

## Preparation of Half-Fat Processed Cheese Made By Using Algae

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### ABSTRACT

Some algae, such as *Chlorella vulgaris* and *Spirulina Platensis*, have been used for decades to promote human health. The aim of this study was to prepare processed cheese analog (PCA) enriched with algae (*Chlorella vulgaris* and *Spirulina platensis*) and compare its properties (chemical, rheological and sensory evaluation) with standard processed cheese (control). Half-fat processed cheese enhanced by different values of slurry of algae. The Half-fat processed cheese tested with values of 2 and 4 % of slurry of algae. The results showed that the addition of 2% of algae was better than 4% for the sensory evaluation of half-fat PCA samples. But it can be use 2 and 4 % of slurry algae (*Chlorella Vulgaris* or *Spirulina platensis*) for manufacture of half-fat processed cheese and adjust the cheese's color by using annatto, in addition to improve the body and texture by using starch. Therefore, the research recommends using slurry of algae (*Chlorella vulgaris* and *Spirulina platensis*) for preparation of half-fat processed cheese.

**Key words:** Processed Cheese, algae, *Chlorella vulgaris*, *Spirulina platensis*.

### INTRODUCTION

Processed cheese holds significant value in the dairy industry since its high level of preservation makes it simple to produce and distribute. Natural cheese of various ages and maturities is combined with emulsifying salts and other dairy and nondairy components to create processed cheese. The mixture is then heated and mixed to create a uniform product with a long shelf life. (Meyer, 1973 and Guinee *et al.*, 2004). Recently, the processed cheese industry has developed to increase its nutritional value, reduce the cost of production, or increase its preservation ability. Unconventional ingredients like pepper, spices, oats, olives, and so on have also been used to create new types of processed cheese. (Kapoor and Metzger, 2008) and (Fox *et al.*, 2017). The aim of this study was to prepare processed cheese analog (PCA) enriched with algae (*Chlorella vulgaris* and *Spirulina platensis*) for some groups of people especially those with heart disease and atherosclerosis. Algae are a huge biological resource and one of the most promising sources to look for novel products and uses. (Pulz and Gross, 2004). *Spirulina* sp. and *Chlorella* sp. contain high-antioxidant components, high-quality proteins, unsaturated fatty acids, and vitamins including A, B2, B 6, B 8, B12, E, and K. Therefore, they are known as therapeutic and functional food (Merchant and Andre, 2001; Gyenis *et al.*, 2005). *Chlorella* sp. is beneficial to health since it can help with conditions like gastric ulcers, wounds, constipation, anaemia, and hypertension. It also contains anticancer and immune-modulating

qualities. (Mohamed *et al.*, 2013). In a previous study on processed cheese, it was studied the increment of nutritional and potential therapeutic value of full-fat processed cheese by using the soft powder of *Chlorella vulgaris* and *Spirulina platensis*. It proved that adding these algae to the processed cheese mixture added nutritional elements such as minerals and vitamins, in addition to increasing antioxidant activity (Tohamy *et al.*, 2019; Tohamy *et al.*, 2018). In this research, the preparation of half-fat processed cheese enhanced by using with values of 2 and 4 % of slurry of algae was tested.

## MATERIAL AND METHODES

### Materials:

Six months old Cheddar cheese and one month old Ras cheese were purchased from local stores which imported from New Zealand by Khaled Khoshala Co. for Food Industries & Cooling, Egypt and Mariam Co., Giza, Egypt, respectively. Skim milk powder was obtained from local market distributed by dairy America, made in U.S.A. S4 emulsifying salt was obtained from Rhone-Poulenc Chimie, France. Algae (*Spirulina platensis* and *Chlorella vulgaris*) in the form of slurry were obtained from Algal Biotechnology Unit, National Research Centre, Dokki, Giza, Egypt. Natural water-soluble annatto (O55-MF-WS) (1.8%) Norbixin (E160b) and potassium hydroxide (E525) was obtained from Misr food additives (S.A.E), Mifad Co., Badr city, Egypt. The corn starch powder was obtained from local market, Egypt. The chemical makeup of the raw ingredients used to prepare the analogue cheese samples is displayed in Table 1.

Table (1): Chemical composition of the raw materials used in processed cheese.

Character Assessed	Cheddar cheese	Ras cheese	Skim milk powder	Slurry <i>Chlorella vulgaris</i>	Slurry <i>Spirulina platensis</i>
Total solids	65.8	54.81	96	10.9	9.95
Fat	34.8	24.77	1.5	1.41	0.85
Crude protein	<sup>1</sup> 25.47	<sup>1</sup> 22.26	<sup>1</sup> 37.13	<sup>3</sup> 5.96	<sup>3</sup> 6.35
Ash	5.42	5.76	7.89	1.1	0.89
Carbohydrate	0.1	1.64	47.43	1.37	1.59
Fiber	ND	<sup>2</sup> ND	ND	1.06	0.26

1: Protein% - N × 6.38. 2: Not Detected. 3: protein% - N × 4.38

### Methods:

#### Preparation of processed cheese samples:

Processed cheese analogue (PCA) samples were manufactured according to Savello *et al.* (1989) with some modifications. The half-fat experimental PCA treatments were formulated to yield PCA with 63% moisture and 33.8 % fat-in-dry-matter. Control processed cheese was made of young Ras cheese and matured Cheddar cheese as a base blend. Half-fat processed cheese samples were manufactured by using slurry of *Spirulina platensis* and *Chlorella vulgaris* in ratios of 2 and 4 %. Control processed cheese was made of Ras cheese and Cheddar cheese as a base blend. The ingredients of half-fat with slurry of algae were shown in Table 2. The ingredients were mixed well and then subjected to heat treatment to prepare processed cheese (control) and PCA treatments. Before filling the blends into tin cans, the blends were heated to 82°C. After that, algae were added, and the blends were processed for 5 to 10 minutes on 10 pars using an ultra turrax homogenizer. The blends were then stored at 5-7°C and examined for chemical, rheological, and microbiological properties as well as sensory evaluation.

Table (2): Composition (kg/100kg) of blends of algae half-fat processed cheese.

Ingredients	Control	Slurry of <i>Chlorella</i> processed cheese		Slurry of <i>Spirulina</i> processed cheese	
		2 %	4 %	2 %	4 %
Cheddar cheese	14.8	14.8	14.8	14.8	14.8
Ras cheese	29.69	29.69	29.69	29.69	29.69
Skim milk powder	4.95	4.72	4.49	4.74	4.53
S4 Emulsifying salt	1.7	1.7	1.7	1.7	1.7
Salt	1	1	1	1	1
Starch (1% in DM)	0.34	0.34	0.34	0.34	0.34
Algae	-	2	4	2	4
Annatto	-	25 ml	50 ml	25 ml	50 ml
Water	47.52	45.75	43.98	45.73	43.94

### Methods of analysis:

The profile of *Chlorella vulgaris* and *Spirulina platensis* were analyzed according AOAC (2006) in terms of fat, protein, moisture, fiber and ash contents. For cheese; total protein, soluble nitrogen, total solids, fiber, ash and titratable acidity contents were determined according to AOAC (2016). The Gerber method, as detailed by Ling (1963), was used to determine the fat content. The salt content was determined using Marshall's (1992) methodology. A digital pH meter type Adwa 1030 was used in the laboratory to test the pH values. The parameters for oiling off were determined using Thomas's method (1973). The samples' meltability was assessed using Olson and Price's (1958) methodology, which Savello *et al.* (1989) somewhat modified. Penetrometer reading of samples were determined as described by Gupta and Reuter (1993). Sensory properties were evaluated by 15 persons of the staff members of the Dairy Department, Al-Azhar University, Cairo, Egypt according Caul (1957), Brandt *et al.* (1963) and Larmond, (1977). The methods used to determine the microbiological characteristics of samples were described in the Standard Procedures for the Examination of Dairy Products according to (Marshall, 1992). According to SAS (2001), statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS version 20 (IBM)). The difference between means at the 0.05 level was ascertained using Duncan's multiple range tests.

## RESULTS AND DISCUSSION

This research studies the properties of half-fat processed cheese containing 2 and 4 % of slurry algae with annatto to suit for some groups of people especially those with heart disease and atherosclerosis. The blends were made by using young Ras and matured Cheddar cheeses, skim milk powder, slurry algae (*Chlorella vulgaris* and *Spirulina platensis*), S4 emulsifying salt, starch, salt and annatto as shown in figures (1 and 2).



Fig. (1): Processed cheese made by using slurry of *Spirulina platensis* with/without adding of annatto.

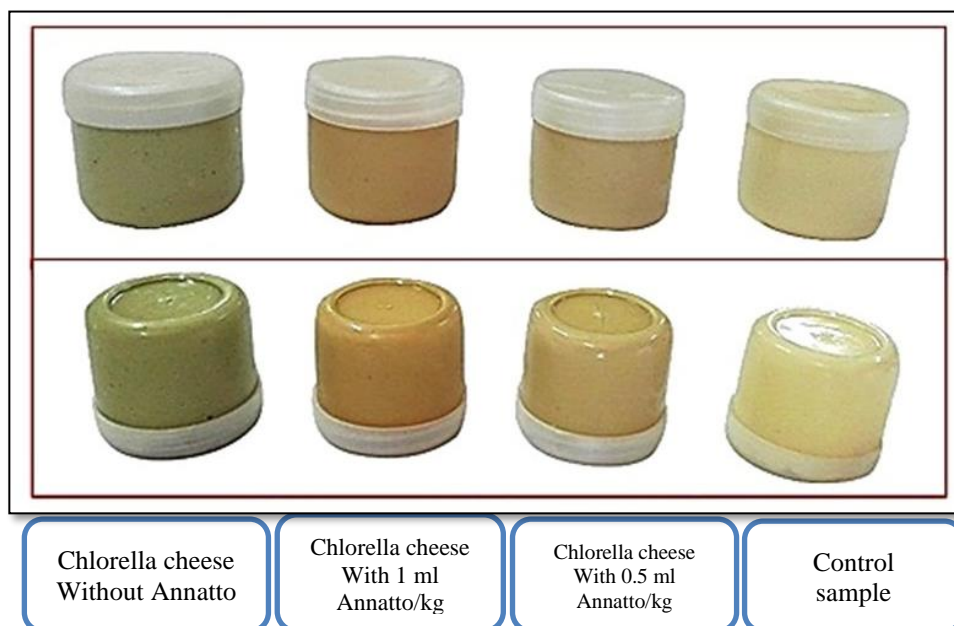


Fig. (2): Processed cheese made by using slurry of *Chlorella vulgaris* with/without adding of annatto.

**Sensory evaluation of half-fat processed cheese made using algae:**

The results of the sensory properties of half-fat processed cheese made by using 2 and 4 % of slurry of algae (*Chlorella Vulgaris* and *Spirulina platensis*) are presented in Table (3). All treatments were acceptable and the products of the 2 % algae addition were the nearest to the control sample, this may be due to reduce of value of algae in cheese. The addition of annatto led to improve the color of cheese in samples of algae cheese. Surface appearance of the control sample was shiny very much with score of 5 from 5, and the cheese with 2 % of algae had score of 4 from 5 due to add of algae and annatto. The control sample had score of 5 from 5 for spreading quality and other samples had score of 4 from 5. This may be due to the algae

additive. The oiling off was absent in all samples due to the using of suitable emulsifying salts. The flavor of cheese samples with 2 % of algae had score of 4 from 5 as compared to the control sample which had 5 from 5 score. Through sensory evaluation, it can be use 2 and 4 % of slurry algae (*Chlorella Vulgaris* and *Spirulina platensis*) for manufacture of half-fat processed cheese.

Table (3): Sensory evaluation of half-fat processed cheese made by using slurry of algae.

Attribute	Control	Chlorella processed cheese		spirulina processed cheese		Score limit (1 - 5)	
		2 %	4 %	2 %	4 %		
Surface appearance	5	4	3	4	3	(1) dull very much	(5) shiny very much
Firmness of body	4	4	3	4	3	(1) very soft	(5) very firm
Spreading quality	5	4	4	4	4	(1) difficult to spread	(5) easy to spread
Stickiness	3	3	3	3	3	(1) not sticky	(5) very sticky
Smoothness of texture	4	3	3	3	3	(1) not smooth	(5) very smooth
Breakdown properties	5	4	3	4	3	(1) doesn't dissolve	(5) dissolve very well
Oiling off	1	1	1	1	1	(1) absent	(5) very pronounced
Flavour	5	4	3	4	3	(1) very weak	(5) very strong
Saltiness	2	2	2	2	2	(1) not salt	(5) very salt
Over all preference	5	4	3	4	3	(1) dislike very much	(5) like very much

### Chemical analysis of half-fat processed cheese made by using slurry of algae:

Chemical analysis of half-fat processed cheese made by using 2 and 4 % of slurry of algae (*Chlorella Vulgaris* and *spirulina platensis*) shows in Table (4). No significant difference was found between all treatments in the TS, F and ash contents compared to the control sample. The percentages of TS, F and ash were ranged between 37.180 - 38.635, 12.5 - 13.5 and 2.56 - 2.89 respectively. As for protein content, the control sample was the highest (13.4 %) followed by the treatment of cheese with 4 % of spirulina (13.36 %). But the sample of the cheese with 4 % chlorella was the lowest (11.77 %). These results were identical with the results of El-Shibiny *et al.* (2007). Also, the pH values ranged between 5.81 and 6.03, which is characteristic of spreadable processed cheese and congruous with Shamsia *et al.* (2011).

Table (4): Chemical analysis of half-fat processed cheese made by using slurry of algae.

Analysis parameters	Control	Slurry of Chlorella cheese		Slurry of Spirulina Cheese	
		2 %	4 %	2 %	4 %
TS	38.395 <sup>a</sup>	37.805 <sup>a</sup>	38.355 <sup>a</sup>	37.180 <sup>a</sup>	38.635 <sup>a</sup>
Fat	13.5 <sup>a</sup>	12.5 <sup>c</sup>	13.5 <sup>a</sup>	12.5 <sup>c</sup>	13.00 <sup>b</sup>
Fat/DM	35.16 <sup>a</sup>	33.06 <sup>b</sup>	35.20 <sup>a</sup>	33.62 <sup>b</sup>	33.65 <sup>b</sup>
Protein	13.4 <sup>a</sup>	12.64 <sup>ab</sup>	11.77 <sup>bc</sup>	10.85 <sup>c</sup>	13.36 <sup>a</sup>
Ash	2.58 <sup>b</sup>	2.89 <sup>a</sup>	2.86 <sup>a</sup>	2.56 <sup>b</sup>	2.86 <sup>a</sup>
Salt	1.11 <sup>a</sup>	1.12 <sup>a</sup>	1.11 <sup>a</sup>	1.15 <sup>a</sup>	1.13 <sup>a</sup>
pH	5.89 <sup>ab</sup>	5.81 <sup>b</sup>	6.00 <sup>a</sup>	5.87 <sup>ab</sup>	6.03 <sup>a</sup>

\* Means with same letters in a row are not significant (p 0.05).

### Rheological characteristics of half-fat processed cheese produced with algae:

Table (5) showed the rheological properties of half-fat processed cheese made by using slurry of algae. Oiling off of sample made by using 2 % of Slurry of *Chlorella vulgaris* was the lowest (10%) and in the sample made by using 2 % of Slurry of *Spirulina platensis* was the highest (14.48%) as compared to the control sample (11.38 %). These results were agreed with the results of Suhila *et al.* (2016). The meltability of the samples made by using 2 % of algae were the nearest to the control sample, where it was 52, 55 and 54 in cheese with chlorella, Spirulina and the control sample respectively. These results were agreed with Awad *et al.* (2014). Generally, although the high of moisture and penetrometer reading, the meltability was low. This may be due to the addition of starch in blends. According to Gampala and Brennan's (2008) findings, starch was added to processed cheese recipes at quantities between 1% and 2% of the total solid ingredients. The hardness of processed cheese rises with the addition of starch. The amylose level of starch was shown to be correlated with both the degree of melting and firmness of cheese when heated. The penetrometer reading of the sample made by using 4 % of Slurry of *Spirulina platensis* was the highest (225 mm) as compared to the control sample (145mm) which was the lowest. Penetrometer reading results were consistent with results of Mohamed *et al.* (2013).

Table (5): Rheological properties of half-fat processed cheese made using of algae.

Rheological Properties	Control	Slurry of Chlorella cheese		Slurry of Spirulina Cheese	
		2 %	4 %	2 %	4 %
Oiling off (%)	11.38 <sup>b</sup>	10 <sup>c</sup>	10.54 <sup>bc</sup>	14.48 <sup>a</sup>	11.14 <sup>b</sup>
Melting index (mm)	54 <sup>ab</sup>	52 <sup>b</sup>	41 <sup>d</sup>	55 <sup>a</sup>	44 <sup>c</sup>
Penetrometer reading(mm)	145 <sup>c</sup>	174 <sup>b</sup>	219 <sup>a</sup>	170 <sup>b</sup>	225 <sup>a</sup>

\* Means with same letters in a row are not significant (p 0.05).

### Microbiological analysis of half-fat processed cheese made using of algae:

Table (6) showed the microbiological counts of half-fat processed cheese made by using slurry algae. All samples were containing very few numbers in the total count test (ranged between 5 – 11 log 1). Yeast, moulds and coliform group didn't detect in all treatments. Few



numbers of anaerobic Spore formers were detected in the control sample (2 log 1), cheese with 2 % *Spirulina platensis* (s log 1). Aerobic Spore formers were detected in cheese with 4 % chlorella (3 log 1) and in cheese with 4 % *Spirulina* (4 log 1). These Scarce numbers may be due to the pollution of samples during filling. Also, these numbers exactly less than the numbers found by El-Shibiny *et al.* (2007) and Shamsia *et al.* (2011).

**Table (6): Microbiological analysis of half-fat processed cheese made using algae.**

Microbial type	Control (log 1)	Slurry Chlorella Cheese (log 1)		Slurry Spirulina cheese (log 1)	
		2 %	4 %	2 %	4 %
TC	10	5	7	11	9
Anaerobic Spore formers count	2	Nil	Nil	5	Nil
Aerobic Spore formers count	Nil	Nil	3	Nil	4

### Conclusions:

This research studied the properties of half-fat processed cheese enhanced by two types of algae (*Chlorella vulgaris* and *Spirulina platensis*) because of their high nutritional and health value. The half-fat processed cheese samples were prepared with addition of 2 and 4 % of slurry of algae. Annatto color was used for improving the color of algal processed cheese. The research was recommended to manufacturing of half-fat processed cheese by using 2 and 4 % of slurry of *Chlorella* and *Spirulina* and adjusting of their color by using annatto. Also, more research should do to gain more knowledge about using the algae in dairy products especially in processed cheese making. It must be attention to the production of algae in Egypt as a dietary supplement.

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