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IMPACT OF CARROT POMACE PASTE (*Daucus carota* L.) ADDITION ON SOME PROPERTIES OF PROCESSED CHEESE

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ABSTRACT

Carrot pomace paste (CPP) was taken on replacement 10, 20 and 30 % of the processed cheese base in the manufacture of block processed cheese. The resultant cheese was analyzed for some of its physicochemical properties and textural profiles. The basic blend of fresh control block processed cheese (BPC) contained 46.03% Fat/DM while the corresponding values of treated cheeses were 45.15, 44.35 and 44.46 for treatments 1, 2 and 3 respectively. The D.M, Fat/DM, protein, carbohydrates, soluble nitrogen (S.N), (TVFA) total volatile fatty acids, salt contents and ash of the fresh obtained products were decreased by the addition of CPP, while the pH value, B- carotenes and vitamin A were significantly increased ($p<0.05$). S.N and TVFA of all treatments gained gradually increased throughout the progress of storage period. Control cheese had higher values of the former parameters than other treatments with the exception of B-carotenes and Vit.A . Total phenolic compounds and radical scavenging activity were found higher in treated cheeses than the control cheese. Texture profile analysis (TPA) indicated rise in the hardness of BPC and decreased in springiness, cohesiveness, chewiness and gumminess with the increased level of CPP. Also, BPC exhibited low oil separation index (OSI) and low meltability with the increase of CPP in the cheese formulation. The obtained BPC for all treatments were organoleptically acceptable and the use of up to 30 % CPP in the manufacture can be recommended to reduce the costs of cheese production.

INTRODUCTION

Processed cheeses are among cheese verities appreciated by consumers, and the Egyptian dairy industry produce about 132.081 ton per year **(CAPMS, 2016).**

To reduce processing costs, Imitation products have been developed and are now widely used in fast food, pizza and formulated foods are in school lunch programs **SHAW (1984).** Imitation processed cheese is made from mixtures of dairy or non-dairy proteins and fat or oils . It is categorized labeled: synthetic, substitute, analogue, imitation, filled, artificial and extruded **Tawfek,(2018)**.

The main idea of processing cheese was to increase its shelf life **Meyer (1973)** as well as use cheese which would otherwise be difficult to sell, such as cheese containing minor defects such as over-ripening, localized incidence of molds, deformations and the more or remnants from cheese-cutting operations Latterly, the producers note that a wide assortments of new products could be made using various species of cheese (different in the degree of ripened), by incorporating other dairy products e.g. whey powder, cream, skim milk powder, butter, whey protein concentrate, emulsifier and flavour by varying the processing conditions. In most countries, the production of processed cheese has been increased steadily because of the variations in consistency, size, shape and flavour of the product. These variations make it attractive and simple to take on at preparation of public dining and at home. Moreover, vegetable and fruit by-products are available in big quantities, characterized by rise dietary fibers, resulting in rise water binding capacity and low enzyme digestible organic matter **Serena and Kundsen (2007).**These by-products which are inexpensive and available in big quantities **Shyamala and Jamuna , (2010**) exhibit less calories content and other important compounds e.g. antioxidants which that give many health benefits **González Centeno *et al.* (2010)**.

Carrot pomace (CP) is a waste obtained during carrot juice processing. The juice yield carrots is about 70% and up to 80% of carotene may be lost with left over CP **Bohme *et al.* (1999).** CP contains high-value compounds e.g. dietary fibers, organic acids, carotenoids, minerals, vitamins and neutral sugars. The water retention and swelling capacities of carrot pomace were relatively higher compared to the other agricultural by-products e.g. pear, orange and apple wastes, **Swati, *et al.* (2019).**The use it as a by-product will reduce the environmental pollution burden. carrot pomace can also be converted by adding it to products into high nutritional value products **Singh *et al*. (2006)**. It can mixed into some food products as cheap and low-caloric agents by partial replacement of some product components e.g sugar or fat, enhancing of oil and water retention and oxidative stabilities or improving emulsion **Elleuch *et al*. (2011).** Also, the nutritional and health importance of fiber-rich foods has been clarified **Yao & Andrew (2017)**.

In this study, carrot pomace was added in processed cheese formula in order to reduce its production costs, improving the nutritional value, adding healthy benefits and increasing its shelf life.

MATERIALS AND METHODS

Materials:

Ras cheese (fresh and mature from 3months) and butter oil were obtained from Faculty of Agriculture, Cairo University, Egypt. Nisaplin and emulsifying salt (Joha SE) were obtained from Danisco cultor, Denmark . carrot was bought from the local market, Dokki, Egypt.

Methods of processing:

Ras cheese manufacture:

Ras cheese (fresh and 3months old) were made by using cow's milk standardized to 3% fat. The other processing steps were made as mentioned by **Hofi *et al,*. (1970)**

Preparation of carrot pomace paste (CPP):

Carrot was washed with tap water for cleaning and removal of extraneous dirt. The clean carrots were peeled manually with knife, juice was extracted, using Juicer-Mixer- Grinder (Singer), and separated from the juice carrots to obtain their pomace. The remaining juice of the collected raw pomace was squeezed out by manual pressing method with the help of muslin cloth .The carrot pomace was put in boiling water (1kg carrot pomac / 200 ml water) for 10 min, then the mixture (carrot pomace and water) was minced well to get quite fine paste which kept frozen in bags, as described by **El- dardiry,*et al.* (2011).** The composition of the raw materials used in the present study is indicated in Table1.

Preparation of carrot pomace paste (CPP):

Table (1) : Chemical composition of Carrot pomace paste and Ras cheese used in formulation of block type processed cheese.

Ingredients	Carrot pomace paste	Ras cheese fresh	Ras cheese Mature
Moisture %	38.92	43.82	33.79
Protein%	2.94	22.31	26.55
Fat %	1.42	26.29	30.12
Ash %	0.69	4.25	5.06
Carbohydrate%(by difference)	16.88	1.76	0.97
Dietry fiber %	39.15	-	-
Salt %	-	3.03	3.51
Soluble nitrogen	0.104	0.548	0.761
TVFA*	5.4	21.4	39.7
pH value	7.91	5.2	4.87

TVFA* : Total volatile fatty Acid (ml NaOH 0.1 N/100g Product).

Block Processed cheese making:

It was made by using Ras cheese (fresh and mature) and carrot pomace paste (CPP) in formulating the base blend. The final products were adjusted to contain 58± 1% DM, 44 ± 1 % fat/DM., 2.38 emulsifying salt in control and 1.3±0.03 % in the other treatments , 0.01% Nisaplin , butter oil and water to all treatments . CPP was used to replace 10, 20 and 30% of cheese base in the mixture (as shown in table (2). All treatments were processed in double jacket ban (locally constructed) at 85-90°C/ 8 min. using indirect steam at pressure 2-2.5 kg/ cm^2.The melted processed cheese was poured into cardboard boxes (500g) and lined with aluminum foil. The resultant cheeses were analyzed when fresh and every month up to 3 months of storage in the refrigerator at 5±1°C . The composition of different used formulas is shown in Table 2.

Table(2) : Composition of different blends used in manufacture of block type processed cheese formulations.

Ingredients	BPC Treatments			
	Control	T_1	T_2	T_3
Ras cheese fresh	52.77	53.18	43.98	34.91
Ras cheese mature	29.02	20.39	20.23	20.07
Butter oil	6.16	6.20	6.16	6.11
Carrot pomace paste	-	8.86	17.59	26.18
Emulsifying salt	2.38	1.33	1.30	1.30
Nisaplin	0.01	0.01	0.01	0.01
Water	9.66	10.03	10.73	11.42
Total	100	100	100	100

Treatments T_1,T_2 and T_3 with 10,20 and 30 % carrot pomace paste substitution of cheese base respectively.

Chemical analysis:

Fat, Dry matter, ash, T.N, soluble nitrogen and fiber contents were analyzed according to **AOAC (2007).** Carbohydrate content of all samples was calculated as described by **Ceirwyn (1995)** using the following formula:

Total carbohydrates % = 100 – (%protein +%fat+%fiber +% ash +% moisture).

Total volatile fatty acids as (**Kosikowski , 1982),** and expressed as ml of 0.1N NaOH/100g cheese. Salt content **(Ling, 1963).** Total phenolic compounds **(Zheng and Wang; 2001)** by floin - Ciocalteu reagent and expressed as mg_s of (GAE) gallic acid equivalents /100g. Free radical scavenging activity by **(Brand-Williams *et al.*,1995).**

Physicochemical properties:

pH values were measured using pH meter with a combined electrodes, (Hanna digital pH meter). Meltability **(Olson and Price ,1958)** and modified by **Savello *et al.* (1989).** Oil separation index of block processed cheese **(Thomas, 1973).**

Texture profile analysis (TPA)

Texture profile analysis of processed cheese treatment was done using a Universal Testing Machine (TMS-Pro). Calculation described by **Bourne (1978)** was used to obtain the texture profile parameters.

Sensory evaluation

The organoleptic properties of processed cheese were evaluated by a test panel of 12 panelists of Dairy Chemistry Department, Animal Production Research Institute. Sensory evaluation design and scores were carried out according to **Meyer (1973).**

Statistical analysis

The data obtained (mean of three replicates) were statistically analyzed according to statistical analyses system user's guide **SAS (1996).**

RESULTS AND DISCUSSION

Chemical composition, antioxidant, β-carotenes and Vitamin A :

Table(3) : Chemical analysis of block type processed cheese (BPC) with different ratios of carrot pomace paste in the base blend.

Chemical composition	BPC Treatments			
	Control	T_1	T_2	T_3
Moisture %	39.59[a]	43.66[a]	45.98[a]	48.94[a]
Fat %	27.81[a]	25.44[a]	23.96[a]	22.70[a]
F/ DM	46.03[a]	45.15[a]	44.35[a]	44.46[a]
Dietry fiber%	-	3.47[c]	6.78[b]	10.26[a]
Protien%	19.47[a]	17.50[b]	15.71[c]	13.88[d]
Ash %	3.71[a]	3.35[b]	3.01[c]	2.68[d]
Carbohydrate*	9.42[a]	6.58[b]	4.56[c]	1.54[d]
Salt %	2.60[a]	2.32[b]	2.04[c]	1.76[d]
B-carotenes(mg/100ge past)	0.241	0.712[c]	1.421[b]	2.129[a]
Vitamin A (µg/100g fat)	467[d]	556[c]	638[b]	714[a]
Antioxidant compounds				
RSA (%)	3.9[d]	11.3[c]	19.4[b]	28.2[a]
TPC (mg/100g equivalent gallic acid)	21.0[d]	114.6[b]	117.5[ab]	121.0[a]

Treatments T_1,T_2,T_3 with 10,20 and 30 % carrot pomace paste substitution of cheese base respectively. The letter possess the factor of the level of CPP. The means with the same letter at any position didn't significantly differ (p>0.05).

Table (3) indicated that D.M, F/DM, protein, fat, ash, carbohydrates and salt were found higher in control cheese than the other treatments. CPP playing an important role in that variation. Diatry fibers, B- carotenes and vitamin A were noticed in a higher level in treated cheeses than that in the control one. A direct relationship was noticed between values of the former parameters (fibers, carotenes and Vit.A) and the level of CPP addition. These results are in agreement with **Awad (2003).**

Free radicals scavenging activity (RSA) and total phenolic compounds (TPC), as Gallic acid equivalent, in BPC control cheese were very low compared to the carrot pomace cheese treatments. Phenolic compounds were increased significantly (P< 0.001) in carrot pomace cheese by increasing the ratio of CPP in the cheese base. A linear relationship was observed between the rate of CPP added and the values of the previous parameters. These results are approximately near to that found by **Goncalves *et al.* (2010).**

pH values:

The changes in pH values of the BPC containing different ratios of CPP during storage are presented in Fig (1). Data indicated that control treatment have significantly (P<0.001) lower pH value than treatments containing CPP, which can be attributed to the high pH value of CPP (7.91) compared to 4.87 or 5.2 for fresh or mature Ras cheeses respectively. During storage the pH values of BPC samples significantly decreased (p<0.001) with the progress of storage period. The changes in pH values of BPC samples during storage could be due to the changes occurred in TVFA and SN contents. These results are in agreement with those findings by **Abd El Hamid *et al.*, (2000)**.

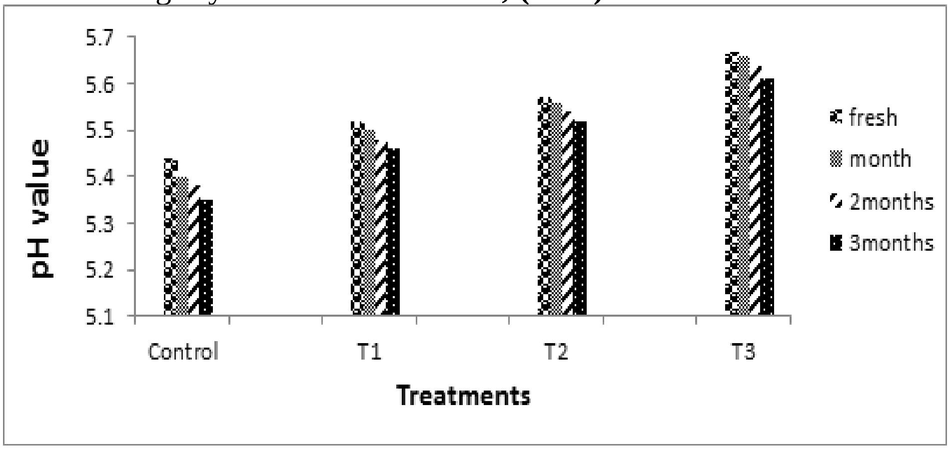

Fig. (1) pH value of block type processed cheese (BPC) with different ratios of carrot pomace paste in the base blend.

Soluble nitrogen & total volatile fatty acids:

The soluble nitrogen contents (SN) of BPC were affected by adding CPP in the base blend (Table 4). Among the fresh block Processed cheeses, control treatment had the highest SN content, over the storage period, while BPC containing 30% of carrot pomace paste had the lowest values. Differences in SN contents can be attributed to the high SN in Ras cheese either fresh or mature used in the formulating blends. The soluble nitrogen increased gradually in all treatments during storage, and this increase may be attributed to the enzymatic activity of the resistant proteinases present in the product. Meanwhile, these results are in agreement with that reported by **Awad *et al.*,(2003).** Also, Statistical analysis of the data indicated, significant differences (p<0.001) among all treatments during 3 months of storage .

Total volatile fatty acids **(**TVFA) behaved the same trend of S.N during storage period and control treatment exhibited the highest values compared with the rest treatments. The differences in TVFA values among all treatments could be attributed to the high percent of these volatile acids in Ras cheese. Values of TVFA increased significantly (P<0.001) during cold storage, probably due to the residual activity of heat-resistant lipases in the base formula. These findings are coincided with **Hassan and Abd El- Gawad (2000).**

Table(4) : Soluble nitrogen (SN), (TVFA) Total volatile fatty acids values*of block processed cheese during cold storage with different ratios of carrot pomace paste.

	Storage period (month)	BPC Treatments			
		Control	T_1	T_2	T_3
S.N	0	2.349^{Ad}	2.076^{Bd}	1.835^{Cd}	1.563^{Dd}
	1	2.367^{Ac}	2.102^{Bc}	1.884^{Cc}	1.597^{Dc}
	2	2.377^{Ab}	2.107^{Bb}	1.908^{Cb}	1.623^{Db}
	3	2.392^{Aa}	2.122^{Ba}	1.951^{Ca}	1.674^{Da}
TVFA	0	43.00^{Ad}	29.10^{Bd}	24.67^{Cd}	20.11^{Dd}
	1	45.78^{Ac}	32.94^{Bc}	27.00^{Cc}	22.02^{Dc}
	2	49.00^{Ab}	36.11^{Bb}	29.40^{Cb}	24.18^{Db}
	3	52.13^{Aa}	38.98^{Ba}	32.00^{Ca}	27.02^{Da}

***ml/ 0.1 N NaOH/ 100g cheese**
See details under Table (3) .

Meltability & oil separation index :

Data in Fig. (2) Showed the meltability values and oil separation index (OSI) of BPC as affected by increasing ratio of CPP to add the processed cheese blend . Addition of CPP in the base formula decreased significantly (P< 0.001) the cheese meltability compared to control. Decreasing the meltability of carrot pomace paste treatments could be due to the higher percent of carbohydrates in the carrot pomace paste (Table, 1), which may act as stabilizer, tightly bind the water in the resultant product and making it less meltable. Also, the lower meltability of cheese treatments containing carrot pomace paste may be due to its low total protein and casein contents. But, during cold storage, the melting values were increased in all treatments, owing to the protein degradation occurred in the cheese which releasing consequently more SN and consequently increasing its flow. These data are agreed with those of **Awad (2003) .**

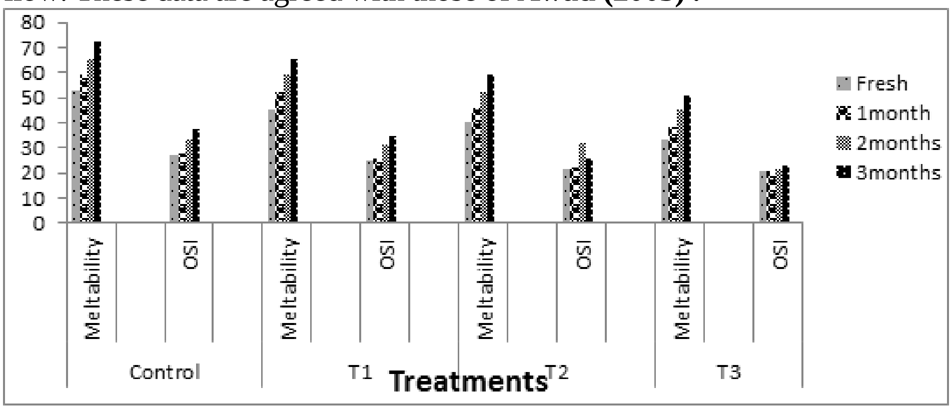

Fig. (2): Oil separation index and Meltability (mm) of block type processed cheese (BPC) during cold storage at 5±1°C with different ratios carrot pomace paste in the base blend.

Regarding the oil separation index (OSI), data indicated that, both the proportional replacement of cheese base with carrot pomace and the prolonging of cold storage period were associated with gradual strength in the fat emulsion, i.e. decreasing in the oil separation. This means that, the emulsion capacity of carrot pomace was higher than that of milk protein. The increase in OSI during storage period could be attributing to the changes took-placed in SN content and the decrease in the pH values during storage period. So the lower pH can cause negative effect on the protein bonds and give a moveable protein network, which lead to emulsify the fat and consequently make it easy to release. Similar results were reported by **Awad *et al.*, (2014).**

Texture profile analysis (TPA) :

Data illustrated in Table (5) indicated that, with the exception of the hardness criterion, other texture parameters, namely cohesiveness, springiness, gumminess and chewiness of treated cheeses exhibited significant proportionally lower values, with the addition of carrot pomace paste in the cheese blend compared to control. The hardness increased with increasing the percent of CPP in the blend.

Table (5): Texture profile analysis (TPA) of block processed cheese (BPC) during cold storage at 5±1°C with different ratios carrot pomace paste in the base blend.

Storage period (month)	BPC Treatments			
	Control	T_1	T_2	T_3
	Cohesiveness(-)			
0	0.45^{Ad}	Fresh	0.45^{Ad}	Fresh
1	0.47^{Ac}	1	0.47^{Ac}	1
2	0.51^{Ab}	2	0.51^{Ab}	2
3	0.54^{Aa}	3	0.54^{Aa}	3
	Hardness (n)			
0	28.4^{Dd}	30.3^{Cd}	33.6^{Bd}	37.9^{Ad}
1	28.9^{Dc}	30.8^{Cc}	34.8^{Bc}	38.7^{Ac}
2	31.5^{Db}	32.2^{Cb}	37.6^{Bb}	41.6^{Ab}
3	33.2^{Da}	35.6^{Ca}	42.2^{Ba}	46.4^{Aa}
	Springiness (mm)			
0	6.27^{Ad}	6.01^{Bd}	5.40^{Cd}	5.01^{Dd}
1	6.55^{Ac}	6.34^{Bc}	5.83^{Cc}	5.38^{Dc}
2	6.92^{Ab}	6.73^{Bb}	6.22^{Cb}	5.72^{Db}
3	7.18^{Aa}	7.01^{Ba}	6.55^{Ca}	6.13^{Da}
	Gumminess (n)			
0	11.46^{Ad}	10.86^{Bd}	9.91^{Cd}	9.34^{Dd}
1	12.22^{Ac}	11.53^{Bc}	10.61^{Cc}	10.09^{Dc}
2	14.54^{Ab}	12.45^{Bb}	12.54^{Cb}	12.39^{Db}
3	16.48^{Aa}	15.18^{Ba}	15.28^{Ca}	15.56^{Da}
	Chewiness (n)			
0	68.92^{Ad}	62.50^{Bd}	50.96^{Cd}	45.85^{Dd}
1	76.70^{Ac}	70.84^{Bc}	59.14^{Cc}	53.34^{Dc}
2	96.88^{Ab}	82.85^{Bc}	75.02^{Cb}	67.84^{Db}
3	116.59^{Aa}	105.53^{Ba}	97.04^{Ca}	92.20^{Da}

See details under Table (3) .

The lower hardness in control treatment could be due to its higher soluble nitrogen content. Hardness is affected by many factors e.g. pH value, SN, state of protein network, fat and moisture contents. Moreover, CCP contents which contain higher carbohydrates and fiber contents may bind the water in the resultant processed cheese and minimized its hardness. During storage period, totally texture profile parameters of cheeses were significantly increased. These data are similar with those **of Awad *et al.*, (2014); Khalil1 & Elkot (2020) .**

Sensory evaluation:

There were no changes in the appearance with adding CPP up to 20% in the base blend. Increasing the ratio up to 30% had slightly affected on the appearance. The body & texture of BPC improved and the cheese gave more ability to slice with increasing the ratio of CPP in the blend. Treatments with up to 30% showed slightly good firm body and texture , while the body started to be firm with adding CPP in the blend . Flavor of BPC became more preferable to panel list and was enhanced with adding carrot pomace paste in the blend up to 30% compared to the control. Data , also, indicated that all the resultant cheeses were generally acceptable compared to the control. The sensory properties of all treatments were decreased gradually during cold storage period. These data were agreed with that found by **Awad *et al*. (2014)**

Cost of the experiment:

The calculated cost per 100 kg of the resultant block processed cheese (Table 6) indicated that incorporating carrot pomace paste in the blend with 10, 20, 30 lowered the costs by 13.61, 23.04 and 32.87 % respectively compared to the cost of control cheese.

Table (6):Cost of ingredients used to formulate different blends (100kg) of processed cheese made with or without carrot pomace paste.

	Price of	PCA Treatments*			
Ingredients	**kg/ L.E**	**Control**	**T_1**	**T_2**	**T_3**
Ras cheese fresh	**60**	**3166.2**	**3190.8**	**2638.8**	**2094.6**
Ras cheese mature	**80**	**2321.6**	**1631.2**	**1618.4**	**1605.6**
Butter oil	**30**	**184.8**	**186**	**184.8**	**183.5**
Carrot pomace paste	**-**	**-**	**-**	**-**	**-**
Emulsifying salt	**150**	**357**	**199.5**	**195**	**159**
Nisaplin	**1300**	**13**	**13**	**13**	**13**
Total cost/ 100 kg	**-**	**6042.6**	**5220.5**	**4650**	**4055.7**
Cost reduction	**-**	**100**	**13.61**	**23.04**	**32.87**

***See Table (2) for details**

CONCLUSION

In conclusion, BPP can be produced with adding CPP up to 30% in the blend without any significant difference than that of control. Impact of CPP up to 30% in the blend highly acceptable BPC with improved body& texture and better flavor. In addition, it produce BPC with higher antioxidants and dietary fibers contents which reflected on the human health and increasing its immunity. This addition will prolonged the shelf Life of the cheese and reducing the total cost by 32.87% compared to the traditional manufacturing method.

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تأثير إضافة عجينة تفل الجزر على خواص الجبن المطبوخ

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استهدفت الدراسة تأثير إضافة عجينة مخلف عصرالجزر(تفل الجزر) على الخواص الحسية والتركيبية للجبن المطبوخ. حيث تم إضافة عجينة تفل الجزر إلى خلطة الجبن المطبوخ بنسب 10%، 20%، 30% كبديل للجبن فى الخلطة الاساسية.وأشارت النتائج الى أن نسب المادة الجافة والدهن/المادة الجافة ، الكاروتينات ، فيتامين A ، الألياف وقيم ال pH. اتجهت للإرتفاع بصورة معنوية عند زيادة نسبة الإستبدال مقارنة بعينة المقارنة وعلى العكس من ذلك فإن نسبة البروتين، الأملاح ،الرماد ، الأحماض الدهنية الطيارة والبروتين الذائب قد إنخفضت معنويا. وفيما يختص بخواص التركيب البنائى لمشابه الجبن المطبوخ والتى تشمل التلاصق، المطاطية، التصمغ والمضغ فجميعها أظهرت إنخفاضا تدريجيا بزيادة نسبة الإضافة بينما أظهرت صفة الصلابة إتجاه معاكس. أما معامل إنفصال الزيت والقابلية للإنصهار فقد أظهرت النتائج إنخفاضا بزيادة نسبة الإضافة. كما أوضحت النتائج أن جميع معاملات الجبن المطبوخ كانت بصفة عامة مقبولة حسيا خاصة نسبة 30%.وأدت إضافة مخلف الجزر لإنخفاض تكلفة الإنتاج تقريبا بحوالى 30%. ومما سبق من الممكن إستخدام مخلف الجزر فى تصنيع مشابه الجبن المطبوخ حتى نسبة 30%.