

Effect of Carrot and Pumpkin Pulps Adding on Chemical, Rheological, Nutritional and Organoleptic Properties of Ice Cream

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How to cite this paper: Hassan, M.F.Y. and Barakat, H. (2018) Effect of Carrot and Pumpkin Pulps Adding on Chemical, Rheological, Nutritional and Organoleptic Properties of Ice Cream. *Food and Nutrition Sciences*, 9, 969-982.

<https://doi.org/10.4236/fns.2018.98071>

Received: July 12, 2018

Accepted: August 13, 2018

Published: August 16, 2018

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Abstract

Ice cream manufactured using a substantial amount of pumpkin pulp (PP) and carrot pulp (CP) has a high organoleptic acceptability. PP and CP were added to typical control ice cream (TC) up to 20%. Through adding PP and CP, natural flavor, unique color, and health-promoting constituents were presented. The resultant ice cream was subjected to chemical, rheological, nutritional, and organoleptic properties investigation. Results revealed that dry matter especially SNF in both PP and CP-ice creams were increased significantly. Accordingly, ash, fiber, and available carbohydrates contents were significantly increased whereas opposite result was recorded for crude protein as a result of PP and CP substitution. The ice cream containing high PP and CP contents had higher melting resistance and lower overrun %. Health beneficial phytochemicals such as carotenoids, flavonoids (TF), flavonols (TFL), and vit. C were commonly detected in PP and CP-ice creams, reflecting the attributes of PP and CP ingredients. PP and CP-ice cream had the valuable content of TPC, vit. C and antioxidant capacity. However, only ice cream made with 15% of PP and CP was highly accepted than others. Therefore, it is possible to use a substantial amount from PP and CP to produce ice cream up to 15% with retained much of natural color, unique vit. C, TPC, carotenoids, TF, TFL contents as well as valuable antioxidant capacity. Health beneficial compounds and organoleptic attributes of prepared ice cream formulas were encouragingly the commercial possibility of using PP and CP for scaling up further.

Keywords

Ice Cream, Pumpkin, Carrot, Chemical, Physical and Nutritional Properties

1. Introduction

From time to time, population's demands develop and healthy products consumption is increasing. Thus, the food industry develops and marks food with added bioactive components, named "functional foods" that not only deliver basic nutrients, but also provide health benefits [1]. Consumption of dairy products is associated with beneficial health effects beyond their nutritional values [2]. Dairy products donate crucial nutrients to our diet, including energy, calcium, protein, and other micro- and macronutrients [3]. Ice cream is the best favoured dairy products consumed in the world [4] whereas the commercial ice cream available is generally poor in natural antioxidants like vitamin C, natural pigments, and polyphenols. Practically, the possibility to improve the nutritional value of ice cream using ingredients with health benefits is valuable, focusing on natural antioxidants, natural pigments, vitamins, low fat and free from synthetic additives such as fruit and vegetables [5] [6] and even producing ice cream which contains probiotic [7] were investigated.

Ice cream preparation involves important processing steps being blending, pasteurization, homogenization, cooling, aging, flavoring and coloring, whipping, packaging, and hardening. It is made from milk fat and milk solids-not-fat (SNF), sugar, water, and other optional ingredients such as stabilizers, emulsifiers and ~0.3% liquid flavors and colors mix [8]. During aging, it is important that adsorbed protein is partially desorbed from fat globule surface. Indeed, the overrun and melting properties are significant variables to evaluate an ice cream product and related processing [9]. Dietary fibers and polysaccharides are widely found in fruits and vegetables which have excellent improvement in physical properties like melting potential with minimal effect on viscosity, overrun and texture [10] due to water-binding capacity [11].

Carrot is a highly nutritious vegetable, non-acidic (pH, 6.3 - 6.4), well known for its high carotenoids content mainly β -carotene as a precursor of vitamin A which is growth promoting substance. Phenolics, flavonoids and appreciable amounts of vitamins B1, B2, and B6 in carrot have been stated [12]. It is containing a significant supply of potassium, calcium, and phosphorus elements. The consumption of carrot and its products is increasing progressively owing its recognition as a vital source of natural antioxidants having anticancer activity, repairing tissues, fighting with infections, keeping eyes healthy, nourishing epithelial tissues in the lungs and skin, reducing risk of cardiovascular disease and having great health-promoting functions [13] [14].

Ripe pumpkin is orange in color, non-acidic (pH, 4.9 - 5.5), has a good shelf-life stability and contains carotenoids, water-soluble vitamins, amino acids and rich in antioxidants, allow it to have an important health-protecting effect [15]. Carotenoids present in pumpkin varieties increasing the uptake of provitamin A and lutein which have special physiological functions [16]. It is believed to reduce the risk of some degenerative diseases developing is responsible for the attractive color. Indeed, carrot and pumpkin are poor in taste with low carbohy-

drates content but higher in vitamins, provitamin A, antioxidants, and minerals as well as low in cost [17]. Vegetables are not widely used as ice cream as flavoring and coloring agents. Interestingly, the use of some non-acid vegetable such as carrot and pumpkin for ice cream production may eliminate adding commercial flavoring and coloring agents and may prevent technical challenges that are associated with the nature of using acidic fruit juice. Various interactions are possible when acidic juices are mixed with milk protein such as protein aggregation, peptide precipitation and polyphenols and proteins interactions which lead to form of polyphenols-protein complexes [18] [19]. Carrot and pumpkin could be converted to value-added products if processed properly when incorporated into ice cream dessert to improve its physical, nutritional and organoleptic properties.

Therefore, the current study aimed to examine the possibility of producing a new type of ice cream product through incorporating a substantial amount of pumpkin pulp (PP) and carrot pulp (CP) in the absence of any added flavoring agent. To scale up such ice cream commercially, chemical, rheological and nutritional properties, as well as organoleptic properties of prepared ice cream, were carried out.

2. Materials and Methods

2.1. Materials

Milk 3% fat, fresh cream 33% fat, dried milk (28% fat & 68% SNF), were purchased from El Marai Company, Al-Qassim, KSA. Sugar, gelatin and both fresh carrot (*Daucus carota*) and pumpkin fruits of American pumpkin (*Cucurbita moschata* L.) were obtained from the local market at Buraydah city, Al-Qassim region, KSA.

2.2. Pumpkin and Carrot Pulp Preparation

Fresh pumpkin and carrot were washed, manually peeled and cut into cubes. Cubes were blanched under live steam for 10 min then vigorously mixed to obtain homogeneous puree using (Santos, VITA-MAX CORP-Light Industrial Food Preparing Machine Model, VM0122E, USA). PP and CP were filled in glass jars then pasteurized at 85°C - 90°C for 10 min, cooled in an ice-water bath for 20 minutes and stored at 4°C for further use in ice cream manufacturing.

2.3. Preparation of Ice Cream

The ice cream was processed in the Department of Food Science and Human Nutrition, Faculty of Agriculture and Veterinary Medicine, Qassim University as described by Arbuckle [9] according to formulas in **Table 1**. Briefly, dried milk powder was first mixed with sugar to generate a “dry mix”. Fresh milk and cream were mixed to generate the “liquid mix”. The “liquid mix” was heated to 30°C - 40°C in a water bath. The “dry mix” was added slowly to the “liquid mix” with gentle stirring, gelatin was dissolved in appropriate water volume by gentle

Table 1. Different formulas of prepared ice-cream supplemented with PP and CP amount per 100 g mix.

Formulas	Milk 3% Fat	Cream 33% Fat	Dried milk (28% Fat & 68% SNF)	Sugar	Gelatin	PP or CP
TC	59.84	20.30	5.36	14.00	0.50	0.00
10% PP	49.15	18.49	8.66	13.20	0.50	10.00
15% PP	43.76	17.39	10.55	12.80	0.50	15.00
20% PP	38.38	16.19	12.53	12.40	0.50	20.00
10% CP	49.00	18.40	8.70	13.40	0.50	10.00
15% CP	43.43	17.39	10.58	13.10	0.50	15.00
20% CP	37.87	16.23	12.60	12.80	0.50	20.00

TC: typical control ice cream, PP: pumpkin pulp and CP: carrot pulp.

stirring over a boiling-water bath then added to the whole mix. The obtained mixture was blended using a mixer (Santos, VITA-MAX CORP-Light Industrial Food Preparing Machine Model, VM0122E, USA) at speed 1 for 1 min, pasteurized in a double boiler at 80°C for 15 min, cooled to 4°C, PP and CP were added by substituting ~10%, 15%, and 20% by PP and CP. As presented in **Table 1**, formulated ice cream batches were calculated basically as 10% fat, 11% SNF, and 14% sugar with considering CP and PP as sweetening ingredient after determining the sugar percentage in °Brix. The sweetness degree of prepared ice creams was equality settled by subtracting the added PP and CP'sugars from the supposed amount of sucrose. The pasteurized mixtures were aged in the fridge at 4°C for 20 h, whipped under a frozen condition in the ice cream maker (Promag, ice cream batch machines, Italy) at middle speed for 20 min. The ice cream was collected at an exit temperature of -5°C, placed in a 1 L plastic container, sealed, hardened under -18°C ± 1°C for 24 h before analysis.

2.4. Proximate Chemical Analysis

Moisture, total solids, SNF, crude protein, fat, ash, crude fiber, available carbohydrates, energy value (kcal 100 g⁻¹ fresh weight) and ascorbic acid content (vit. C) were determined in accordance with standard methods of AOAC [20].

2.5. The Overrun, Melting Temperature and Melting Resistance

Three batches of both types of pumpkin ice cream (PP-ice cream) and carrot ice cream (CP-ice cream), as well as typical control ice cream (TC-ice cream) were produced for the overrun and melting resistance assessment [9] [21]. The overrun was calculated using the equation of “% Overrun = (Volume of ice cream – Volume of mix used)/Volume of mix used × 100”. The melting temperature and melting resistance of ice cream samples were determined by allowing 25 g of sample to melt at room temperature 22°C ± 1°C. The samples were placed on a narrow wire screen which had been placed over a glass funnel and the dripping were collected in a beaker. The time of first drop was recorded as melting temperature. The weight of drainage was determined at 45 and 90 mi-

minutes. The percentage of the relative melted amount during each period to determine the melting resistance was calculated [22].

2.6. Phytochemicals and Antioxidant Activity

2.6.1. Determination of Total Extractable Phenolic Content (TPC)

The Folin-Ciocalteu reagent method was applied to determine the TPC of prepared ice cream samples according to adapted method by Bettaieb *et al.* [23]. The absorbance at 760 nm was measured then measurements were compared to Gallic acid (GA) standard curve. TPC was expressed as mg of Gallic acid equivalents (GAE) per g on dry weight (mg of GAE g⁻¹ dw).

2.6.2. Determination of Total Flavonoids (TF) and Total Flavonols (TFL)

The TF content of ice cream samples were determined according to method of Mohdaly *et al.* [24]. The TF content were presented as mg quercetin equivalent (QE) per 100 g⁻¹ dw. The TFL content were determined according to Kumaran and Karunakaran [25]. The absorbance at 440 nm was measured then TFL content were expressed as mg quercetin equivalent (QE) per 100 g⁻¹ dw.

2.6.3. DPPH Radical Scavenging Assay

Radical scavenging activity was determined spectrophotometrically using DPPH radicals according to adapted method by Lu *et al.* [26]. The antiradical activity of PP-ice cream and CP-ice cream was presented as micromoles of Trolox equivalents (TE) per 100 g of dry weight ($\mu\text{mol TE } 100 \text{ g}^{-1} \text{ dw}$).

2.7. Organoleptic Properties

After one day of frozen storage, organoleptic properties of the different formulas were carried out. Twelve panelists from the staff members of Food Science and Human Nutrition Department, Faculty of Agriculture and Veterinary Medicine, Qassim University were asked to evaluate the prepared PP-ice cream and CP-ice cream. The following parameters such as flavor (40), texture (30), melting (10), color (10), appearance (10) and overall acceptability (100) were judged. Results were statistically analyzed and average of the mean values of aforementioned attributes and their standard error were calculated [9].

2.8. Statistical Analysis

The statistical analysis was carried out using SPSS program (ver. 19), data were analyzed using one-way ANOVA regarding to the experimental design and comparisons were carried out applying Tukey' LSD at 0.05 significance level according to Steel *et al.* [27].

3. Results and Discussion

3.1. Approximate Chemical Composition of Different Prepared Ice Cream Formulas

The chemical composition of prepared PP-ice cream and CP-ice cream and their

caloric value were illustrated in **Table 2**. The PP-ice cream and CP-ice cream formulas were characterized by increasing concentration of the dry matter especially SNF, significantly ($P < 0.05$). Similarly, significant increases in ash and carbohydrates were recorded as a result of adding PP and CP when compared to TC-ice cream sample. In contrary, significant decreases in crude protein was found due to replacing of fresh milk when compared with TC-ice cream sample. However, very low amount of fiber has been detected as a function of adding PP and CP in range of 0.02% - 0.06% on fresh weight which had similarly confirmed by Matter *et al.* [28]. Practically, obtained results of proximate chemical composition concluded that prepared PP and CP-ice cream formulas had remarkable effect of caloric value by increasing it significantly ($P < 0.05$) with 15% and 20% substitution levels.

3.2. Rheological Parameters of Different Prepared Ice Cream Formulas

The overrun of the PP-ice cream and CP-ice cream formulas was in range 40.29% - 43.43% and 41.88% - 44.10%, respectively (**Figure 1**). Increasing PP and CP substitution level more than 15% resulted significant ($P < 0.05$) reduction in overrun % of PP-ice cream when compared with TC-ice cream, a result which not showed in CP-ice cream. These results indicated that the increasing of PP over 20% may drastically affect the overrun. Indeed, the overrun depends upon the fat, milk-SNF and solid content of the ice cream mix [29]. The ice creams produced for this study had moderate fat content of 10%. It is recognized that an elevated fat content enables a higher overrun, as more coalesced fat droplets are existing to trap a superior amount of air bubbles in the ice cream [30]. The alteration in the emulsification ability of milk proteins such as the amphiphilic property can change their interactions with other components on the air-cell interfaces of ice cream, resulting in different overrun values [21].

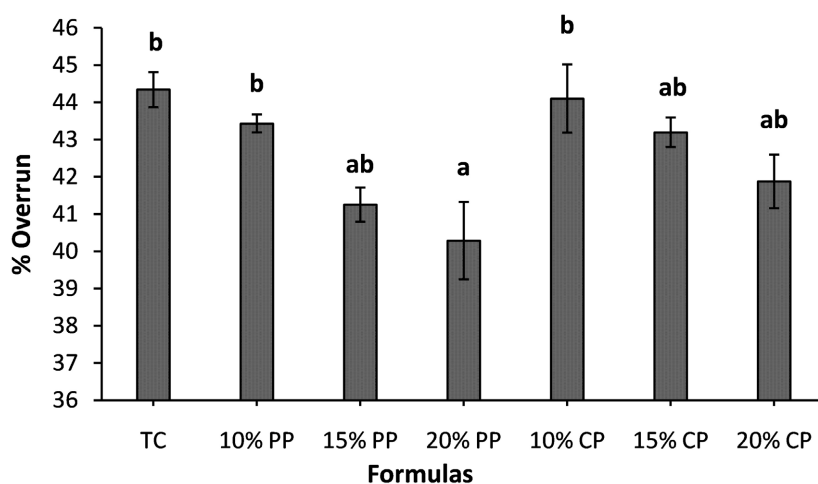


Figure 1. The overrun % of prepared ice cream formulas incorporated PP and CP (Mean \pm SE), $n = 3$. a, b, c... superscripted letters refer that there is no significant difference ($P > 0.05$) between any two means have the same superscripted letter.

Table 2. Approximate chemical composition and relative energy value of prepared ice cream formulas supplemented with PP and CP (Mean \pm SE), n = 3.

Component (%)	Ice cream formulas						
	TC	10% PP	15% PP	20% PP	10% CP	15% CP	20% CP
Moisture	64.49 ^d \pm 0.06	62.3 ^c \pm 0.17	61.26 ^{ab} \pm 0.15	60.71 ^{ab} \pm 0.4	63.64 ^d \pm 0.33	62.20 ^{bc} \pm 0.17	61.85 ^{bc} \pm 0.09
Total solid (TS)	35.51 ^a \pm 0.06	37.70 ^b \pm 0.17	38.74 ^{cd} \pm 0.15	39.29 ^{cd} \pm 0.4	36.36 ^a \pm 0.33	37.80 ^{bc} \pm 0.17	38.15 ^{bc} \pm 0.09
SNF	25.47 ^a \pm 0.16	27.67 ^c \pm 0.07	28.64 ^{de} \pm 0.03	29.22 ^e \pm 0.32	26.36 ^b \pm 0.22	27.74 ^c \pm 0.03	28.05 ^{cd} \pm 0.03
Crude protein	4.28 ^d \pm 0.02	3.92 ^c \pm 0.01	3.78 ^b \pm 0.01	3.64 ^a \pm 0.01	3.91 ^c \pm 0.01	3.75 ^b \pm 0.01	3.60 ^a \pm 0.01
Fat	10.03 ^a \pm 0.22	10.03 ^a \pm 0.12	10.10 ^a \pm 0.12	10.07 ^a \pm 0.09	10.00 ^a \pm 0.12	10.07 ^a \pm 0.15	10.10 ^a \pm 0.12
Ash	0.75 ^a \pm 0.03	0.86 ^b \pm 0.03	0.92 ^{bcd} \pm 0.01	0.96 ^{cd} \pm 0.01	0.89 ^{bc} \pm 0.01	0.92 ^{bcd} \pm 0.01	0.98 ^d \pm 0.01
Crude fiber	0.00 ^a \pm 0.00	0.02 ^b \pm 0.01	0.04 ^{bc} \pm 0.01	0.05 ^{bc} \pm 0.01	0.03 ^b \pm 0.00	0.05 ^{bc} \pm 0.01	0.06 ^{bc} \pm 0.01
Available carbohydrates	20.44 ^a \pm 0.21	22.71 ^c \pm 0.09	23.90 ^d \pm 0.01	24.58 ^e \pm 0.31	21.54 ^b \pm 0.22	23.02 ^c \pm 0.02	23.41 ^{cd} \pm 0.01
Energy value (kcal 100 g ⁻¹ fw)	186.58 ^a \pm 2.86	193.9 ^b \pm 1.46	198.59 ^c \pm 1.16	200.37 ^d \pm 2.05	189.07 ^a \pm 1.98	194.81 ^b \pm 1.48	195.97 ^b \pm 1.16

TC: typical control ice cream, PP: pumpkin pulp and CP: carrot pulp. ^{a,b,c,d,e}: the means within the same row have the same superscript letter are no significant differed ($P > 0.05$).

The differences in the soluble non-starch polysaccharide, protein and/or sugar contents of PP and CP are accountable for the noticed overrun values. For example, there were significant quantities of pectic polysaccharides in pumpkin and carrot [12] [13] [15]. These pectic polysaccharides would have influenced the process of milk coagulation, rheological properties of the ice cream emulsion, and consequently the ice cream microstructure [21] [29] [31].

Results compromised that 15% of both PP and CP substitution give appropriate color and flavor and the increasing more than 20% may affect the overrun. Lack of creaminess and smoothness comes from extremely low overrun which indicates little air has been included, causing an excessively cold sensation in the mouth. In contrary, high overrun as possible make the ice cream frothy even some countries set 100% as the legal overrun limit for ice cream [29].

The melting temperature of the PP-ice cream and CP-ice cream formulas were recorded in (Figure 2). Increasing pumpkin and carrot substitution level more than 10% resulted significant increase in melting temperature. Addition of PP shows high melting temperature higher than CP adding. This may be due to that PP have higher pectic and polysaccharide substances and building a good matrix with water in the acidic nature of ice cream mixture. However, numerous factors such as ice crystal size, ice crystal content, overrun, extent of fat destabilization, and rheological properties of the mix were found to influence hardness of ice cream [13] [15] [22].

The melting resistance of PP-ice cream and CP-ice cream samples was presented in Figure 3. The weight loss % of TC-ice cream samples was significantly ($P < 0.05$) higher than PP-ice cream and CP-ice cream formulas. PP-ice cream was more resistance to melting than CP-ice cream. Low overrun with high

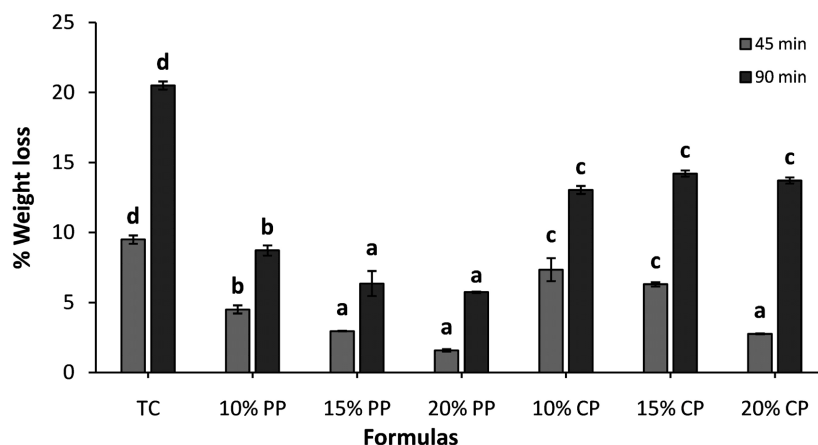


Figure 2. Melting resistance of prepared ice cream formulas incorporated PP and CP after 45 and 90 min, respectively (Mean \pm SE), $n = 3$. a, b, c... superscripted letters refer that there is no significant difference ($P > 0.05$) between any two means have the same superscripted letter.

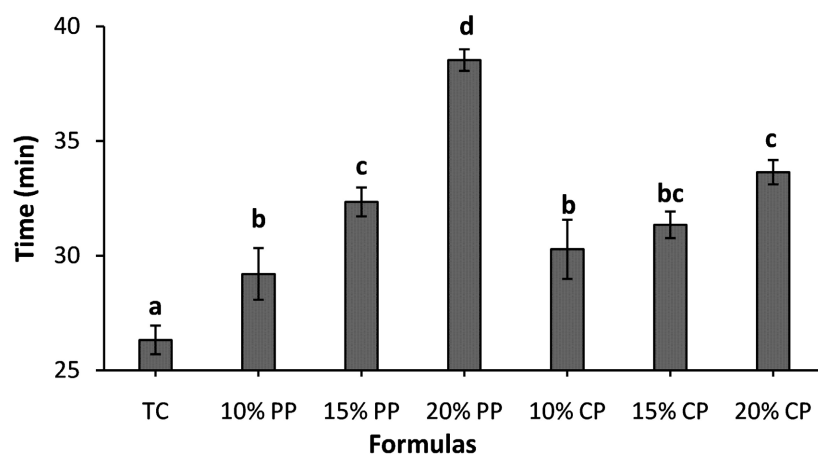


Figure 3. Melting temperature of prepared ice cream incorporated PP and CP (Mean \pm SE), $n = 3$. a, b, c... superscripted letters refer that there is no significant difference ($P > 0.05$) between any two means have the same superscripted letter.

amount of pumpkin indicates a compact structure with high melting resistance may be due to preventing ambient air to across into ice cream matrix as shown in **Figure 3**. PP-ice cream was more resistance to melting than CP-ice cream at both 45 and 90 min. These results are correlated to overrun as shown in **Figure 1**, as low overrun was related to high melting resistance as previously shown [22] [29] [32].

3.3. Phytochemicals and Its Antioxidant Capacity of Different Prepared Ice Cream Formulas

Table 3 shows the TPC, carotenoids, FT, and TFL contents, as well as antioxidant capacity applying DPPH radicals of ice cream formulated by adding 10%, 15% and 20% of PP or CP. The highest TPC content (288.94 mg GAE g^{-1} dw) was found in

20% PP-ice cream and the lowest TPC content (208.37 mg GAE g⁻¹ dw) was found in 10% CP-ice cream. However, TC-ice cream exhibited 173.94 mg GAE g⁻¹ dw. TPC content was increased gradually by increasing both PP and CP. The TPC in PP-ice cream was significantly ($P < 0.05$) higher than TPC content in CP-ice cream when compared with TC-ice cream. Carotenoids content was ranged from 1.35 to 2.32 mg 100 g⁻¹ dw in PP-ice cream and from 1.49 to 2.56 mg 100 g⁻¹ dw in CP-ice cream while carotenoids were not detected in TC-ice cream. The TF content was ranged from 2.7 to 4.65 mg QE 100 g⁻¹ dw in PP-ice cream and from 2.97 to 5.11 mg QE 100 g⁻¹ dw in CP-ice cream. TF content in TC-ice cream was not found. In the same context, TFL content was ranged from 1.08 to 1.86 mg QE 100 g⁻¹ dw in PP-ice cream and from 1.19 to 2.05 mg QE 100 g⁻¹ dw in CP-ice cream while, TFL was not detected in TC-ice cream. Comparing with TC-ice cream, incorporation of PP and CP into ice cream resulted in valuable TPC, carotenoids, TF and TFL contents as similarly indicated by adding PP in milk products [33] [34] [35]. Those extractable phytochemicals enrich the functional properties of prepared ice cream and could be scaled up further, even polyphenols of pumpkin and carrot forming complexes with ice cream components such as milk proteins and polysaccharides during mixing and/or aging processing [36]. The trend vitamin C was like those of TPC, TF and TFL, indicating that increasing PP and CP substitution level increased the vit. C content. The detected vit. C content in PP-ice cream and CP-ice cream was significantly increased. As shown as an adequate quantity of vit. C through dietary intake is very important for humans, who are not able to synthesize this compound but require it to neutralize reactive oxygen species [37]. The antioxidant activities of PP and CP ice cream samples are shown in the same table. PP-ice cream and CP-ice cream had higher antioxidant activity than TC-ice cream. The DPPH radical scavenging activity of 10% PP-ice cream was 43.37 $\mu\text{mol TE } 100 \text{ g}^{-1} \text{ dw}$, which significantly ($P < 0.05$) increased with increasing PP substitution level. Similar trend in CP-ice cream was observed. The higher antioxidant activity in PP and CP ice cream might resulted from the phytochemicals content added from incorporating PP and CP. Similar findings had been previously mentioned [33] [38].

3.4. Organoleptic Properties of Different Prepared Ice Cream Formulas

Table 4 shows the sensory scores of PP and CP-ice cream samples in comparison with TC-ice cream. Fortifying ice cream with PP and CP at successive levels was associated with a statistically significant effect on color, flavor, texture, melting and overall acceptability. The score of appearance was not significantly ($P > 0.05$) affected. Color score of TC-ice cream showed the lowest score while higher substitution levels of both PP and CP were the highest significantly ($P < 0.05$). PP and CP contains a yellow color from carotenoids contributes to ice cream color which may favored for panelists. Improving the flavor and color of

Table 3. Phytochemicals composition of prepared ice cream formulas supplemented with PP and CP (Mean \pm SE), n = 3.

Component (%)	Ice cream formulas						
	TC	10% PP	15% PP	20% PP	10% CP	15% CP	20% CP
Total Phenolic content [mg GAE 100 g ⁻¹]	173.94 ^a \pm 4.49	231.53 ^{cd} \pm 2.66	243.73 ^d \pm 1.11	288.94 ^f \pm 6.04	208.37 ^b \pm 2.4	219.35 ^{bc} \pm 1.00	260.05 ^e \pm 5.44
Carotenoids [mg 100 g ⁻¹]	0.00 ^a \pm 0.00	1.35 ^b \pm 0.1	1.91 ^c \pm 0.07	2.32 ^{df} \pm 0.11	1.49 ^b \pm 0.1	2.10 ^{cd} \pm 0.07	2.56 ^e \pm 0.12
Total flavonoid [mg QE 100 g ⁻¹]	0.00 ^a \pm 0.00	2.70 ^b \pm 0.19	3.82 ^c \pm 0.13	4.65 ^{de} \pm 0.21	2.97 ^b \pm 0.21	4.20 ^{cd} \pm 0.14	5.11 ^e \pm 0.24
Total flavonols [mg QE 100 g ⁻¹]	0.00 ^a \pm 0.00	1.08 ^b \pm 0.08	1.53 ^c \pm 0.05	1.86 ^{de} \pm 0.09	1.19 ^b \pm 0.09	1.68 ^{cd} \pm 0.06	2.05 ^e \pm 0.09
Vitamin C [mg 100g ⁻¹ fw]	0.00 ^a \pm 0.00	3.56 ^b \pm 0.12	5.05 ^c \pm 0.08	6.14 ^d \pm 0.14	3.93 ^b \pm 0.14	5.54 ^c \pm 0.09	6.77 ^d \pm 0.14
DPPH [μ mol TE 100 g ⁻¹]	0.00 ^a \pm 0.00	43.37 ^b \pm 1.49	60.53 ^c \pm 2.38	90.71 ^d \pm 2.75	41.2 ^b \pm 1.42	57.51 ^c \pm 2.26	86.17 ^d \pm 2.61

TC: typical control ice cream, PP: pumpkin pulp and CP: carrot pulp. ^{a,b,c}: the means within the same row have the same superscript letter are no significant differed ($P > 0.05$).

Table 4. Organoleptic properties of prepared ice cream formulas supplemented with PP and CP (Mean \pm SE), n = 3.

Organoleptic parameters	Ice cream formulas						
	TC	10% PP	15% PP	20% PP	10% CP	15% CP	20% CP
Appearance	9.00 ^a \pm 0.28	9.00 ^a \pm 0.33	9.25 ^a \pm 0.22	8.92 ^a \pm 0.56	8.50 ^a \pm 0.36	8.58 ^a \pm 0.19	8.00 ^a \pm 0.39
Color	7.17 ^a \pm 0.41	8.00 ^a \pm 0.60	9.17 ^{cd} \pm 0.37	9.42 ^d \pm 0.34	8.42 ^a \pm 0.36	8.50 ^{ab} \pm 0.38	8.67 ^{bc} \pm 0.28
Flavor	32.17 ^a \pm 1.23	37.17 ^{bc} \pm 0.89	38.67 ^{bc} \pm 0.89	35.25 ^{ab} \pm 0.77	34.83 ^{ab} \pm 1.65	35.17 ^b \pm 1.32	35.92 ^b \pm 1.48
Texture	26.08 ^a \pm 1.08	28.00 ^b \pm 0.49	28.50 ^b \pm 0.60	27.58 ^{ab} \pm 0.83	27.00 ^a \pm 1.51	27.00 ^a \pm 1.02	28.50 ^b \pm 0.48
Melting	8.25 ^a \pm 0.60	8.92 ^a \pm 0.31	9.25 ^b \pm 0.29	9.42 ^b \pm 0.30	8.50 ^a \pm 0.40	8.92 ^a \pm 0.56	9.17 ^{ab} \pm 0.17
Overall acceptability	80.15 ^a \pm 1.69	85.92 ^b \pm 1.22	97.08 ^d \pm 1.13	92.50 ^c \pm 3.51	82.50 ^{ab} \pm 1.69	93.08 ^c \pm 1.43	87.50 ^{bc} \pm 3.51

TC: typical control ice cream, PP: pumpkin pulp and CP: carrot pulp. ^{a,b,c}: the means within the same row have the same superscript letter are no significant differed ($P > 0.05$).

ice cream fortified with fruits and vegetables were confirmed [12] [17]. The flavor of TC-ice cream showed the lowest score while highest scores were given to 15% PP-ice cream and 20% CP-ice cream. The significant variation of texture and melting was observed only with higher level of PP and CP. Thus, evaluating those ice cream formulas need deep rheological study, further. The overall acceptability of 15% PP-ice cream and 20% CP-ice cream showed the highest score when compared with TC-ice cream. It is clearly showed that panelists were favored the prepared ice cream formulas with PP and TC and gave the samples high scores. Thus, scaling up these economics formulas as designated in this investigation could be concerned as also suggested for commercial production [12].

4. Conclusion

The PP-ice cream and CP-ice cream were characterized by increasing concentration of dry matter especially SNF, significantly. Accordingly, ash, fiber and available carbohydrates contents were significantly increased whereas opposite finding was recorded for crude protein because of PP and CP substitution. The ice cream containing high PP and CP contents had higher melting resistance and lower overrun %. Health beneficial phytochemicals such as carotenoids, flavonoids, flavonols and vit. C were commonly detected in PP and CP-ice creams, reflecting the attributes of the PP and CP ingredients. PP and CP-ice cream had the highest level of TPC, vit. C and antioxidant capacity. Only, the ice cream made with 15% of PP and CP was highly accepted. Therefore, it is possible to use a substantial amount from PP and CP to produce ice cream up to 15% with retained much of the natural colors as well as the unique vit. C, TPC, carotenoids, TF and TFL as well as valuable antioxidant capacity.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Villava, F.J., Cravero Bruneri, A.P., Vinderola, G., Goncalvez De Oliveira, E., PAZ, N.F. and Ramon, A.N. (2017) Formulation of a Peach Ice Cream as Potential Symbiotic Food. *Food Science and Technology*, **37**, 456-461. <https://doi.org/10.1590/1678-457x.19716>
- [2] Thorning, T.K., Bertram, H.C., Bonjour, J.-P., De Groot, L., Dupont, D., Feeney, E., Ipsen, R., Lecerf, J.M., Mackie, A. and McKinley, M.C. (2017) Whole Dairy Matrix or Single Nutrients in Assessment of Health Effects: Current Evidence and Knowledge Gaps. *The American Journal of Clinical Nutrition*, **105**, 1033-1045. <https://doi.org/10.3945/ajcn.116.151548>
- [3] Astrup, A. (2014) Yogurt and Dairy Product Consumption to Prevent Cardiometabolic Diseases: Epidemiologic and Experimental Studies. *The American Journal of Clinical Nutrition*, **99**, 1235S-1242S. <https://doi.org/10.3945/ajcn.113.073015>
- [4] Elwood, P.C., Pickering, J.E., Givens, D.I. and Gallacher, J.E. (2010) The Consumption of Milk and Dairy Foods and the Incidence of Vascular Disease and Diabetes: An Overview of the Evidence. *Lipids*, **45**, 925-939. <https://doi.org/10.1007/s11745-010-3412-5>
- [5] Sun-Waterhouse, D. (2011) The Development of Fruit-Based Functional Foods Targeting the Health and Wellness Market: A Review. *International Journal of Food Science & Technology*, **46**, 899-920. <https://doi.org/10.1111/j.1365-2621.2010.02499.x>
- [6] Van Kleef, E., Van Trijp, H.C., Luning, P. and Jongen, W.M. (2002) Consumer-Oriented Functional Food Development: How Well Do Functional Disciplines Reflect the "Voice of the Consumer"? *Trends in Food Science & Technology*, **13**, 93-101. [https://doi.org/10.1016/S0924-2244\(02\)00068-7](https://doi.org/10.1016/S0924-2244(02)00068-7)
- [7] Cruz, A.G., Antunes, A.E., Sousa, A.L.O., Faria, J.A. and Saad, S.M. (2009) Ice-Cream as a Probiotic Food Carrier. *Food Research International*, **42**, 1233-1239.

- <https://doi.org/10.1016/j.foodres.2009.03.020>
- [8] Smith, J.S. and Hui, Y.H. (2008) Food Processing: Principles and Applications. John Wiley & Sons, Hoboken.
- [9] Arbuckle, W.S. (2013) Ice Cream. Springer, New York.
<https://doi.org/10.1016/j.foodchem.2008.12.070>
- [10] Soukoulis, C., Lebesi, D. and Tzia, C. (2009) Enrichment of Ice Cream with Dietary Fibre: Effects on Rheological Properties, Ice Crystallisation and Glass Transition Phenomena. *Food Chemistry*, **115**, 665-671.
- [11] Tiwari, A., Sharma, H.K., Kumar, N. and Kaur, M. (2015) The Effect of Inulin as a Fat Replacer on the Quality of Low-Fat Ice Cream. *International Journal of Dairy Technology*, **68**, 374-380. <https://doi.org/10.1111/1471-0307.12176>
- [12] Denzil, D. (2014) Development of Technology for Use Carrot as a Function Ingredient in Ice Cream, in Department of Dairy Technology. Anand Agricultural University, Gujarat.
- [13] da Silva Dias, J.C. (2014) Nutritional and Health Benefits of Carrots and Their Seed Extracts. *Food and Nutrition Sciences*, **5**, 2147-2156.
<https://doi.org/10.4236/fns.2014.522227>
- [14] Brandt, K., Christensen, L.P., Hansen-Møller, J., Hansen, S.L., Haraldsdottir, J., Jespersen, L., Purup, S., Kharazmi, A., Barkholt, V. and Frøkiær, H. (2004) Health Promoting Compounds in Vegetables and Fruits: A Systematic Approach for Identifying Plant Components with Impact on Human Health. *Trends in Food Science & Technology*, **15**, 384-393. <https://doi.org/10.1016/j.tifs.2003.12.003>
- [15] Kwon, Y., Apostolidis, E., Kim, Y. and Shetty, K. (2007) Health Benefits of Traditional Corn, Beans, and Pumpkin: *In Vitro* Studies for Hyperglycemia and Hypertension Management. *Journal of Medicinal Food*, **10**, 266-275.
<https://doi.org/10.1089/jmf.2006.234>
- [16] Murkovic, M., Mülleder, U. and Neunteufl, H. (2002) Carotenoid Content in Different Varieties of Pumpkins. *Journal of Food Composition and Analysis*, **15**, 633-638. <https://doi.org/10.1006/jfca.2002.1052>
- [17] Singh, B., Panesar, P. and Nanda, V. (2006) Utilization of Carrot Pomace for the Preparation of a Value Added Product. *World Journal of Dairy & Food Sciences*, **1**, 22-27.
- [18] Pérez-Jiménez, J. and Saura-Calixto, F. (2006) Effect of Solvent and Certain Food Constituents on Different Antioxidant Capacity Assays. *Food Research International*, **39**, 791-800. <https://doi.org/10.1016/j.foodres.2006.02.003>
- [19] Rohn, S., Rawel, H.M. and Kroll, J. (2004) Antioxidant Activity of Protein-Bound Quercetin. *Journal of Agricultural and Food Chemistry*, **52**, 4725-4729.
<https://doi.org/10.1021/jf0496797>
- [20] A.O.A.C. (2000) Official Methods of Analysis of the Aoac. 17th Edition, Association of Official Analytical Chemists.
- [21] Schmidt, K.A. (2004) Dairy: Ice Cream. In: Smith, J.S. and Hui, Y.H., Eds., *Food Processing: Principles and Applications*, Wiley-Blackwell, Hoboken, 287-296.
<https://doi.org/10.1002/9780470290118.ch15>
- [22] Muse, M. and Hartel, R.W. (2004) Ice Cream Structural Elements That Affect Melting Rate and Hardness. *Journal of Dairy Science*, **87**, 1-10.
[https://doi.org/10.3168/jds.S0022-0302\(04\)73135-5](https://doi.org/10.3168/jds.S0022-0302(04)73135-5)
- [23] Bettaieb, I., Bourgou, S., Wannas, W.A., Hamrouni, I., Limam, F. and Marzouk, B. (2010) Essential Oils, Phenolics, and Antioxidant Activities of Different Parts of

- Cumin (*Cuminum cyminum* L.). *Journal of Agricultural and Food Chemistry*, **58**, 10410-10418. <https://doi.org/10.1021/jf102248j>
- [24] Mohdaly, A.A.A., Hassaniien, M.F.R., Mahmoud, A., Sarhan, M.A. and Smetanska, I. (2012) Phenolics Extracted from Potato, Sugar Beet, and Sesame Processing by-Products. *International Journal of Food Properties*, **16**, 1148-1168. <https://doi.org/10.1080/10942912.2011.578318>
- [25] Kumaran, A. and Karunakaran, R.J. (2007) *In Vitro* Antioxidant Activities of Methanol Extracts of Five Phyllanthus Species from India. *LWT—Food Science and Technology*, **40**, 344-352. <https://doi.org/10.1016/j.lwt.2005.09.011>
- [26] Lu, J., Zhao, H., Chen, J., Fan, W., Dong, J., Kong, W., Sun, J., Cao, Y. and Cai, G. (2007) Evolution of Phenolic Compounds and Antioxidant Activity during Malting. *Journal of Agricultural and Food Chemistry*, **55**, 10994-11001. <https://doi.org/10.1021/jf0722710>
- [27] Steel, R., Torrie, J. and Dickey, D. (1997) Principles and Procedures of Statistics: A Biometrical Approach. 3rd Edition, McGraw-Hill, New York.
- [28] Matter, A.A., Mahmoud, E.A.M. and Zidan, N.S. (2016) Fruit Flavored Yoghurt: Chemical, Functional and Rheological Properties. *International Journal of Environmental & Agriculture Research*, **2**, 57-66.
- [29] Sun-Waterhouse, D., Edmonds, L., Wadhwa, S. and Wibisono, R. (2013) Producing Ice Cream Using a Substantial Amount of Juice from Kiwifruit with Green, Gold or Red Flesh. *Food Research International*, **50**, 647-656. <https://doi.org/10.1016/j.foodres.2011.05.030>
- [30] Abd El-Rahman, A., Madkor, S., Ibrahim, F. and Kilara, A. (1997) Physical Characteristics of Frozen Desserts Made with Cream, Anhydrous Milk Fat, or Milk Fat Fractions. *Journal of Dairy Science*, **80**, 1926-1935. [https://doi.org/10.3168/jds.S0022-0302\(97\)76133-2](https://doi.org/10.3168/jds.S0022-0302(97)76133-2)
- [31] Fagan, C.C., O'Donnell, C.P., Cullen, P.J. and Brennan, C.S. (2006) The Effect of Dietary Fibre Inclusion on Milk Coagulation Kinetics. *Journal of Food Engineering*, **77**, 261-268. <https://doi.org/10.1016/j.jfoodeng.2005.06.030>
- [32] Moeenfarid, M. and Mazaheri Tehrani, M. (2008) Effect of Some Stabilizers on the Physicochemical and Sensory Properties of Ice Cream Type Frozen Yogurt. *American-Eurasian Journal Agriculture and Environment Science*, **4**, 584-589.
- [33] Nguyen, L. and Hwang, E.S. (2016) Quality Characteristics and Antioxidant Activity of Yogurt Supplemented with Aronia (*Aronia Melanocarpa*) Juice. *Preventive Nutrition and Food Science*, **21**, 330-337. <https://doi.org/10.3746/pnf.2016.21.4.330>
- [34] Fayed, A.E. (2015) Review Article: Health Benefits of Some Physiologically Active Ingredients and Their Suitability as Yoghurt Fortifiers. *Journal of Food Science and Technology*, **52**, 2512-2521. <https://doi.org/10.1007/s13197-014-1393-8>
- [35] Yu, M.S., Kim, J.M., Lee, C.H., Son, Y.J. and Kim, S.K. (2014) Quality Characteristics of Stirred Yoghurt Added with Fermented Red Pepper. *Korean Journal of Food Science and Animal Resource*, **34**, 408-414. <https://doi.org/10.5851/kosfa.2014.34.4.408>
- [36] Arts, M.J., Haenen, G.R., Wilms, L.C., Beetstra, S.A., Heijnen, C.G., Voss, H.-P. and Bast, A. (2002) Interactions between Flavonoids and Proteins: Effect on the Total Antioxidant Capacity. *Journal of Agricultural and Food Chemistry*, **50**, 1184-1187. <https://doi.org/10.1021/jf010855a>
- [37] Rababah, T.M., Ereifej, K.I. and Howard, L. (2005) Effect of Ascorbic Acid and Dehydration on Concentrations of Total Phenolics, Antioxidant Capacity, Anthocya-

nins, and Color in Fruits. *Journal of Agricultural and Food Chemistry*, **53**, 4444-4447. <https://doi.org/10.1021/jf0502810>

- [38] Barakat, H. and Hassan, M.F. (2017) Chemical, Nutritional, Rheological, and Organoleptical Characterizations of Stirred Pumpkin-Yoghurt. *Food and Nutrition Sciences*, **8**, 746-759. <https://doi.org/10.4236/fns.2017.87053>