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Production of Processed Cheese Food Enriched with Vegetable and Whey Proteins

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ABSTRACT

The present study aims to produce processed cheese food of high protein content using blends of Cheddar cheese, whey protein concentrate (WPC), soybean protein concentrate powder (SPC) and chick-pea flour. Full and half fat processed cheese food were produced from these blends. The resultant products were stored at either refrigerator or room temperature for 2 months.

The most acceptable product was obtained from blends in which 25, 20, 27·5 and 27·5% of solids-non-fat were supplied from Cheddar cheese, WPC, SPC, and chick-pea flour (CPF), respectively. The product showed fine consistency and high protein content.

INTRODUCTION

A category of products called 'dairy blends' have evolved in the food ingredient system, characterized by enriched protein content. These blends can be a combination of two or more of the protein sources. The sources of dairy proteins are, of course, non-fat dry milk, dry butter milk, caseinates, coprecipitates and whey proteins. Soybeans, soy flour, soy concentrate and soy isolate are recognized as the most important vegetable protein sources in processed foods. There are a number of other protein sources used in processed foods including cereal, cottonseed, peanut and some single cell proteins, but they are classified as of relatively lesser importance (Mykleby, 1978).

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The utilization of vegetable protein in place of milk protein products in a number of dairy food systems was reviewed by Morr (1979). Recently, Scrimshaw (1978) reported that soy proteins, consumed at normal dietary levels, compare favourably with animal proteins for meeting human nutritional requirements and efforts have been made to improve the flavour of soy protein ingredients (Honing *et al.*, 1976).

On the other hand, Campbell *et al.* (1963) reported that the biological values of chickpea and soy bean seeds were only 64·8 and 57·4, respectively. Ling (1972) observed that chickpea fat content was 5%, which consists of linoleic acid, 55·65%; oleic acid, 24%; palmitic, 11·2% and a small quantity of linolenic, stearic, arachidonic and myristic acids. Also, Krivelevich *et al.* (1981) noticed that chickpea seed lipids ranged from 6·15–7·71% and contain more poly unsaturated fatty acids, especially linoleic acid (62·44%). Youssef (1980) showed that chickpea flour contains about 23–24% protein which is rich in glutamic acid.

However, soy and chickpea proteins are deficient in the sulfur-containing amino acids. Therefore, blending of these proteins with whey proteins is, of course, a possible solution of the problem.

The present study was carried out as an attempt to produce processed cheese foods with enriched protein content from blends containing Cheddar cheese, whey protein concentrate, soy concentrate and chickpea flour.

MATERIALS AND METHODS

Whey protein concentrate (WPC)

Salted whey was collected from the Dairy Laboratory, Food Science Department, Faculty of Agriculture, Zagazig University. WPC was prepared as described by Ahmed & Ismail (1978).

Soy protein concentrate

Imported soy protein concentrate from A. E. Staley Manufacturing Company, Chicago, USA, was obtained from the Institute of Nutrition, Cairo, Egypt.

Chickpea flour

Chickpea seeds were obtained from Zagazig local market and used for flour preparation as follows.

The seeds were cleaned, washed, sterilized at 121°C for 15 min, dried in an

oven, milled and seived using normal meshes (Abd El-Rahman *et al.*, 1980). The resultant flour was used in processed cheese making.

Preparation of Bascee

Skim milk powder was reconstituted at a rate of 1:8, heated at 72°C for 15 s, cooled to 37°C, inoculated with 2% of an active yoghurt culture and incubated at room temperature for 24 h. Then the solids content of the resultant fermented milk was increased up to 50% by adding skim milk powder with continuous blending. The resultant product is known locally as Bascee and is used in processed cheese making.

Ingredients used in processed cheese making

Cheddar cheese, butter oil and emulsifier were obtained from the National Center for Training, Misr Milk and Food Company, Siclam, Alexandria.

Processed cheese food making

Full fat (40–45% fat per DM) and half fat (20–25% fat per DM) processed cheese foods were manufactured from blends of Cheddar cheese, whey protein concentrate (WPC), soy protein concentrate (SPC), chickpea flour (CPF) and butteroil as follows.

At all blends, Cheddar cheese represents 25% of the milk solids non-fat (SNF) then the solids non-fat of the blends were completed as follows:

(A) 10% and 65% of blend SNF were supplied from WPC and SPC, respectively.
(B) 10% and 65% of blend SNF were supplied from WPC and CPF, respectively.
(C) 10%, 32·5% and 32·5% of blend SNF were supplied from WPC, SPC and CPF, respectively.
(D) 20% and 55% of blend SNF were supplied from WPC and SPC, respectively.
(E) 20% and 55% of blend SNF were supplied from WPC and CPF, respectively.
(F) 20%, 27·5% and 27·50% of blend SNF were supplied from WPC, SPC and CPF, respectively.

Control cheese was also made from blends in which SNF were supplied from Cheddar cheese and Bascee. The cheeses were processed at the National Centre for Training, Misr Milk and Food Company, Siclam, Alexandria, Egypt. The formulations of the different blends are shown in

TABLE 1
Chemical Composition of the Ingredients used in the Different Blends for Processed Cheese Food Making

Ingredients	*Moisture*	*TS*	*Fat*	*SNF*	*Protein*
Cheddar cheese	40	60	29·5	30·5	25·2
Whey protein concentrate (WPC)	80·0	20	—	20·0	12·8
Soy protein concentrate (SPC)	5·0	95·0	—	95·0	62·0
Chickpea flour (CPC)	5·0	95·0	5·0	90·0	23·0
Bascee	51·0	49	—	49	21·4
Butter oil	0·10	—	99·9	—	—

Tables 2 and 3. Cheddar cheese was cleaned, minced, milled and blended with the different ingredients (Tables 2 and 3). Fat and moisture contents of each blend were adjusted by adding the required amount of butter oil and water. Emulsifying salts were added at a level of 3% for each blend. The blends were processed with direct steam injection at a pressure of 3–5 kg/cm^2 with continuous agitation. The processing temperature (85–90°C) was attained within 3–5 min and the holding time at this temperature was 10 min (Meyer, 1973).

The resultant processed cheese foods (all blends) were packaged in aluminium foil-lined cardboard (120 g capacity) and stored at refrigerator (5–8°C) and room (20–25°C) temperatures for 2 months. All trials were conducted in triplicate.

Tables 1, 2 and 3 show the chemical compositions of the different ingredients and the formulation of the different blends, respectively.

TABLE 2
Formulation of Ingredients used in Different Blends for Full Fat Processed Cheese Food Making

Ingredients	*Blends*						
	Control	*A*	*B*	*C*	*D*	*E*	*F*
Cheddar cheese	50·0	20·0	20·0	20·0	20·0	20·0	20·0
Bascee	18·0	—	—	—	—	—	—
Whey protein concentrate	—	12·0	12·0	12·00	24·0	24·0	24·0
Soy protein concentrate	—	16·30	—	8·15	13·70	—	6·85
Chickpea flour	—	—	17·30	8·65	—	14·40	7·20
Butter oil	8·30	17·10	16·30	16·70	17·10	16·40	16·75
Emulsifiers	3·00	3·0	3·00	3·00	3·00	3·00	3·00
Added water	20·70	31·60	31·40	31·50	22·20	22·20	22·20
Total	100	100	100	100	100	100	100

TABLE 3
Formulation of Ingredients used in Different Blends for Half Fat Processed Cheese Making

Ingredients	*Blends*						
	Control	*A*	*B*	*C*	*D*	*E*	*F*
Cheddar cheese	40·0	25·0	25·0	25·0	25·0	25·0	25·0
Bascee	36·0	—	—	—	—	—	—
Whey protein concentrate	—	15·0	15·0	15·0	30·0	30·0	30·0
Soy protein concentrate	—	20·50	—	10·25	17·4	—	8·70
Chickpea flour	—	—	21·70	10·85	—	18·30	9·15
Butter oil	—	4·50	3·40	4·0	4·50	3·6	4·05
Emulsifiers	3·0	3·0	3·0	3·0	3·0	3·0	3·0
Added water	21·0	32·0	31·90	31·90	20·10	20·10	20·10
Total	100	100	100	100	100	100	100

Processed cheese examinations

Processed cheese samples resulting from all blends were chemically analysed for moisture, fat, salt, total nitrogen and soluble nitrogen according to Ling (1963). Also the processed cheese foods were organoleptically evaluated according to the scale suggested by Meyer (1973) as follows: 20 points for outer appearance, 40 points for inner appearance and 40 points for flavour. The evaluation was carried out by a score panel of the staff members of the Food Science Department, Faculty of Agriculture, Zagazig University.

RESULTS AND DISCUSSION

Organoleptic properties

The organoleptic properties of full or half fat processed cheese foods resulting from the different blends during storage at both refrigerator and room temperature are presented in Tables 4 and 5. It can be seen that increasing the level of added whey protein concentrate (WPC) greatly improved the consistency and spreadability (inner appearance), as well as flavour, of the resultant processed cheese food. Also it can be seen that cheese made from blends containing chickpea flour (B and E) showed higher scores for consistency and flavour compared with those made from blends containing soy concentrate (A and D). The processed cheese made from blends containing both chickpea flour and soy concentrate (C and F) showed

TABLE 4
Organoleptic Properties of Processed Cheese Foods Enriched with Whey Protein and Vegetable Proteins during Storage at Refrigerator Temperature (5–8°C)

Type of cheese	*Storage period (months)*	*Properties*		*Control*	*A*	*B*	*C*	*D*	*E*	*F*
Full fat	Fresh	Outer appearance	(20)	18	18	17	17	18	16	18
		Inner appearance	(40)	35	30	32	35	32	34	38
		Flavour	(40)	36	32	33	35	34	35	37
		Total	100	89	80	82	87	84	85	93
	1	Outer appearance	(20)	17	17	15	17	17	12	18
		Inner appearance	(40)	35	30	33	34	31	33	34
		Flavour	(40)	35	31	33	34	33	36	36
		Total	100	87	78	81	85	81	81	88
	2	Outer appearance	(20)	17	17	14	16	16	11	17
		Inner appearance	(40)	34	30	32	33	30	32	32
		Flavour	(40)	34	30	32	34	32	35	34
		Total	100	85	77	78	83	78	78	83
Half fat	Fresh	Outer appearance	(20)	18	18	16	17	18	16	16
		Inner appearance	(40)	34	30	32	32	32	35	36
		Flavour	(40)	36	32	34	38	33	34	38
		Total	100	88	80	82	87	83	85	90
	1	Outer appearance	(20)	17	17	14	17	17	15	15
		Inner appearance	(40)	33	29	31	33	33	34	37
		Flavour	(40)	35	31	34	37	33	34	37
		Total	100	85	77	79	86	83	83	87
	2	Outer appearance	(20)	17	26	13	16	16	14	14
		Inner appearance	(20)	32	27	30	32	32	32	34
		Flavour	(40)	34	30	33	35	31	32	36
		Total	100	83	73	76	83	79	79	84

the highest scores and this was remarkable in the blend (F) which also contains the higher level of whey protein concentrate.

Moreover, the processed cheese food resulting from the different blends showed acceptable quality up to the end of the storage period (2 months). This was more marked when the cheese was stored at refrigerator temperature. Shutin *et al.* (1975), Tesvetkova *et al.* (1975) and Shilovskaya *et al.* (1978) reported that addition of whey protein concentrate to processed cheese blends resulted in a product of fine consistency and good characteristics during storage.

TABLE 5
Organoleptic Properties of Processed Cheese Foods Enriched with Whey Protein and Vegetable Proteins during Storage at Room Temperature (20–25°C)

Type of cheese	*Storage period (months)*	*Properties*		*Control*	*A*	*B*	*C*	*D*	*E*	*F*
Full fat	Fresh	Outer appearance	(20)	18	18	17	17	18	16	18
		Inner appearance	(40)	35	30	32	35	32	34	38
		Flavour	(40)	36	32	33	35	34	35	37
		Total	100	89	80	82	87	84	85	93
	1	Outer appearance	(20)	16	17	16	16	16	16	17
		Inner appearance	(40)	33	32	31	33	32	34	35
		Flavour	(40)	33	30	30	32	31	34	34
		Total	100	81	77	77	81	79	94	86
	2	Outer appearance	(20)	16	16	16	17	16	16	16
		Inner appearance	(40)	32	30	30	32	31	32	34
		Flavour	(40)	30	28	28	31	30	33	30
		Total	100	78	74	74	80	77	81	80
Half fat	Fresh	Outer appearance	(20)	18	18	17	18	16	16	16
		Inner appearance	(40)	34	30	32	32	32	35	36
		Flavour	(40)	36	32	34	38	33	34	38
		Total	100	88	80	82	87	83	85	90
	1	Outer appearance	(20)	16	16	15	16	16	15	16
		Inner appearance	(40)	32	28	30	32	31	33	34
		Flavour	(40)	33	28	30	34	30	32	35
		Total	100	81	72	75	82	77	80	84
	2	Outer appearance	(20)	15	14	14	14	14	14	15
		Inner appearance	(40)	30	26	29	30	30	31	33
		Flavour	(40)	30	26	29	30	29	30	34
		Total	100	75	66	73	74	73	75	82

Chemical composition

Table 6 illustrates the changes in moisture content of full fat and half fat processed cheese foods made from the different blends during storage at either refrigerator or room temperature. It can be seen that moisture of processed cheese food of both types (full fat or half fat) was nearly similar at all treatments. This could be due to the adjustment of moisture content of the different blends before processing. However, a slight increase in the

TABLE 6
Moisture Content of Processed Cheese Foods Enriched with Whey Protein and Vegetable Proteins during Storage

Processed cheese type	*Storage period and temperature*		*Control*	*A*	*B*	*C*	*D*	*E*	*F*
Full fat	Fresh		51·0	51·80	52·10	52·6	52·80	52·78	52·90
	2 Months	Ref. temp.	50·50	51·20	51·62	52·0	52·0	51·80	52·40
		Room temp.	50·0	50·50	50·70	51·30	51·40	51·0	52·0
Half fat	Fresh		55·38	55·70	56·00	56·00	55·90	56·10	55·85
	2 Months	Ref. temp.	54·82	55·0	55·50	55·40	55·40	55·60	55·40
		Room temp.	53·96	54·40	54·61	54·48	55·0	54·85	54·78

Ref. temp. = Refrigerator temperature (5–8°C).
Room temp. = Room temperature (20–25°C).

moisture content was observed in cheese with added whey protein concentrate at the higher level. During storage a slight decrease in the moisture content of cheese from the different blends was observed. This was more marked when the cheese was stored at room temperature.

On the other hand, Table 7 shows that full fat processed cheese food, resulting from the different blends, contained a near similar fat content (in dry matter). This was also observed in the half fat processed cheese food. This could be attributed to the adjustment of the fat contents of the different blends before processing. A slight increase in the fat content of cheese from the different blends was observed during storage.

Table 8 shows the total nitrogen content (on dry basis) of both full and half fat processed cheese foods made from the different blends. It can be seen

TABLE 7
Fat Content (DM) of Processed Cheese Foods Enriched with Whey Protein and Vegetable Proteins during Storage

Processed cheese type	*Storage period and temperature*		*Control*	*A*	*B*	*C*	*D*	*E*	*F*
Full fat	Fresh		46·38	43·10	44·16	44·30	43·90	44·0	44·20
	2 Months	Ref. temp.	46·81	43·61	44·22	44·56	44·15	44·24	44·38
		Room temp.	47·21	44·11	44·68	43·63	44·41	44·57	44·62
Half fat	Fresh		25·11	23·80	24·0	24·0	24·51	24·30	24·60
	2 Months	Ref. temp.	25·28	24·08	24·15	24·21	24·67	24·54	24·73
		Room temp.	25·81	24·51	24·56	24·61	24·92	24·73	24·81

Ref. temp. = Refrigerator temperature (5–8°C).
Room temp. = Room temperature (20–25°C).

TABLE 8
Total Nitrogen (DM) of Processed Cheese Foods Enriched with Whey Protein and Vegetable Proteins during Storage

Processed cheese type	*Storage period and temperature*		*Control*	*A*	*B*	*C*	*D*	*E*	*F*
Full fat	Fresh		5·86	8·03	6·52	7·59	7·94	7·00	7·74
	2 Months	Ref. temp.	6·06	8·11	6·86	7·81	7·98	7·16	7·86
		Room temp.	6·11	8·18	7·08	8·01	8·04	7·23	7·91
Half fat	Fresh		6·92	10·4	7·50	8·86	9·52	8·29	9·14
	2 Months	Ref. temp.	7·18	10·7	7·82	8·96	9·67	8·35	9·26
		Room temp.	7·31	10·7	7·91	8·88	9·71	8·39	9·37

Ref. temp. = Refrigerator temperature (5–8°C).
Room temp. = Room temperature (20–28°C).

that processed cheese made from blends containing WPC, SPC and CPF had a higher total nitrogen content compared with the control cheese. The increase in total nitrogen was more marked in cheese made from blend A in which 65% of the blend SNF was supplied from SPC. Also the half fat cheese has a higher nitrogen content than full fat cheese.

The total nitrogen content of cheese resulting from the different blends showed a similar trend during storage, being slightly increased. This was marked during storage at room temperature. El-Sayed (1984) showed that incorporation of soy milk curd into processed cheese blend increased the total nitrogen of the resultant cheese. Also, Samodurov (1983) has reported that soya protein isolates may be used for the production of high-protein low-fat processed cheese for children and dietetic feeding. It is also evident from Table 9 that processed cheese food made from blends containing WPC, SPC

TABLE 9
Soluble Nitrogen Content (% TN) of Processed Cheese Foods Enriched with Whey Protein and Vegetable Proteins during Storage

Processed cheese type	*Storage period and temperature*		*Control*	*A*	*B*	*C*	*D*	*E*	*F*
Full fat	Fresh		42·8	45·3	43·6	44·7	46·0	43·2	46·9
	2 Months	Ref. temp.	43·6	46·0	44·1	45·3	46·2	45·3	47·4
		Room temp.	45·5	49·4	45·7	46·1	47·0	46·9	48·6
Half fat	Fresh		40·3	42·2	40·4	41·2	41·8	41·0	42·7
	2 Months	Ref. temp.	42·3	42·5	41·2	43·5	42·5	44·5	46·0
		Room temp.	44·1	43·1	44·6	45·1	44·0	46·8	47·4

Ref. temp. = refrigerator temperature (5–8°C).
Room temp. = room temperature (20–25°C).

TABLE 10
Salt Content (DM) of Processed Cheese Food Enriched with Whey Protein and Vegetable Proteins during Storage

Processed cheese type	*Storage period and temperature*		*Control*	*A*	*B*	*C*	*D*	*E*	*F*
Full fat	Fresh		4·08	4·16	4·52	4·33	5·23	5·28	5·39
	2 Months	Ref. temp.	4·24	4·40	4·68	4·57	5·42	5·53	5·64
		Room temp.	4·46	4·54	4·89	4·79	5·61	5·83	5·91
Half fat	Fresh		4·28	4·45	4·65	4·77	5·65	5·45	5·79
	2 Months	Ref. temp.	4·62	4·73	4·91	5·06	5·86	5·16	5·92
		Room temp.	4·81	4·88	5·08	5·28	5·93	5·78	6·01

Ref. temp. = refrigerator temperature (5–8°C).
Room temp. = room temperature (20–28°C).

and CPF had a slightly higher soluble nitrogen content compared with the control. The soluble nitrogen content of cheese made from the different blends slightly increased during storage. The increase was more pronounced during storage at room temperature. The increase in the soluble nitrogen during storage could be attributed to heat resistant proteases present in the blends (Abdel-Baky, 1979). The general trend of these results is in agreement with those reported by Emara (1984) and El-Dsuky (1986).

Table 10 shows the salt content of processed cheese food resulting from the different blends. Increasing the level of WPC used in the blend slightly increased the salt content of cheese. This could be due to the use of WPC prepared from salted whey. Also the half fat cheese had a slightly higher salt content compared with the full fat one. This could be due to the increase in the amounts of both Cheddar cheese and WPC used for formulation of the different blends of that type. During storage the salt content of cheese from the different blends showed a similar trend, being slightly increased, especially at room temperature. The general trend of these results is in agreement with those reported by Shehata *et al.* (1982), El-Sayed (1984), Emara (1984) and El-Dsuky (1986).

In the light of the foregoing results it may be concluded that full fat or half fat processed cheese food of high protein content and acceptable quality could be obtained when 20, 27·50 and 27·50 of the solids-non-fat of the blend was supplied from WPC, SPC and CPF, respectively.

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