J. Agric. Sci. Mansoura Univ., 25 (9): 5755 - 5760, 2000.

EFFECT OF EMULSIFIER SALTS ON QUALITY OF PROCESSED CHEDDAR CHEESE

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ABSTRACT

Commercial (imported) emulsifying salts can be successfully replaced in processed cheese manufacture on large scale with other permitted cheaper, available and edible salts such as sodium citrate (the main salt) in addition to mono and di-sodium phosphate, citric acid, self 363 and CMC were used with different percentages to enhance the texture properties of the final product. The effect of the emulsifying salt mixtures on rheological characteristics (penetration and maximum deformation force) and organoleptic properties were determined.

The blend (5) which contained Cheddar cheese (78.53%), sodium citrate (1.97%), di-sodium phosphate (0.28%), citric acid (0.1%) and Self 363 (0.14%) gained highest score compared with other blends.

INTRODUCTION

The consumption of processed cheese has been increased at the last decades and constitutes an important part of the cheese products marketed in Egypt (Gooda, 1993).

The emulsifying salts play an important role in the manufacture of processed cheese products (Caric *et al*., 1985). They essentially supplement the emulsifying capability of the cheese proteins. Therefore, success of using any emulsifying salt is dependent on their interaction with proteins in cheese blends and any changes in these proteins would need adjusting or changing the type or amount of emulsifying salt used (Abd El-Salam *et al*., 1996).

To solve the problem of unavailable suitable imported emulsifying salts and a huge amount of imported Cheddar cheese, which faced one of food company importation in Egypt, this investigation was carried out to produce processed cheese with a good taste and rheological properties using Cheddar cheese as a sole source of protein and fat beside using food grade emulsifying salts which are available, cheaper, permitted in food industries according to Egyptian low, EEC, FAO and WHO such as sodium citrate, mono-sodium and di-sodium phosphate and carboxy methyl cellulose (CMC).

MATERIALS AND METHODS

Imported Cheddar cheese grade AA, USA, 10 months old, low heat skim milk powder (Belgium), unsalted butter (New-Zealand) and emulsifying salts Self 363 (France), di-sodium hydrogen phosphate, sodium citrate (edible grade, AR), carboxy methyl cellulose (CMC) (El-Nasr, Egypt). Tri-sodium citrate (TSC, AR), SE (Joha) and potassium sorbate (Pfizer) were used.

Chemical analysis:

Fat content of all ingredients and processed cheese were determined by the Gerber's method. pH values were determined using Fisher Accumet pH meter model 810 with combined electrode. Moisture and protein were determined according to APHA (1978).

Microbiological analysis :

Microbiological analysis for processed cheese was carried out as prescribed method for cheese (APHA, 1978).

Different selective media were used to enumerate viable microorganisms. Violet red bile agar for coliforms and acidified potato dextrose agar for yeasts and moulds. Brewers thioglycolate broth medium covered with vaspar was used for detection of clostridia (Gibbs and Freams, 1965).

Rheological measurements :

Penetration :

The penetration was determined by using Precision Universal Penetrometer with time controller (GCA, Precision, Scientific with standard needle CAT No 73520). The weight used on the pin was 20 g in 5 sec. The depth of penetration was measured on a dial calibrated from 0-0.38 in (mm x 10) increments. Ten readings were taken for each sample of processed cheese.

Maximum deformation force :

The Ottawa Texture Measuring System (OTMS) (Canners Machinery Limited, Ontario, Canada) with 900 S Main Frame Dytronic Digital Indicator and Recorder (Model SP, G5P), Ricken Denshi Co. Ltd., Japan. The Kramer shear compression cell (Cat No. CS-1), containing 100 g of processed cheese was used. The Kramer chear force during the deformation was electronically determined and expressed as kg/100 g of sample.

Organoleptic evaluation :

The organoleptic properties score of processed cheese was carried out according to Lees (1975).

Cheese processing :

Cheese was manufactured in industrial scale at one of milk and food companies using Kustner 100 liter kettle (Kustner Freres and Co., Geneva, Switzerland). The empty kettle was first preheated to 95^{o}C before the ingredients were added. The ingredients were mixed at low speed and heated with direct injection of steam until the temperature reached 80^{o}C in about 3 min. The mixing was stopped and the blends of the stirring parts were cleaned. The mixture was then mixed and heated with steam until the temperature reached 85ºC (3 min). The steam was turned off and the cheese was then poured from the kettle into clean dry polystyrene bags, sealed and packaged in carton boxes. The products were cooled overnight at room temperature and held at 4ºC until evaluated.

RESULTS AND DISCUSSION

The first three blends (1, 2 and 3) were designed by the factory using Cheddar cheese, skim milk powder and unsalted butter. These blends were used because of their lack information about processed cheese. The other seven blends were made up using Cheddar cheese as a sole source for protein and fat (Table 1) and had almost the same main composition, but differ from each other in the percentage and the kind of emulsifying salt, as described in Table (2). As mentioned by Caric *et al*. (1985), the success of using any emulsifying salt is dependent on their interaction with proteins in the cheese blends and any changes in these proteins would need adjusting or changing the type or amount of emulsifying salt used.

Table (1): Formulation of different ingredients (%) in various blends.

Ingredient	Blend No.									
	1	2	3	4	5	6	7	8	9	10
Cheddar cheese	69.61	69.86	73.71	78.71	78.53	78.61	78.49	78.72	78.80	79.00
Skim milk powder	11.04	11.18	9.90	-	-	-	-	-	-	-
Unsalted butter	2.10	-	-	-	-	-	-	-	-	-
Emulsifiers	0.66	2.00	0.88	2.00	2.49	2.62	2.34	2.98	2.77	2.77
Potassium sorbate	-	-	0.11	0.16	0.15	0.15	0.15	0.15	0.15	0.15
Salt	-	-	-	0.60	0.50	0.50	0.50	0.50	0.50	0.50
Water	16.57	16.96	15.40	18.71	18.11	18.20	18.29	17.78	17.87	17.87

Table (2): Emulsifying salts used in the blends (%).

Emulsifying salts	Blend No.									
	1	2	3	4	5	6	7	8	9	10
TSC	0.66	2.00	0.66	-	-	-	-	-	-	-
SE	-	-	-	2.00	-	-	-	-	-	-
Sodium citrate	-	-	-	-	1.97	1.96	1.96	1.96	1.97	1.97
Mono-sodium phosphate	-	-	-	-	-	-	-	-	-	0.14
Di-sodium phosphate	-	-	-	-	0.28	0.28	0.28	0.28	0.28	0.14
Citric acid	-	-	0.22	-	0.10	0.10	0.10	0.10	0.10	0.10
Self 363	-	-	-	-	0.14	0.28	-	0.14	0.14	0.14
CMC	-	-	-	-	-	-	-	0.50	0.28	0.28

Mono and di-sodium phosphate are commonly used in the industrial production of processed cheese because of their buffering action and the ability to combine with calcium which imparts a high degree of stability and rigidity to casein complex. Citric acid and sodium citrate was used to adjust the pH of the blends beside covering the slight bitter flavour which found in imported Cheddar cheese.

From Table (3), it is clear that the blends 1, 2 and 3 are different than the other blends in fat/protein, moisture and fat/dry matter, while the other blends contained similar fat/protein, moisture and fat/dry matter ratios. The pH of the blends ranged from 5.45 to 5.70, depending on the amount of citric acid and other emulsifying salts. Mayer (1973) mentioned that processed cheese with a firm body should have a pH value of 5.7. Processed cheese prepared from Cheddar cheese with skim milk powder and low percentage of emulsifying salts had a hard texture indicated by lower penetration value and higher maximum deformation force (MDF), compared with those prepared from Cheddar cheese only, that is related to the fat/D.M ratio. Kokini and Dikie (1982) found that the spreadability is inversely related to shear stress on the surface of the knife, consequently processed cheese has low Kramer's force deformation would have good spreadability properties. Therefore, the blend No. 5 has the best texture properties followed by blends No. 9 and 10 from the point of texture view.

Table (3): Compositional quality and rheological properties of the processed cheese.

Properties	Blend No.									
	1	2	3	4	5	6	7	8	9	10
Fat/protein	1.18	1.10	1.23	1.36	1.36	1.36	1.36	1.36	1.36	1.37
PH	5.60	5.70	5.45	5.63	5.52	5.49	5.50	5.47	5.50	5.53
Moisture	41.29	41.48	41.11	45.68	45.24	45.18	44.31	44.83	44.97	44.97
Dry matter	58.71	58.52	58.89	54.32	54.76	54.82	54.69	55.17	55.03	55.03
Fat	24.90	24.27	27.78	27.18	27.19	27.16	27.23	27.26	27.33	27.33
Fat/D.M	42.42	41.47	47.18	50.07	49.66	49.54	49.79	49.42	49.67	49.67
Penetration	110.80	102.30	112.50	120.20	135.10	125.70	98.80	118.50	129.50	128.30
M.D.F*	47.10	48.92	47.12	44.18	37.41	40.92	48.15	46.79	42.00	42.21

*** M.D.F = Maximum deformation force**

The relation between texture parameter and the emulsifying salts revealed that using sodium phosphate salts with sodium citrate and citric acid with a small amount (0.14%) of Self 363 is better than using TSC or SE salts. Also, the addition of CMC (blends 8, 9 and 10) which bounded with water had decreased the penetration value and increased the maximum deformation force. Abd El-Salam *et al*.(1996) found that the addition of higher percentage of emulsifying salt improved the texture of the resultant processed cheese, while Chen *et al*.(1979) found that increased protein content and pH resulted in higher cheese hardness. However, increasing water, fat and NaCl reduced hardness.

The acceptability of processed cheese for human consumption is seriously affected by the organoleptic properties. Body and texture ratings were used as major factors in judging quality (Charlotte *et al*., 1982). Texture is defined by most people in the food industry as the overall physical sensation perceived about a food during mastication (Prentice, 1972). Also, Gupta *et al*.(1984) found that some textural properties of cheese can be characterized by a variety of instruments, but sensory assessments of flavour and textural attributer are required also to assure recognition of factors affecting consumer preferences.

Data in Table (4) revealed that increasing the fat/protein and fat/D.M ratios affected both flavour and texture evaluation of processed cheese. Also, the absence of skim milk powder improved the flavour and colour of product. The low percentage of emulsifying salts, in blends 1 and 3 resulted in lower texture properties and low score, while increasing the percentage of the same salt in blend No. 2 improved the texture characteristics. These results are in agreement with those of Abd El-Salam *et al*.(1996). The evaluation of texture in blends from 5 to 10, in which a mixture of different salts was used, was higher than the first three blends and was slightly varied except in blend No.8, which had a low score may be due to the high percentage (0.5%) of CMC.

Table (4): Organoleptic evaluation of processed cheese.

Blend No.	Flavour 45	Texture 35	Colour 10	General appearance	Total 100	Remarks
1	37.5	27	7	9	80.5	Slightly (firm, cooked, flavour and dark colour)
2	37.0	29	7	9	82.0	Slightly firm
3	38.0	27	8	9	82.0	Crumbly texture
4	40.0	31	9	9	89.0	Mild flavour and good tex.
5	42.0	31	9	9	91.0	Good taste and texture
6	40.0	31	9	9	89.0	Mild flavour and good tex.
7	39.5	28	9	9	85.5	Slight rubbery texture
8	40.5	30	9	9	88.5	Slight rubbery texture
9	41.0	31	9	9	90.0	Mild flavour and good tex. Mild flavour and good
10	41.0	31	9	9	90.0	tex.

Generally, the organoleptic evaluation differed due to the emulsifying salts used, and using sodium citrate, sodium phosphate salts and citric acid improved texture properties.

All suggested blends (from 4 to 10) resultant processed cheese were of high microbiological standards as demonstrated by low coliforms, yeasts and molds counts (not detected in 0.1 g). Also, anaerobic spore formers were not detected in the resultant product. A few colonies of yeast and moulds (30-50 cfu/g) and anaerobic spore formers were detected in blends 1, 2 and 3. These data were a result of good microbiological characteristics of ingredients used and the presence of potassium sorbate beside the use of sodium emulsifier salts. Tanaka *et al*.(1979) stated that blends of sodium emulsifier salts currently employed in cheese processing, achieve certain rheological and functional properties, but also contribute to microbiological safety and stability against spoilage.

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تأثير أملاح الاستحلاب على خواص جبن التشيدر المطبوخ

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تم إستبدال أملاح الاستحلاب التجارية (المستورده) اللازمة لتصنيع الجبن المطبوخ بأخرى متاحه ورخيصه ومسموح بإضافتها مثل سترات الصوديوم (الملح الرئيسى) بالإضافة إلى أحادى وثنائى فوسفات الصوديوم، حمض الستريك، Self 363 و CMC، التى يمكن استعمالها بنسب مئوية مختلفة لتحسين خواص التركيب فى الجبن النهائى. وقد تم تصنيع الجبن المطبوخ بإستخدام هذه الأملاح على نطاق تصنيعى كبير. وقد تم تقدير تأثير مخاليط أملاح الاستحلاب المستخدمة على خواص الجبن الريولوجية (الإختراق،أقصى قوة لتغيير الشكل Maximum deformation force) وكذلك التقييم الحسى.
أظهرت الخلطة رقم (5) والتى تحتوى على جبن تشيدر 78.53%، سترات صوديوم 1.97%، فوسفات ثنائى الصوديوم 0.28%، حمض ستريك 0.1% و Self 363 0.14% أعلى الدرجات من حيث التقييم الحسى مقارنة بالخلطات الأخرى.