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Research Article

Quality Characteristics and Acceptability of an Analogue Processed Spreadable Cheese Made with Carrot Paste (*Daucus carota* L.)

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Abstract

Carrot (*Daucus carota* L.) is one of the great nutritious origin vegetables. It is the richest source of β-carotene, precursor of vitamin A and a lot of nutrients. So, the main aims of preparing carrot based processed cheese analogue, were to enhance its nutritive value and presented new cheese for children. Carrot analogue processed cheeses (CPCSs) were made with various ratios of carrot paste (5, 10 and 15%) which sweetened with 15% sugar in all treatments. The base blends were standardized to contain 36% F/DM (fat in dry matter) and 60% moisture in the resultant control spreads. Various chemicals parameter such as total solids, ash, salt and carbohydrate were determined. Some important nutrients which the carrot presented as vitamin A, carotenoids and phenolic compounds were also measured, in addition to sensory evaluation. The CPCAs samples displayed that, insignificant higher in total solids, significant reductions in the average values of F/DM, protein and salt in water phase and insignificant for ash content; these reductions commensurate with increasing the proportion of the carrot paste addition. Moreover, enhanced cheese with carrot paste were higher than control in the each nutritional components, vitamin A, carotenoids and phenolic compounds, antioxidant activity plus lower sodium/potassium ratio. In addition, sensory evaluation showed that all samples were accepted and that the use of carrot paste as optional ingredient in processed cheese analogue would be a great way to introduce of a healthy cheese with orange color, which could be introduced to children instead of other sweetened products.

Key words: Processed cheese analogue, carrot, chemical properties, texture pattern, carotenoids, vitamin A, antioxidant activity

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The concept of food having curative value has been renovated as 'functional foods'. The record of health benefits accredited to functional foods continue to increase and the gut is a main target for the development of functional foods, because it acts as an interface between the diet and all other body missions. In another meaning new food industry moves to cheaper, healthier and more suitable products, in response to insistent demand consumers (Abd El-Razik and Mohamed, 2013). One of the most promising ways for the development of functional food ingredients lies in the use of vegetables and fruits in the dairy products, especially processed cheeses and its analogues. Analogue cheeses are defined as products prepared by blending food ingredients, involving sources of fat and protein along with water, acid, Emulsifying Salts (ES) and cheese flavoring and employing thermal and mechanical energy to produce a homogeneous product, simulating a specific cheese variety (Noronha *et al*., 2008).

Carrot is an economically important vegetable that has developed popularity in recent decades due to increased awareness of its nutritional account (Arscott and Tanumihardjo, 2010). Carrot is one of the big nutritious vegetables root. It is the richest source of β-carotene and precursor of vitamin A. Fresh carrot on an average contains (g/100 g) 86 moisture, 0.9 protein, 0.2 fat, 1.1 total minerals, 1.2 crude fiber, 10.6 carbohydrates, 1890 µg β -carotene, 0.08 calcium, 0.53 phosphorous and 0.001 iron (Mridula, 2011). Its carbohydrate contains simple sugars, predominantly sucrose, glucose and fructose with little amount of starch (USDA., 2008). Carrots participate significantly to dietary vitamin A intake through α- and β-carotene and less to other nutrients. A 100 g serving of raw carrot grants the following percent of the recommended daily allowance of a female aged 19-30 year; 120% vitamin A (equivalent as retinol activity), 11% fiber, 7% potassium, 4.5% vitamin E, 4% magnesium and 3% calcium. Carrots also contain the B vitamins niacin, thiamin and riboflavin in proper quantities when compared with other commonly used vegetables. Nicolle *et al*. (2004) mentioned that potassium was the most abundant mineral in 20 various cultivars of white, purple and orange carrots, with a mean of 579 mg/100 g fresh weight in a range from 443-758 mg/100 g fresh weight. Moreover, as levels of calcium increased, the iron content also increased. There was no correlation between color and the content of minerals or trace element, but dark orange carrots (high β-carotene) considered the highest mineral content.

Orange carrots are highly consider as good for the eyes due to their major content of hydrocarbon carotenoids, a class of phytochemicals that are predominating precursors to vitamin A. The α- and β-Carotene predominate in orange carrots. Carrots have highest carotene content among several vegetables (Bandyopadhyay *et al*., 2007). Generally, carrot contains 6.9-15.8 mg carotenoids in 100 g of carrot. It has been reported that β-carotene is the high constituent (60-80%) of carotenoids in carrots, then α-carotene (10-40%), lutein (1-5%) and the other minor carotenoids (Heinonen, 1990). Carotenoids are the most widespread natural lipid-soluble pigments with many important biological activities and industrial applications (Marova *et al*., 2012). Carotenoids have important biological value due to its provitamin A activity and properties which resulting prospected health benefits such as increasing the immune system and reduced the risks of degenerative diseases. Moreover, carotenoids have antioxidant labor which act as electron donors to neutralizing free radicals. So, antioxidant activities of carotenoids prevent the damage caused on living cells by the free radicals and have ability to reduce chronic diseases (Kanzy *et al*., 2015). Both of provitamin and nonprovitamin carotenoids have ability to limit the result of lipid oxidation in tissues. Thus carotenoids could be helpful and provide a logical prevention or even a complementary curative versus diseases (Hudson, 1990).

Due to the increasing demand of such compounds in food, pharmaceutical, cosmetic and feed industries, there is growing interest in natural carotenoids that obtained by vegetables and fruits such as carrot. So, the main aim of this study is producing a spread analogue processed cheese with various ratios of carrot paste to prepare a functional cheese with high nutritive value. Then study the role of carrot paste in enhancing flavor and color to increase its acceptability among children by assessing the changes of sensory acceptance, chemical composition and physical properties that resulted by this addition.

MATERIALS AND METHODS

Materials: Calf rennet powder (Ha-La) and whey protein powder were obtained from CHR- Hansen's Lab., Denmark. Unsalted butter was obtained from Dina farm, Sadat city. Low heat skim milk powder was procured from Irish Dairy Board, Grattan House, Lower Mount St., Dublin, Ireland. Commercial JOHA emulsifying salts were obtained from BK-Ladenburg corp, Gmbh, Germany. Fresh raw buffalo's milk was obtained from the National Research Centre, Giza. The following ingredients were bought from local market in Cairo, Egypt.

Table 1: Chemical composition of the used ingredients in manufacture of carrot processed cheese analogue spreads

Ingredient	TS (%)	F (%)
Unsalted cheese	31.5	11.5
Whey protein powder	95.0	0.7
Unsalted butter	84.0	82.0
Skim milk powder	96.0	0.1
Carrot paste	24.0	-

TS: Total solids and F: Fat

Table 2: Formulations of the various used blends for manufacture of carrot processed cheese analogue spreads

		Carrot ratios (%)		
Ingredients	Control	5	10	15
Unsalted cheese base	36.01	21.98	20.90	19.92
Whey protein powder	12.15	7.32	6.97	6.64
Skim milk powder	4.81	2.93	2.78	2.66
Unsalted butter	14.15	10.26	9.75	9.30
Carrot paste	-	5.00	10.00	15.00
Sugar	-	15.00	15.00	15.00
Emulsifying salt	1.45	0.85	0.81	0.77
Water	31.43	36.66	33.79	30.71
Total	100.00	100.00	100.00	100.00

Sugar and carrot (*Daucus carota* L.): Chemical composition of the used ingredients in the manufacturing of carrot processed cheese analogue (CPCS) showed in Table 1.

Methods of manufacturing and analysis

Preparation of carrot paste: The carrot paste was prepared according to the method described by Bandyopadhyay *et al*. (2008). Carrots after cleaning were cut along with skin into round thin slices (1-2 cm thickness) and blanched in boiling water (100°C) for 2 min. The blanched carrot slices were ground in a kitchen aid mixer (Philips, Japan) at 8000 rpm for 10 min to get a smooth paste orange carrot. Carrots were used beside with their skin because carotenoids are found with high levels in the peel than in the pulp of most carotenogenic vegetables and fruits.

Manufacture of unsalted soft cheese base: The soft cheese manufacture was carried out according to method reported by Shahein *et al*. (2014). Milk was pasteurized at 72°C for 15 sec in a water bath then cooled immediately to 39±1°C, 0.04% calcium chloride and calf rennet at the rate of 4 g/100 k of milk (after diluted 10 times with water) were added to coagulate in about 3 h. The resulted curd was then transferred to perforated cheese molds over night to remove all the whey then stored at 4°C until used.

Manufacture of carrot processed cheese analogue spreads (CPCSs): Processed cheese spreads (CPCSs) were manufactured, according to the method of Meyer (1973). The control processed cheese was prepared to be almost 59±1% moisture and 36±1% fat in dry matter and manufactured from unsalted soft cheese and butter as a base blend. Processed cheese treatments manufactured by adding carrot paste in the base blend at ratios of 5, 10 and 15% and sugar 15% for each carrot treatment. All blends were cooked with controlled agitation for 8 min at 85-90°C using direct injection steam at pressure of 1.5 bar. The hot product of CPCSs were manually filled into 150 cc sterilized glass jar and also covered with aluminum foil, then cooled rapidly at 7±1°C. The resultant CPCSs were analyzed when fresh and after 1, 2 and 3 months of storage at 7±1 and 25±1°C. The compositions of various blends of CPCSs are presented in Table 2. Three replicates of each treatment were manufactured and subjected for analysis.

Chemical analysis: Samples of cheese analogues were tested for moisture, ash and fiber contents as mentioned in AOAC (2006). Fat, total, soluble and non-protein nitrogen contents were determined according to the method described in Ling (1963). Values of pH were measured using a digital pH meter (HANNA), with combined glass electrode (electric instruments limited). Total carbohydrates were calculated by differences as described by James (1995). Salt content was determined as described by Bradley *et al*. (1992). Mineral profile of fresh PCSs was assayed for determined K, Na contents using a flame photometer (Corning 410, Corning Medical and Scientific Instrument, Modified, MA, USA) as mentioned by Mohamed *et al*. (2011).

Total Phenolic Contents (TPC): Total phenolic compounds were determined as described by Zheng and Wang (2001) by using Folin-Ciocalteu reagent and expressed as milligrams of Gallic Acid Equivalents (GAE) per 100 g.

Antioxidant capacity: Free Radical Scavenging Activity (RSA%) assay of the samples was measured using the method of Brand-Williams *et al*. (1995) by the following equation:

$$\text{RSA (\%)} = \frac{\text{Abs}_{\text{control}} - \text{Abs}_{\text{sample}}}{\text{Abs}_{\text{control}}} \times 100$$

and expressed as percentage inhibition of the DPPH radical.

Determination of carotenoids: Carotenoids content was determined by HPLC method as described by Nicolle *et al*. (2004).

Determination of vitamin A: The concentrations of vitamin A (all trans retinol) in the cheeses were measured simultaneously by means of normal phase HPLC using a UV-VIS photodiode-array detector after saponification and hexane extraction, as mentioned by Lucas *et al.* (2006). The results were expressed as µg vitamin/100 g fat.

Textural measurements: Force and torque measurements of processed cheese treatments were measured using a Texturometer model Mecmesin Emperor TMLite 1.17 (USA). Mechanical primary characteristics of hardness, springiness, gumminess and cohesiveness were determined from the deformation Emperor TMLite Graph. Also the secondary characteristic of chewiness (hardness×cohesiveness× springiness) was selected because the cheese samples showed springiness (Lobato-Calleros *et al.*, 1997).

Sensory evaluation: Sensory properties of carrot processed cheese analogue samples were evaluated by the staff members at Department of Dairy Science, National Research Centre. Samples were evaluated according to Bandyopadhyay *et al.* (2007).

A 9-point hedonic scale ranging from 1 = dislike extremely to 9 = like extremely was used to evaluate color and overall acceptance (in terms of flavor, smell, taste and texture) of the samples.

Statistical analysis: All data were expressed as mean values. The statistical analyses were carried out using the SPSS 16.0 Syntax Reference Guide (SPSS., 2007). Significance of differences of various groups was determined by the LSD (least significant difference) test ($p \leq 0.05$).

RESULTS AND DISCUSSION

Chemical profile of Carrot Processed Cheese Analogues (CPCAs): The addition of carrot paste to the processed cheese analogue formula should occur changes in its chemical gross composition as summarized in Table 3. As can be seen from the table, some chemical properties of the cheese samples showed significant differences depending on additives ratios ($p \leq 0.05$). The amount of total solids in CPCAs showed differences according to the ratio of carrot paste added. The dry matter in control sample was insignificantly ($p \leq 0.05$) less than carrot cheese samples. The addition of carrot paste and sugar is a cause of these differences. This results in agreement with those of Ayar and Gurlin (2014), who found the addition of carrot increased dry matter in yogurt. The CPCAs samples displayed significant reductions in the average values of fat in dry matter, protein and salt in water phase and insignificant for ash content; these reductions commensurate with increasing the proportion of the carrot paste addition. These decreases are respectable due to the reduction of those components in the added carrot paste. But for each of fiber and carbohydrates, it is various where it's higher in carrot cheese samples than the control one. It may be due to the addition of sugar and the high content of fiber in carrot paste. The obtained results for fiber and 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 3: Proximate composition and pH values of various analogue processed cheese spreads made with various ratios of carrot paste

		Carrot paste ratios (%)		
Compositions	Control	5	10	15
TS (%)	39.75[a]	40.78[a]	40.82[a]	40.90[a]
F/DM	37.50[a]	26.75[b]	25.60[b]	24.50[b]
Protein	14.66[a]	12.18[b]	12.01[b]	11.55[b]
Ash (%)	4.02[a]	3.25[a]	3.82[a]	3.34[a]
Salt in moisture (%)	1.71[a]	1.12[b]	1.08[b]	1.08[b]
Na (mg kg^{-1})	1680.00[a]	470[b]	430.00[b]	360.00[b]
K (mg kg^{-1})	105.00[c]	880[b]	915.00[b]	1100.00[a]
Na/K ratio	16.00	0.53[a]	0.47[ab]	0.33[b]
Fiber (%)	-	0.445[a]	0.630[a]	0.691[a]
Carbohydrates (%)	2.30[b]	16.5[a]	16.39[a]	16.30[a]
β-carotenes (µg/100 g)	ND	15.6[c]	22.16[b]	29.23[a]
Vitamin A (µg/100 g fat)	421.00[d]	511[c]	653.00[b]	785.00[a]
pH	5.70[a]	5.78[a]	5.85[b]	5.88[b]

TS: Total solids, F/DM: Fat in dry matter, Na: Sodium, K: Potassium, ND: Not detected, [a, b, c]Means in the same row with various superscripts are significantly, various with a>b>c ($p \leq 0.05$)

Effect of carrot paste on the pH values of processed cheese analogues is summarized in Table 3. The pH values of carrot cheese treatments were significantly higher than control sample and the value was increased by increasing the portion of carrot paste. This may be due to the higher pH value of carrot paste used in the formula as compared with pH of control (pH range of carrots 5.88-6.40).

Potassium and sodium content of CPCAs: Potassium is considered as an essential mineral and nutrient for normal cell function together with sodium; potassium acts a critical role in fluid homeostasis, with broad health effects. Potassium's action in lowering elevated blood pressure is good-documented. Potassium has been reported to reduce both of systolic and diastolic blood pressure in people with normal and high blood pressure. Potassium also decreases salt sensitivity, a freelance risk factor for heart disease. The blood pressure is reduced with increasing potassium and with an increasing in the ratio of potassium to sodium (IFICF., 2011).

Eating adequate potassium-rich foods decreases or prevents the blood pressure response to dietary sodium, possibly by stimulating excretion of sodium chloride, or inhibiting sympathetic nerve response (Ando *et al.*, 2010). One final reminiscence about potassium and the system of cardiovascular is that it may improve more than blood pressure. Rich diets in potassium such as vegetables, fruits and low fat dairy products have been recorded to lower blood pressure. Several studies have reported that an increased intake of potassium via the diet can provide a protective effect in individuals with sodium-induced hypertension, decreases urinary calcium excretion, potentially protects skeletal mass (Karagozlu *et al.*, 2008) and prohibit the incidence of kidney stones. As cheese products consumption are increasing worldwide, lowering of salt as sodium carrier (without affecting its acceptability) needs to take into consideration (Johnson *et al.*, 2009; Agarwal *et al.*, 2011; Drake *et al.*, 2011). Therefore, our choice of carrot as one of the vegetables to achieve more than one goal which, including increasing potassium against sodium content and thus decrease the sodium/potassium ratio to obtain healthy cheese for children and adults.

Mineral contents data presented in Table 3, indicate the mean concentrations of macro minerals potassium and sodium. Potassium was detected at the highest content in the cheese with highest carrot ratio (15%). Furthermore, the lowest level of sodium was found in this treatment. It is clear that increasing the proportion of the carrot added to cheese led to the decrease the ratio of sodium/potassium in the resultant cheeses.

The results of potassium content are in the same line with those obtained by Ihemeje *et al.* (2015), who reported that the addition of carrot caused increasing the content of potassium in the resultant yogurt. Also, Nicolle *et al.* (2004) mentioned that potassium was the most considerable mineral in 20 cultivars of yellow, orange, purple and white carrots, with an average of 579 mg/100 g fresh weight.

β-Carotenes content of CPCAs: Vegetables are essential sources of β-carotene than fruits. Carrot roots are rich source of carotenes particularly β-carotene. In 2007, carrots provided an estimated 37% of the available fresh vegetable β-carotene, the main provitamin A carotenoid in the U.S. diet (Arscott and Tanumihardjo, 2010). The carotenoid pigments are effective antioxidants that quench free radicals, improve protection against oxidative damages to cells and abundance of degenerative diseases and stimulate immune function also.

In Table 3 it can be seen that there was a linear and significant increase in the β-carotene content in the carrot cheese samples with increasing portion of carrot paste, which was obvious. The higher β-carotene content of carrot cheese treatments suggest that they were fairly good sources of the nutrient. However, the absence of carotenes in the control processed cheese analogue is an indication of its poor source of the nutrient. In the same context, Mridula (2011) reached that the β-carotene content of fortified biscuits with carrot powder was increased from 0.56 mg/100 g in the control to 2.39 mg/100 g in carrot treatments. Also, Madukwe and Eme (2012) reported that the content of β-carotene in fortified soy milk with carrot powder was increased by increasing the level of carrot to the milk from 13.40 in control to 90.10 (Retinol Equivalent RE/100 g) in the higher portion carrot fortified soy milk.

Vitamin A content of CPCAs: Carrots provide significantly to dietary vitamin A intake through α- and β-carotene and moderately to other nutrients. A 100 g of raw carrot (about 0.75 cup chopped carrot) introduces the following proportion of the recommended daily allowance of a female aged 19-30 years; 120% vitamin A (as retinol activity equivalents), 11% fiber, 7% potassium, 4.5% vitamin E, 4% magnesium and 3% calcium (Arscott and Tanumihardjo, 2010). Structurally, vitamin A (retinol) is essentially one half of the β-carotene molecule (Rodriguez-Amaya and Kimura, 2004). Dietary vitamin A is used either as preformed vitamin A from fortified or animal-based foods, or as provitamin A carotenoids supplied by plant-based foods.

Vitamin A Deficiency (VAD) is one of the main nutritional public health problems in many developing countries. The VAD is primarily caused due to inadequate intake of vitamin A and vitamin A precursors (provitamin A carotenoids) and diseases (WHO., 2009). Being rich in carotene content, carrot and its processed products can serve an easiest mean in reducing the vitamin A deficiency and improving the health of vulnerable groups.

The results of vitamin A as shown in the Table 3 indicted that the carrot treatments are higher than control cheese significantly. It is increased from 421 (μg/100 g fat) in control sample to 785 (μg/100 g fat) in the highest carrot ratio sample. The higher micronutrients level of vitamin A in carrot cheese samples suggests that they are better sources of this vitamin. These significantly increase in the micronutrients by increasing the addition of carrot paste might be attributed to synergistic effect of carrot to processed cheese analogue treatments. This result confirmed that when nutrients from various foods are blended, the nutrients so produced would be better than any other foods alone (Egbekun *et al.*, 2004). The obtained results are in agreement with those of Ihemeje *et al.* (2015) in carrot flavored yoghurt.

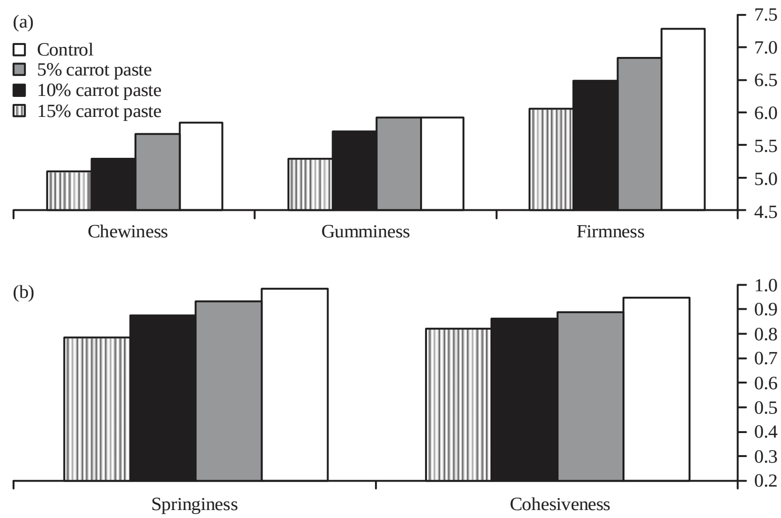

Fig. 1(a-b): Texture properties of carrot porcessed analogue cheeses

Table 4: Antioxidant activity of processed cheese analogue spreads made with several ratios of carrot paste

		Carrot paste ratios (%)		
Antioxidant properties	Control	5	10	15
RSA (%)	2.1	30.1[c]	32.5[b]	34.8[a]
TPC (mg/100 g equivalent gallic acid)	15.0	149.1[b]	151.2[ab]	153.9[a]

RSA: Free radical Scavenging activity TPC: Total phenolic compounds, [a,b,c]Means in the same row with various superscripts are significantly various with a>b>c ($p \leq 0.05$)

Antioxidant activity of CPCAs: Milk represents as a good source of antioxidants. The antioxidant activity of milk has been referred to compounds such as antioxidant vitamins (vitamin E, vitamin C) and carotenoids; both whey proteins and caseins have antioxidant activity. So milk and its products are good choice for the enhancement of its natural antioxidants by adding many of vegetables and fruits (Chen *et al*., 2003; Lindmark-Mansson and Akesson, 2000; Tong *et al*., 2000). So, carrot can be used in milk or dairy products as a convenient source of natural antioxidants (Bandyopadhyay *et al*., 2007).

The content of total phenolic compounds in carrot cheese as gallic acid (GAE) and free Radical Scavenging Activity (RSA) were summarized in Table 4. Control cheese was very low content of phenols and the value of RSA compared to carrot cheese samples, so we did not put it in the statistical analysis. Carrot cheese content of phenolic compounds was increased by increasing the ratio of carrot paste to the cheese base, so the antioxidant activity of them was also increased in linear way, As a result of presence of these compounds in the carrot paste which added to the cheese base. These obtained results are in the range of values which found by Goncalves *et al*. (2010), the total phenolic content of raw carrots was 84±0.96 (GAE)/100 g fresh tissue.

Texture properties of CPCAs: The texture pattern of processed cheese analogue as affected by adding carrot paste in various ratios is presented in Fig. 1a and b. Enhancement of processed cheese analogue by carrot paste have no 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 presences 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 (Table 3). Furthermore, Ayar and Gurlin (2014) mentioned that decreased protein content in yogurt mix decreased casein-casein and casein-whey interactions and decreased hardness of yogurt. Although, the carrot cheeses were lower in its texture profile than control cheese but all treatments with carrot paste were found acceptable on sensory evaluation.

Sensory attributes of CPCAs: The scores of the consumer acceptance test for processed cheese analogues with carrot in the storage period are presented in Fig. 2 and 3. All the samples were accepted and had high rating for all the tested

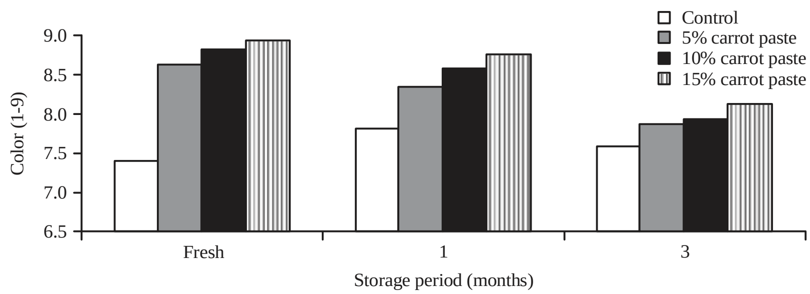

Fig. 2: Color score of carrot processed cheese analogues during storage period

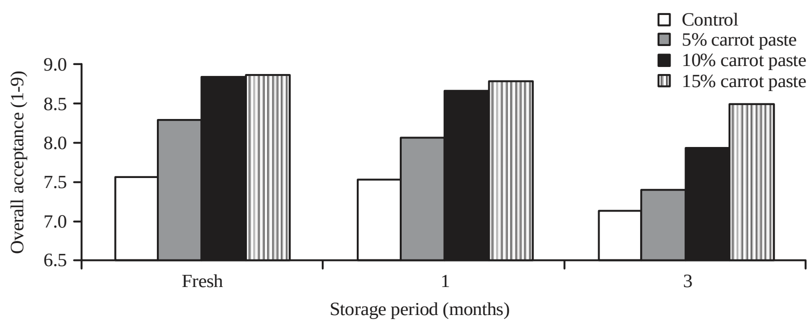

Fig. 3: Overall acceptance score of carrot processed cheese analogues during storage period

properties in the various storage periods. The color score of the cheese with carrot paste was higher than the control sample in the three storage periods; this is expected because of its attractive orange color. It can be seen from the figures, the score of the color was increased by increasing the ratio of carrot paste, but this increasing was insignificant. On the other hand, the score of color was decreased by the storage time and also insignificant decrease. The obtained results of color 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 nonenzymatic browning reaction). The browning took place due to of the reaction between sugars and organic acids of rasogolla cheese. In the control rasogolla cheese, the rate of browning reaction varied from carrot rasogolla, this could be due to the higher amount of protein content in control rasogolla cheese.

The overall acceptance scores of all samples were rated good, the panelists preferred the highest carrot paste ratio (15%) and gave it the highest score. On the other hand, the consumers gave insignificantly lower rating with the longer storage time, this is due to the fact that with the increasing storage time, the color, flavor and smell are changed.

The obtained results thus indicated that, the processed cheese prepared by various ratios of carrot paste was accepted by the panelist. Thus, the overall mean acceptability scores of more than 8 for various cheese samples up to 10% carrot paste indicates the commercial scope for manufacturing healthy cheese with carrot paste, which will also be helpful in providing daily dietary requirement of β-carotene and vitamin A and the other important nutrients that exist in the carrot.

CONCLUSION

The incorporation of carrot paste in processed cheese analogues resulted in quality products with nutritional and functional factors. Moreover, the use of carrot paste in cheese can be improving its antioxidant activity, vitamin A content and sodium/potassium ratio compared with the control cheese, which is desirable since there is a search for healthy foods. In the same time, the carrot cheeses which have all milk comments plus carrot and sugar taste is good choice for children than the jam which carrot and more sugar than 15% only.

REFERENCES

AOAC., 2006. Official Methods of Analysis. 18th Edn., Association of Official Analytical Chemists Inc., Arlington, TX., USA.

Abd El-Razik, M.M. and A.G. Mohamed, 2013. Utilization of acid casein curd enriched with *Chlorella vulgaris* biomass as substitute of egg in mayonnaise production. World Applied Sci. J., 26: 917-925.

Agarwal, S., D. McCoy, W. Graves, P.D. Gerard and S. Clark, 2011. Sodium content in retail Cheddar, Mozzarella and process cheeses varies considerably in the United States. J. Dairy Sci., 94: 1605-1615.

Ando, K., H. Matsui, M. Fujita and T. Fujita, 2010. Protective effect of dietary potassium against cardiovascular damage in salt-sensitive hypertension: Possible role of its antioxidant action. Curr. Vascular Pharmacol., 8: 59-63.

Arscott, S.A. and S.A. Tanumihardjo, 2010. Carrots of many colors provide basic nutrition and bioavailable phytochemicals acting as a functional food. Compr. Rev. Food Sci. Food Saf., 9: 223-239.

Ayar, A. and E. Gurlin, 2014. Production and sensory, textural, physicochemical properties of flavored spreadable yogurt. Life Sci. J., 11: 58-65.

Bandyopadhyay, M., R. Chakraborty and U. Raychaudhuri, 2007. Role of carrot on shelf stability of dairy dessert (*Rasogolla*) during refrigerated storage. J. Food Process. Preserv., 31: 714-735.

Bandyopadhyay, M., R. Chakraborty and U. Raychaudhuri, 2008. Effect of carrot on quality improvement of sweet syrupy cheese ball (Rasgulla). Inter. J. Dairy Technol., 61: 290-299.

Bradley, Jr. R.L., E. Arnold Jr., D.M. Barbano, R.G. Semerad, D.E. Smith and B.K. Vines, 1992. Chemical and Physical Methods. In: Standard Methods for the Examination of Dairy Products, Marshall, R.T. (Ed.). 16th Edn., American Publication Health Association, USA., ISBN-13: 978-0875532080, pp: 433-529.

Brand-Williams, W., M.E. Cuvelier and C. Berset, 1995. Use of a free radical method to evaluate antioxidant activity. LWT-Food Sci. Technol., 28: 25-30.

Chen, J., H. Lindmark-Mansson, L. Gorton and B. Akesson, 2003. Antioxidant capacity of bovine milk as assayed by spectrophotometric and amperometric methods. Int. Dairy J., 13: 927-935.

Drake, S.L., K. Lopetcharat and M.A. Drake, 2011. Salty taste in dairy foods: Can we reduce the salt? J. Dairy Sci., 94: 636-645.

Egbekun, M.K., P.C. Isolokeu and P.I. Akubor, 2004. Chemical and Sensory properties corn cassavasoybean flour blends for the production of Ojeaku-A Nigeria traditional food. Book of Abstracts, Nutrition Society of Nigeria, pp: 9.

Goncalves, E.M., J. Pinheiro, M. Abreu, T.R.S. Brandao and C.L. Silva, 2010. Carrot (*Daucus carota* L.) peroxidase inactivation, phenolic content and physical changes kinetics due to blanching. J. Food Eng., 97: 574-581.

Heinonen, M.I., 1990. Carotenoids and provitamin A activity of carrot (*Daucus carota* L.) cultivars. J. Agric. Food Chem., 38: 609-612.

Hudson, B.J.F., 1990. Food Antioxidants. Elsevier Applied Science, London, pp: 1-18, 193-200.

IFICF., 2011. Potassium and heart health fact sheet. International Food Information Council Foundation (IFICF), April 2011. http://www.foodinsight.org/Content/3840/IFIC_PotassimFactSheet_FINAL%20(2).pdf.

Ihemeje, A., C.N. Nawachukwu and C.C. Ekwe, 2015. Production and quality evaluation of flavoured yoghurts using carrot, pineapple and spiced yoghurts using ginger and pepper fruit. Afr. J. Food Sci., 9: 163-169.

James, C.S., 1995. Analytical Chemistry of Foods. Chapman and Hall, London.

Johnson, M.E., R. Kapoor, D.J. McMahon, D.R. McCoy and R.G. Narasimmon, 2009. Reduction of sodium and fat levels in natural and processed cheeses: Scientific and technological aspects. Compr. Rev. Food Sci. Food Saf., 8: 252-268.

Kaminarides, S., D. Kalogridis and T. Massouras, 2006. Creation and quality characterization of processed cheeses derived mainly from Halloumi cheese. Lait, 86: 333-343.

Kanzy, H.M., N.F. Nasr, H.A.M. El-Shazly and O.S. Barakat, 2015. Optimization of Carotenoids production by yeast strains of *Rhodotorula* using salted cheese whey. Int. J. Curr. Microbiol. Applied Sci., 4: 456-469.

Karagozlu, C., O. Kinik and N. Akbulut, 2008. Effects of fully and partial substitution of NaCl by KCl on physico-chemical and sensory properties of white pickled cheese. Int. J. Food Sci. Nutr., 59: 181-191.

Lindmark-Mansson, H. and B. Akesson, 2000. Antioxidative factors in milk. Br. J. Nutr., 84: 103-110.

Ling, E.R., 1963. A Textbook of Dairy Chemistry, Volume 2: Practical. Chapman and Hall Ltd., London.

Lobato-Calleros, C., E.J. Vernon-Carter, I. Guerrero-Legarreta, J. Soriano-Santos and H. Escalona-Beundia, 1997. Use of fat blends in cheese analogs: Influence on sensory and instrumental textural characteristics. J. Texture Stud., 28: 619-632.

Lucas, A., E. Rock, J.F. Chamba, I. Verdier-Metz, P. Brachet and J.B. Coulon, 2006. Respective effects of milk composition and the cheese-making process on cheese compositional variability in components of nutritional interest. Lait, 86: 21-41.

Madukwe, E. and P.E. Eme, 2012. Chemical evaluation and sensory attributes of soymilk fortified with carrot powder. Afr. J. Food Sci., 6: 483-486.

Marova, I., M. Carnecka, A. Halienova, M. Certik, T. Dvorakova and A. Haronikova, 2012. Use of several waste substrates for carotenoid-rich yeast biomass production. J. Environ. Manage., 95: S338-S342.

Meyer, A., 1973. Processed Cheese Manufacture. 1st Edn., Food Trade Press Ltd., London, UK., Pages: 329.

Mohamed, A.G., H.M. Abbas, H.M. Bayoumi, J.M. Kassem and A.K. Enab, 2011. Processed cheese spreads fortified with oat. J. Am. Sci., 7: 631-637.

Mridula, D., 2011. Physico-chemical and sensory characteristics of β-carotene rich defatted soy fortified biscuits. Afr. J. Food Sci., 5: 305-312.

Nicolle, C., G. Simon, E. Rock, P. Amouroux and C. Remesy, 2004. Genetic variability influences carotenoid, vitamin, phenolic and mineral content in white, yellow, purple, orange and dark-orange carrot cultivars. J. Am. Soc. Hortic. Sci., 129: 523-529.

Noronha, N., E.D. O'Riordan and M. O'Sullivan, 2008. Influence of processing parameters on the texture and microstructure of imitation cheese. Eur. Food Res. Technol., 226: 385-393.

Rodriguez-Amaya, D.B. and M. Kimura, 2004. Harvest Plus Handbook for Carotenoid Analysis. International Food Policy Research Institute (IFPRI), Washington, DC., USA., Pages: 58.

SPSS., 2007. Statistical Package for Social Sciences for Windows. Version 16.0, SPSS Company Inc., Chicago, IL., USA., Pages: 444.

Shahein, M.R., A.M. Hassanein and A.F. Zayan, 2014. Evaluation of soft cheese manufactured from camel and buffalo milk. World J. Dairy Food Sci., 9: 213-219.

Tong, L.M., S. Sasaki, D.J. McClements and E.A. Decker, 2000. Mechanisms of the antioxidant activity of a high molecular weight fraction of whey. J. Agric. Food Chem., 48: 1473-1478.

USDA., 2008. National nutrient database for standard reference. Release 21, Agricultural Research Service, USA. http://ndb.nal.usda.gov//.

WHO., 2009. Global Prevalence of Vitamin A Deficiency in Populations at Risk 1995-2005: Who Global Database on Vitamin A Deficiency. World Health Organization, Geneva, Switzerland, ISBN: 978-92-4-159801-9, pp: 9-10.

Zheng, W. and S.Y. Wang, 2001. Antioxidant activity and phenolic compounds in selected herbs. J. Agric. Food Chem., 49: 5165-5170.