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THE USE OF A BLEND OF MILK INGREDIENTS AND DIFFERENT PALM OIL FRACTIONS IN PROCESSED CHEESE FORM

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ABSTRACT

The objective of this research was to study the effect of using unhydrogenated palm oil fractions on processed cheese properties. Five treatments of processed cheese were manufactured using hydrogenated palm kernel oil (HPKO), palm kernel olein (PKO), double fractionated palm olein (DFPO), mixture of HPKO and PKO (1:1) and mixture of HPKO and DFPO (1:1).

Results showed that using of PKO and DFPO slightly decreased pH values of processed cheese and had no effect on moisture, fat, TN and salt contents. PKO cheese was lighter whereas DFPO cheese was more yellowish as compared with other treatments. Addition of DFPO to formula of processed cheese decreased the texture profile analysis hardness and increased the meltability values. The scores of sensory evaluation of HPKO and PKO cheeses were similar and higher than those of DFPO cheese.

It is suggested that processed cheese can be produced by using palm kernel olein instead of hydrogenated palm kernel oil.

Keywords: Palm Oil- palm kernel olein -Processed cheese.

INTRODUCTION

In Egypt processed cheese is one of the most popular varieties of cheese, particularly, among the children due to its palatability, high nutritive value and spreadability. The ingredients used in processed cheese manufacture different from plan to other but they usually consists from aged cheese such as Ras cheese , young cheese or Quark cheese, butter oil , hydrogenated palm oil , skim milk powder and emulsifying salts (Hamad and Ismail 2009). The selection of base cheese is critical in the manufacture of processed cheese. The base cheese serves to provide body and texture as well as flavor. Body and texture is generally achieved with young cheese, and flavor with aged cheese. Therefore, a blend of young and aged cheese is required (Kosikowski and Mistry, 1997). Excessive amounts of young cheese will lead to poor flavor, whereas excessive amounts of aged cheese will produce poor body.

On the other hand, palm kernel oil is derived from the palm tree, but differs from palm oil in that it is extracted from the palm tree's fruit seeds. It is often hydrogenated, which converts it into a trans fat. Trans fats are considered to be unhealthy due to its negative effect on cholesterol levels. Also, palm kernel oil contains a high level of saturated fat, which can be unhealthy if consumed in large amounts (Balch 2003). On the contrary, McNamara (2010) stated that non- hydrogenated palm fruit or kernel oils

contain a variety of fats, vitamins and nutrients, but NO trans-fatty acids. Trans-fatty acids are found predominantly in hydrogenated oils.

The present study was undertaken to investigate the suitability of unhydrogenated palm oil fractions in manufacture of processed cheese and evaluate the chemical, rheological and sensory properties of the resultant cheese.

MATERIALS AND METHODS

Materials:

Four months old Cheddar cheese used in this study was obtained from Cheddar cheese factory (Fonterra LTD, Auckland, New Zealand) whereas fresh Ras and soft cheeses were obtained from private cheese production laboratory in Domiatt Governorate. Skim milk powder (Pasteurized spray processed, Grade A, Low Heat) was obtained from Dairy America Factory, California, USA. Palm kernel oil fractions (Interfiling Fat Cocoa butter substitute) were obtained from Intercontinental Specialty fats Sdn. Bhd-Malaysia. The chemical composition of Cheddar, Ras and soft cheeses was indicated in Table 1. Joha® SE & S9 emulsifying salts (BK Giulini Chemie GmbH, Landenburg, Germany) was obtained from the local market whereas Egy Dairy stabilizer was obtained from The Egyptian Company for Dairy Products and Food Additives, 10th of Ramadan city, Egypt. Other ingredients were citric acid, potassium sorbate and nisin (Pharmacentical Company, Pfizer).

Methods:

Preparation of denatured whey proteins:

Ras cheese whey (pH 5.97) was heated to 95°C for 10 min., cooled and the flocculated denatured whey proteins were recovered by straining through cloth bags for three hrs. The precipitate was transferred to wooden frames and pressed overnight.

Table 1. Chemical composition of ingredients used in processed cheese making

Ingredients	pH	TS %	Fat %	Protein %	Salt %
Cheddar cheese	**4.91**	**64.12**	**33.9**	**27.24**	**3.85**
Ras cheese	**5.25**	**61.33**	**26.4**	**19.40**	**1.92**
Soft cheese	**6.51**	**34.84**	**17.9**	**13.21**	**3.11**
Denatured whey proteins	**5.12**	**24.18**	**0.8**	**17.08**	**6.87**

Manufacture of processed cheese spread:

The manufacture of processed cheese spread was carried out as described by Meyer (1973). The amounts of ingredients for manufacture were calculated in order to fulfill the legal standard specification of the final product (~45%) fat/dry matter (F/DM). All the calculated ingredients were shown in Table 2. Processed cheese was made as follows:

Cheddar and Ras cheeses were cut into small-pieces with a sharp knife. The pieces were fed into electric mincer to convert them into finally

minced cheese. Each formulation of blends (except nisin) was placed in the processing kettle (Stephans Universal machine, Switzerland) of 2.5 kg capacity and heated by direct steam injection at pressure of 3-5 kg/cm2 under continuous stirring, at a temperature of 90-94°C for 10 minutes, and the melted cheese was maintained at such temperature for 3 minutes and then nisin and citric acid were added to adjust the pH of the final product to approximately 5.6. Cheese was poured into 0.5kg pouches and stored at 5°C overnight. Process cheese blocks were then repacked, vacuum-sealed, and stored again at 5°C. The compositional, rheological and organoleptical analyses were determined at zero time and then after 30, 60 and 90 days of storage.

Cheese analyses:

Moisture, total nitrogen, and ash contents of various ingredients and processed cheese samples were determined in triplicate (AOAC, 1990). The fat content of samples was determined by the Babcock-fat test described by Bartels *et al.,* (1987). Cheese pH was measured using a Spear Tip combination electrode (VWR Scientific, Montreal, QC, Canada). Salt contents of ingredients were estimated using Volhard method according to Richardson (1985).

Table 2. Blend formulations used to manufacture processed cheese

Treatment A (control)	Treatment B	Treatment C	Treatment D	Treatment E	%
Hydrogenated Palm Kernel Oil (HPKO)	Palm Kernel Olein (PKO) 50% + HPKO 50%	PKO 100%	Double Fractionated Palm Olein (DFPO) 50% + HPKO 50%	DFPO 100%	16
Cheddar cheese					16
Fresh Ras cheese					8
Denatured whey protein					15
Soft white cheese					34
Skim milk powder (nonfat dry milk)					4
Emulsifying salts					3
Water					4
Total					100
Salt (NaCl)					0.2
Stabilizer					0.6
Potassium sorbate					0.4
Nisin					0.16
Citric acid for adjusting pH of the product to 5.6					

Physical measurements of processed Cheese:

The colour of the produced processed cheese spreads was measured using Hunter Colorimeter Model D2s A-2 (Hunter Assoc. Lab. Inc. Va, USA) following the instruction of the manufacturer (Hunter colorimeter, 1976). The instrument was first standardized using a white tile (top of the scale) and a black tile (bottom of the scale). A specimen of the cheese (flate layer) was placed at the specimen port; the trisimlus values of the colour namely; L, a and b were measured where: L value represents darkness from black (0) to white (100), a; value represents colour ranging from red (+) to green (-) and b value represents yellow (+) to blue (-).

Determination of Texture Profile hardness:

Texture profile analysis (TPA) compression was measured using a TA.XT2 Texture Analyzer (Texture Technologies Corp., Scarsdale, NY) equipped with a 25-kg load cell. Samples with a diameter of 16 mm and a height of 17.5 mm were cut from processed cheese blocks using a cork borer and were compressed to 20% of the original height by a 50-mm aluminum cylinder test probe with a cross-head speed of 0.8 mm/s. The TPA-hardness was determined as described by Breene (1975) and is a measure of the unmelted texture of a cheese and describes cheese firmness (Breene, 1975).

Determination of Meltability:

Meltability of cheese was measured in duplicate by using the melting test as described by Olson and Price (1985). A cylinder of cheese sample (15±0.2g) was put in a Pyrex glass tube, 30 mm in diameter and 250 mm long and a reference line was marked on the tube aligned with the front edge of the cheese sample. The tube was immediately placed in horizontal position in an oven at 110°C for 30 min. The distance of flow from the reference line to the leading edge of the melted cheese was quickly measured and recorded in mm as cheese meltability.

Sensory evaluation

The processed cheese was subjected to sensory evaluation for flavour, body and texture, color, appearance and overall acceptability by six experienced judges using the score card recommended by Bureau of Indian Standards (BIS 1982).

RESULTS AND DISCUSSION

Chemical composition of processed cheese:

Compositional analyses of the fresh processed cheese spread and during storage period are given in Table (3). The pH values of fresh processed cheese ranged between 5.95 and 5.86 which fall in the range of pH of processed cheese (Kosikoweski 1978). It is seen that processed cheese made using of unhydrogenated palm oil fractions especially double fractionated palm olein (treatments D and E) was relatively more acidic compared to that made using hydrogenated palm oil (treatment A). The pH values of treatments A, C and E after 30 days of storage were 5.91, 5.89 and 5.81 respectively.

As ripening period advanced, the pH values of cheese in all treatments slightly decreased. This may be due to hydrolysis of the emulsifying salts and/or fermentation of lactose. Similar results were found by Hamad and Ismail (2009).

Table 3. Effect of using various unhydrogenated palm oil fractions on the chemical composition of processed cheese.

Treatments	Storage period (days)	pH	Moisture %	Fat %	Total nitrogen %	Salt (NaCl) %
A	0	5.95	42.92	30.8	3.22	1.94
	30	5.91	42.36	30.8	3.24	1.91
	60	5.88	42.26	30.7	3.24	1.93
	90	5.85	42.11	30.9	3.25	1.92
B	0	5.94	42.50	30.7	3.24	1.95
	30	5.90	42.44	30.7	3.23	1.93
	60	5.86	42.31	30.8	3.25	1.94
	90	5.83	42.13	30.8	3.25	1.91
C	0	5.92	42.89	30.7	3.26	1.91
	30	5.89	42.45	30.9	3.27	1.89
	60	5.85	42.28	31.0	3.27	1.90
	90	5.81	42.14	31.0	3.28	1.91
D	0	5.90	42.91	30.7	3.25	1.92
	30	5.85	42.77	30.8	3.24	1.91
	60	5.81	42.34	30.8	3.26	1.93
	90	5.77	42.24	30.9	3.26	1.92
E	0	5.86	42.84	30.7	3.25	1.91
	30	5.81	42.69	30.8	3.26	1.91
	60	5.77	42.57	30.8	3.27	1.92
	90	5.74	42.43	30.8	3.27	1.92

A: Hydrogenated Palm Kernel Oil (HPKO)
B: Palm Kernel Olein (PKO) 50%+ HPKO 50%
C: PKO100%
D: Double Fractionated Palm Olein (DFPO) 50% +HPKO 50%
E: DFPO100%

The results of the effect of addition of different palm oil fractions on moisture, fat, total nitrogen and salt contents of processed cheese are given in Table 3. There was no effect of incorporation of palm kernel olein (PKO) or double fractionated palm olein (DFPO) at 50 and 100% levels on the chemical composition of fresh processed cheese or during storage period. Moisture contents of treatments A, B, C, D and E after 90 days were 42.11, 42.13, 42.14, 42.24 and 42.43% respectively.

Abd El-Malek and Abd El-Khair (2002) stated that replacing of milk fat with fractionated hydrogenated palm kernel oil in UF-Feta cheese producing caused a significant increase in moisture content, while the TS decreased.

During storage period, the moisture content decreased slightly and fat and total nitrogen contents showed slightly increased in all samples. This may be associated with some dehydration during storage (Abd El-Baky *et al.,* 1987).

Colour parameter:

Data in Table (4) illustrated the color of processed cheese as affected by using of different unhydrogenated palm oil fractions in production. Processed cheese made using PKO (treatments B and C) was found to be lighter than the one made using DFPO (treatments D and E). The L-value of samples C and E cheese were 91.63 and 88.51 respectively. For degree of yellowness, DFPO cheese was relatively more yellowish compared to PKO cheddar cheese.

Azzam (2007) made processed cheese spread by replacing 50% milk fat in the base blend with palm oil, palm stearin, coconut or sunflower oil. He found that fresh control cheese was darker than cheeses from other treatments, whereas that containing palm stearin was the whitest followed by that containing palm oil.

The use of different unhydrogenated palm oil fractions affected the pH (Table 3) of the processed cheese which explains the various colour attributes of cheese from different treatment. pH was reported to play an important role in colour changes of Processed cheese (Caric and Kalab, 1993).

Rheological properties:

The results of rheological properties of processed cheese including texture profile analysis hardness (TPA-hardness) and meltability are shown in Table (4).

Texture results showed the type of palm fat incorporated has an influence on the texture of processed cheese. Addition of palm kernel olein (treatments B and C) slightly decreased the hardness of cheese. On the other hand, when double fractionated palm olein was used, cheese hardness decreased from 370.979 (control) to 315.201 (treatment D) and 291.612g (treatment E) with increase in level of DFPO concentration. So, the produced processed cheese was characterized by a softer texture than those of other treatments.

Table 4. Influence of using of different unhydrogenated palm oil fractions on the color, texture profile and meltability values of fresh processed cheese.

Treatments	Color			TPA-hardness	Meltability (mm)
	L	a	b		
A	90.11	-2.70	14.61	370.979	16
B	90.87	-2.73	14.60	368.024	16
C	91.63	-2.79	14.69	365.867	17
D	89.46	-2.55	14.91	315.201	34
E	88.51	-2.49	15.15	291.612	45

As shown in Table 4, meltability of processed cheese ranged from 16 (control) to 45 mm (treatment E). There were no differences between meltability of control (16 mm) and PKO processed cheese (16 and 17 mm) cheeses, but DFPO cheeses exhibited pronounced higher meltability (34 and 45 mm) than those of other cheeses.

Sensory Evaluation:

Table (5) shows the average scores of different sensory attributes of processed cheese with different palm oil fractions content. There were no differences in the appearance & color and body & texture scores of the process cheese from different treatments. The most obvious differences were found in the flavour attributes. With the use of double fractionated palm olein (DFPO), the flavour scores of obtained cheese were lower than those of control and PKO cheeses. The flavour scores of cheese after 15 days of storage were 45, 44, 44, 40 and 38 for treatments A, B, C, D and E

respectively. Storage of processed cheese up to three months decreased the total scores of sensory evaluation of all treatments including the control. This decrease could be related to the changes in the chemical properties of cheese samples during storage (Abd El-Salam *et al.,* 1996 and Hamed *et al.,* 1997). These data agree with findings of Awad and Wafaa (2010) who mentioned that the acceptability of processed cheese decreased with extending the storage period.

Table 5. Sensory evaluation of processed cheese

Treatments	Storage time (days)	Appearance & Color (15)	Body & Texture (35)	Flavour (50)	Total (100)
A	0	13	33	44	90
	30	13	33	45	91
	60	12	33	43	88
	90	12	32	43	87
B	0	13	33	44	90
	30	13	33	44	90
	60	13	33	44	90
	90	12	33	43	88
C	0	13	33	44	90
	30	13	33	44	90
	60	13	32	43	88
	90	12	33	43	88
D	0	13	33	41	87
	30	12	33	40	85
	60	13	32	37	82
	90	12	32	37	81
E	0	12	33	40	85
	30	13	32	38	83
	60	13	32	36	81
	90	13	32	36	81

CONCLUSIONS

From the results of this study, it can be concluded that processed cheese with good chemical properties, meltability, desired body and texture characteristics, and improved sensory evaluation can be prepared by using palm kernel olein instead of hydrogenated palm kernel oil.

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استخدام مخلوط من مكونات لبنية و انواع مختلفة من مشتقات زيت النخيل في صناعة الجبن المطبوخ

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تم في هذا البحث دراسة تأثير استبدال زيت نوى النخيل المهدرج بآخر غير مهدرج على خواص الجبن المطبوخ. فقد صنعت خمس معاملات من الجبن المطبوخ باستخدام زيت نوى النخيل المهدرج (مقارنة- معاملة 1) وخليط من زيت نوى النخيل المهدرج و زيت أولين نوى النخيل (1:1 معاملة 2) و زيت أولين نوى النخيل (معاملة 3) و خليط من زيت نوى النخيل المهدرج و زيت أولين النخيل المزدوج التجزئة (1:1 معاملة 4) و زيت أولين النخيل المزدوج التجزئة (معاملة 5).

و قد أظهرت النتائج أنخفاض طفيف في قيم الرقم الهيدروجيني للجبن المصنع باستخدام الزيت الغير مهدرج عن جبن المقارنة، في حين كانت نتائج الرطوبة و الدهن و النتروجين الكلي و الملح متشابهة في كل المعاملات. و قد تميز الجبن المصنع باستخدام زيت أولين النخيل المزدوج التجزئة بلون أكثر أصفراراً و انخفاض قيم الصلابة و ارتفاع قيم القابلية للذوبان مقارنة بالمعاملات الأخرى. و كانت نتائج الخواص الحسية متشابهة لكلاً من الجبن المصنع باستخدام زيت نوى النخيل المهدرج أو زيت أولين نوى النخيل إلا أنها كانت أعلى عن تلك الخاصة بالجبن المصنع باستخدام زيت أولين النخيل المزدوج التجزئة. و بناءً على هذه النتائج فأنه يمكن استبدال زيت نوى النخيل المهدرج بزيت أولين نوى النخيل في صناعة الجبن المطبوخ.

قام بتحكيم البحث

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