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Composition and some Properties of Processed Cheese Spread Made from Blends Containing different Quantities of The Same Main Ingredients

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ABSTRACT

The attained results revealed that due to the difference in the concentrations of the main ingredients used in making of different blends of processed cheese spreads (PCS) (T_1, T_2, and T_3), the gross chemical composition and certain properties of the resultant fresh PCS were affected. So, moisture and carbohydrates were the highest in case of T_3, fat and fat/DM had the highest values in T_1 while PCS from T_2 contained maximum ($P \leq 0.05$) ash and protein values. Acidity, pH, total volatile fatty acids (TVFA) and SN/TN were significantly affected by the applied treatments, while meltability had values of 1.48 , 1.40 and 1.02 cm ($P \leq 0.05$) in cheese from T_1, T_2 and T_3 respectively. The fresh PCS were of the highest values of hardness, gumminess and chewiness in T_2, whereas T_1 resulted in the minimum corresponding values ($P \leq 0.05$). Springiness and adhesiveness decreased in T_3, T1 and T_2, respectively, whereas the differences in cohesiveness were insignificant ($P > 0.05$). The examined treatments showed no impact on the organoleptic properties of the fresh PCS. Advancing storage period resulted in significant decrease in moisture and carbohydrate contents and significant increase in value of fat, Fat/DM, protein, ash, TVFA, SN/TN and the meltability. Changes in pH and acidity - on storage - were significant only in T_2 and T_3.

Keywords: Different blends, Composition and quality, Processed cheese spread.

INTRODUCTION

As early as 1895 processed cheese (PC) was made without adding emulsifying salts (ES), but in 1911PC was invented in Switzerland by Gerber and Stetter who used Swiss cheese and sodium citrate as ES to produce a smooth homogeneous product. This was followed by developing of PC in the USA by J. L. Kraft who processed Cheddar cheese with citrates and orthophosphates. However, it was reported that texture, meltability and quality of PC are greatly affected by many factors such as pH, moisture, degree of shear, processing time and temperature, cooling rate and type and concentration of ES (Caric *et al*., 1985; Kapoor and Metzger, 2008; Caric and Kalab, 1993; Fox *et al*., 2000 and Salek *et al.*, 2015). Impact of the prementioned factors was given - in details- by Caric *et al*. (1985), Fox *et al*. (2000) and Salek *et al.* (2015).

Selection of natural cheese (NC) of different ages and maturity is also unique affecting factor. Kapac (1970) used Kachkaval cheese for making PC while Tamime *et al*., (1990) and Pinto *et al*., (2007) used Cheddar cheese. In this respect, Dimitreli and Thomareis (2004) prepared blends containing Gouda cheeses for making PC. In Egypt, Ras cheese was also used by El-Sayed *et al.* (1997) and Awad *et al.* (2003).

Recently different alternatives for NC were introduced for making PC such as acid or rennet casein (Abou El-Nour 2003 and Lee *et al* .2004), Calcium or sodium caseinate (Gouda *et al*.1985, Abd El Kader 2017), whey protein preparations(Abd El-Salam *et al*.1997; Abd Elkader , 2017) and total milk protein or casein co-precipitate (Shazly *et al*.2008)

In the present study, a combinations of milk protein concentrate (MPC), skim milk powder (SMP), Cheddar cheese and butter with different quantities were applied in making PC aiming to study their effects on composition, properties and quality of the resultant product. Impact of storage was also taken into consideration.

MATERIALS AND METHODS

The main ingredients used for preparation of the processed cheese spread (PCS) blends were kindly obtained from Green Fields Dairy Factory, Kafr El-Sheikh governorate, Egypt. These ingredients included milk protein concentrate, MPC (Australia) , skim milk powder, SMP (Finland), Cheddar cheese, CC (Newzealand) and butter (Newzealand). Emulsifying salt, ES (Joha S4 , Germany) containing poly and diphosphate, xanthan gum, XG (E-415, China), guar gum, GG [E-412, India), meyprogen (Jo-73, Denmark), salt andnisin (E- 234, China) were also kindly supplied by the prementioned Egyptian Dairy factory.

Making processed cheese spreads was carried by calculating the concentrations of the required ingredients as given by Meyer (1973), Dimitreli and Thomareis (2004), whereas the procedure of Ibraheem (1980) was followed for making PCS at 85°C/8min using a double Jacket pan. The prepared product was filled at the same temperature into air tightly closed plastic jars before storage at 5±1°C for 6 months. The examined blends were consisted of the

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following ingredients: Treatment 1: (2%MPC+ 15% SMP+ 7% Cheddar cheese+ 24.5% butter+ 2.8% emulsifying salt (S4)+ 0.8% salt + 0.1% xanthan gum 0.1%+ guar gum+ 0.1% myprogene+ 0.1% potassium sorbate+ 0.03% nisin).

Treatment 2: (5% MPC+ 10.5% SMP+ 11% Cheddar cheese+ 23% butter+ 2.8% emulsifying salt (S4)+ 0.8% salt+ 0.1% xanthan gum+ 0.1% guar gum+ 0.1% myprogene+ 0.1% potassium sorbate+ 0.03% nisin). Treatment 3: (6% MPC+ 6% SMP+ 18% Cheddar cheese+ 18% butter+ 2.8% emulsifying salt (S4)+ 0.8%salt+ 0.1%xanthan gum+ 0.1% guar gum+ 0.1% myprogene+ 0.1% potassium sorbate+ 0.03% nisin).

Samples of PCS were analysed when fresh and during storage period for moisture (air oven at 105°C), fat (Gerber method) total and soluble nitrogen (micro-Kjeldahl method) and salt as given by AOAC (2010). Ash content was measured as mentioned by Hagrass (1974), whereas carbohydrate (lactose) content was calculated from the following equation:

Carbohydrate = Total solids - (Fat + Protein + Ash).

The method described by Ling (1963) was applied for acidity (as lactic acid) determination, while pH meter (Jenway 3510 Uk) was used for pH measurement.

The PCS samples were also analysed for total volatile fatty acids, TVFA (Kosikowski, 1978), meltability (Olson and Price, 1958) and for the rheological attributes (Texture profile analysis, TPA). TPA was carried out using a Universal Testing Machine (verginia, USA), while calculations were done from the attain profile (Bourne, 1978).

Organoleptic properties of the examined treatments of PCS were carried as described by Meyer (1973) by 13 panelists from the staff members of Dairy departments belonging to Fac. Agric., kafr El-Sheikh Univ. and Food Tech. Res. Inst.

Statistical analysis of the examined treatments of PCS was done by the SPSS, statistical software using one-way ANOVA. Analysis of variance and Duncan's test as well as average and standard error were carried out using SPSS computer program (SPSS, 2016; version 24) at $p \leq 0.05$.

RESULTS AND DISCUSSION

Results revealed in Table (1) show the gross chemical composition of processed cheese spread (PCS) when fresh and during storage, as affected by using different blends (T_1, T_2 and T_3) which contain the same main ingredients but in different concentrations. The combined impact of such ingredients was greatly affected the composition of the resultant PCS. Moisture and carbohydrate contents were the highest in fresh cheese made from T_3 with corresponding values 59.52 and 5.67 % respectively .Significant lower values were recorded for T_1 being 57.34 and 5.09.and 56.95 and 4.88 % for T_2 in order.

Decreasing the amount of the used butter from 24.5 % (T_1) to 23.0 (T_2) and 18.0% (T_3) may be the main factor responsible for the decrease of the corresponding contents of fat and fat/dry matter in the examined different treatments (T_1, T_2 and T_3) of PCS made from. Fresh PCS of T_2 characterized with the highest ($P \leq 0.05$) protein and ash contents with corresponding values of 11.5% and 4.12, respectively, whereas the minimum values of 10.11% and 3.82 were recorded in T_3 in order. Salt content was not affected in the tested treatments (Table 1).

Data obtained in Table (1) show gradual and significant decrease with respect to moisture during storage period, which had values of 56.51, 56.08 and 58.69 % at the end of storage, PCS in treatments T_1, T_2 and T_3, in order. Such decrease could be attributed to loss of some moisture and might be responsible for the corresponding increase in fat /dry matter since the values were 53.42, 52.86 and 52.08 % at the end of storage period. Protein and ash followed the same significant increase during storage of PCS, while carbohydrate took the opposite trend. This was true in all PCS prepared from different blends (T_1, T_2 and T_3) and could be also due mainly to loss in moisture and development of acidity from lactose in case of carbohydrate content.

Table 1. Gross Chemical Composition (%) of Fresh and Stored Processed Cheese Spread (PCS) made from Different Blends of Treatments 1, 2 and 3 (Average ± SE from 3 replicates).

Treatments*	Storage (mo.)	Moisture	Fat/Dm	Protein	Ash	Carbohydrate	Salt
	0	57.34 ± 0.04^{Ab}	52.94 ± 0.15^{Ba}	11.04 ± 0.04^{Cb}	3.94 ± 0.02^{Cb}	5.09 ± 0.08^{Ab}	1.13 ± 0.03^{Aa}
T_1	3	56.93 ± 0.04^{Bb}	53.13 ± 0.14^{ABa}	11.42 ± 0.04^{Bb}	4.15 ± 0.02^{Bb}	4.61 ± 0.08^{Bb}	$1.17\pm0.03^{A\,a}$
	6	56.51 ± 0.04^{Cb}	53.42 ± 0.14^{Aa}	11.83 ± 0.04^{Ab}	4.37 ± 0.02^{Ab}	4.06 ± 0.08^{Cb}	$1.21\pm0.04^{A\,a}$
	0	56.95 ± 0.03^{Ac}	52.36 ± 0.08^{Bb}	11.50 ± 0.04^{Ca}	4.12 ± 0.05^{Ca}	4.88 ± 0.05^{Ac}	1.14 ± 0.01^{Ca}
T_2	3	56.52 ± 0.02^{Bc}	52.57 ± 0.07^{Bb}	11.92 ± 0.03^{Ba}	4.34 ± 0.05^{Ba}	4.37 ± 0.04^{Bc}	1.18 ± 0.01^{Ba}
	6	56.08 ± 0.03^{Cc}	52.86 ± 0.10^{Ab}	12.35 ± 0.04^{Aa}	4.57 ± 0.06^{Aa}	3.79 ± 0.05^{Cc}	1.22 ± 0.01^{Aa}
	0	59.52 ± 0.02^{Aa}	51.58 ± 0.05^{Cc}	10.11 ± 0.04^{Cc}	3.82 ± 0.01^{Cc}	5.67 ± 0.03^{Aa}	1.20 ± 0.05^{Ca}
T_3	3	59.09 ± 0.01^{Ba}	51.84 ± 0.03^{Bc}	10.47 ± 0.05^{Bc}	4.03 ± 0.02^{Bc}	5.20 ± 0.03^{Ba}	1.24 ± 0.05^{Ba}
	6	58.69 ± 0.01^{Ca}	52.08 ± 0.03^{Ac}	10.85 ± 0.05^{Ac}	4.24 ± 0.01^{Ac}	4.70 ± 0.03^{Ca}	1.28 ± 0.06^{Aa}

***Treatment 1: (2% MPC+ 15% SMP+ 7% Cheddar cheese+ 24.5% butter+ 2.8% emulsifying salt (S4)+ 0.8% salt+ 0.1% xanthan gum+ 0.1% guar gum+ 0.1% myprogene+ 0.1% potassium sorbate+ 0.03% nisin).**

Treatment 2: (5% MPC+10.5% SMP+ 11% Cheddar cheese+ 23% butter+ 2.8% emulsifying salt (S4)+ 0.8% salt+ 0.1% xanthan gum+ 0.1% guar gum+ 0.1 % myprogene+ 0.1% potassium sorbate+ 0.03% nisin).

Treatment3: (6% MPC+ 6% SMP+ 18% Cheddar cheese+ 18% butter+ 2.8% emulsifying salt (S4)+ 0.8% salt+ 0.1% xanthan gum+ 0.1% guar gum+ 0.1% myprogene+ 0.1% potassium sorbate+ 0.03 % nisin).

-Averages with different small superscripts (a, b...etc) due to the applied treatments differed significantly ($P \leq 0.05$).

-Averages with different capital superscripts (A, B etc.) due to storage period differed significantly ($P \leq 0.05$).

As shown in Table (2) acidity values of 0.98, 1.00 and 1.10% were gained in fresh cheese prepared from blends 1, 2 and 3, which contain 7, l1 and 18 % mature Cheddar cheese (9mon. old), respectively. Fresh PCS (T1) had of the lowest pH. A gradual increase in acidity and decrease in pH were recorded during storage, with

significant changes ($P \leq 0.05$) in case of T_2 and T_3. Total volatile fatty acids (TVFA) and SN/TN varied significantly due to the applied treatments and with advancing storage. Such differences-on storage- could be attributed to activity of heat-stable lipolytic and proteolytic enzymes in order.

Such changes in most parameters of PCS during storage came in agreement with those given by Abd El-Salam *et al.,* 1997; kebary *et al*., 2001; Abdel Raziq and Yousif, 2010 and Abdel Kader 2017.

Meltability is considered an important factor affecting the quality of PCS. Table (2) shows that this property was significantly affected by the composition of the blends used in making PCS, and by the length of the storage period. Treatment 1 of the tested cheese was characterized with the highest meltability, followed by those of T_2 and T_3, respectively. This was true in fresh and stored PCS samples but was significantly ($P \leq 0.05$) increased during storage.

Table 2. Changes in Certain Parameters During Storage of Process Cheese Spread (PCS) Made from Different Blends (Average ± SE from 3 treatments)

Treatments*	Storage (mo.)	Acidity (%)	pH	TVFA**	SN/TN (%)	Meltability (cm)
	0	$0.98\pm0.04^{A\,b}$	$5.97\pm0.02^{A\,b}$	$40.19\pm0.08^{C\,b}$	48.55 ± 0.30^{Ca}	1.48 ± 0.04^{Ca}
T_1	3	$1.01\pm0.04^{A\,b}$	$5.93\pm0.02^{A\,b}$	$42.82\pm0.11^{B\,b}$	50.84 ± 0.40^{Ba}	3.40 ± 0.07^{Ba}
	6	$1.04\pm0.04^{A\,b}$	$5.78\pm0.02^{B\,b}$	$45.72\pm0.09^{A\,b}$	53.51 ± 0.50^{Aa}	8.08 ± 0.11^{Aa}
	0	$1.00\pm0.02^{B\,b}$	6.03 ± 0.01^{Aa}	43.20 ± 0.37^{Ca}	42.22 ± 0.35^{Cb}	1.40 ± 0.05^{Cb}
T_2	3	$1.04\pm0.02^{AB\,b}$	5.93 ± 0.01^{Ba}	45.70 ± 0.54^{Ba}	44.39 ± 0.26^{Bb}	3.08 ± 0.04^{Bb}
	6	$1.08\pm0.02^{A\,b}$	5.83 ± 0.02^{Ca}	49.10 ± 0.46^{Aa}	46.39 ± 0.44^{Ab}	7.08 ± 0.02^{Ab}
	0	1.10 ± 0.00^{Ca}	5.99 ± 0.04^{Aab}	37.20 ± 0.58^{Cc}	43.67 ± 0.20^{Cc}	1.02 ± 0.07^{Cc}
T_3	3	1.14 ± 0.00^{Ba}	5.88 ± 0.01^{Bab}	39.70 ± 0.58^{Bc}	46.95 ± 0.29^{Bc}	1.92 ± 0.02^{Bc}
	6	1.18 ± 0.01^{Aa}	5.79 ± 0.02^{Cab}	42.50 ± 0.69^{Ac}	50.59 ± 0.77^{Ac}	4.84 ± 0.02^{Ac}

*** See footnote of Table (1) for details.**
**** Ml 0.l N-NaOH/100g PCS.**

The highest meltability in T_1 (1.48cm), and the lowest were the values of hardness (12.25 N), Gumminess (8.4 N) and chewiness (46.82 Mj) as shown in Table (3). It could also be seen that the prementioned rheological properties had the lowest values in case of PCS fromT_1which was made from blend containing the lowest quantity of milk protein concentrate (MPC) and Cheddar cheese and the highest quantity of skim milk powder (SMP). More researches are needed to reveal the impact of such ingredients on the rheological properties of PCS.

Table 3. Texture Analysis Parameters of Fresh Processed Cheese Spread (PCS) Made from Different Blends (Average± SE of 3 replicates)

Treatments	Hardness (N)	Gumminess (N)	Springiness (MM)	Cohesiveness(%)	Chewiness (MJ)	Adhesiveness (MJ)
T_1	$12.25\pm.03^{c}$	8.40 ± 0.00^{b}	6.32 ± 0.01^{a}	0.43 ± 0.03^{a}	46.82 ± 3.70^{b}	87.14 ± 0.29^{b}
T_2	$22.25\pm.43^{a}$	12.25 ± 0.43^{a}	5.55 ± 0.09^{b}	0.43 ± 0.00^{a}	68.04 ± 3.47^{a}	84.73 ± 0.48^{b}
T_3	$16.10\pm.29^{b}$	9.10 ± 0.35^{b}	6.40 ± 0.22^{a}	0.44 ± 0.01^{a}	58.20 ± 4.19^{ab}	93.54 ± 2.82^{a}

*** See footnote of Table (1) for details.**

Generally, the rheological properties are affected by several factors such as pH, SN, fat, moisture and the state of protein network. The correlation coefficient between milk constituents and rheological properties of soft cheese was given by Mehanna *et al*. (2014). However, such increase in quantities of MPC and Cheddar cheese and the decrease in quantity of SMP seem to have slight effect ($P>0.05$) on the organoleptic properties of the fresh PCS (Table 4) since the scores given for appearance, body and texture and flavor were always slightly higher in cheese made from T_3 than PCS made from T_1 and T_2.

Table 4. Organoleptic Properties of Fresh Processed Cheese Spread (PCS) as Affected by the Applied Treatments Made from Different Blends. (Average ± SE from 13 panelists)

Treatment	Appearance (20)	Body & texture (40)	Flavour (40)	Total (100)
T1	16.31 ± 0.58^{a}	35.08 ± 1.06^{a}	35.15 ± 0.71^{a}	86.54 ± 1.89^{a}
T2	17.00 ± 0.48^{a}	36.08 ± 0.96^{a}	35.92 ± 0.76^{a}	89.00 ± 2.02^{a}
T3	17.08 ± 0.57^{a}	36.31 ± 0.87^{a}	36.38 ± 0.80^{a}	89.77 ± 2.05^{a}

*** See footnote of Table (1) for details.**
-Averages with small superscripts due to the applied treatments differed significantly ($P \leq 0.05$).

CONCLUSION

In conclusion, the combined impact of quantities of the main ingredients used for making PCS should be taken into consideration besides the cost of using them in making a good quality product.

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تركيب و بعض خواص معجون الجبن المطبوخ المصنع من مخاليط تحتوي علي كميات مختلفه من نفس مكونات المخلوط الاساسيه

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اهتمت هذه الدراسة بتصنيع معجون الجبن المطبوخ من ثلاث مخاليط 1, 2, 3 اختلفت فقط في نسب المكونات الأساسية وهي مركز بروتين اللبن وجبن تشدر المسوي واللبن الفرز المجفف والزبد حيث كانت النسب 2, 7, 15, 24.5 % علي التوالي للمخلوط رقم (1) , 5, 11,5, 10,5, 23 % للمخلوط رقم (2) , 6 , 18, 6, 18 % للمخلوط رقم 3 علي التوالي. أوضحت نتائج تحليل المنتج الطازج أن المحتوي من الرطوبه والكربوهيدرات كان الأعلي في منتج المخلوط رقم (3) في حين ان المحتوي من الدهن و الدهن/ الماده الجافه كان الأعلي في المنتج المصنع من المخلوط رقم (1) وكانت قيم الرماد والبروتين الأعلي في منتج المخلوط رقم (2) . وتأثرت أيضا قيم الحموضة والرقم الهيدروجيني والأحماض الدهنيه الطياره الكليه والنيتروجين الذائب / النيتروجين الكلي تأثيرا معنويا بتركيب المخلوط بينما كان للقابليه للإنصهار قيما تساوي 1,48 , 1,4, 1,02 سم للمعجون من المخاليط 1، 2، 3 علي التوالي وصاحب ذلك قيما أعلي للصلابه , الصمغيه, القابليه للمضغ, في المنتج المصنع من المخلوط رقم (2) في حين كانت قيم الصفات الريولوجيه الثلاث المذكوره اقل قيم عند استخدام المخلوط رقم (1). اما قيم صفات الليونه ودرجة الإلتصاق فتناقصت مع ترتيب المخاليط (3) ثم (1) ثم (2) بينما لم تتأثر درجة التماسك ولا الخواص الحسيه بتركيب المخاليط الثلاثه المذكوره. أما بخوص تأثير التخزين فقد أدي التخزين المبرد لمدة ستة أشهر الي تناقص قيم الرطوبه والكربوهيدرات وزياده معنويه في قيم الدهن، الدهن/ الماده الصلبه ، البروتين، الرماد، النيتروجين الذائب / النيتروجين الكلي، الأحماض الدهنيه الطياره الكليه والقابليه للإنصهار في حين كان هناك زياده معنويه إحصائيا في الحموضه وتناقصا في الرقم الهيدروجيني للمنتج المصنع من المخاليط رقم (2) و (3) فقط.