Introduction

Processed cheese is a dairy product which differs from natural cheese in the fact that processed cheese is not made directly from milk. However, the main ingredient of process cheese is natural cheese. Process cheese is produced by blending natural cheese of different ages and degrees of maturity in the presence of emulsifying salts and other dairy and nondairy ingredients followed by heating and continuous mixing to form a homogeneous product with an extended shelf life **(Guinee *et al.*, 2004; Kycia *et al.*, 2006 and Kapoor *et al.*, 2007).**

During the manufacturing of processed cheese, the addition of emulsifying salts, such as sodium salts of phosphates and citrates, improves the emulsification properties of caseins in natural cheese by disrupting the calcium–phosphate protein network **(Berger *et al.*, 1998)**

Emulsifying salts and other ingredients used while formulating a processed cheese, in combination with the processing conditions(cook temperature ,cook time ,rate of agitation during cooking ,and the rate of cooling after manufacture), are the key factors that provide the final processed cheese with its unique microstructure **(Kapoor and Metzger 2008).**

Carrot (Daucus carota L.) is an important root vegetable. Rich in bioactive compounds like carotenoids and dietary fibres, it also contains appreciable levels of several other functional components. Hence, it can produce a significantly beneficial influence on the human health. The consumption of carrots and carrot products grows steadily because the vegetable is thought to be an important

source of natural antioxidants with anticancer activity **(Sharma *et al.*, 2012).**

Carrot pigments such as carotenoids, poly acetylenes, and phenolic acids are effective antioxidants. Foods such as carrot that contain natural antioxidants enhance resistance to oxidative damage **(Leiss *et al.*, 2013)** and have a substantial impact on human health. Keeping in mind the beneficial properties of carrot phytochemicals in the human diet, it is necessary to make policy makers aware of the promotion of carrot as a food security crop in the future to meet global food demands and to improve the health of poor people through natural resources.

Physalis is a genus of flowering plants in the nightshade family (Solanaceae), which grow in warm temperature and subtropical regions of the world. Most of the species, of which there may be 75-90, are indigenous to the new world. Cultivated species and weedy annuals have been introduced worldwide. A notable feature is the formation of a large papery husk derived from the calyx, which partly or fully encloses the fruit. The fruit is small and orange, similar in size, shape and structure to a small tomato. At least 46 species are endemic to the country of Mexico **(Whiston and Manos, 2005).**

Cape gooseberry or Physalis (*Physalis Peruviana)* commonly known as cape gooseberry, poha, ground cherry, and husk tomato, the fruit contains many seeds, and is juicy, sweet, and tangy, with a high content of vitamin C, carotenoids, and bioflavonoid with antioxidant properties. The berries are eaten fresh or used in making jam. Locally, the fruit is eaten fresh, preserved as jam, or prepared in pies, or ice-cream. A number of ethnic and cultural groups employ the leaves, stems, and fruits of Cape gooseberry in

medicinal folkloric medicine (s) for the treatment of asthma, abdominal ailments in children, constipation, diuretic, glaucoma, headache, jaundice, reducing swelling and inflammation, postpartum, pain, skin diseases, and as a vermifuge **(Anjalam *et al.*, 2016).**

MATERIALS AND METHODS

MATERIALS:

Ras Cheese, Skim milk powder, Butter were purchased from the local market at Shebin El-Kom, Menoufia, Egypt.

Cottage cheese was purchased from the local market at El Shohadaa ,Menoufia, Egypt.

Carrot & cape gooseberry obtained fresh from the local markets of Menoufia and Tanta respectively.

Emulsifying salts: Sodium citrate and Dioxide Phosphate were purchased from Al Gomhouria Company, Tanta.

Cheese preservative: Potassium sorbate was the cheese preservative and it was obtained from National Research Center EL- Giza, Cairo, Egypt.

Methods:

Preparation of processed cheese spread:

Processed cheese "spread" was manufactured by mixing ras cheese, cottage cheese, butter, skim milk powder and grinding them well then dissolving the mixture of Emulsifying salts(3%) in the water, mixing the blend and processing at 85°C for 8-10 min described by **Mayer (1973)** using a double jacket pan; cheese preservative added by 0.1% to the blend. Thereafter, the resultant spreads filled

into plastic containers (100 g) , sealed well and cold stored at 5±2°C for 3 months.

Chemical analysis

Cheese samples were analyzed for moisture, ash, acidity, fat which were determined according to the methods described by **A.O.A.C. (2010).**

Soluble nitrogen and total nitrogen was determined according to the method described in **Ling (1963)**.

Carbohydrates(%) was calculated with the following equation: Carbohydrates (%) = Total solids (%) – [Fat (%) + Protein (%) + Ash (%)]

Caloric value of processed cheese samples was calculated based on conversion factors as follows: protein (4), fat (9), carbohydrates (4) and expressed as kcal/100 g processed cheese.

Sensory evaluation:

Samples of cheese were evaluated for outer color and appearance (20 points), body and texture (40 points) and aroma and flavor (40 points) according to **Awad *et al.*, (2004)** by 20 panelists from the staff of the department of Nutrition and Food Science Dept., Faculty of Home Economics, Menoufia University, and students of the same college. Judges were provided with room temperature rinse water, plastic spoons and score sheets. The course was repeated three times.

Rheological properties of processed cheese :

The texture profile analysis test (TPA) such as hardness, springiness, cohesiveness, adhesiveness, gumminess and chewiness of processed cheese was by LFRA-Texture analyzer (1000) using computer interface

software (CNS Farnell, Bore Harwood, Hertfordshire, England WD61WG) according to **(Breen, 1975 and Bourne, 1978).**

Statistical analysis:

The data were analyzed using a completely randomized factorial design **(SAS, 1988)** when a significant main effect was detected; the means were separated with the Student-Newman-Keuls Test. Differences between treatments of ($P \leq 0.05$) were considered significant using Costat Program. Biological results were analyzed by One Way ANOVA.

RESULTS AND DISCUSSION

Table (1): Effect of storage period on the appearance of processed cheese spread with different additives

Treatment	Storage period				
	Zero time	1 month	2 months	3 months	LSD
Control sample	17.38 ^{a} ± 0.17	16.92 ^{b} ±0.12	15.2^{c} ±0.42	14.5^{d} ±0.3	0.253
Cape gooseberry 10%	18.9^{a} ±1.3	18.44^{a} ±1.14	17.5^{b} ±0.7	17.3^{b} ±0.8	0.564
Cape gooseberry 20%	18.7^{a} ±0.8	18.1^{b} ±0.6	17.78^{c} ±0.58	17.7^{c} ±0.5	0.255
Carrots 10%	17.44^{a} ±0.54	17.4^{a} ±0.3	17.35^{a} ±0.25	16.8^{b} ±0.7	0.421
Carrots 20%	17.5^{a} ±0.7	17.38^{a} ±0.48	16.9^{ab} ±1.2	16.2^{b} ±0.3	0.778

It could be noticed that all values decreased over three months; the highest score was recorded in Cape gooseberry 10% as it was (18.9) followed by Cape gooseberry 20% as it was (18.7), then carrots 20% as it was

(17.5) followed by carrots 10% as it was (17.44). The lowest value was the control sample over three months.

Table (2): Effect of storage period on the body & texture of processed cheese spread with different additives

Treatment	Storage period				
	Zero time	1 month	2 months	3 months	LSD
Control sample	37^{a} ±0.6	36.38^{b} ±0.17	35.2^{c} ±0.2	34^{d} ±0.3	0.392
Cape gooseberry10%	37.61^{a} ±0.71	37.28^{a} ±0.88	36.51^{b} ±0.81	36.2^{b} ±0.5	0.331
Cape gooseberry20%	38.7^{a} ±0.9	37.77^{b} ±0.66	37.7^{b} ±0.5	37.2^{c}±0.4	0.436
Carrots 10%	37.4^{a} ±0.3	36.88^{ab} ±0.77	36.77^{b} ±0.91	36.5^{b} ±0.8	0.540
Carrots 20%	37.5^{a} ±0.6	37.2^{b} ±0.8	36.5^{c} ±0.8	36.2^{d} ±0.5	0.299

It could be noticed that all values decreased over three months; the highest score was recorded in Cape gooseberry 20% as it was (38.7)followed by Cape gooseberry 10% as it was (37.61), then carrots 20% as it was (37.5) followed by carrots 10% as it was (37.4). The lowest value was the control sample over three months.

Table (3): Effect of storage period on the flavor of processed cheese spread with different additives

Treatment	Storage period				
	Zero time	1 month	2 months	3 months	LSD
Control sample	36.42^{a} ±0.12	35.5^{b} ±0.3	34.3^{c} ±0.3	31.6^{d} ±1.02	0.797
Cape gooseberry10%	38.66^{a} ±1.26	37.6^{b} ±0.7	37.28^{bc} ±0.78	36.7^{c} ±1.3	0.627
Cape gooseberry20%	38.6^{a} ±0.5	37.1^{b} ±0.3	37.05^{b} ±0.35	36.92^{b} ±0.52	0.218
Carrots 10%	37.22^{a} ±0.07	36.92^{a} ±0.62	36.1^{b} ±0.6	35.7^{b} ±0.6	0.536

Carrots 20%	37.11[a] ±0.41	36.35[b] ±0.25	36.1[b] ±0.2	34.4[c] ±0.8	0.543

It could be noticed that all values decreased over three months; the highest score was recorded in Cape gooseberry 10% as it was (38.66) followed by Cape gooseberry 20% as it was (38.6), then carrots 10% as it was (37.22) followed by carrots 20% as it was (37.11). The lowest value was the control sample over three months.

All obtained processed cheese analogue were acceptable but the most acceptable blends of cheese analogue were produced with adding 10% of additives to cheese which ranked slightly higher scores than which adding by 20%.

The sensory quality attributes of all treatments including the control decreased during storage. These data was in the same line with the findings of **(Awad and Salama, 2010 a,b)** who mentioned that the acceptability of processed cheese decreased with extending the storage period.

All the samples were accepted and had high rating for all the sensory properties in the various storage periods. Sensory properties scores of the cheese with carrot paste whether by 10% or 20% were higher than the control sample in the three storage periods; this is expected because of its attractive orange color and spreadable texture.

On the other hand, the score of color was decreased by the storage period but this decreasing was insignificant.

The overall acceptance scores of all samples were rated good. On the other hand, the panelists gave insignificantly lower rating with the longer storage period,

this is due to the fact that with the increasing storage time, the color, flavor and texture are changed.

The obtained results of sensory properties are in the same line with **(Bandyopadhyay *et al.*, 2007)** who reported that carrot with attractive orange color and a higher quantity of carrot induced more attractive orange color in Indian rasogolla cheese samples. The same authors explain the reduction of color score fading by the storage is might be due to Maillard reaction (the non enzymatic browning reaction).

Cheese prepared by various ratios of carrot paste was accepted by the panelist. Thus, the overall mean acceptability scores for various cheese samples of carrot paste indicates the commercial scope for manufacturing healthy cheese with carrot paste, which will also be helpful in providing daily dietary requirements of β-carotene and vitamin A and the other important nutrients that exist in the carrot.

The obtained results for cape gooseberry were in agreement with those of other studies conducted by **(Bravo *et al.*, 2015)** and **(Moura *et al.*, 2016b)**.

Table (4): Chemical composition of processed cheese spread (control)

Storage period	Moisture%	Ash%	Sodium chloride%	Total protein%	Fat%	Carbohydrate%	Acidity%	Calories Kcal/100g
Zero time	46.38	4.16	4.96	16.38	23.12	5	1.05	293.6
1month	46.10	4.18	4.99	16.46	23.24	5.03	1.06	295.12
2months	45.96	4.19	5	16.49	23.30	5.06	1.06	295.9
3months	45.83	4.20	5.01	16.55	23.35	5.06	1.06	296.59
Average	46.07	4.18	4.99	16.47	23.25	5.04	1.06	295.30

Moisture: It could be noticed that the moisture decreased with long storage period and the moisture average of three months was (46.07).

Ash, Sodium chloride, Total protein, Fat, Carbohydrate , Acidity and Calories were increased with long storage period and their average of three months were (4.18) ,(4.99), (16.47), (23.25), (5.04), (1.06), (295.30) respectively.

Table (5): Chemical composition of processed cheese spread with Cape gooseberry 10%

Storage period	Moistue %	Ash %	Sodium chloride %	Total protei n%	Fat%	Carbohyd rate%	Acidity%	Calories Kcal/10g
Zero time	50.28	3.82	4.46	14.92	20.84	5.68	1.22	269.96
1month	50.06	3.84	4.48	14.98	20.93	5.71	1.23	271.13
2months	49.84	3.85	4.50	15.05	21.02	5.74	1.23	272.34
3months	49.62	3.87	4.52	15.12	21.10	5.77	1.24	273.46
Average	49.95	3.85	4.49	15.02	20.97	5.73	1.23	271.72

It could be noticed that the moisture decreased with long storage period but it was higher than the control over the three months, and it's average was (49.95).

Ash, sodium chloride, total protein, fat and calories were increased with long storage period but it was lower than the control over the three months and their averages of three months were (3.85) , (4.49), (15.02), (20.97), (271.72) respectively.

Carbohydrate and acidity were increased with long storage period but had higher values than the control over the three months, and their averages were (5.73) , (1.23) respectively.

Table (6): Chemical composition of processed cheese spread with Cape gooseberry 20%

Storage period	Moisture%	Ash%	Sodium chloride%	Total protein%	Fat%	Carbohy drate%	Acidity%	Calories% Kcal/100g
Zero time	54.17	3.48	3.97	13.46	18.57	6.35	1.25	246.37
1month	53.95	3.50	3.99	13.52	18.66	6.38	1.26	247.54
2months	53.73	3.51	4.01	13.59	18.75	6.11	1.26	247.55

3months	53.51	3.53	4.03	13.65	18.84	6.44	1.27	249.92
Average	53.48	3.51	4	13.56	18.71	6.32	1.26	247.85

It could be noticed that the moisture decreased with long storage period but it was higher than the control over the three months and it's average was (53.48).

Ash, sodium chloride, total protein, fat and calories were increased with long storage period but it were lower than the control over the three months, and their averages of three months were (3.51) , (4) , (13.56) , (18.71) , (247.85) respectively.

Carbohydrate and acidity were increased with long storage period but it were higher than the control over the three months, and their averages were (6.32) , (1.26) respectively.

The obtained results were in agreement with those of other studies conducted by **(Bravo *et al.*, 2015)** and **(Moura *et al.*, 2016b)**.

Table (7): Chemical composition of processed cheeses spread with Carrots 10%

Storage period	Moisture%	Ash%	Sodium chloride%	Total protein%	Fat%	Carbohy drate%	Acidity%	Calories% Kcal/100g
Zero time	50.65	3.85	4.47	14.86	20.84	5.33	1.10	268.32
1month	50.47	3.86	4.49	14.91	20.92	5.35	1.10	269.32
2months	50.28	3.88	4.50	14.97	21	5.37	1.11	270.36
3months	50.10	3.89	4.52	15.02	21.08	5.39	1.11	271.36
Average	50.38	3.87	4.50	14.94	20.96	5.36	1.11	269.84

It could be noticed that the moisture decreased with long storage period but it was higher than the control over the three months and it's average was (50.38).

Ash, sodium chloride, total protein, fat and calories were increased with long storage period but it was lower than the control over the three months, and their averages of

three months were (3.87) , (4.50) , (14.94) , (20.96) , (269.84) respectively.

Carbohydrate and acidity were increased with long storage period but it was higher than the control over the three months, and their averages were (5.36) , (1.11) respectively.

Table (8): Chemical composition of processed cheese spread with Carrots 20%

Storage period	Moisture%	Ash%	Sodium chloride%	Total protein%	Fat%	Carbohydrate%	Acidity%	Calories% Kcal/100g
Zero time	54.96	3.53	3.95	13.34	18.56	5.66	1.12	243.04
1month	54.79	3.54	3.97	13.39	18.63	5.68	1.25	243.95
2months	54.62	3.56	4	13.42	18.70	5.70	1.13	244.78
3months	54.45	3.57	4	13.49	18.77	5.72	1.15	245.77
Average	54.71	3.55	3.98	13.41	18.67	5.69	1.16	244.39

It could be noticed that the moisture decreased with long storage period but it was higher than the control over the three months and it's average was (54.71).

Ash, sodium chloride, total protein, fat and calories were increased with long storage period but it were lower than the control over the three months, and their averages of three months were (3.55) , (3.98) , (13.41) , (18.67) , (244.39) respectively.

Carbohydrate and acidity were increased with long storage period but it was higher than the control over the three months, and their averages were (5.69) , (1.16) respectively.

These results are in agreement with those of **(Ayar and Gurlin, 2014)** who found the addition of carrot increased dry matter in yogurt.

For the carbohydrates, it is various where it's higher in carrot cheese samples than the control one. It may be due to the high content of carbohydrate in carrot paste. The obtained results for carbohydrates were in the same line of obtained results of **(Madukwe and Eme, 2012)** who mentioned that the addition of carrot powder to the soy milk increased the content of those components and were increased with increasing the ratio of carrot powder.

Table (9): Effect of storage period on the Gumminess of processed cheese spread with different additives

Treatment	Storage period		
	Zero time	3 months	LSD
Control sample	23.9^{a} ±1.1	24.2^{a} ±0.4	1.739
Cape gooseberry10%	10.5^{a} ±0.7	6^{b} ±0.3	0.994
Cape gooseberry20%	5.7^{a} ±0.9	2.8^{b} ±0.9	2.040
Carrots 10%	12.2^{a} ±0.4	12.2^{a} ±0.5	0.248
Carrots 20%	14.6^{a} ±0.7	1.4^{b} ±0.3	0.994

All of the additives decreased the gumminess than the control, especially the addition of cape gooseberry whether by 10% or 20% as it was (10.5) (5.7) respectively, so it will be easier in chewing and reduce the amount of energy needed to chew the processed cheese.

Table (10): Effect of storage period on the Cohesiveness of processed cheese spread with different additives

Treatment	Storage period		
	Zero time	3 months	LSD
Control sample	0.29^{b} ±0.01	0.43^{a} ±0.02	0.025
Cape gooseberry10%	0.3^{b} ±0.02	1.12^{a} ±0.22	0.497
Cape gooseberry20%	0.79^{b} ±0.07	2.35^{a} ±0.44	0.919
Carrots 10%	0.35^{b} ±0.03	0.8^{a} ±0.04	0.151
Carrots 20%	0.5^{a} ±0.02	0.48^{a} ±0.08	0.149

All of the additives increased the cohesiveness than the control in both cases whether the addition was by 10% or 20%.

The highest score was recorded in addition of cape gooseberry by 20% as it was (0.79) then carrots 20% as it was (0.5), then carrots 10% as it was (0.35) and finally cape gooseberry as it was (0.3).

Table(11) : Effect of storage period on the Hardness of processed cheese spread with different additives

Treatment	Storage period		
	Zero time	3 months	LSD
Control sample	82.8^{a} ±0.9	56.6^{b} ±4.1	7.949
Cape gooseberry10%	34.6^{a} ±0.9	5.3^{b} ±0.4	1.242
Cape gooseberry20%	7.3^{a} ±0.8	1.2^{b} ±0.22	1.441
Carrots 10%	32.2^{a} ±0.5	15.2^{b} ±0.3	0.497
Carrots 20%	29^{a} ±1.1	3^{b} ±0.2	2.236

All of the additives decreased the hardness than the control in both cases whether the addition was by 10% or 20% so it was the highest value as it was (82.8) in zero time and (56.6) after 3 months.

The lowest value was cape gooseberry 20% whether in zero time or after 3 months as it was (7.3) , (1.2) respectively.

Table (12): Effect of storage period on the Adhesiveness of processed cheese spread with different additives

Treatment	Storage period		
	Zero time	3 months	LSD
Control sample	57.73^{a} ±1.33	3.653^{b} ±1.033	0.738
Cape gooseberry10%	23.27^{a} ±0.989	3.901^{b} ±1.321	0.825
Cape gooseberry20%	32.999^{a} ±17.37	2.866^{a} ±0.216	42.686
Carrots 10%	70.076^{a} ±0.792	7.183^{b} ±1.058	0.661
Carrots 20%	92.858^{a} ±1.172	1.788^{b} ±0.139	2.566

The addition of carrot by 20% has increased the adhesiveness compared with the control as it was (92.8) then adding carrots by 10% as it was (70.07).

while the adhesiveness values decreased from the control and the lowest value was in case of adding cape gooseberry addition by 10% as it was (23.27).

The texture pattern of processed cheese analogue as affected by adding carrot paste in various ratios indicated that enhancement of processed cheese analogue by carrot paste have significant effect of all tested texture properties of the samples, but the values of these properties were lower in enhanced cheeses with carrot than control cheese and were decreased by increasing the ratio of carrot paste. The reason for that could be the lower content of protein of carrot paste than that in the control cheese, also the presence of sugar which weak the network of cheese. These obtained results are in the same line with those of **(Kaminarides *et al.,* 2006)** who revealed that ash and salt contents of the cheese blend increased the hardness of the resulting processed cheese, so the control cheese was harder than the carrot cheese.

These results were in agreement with **(Awad *et al.,* 2014)** who showed that gumminess greatly reduced with increasing the added ratio of lupine in the formula of processed cheese . The same trend was spotted with **(Mohamed *et al.,* 2016)** who illustrated that enhancement of processed cheese with carrot paste had lower values of texture parameters than control sample.

The obtained results for cape gooseberry were in agreement with those of other studies conducted by **(Bravo *et al.,* 2015)** and **(Moura *et al.,* 2016b)**.

It is concluded that fruits and vegetables developed the desirable characteristics of processed cheese.

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