Studies on Using of Ultrafiltered Retentated Milk in Processed Cheese Making

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Abstract Processed cheese was made from retentated milk by using of ripening agent to accelerating flavour development. The results showed that, good-quality flavour could be obtained by using 5% mixture of commercial amino acid and lipase (ATLc132) preparation after incubation at 37°C for 5 days. Mature Ras cheese used for manufacture of processed cheese was replaced by ATLc132 treated retentates at levels of 0, 25, 50, 75 and 100%. The resultants of processed cheese were stored up to 3 months at refrigerator (6-8°C) or at ambient (22-25°C) temperature. The results indicated that, increasing the level of replacement mature cheese by a ripened retentate tended to increase moisture content; fat/dry matter and TVFFA in the resultant cheese, either after manufacture (control) or during storage (up to 3 months). The values are higher in processed cheese after storage than in the fresh cheese. Moreover, the increasing of the level of ripened retentate used tended to increase the numbers of total bacterial and spore former counts in all processed cheeses during storage either at refrigerator or at room temperature, as well as, fresh cheese. The total bacterial and spore former counts were higher in all processed cheese stored at room temperature than in those stored in the refrigerator. On the other hand, the experimental processed cheese showed a better appearance, structure and flavour in the fresh cheese than the cheese stored at refrigerator or at room temperature. In addition, the processed cheese can made by substitution Ras cheese by ripened retentate up to 75% in the fresh cheese, but if cheese is going to be consumed after storage, the cheeses must be stored at refrigerator temperature than at room temperature.
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1. Introduction

Processed cheese products have been important commercial foods since the early years of this century (Meyer, 1973). In Egypt, most of these 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. On the other hand, locally produced Ras cheese requires a long ripening period to develop the desired flavour and body characteristics, and this increases the total capital cost of production. The natural cheese production is relatively inefficient in recovering proteins from milk, removing only about 80% of total milk proteins. Moreover, the processed cheese can made from replacing 25% of skim milk powder with vegetable protein and replacing all added water with whey received higher scores of flavour, section and overall grade than the corresponding cheeses made without whey (Heraz *et al*., 2010).

Recently, the attention of cheese manufacturers has been drawn to the overall efficiency of recovering milk proteins. Application of ultrafiltration to produce a milk concentrate for subsequent incorporation into processed cheese products as a partial replacement for natural cheese has been shown to be feasible (Kumar & Kosikowski, 1977; Kumar, 1979; Sood & Kosikowski, 1979 and Tamime *et al*., 1990). In the present study, attention was focused on evaluating the effectiveness of ripening agent (ATLc132) in accelerating flavour development in ultrafiltered retentatesto produce rapidly ripened products having flavour characteristics similar to that of mature Ras cheese. Evaluation of the quality of processed cheese made using the best ripened retentate immediately after manufacture and during storage at refrigerator or at room temperature was investigated.

2. Materials and Methods

Materials:

Fresh cow's milk was obtained from the reception section at Katilo Halayeb Company for dairy products in Damietta.

Skim milk powder: Natural non-fat dry milk powder low heat Extra Grade made from pasteurized milk origin India.

Butter oil: Manufactured and imported from Netherlands.

Ripened Ras cheese, aged for 90-120 days, was prepared from Katilo Halayeb Company for dairy products in Damietta according to the method described by Abdel-Tawab (1963).

Ripening agent (ATTc132): Commercial mix of pure amino acid and lipase from (Chr. Hansen's Laboratorium, Copenhagen, Denmark).

The emulsifying salt used was JOHA-S,S (Hansen's Laboratorium).

Methods:

Preparation of ultrafiltered whole milk retentate treated with ripening agents:

Cow's milk (3% fat and 8.5% SNF) was heated at 75°C for 15 s, cooled to 50°C and ultrafiltered using a UF unit (Model carbosep ultrafiltration unit type 4S 252, France), equipped with membrane type M8 with total surface area of 57 m^2. The total solids content of the final retentate was almost 35%. The retentate was heated to 85°C for 2 min, homogenized and cooled to 30°C. It was treated with 5% mixture of commercial amino acid and lipase (ATLc132) preparation after incubation at 37°C for 5 days. All treatments were carried out in triplicate.

Manufacture of processed cheese:

Processed cheese was manufactured as described by Meyer (1973) as follow:

Mature Ras cheese was replaced by ATLc132-treated retentate at levels of 25, 50, 75 or 100%. In addition, control processed cheese was made using mature Ras cheese only. The composition and percentage of ingredients used in the formulation for each batch of processed cheese are given in Tables 1 and 2. The batches were made at the Katilo Halayeb Company for dairy products in Damietta.

Table 1: Chemical composition of ingredients used for processed cheese.

Property	Skim milk powder	Ras cheese	Ripened retentate	Butter oil
Moisture %	4.02	38	62.8	0.50
Fat/DM %	1.03	51.8	53.7	99.4
TN %	6.61	6.51	6.6	-
SN %	-	1.35	1.78	-
(SN/TN) %		20.7	27.0	
TVFFA*	-	18.4	22.0	-
pH	-	5.1	5.03	-

DM = Dry Matter, TN = Total Nitrogen, SN =Soluble Nitrogen, Ripened retentate = Retentate+ATL132, TVFFA*: ml 0.1 N NaOH/100 g cheese or retentate

Table 2: Ingredients used in the preparation of blends for processed cheese (Kg/100 Kg of blend).

Ingredient	Percentage of substitution (%)				
	Control	**25**	**50**	**75**	**100**
Ras cheese	55	42.8	31	18.8	-
Ripened retentate	-	13.7	29	50.4	77.5
Skim milk powder	5.5	5.7	6.1	6.2	6.8
Butter oil	5.5	5.8	6.4	7.4	8.5
Emulsifying salts	3	3	3	3	3
Added water	31	29	24.5	14.2	4.2
Total	100	100	100	100	100

The ingredients for each type of processed cheese were mixed and heated at 85-90°C within 4-5 min and held for 3 min (Meyer, 1973). The resultant processed cheeses were packed in 120 gm plastic cups and stored monthly intervals for 3 months at refrigerator (6-8°C) or at room (22-25°C) temperature. Three replicates were made for each batch. Samples of processed cheese were analysed and evaluated at control and after stored for properties of chemical, microbiological and sensorial.

Chemical analysis:

Retentate and cheese samples were analysed for moisture, fat content, titratable acidity, salt, soluble nitrogen (SN) and total nitrogen (TN) according to Association of Official Analytical Chemists (AOAC, 1990). pH was measured directly in the cheese or retentate samples by using pH meter (PTI-15, Aqua Chemical Co., England). Total volatile free fatty acids (TVFFA) were determined as described by Kosikowski (1982). Milk powder was also analysed for moisture, fat content and TN according to AOAC, 1990.

Bacteriological examination:

The total bacterial counts and spore-forming bacteria of processed cheese were determined according to the American Public Health Association (APHA, 1992), using nutrient agar medium (Difco); plates were incubated at 32°C for 3 days.

Sensory evaluation:

All retentate samples were evaluated for flavour development on an eight-point scale (Singh and Kristoffersen, 1970). The cheese samples were scored by the scheme described by Meyer (1973) with a maximum score of 20, 40 and 40 points for

appearance, structure and flavour, respectively. Sensory evaluation was carried out by a panel of twelve judges.

3. Results and Discussion

The gross composition of processed cheese:

Data presented in Table 3 illustrate the chemical properties of processed cheese made with different substitution levels of ripened retentate with mature Ras cheese stored at refrigerator (6-8°C) or at room (22-25°C) temperature for 1, 2 and 3 months.

Moisture content:

The moisture content of all treatments slightly decreased throughout the storage periods. This would possibly result from the loss of moisture during storage. The results showed that, cheeses contained ripened retentate had higher moisture than control cheese and increased gradually with increasing the level of ripened retentate replacement. Slight differences were observed in the moisture content of processed cheese from different treatments suggesting that replacement of ripened retentate with mature Ras cheese stored at refrigerator or at room temperature for 3 months. The general trends of these results is in agreement with those reported by Emara, 1984; Abdel-Baky *et al*., 1987; El-Neshawy *et al*., 1987; Aly *et al*., 1995 and Awad *et al*., 2005. However, the moisture content of all processed cheese was within the legal limits. El-Neshawy *et al*., 1987 reported that, using enzyme-treated cheese and slurries tended to slightly increase the moisture content of processed cheese spread.

Fat and salt contents:

The fat content of processed cheese had lower values after manufacture than after storage, and all treatments slightly increased throughout the storage periods either at refrigerator or at room temperature. Slight differences were observed in the fat content of processed cheese from different treatments suggesting that replacement of ripened retentate with mature Ras cheese stored at refrigerator or at room temperature. There was a gradual increase in fat content of cheese of all treatments during storage. This might be attributed to the decrease in the moisture content and of non-fat solids content may be due to partial degradation of proteins and fermentation of lactose. However, the fat content of all processed cheese were within the legal limits. The general trends of these results is in agreement with those reported by Emara, 1984; Abdel-Baky *et al*., 1987; El-Neshawy *et al*., 1987; Aly *et al*., 1995 and Awad *et al*., 2005.

On the other hand, replacing mature Ras cheese by ripened retentate had light effect on the salt content of the processed cheese, either after manufacture or after storing. The general trends of these results are in agreement with those reported by El-Neshawy *et al*., 1987 and Awad *et al*., 2005.

Fat and salt/Dry Matter (F/DM and salt/DM):

The results showed that, processed cheese contained ripened retentate had higher values of Fat/DM and salt/DM than control. This attributed to the content of fat and total solids. In addition, the data, demonstrated that both F/DM and salt/D.M. increased during storage either at refrigerator or at room temperature. The values are increased gradually with increasing the level of ripened retentate replacement in all treatments. On the other hand, the cheeses stored at refrigerator had lower values than at room temperature. These results are in agreement with Awad *et al*., 2005.

Total Volatile Free Fatty Acids (TVFFA):

The results presented in Table 3 show that, replacing mature Ras cheese by ripened retentate increased the levels of TVFFA in the fresh processed cheese and during storage either at refrigerator or at room temperature in all treatments, the extend of the increase being related to the level of ripened retentate used in the manufacture of the processed cheese. This is attributed to the higher levels of both soluble nitrogenous compounds and TVFFA in the ripened retentate (Table 1).

The TVFFA levels in the processed cheese increased during storage, especially at room temperature. The increases in the TVFFA during storage may be due to the residual activity of heat resistant proteinases and lipases, respectively, present in the blend (Abdel-Baky, 1979). The general trend of these results is in agreement with those of Abdel-Salam *et al*., 1983; Abdel-Baky *et al*., 1987; El-Neshawy *et al*., 1987 and Awad *et al*., 2005.

pH values:

The pH values of processed cheese after manufacture (control) had higher values than contained ripened retentate. In addition, the data demonstrated that pH values decreased during storage either at refrigerator or at room temperature for 3 months in all treatments as a result of fermentation of residual lactose and degradation of compounds of protein and fat (Hofi *et al*., 1991). Also, this could be due to hydrolysis of the polymerized polyphosphates present in the Joha emulsifing salts and their interaction with proteins (Caric *et al*., 1985). On the other hand, the results indicated that processed cheeses stored at refrigerator had higher values than stored at room temperature. These results are in agreement with Awad *et a*l., 2005.

Bacteriological quality of cheese:

Heating of cheese blend is the most important step in making of processed cheese, it is considered the main factor responsible for good keeping quality of cheese during the following period: fresh and during storage either at refrigerator or at room temperature.

Table 3: Chemical composition of processed cheese as affected by replacing mature Ras cheese by ripened retentate.

Component (%)	Storage temperature (°C)	Storage period (months)	Percentage of substitution (%)				
			Control	25	50	75	100
Moisture	Fresh	-	52.49	53.37	54.07	55.00	55.53
	Ref. temp.*	1	52.41	53.33	54.01	54.98	55.51
		2	52.26	53.30	53.95	54.95	55.50
		3	52.22	53.29	53.93	54.93	55.49
	Amb. temp.**	1	52.39	53.32	54.00	54.97	55.48
		2	52.24	53.27	53.94	54.95	55.37
		3	52.21	53.24	53.92	54.91	55.32
Fat	Fresh	-	20.59	20.64	20.62	20.64	20.57
	Ref. temp.	1	20.63	20.66	20.66	20.67	20.58
		2	20.71	20.69	20.69	20.69	20.65
		3	20.77	20.71	20.71	20.71	20.70
	Amb. temp.	1	20.66	20.67	20.69	20.68	20.69
		2	20.77	20.75	20.73	20.69	20.77
		3	20.80	20.77	20.76	20.71	20.80
Fat/DM	Fresh	-	43.34	44.26	44.89	45.87	46.26
	Ref. temp.	1	43.35	44.27	44.92	45.91	46.26
		2	43.38	44.30	44.93	45.93	46.40
		3	43.47	44.34	44.95	45.95	46.51
	Amb. temp.	1	43.39	44.28	44.98	45.92	46.47
		2	43.49	44.40	45.01	45.93	46.54
		3	43.52	44.42	45.05	45.93	46.55
Salt	Fresh	-	1.31	1.32	1.33	1.31	1.31
	Ref. Temp.	1	1.33	1.35	1.34	1.33	1.32
		2	1.36	1.36	1.35	1.33	1.32
		3	1.38	1.37	1.36	1.33	1.30
	Amb. temp.	1	1.35	1.36	1.34	1.32	1.31
		2	1.37	1.37	1.36	1.33	1.32
		3	1.38	1.39	1.35	1.34	1.33
Salt/DM	Fresh	-	2.76	2.83	2.90	2.93	2.95
	Ref. temp.	1	2.79	2.89	2.91	2.95	2.97
		2	2.85	2.91	2.93	2.95	2.97
		3	2.89	2.93	2.95	2.95	2.97
	Amb. temp.	1	2.84	2.91	2.91	2.93	2.94
		2	2.87	2.93	2.95	2.95	2.96
		3	2.89	2.95	2.97	2.97	2.98
TVFFA	Fresh	-	17.90	18.50	21.00	22.30	22.58
	Ref. temp.	1	18.41	18.70	21.60	22.55	22.63
		2	19.92	20.12	23.00	23.26	23.99
		3	22.00	22.20	24.20	24.70	24.98
	Amb. temp.	1	18.66	19.34	23.02	23.32	22.75
		2	21.67	24.01	26.23	26.98	29.45
		3	24.46	26.60	28.40	29.50	30.22
pH	Fresh	-	5.70	5.69	5.63	5.68	5.77
	Ref. temp.	1	5.65	5.63	5.60	5.65	5.69
		2	5.62	5.59	5.49	5.56	5.67
		3	5.58	5.55	5.44	5.51	5.62
	Amb. temp.	1	5.64	5.61	5.56	5.62	5.68
		2	5.56	5.55	5.43	5.51	5.66
		3	5.55	5.49	5.39	5.47	5.60

Ref. temp.*: refrigeration temperature (6-8°C); Amb. temp.**: ambient temperature (22-25°C)

Untabulated data showed that, heating cheese blend caused in sharp reduction in total bacterial count, as well as the count of aerobic spore forming bacteria. However, the aerobic spore forming bacteria comprised mostly the whole sum of total bacterial count such finding might be attributed to the heat resistance ability of aerobic spore formers bacteria.

The results in Table 4 show that, replacing mature Ras cheese by ripened retentate in the blends used for the manufacture of processed cheese tended to increase the total bacterial and spore-formers counts in the resultant processed cheese. These increases in bacterial counts were related to the level of ripened retentate used in the processed cheese. El-Neshawy *et al*., 1987 found that, using enzyme-treated cheese curd slurries tended to slightly increase the total bacterial and spore-former counts in processed cheese spreads.

As shown in Table 4, the total bacterial and spore former counts increased in all processed cheeses during storage either at refrigerator or at room temperature, as well as, fresh cheese. The total bacterial and spore former counts were higher in all processed cheese stored at room temperature than in those stored in the refrigerator. Similar results were obtained by Emara, 1984; Abdel-Baky *et al*., 1987 and El-Neshawy *et al*., 1987.

Organoleptic properties:

The consumption of processed cheese is mainly determined by its organoleptic properties such as; flavor, appearance and structure. Indeed the involving of any new ingredient into cheese blend should be evaluated throw its affect on the organoleptic properties of produced cheese. Mean values of the organoleptic scores within each processed cheese, were examined after manufacture or after storage by panel test and score were awarded for appearance (20 points), structure (40 points) and flavor & aroma (40 points), according to Meyer, 1973.

The average scores for processed cheese made from blends containing rapidly ripened retentate are shown in Table 5. The data showed the organoleptic properties assessment of processed cheese samples, either of control or of this made by using ripened retentate. The tabulated results revealed that, the mean organoleptic score of control samples was 88 points, while that of processed cheese of 75 % replaced ripened retentate curd being 94 points for fresh processed cheese. It is clear from the results that, replacing up to 75% of mature Ras cheese by ripened retentate resulted in a processed cheese with superior texture, appearance and flavour to the control product.

On the other hand, the experimental processed cheese showed a better appearance, structure and flavour in the fresh cheese than the cheese stored at refrigerator or at room temperature. The evaluation of the 100% ripened retentate replacement showed the lowest score. In addition, it could be observed that values of.

From the forgoing results, it could be concluded that processed cheese can made by substitution Ras cheese by ripened retentate up to 75%. But if cheese is going to be consumed after storage, the cheese must be stored at refrigerator temperature than at room temperature.

These results may be explained on the basis that the high levels of TVFFA in the ripened retentate are essential contributors to the improved flavour and appearance of the resultant product.

Kosikowski, 1978 and Lazaridis *et al*., 1981 showed that, increasing the extent of proteolysis of cheese proteins gave a softer and more meltable processed product. In addition, accelerated lipolysis provided a pool of flavour compounds, which enhanced cheese flavour.

Kumar, 1979 and Sood & Kosikowski, 1979 reported that, using retentates containing small amounts of added food-grade fungal proteinase and lipase preparations improved the quality of the resultant cheese.

Table 4: Bacteriological examination of processed cheese as affected by replacing mature Ras cheese by ripened retentate (Counts×10/gm).

Microbial type	Storage temperature. (°C)	Storage period (months)	Percentage of substitution (%)				
			Control	25	50	75	100
Total bacteria count	Fresh	-	15	16	18	20	22
	Ref. temp.	1	15	17	19	21	23
		2	16	18	21	22	25
		3	17	19	23	23	27
	Amb. temp.	1	23	29	41	46	52
		2	26	32	49	51	53
		3	39	49	53	56	59
Spore formers count	Fresh	-	7	8	10	11	13
	Ref. temp.	1	8	9	11	12	12
		2	10	11	12	13	14
		3	11	12	13	14	15
	Amb. temp.	1	13	19	23	31	42
		2	18	23	31	33	40
		3	22	26	34	40	48

Table 5: Sensory properties of processed cheese as affected by replacing mature Ras cheese by ripened retentate.

Storage temp. (°C)	Properties		Percentage of substitution (%)				
			Control	25	50	75	100
Fresh	Appearance (20)		18	18	18	18	16
	Structure	(40)	35	36	37	38	36
	Flavor	(40)	35	36	37	38	36
	Total	(100)	88	90	92	94	88
Ref. temp. (1month)	Appearance (20)		17	17	17	17	16
	Structure	(40)	34	35	37	38	35
	Flavor	(40)	35	36	37	37	35
	Total	(100)	86	88	91	92	86
(2 months)	Appearance (20)		16	16	16	17	16
	Structure	(40)	34	35	36	37	34
	Flavor	(40)	35	36	37	37	35
	Total	(100)	85	87	89	91	85
(3 months)	Appearance (20)		16	17	17	18	16
	Structure	(40)	34	34	35	35	34
	Flavor	(40)	34	35	38	38	34
	Total	(100)	84	86	90	91	84
Amb. temp. (1month)	Appearance (20)		16	16	16	16	15
	Structure	(40)	34	35	36	38	35
	Flavor	(40)	34	34	36	36	35
	Total	(100)	84	85	88	90	85
(2 months)	Appearance (20)		16	16	16	16	15
	Structure	(40)	34	35	36	37	35
	Flavor	(40)	33	34	35	36	35
	Total	(100)	83	85	87	89	84
(3 months)	Appearance (20)		15	16	17	17	14
	Structure	(40)	33	34	34	35	32
	Flavor	(40)	34	35	36	36	34
	Total	(100)	82	85	87	88	80

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