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

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ABSTRACT

Beetroot is the taproot portion of the beet plant. It is a very good food which imparts important role for the growth and development of human body. Carrot is a root vegetable that has health benefits and remarkable nutritional values. Beetroot juice was added to typical control ice cream (TC) in different ratios (1%, 3% and 5%) while carrot pulps were added to typical ice cream in 5%, 10% and 15% ratio. Through adding beetroot juice or carrot pulps, unique color, natural flavor and health promoting constituents were presented. Rheological chemical, nutritional, and organoleptic properties were investigated. The addition of substantial amount of beetroot juice and carrot pulps to Ice cream manufactured had a high organoleptic acceptability. Results revealed that it is possible to use carrot pulps at 10 % and 15 % to produce ice cream with retained much of carotenoids, natural color, total phenol and valuable anti-oxidant capacity as well as good amount of crude fiber. Also, it is possible to use beetroot juice at 5 % ratio to produce ice cream with retained much of betalains, total phenol and anti-oxidant. Organoleptic attributes and health beneficial compounds of prepared ice cream formulas were encouraging for the possibility of using beetroot juice and carrot pulps at the commercial scale.

Keywords: Ice cream, Beetroot, Carrot, and nutritional properties.

INTRODUCTION

Recently, the consumers became more interested in healthy products. Thus, the food industry developed that provide health benefits adding bioactive components. Villava *et al.* (2017). Ice cream is one of the popular diary products for all age groups of people, but currently available ice cream available is deficient in antioxidants like natural pigments, vitamin C and polyphenols. The demand for natural ingredients like vegetables and fruits to improve nutritional value of ice cream is increasing especially to deliver pigment, natural antioxidants, low fat vitamins and to reduce synthetic additives Sun-Waterhouse (2011) and Manoharan *et al.* (2012). The beet is a super food which impart important role for the growth and development of human body. It is naturally consumed as colorant and as medicinal plant. It serves as an economic package of heath care to cure the various diseases. Beet root juice is not only blessed with a beautiful natural color but also packed with nutrients like vitamins, minerals, amino acids, calories, and antioxidants yashwant, (2015). Beet juice is a very good therapy to excrete out bladder and kidney stones. Also all parts of beetroots have numerous medicinal properties such as ant-hypergolic cadmic, anti-microbial, anti-oxidant, ant-cancer, anti-inflammatory, hepatic protective and diuretic. Chawla *et al.* (2016). The carrot is a root vegetable with flavonoids, carotenoids, vitamins (B1, B2, B6 and B-carotene as a precursor of vitamin A), polyacetyle-ness and minerals (calcium, potassium, and phosphorus Denzil (2014) and Dias (2014). The consumption of carrot and its products is increasing as a valuable source of natural anti-oxidants having anti-cancer activity, fighting with infection nourishing epithelial tissues in the skin and lungs, repairing tissues, keeping eyes healthy, protecting a against cardiovascular disease and having more health–promoting function Brandt *et al.* (2004) and Denzil (2014). Carrot has health benefits and remarkable nutritional value. Hence, there are good reasons to incorporate carrots in human diet Dias (2014).

Therefore, the current study aimed at evaluating chemical, rheological, organoleptic and nutritional properties of a new type of ice cream product that includes beetroot juice and carrot pulp at different ratio.

MATERIALS AND METHODS

Materials:

Buffalos milk 7%fat, skim milk 8% SNF, fresh cream 68% fat were obtained from farm of agriculture faculty of Sohag University. Dried milk, gelatin, vanillia, carrot and beetroot were obtained from local market at Sohag city, Egypt.

Beetroot juice preparation:

Fresh beetroots are peeled and then cut into small pieces, the chopped beetroots is mixed with a blender and labeled as the product for the juice to be placed at 4 C ^{o} until use.

Preparation of carrot pulps:

Fresh carrot was washed manually peeled and then boiled for 20 minutes and mixed to obtain a homogenous product and kept at 4 C^{o} until use.

Ice cream manufacturing.

As presented in Table (1) the standard formulation for all preparation procedure studies has been consisted of 10% fat, 11.5% milk solids not fat, 16% sucrose and 0.5% stabilizer. And different ratios of both Carrot pulps and beetroot juice were used as follows: was adding 1%, 3% and 5% with beetroot juice while, it was 5 %, 10% and 15% for the carrot pulps. The hard ingredients were mixed together (sugar - gelatine - skim milk) was dissolved in heated distilled milk (about 45 C) Then it was added Cream and other ingredients in each treatment. The stirring is good until the ingredients are mixed together and the heat process is done at 71 C^{o} for 15 minutes the mix was blended in laboratory mixer at maximum speed from 10min. Then rapidly cooled to belw and aged at this temperature for at time ranged from zero to 24 hour After aging , it was noticed that in the case of adding flavoring substances each mixture was whipped in ice cream freezing machine using its refrigerating container which was placed in the deep –freezer to cool it at -25C^{0} for. this machine was controlled to stop whipping when ice cream reaches the proper consistency after 30 min. The resultant ice cream was packaged in a plastic cups (120 ml in volume) and placed in a deep – freezer at -25 C^{0} for hardening.

Table 1. Formulas of prepared ice-cream containing different ratios of beet root juice and Carrot pulps amount per 2.5 k g mix.

Formulas	Cream (g) 68% Fat	Dried milk (g)	Skim milk(g) 9% SNF	Sugar (g)	Gelatin vanilia (1: 1)	Beet J or Carrot P (g)
TC	368	141	1566	400	25	0
1% Beet J	368	144	1539	400	25	25
3% Beet J	368	149	1483	400	25	75
5% Beet J	368	154	1428	400	25	125
5 % Carrot P	368	154	1428	400	25	125
10% Carrot P	368	167	1290	400	25	250
15% Carrot P	368	180	1152	400	25	375

TC: typical control ice cream, Beet J: Beetroot Juice, Carrot P: carrot pulps.

Chemical analysis:

Total solids, Moisture, protein, ash, available carbohydrates and energy value were measured according to AOAC (2000)

The overrun, melting temperature and melting resistance:

Typical control ice cream (TC-ice cream), as well as Three batches of both types of beetroot juice ice cream and carrot pulps ice cream were produced for the overrun and melting resistance assessment according to Schmidt (2004), Muse *et al*. (2004) and Arbuckle (2013).

Determination of bioactive components:

Total phenolic compounds (TPC): Concentration of total phenolic content was determined according to Beskow *et al*. (2015).

Antioxidant activity: The method described by Brand-Williams *et al.* (1995) was used with some modification, for the determination of the antioxidant activity. The stable 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical was used. Absorbance was measured at 517 nm. The IC50 was that concentration of an antioxidant which was required to quench 50% of the initial DPPH radical under the experimental condition given. Radical scavenging activity (%) was calculated as follow: Radical scavenging activity (%) = (1-absorbance of sample /absorbance of control) x100.

Carotenoid content and crude fibers: Carotenoid and Crude fibers were determined according to AOAC (2005).

Extraction and Determination of betalains: The Extraction method was described by Francis (2000) and the concentrated of betalains measurement according to Castellar *et al.* (2003).

Organoleptic properties:

Organoleptic properties of formulas were measured, after 24 hour of frozen storage. 44 (forty four) panelists from the staff members of dairy Science and food science Department, Faculty of Agriculture, Sohag University were asked to assessment the prepared beetroot juice ice cream and Carrot pulps ice cream. The following parameters such as taste (50), body and texture (30), color (10), melting quality (10), and overall acceptability (100) were judged Arbuckle (2013).

Statistical analysis:

The statistical analysis was carried out using SPSS program according to Steel *et al*. (1979).

RESULTS AND DISCUSSION

Chemical composition of ice cream formulas:

The results presented in Table (2) showed chemical composition of beetroot juice ice cream and carrot pulps ice cream as well as caloric values.

Table 2. chemical composition and relative energy value of prepared ice cream formulas containing beet root juice and Carrot pulps.

Component (%)	Ice cream formulas					
	TC	1% Beet J	3% Beet J	5% Beet J	5 % Carrot P	10 % Carrot P	15 % Carrot P
Moisture	59.96± 0.037	59.88±0 .07	58.29± 0.81	57.99±0 .2	58.58± 0.16	56.47± 0.3	56.83 ± 0.3
Total solid (TS)	40.04 ± 0.37	40.12± 0.67	41.71 ± 0.81	42.01 ± 0.2	41.41 ± 0.16	43.52± 0.3	43.61 ± 0.3
Crude protein	4.98± 0.19	4.93± 0.16	4.74± 0.18	3.95± 0.3	4.94± 0.17	4.80± 0.3	4.41± 0.4
Fat	10.00 ± 0.0	10.17 ± 0.0	10.17 ± 0.00	10.17 ± 0.0	10.24 ± 0.0	10.24 ± 0. 0	10.24 ± 0.0
Ash	2.18± 0.00	1.91± 0.19	2.05± 0.07	1.94± 0.01	1.61± 0.01	1.56± 0.8	1.01± 0.1
Available carbohydrates	22.76± 0.21	22.72± 0.08	24.26± 0.7	25.05± 0.5	22.88± 0.4	24.33± 0.6	25.0± 0.3
Energy value (kcal 100 $g^{-1\ fw}$)	201.00± 0.14	201.13± 0.77	207.59 ± 35	207.6± 0.7	203.46± 0.8	139.1± 6.8	210.6± 0.3

TC: typical control ice cream, Beet J: Beetroot Juice, Carrot P: carrot pulps.

The total solids of the beetroot juice ice cream and carrot pulps ice cream were increased significantly with increasing the ratio of beetroot juice and carrot pulps. Similarly, significant increase in carbohydrates was recorded as a result adding beetroot juice and carrot pulps. The result revealed that there were decreases in proteins with increase the ratio of beetroot juice (4.93 to 3.95) and carrot pulps (4.94 to 4.41) which were agreement with Hassan and Brakat (2018).

Rheological parameters of different prepared ice cream formulas.

Overrun:

The overrun of beetroot juice ice cream and carrot pulps ice cream formulas was illustrated in figure 1. It was in rang 17.17% - 20.63 % and 22.4 % - 26.59 %, respectively. Increasing beetroot juice level reduced overrun significantly 20.63 for beet juice 1% to 17.7 % for beetroot juice 5 % while increasing carrot pulps increased the overrun 22.4 % for carrot 5% to 26.59 for carrot pulps 15 %. The overrun affected by the solid content, fat and

milk-SNF of ice cream mix Sun-Waterhouse *et al* (2013). The increasing of the overrun by increase carrot pulps maybe due to the increase of viscosity. Viscosity is one of the most important factors affecting overrun because the viscosity improve the ability of the matrix to beat accordingly. Also This result agrees with Lim *et al*. (2010) Opining that, in general, as the viscosity increases, the resistance to melting and the rate of whipping ability also will increase.On the other hand, different overrun values alter from changes in properties that affect the emulsifying ability of milk proteins such as amphilic proteins, that alter the interaction of milk proteins on the air-cell interface of ice cream with other components Schmidt (2004).

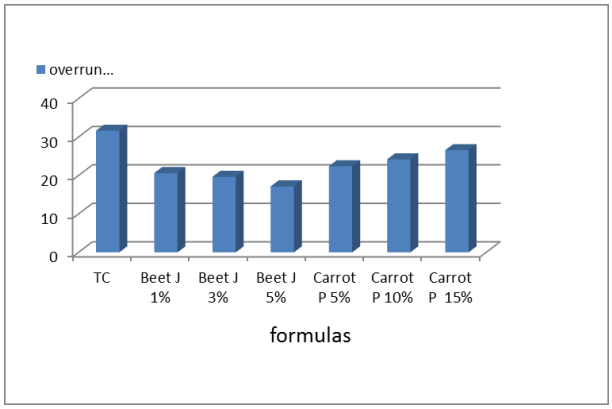

Figure1. overrun of different ice cream formulas.
TC: typical control ice cream, Beet J: Beetroot Juice, Carrot P: carrot pulps.

Melting point:

The melting temperature of the beet juice ice cream and carrot pulps ice cream formulas were illustrated in figure 2. Increasing beetroot juice and carrot pulps substitution level gave significantly increased in melting temperature. Addition of carrot pulps shows higher melting temperature than beetroot juice adding. This results may be due to that carrot pulps has high pectin sustains and a good matrix with water in the mixture of ice cream. However, the hardness of ice cream was influenced by many factors like ice crystal content, ice crystal size, the overrun, rheological properties and extent of fat destabilization of the mix Dias (2014), Hartel and Muse (2004) and Kwon *et al*. (2007).

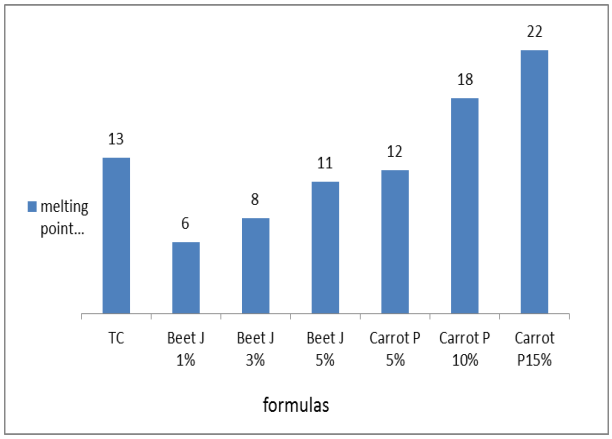

Figure 2. Melting point of different ice cream formulas.
TC: typical control ice cream, Beet J: Beetroot Juice, Carrot P: carrot pulps.

Melting resistance:

The melting resistance of beetroot juice ice cream and carrot pulps ic cream samples was recorded in figure 3. The weight loss % of beet root juice ice cream, TC-ice cream and carrot juice pulps 5 % were significantly higher than carrot pulps 10% ice cream and carrot pulps 15 % ice cream. Generally carrot pulps ice cream was more resistance to melting than beetroot juice ice cream and TC-ice cream.

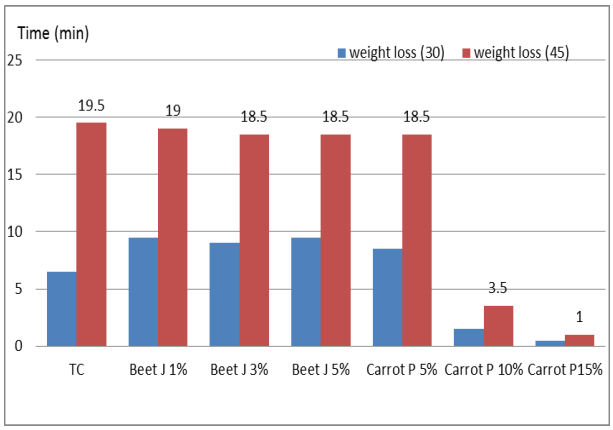

Figure 3. melting resistance of different ice cream formulas.
TC: typical control ice cream, Beet J: Beetroot Juice, Carrot P: carrot pulps.

Bioactive components of ice cream formulas containing beetroot juice and Carrot Pulps.

Total phenol:

Table (3) shows the total phenolic contents of ice cream samples. Blank sample had the lowest phenolic contents .Total phenolic contents of ice creams were in the range of 90.94 – 286.38 mg/100 Gallic acid .All supplementations increased phenolic content of ice cream samples. It was clear from that the beetroot juice 3% supplementation made the highest total phenolic content of ice cream , followed by carrot pulps 15%, beetroot juice 3%, carrot pulps 10%, beetroot juice 1% and carrot pulps 5% recorded the lowest value among all supplementations .This results are in the same line with this reported by Cruxen *et al.* (2017) they study, effect of ellagic acid, gallic acid, grape seed extract, pomegranate peel extract , and peppermint essential oil supplementation on anti-oxidative properties of ice cream was determined. Additionally, survival of Lactobacillus and found that all the supplements increased total phenolic content of ice creams.

Antioxidant activity (Ic50):

It was clear from Table (3) all supplementation increased the DPPH radical scavenging ability significantly ($P<0.05$);however, Ice creams supplemented with beetroot juice 3% and carrot pulps 15% exhibited the highest radical scavenging abilities with the values of 87.49 and 88.38 IC50, respectively. As expressed above, was also the biggest contributor of the total phenolic (Table 3). The high total content of phenolic compounds present in some fruits is related to their antioxidant activity, which provides beneficial health effects, such as the prevention of cancerous diseases Eichholz *et al*. (2011).

Betalain:

Betalains are including natural food colorants (red-violet betacyanins and yellow-orange betaxanthins) that are

not properly exploited. In addition, beetroot is practically the main sources of betacyanins Roriz *et al*. (2017). Betalain are the most important antioxidant in beet root because of their antioxidant activity and important nutritional activity. Betalain content of beetroot juice 5% (253.16 mg/100g) was higher than that (216.38 and 195.89 mg/100g) of beetroot juice 3% and beetroot juice 1% respectively (Table 4). While all supplementation of carrots recorded the lowest value compared with beetroot juice.This data indicated that the beetroot juice is good source of Betalains.

B-carotene content:

Data in Table (4) show there was a huge variation between samples in β-carotene content. Since the carrot pulps 15% ice cream had (3737.76 mg /100g), this value decreased to 984.22 mg/100g in beetroot juice 5%), while the control had the lowest value (12.42 mg /100g).That may be due to the high content of β-carotene in carrot which estimated by 16700 UI/100g Fikselová *et al.* (2008). While, it valued of 6777.94 UI/100g in carrot pulps and 17.39 for blank Swelam *et al*. (2015).

Table 3. bioactive components of ice cream formulas containing beet root juice and Carrot pulps.

Component (%)	Ice cream formulas						
	T C	Beet J 1%	Beet J 3%	Beet J 5%	Carrot P 5%	Carrot P 10%	Carrot P 15%
Total phenol	90.94 ±11 .3	229.17 ±0 .2	250.46±0 .03	268.38±0 .16	186.28±0 .1	235.5±0 .02	256.99±2
Antioxidant activity ic50	179.06 ±4 .8	87.97 ±4 .8	87.76 ±4 .7	87.49 ±4 .8	89.4 ±4 .74	88.97 ±4 .8	88.38 ±4 .7
Biotain	ND	195.89 ±1 .6	216.38 ±1 .9	253.2 ±28 .8	85.77 ±1 .8	102.60 ±1	117.89 ±1 .2
B- carotene	12.42 ±6 .9	195.89 ±1 .6	560.81 ±57 .3	775.4 ±25 .7	984.22 ±3 .3	1528.6 ±6 .9	2632±2 .8
Crude fiber	0.105 ±0 .4	0.353 ±0 .3	0.472 ±0 .01	0.875 ±0 .1	1.75 ±0 .3	2.58 ±0 .4	3.00 ±0 .3

TC: typical control ice cream, Beet J: Beetroot Juice, Carrot P: carrot pulps.

Crude fibre:

The crude fibre content in both of the control and the experimental ice cream formulas ranged from 0.105 to 3.00. It increased as the quantity of all supplementation blended with milk. The crude fibre content of all carrot pulps ice cream supplementation samples were relatively high compared to beetroot juice ice cream. The reason may be that the carrots which are naturally rich in fibre contributed high fibre to the ice cream since only the blank and supplementation with beetroot juice extract was used. The differences in the chemical composition of beetroot juice and carrot pulps ice creams may be attributed to the differences in the chemical composition of both. According to Swelam *et al.* (2015) carrot ice cream had highest value of fiber 3.27%, this implied that the high fiber content in carrot containing formulas can help to solve health problems related such as constipation.

Organoleptic properties of ice cream formulas:

The sensory scores of beetroot juice ice cream and carrot pulps ice cream in comparison with TC-ice cream were showed in Table (4) Fortifying ice cream with beetroot juice and carrot pulps was effected significantly on organoleptic properties. Color score of TC-ice cream and beetroot juice 3 % have the lowest score while carrot pulps 10% and carrot pulps 15 % have the highest level 9 and 9.2 respectively.

Table 4. Organoleptic properties of prepared ice cream formulas supplemented with beet root juice and Carrot pulps.

Ice-cream formulas	Organoleptic parameters				
	Overall acceptability	Color	Taste and flavor	Body and Texture	Melting quality
TC	87.61±1.03	8.2±0.13	43.7±0.09	26.81±0.89	8.9±0.11
Beet J 1%	81.88±8.01	8.44±2.03	38.9±1.92	26.04±0.01	8.5±7.01
Beet J 3%	74.87±11.02	8.2±1.10	32.4±0.18	26.02±0.66	8.25±1.67
Beet J 5%	85.89±5.88	8.46±7.03	42.97±2.2	25.65±2.11	8.81±0.23
Carrot P 5%	85.98±2.03	8.3±8.13	43.2±0.07	26.04±2.06	8.62±1.00
Carrot P10%	84.64±0.90	9±0.89	39.6±1.13	27.16±0.11	8.7±6.03
Carrot P15%	84.14±1.11	9.2±2.99	40.3±0.30	26.3±7.13	8.34±0.11

TC: typical control ice cream, Beet J: Beetroot Juice, Carrot P: carrot pulps.

These findings illustrate that carrot pulps contains a yellow color which favoured for panellists. Fortified ice cream with fruits and vegetables improved the flavour and color Singh (2006) and Denzil (2014). The flavour of TC and carrot pulps 5% showed the highest scores while beetroot juice 3% gave the lowest scores.

The overall acceptability of carrot pulps 5 % ice cream and beetroot juice 5% ice cream showed the highest score after TC-ice cream. Also, the overall acceptability of carrot pulps 10 % ice cream and carrot pulps 15 % ice cream had very good score

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تاثير إضافة عصير جذور البنجر ولب الجزر علي الخواص الريولوجية والكيميائية والغذائية والحسية للمثلجات القشدية

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تعتبر جذور البنجر من الاغذية الهامة لنمو وتطور جسم الانسان لما لها من فوائد صحية وغذائية ملحوظة , وقد اوضحت هذة الدراسة ان الايس كريم المصنع باستخدام كميات من عصير البنجر ولب الجزر قد لاقت قبول حسي كبير ، فقد تمت اضافة نسب مختلفة من عصير البنجر (١ %, ٣ % , ٥ %) ونسب مختلفة من لب الجزر (٥ % , ١٠% , ١٥ %) الي توليفة مكونات الايس كريم التقليدي. وقد اظهرت هذة الاضافات نتائج جيدة تمثلت في اللون الطبيعي والنكهة الطبيعية والفوائد الصحية الكبيرة , حيث اظهرت النتائج انه من الممكن استخدام لب الجزر بنسبة ١٠ % , ١٥ % لانتاج ايس كريم عالي المحتوي من الكاروتينيات والالوان الطبيعية والمحتوي الكلي من الفينولات ومضادات الاكسدة بالاضافة الي كمية جيده من الالياف , كما اوضحت الدراسة انة من الممكن استخدام عصير البنجر لانتاج الايس كريم عالي المحتوي من الصبغات الطبيعية والفينول الكلي ومضادات الاكسدة , وقد اظهر التقييم الحسي والفوائد الصحية للايس كريم المصنع نتائج يمكن ان تكون مشجعة للتوسع في استخدام عصير البنجر ولب الجزر علي النطاق التجاري.