 2006). Data also revealed that values of springiness leveled off in all Ras cheese treatments at fresh and decrease slowly during ripening period until 4 months then increased after 6 months. Values of adhesiveness and resilience decreased in all cheese treatments during ripening period since cheese become softer and smoother.

Sensory evaluation

All sensory parameters and overall acceptability of cheese treatments enhanced during ripening period (Table 5), these might be due to increasing levels of free amino acids which influence cheese characteristics (Kanawjia *et al.*, 1995 and Awad, 2006). There were significant differences in the intensity of color, texture and flavor in control and other treatments. Treatments 1, 3 and 4 received high scores in flavor after 4 and 6 months of ripening when compared with control. As well as all treatments (1, 2, 3 and 4) received high scores in texture after 2, 4 and 6 months of ripening when compared with control. This might be related to biochemical changes during ripening as affecting by several factors such as pH, water activity, proteolysis, and lipolysis. The results of this study confirm that it could be do salting of Ras cheese in brine solution (24%) for 24 hours without dry salting (T3) or do salting in brine solution (24%) for 12 hours, then do

second stage by dry salting (T4), this will produce good quality Ras cheese.

Table 4. Effect of different methods of salting on the rheological properties of Ras cheese during ripening period

Component	Treatments	Ripening period (days)				
		1	30	60	120	180
Hardness (N)	C	14.17	14.56	20.45	35.51	34.66
	T1	20.40	22.44	24.48	26.93	28.88
	T2	10.71	11.66	19.93	26.05	19.11
	T3	13.53	15.08	16.93	22.78	14.73
	T4	10.51	17.44	23.40	20.85	16.98
Adhesiveness(J)	C	1.496	5.158	5.190	3.214	0.68
	T1	1.601	5.920	5.240	3.099	0.78
	T2	1.868	4.529	4.769	3.105	0.91
	T3	1.964	5.602	4.014	3.970	0.85
	T4	1.660	5.925	4.319	3.729	0.94
Springiness(mm)	C	0.995	0.984	0.990	0.897	1.882
	T1	1.005	0.987	0.995	0.493	1.448
	T2	0.995	0.992	0.995	1.039	1.655
	T3	0.952	0.997	0.954	0.668	1.548
	T4	0.907	0.948	0.990	0.708	1.989
Cohesiveness(ratio)	C	0.917	0.8745	0.856	0.856	0.859
	T1	0.897	0.8855	0.874	0.456	0.851
	T2	0.917	0.8865	0.853	0.859	1.014
	T3	0.881	0.8775	0.854	0.447	1.36
	T4	0.871	0.8635	0.818	0.414	0.69
Gumminess (N)	C	13.00	12.73	17.51	30.40	29.77
	T1	18.30	19.87	21.39	12.28	24.57
	T2	9.82	10.34	17.00	22.38	19.37
	T3	11.92	13.23	14.46	10.18	20.03
	T4	9.15	15.06	19.14	8.63	11.71
Chewiness (J)	C	12.93	12.53	17.33	27.27	56.03
	T1	18.39	19.61	21.29	6.05	35.58
	T2	9.77	10.25	16.91	23.25	32.06
	T3	11.34	13.19	13.79	6.80	31.00
	T4	8.30	14.28	18.95	6.11	23.30
Resilience (ratio)	C	0.752	0.695	0.570	0.529	0.573
	T1	0.583	0.552	0.491	0.113	0.639
	T2	0.715	0.665	0.583	0.571	0.574
	T3	0.616	0.573	0.485	0.173	0.538
	T4	0.571	0.562	0.454	0.157	0.45

Values are mean of three replicates.

C:Control Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage then dry salting.

T1:Ras cheese was salted by adding salt (5% of the milk) to the curd after the whole whey drainage without dry salting.

T2:Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage without dry salting.

T3:Ras cheese was salted by brine solution (24%) for 24 hours without dry salting.

T4:Ras cheese was salted by brine solution (24%) for 12 hours then dry salting.

Table 5. Effect of different methods of salting and packaging on the sensory evaluation of Ras cheese during ripening period

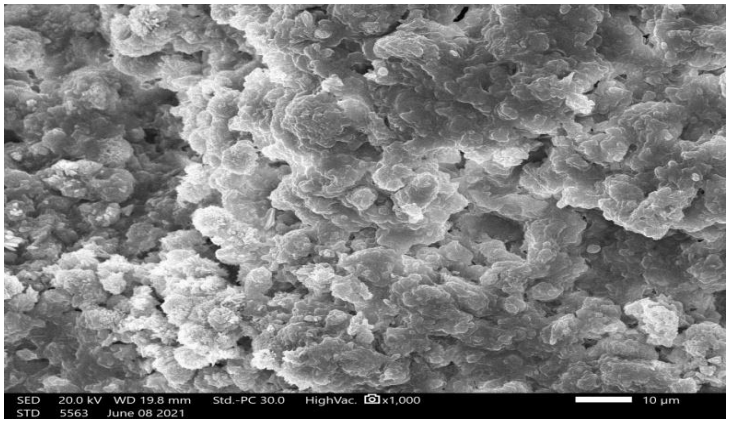
Treatments	Ripening period (days)	Color (5)	Treatment Overall mean	Flavor (5)	Treatment Overall mean	Texture (5)	Treatment Overall mean	Overall acceptability (100)	Treatment Overall mean
C	1	2.58±0.14	2.95^{B}	2.16±0.28	2.75^{C}	2.00±0.25	2.48^{B}	77.83±4.93	81.06^{BC}
	30	2.66±0.14		2.58±0.28		2.41±0.14		78.33±4.67	
	60	2.91±0.14		2.75±0.43		2.41±0.14		81.50±5.58	
	120	3.25±0.25		3.00±0.25		2.75±0.00		82.83±3.64	
	180	3.33±0.14		3.25±0.25		2.83±0.14		84.83±3.22	
T1	1	2.75±0.25	3.08^{AB}	2.66±0.28	3.08^{AB}	1.91±0.28	2.43^{B}	75.83±1.18	81.53^{BC}
	30	3.00±0.25		2.75±0.25		2.16±0.28		78.41±1.94	
	60	3.08±0.28		3.08±0.14		2.25±0.00		81.25±1.95	
	120	3.25±0.25		3.33±0.14		2.83±0.38		83.91±1.12	
	180	3.33±0.14		3.58±0.38		3.00±0.00		88.25±2.38	
T2	1	2.83±0.14	3.15^{A}	3.00±0.25	3.25^{A}	2.08±0.14	2.63^{AB}	83.58±1.28	87.11^{A}
	30	3.08±0.14		3.08±0.14		2.33±0.57		85.58±0.76	
	60	3.00±0.00		3.08±0.14		2.50±0.43		86.41±0.52	
	120	3.25±0.25		3.41±0.14		3.08±0.28		89.25±0.75	
	180	3.58±0.14		3.66±0.38		3.16±0.28		90.75±1.52	
T3	1	2.75±0.25	3.13^{A}	2.25±0.25	2.75^{C}	2.25±0.25	2.76^{A}	75.58±9.55	80.50^{C}
	30	2.91±0.14		2.41±0.14		2.50±0.00		77.75±6.90	
	60	3.00±0.25		2.58±0.28		2.91±0.14		80.41±6.02	
	120	3.33±0.14		3.08±0.14		3.08±0.28		82.91±5.13	
	180	3.66±0.28		3.41±0.38		3.08±0.14		85.83±4.20	
T4	1	2.66±0.28	3.13^{A}	2.33±0.14	3.03^{B}	2.08±0.52	2.61^{AB}	77.58±3.26	83.98^{B}
	30	3.00±0.25		2.75±0.00		2.33±0.52		81.41±2.88	
	60	3.16±0.28		3.08±0.14		2.75±0.43		82.75±1.14	
	120	3.25±0.25		3.33±0.14		2.75±0.25		86.58±1.62	
	180	3.58±0.38		3.66±0.14		3.16±0.14		91.58±1.84	
Ripening period Overall mean	1	2.71^{d}		2.48^{e}		2.06^{d}		78.08^{d}	
	30	2.93^{c}		2.71^{d}		2.35^{c}		80.30^{cd}	
	60	3.03^{c}		2.91^{c}		2.56^{b}		82.46^{bc}	
	120	3.26^{b}		3.23^{b}		2.90^{a}		85.10^{b}	
	180	3.50^{a}		3.51^{a}		3.05^{a}		88.25^{a}	

Values are expressed as mean ± SD (n=3). Numbers with different superscript are significantly different (P <0.05).
C:Control Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage then dry salting.
T1:Ras cheese was salted by adding salt (5% of the milk) to the curd after the whole whey drainage without dry salting.
T2:Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage without dry salting.
T3:Ras cheese was salted by brine solution (24%) for 24 hours without dry salting.
T4:Ras cheese was salted by brine solution (24%) for 12 hours then dry salting.

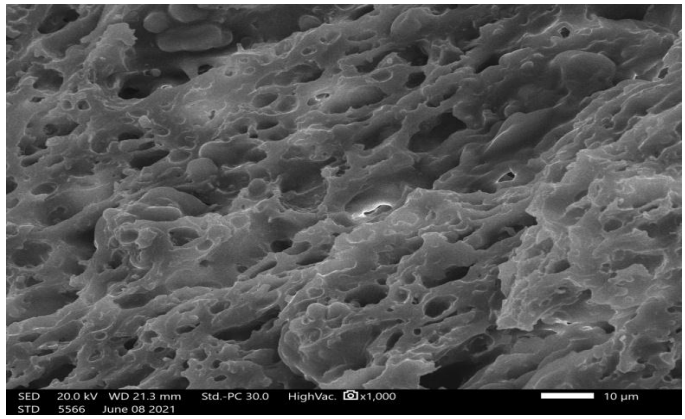
Microstructure:

The microstructure images in Fig. 1 (c, T1, T2, T3, T4) show the microstructure of 6 months old Ras cheese as affected by different salting methods. It can be observed that initial protein matrix of Ras cheese treatments had free large cavities with heterogeneous dispersion of casein particle. The protein matrix was more compacted in control Ras cheese and T3 cheese. The more open structure was observed in T4 cheese, might be due to increase hydration of protein matrix. The open structure of protein matrix is associated to proteolysis of protein, while protein void interface and increase accessibility of Para casein to proteases and thereby contributed to a higher level of primary proteolysis in cheese (Buffa *et al.*, 2001 and Burgos *et al.*, 2016).

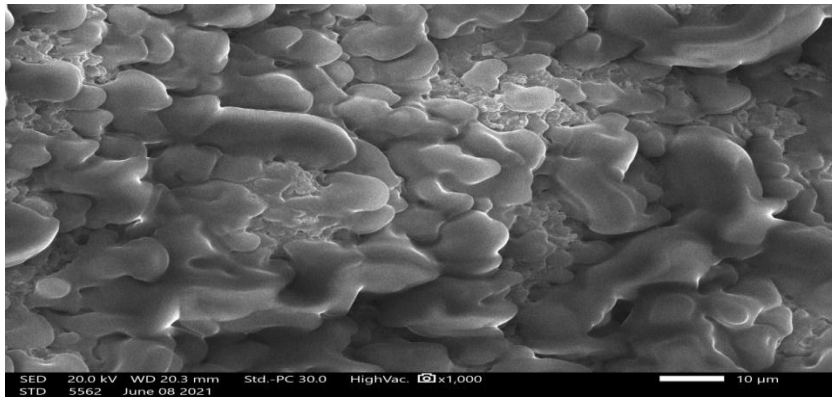
(T1)



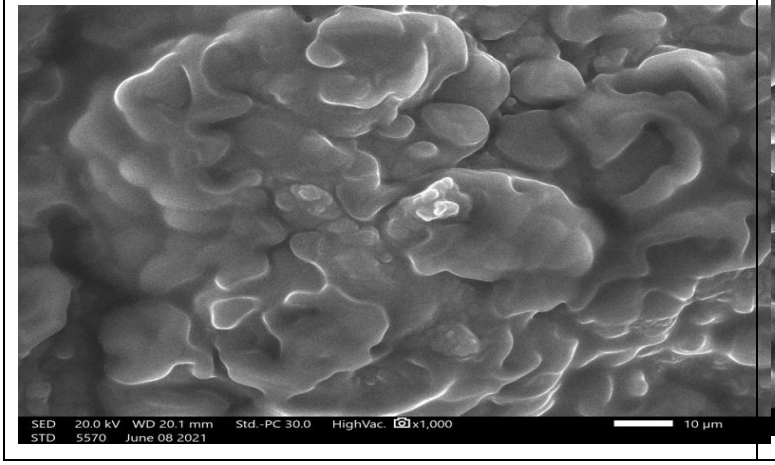
(T2)



(C)



(T3)



(T4)

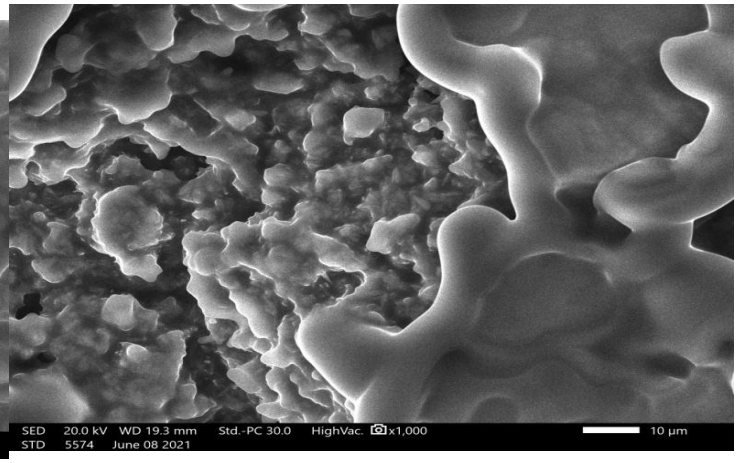


Fig. 1. Scanning electron microscopy photographs (×1000) of Ras cheese

C:Control Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage then dry salting.
T1:Ras cheese was salted by adding salt (5% of the milk) to the curd after the whole whey drainage without dry salting.
T2:Ras cheese was salted by adding salt (5% of the milk) to the curd after the half to two thirds whey drainage without dry salting.
T3:Ras cheese was salted by brine solution (24%) for 24 hours without dry salting.
T4:Ras cheese was salted by brine solution (24%) for 12 hours then dry salting.

CONCLUSION

From the obtained results, it can be concluded that using different methods of salting of Ras cheese had minor effect on physicochemical properties, chemical compositions and texture profile analysis. The Ras cheese salted by one stage with adding 5% salt to the curd after the half to two-thirds whey drainage without dry salting achieved high yield and received highest overall acceptability. As well as the Ras cheese salted in only one stage in brine solution (24%) for 24 hours or salting in brine solution (24%) for 12 hours,then by dry salting, received high scores of texture and flavor. So, the obtained results recommended to apply salting in just one stage without need for further dry salting.

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الملخص العربي

تأثير بعض طرق التمليح على جودة جبن الراس

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في هذه الدراسة، تم صناعة خمس تجارب للجبن الراس من لبن الأبقار باستخدام طرق مختلفة للتمليح. جبن الراس: – ١– الكنترول، التمليح بإضافة الملح (٥٪ من وزن اللبن) إلى الخثرة بعد تصفيته من نصف إلى ثلثي الشرش، ثم التمليح الجاف(T1)، ٢ (المعاملة الأولي)، التمليح بإضافة الملح (٥٪ من وزن اللبن) إلى الخثرة بعد التصفية من الشرش، بدون التمليح الجاف (T2)، ٣– (المعاملة الثانية)، التمليح بإضافة الملح (٥٪ من وزن اللبن) إلى الخثرة بعد تصفيته من نصف إلى ثلثي الشرش، بدون التمليح الجاف (T3)، ٤– (المعاملة الثالثة)، التمليح في محلول ملحي (٢٤) ٪) لمدة ٢٤ ساعة بدون تمليح جاف (T4)، و ((المعاملة الرابعة)،) تمليح جبن الراس بمحلول ملحي (٢٤٪) لمدة ١٢ ساعة ثم التمليح الجاف(T5). تم تسوية الجبن تحت ظروف درجة حرارة مضبوطة (١٣ ± ٢ درجة مئوية) والرطوبة النسبية (حوالي ٨٥٪). تمت دراسة الخواص الكيميائية والريولوجية والتقييم الحسي والتركيب الدقيق لأجبان الراس. أشارت النتائج إلى أن المعاملات (الثانية والثالثة والرابعة) للجبن الراس الكامل النضج كان لها أعلى درجة في القوام. حصلت المعاملات الثانية والرابعة على أعلى درجة عامة للخواص الحسية. الجبن الناتج من المعاملات ٣ و ٤ كانت تحتوي على مستويات منخفضة من الملح مع نكهة وقوام مقبول، لذلك يمكن إنتاج جبن راس بالتمليح في محلول ملحي لمدة ١٢ ساعة مع مزيد من التمليح الجاف أو بالتمليح في محلول ملحي لمدة ٢٤ ساعة دون مزيد من التمليح الجاف، لذلك يمكن استخدام الشرش الحلو في بعض الصناعات الغذائية.

الكلمات المفتاحية: التركيب الدقيق، الجبن الراس، الخواص الريولوجية، التسوية، الخواص الحسية.