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Impact of Nacl Substititution with Other Salts on Kareish Cheese Characteristics

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ABSTRACT

This study was carried out to evaluate the effect of the partial substitution of NaCl with different levels of KCl and $MgCl_2$ on the manufacture of Kareish cheese. Kariesh cheese was made by using vat set lyophilized starter cultures using different concentrations of salts namely: NaCl with KCl or MgCl2 (1:1, 2:1and 1:2 %). Kariesh cheese being made with only (3%) NaCl was considered as control, the salt added in all treatments after fermentation. All treatments analyzed when fresh, after one week and two weeks for chemical (Total protein (TP), non-protein nitrogen (NPN), soluble nitrogen (SN), total solid (TS), pH values and minerals of (Na, K, Mg)), as well as microbial analysis, organoleptic indices (flavor, body & texture and appearance & color) and rheological properties (Hardness, cohesiveness, springiness, Adhesiveness, Gumminess and chewiness).it could be notic that the total solid is inversely proportional to substitution percentage of NaCl with KCl or MgCl2. On the other hand, Cheese yield is directly proportional to substitution percentage of NaCl with KCl or $MgCl_2$. pH value of all treatments was lower than control. NPN and SN contents significantly increased during storage period ($p<0.05$), while TP content and pH value significantly decreased during storage period ($p<0.05$). The replacement of NaCl with MgCl2 by the ratio (1: 2) enhanced the organoleptic and texture properties of the cheese comparing with the control. NaCl retention percentage in Kareish cheese curd was the highest, compared with other salts, followed by KCl and then $MgCl_2$. Hardness, gumminess and chewiness were significantly lower ($P< 0.05$) in karish cheese made with the partial substitution of sodium chloride (KCl or $MgCl_2$) than cheese salted with sodium chloride alone (control). Cohesiveness, adhesiveness and springiness were significantly higher in cheese salted with NaCl/ KCl or NaCl/$MgCl_2$ mixtures. It could be concluded that the partial substitution of NaCl with KCl or $MgCl_2$ resulted a positive effect on Karish cheese textural characteristics. Instrumental and sensory properties showed indicated that Karish cheese being made using partial substitution of NaCl with KCl or $MgCl_2$ was softer and smother than control.

Keywords: Kariesh cheese, substitution, KCl and $MgCl_2$.

INTRODUCTION

Kareish cheese is generally a public soft cheese in Egypt, especially the countryside owing to its high protein, low fat and price (Kebary et al., 1997) . Therefore, Kareish cheese will be the most promising food to avoid the health problems associated with fat. It is acid cheese made from skimmed cow's and buffalo's milk or buttermilk from sour cream. At first, kareish is made from Laban Khad (fermented buttermilk) or Laban Rayeb (sour skimmed milk). Rayeb infectious from fresh full milk placed in pottery jugs and left serene, the fat rises to the surface and the sour milk was in the bottom(Hussein and Shalaby, 2014). Increasing the request of kareish consumption led to the trade production of Kareish cheese which, is frequently made from pasteurized and/or homogenized skimmed milk or reconstituted milk using *Lactobacillus delbrueckii* ssp. *bulgaricus* as starter and usually with rennet rather than acid as coagulant (Phelan et al., 1993).

(Greeley, 1997) reported that sodium's salt is considered the most abundant component in extracellular fluids and authorize the transport of nutrients. Sodium's intake is fundamental, as it participates to the mechanism of blood pressure regulation, regulation of osmotic pressure transport of intracellular water, and transmission of nerve impulses. Diets with high amounts of sodium cause confinement the water in the body, that is may cause abnormally high blood pressure, which is an serious peril factor for the extending of the heart and blood vessels diseases (Tuomilehto et al., 2001).

One mechanism for sodium reduction in cheese is the use of replacement mineral salts such as KCl, MgCl2, and CaCl2 to obtain similar water activities while reducing the level of Na (Grummer et al., 2013).The clinical and epidemiological studies have shown that potassium has a substantial mission on hypertension of artery in both normal blood pressure people and high blood pressure people. Both of potassium and sodium intake have counteractive effects on an arterial blood pressure, these were useful results when the potassium intake was increased and the sodium intake decreased (He and MacGregor, 2001).

Therefore, this study was carried out to evaluate the effect of substitution of NaCl others in different levels and determine its effect in kariesh cheese characteristics.

MATERIALS AND METHODS

Fresh standardized skimmed milk of buffalo was obtained from the experimental center of the Dairy Department, Faculty of Agriculture Mansoura University. Dried trade category food of sodium chloride, potassium chloride and magnesium chloride obtained from El-Nasr Salines Company, Egypt. Chemicals used for the detecting the acidity, protein, etc, were obtained from El-Gomhoria chemicals company.

Kariesh cheese was made according to Abou-Donia, (2008), by using vat set lyophilized starter cultures (traditional yoghurt starter) using different salts in different ratio of NaCl with KCl or MgCl2 (1:1, 2:1and 1:2 %). Kariesh cheese being made with only (3%) NaCl was considered as control, and the salt added in all treatments after fermentation. All treatments are made in triplicates and analyzed when freshand after 1 and 2 weeks for chemical and microbial analysis as described by the Bradley et al., (1992) and organoleptic properties which scored using scorecard (50, 40, 10 points) for flavor, body & texture and appearance & color respectively according to Nelson and Trout, (1965).

Total protein (TP), non protein nitrogen (NPN) and soluble nitrogen (SN) were estimated according to Ling, (1963), total solid (TS) according to AOAC, (2005), pH values measured using pH meter type (CG710, West Germany) according to Ling, (1963). Minerals of (Na, K, Mg) were measured according to to AOAC, (2005).

Cheese yield was calculated by the formulation of Metzger et al., (2000).

Textural properties of cheese were evaluated using a texture analyzer (TA1000, Lab Pro (FTC TMS-Pro), USA). Cheese samples were cut into 50 mm^3. A two-bite penetration test was performed with the TA60 degree cone, Perspex probe for Kareish cheese operated at a crosshead speed 50 mm/sec. Hardness, cohesiveness, springiness and chewiness were evaluated in triplicate as described by Szczesniak et al., (1963) and Bourne, (1978).

Data were statistically analyzed by analysis of variance using the General Linear Model procedures of SAS, (2004). Duncan multiple range test was used to test the differences among means Duncan, (1955) at $P<0.05$.

RESULTS AND DISCUSSION

The effect of NaCl partial substitution with KCl and $MgCl_2$ with different levels on NPN, SN, TP, pH and TS are presented in Table (1).Generally a significant decrease in total solid was recorded in all treatments, compared with the control (Table 1). It could been noticed that the total solid is inversely proportional to substitution percentage of NaCl with KCl or $MgCl_2$. The maximum decrease of T.S was recorded by using NaCl: $MgCl_2$ (1:2), which was about 21.2% followed by NaCl: KCl (1:2) of 23.4%. However different levels of substitution resulted in an increase in the cheese yield, comparing with control, and the highest was NaCl: $MgCl_2$ (1:2). The it could also be indicated that cheese yield is directly proportional to substitution percentage of NaCl with KCl or $MgCl_2$.

Different levels of substitution were of significant effect on all of the studied parameters. NPN, SN, TP ratios and pH value were significantly higher in control compared with the different levels of substitution. The lowest contents of NPN,SN and TP were detected by the substitution of NaCl:$MgCl_2$ (1:2), NaCl : KCl (1:2), NaCl: $MgCl_2$ (1:2), respectively (Table 1).This variation of NPN, SN and TP contents could be attributed to the decrease in total solid associated to the increase of substitution percentage of NaCl with KCl or $MgCl_2$. This might be due to the ability of KCl or $MgCl_2$ of water binding capacity, compared with NaCl.

Table 1. Effect of partial substitution of NaCl with KCl or $MgCl_2$ on nitrogen fractions, total solid, pH value and cheese yield of Karish cheese.

Treatment	Storage Period (days)	NPN/TN%	SN/TN%	TP%	TS%	pH	Cheese yield (%)
Control NaCl (3%)	0	13.12	13.93	18.56	26.83	4.24	20.3^{e}
	7	14.25	15.00	17.21		4	
	15	15.88	17.92	16.10	26.71	3.82	
	Mean	14.42^{a}	15.62^{a}	17.29^{a}	26.77	4.02^{a}	
NaCl:KCl 1:1	0	9.97	8.25	17.33	24.10	3.74	23.5^{b}
	7	12.31	9.30	15.85		3.68	
	15	15.44	11.81	12.86	24.02	3.69	
	Mean	12.57^{b}	9.79^{d}	15.35^{b}	24.06	3.70^{c}	
NaCl:KCl 1:2	0	10.79	7.89	17.46	23.18	3.67	24.3^{a}
	7	11.84	8.42	14.51		3.6	
	15	13.43	9.71	12.73	23.12	3.45	
	Mean	12.02^{cb}	8.67^{e}	14.90^{b}	23.15	3.57^{d}	
NaCl:KCl 2:1	0	10.82	9.97	16.97	24.70	3.83	21.3^{d}
	7	12.39	12.31	16.97		3.78	
	15	15.63	15.09	15.63	24.58	3.74	
	Mean	12.95^{b}	12.46^{b}	16.52^{a}	24.64	3.78^{cb}	
NaCl:$MgCl_2$ 1:1	0	8.93	10.94	13.40	22.20	3.86	23.25^{b}
	7	10.36	12.41	12.50		3.83	
	15	14.58	13.70	12.50	22.15	3.83	
	Mean	11.29^{c}	12.35^{b}	12.80^{cd}	22.18	3.84^{b}	
NaCl: $MgCl_2$ 1:2	0	8.33	10.00	12.50	21.2	3.83	24.25^{a}
	7	9.64	11.43	12.50		3.83	
	15	12.50	11.79	10.72	21	3.8	
	Mean	10.16^{d}	11.07^{c}	11.91^{d}	21.1	3.82^{b}	
NaCl: $MgCl_2$ 2:1	0	10.00	11.98	14.29	23.70	3.9	22.55^{c}
	7	12.07	12.65	12.95		3.86	
	15	14.81	12.89	12.06	23.64	3.85	
	Mean	12.29^{b}	12.51^{b}	13.10^{c}	23.67	3.87^{b}	

The above results are not consistent with those reported by Nasr, (2015), who stated that the moisture content of mozzarella cheese made from buffalo milk (3% fat) salted with NaCl: KCl (1:3) was higher than control (Mozzarella cheese manufactured from com milk and salted by NaCl). The same treatment contained high level of total protein, fat and ash, compared with control. This variation of results could be attributed to difference of cheese type, where the moisture content of

Mozzeralla cheese is higher than Kariesh cheese. In addition, Mozerralla cheese had been hardly treated, compared with Kariesh cheese. It could also be noticed from Table (1) that pH value of Kareish cheese salted by substitution of NaCl with KCl or $MgCl_2$ was lower than control. Nearly liner relationship between the percentage of substitution of NaCl with KCl or $MgCl_2$ and pH values was established. This might be due to the ability of KCl or $MgCl_2$ to activate starter culture of Kareish cheese.

NPN and SN contents significantly increased during storage period ($p<0.05$), while TP content and pH value significantly decreased during storage period ($p<0.05$).

Data presented in Table (2) show the ssory properties of kariesh cheese being made with different substitutions of NaCl, KCl and MgCl2. The best substitution in all sensory properties was NaCl:MgCl2 (1:2), and the worst one was NaCl:KCl (1:2).

From the previously mentioned data, it could be concluded that the replacement of NaCl with MgCl2 by the ratio (1NaCl: 2MgCl2) enhanced the organoleptic and texture properties of the cheese, compared with the control.

Table 2. Effect of partial substitution of NaCl with KCl or $MgCl_2$ on organoleptic properties of Karish cheese.

Treatment	Storage Period (days)	Appearance (10)	Body and texture (40)	Flavor (50)	Total (100)
	0	7	38	47	90
Control	7	6	35	46	86
NaCl (3%)	15	5	35	45	85
	Mean	6.00^{b}	36.00^{b}	46.00^{a}	87.00^{c}
	0	7	38	48	92
NaCl:KCl	7	5	36	48	89
1:1	15	5	35	45	85
	Mean	5.67^{c}	36.33^{b}	47.00^{a}	88.67^{b}
	0	5	30	40	75
NaCl:KCl	7	5	30	37	72
1:2	15	5	30	35	70
	Mean	5.00^{e}	30.00^{d}	37.33^{d}	72.33^{f}
	0	6	35	45	86
NaCl:KCl	7	5	35	45	85
2:1	15	5	33	40	78
	Mean	5.33^{d}	34.33^{c}	43.33^{b}	83.00^{d}
	0	4	36	43	83
$NaCl:MgCl_2$	7	3	35	42	80
1:1	15	3	34	40	77
	Mean	3.33^{g}	35.00^{c}	41.67^{c}	80.00^{e}
	0	8	38	48	94
$NaCl: MgCl_2$	7	7	38	48	93
1:2	15	7	36	45	88
	Mean	7.33^{a}	37.33^{a}	47.00^{a}	91.67^{a}
	0	6	35	43	84
$NaCl: MgCl_2$	7	5	35	43	83
2:1	15	1	33	39	73
	Mean	4.00^{f}	34.33^{c}	41.67^{c}	80.00^{e}

Total count (T.C) of bacteria increased in all treatments, compared control during different storage periods. T.C in all treatments were in normal range. Na:KCl (2:1) treatment resulted in reduction in count of protiolytic bacteria, compared with other treatments (Table 3).

The salt retention Kareish cheese was significantly different between most treatments ($P< 0.05$). Furthermore, NaCl retention percentage in Kareish cheese curd had the highest contents of salts, compared to other salts, followed by KCl and then $MgCl_2$. It could also be noticed that the salt retention in Kareish cheese curd is inversely proportional to substitution percentage of NaCl with KCl or $MgCl_2$. The maximum decrease of salt retention was recorded by adding of NaCl: $MgCl_2$ (1:2). On the other hand, the ability of water binding of Kareish cheese curd is directly proportional to substitution percentage of NaCl with KCl or $MgCl_2$ (table 4).

Results in (Table 4) are consistent with those reported by Nasr (2015), who detected the influence of substitution NaCl with KCl (1:3) on minerals contents of Mozzarella cheese, being salted with NaCl: KCl (1:3) had high content of K and the lowest values of Na.

These results are in harmony with the previous results (in Table 1), which detected the total solid is inversely proportional to substitution percentage of NaCl with KCl or $MgCl_2$. It could also be seen from the previous results that the best treatment is $NaCl:MgCl_2$, as it is of the lowest salt retention, which is suitable for patients with cardiovascular disease or hypertensive patients. On the other side, this treatment scored the highest score of organoleptic properties compare with other treatments, in addition to, the $MgCl_2$ had a high ability to water binding, compare to NaCl or KCl, so the highest one of cheese yield was $NaCl:MgCl_2$ (1:2).

Table 3. Effect of partial substitution of NaCl with KCl or $MgCl_2$ on microbial count of Karish cheese.

Treatment	Storage Period (days)	T.C bacteria ×10^4	Proteolytic bacteria ×10^4	E. Coli ×10
	0	2	0	0
Control	7	8	10	0
NaCl (3%)	15	26	23	0
	Mean	12	11	0
	0	8	0	0
NaCl:KCl	7	15	3	0
1:1	15	35	23	0
	Mean	19.33	8.67	0
	0	3	0	0
NaCl:KCl	7	13	8	0
1:2	15	38	19	0
	Mean	18	9	0
	0	13	0	0
NaCl:KCl	7	19	1	0
2:1	15	45	13	0
	Mean	25.67	4.67	0
	0	5	4	0
NaCl:$MgCl_2$	7	30	5	0
1:1	15	47	15	0
	Mean	27.33	8.00	0
	0	4	0	0
NaCl: $MgCl_2$	7	6	5	0
1:2	15	15	10	0
	Mean	25	15	0
	0	2	0	0
NaCl: $MgCl_2$	7	5	7	0
2:1	15	10	13	0
	Mean	17	20	0

Table 4. Effect of partial substitution of NaCl with KCl or $MgCl_2$ on retention salts of Karish cheese.

Treatment	Storage Period (days)	Na	% Na in curd	K	% K in curd	Mg	% Mg in curd	Total of salt (mg)	% Total of salt
	0	1912		-	-	-	-	1912	
Control	7	1911		-	-	-	-	1911	
NaCl (3%)	15	1908		-	-	-	-	1908	
	Mean	1910.33[a]	63.33	-		-	-	1910.33	63.33
	0	960		910		-	-	1870	
NaCl:KCl	7	954		907		-	-	1861	
1:1	15	950		907		-	-	1857	
	Mean	954.66[c]	63.64	907.33[b]	60.48	-	-	1861.99	62.1
	0	637		1215		-	-	1852	
NaCl:KCl	7	637		1214		-	-	1851	
1:2	15	635		1211		-	-	1846	
	Mean	636.33[d]	63.63	1213.33[a]	60.66	-		1849.66	61.65
	0	1266		610.7		-	-	1876.7	
NaCl:KCl	7	1265		602		-	-	1867	
2:1	15	1260		600		-	-	1860	
	Mean	1263.66[b]	63.18	604.23[c]	60.42			1867.89	62.26
	0	952		-	-	684		1636	
NaCl:$MgCl_2$	7	956		-	-	683		1642	
1:1	15	959		-	-	680		1639	
	Mean	955.66[c]	63.71			682.33[b]	45.48	1637.99	54.59
	0	640		-	-	815		1455	
NaCl: $MgCl_2$	7	641		-	-	814		1455	
1:2	15	638		-	-	810		1448	
	Mean	639.66[d]	63.96	-	-	813[a]	40.65	1452.66	48.42
	0	1275		-	-	517		1792	
NaCl: $MgCl_2$	7	1270		-	-	517		1787	
2:1	15	1267		-	-	514		1781	
	Mean	1270.66[b]	63.53	-	-	516[c]	51.6	1786.66	59.55

Several parameters of texture profile analysis were determined in Karish cheese salted with various percentages of NaCl, KCl and $MgCl_2$ (Table 5). Karish cheese textural properties were significantly affected by using partial substitution of NaCl by KCl or $MgCl_2$. Hardness, gumminess and chewiness were significantly lower ($P < 0.05$) in karish cheese made with the partial substitution of sodium chloride (KCl or $MgCl_2$) than cheese salted with sodium chloride (control). However, the cohesiveness, adhesivenss and springiness were significantly higher in cheese salted with NaCl/ KCl or NaCl/$MgCl_2$ mixtures. Hardness, Gumminess and chewiness are inversely proportional to substitution percentage of NaCl with KCl or $MgCl_2$. The partial substitution of sodium chloride with magnesium chloride was of higher effects on textural properties of cheese than with using potassium chloride as partial salt replacer (Table 5).

The lower values of Hardness, Adhesivenss, Gumminess and Chewiness in cheese salted with NaCl/KCl or NaCl/$MgCl_2$ mixtures could be attributed to its higher moisture content and non-compact

structure, where the high moisture decrease protein network strength resulting smooth cheese that coats the mouth during mastication (Maifreni et al., 2002).

The present results are generally in agreement with those observed by Hassan et al., (2004). Beal and Mittal, (2000) reported that high moisture reduce stability of protein network strength resulting a low hard cheese. In addition to producing higher content of moisture kariesh cheese curd, the increasing of salt and ash contents in cheese resulting in a high firm cheese (Kaminarides et al., 2006).

Table 5. Effect of partial substitution of NaCl with KCl or $MgCl_2$ on rheological properties of Karish cheese.

Treatment	Storage Period (days)	Hardness (N)	Adhesiveness (J)	Cohesivness	Springiness (mm)	Gumminess (N)	Chewiness (J)
Control NaCl (3%)	0	4.17	26.65	0.30	0.40	1.25	0.50
	15	4.15	27.00	0.30	0.40	1.26	0.50
	Mean	4.16^{a}	26.83^{e}	0.30^{d}	0.40^{d}	1.26^{a}	0.50^{a}
NaCl:KCl 1:1	0	2.26	32.31	0.42	0.47	0.95	0.44
	15	2.20	32.79	0.43	0.47	0.95	0.44
	Mean	2.23^{c}	32.55^{d}	0.43^{b}	0.47^{b}	0.95^{b}	0.44^{b}
NaCl:KCl 1:2	0	1.57	34.37	0.50	0.53	0.78	0.41
	15	1.53	35.63	0.50	0.54	0.76	0.41
	Mean	1.55^{e}	35.00^{c}	0.50^{a}	0.54^{a}	0.77^{d}	0.41^{c}
NaCl:KCl 2:1	0	3.14	28.67	0.33	0.42	1.04	0.44
	15	3.12	29.00	0.34	0.43	1.06	0.45
	Mean	3.13^{b}	28.84^{e}	0.34^{c}	0.42^{d}	1.05^{b}	0.44^{b}
NaCl:$MgCl_2$ 1:1	0	1.96	49.85	0.43	0.48	0.85	0.41
	15	1.89	50.42	0.44	0.48	0.84	0.40
	Mean	1.925^{d}	50.135^{b}	0.43^{b}	0.480^{b}	0.845^{c}	0.405^{c}
NaCl: $MgCl_2$ 1:2	0	1.20	86.93	0.52	0.53	0.62	0.33
	15	1.17	87.45	0.53	0.53	0.62	0.33
	Mean	1.18^{f}	87.19^{a}	0.53^{a}	0.53^{a}	0.62^{e}	0.33^{d}
NaCl: $MgCl_2$ 2:1	0	2.55	39.14	0.38	0.44	0.97	0.43
	15	2.47	40.22	0.37	0.44	0.92	0.40
	Mean	2.51^{c}	39.68^{c}	0.38^{c}	0.44^{c}	0.94^{b}	0.42^{c}

CONCLUSION

This study reported that the partial substitution of NaCl with KCl or $MgCl_2$ is of a positive effect on Karish cheese textural characteristics. Evaluation of instrumental and sensory properties showed promising results, indicating that Karish cheese made using partial substitution of NaCl with KCl or $MgCl_2$ was softer and smother than control. Improvement of textural properties could enhance acceptability of karish cheese.

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تأثير استبدال كلوريد الصوديوم بأملاح أخرى علي خصائص الجبن القريش

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تهدف هذه الدراسة الى قياس تأثير الاستبدال الجزئي لكلوريد الصوديوم بكل من كلوريد البوتاسيوم وكلوريد الماغنسيوم بمستويات مختلفة في صناعة الجبن القريش. تم تصنيع الجبن القريش باستخدام بادئ مجفد مع استخدام ثلاث مستويات مختلفة من الاستبدال بين كلوريد الصوديوم وكلا من كلوريد البوتاسيوم و الماغنيسيوم (١:١ ، ٢:١ و ١:٢). تم اضافة الملح للجبن المصنع بعد تمام التجبن بنسبة ٣ %. تم عمل ثلاث مكررات لجميع المعاملات و أخذ العينات اللازمة للتحليل على ٣ فترات (عينة طازجة – بعد مرور اسبوع – بعد مرور اسبوعين) ، وتم اجراء الاختبارات الكيميائية (البروتين الكلي – البروتين الذائب – النيروجين غير البيروتيني – المادة الصلبة – قيمة pH و تقدير نسبة المعادن لكل من الصوديوم والبوتاسيوم والماغنسيوم). كما تم اجراء كلا من الاختبارات البيكتريولوجية والتقييم الحسي والخواص الريولوجية لجميع المعاملات. اوضحت النتايج وجود علاقة عكسية بين المادة الصلبة ونسب الاستبدال المختلفة بين كلوريد الصوديوم وكلا من كلوريد البوتاسيوم والماغنيسيوم بينما تزداد محصول الجبن (الريع) مع الاستبدال الجزئي للاملاح. كذلك اشارت النتائج الى ان محتوى البروتين الذائب و النيروجين غير البيروتيني يزداد زيادة معنوية اثناء فترات التخرين المختلفة ، بينما تنخفض المادة الصلبة و مستوى pH انخفاضا معنويا طوال فترة التخزين.الاستبدال الجزئي لكلوريد الصوديوم بـ كلوريد الماغنسيوم بنسبة (٢:١) نتج عنه تحسن في الخواص الحسية للجبن التانج مقارنة بالمعاملة القياسية . كذلك اوضحت النتائج ان محتوى خثرة الجبن من كلوريد الصوديوم كان الاعلى بين الانواع المختلفة من الأملاح يليه في ذلك كلوريد البوتاسيوم ثم كلوريد الماغنسيوم. عند تقدير الخواص الريولوجية وجد ان كلا من hardness, gumminess and chewiness اظهر انخفاضا معنويا في المعاملات التي حدث بها استبدال جزئي لكلوريد الصوديوم مقارنة بالمعاملة القياسية. بينما كلا من cohesiveness, adhesivenss and springiness اظهر ارتفاعا معنويا مقارنة بالمعاملة القياسية. تقييم الدور الفعال والخواص الحسية أظهرت أن الجبن القريش الناتج من عملية استبدال جزئي لكلوريد الصوديوم بكلوريد البوتاسيوم أو كلوريد الماغنسيوم كانت أكثر نعومة من العينة القياسية.