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ORIGINAL ARTICLES

Production and Quality Evaluation of Processed Cheese Containing Legumes

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ABSTRACT

Processed cheese spreads (PCSs) were made by replacing the hard cheeses in the base blend with lentil paste (LEP) or lupine paste (LUP) or common bean paste (CBP) as dentifrice at ratios of 0 (control), 10, 20 and 30 % and use of coconut oil. The chemical, physical and sensory quality properties of the PCSs were evaluated. The obtained results showed that all treatments showed improvement in the ratio of Na/K as compared with the control. The best percentage of tested legumes paste addition, in general was 10 % for calcium : phosphorus ratio. Spreads made with the LUP were characterized by the highest content of iron between treatments. Legumes processed cheese possessed all the amino acids contained in the control sample. In the processed cheese made with either the LUP or the LEP the total saturated fatty acids decreased and the total unsaturated fatty acids increased. The best treatment for organoleptic quality properties was found to be the LEP processed cheese with all percentages for it, then the LUP processed cheese at 10, 20 % replacement, but the processed cheese that made using the CBP was acceptable only at 10 % replacement. The best treatment was the LEP spreads for oil separation, meltability and penetrometer. It is recommended for manufacture new processed cheeses using 10, 20 and 30% of the LEP, 10 and 20 % of the LUP and 10 % of the CBP, also use the coconut oil with these level of replacements of legume in the processed cheese blends.

Key words: of Processed Cheese, Production and Quality, Legumes

Introduction

Processed cheese is an attractive product that enjoys great popularity. Processed cheese products have been important commercial foods since the early years of this century (Meyer, 1973). It is produced by heating and stirring blends of various natural cheeses, milk proteins, fats, mineral salts and other ingredients in the presence of emulsifying salts (Uhlman, 1985). Also, many unconventional ingredients are currently used for production of processed cheese analogue (Caric and Kalab, 1993 and Fox, 1993). This made it possible to produce processed cheeses differing in consistency, flavour, size and shape. In Egypt, processed cheese products are made mainly from blends containing imported Cheddar and Gouda cheeses as well as locally produced Ras cheese. The imported cheeses are usually stored for a long period, resulting in defects in their flavour and consistency (Mansour *et al.,* 2010) also the imported cheesed make the products very costly. On the other hand, the locally produced Ras cheese requires a ripening of about 4 – 6 months to develop the desired flavour and body characteristics which in turn increases the total capital costs of production. Research attempts are seeking for suitable substitutes to be used instead of Ras cheese and other imported cheeses not only to make the products inexpensive but also to supplement the products with important particles like minerals, vegetable proteins and fat and fiber or flavoured particles. Therefore, the present study was undertaken to gain more knowledge about the performance capability of using three type of legumes as partial substitute for the traditional hard cheese in the manufacture of processed cheese.

Materials And Methods

Materials:

Matured cheddar cheese (12months old) was obtained from Khaled Khoshala Co. for Food Industries & Cooling, Egypt. Ras cheese (1 month old) was obtained from Mariam Co., Giza, Egypt. The Fonterra butter was obtained from Sakr Group Co., Egypt .Kasomel emulsifying salt K2394 provided by International Dairy & Foods Co., (Milk Land). Citric acid, coconut oil and dry legumes including lentil (*Lens esculenta*), lupine (*Lupinus termis*) and common bean seeds (*Phaseolus vulgaris*) were obtained during the season of 2009–2010 from the local markets in Cairo, Egypt.

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Methods:

Preparation of Legumes Paste:

Legumes seeds; common beans, lentils and lupine seeds, were prepared individually to remove the antinutritional factors which naturally occurred in them according to the procedures of Dahiya and Kapoor (1993) and (Griffith *et al*. (1998). Whereas, the pulses were washed and soaked in tap water (1:5 W/V) at ambient temperature (25±5° C) for 24 hrs. whereas, common been and lupine seeds transferred to keep them between moistened cotton layers and allowed to germinate in the dark at ambient temperature for 72 hrs., then the germinated samples were manually decorticated. The yellow lentil seeds and germinated samples of both common been and lupine seeds were autoclaved (at 1.2 bar and 121° C) for 10 minutes and mixed carefully with 1 % Kasomel emulsifying salt until the pulse paste is formed.

Manufacture of Processed Cheese:

Ras and cheddar cheese were milled and mixed with 10, 20 and 30 % of prepared legume's paste , water, coconut oil, citric acid and emulsifying salt and the control blend too, which was without coconut oil or legume's dentifrices but butter by mixer until they were assorted. All blends shown in Table (1). The blends were placed into the processing bath type kettle of 10 kg capacity, a pilot machine at National Research Center. The cheese blends were heated using direct injection of steam at pressure of 1.5 bar. Agitation time of cheese blends was increased in some treatments. The composition of each blend was adjusted for fat, pH and moisture content to obtain a final product with 55 % moisture as a maximum , 50 % F/DM as a minimum and the pH value between 5.2 – 6 to be similar to the processed cheese made traditionally according to the Egyptian Standard Specification (1988). The hot product of processed cheese was manually filled into 40 ml glass cups covered with aluminum foil, cooled and then stored at about 5-7 °C and 25±5°C for analysis .

Chemical and Physical Analysis:

Total solids, fat, total nitrogen and titratable acidity were determined as described by Ling (1963). The ash content was determined according to method of IDF standard method (1964). The salt content was determined according to the procedure of Davies (1932). The pH values were measured using a laboratory digital pH meter model Adwa 1030. Amino acids was determined by Amino acid analyzer LC3000 eppendrof, Germany. Fatty acids content were determined by shimadzu GC/MS- QP5050A. Minerals content were measured using flame ionization by atomic absorption spectrophotometer (model: GBC932AA). Fat content of legume's dentifrice (by Soxhelt method) and fiber content in processed cheeses were determined as mentioned in A.O.A.C. (1990). The samples firmness was measured using a Penetrometer (Koehler Instrument co. Inc., USA) as described by Gupta and Reuter (1993). Oil separation was determined according to the method outlined by Thomas (1973). Meltability of the sample of processed cheese was determined according to Savello *et al*. (1989).

Table 1: Mix composition of the formulated processed cheese spreads.

Raw materials	Blends									
	Control	Lentil-cheese			Lupine-cheese			Common bean cheese		
	%	10%	20%	30%	10%	20%	30%	10%	20%	30%
Ras cheese	28	24.9	22.1	19.9	24.9	22.4	20.2	24.8	21.9	19.7
Cheddar cheese	28	24.9	22.1	19.9	24.9	22.4	20.2	24.8	21.9	19.7
Butter	2.5	-	-	-	-	-	-	-	-	-
Legume paste	-	10	20	30	10	20	30	10	20	30
Coconut oil	-	4.3	6.1	7.5	3.9	5.4	6.6	4.5	6.6	7.9
K- 2394	2	2	2	2	2	2	2	2	2	2
Citric acid	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Water	39.2	33.6	27.4	20.4	34	27.5	20.7	33.6	27.3	20.4
Total	100	100	100	100	100	100	100	100	100	100

K- 2394 : kasomel emulsifying salt (Commercial emulsifying salt)

Sensory Evaluation:

All samples of processed cheese were evaluated organoleptically for the different sensory properties using a hedonic scale of 1-5, whish was designed based on the hedonic scales provided by Caul (1957), Brandt *et al.*(1963) and Ottawa (1977). The sensory evaluation was carried out by the staff members of the Dairy Depart., Fac. of Agric., Al-Azhar University.

3. Statistical Analysis:

Each preparation and measurement was conducted in triplicate. The experimental data were subjected to an analysis of variance for a completely random design using a Statistical Analysis System (SAS Institute, Inc., 2000). Duncan's multiple range tests were used to determine the difference among means at the level of 0.05.

Rasults And Discussion

Chemical Composition of Tasted Processed Cheese Spreads:

Table (2) reveals that there were no significant differences among the control and 10, 20 and 30% LEP, 10 and 20 % LUP and CBP for F/DM. The addition of increasing percentages of the LEP, LUP and CBP decreased the total solid of spreads. The salt in DM content of the cheese spreads decreased with the increase in the percentage of added the LEP and the LUP but increased with the CBP. The addition of increasing percentages of the LEP and the LUP increased the ash contents of spreads. As regard to the protein content of the processed cheese samples, a slight decrease was observed in the total protein content of the final product of processed cheese when a higher level of the LEP was used in the initial blend of such cheese but a slight increase observed when a higher level of the LUP and the CBP was used. But no significant differences among control and 10% concentration all treatments for protein. The addition of legumes paste to the cheese blends added a fiber to processed cheese.

Table 2: Chemical composition of processed cheese made with tested legumes pastes.

Component (%)	Control	Processed cheese containing legumes								
		Lentil paste cheese			Lupine paste cheese			Common been paste cheese		
		10 %	20 %	30 %	10 %	20 %	30 %	10 %	20 %	30 %
Fat	21.50^{BC}	21.17^{BCD}	20.00^{EFG}	19.50^{FG}	21.83^{AB}	22.00^{AB}	22.67^{A}	20.67^{CDE}	20.33^{DEF}	19.17^{G}
T.S	44.08^{A}	43.25^{D}	42.49^{E}	41.44^{G}	43.89^{AB}	43.59^{BC}	42.62^{E}	44.04^{A}	43.47^{CD}	42.18^{F}
F/DM	48.78^{BCD}	48.94^{BCD}	47.07^{CDE}	47.05^{CDE}	49.74^{BC}	50.48^{B}	53.19^{A}	46.92^{DE}	46.78^{DE}	45.44^{E}
Salt	4.25^{A}	4.06^{B}	3.64^{C}	3.41^{D}	2.70^{F}	2.43^{G}	2.12^{H}	2.34^{G}	2.62^{F}	2.93^{E}
Ash	3.61^{G}	4.65^{C}	4.79^{AB}	4.85^{A}	3.92^{F}	4.34^{D}	4.75^{B}	4.18^{E}	3.54^{G}	3.12^{H}
Protein	14.80^{DE}	14.50^{E}	13.60^{F}	13.08^{G}	15.00^{D}	15.68^{B}	16.02^{A}	14.75^{DE}	15.36^{C}	15.83^{AB}
Fiber	0.00^{E}	0.12^{D}	0.20^{C}	0.29^{B}	0.13^{D}	0.29^{B}	0.41^{A}	0.13^{D}	0.19^{C}	0.31^{B}

* Results are the average of three triplicates from the same samples.

* Different superscripts at the same row are significantly different ($P < 0.05$).

Change in The pH Value of Tested Processed Cheese Spreads During Storage:

Data in Table (3) shows that the pH values of the cheeses from the different treatments increased with the increase in the percentage of the addition of legumes. The pH value of the control did not record significant differences during storage at 5±2°C and storage at 25±5°C after 1 month but it slightly decreased when the processed cheese stored at 25±5° C after 2 and 3 months. That difference was probably due to the action of emulsifying salt as Caric *et al*. (1985) and Caric and Kalab (1993) reported. It may be also due to the limited growth and activity of cheese microflora as mentioned by Abd El-Salam *et al*. (1996) and Metwally *et al*. (1996).While the pH values of processed cheese mad by using legumes showed significant differences advanced storage compared to the fresh spreads. These differences may be due to the legumes them selves. The control cheeses that stored at ambient temperature (25±5°C) showed lower pH values than those at refrigerator, while all treatments that stored at ambient temperature showed higher pH values than those at refrigerator. These results confirms that the legumes paste addition increases the pH value.

Change in The Acidity of Tested Processed Cheese Spreads during Storage:

The obtained results for acidity in Table (3) showed that the titratable acidity values of studied treatments decreased regularly throughout storage and with the increase the percentage of legumes paste addition. But the acidity increased in control by storage. The obtained data (Table 3) also sowed that no significant difference found among the cheese with 10 % of the LEP and 10 % of the CBP when they were fresh . also no significant difference found in acidity among the cheese with 10 % of the LEP and 10 % of the CBP after 1 month of storage at 5±2°C and 25±5°C, also after 3 months at 25±5°C. No significant difference found in acidity among the cheese with 20% of the LEP and 20 % of the LUP after 1 month of storage at 5±2°C, also after 3 months at 25±5°C. No significant differences found in acidity among the cheese with 20% of the LEP and 20 % of the

LUP after 2 month, also after 3 months of storage at 5±2°C . No significant differences found in acidity among the cheese with 20 % of the LEP and 10 and 20 % of the LUP after 3 months of storage at 25±5°C.

Minerals Content of Tested Processed Cheese Spreads:

All treatments showed that there was an improvement in the ratio of Na/K as compared with the control whereas the ratio of Na/K decreased in legume processed cheese as in Table (4). Also, the obtained data (Table 4) indicated that the control treatment had the highest sodium content (8.12 ppm) as compared with studied treatments. Also the ratio of Na to K in control was a higher than all treatments. Processed cheese made with either the LEP or the CBP were supplemented with phosphorus content as compared with control. But in that made by using the LUP, the phosphorus content slightly decreased. The calcium content was markedly decreased in all treatments as compared with control, but the LUP cheese was the nearest to the control. The ratio of calcium : phosphorus decreased with the LEP and the CBP addition. We can say that the best percentage of additive of legumes generally was 10% for calcium content and calcium : phosphorus ratio. The CBP and the LUP addition supplemented the cheese with a little quantity of magnesium. The LEP addition supplemented the cheese with iron, but in processed cheese made with the LUP, the iron content slightly decreased.

Table 3: Change in the pH value and acidity of processed cheese spreads made with tested legume pastes during storage period.

The pH value								
Processed cheese	%	Storage period (months)						
			5±2°C			25±5°C		
		fresh	1 month	2 months	3 months	1 month	2 months	3 months
Control		5.40^{Hab}	5.36^{Hab}	5.33^{Hbc}	5.30^{Hbc}	5.34^{Ib}	5.27^{Ea}	5.21^{Gc}
Lentil paste cheese	10	5.45^{Ff}	5.50^{Fe}	5.56^{Ec}	5.61^{Ea}	5.52^{Gd}	5.58^{CDb}	5.62^{Ea}
	20	5.56^{De}	5.59^{Dd}	5.62^{Dc}	5.66^{Db}	5.62^{Ec}	5.65^{Cb}	5.68^{Da}
	30	5.77^{Bf}	5.79^{Be}	5.83^{Cc}	5.85^{Cb}	5.81^{Cd}	5.85^{Bb}	5.88^{Ca}
Lupine paste cheese	10	5.43^{Gf}	5.47^{Ge}	5.51^{Gc}	5.55^{Gb}	5.49^{Hd}	5.52^{DEc}	5.59^{Fa}
	20	5.69^{Cf}	5.77^{Ce}	5.85^{Bd}	5.92^{Bb}	5.78^{De}	5.87^{ABc}	5.94^{Ba}
	30	5.82^{Ae}	5.87^{Ad}	5.95^{Ab}	6.01^{Aa}	5.89^{Bc}	5.96^{Ab}	6.02^{Aa}
Common been paste cheese	10	5.45^{Fe}	5.48^{Gd}	5.53^{Fc}	5.58^{Fa}	5.49^{Hd}	5.55^{CDEb}	5.59^{Fa}
	20	5.51^{Ee}	5.54^{Ed}	5.57^{Ec}	5.61^{Eb}	5.55^{Fd}	5.58^{CDc}	5.63^{Ea}
	30	5.56^{Df}	5.58^{De}	5.62^{Dd}	5.66^{Db}	5.99^{Aa}	5.64^{Cc}	5.67^{Db}
Acidity								
Processed cheese	%	Storage period (months)						
			5±2°C			25±5°C		
		fresh	1 month	2 months	3 months	1 month	2 months	3 months
Control		1.75^{Ae}	2.00^{Ad}	2.25^{Ac}	2.50^{Ab}	2.25^{Ac}	2.50^{Ab}	2.70^{Aa}
Lentil paste cheese	10	1.7^{ABa}	1.61^{Bb}	1.52^{Cbc}	1.4^{Cd}	1.6^{Bb}	1.5^{Cc}	1.48^{Bcd}
	20	1.55^{DEa}	1.38^{DEb}	1.25^{Fcd}	1.11^{Fe}	1.30^{Dbc}	1.21^{Fd}	1.10^{De}
	30	1.35^{Fa}	1.21^{Gb}	1.12^{Gcd}	1.03^{Ge}	1.20^{Ebc}	1.11^{Hde}	0.93^{Ef}
Lupine paste cheese	10	1.61^{CDa}	1.45^{CDb}	1.34^{Dccd}	1.22^{DEef}	1.42^{Cbc}	1.29^{Ede}	1.20^{CDf}
	20	1.52^{DEa}	1.33^{EFb}	1.28^{Efb}	1.18^{EFcd}	1.33^{Db}	1.19^{FGc}	1.11^{Dd}
	30	1.30^{Fa}	1.25^{Fgab}	1.20^{Fabc}	1.15^{EFc}	1.21^{Eabc}	1.12^{GHc}	0.94^{Ed}
Common been paste cheese	10	1.70^{ABa}	1.65^{Bab}	1.60^{Bbc}	1.55^{Bcd}	1.62^{Babc}	1.59^{Bbc}	1.50^{Bd}
	20	1.64^{BCa}	1.51^{Cb}	1.42^{Dcd}	1.27^{De}	1.48^{Cbc}	1.40^{Dd}	1.27^{Ce}
	30	1.48^{Ea}	1.34^{Eb}	1.27^{EFbc}	1.17^{EFde}	1.33^{Db}	1.24^{EFcd}	1.14^{De}

Different superscripts (A, B,...) at the same column are significantly different (P<0.05).
Different superscripts (a, b,...) at the same row are significantly different (P<0.05).

Table 4: Minerals content of processed cheese spreads made with tested legume pastes.

Component	control	Processed cheese containing legumes								
		Lentil paste cheese			Lupine paste cheese			Common been paste cheese		
		10 %	20 %	30 %	10 %	20 %	30 %	10 %	20 %	30 %
Sodium (ppm)	8.12	7.15	6.19	5.22	6.55	4.99	3.43	6.2	4.27	2.34
Potassium (ppm)	0.42	0.44	0.46	0.48	0.39	0.36	0.33	0.37	0.31	0.25
Calcium (ppm)	5.64	4.13	2.63	1.13	5.12	4.61	4.1	4.16	2.73	1.28
Posphorus (ppm)	2.7	2.84	2.98	3.12	2.66	2.68	2.7	2.84	2.98	3.12
Magnisium(ppm)	0.06	0.06	0.05	0.04	0.06	0.07	0.08	0.06	0.07	0.08
Iron (ppm)	0.18	0.19	0.2	0.21	0.17	0.16	0.15	0.14	0.11	0.08
Na / K ratio	19.33	16.25	13.46	10.88	16.79	13.86	10.39	16.76	13.77	9.36
Ca / P ratio	2.09	1.45	0.88	0.36	1.92	1.72	1.52	1.46	0.92	0.41

Amino Acids Content of Tested Processed Cheese Spreads:

The obtained results (Table 5) illustrated that the legumes processed cheese contained all amino acids which in the control including the essential amino acids. In spreads was made with the LEP, the threonine,

serine, glutamic, histidine and lysine increased with increasing the percentage of addition and they were more concentration than the control. In processed cheesed made with the LUP, the amount of the most essential amino acids increased by increasing the level of the LUP addition in cheese which might be probably due to increase the protein content; which characterized with a high content of the most essential amino acids. In processed cheese made with the CBP; threonine, histidine, lysine, aspartic, glycine, serine, glutamic and $NH4^+$ increased by increasing the CBP addition and they were increased more than the control.

Fatty Acids Content of Tested Processed Cheese Spreads:

Data in Table (6) exhibits that in the processed cheese made with the LEP and the LUP, the total saturated fatty acids decreased and therefore the total unsaturated increased with the rise in the addition percentage of the LEP and the LUP in spreads, when compared to the control. So, the ratio of total saturated to unsaturated fatty acids decreased with both legume pastes. The decrease of saturated fatty acids in the LEP cheese or the LUP cheese could be attributed to a higher content of total unsaturated fatty acids and the lower content of total saturated fatty acids in either the LEP oil or the LUP oil than tested control processed cheese oil. On the other hand, the addition of coconut oil supported cheese with saturated fatty acids, in conformity with those reported by Calvo *et al.* (2007). But on the contrary, the ratio of total saturated to unsaturated fatty acids in processed cheese containing the CBP increased with the rise in the percentage of the CBP addition in spreads and they also increased than the control. This may be due to the fatty acids in the CBP oil. The current results (Table 6) evident that the total short and middle chain fatty acids in processed cheese spreads containing any tested pulse paste decreased with increasing the pulse paste addition, when compared with control processed cheese. While, the total long chain fatty acids increased. In addition that all of fatty acids in processed cheese containing the LEP decrease with rise in its addition percentage and they were lower than the control with the exception of oleic acid. The incorporation of the LUP into the processed cheese caused a high increment in palmitoleic, heptadecanoic, oleic and linoleic acide as the incorporation level increased. On the other hand, the addition of the CBP into the processed cheese caused a marked increase in its content of lauric, myristic, stearic, palmitoleic, heptadecanoic and linolenic acids.

Table 5: Amino acids content of processed cheese made with tested legume pastes.

Amino acids (g/100g)	control	Lentil paste cheese			Lupine paste cheese			Common been paste cheese		
		10%	20%	30%	10%	20%	30%	10%	20%	30%
Threonine**	0.2	0.31	0.42	0.54	0.45	0.7	0.96	0.28	0.36	0.44
Valine**	0.94	0.87	0.8	0.73	1.14	1.34	1.53	0.85	0.77	0.69
Methionine**	0.42	0.36	0.3	0.24	0.47	0.52	0.57	0.35	0.29	0.23
Isoleucine**	0.43	0.41	0.39	0.37	0.56	0.69	0.83	0.41	0.4	0.39
Leucine**	1.4	1.34	1.27	1.2	1.79	2.18	2.56	1.36	1.32	1.28
Phenylalanine**	1.3	1.22	1.15	1.08	1.62	1.94	2.26	1.22	1.15	1.08
Histidine**	0.47	0.51	0.55	0.59	0.71	0.95	1.18	0.51	0.55	0.6
Lysine**	0.73	0.8	0.87	0.95	0.98	1.23	1.49	0.74	0.75	0.76
Arginine**	0.95	0.94	0.92	0.91	1.2	1.45	1.71	0.89	0.83	0.77
Aspartic*	0.73	0.73	0.72	0.71	1	1.27	1.54	0.74	0.75	0.76
Glycine*	-	-	-	-	0.09	0.19	0.28	0.05	0.09	0.13
Proline*	1.13	1.04	0.94	0.84	1.41	1.69	1.96	1.03	0.93	0.83
Tyrosine*	0.77	0.73	0.69	0.65	0.99	1.21	1.44	0.74	0.72	0.7
Alanine*	1.08	1.05	1.01	0.97	1.16	1.24	1.31	0.92	0.75	0.58
Serine*	0.24	0.37	0.5	0.64	0.59	0.94	1.28	0.35	0.46	0.58
Glutamic*	2.14	2.21	2.28	2.35	2.98	3.82	4.65	2.26	2.38	2.49
$NH4^+$	0.72	0.72	0.72	0.72	1	1.28	1.55	0.77	0.82	0.86
Total essential AA	6.84	6.76	6.67	6.61	8.92	11	13.09	6.61	6.42	6.24
Total Nonessential AA	6.09	6.13	6.14	6.16	9.06	12.03	12.46	6.09	6.08	6.07

** Essential AA * Nonessential AA - NH4+ = ammonium

Organoleptic Quality Properties of Tested Processed Cheese Spreads:

The data in Table (7) shows the organoleptic quality for processed cheese as effected by incorporation of tested 3 types of legume; lentil, lupine and common been paste. Sensory evaluation results (Table 7) illustrated that all processed cheese spreads at all tested replacement ratios (10, 20 and 30%) with tested legume pastes had a very good organoleptic quality and were more acceptable with the exception of that containing 30 % lupine paste because of the presence off- flavour. The best replacement ratio with the tested legumes paste giving the better organoleptic quality and more acceptability was found to be 10 %. Its interesting to notice that the samples of processed cheese spreads containing either the LEP or the CBP were nearest to the control

processed cheese spreads for surface appearance, spreading quality, smoothness of texture, breakdown properties, oil separation, flavour properties and over all preference. While, the most sensory quality attributes values for processed cheese spreads containing the LUP at replacement ratio more than 10 % were lower than the control processed cheese. Therefore, it could be seen that the best treatment giving processed cheese spread has better organoleptic quality and more acceptability is found to be the incorporation of either the LEP or the CBP at replacement ratio of 10 %.

Table 6: Fatty acids (FAs) content of processed cheese made with tested legume paste.

Fatty acids %	Control	Lentil paste cheese			Lupine paste cheese			Common been paste cheese		
		10%	20%	30%	10%	20%	30%	10%	20%	30%
Caprylic(C8)*	0.71	0.48	0.24	0	0.48	0.24	0	0.48	0.24	0
Lauric(C12)*	0.33	0.22	0.11	0	0.26	0.2	0.14	1.02	1.71	2.39
Myristic(C14)*	0.95	0.64	0.32	0	0.64	0.32	0	1.33	1.71	2.08
Pentadecanoic(C15)*	0.23	0.16	0.08	0	0.16	0.08	0	0.16	0.08	0
Palmitoleic(C16:1)	0	0	0	0	0.13	0.26	0.39	0.21	0.42	0.63
Palmitic(C16)*	26.04	19.38	12.72	6.06	22.54	19.03	15.52	24.13	22.22	20.31
Heptadecanoic(C17)*	0	0	0		2.07	4.14	6.21	8.43	16.86	25.3
Oleic(C18:1)	42.49	55.85	69.21	82.56	47.82	53.15	58.49	34.65	26.82	18.99
Stearic(C18)*	9.06	7.47	5.88	4.29	6.17	3.28	0.39	11.6	14.14	16.67
Linoleic(C18:2)	11.17	9.82	8.46	7.1	13.55	15.93	18.32	8.32	5.48	2.64
Linolenic(C18:3)	4.51	3	1.5	0	3	1.5	0	6.67	8.83	11
Arachidic(C20)*	0.53	0.36	0.18	0	0.46	0.4	0.34	0.36	0.18	0
Behenic(C22)*	2.67	1.78	0.89	0	1.78	0.89	0	1.78	0.89	0
Total saturated FAs	40.52	30.49	20.42	10.35	34.56	28.58	22.6	49.29	58.03	66.75
Total unsaturated FAs	58.17	68.67	79.17	89.66	64.5	70.84	77.2	49.85	41.55	33.26
Saturated/unsaturated	0.7	0.44	0.26	0.12	0.54	0.4	0.29	0.99	1.4	2.01
Short chain FAs	0.71	0.48	0.24	0	0.48	0.24	0	0.48	0.24	0
Middle chain FAs	27.55	20.4	13.23	6.06	23.73	19.89	16.05	26.85	26.14	25.41
Long chain FAs	70.43	78.28	86.12	93.95	74.85	79.29	83.75	71.81	73.2	74.6

* saturated fatty acids - short chain fatty acids (C8) - Middle chain fatty acids (C12 – C16) - Long chain fatty acids (C17 – C22)

Penetrometer Reading for Tested Processed Cheese Spreads:

A Penetrometer reading, expressed in mm, was used for the determination of processed cheese firmness. It is related inversely to the firmness of processed cheese and has been generally considered as an important parameter for cheese quality. The obtained results (Table 8) showed that the processed cheese made by addition of 20% or 30% of the LUP was the worst treatment for firmness. The best treatments giving better firmness was found to be the incorporation of either 10% or 20% from the LEP followed by adding of either 10% or 20% from the CBP. The current data (Table 8) also exhibited that penetrometer reading of all processed cheese spreads containing legumes paste increased gradually during storage at ambient temperature (25±5°C), while it decreased gradually in the control processed cheese no containing any legume paste throughout ambient storage temperature. The former observation in processed cheese containing legumes paste may be due to the addition coconut oil which is on the liquid case at ambient temperature, while that in the control processed cheese may be due to the evaporation of cheese moisture (Mohamed, 2004). The same results (Table 8) also illustrated that under all tested storage conditions; ambient storage and refrigeration storage temperatures, there were no significant differences ($p \leq 0.05$) observed in penetrometer reading between the control processed cheese and those contained either the LEP at ratio of 20 and 30 % or the CBP at ratio of 30% after the first month of storage. Also, no significant differences ($p \leq 0.05$) were found in penetrometer reading between the control processed cheese and those contained either the LEP at ratio of 10, 20 and 30% or the CBP at ratio of 10 and 20%, after the second month of tested storage conditions. In addition, there was no significant variation ($p \leq 0.05$) in penetrometer reading between the control processed cheese and those contained 10% of either LEP or LUP and 30 % CBP after 3 months of refrigeration storage. On the other hand, under the ambient storage temperature, not only, there was no significant differences ($p \leq 0.05$) noticed between the control processed cheese and those contained CBP at ratio of 10 and 30%, after the first month, but also between the control processed cheese and those contained either the LEP at level of 10 and 20% or 10 % LUP; after the second month of ambient storage temperature.

Table 7: Sensory evaluation of processed cheese made with tested legume paste .

Sensory attribute	Control	Treatments									Score limit
		Lentil paste chees			Lupine paste cheese			Common been paste cheese			
		10%	20%	30%	10%	20%	30%	10%	20%	30%	
Surface appearance	3.55	3.51	3.29	3.27	2.83	2.67	2.33	3	2.33	2	1dull very 5 shiny very much much
Firmness of body	4.16	3.33	3.27	3.17	4	3.16	3.34	3.84	2.83	2.5	1very soft 5 very frim
Spreading quality	4.11	3.83	3.33	3	3.12	2.67	2.51	3.21	2.72	2.61	1difficult to 5 easy to spread spread
Stickiness	1.67	2.17	2.33	2.51	1.67	2.51	3.17	2.17	2.16	2.67	1not sticky 5 very sticky
Smoothness of texture	4.31	3.66	3.43	3.38	3	2.32	2.22	3.17	2.52	2.31	1not smooth 5 verysmooth
Breakdown properties	4.31	3.83	3.67	2.33	3.33	2.67	2.50	3.53	2.77	2.56	1desont5 dissolve dissolves very well
Chewiness	1.18	2	2.67	3.33	2.01	2.16	3.17	2.32	2.5	2.51	1 not chewing 5 very chewing
Gumminess	2.04	82.7	2.83	2.83	2.82	3	3.33	2.01	2.34	2.57	1 absent 5 very pronounced
Oil separation	1	1	1	2	2	2.16	3	1.53	1.72	2.53	1 absent 5 very pronounced
Flavour	4	2.83	2.71	2.62	2.66	2.5	1.77	2.73	2.67	2.32	1 very weak 5 very strong
Saltiness	3.17	2.32	2.22	2	2.01	2.67	2.67	2.33	2.33	2	1not salt 5 very salt
Over all preference	4	3.26	3.07	2.97	3	2.01	1.51	3.13	2.97	2.33	1 dislike very 5 like very much much

Table 8: Change in Penetrometer reading, melting index and oil separation reading of processed cheese spreads containing the tested three types of legumes during storage period.

Penetrometer reading								
Added legume paste	Addition ratio %	Storage period (months)						
		Fresh	5±2°C			25±5°C		
			1 month	2 months	3 months	1 month	2 months	3 months
Control		171.67^{Aa}	143.67^{Cbc}	131.00^{Ccd}	122.33^{DEd}	155.33^{Bab}	146.33^{Cbc}	135.33^{Fcd}
Lentil paste cheese	10	107.33^{CDc}	123.00^{DEbc}	141.00^{BCa}	154.67^{BCDa}	121.00^{Dbc}	138.00^{Cab}	152.33^{Ea}
	20	118.00^{BCc}	130.67^{CDbc}	148.33^{ABCb}	165.67^{ABCa}	139.00^{Cb}	144.67^{Cb}	172.67^{Da}
	30	132.67^{Bd}	140.00^{Ccd}	157.67^{ABCbc}	175.00^{ABab}	139.67^{Ccd}	166.67^{Bb}	186.00^{CDa}
Lupine paste cheese	10	90.33^{Ee}	94.00^{Fde}	94.67^{Dde}	111.00^{Ecd}	121.00^{Dbc}	136.67^{Cab}	151.67^{Ea}
	20	127.33^{Bc}	177.67^{Bab}	180.33^{Aa}	182.67^{ABa}	138.67^{Cc}	164.67^{Bb}	192.00^{Ca}
	30	161.00^{Ab}	194.33^{Ab}	181.33^{Ab}	165.67^{ABCb}	169.67^{Ab}	189.33^{Ab}	253.67^{Aa}
Common been paste cheese	10	100.67^{DEd}	111.67^{Ed}	141.00^{BCc}	180.67^{Abab}	149.00^{BCc}	169.00^{Bb}	187.67^{CDa}
	20	121.33^{BCe}	133.00^{CDde}	154.00^{ABCc}	197.33^{Aa}	136.33^{Cd}	175.33^{ABb}	199.67^{Ca}
	30	134.33^{Bc}	145.33^{Cc}	170.67^{ABb}	132.67^{CDEc}	149.00^{BCc}	186.67^{Ab}	238.33^{Ba}
melting index								
Treatments	Addition ratio %	Storage period (months)						
		Fesh	5° C			25° C		
			1 month	2 months	3 months	1 month	2 months	3 months
Control		86.92^{a}	83.85^{ab}	80.77^{bc}	77.69^{CDc}	70.00^{d}	66.15^{e}	56.92^{f}
Lentil paste cheese	10	30.77^{e}	42.31^{d}	46.15^{c}	49.23^{Fc}	43.85^{d}	53.08^{b}	60.77^{a}
	20	45.38^{e}	48.46^{de}	50.00^{d}	53.08^{Fd}	59.23^{c}	66.92^{b}	75.38^{a}
	30	46.92^{e}	52.31^{cd}	60.00^{bc}	63.08^{Ec}	62.31^{bc}	76.15^{ab}	81.54^{a}
Lupine paste cheese	10	43.08^{e}	50.00^{e}	64.62^{cd}	77.53^{CDab}	52.31^{de}	68.46^{bc}	82.31^{a}
	20	50.00^{c}	53.85^{c}	73.08^{b}	88.42^{ABa}	57.69^{c}	75.38^{b}	91.54^{a}
	30	69.23^{d}	71.54^{cd}	90.77^{ab}	93.28^{Aa}	81.54^{bc}	92.31^{a}	97.69^{a}
Common been paste cheese	10	46.15^{d}	51.54^{c}	60.00^{b}	73.08^{Da}	52.31^{c}	60.77^{b}	74.62^{a}
	20	53.08^{d}	56.15^{d}	62.31^{c}	76.92^{CDa}	56.92^{d}	69.23^{b}	79.23^{a}
	30	63.08^{d}	66.15^{cd}	68.46^{bc}	83.08^{BCa}	67.69^{bcd}	71.54^{b}	83.85^{a}

Oil separation								
Treatments	Addition ratio %	Storage period (months)						
		Fresh	5±2°C			25±5°C		
			1 month	2 months	3 months	1 month	2 months	3 months
Control		40.21^{Hg}	43.23^{If}	49.06^{Je}	51.56^{Hd}	56.25^{Gc}	59.38^{Ib}	74.06^{Fa}
Lentil paste cheese	10	41.52^{Gg}	44.50^{Hf}	50.00^{Ie}	59.48^{Gc}	57.06^{FGd}	61.88^{Hb}	75.94^{Ea}
	20	43.13^{Fg}	47.19^{Gf}	52.19^{He}	70.00^{Fb}	58.56^{DEd}	62.50^{Hc}	77.25^{Ea}
	30	44.38^{Ef}	51.10^{Fe}	59.06^{Gd}	74.69^{Db}	59.38^{Dd}	64.43^{Gc}	80.52^{Da}
Lupine paste cheese	10	41.15^{Gg}	55.11^{Ef}	62.50^{Fd}	72.19^{Eb}	57.69^{EFe}	67.29^{Fc}	76.35^{Ea}
	20	50.83^{Dg}	56.25^{Df}	69.38^{Ed}	76.04^{Dc}	59.56^{De}	78.85^{Db}	84.79^{Ca}
	30	56.36^{Bg}	62.08^{Cf}	73.13^{Dd}	79.06^{Cc}	62.81^{Ce}	87.81^{Bb}	93.75^{Ba}
Common been paste cheese	10	43.75^{EFg}	50.63^{Ff}	73.96^{Cd}	90.21^{Bb}	59.35^{De}	76.56^{Ec}	93.02^{Ba}
	20	53.65^{Cg}	65.63^{Bf}	76.56^{Bd}	91.88^{Ab}	69.59^{Be}	80.63^{Cc}	94.17^{Ba}
	30	62.81^{Af}	73.75^{Ae}	78.65^{Ad}	92.92^{Ac}	78.65^{Ad}	94.06^{Ab}	99.69^{Aa}

Different superscripts (A, B,...) at the same column are significantly different (P<0.05).
Different superscripts (a, b,...) at the same row are significantly different (P<0.05).

Meltability for Tested Processed Cheese Spreads:

Meltability for the processed cheese spreads was expressed as the distance of cheese flow in millimeter and represented in Table (8). The current results of Table (8) exhibited that processed cheese spreads made with the LUP had the highest meltability index, while spreads containing the LEP had the lowest one at fresh state and throughout the tested refrigeration and ambient temperature storage conditions. The melting index values of all tested processed cheese spreads containing any tested legume paste tended to increase as the storage period extended and the effect of storage conditions, and storage conditions on meltability was pronounced in cheese spreads stored at ambient temperature (25±5°C). This difference among the treatments and control may be due to the orientation of the pH value during storage. The results of control cheese during storage are agreement with those of Awad (1996), Al-Khamy *et al*. (1997) and Mohamed (2004). But the results differed with all cheese spreads treated with legume pastes because of their pH values. So the meltability increased with increase the percentage of legumes in spreads because of increase of the pH values.

Oil separation of Tested Processed Cheese Spreads:

From the obtained results of Table (8), it could be observed that the processed cheese that made with the LUP was worst treatment for oil separation especially when it stored at ambient temperature (25±5°C). The best treatment was cheese that made using the LEP for oil separation. The high separation of fat in cheese that made with incorporating the LUP and the CBP may be due to the role of legume on emulsification of fat in the protein matrix in the cheese. In this concern, Dalglish and Low (1988) reported that emulsifiers and stabilizers led to emulsification of fat in protein matrix. Also, the high of oil separation in the spreads contained either the LUP or the CBP due to the inability of the lupine or common been particles on the retention with coconut oil inside, while the lentil particles kept the coconut oil inside. The oil separation values of all treatments even in control tended to increase as storage period progressed. Also the oil separation values increased with increasing the legume ratio in spreads

Recommendations:

It is recommended for manufacture new processed cheeses using legumes as follows:
. Use tested legumes as pastes which prepared using 1% kasomel emulsifying salt (K2394)
. Mixing of legume pastes with milled cheeses before heating.
. Addition of 10, 20 and 30% of lentil paste .
. Addition of 10 and 20 % of common been paste.
. Addition of 10 % of lupine paste.
. Use the coconut oil with the former levels of legume pastes replacements in the processed cheese blend.

References

A.O.A.C., 1990. Official Methods of Analysis. 15th ed., Association of Official Analytical Chemists, Inc Arlington. Virginia USA., pp: 842.

Abd El-Salam, M.H., A.F. Al-Khamy, G.A. El- Garawany, A. Hamed and A.F. Khader, 1996. Composition and rheological properties of processed cheese spread as affected by the level of added whey protein concentrate and emulsifying salt. Egyptian J. Dairy Sci., 24: 309-322.

Al-Khamey, A.F., G.A. El- Garawany, A. Khader, A. Hamed, and M.H. Abd El-Salam, 1997. The use of whey pretein concentrates in processed cheese spread. 1. Effect of type of emulsifying salt. Egyptian J. Dairy Sci., 25(1): 99-112.

Awad, R.A., 1996. Studies on emulsifying salt mixtures for processed cheese. Ph.D. Thesis, Fac. of Agric., Ain Shams university.

Brandt, M.A., E.B. Skinner and J.A.Coleman, 1963. Texture Profile Method. J. Food Sci., 28: 404-409.

Calvo, M.V., M.Juarez, J. Fontecha, M. El-Aasar, M. Naguib and M.H. A.El-Salam, 2007. Effect of milk fat replacement with vegetable oils on fatty acids composition and conjugated linoleic acid content of market Egyptian processed cheeses. Egyptian Journal of Dairy Science, 35(1): 97-107.

Caric, M. and M. Kalab, 1985. Effect of emulsifying agen on the microstructure and other characteristics of processed cheese review. Food Microstructure., 4: 297-312.

Caric, M. and M. Kalab, 1993. Processed Cheese Products. Ch. 15 "Cheese Chemistry, Physics and Microbiology". Second en. Fox, P.F.(Ed),.Chapman & Hall, 2-6 boundary Row, London SE IHN, UK.

Caul, J.F., 1957. The profil method of flavour analysis. Advance in Food Research, 7: 1-40.

Dalglish, D.G. and A.J. R.Law, 1988. Sodium caseinate composition and properties of different preparations. J. Soc. Dairy Tech., 41: 1-4.

Davies, W.L., 1932. The determination of sodium chloride. Analyst, (57) 81 cited by Ling 1963.

Egyptian Standard Specifications, 1988. Processed cheese. Part 1: Processed cheeses. Egyptian Organization for Standardization and Quality Control.

Fox, P.F., 1993. Cheese: Chemistry, Physics and Microbiology. Second Edition, Vol. 2, Elsevier Applied Science, London, UK.

Gupta, V.K. and H. Reuter, 1993. Firmness and melting quality of processed cheese foods with added whey protein concentrates. Lait., 73 (4) 381-388. C.F. Dairy Sci. Abstr. 56: 787.

International Dairy Federation, 1964. Determination of the ash content of processed cheese products. Standard No. 27, Brussels, Belgium.

Ling, E.R., 1963. A Text Book of Dairy Chemistry. Vol. 2. Practical, 3rd Ed. Chapman and Hell Ltd. London.

Mansour, A.I.A., M.A.M.Omar and W.I. EL – Dosoki, 2010. Studies on using of ultrafiltered retentated milk in processed cheese making. Internet J. of Food safety, 13: 353-309.

Metwally, M.M., S. El-shibiny, S.M. El-Dieb and F.M. Asem, 1996. Effect of packaging materials on the keeping quality of processed cheese. Egyptian J. Dairy Sci., 24: 1.

Meyer, A., 1973. Processed Cheese Manufacture. 1st ed. Food Trade Press, London.

Mohamed, A.G., 2004. Studies on spreadable processed cheese emulsifying salts. Ph. D. Thesis, Fac. of Agric., Cairo Univ., Giza, Egypt.

Ottawa, ont. 1977. Laboratory Method for sensory Evaluation for food. Research Branch Canda Department of Agriculture. Puolication, 163.

SAS Institute, 1990: SAS User's Guide/ STAT ver. 6.04 fourth edition SAS Inst. Inc., Cary, NG.

Savello, P.A., C.A. Ernstrom and M. Kalab, 1989. Microstructure and Meltability of Model Process Cheese Made with Rennet and Acid Casein. J. Dairy Science, 72(1): 1-11.

Thomas, M.A., 1973. The use of hard milk fat fraction in processed cheese. Australian J. Dairy Technology. June, 77-80.

Uhlman, D., 1985. Processed cheese. In Latiset Produits Laitiers. Vache, Brebis, Chevre. Les Produits Laitiers Transformation et technologie, (2): 268 (ed. F.M. Luquet) Paris.