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Use of Alcoholic Extracts of Chicory, Clove and Pomegranate Peel in Production of Functional Ice- cream with Desirable Quality

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ABSTRACT: The aim of present study was to produce functional ice-cream using chicory, clove and pomegranate peel extracts and investigate the antioxidant activity, physicochemical and sensory properties of the extract.The alcoholic extracts of chicory, clove and pomegranate peel (0.5, 1 and 1.5 percent) were used in ice-cream formulation. The samples were stored for three months. The characteristics of the samples were studied on the first, 30th, 60th and 90th days.The results showed that by increasing the concentration of the extracts in the samples, viscosity significantly decreased and melting resistance and acidity increased ($p<0.05$). Moreover, by increasing the concentration of the extracts in the samples, their antioxidant activities increased. The highest antioxidant activity was related to the sample containing 1.5% clove extract and this sample had the most content of phenolic compounds. During storage, melting resistance and viscosity significantly decreased and acidity increased ($p<0.05$). The highest score of overall acceptance was related to the sample containing 0.5% chicory extract. Moreover, this sample had desirable viscosity. Considering the above mentioned points, the sample containing 0.5% chicory extract was selected as the best sample. It can be concluded that it is possible to produce the functional ice-cream with desirable physicochemical and sensory properties using 0.5% chicory extract.

Keywords: *Antioxidant Activity, Chicory Extract, Clove Extract, Functional Ice-Cream, Pomegranate Peel Extract.*

Introduction

Ice-cream is a frozen mixture that is composed of ingredients such as milk, sweeteners, stabilizers, various emulsifiers and flavors. This structure consists of air bubbles, fat globules, ice crystals and non-frozen serum phase. The serum phase consists of high molecular weight sugars and polysaccharides in a condensed freezed solution (Bhandari, 2001). The ingredients of ice-cream are divided into two dairy and non-dairy groups. Dairy ingredients include milk and its products as the major part of ice-cream. Non-dairy ingredients include sweeteners, thickeners, emulsifiers and flavors effective on the texture, taste, nutritional value, and overall acceptance of ice-cream (Goff and Hartel, 2013).

Chicory, with the scientific name of *Cichorium intybus L*. is a plant of Asteraceae family, herbaceous with a mean height of 1 m that grows in wet areas of low altitude and is native to the areas of Europe, India and Egypt. The main components of the plant

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include inulin, chicoric acid, flavonoids, polyphenols, pectin, glycoside and oligofructose (Finke *et al.*, 2002).

Clove is a plant of Myrtaceae family with the scientific name of *Syzygium aromaticum*. In terms of the chemical composition, clove has a significant amount of volatile oil, 10 to 13 percent tannin, a crystalline material called caryophylline and various amounts of triterpene acids and esters. Cloves' glycosides include aliphatic alcohols, monoterpenoids, eugenol, isoeugenol, farnesol, cytosterol, nerolidol and campestrol (Lam and Kenney, 1992).

Pomegranate peel is considered as one of the agricultural waste. This by-product contains important compounds such as raw fiber, protein and carbohydrates. Pomegranate peel, which forms about 50% of the weight of the fruit, is characterized by the presence of high amounts of high molecular weight phenols, ellagitannins, proanthocyanidins, complex polysaccharides, flavonoids, and an acceptable amount of micronutrients, which in general have a strong anti-mutagenesis, antioxidant and antimicrobial activity. Approximately 30% of anthocyanidins are concentrated in the pomegranate peel. The concentration of these compounds depends on the type of varieties and different phases of fruit growth and development, which is the cause of changes in the peel color of pomegranate. Approximately 48 phenolic compounds (anthocyanins, galactanins, hydroxycinnamic acids, hydroxybenzoic acids and decomposition tannins, such as ellagitannins and gallagyl esters) have been identified in pomegranate and other parts (Akhtar *et al.*, 2015).

Several studies have been conducted on the use of herbal extracts in ice-cream and dairy products. Some researchers have investigated the antioxidant activity of ice cream containing medicinal plant powder (asparagus, green asparagus, purple salep and pomegranate) with various methods such as free radical assay (DPPH)) and *Fluorescence recovery after photobleaching* (FRAP). The powder of each plant was added to the formulation of ice-cream at 1, 2, 3 and 4%. The highest activity of DPPH was 41.43% in asparagus powder (4%) and the highest FRAP was observed in asparagus and pomegranate (Ali *et al*., 2014). The effect of basil and savory extracts on antioxidant activity and microbial properties of probiotic yogurt was also investigated and it was reported that the extracts increased the antioxidant activity and viability of probiotic bacteria (Ghaleh Mosiyani *et al*., 2017).

Considering the above mentioned, study of the use of chicory, clove and pomegranate peel extracts as a health product and development of its application in the food industry, especially dairy industry, is very important and in this field no study has been conducted. The aim of this study was to investigate the effect of adding chicory, clove and pomegranate peel extracts on antioxidant activity, and physicochemical and sensory properties of ice-cream.

Materials and Methods

-Preparation of herbal extracts

Regarding the praparation of pomegranate peel extract, it should be noted that pomegranate peel was dried for a week in darkness at room temperature (25 °C) and then crushed to a particle size of about 0.5 mm. 50 g of pomegranate peel was extracted. 70% methanol was used for extraction by static and dynamic method (using a stirrer). The extracts in bath and freeze-dryer (Alpha 1-2 LD Plus, Christ Co., Germany) dried at 30 °C after the initial condensation (Li and Kong, 2015).

For preparation of chicory and clove extracts, root of chicory and petal of clove were powdered by electric grinding machine, then for extraction, the powdered plants were poured in 96% ethanol and at the next stage poured in a separating funnel for 3 days at 25 °C. The funnel valve was then

opened to remove ethanol from powder. Ethanol containing extract was placed in a glass and placed under a hood for 3 days to dry. 96% ethanol was added to soaked powder again, and placed in a separating funnel at room temperature for 2 days. After that, the funnel valve was opened and placed in the glass under the hood for 2 days to dry. This procedure was repeated again for 1 day to complete the extraction of the plants (Dua *et al*., 2014).

-Preparing ice-cream

The ingredients used to make ice-cream included: 63.43% fresh milk (3% fat, Domino Co., Iran), 17% sugar, 3% liquid glucose (Glucosan Co., Iran), 4% skim milk powder (Pegah Co., Iran), 0.5% CMC as stabilizer (Danisco Co., USA), 0.07% vanilla, and 12% cream (40% fat, Domino Co., Iran). In order to produce ice-cream, first liquid ingredients (milk, cream and glucose) were mixed, stirred and heated to 45-50 °C in the tank. Then, powdered ingredients (sugar, milk powder, vanilla, and stabilizer) were added. The resulting mixture was pasteurized at 85 °C for 15 seconds. It was then cooled to 4 °C and kept for 24 hours. In the next stage, the mixture was freezed inside a heat exchanger and kept at -5 °C until complete freezing (Iguttia *et al.*, 2011). Then, ice cream was stored at -30 °C for hardening. It should be noted that raw materials were first prepared according to the amounts indicated in the formulation of control ice cream and then the extracts of chivory, clove and pomegranate peel (0.5, 1 and 1.5%) were added at aging stage. The samples were stored at – 18 °C for three momths. The antioxidant activity, physicochemical and sensory properties of the samples were evaluated on the 1, 30, 60 and 90 days. All experiments were performed in triplicate.

-Antioxidant activity

In order to measure the antioxidant activity, 50 g of ice-cream sample was mixed with 25 ml of methanol for 12 hours. Then, the mixture passed through Whatman 4 paper and then 3 ml of it was added to 1.2 ml of methanol and 1.5 ml of radical stable 1, 1-diphenyl-2-picrylhydrazyl (DPPH). The resulting solution was placed at 25 °C for 90 minutes and absorbed at 517 nm wavelength by spectrophotometer (Unico, USA). The percentage of inhibition was calculated as follows (Rahman *et al*., 2014):

$$\text{Inhibition \%} = (A_{control} - A_{sample}/A_{control}) \times 100$$

Where, $A_{control}$ is the control solution absorption and A_{sample} is absorption of ice-cream samples containing extracts of chicory, clove and pomegranate peel.

-Phenolic compounds

First, ice cream samples were extracted. 0.5-1 g of ice-cream samples was extracted with whirlwind mechanical vortex for 4 hours and finally sonication for 20 minutes with 50 ml of methanol. The methanolic extract passed through Whatman 1 paper and the supernatant was tested. The total content of polyphenolic compounds of the samples was determined by Folin-Ciocalteu reagent. Therefore, 0.5 ml of ice cream extract and 0.1 ml of Folin-Ciocalteu reagent (0.5 normal) were mixed at 25 °C for 15 minutes. Then, 2.5 ml of saturated sodium carbonate was added and placed at 25 °C for 30 minutes. The absorption was measured at 760 nm by a spectrophotometer (Unico, USA). Gallic acid was considered as a positive control sample. Phenolic compounds were expressed as standard equivalents (mg / g of extract compounds) (Kanika *et al*., 2015).

-Acidity

For acidity measurement, 3 g of samples and 20 ml of distilled water were placed in Erlenmeyer and titrated with 0.1 N NaOH in the presence of phenylphethalene reagent (Akalin and Erisir, 2008).

-*Viscosity*

Viscosity was measured using DV-II + Pro Brookfield viscometer using a spindle 62 at shear rate 30 and 25 °C (Soukoulis *et al*., 2008).

-*Melting resistance*

First, 30 g of ice-cream sample immediately after leaving the freezer was placed on 2 mm wire mesh above the glass funnel. Then the sample was incubated at 25 °C for 45 minutes. The amount of melted ice-cream in Erlen was considered as an index of determining the quality of melting Sun-Waterhouse *et al*., 2011).

-*Sensory evaluation*

Sensory evaluation was performed by 12 trained sensory evaluators and using 5-point hedonic method. The characteristics of flavor, texture, color and overall acceptance were examined. Therefore, the scoring was carried out by sensory evaluators from 1 to 5 according to the designed forms. For evaluating each characteristic, score 5 was assigned to very desired sample, and score 1 was assigned to very undesired sample (Crizel *et al*., 2014).

-*Statistical analysis*

Analysis of variance and Duncan's test were used to compare the mean of data at 95% confidence level. The software used was SPSS 20.

Results and Discussion

-*Antioxidant activity and phenolic compounds of the ice-cream samples*

According to Tables 1 and 2, adding chicory, clove and pomegranate peel extracts had a significant effect on the antioxidant activity and phenolic compounds content of ice-cream ($p<0.05$). The antioxidant activity and phenolic compounds content in the samples containing herbal extracts was more than those of control sample. The sample containing 1.5% clove extract had the highest antioxidant activity and phenolic compounds content. During storage, the antioxidant activity and phenolic compounds content of the samples decreased significantly ($p<0.05$). The antioxidant capacity of the extracts is due to the presence of various functional groups such as hydroxyl and carbonyl groups, and with increasing the concentration of polyphenols, antioxidant properties increase (Elfalleh *et al*., 2012). Reducing the antioxidant activity of the samples can be attributed to the transfer properties of phenolic compounds. The transfer of iron or hydrogen peroxide reduces the antioxidant capacity of phenolic compounds (Simic *et al*., 2007). Reducing pH reduces the amount of total phenolic compounds (due to reduced solubility of some of them under acidic conditions and therefore their sedimentation), which, as a result, also reduces antioxidant properties. On the other hand, with preserving ice-cream samples containing extracts, solubility of phenolic compounds and antioxidant properties reduced. Some researchers stated that all samples of tea ice- cream had polyphenolic compounds and antioxidant properties higher than thoes of the control sample. The results of the present study were similar to those of the above researchers (Baruah *et al*., 2012). Other researchers reported that addition of broccoli had an effect on the antioxidant activity of ice-cream, which was similar to the results of the present study (Neswati *et al*., 2014). In addition, extraction of antioxidants from the peel of pomegranate, lemon and orange and their use in cheese was studied. The results showed that pomegranate peel extract at 1 and 2% levels had the highest antioxidant activity compared to orange and lemon (Immanuel and Singh, 2014). Another similar studies showed that, with increasing the concentration of polyphenol compounds, antioxidant properties of pomegranate peel

extract also increased (Shiban *et al*., 2012; Wang *et al*., 2011; Al-Rawahi *et al*., 2014).

-Acidity of the ice-cream samples

According to Table 3, adding chicory, clove and pomegranate peel extracts had a significant effect on the acidity of ice-cream ($p<0.05$). During storage, acidity of the samples increased significantly ($p<0.05$). The control sample had the lowest acidity. The reason for high acidity of ice-cream containing chicory, clove and pomegranate peel is the presence of acids such as ascorbic acid and other acidic compounds in comparison with the control treatment. In a similar study, juice and flesh of kiwi fruit in 49% v / v were added to initial low-fat ice-cream mixture without flavoring or coloring agents. The results showed that by adding flesh and juice of kiwi fruit, pH of the samples reduced and the acidity of the samples increased (Sun-Waterhouse *et al*., 2013).

Table 1. Antioxidant activity (inhibitory percent of DPPH) of the ice-cream samples during storage

Sample	First day	30th day	60th day	90th day
Control	18.277 ± 0.61^{Aj}	18.353 ± 0.847^{Ah}	12.877 ± 0.206^{Bj}	12.777 ± 0.28^{Bi}
0.5% Chicory extract	32.69 ± 0.233^{Ai}	21.87 ± 0.478^{Bh}	20.63 ± 0.832^{Ci}	21 ± 0.781^{BCh}
1% Chicory extract	40.93 ± 0.292^{Ah}	26.66 ± 0.06^{Bg}	22.453 ± 0.793^{Ch}	21.75 ± 0.332^{Ch}
1.5% Chicory extract	43.947 ± 1.288^{Ag}	35.767 ± 6.273^{Bf}	24.723 ± 0.502^{Cg}	24.65 ± 0.527^{Cg}
0.5% Pomegranate peel extract	59.437 ± 0.902^{Af}	38.933 ± 1.02^{Bf}	31.69 ± 1.407^{Cf}	31.517 ± 1.271^{Cf}
1% Pomegranate peel extract	64.543 ± 0.394^{Ae}	52.83 ± 0.932^{Bd}	41.053 ± 1.028^{Cd}	41.017 ± 0.362^{Cd}
1.5% Pomegranate peel extract	74.437 ± 1.128^{Ad}	71.01 ± 1.197^{Bb}	67.523 ± 1.126^{Cb}	67.573 ± 0.921^{Cb}
0.5% Clove extract	83.62 ± 1.291^{Ac}	43.793 ± 0.951^{Be}	39.603 ± 0.464^{Ce}	38.95 ± 0.999^{Ce}
1% Clove extract	89.297 ± 0.085^{Ab}	61.97 ± 1.521^{Bc}	60.777 ± 0.571^{Bc}	60.87 ± 0.72^{Bc}
1.5% Clove extract	95.073 ± 1.318^{Aa}	83.14 ± 0.771^{Ba}	77.703 ± 0.444^{Ca}	76.697 ± 0.316^{Ca}

The values of the same large letters in each row have no significant difference ($p>0.05$).
The values of the same small letters in each column have no significant difference ($p>0.05$).

Table 2. Phenolic compounds (mg/ml Galic acid) of the ice-cream samples during storage

Sample	First day	30th day	60th day	90th day
Control	141.01 ± 1.108^{Ae}	141.09 ± 3.643^{Ag}	72.32 ± 1.839^{Bf}	68.903 ± 1.05^{Bh}
0.5% Chicory extract	193.643 ± 1.559^{Ac}	188.097 ± 0.195^{Bd}	162.507 ± 1.903^{Ce}	152.217 ± 1.747^{Dg}
1% Chicory extract	212.02 ± 1.276^{Aa}	200.243 ± 8.032^{Bcd}	163.637 ± 4.711^{Ce}	156.883 ± 5.788^{Cf}
1.5% Chicory extract	212.58 ± 2.235^{Aa}	212.97 ± 10.981^{Aa}	178.22 ± 2.017^{Bd}	162.247 ± 1.565^{Ce}
0.5% Pomegranate peel extract	174.717 ± 3.064^{Ad}	177.37 ± 2.581^{Af}	174.453 ± 1.615^{Ad}	166.61 ± 3.06^{Bd}
1% Pomegranate peel extract	185.917 ± 11.866^{ABc}	191.777 ± 2.236^{Ae}	184.747 ± 1.994^{ABc}	175.603 ± 1.329^{Bc}
1.5% Pomegranate peel extract	202.567 ± 2.248^{Ab}	192.197 ± 0.1^{Bde}	183.213 ± 0.11^{Cc}	181.777 ± 1.257^{Cb}
0.5% Clove extract	198.553 ± 1.531^{Ac}	190.26 ± 0.052^{Bcd}	192.32 ± 3.569^{Bb}	190.31 ± 0.121^{Ba}
1% Clove extract	211.073 ± 3.704^{Aa}	203.42 ± 1.821^{Bbc}	194.287 ± 3.427^{Cb}	185.47 ± 0.632^{Db}
1.5% Clove extract	211.127 ± 1.661^{Aa}	211.29 ± 1.824^{Aab}	200.413 ± 2.396^{Ba}	192.877 ± 2.568^{Ca}

The values of the same large letters in each row have no significant difference ($p>0.05$).
The values of the same small letters in each column have no significant difference ($p>0.05$).

Table 3. Acidity (percent of lactic acid) of the ice-cream samples during storage

Sample	First day	30th day	60th day	90th day
Control	0.142 ± 0.002^{Bb}	0.144 ± 0.004^{Bd}	0.152 ± 0.003^{Ac}	0.156 ± 0.003^{Ad}
0.5% Chicory extract	0.174 ± 0.005^{Ca}	0.231 ± 0.004^{Ba}	0.310 ± 0.003^{Aa}	0.315 ± 0.005^{Aab}
1% Chicory extract	0.174 ± 0.006^{Ca}	0.232 ± 0.005^{Ba}	0.311 ± 0.006^{Aa}	0.317 ± 0.012^{Aab}
1.5% Chicory extract	0.175 ± 0.005^{Da}	0.234 ± 0.005^{Ca}	0.315 ± 0.006^{Ba}	0.325 ± 0.013^{Aa}
0.5% Pomegranate peel extract	0.175 ± 0.005^{Ca}	0.221 ± 0.004^{Bb}	0.308 ± 0.008^{Aa}	0.310 ± 0.006^{Ab}
1% Pomegranate peel extract	0.175 ± 0.005^{Ca}	0.221 ± 0.004^{Bb}	0.309 ± 0.005^{Aa}	0.312 ± 0.003^{Ab}
1.5% Pomegranate peel extract	0.177 ± 0.01^{Ca}	0.223 ± 0.006^{Bb}	0.312 ± 0.006^{Aa}	0.314 ± 0.006^{Aab}
0.5% Clove extract	0.175 ± 0.005^{Ba}	0.181 ± 0.002^{Bc}	0.182 ± 0.008^{ABb}	0.184 ± 0.003^{Ac}
1% Clove extract	0.175 ± 0.005^{Ba}	0.181 ± 0.008^{ABc}	0.184 ± 0.008^{Ab}	0.186 ± 0.006^{Ac}
1.5% Clove extract	0.176 ± 0.006^{Ba}	0.182 ± 0.003^{Bc}	0.184 ± 0.004^{ABcb}	0.192 ± 0.003^{Acd}

The values of the same large letters in each row have no significant difference ($p > 0.05$).
The values of the same small letters in each column have no significant difference ($p > 0.05$).

- *Viscosity of the ice-cream samples*

According to Table 4, adding chicory, clove and pomegranate peel extracts had a significant effect on the viscosity of ice-cream ($p<0.05$). The control sample had the highest viscosity. Among test samples, the sample containing 1.5% chicory extract had higher viscosity. During storage, viscosity of the samples containing herbal extracts decreased significantly ($p<0.05$). Acids can have hydrogen reaction with hydroxyl groups of monosaccharide sugars in ice-cream formulation. Therefore, increasing acidity reduces viscosity of ice-cream (Panovska *et al*., 2012). Some researchers reported that ice-cream viscosity reduced by adding kiwi juice, which the results of the present study were consistent with the findings of the researchers (Sun-Waterhouse *et al*., 2013). In another similar study, it was also reported that adding broccoli reduced viscosity of ice-cream (Neswati *et al*., 2014).

- *Melting resistance of the ice-cream samples*

According to Table 5, adding chicory, clove and pomegranate peel extracts significantly increased melting resistance of ice-cream ($p<0.05$). The samples containing 1.5% chicory, clove and pomegranate peel extracts had the highest melting resistance. During storage, melting resistance of the samples decreased significantly ($p<0.05$). Some researchers added juice and flesh of kiwifruit in 49% v / v to a low-fat ice-cream mixture that lacked flavoring or coloring agents and stated that melting resistance of test samples increased compared to the control that was similar to that of the present study (Sun-Waterhouse *et al*., 2013). Also, other researchers added broccoli 5, 10, 15, 20, 25 and 30% to ice-cream formulation to increase functional properties of ice-cream. The results showed that broccoli addition influenced melting time, which was similar to the results of the present study (Neswati *et al*., 2014). Similary, in another study, orange fiber was added to lime ice- cream as a substitute for fat. The results showed that the sample containing 1% fiber showed a lower melting rate than the control sample (Crizel *et al*., 2014).

-*Sensory features of the ice-cream samples*

According to Table 6, adding chicory, clove and pomegranate peel extracts had a significant effect on the flavor of ice-cream ($p<0.05$). During storage, the score of flavor of the samples did not change significantly. The samples containing 0.5%, 1% and 1.5% clove extracts had the lowest score of flavor but other samples did not have significant difference. In the above study, no off- flavor

was reported by the panelists. This could be due to the natural antioxidant properties of the plant extracts used and short duration of keeping produced test samples. Some researchers in a similar study on the possibility of using three kinds of green tea, black tea and dissolved black tea in ice-cream making stated that all tea ice cream samples had an acceptable flavor (Baruah *et al*., 2012). Also, in another similar study, it was reported that all samples of low-fat ice-cream kept polyphenolic compounds and vitamin C, and on the other hand, flavor of kiwi well (Sun-Waterhouse *et al*., 2013).

Table 4. Viscosity (centipoise) of the ice-cream samples during storage

Sample	First day	30th day	60th day	90th day
Control	4415 ± 21.008^{Aa}	3586.667 ± 35.119^{Ba}	3350 ± 55.076^{Ca}	3047 ± 2.646^{Da}
0.5% Chicory extract	4246.667 ± 50.332^{Ab}	3401 ± 28.688^{Bb}	3231.667 ± 29.535^{Cc}	2952.333 ± 8.737^{Db}
1% Chicory extract	4128.667 ± 25.007^{Ac}	3365 ± 30.643^{Bb}	3304.333 ± 64.392^{Bab}	2940.667 ± 11.015^{Cb}
1.5% Chicory extract	4030.667 ± 10.066^{Ad}	3259.333 ± 26.102^{Bc}	3259.333 ± 26.102^{Bbc}	2922.667 ± 2.517^{Cb}
0.5% Pomegranate peel extract	3871 ± 73.993^{Af}	3060.667 ± 34.078^{Bd}	3060.667 ± 34.078^{Be}	3039.667 ± 4.509^{Ba}
1% Pomegranate peel extract	3954.333 ± 12.503^{Ae}	3350.667 ± 11.015^{Bb}	3183 ± 11.015^{Bd}	3034 ± 5.292^{Ca}
1.5% Pomegranate peel extract	3929.333 ± 10.066^{Aef}	3368 ± 25.534^{Bb}	3368 ± 25.534^{Ba}	2761.333 ± 33.546^{Cc}
0.5% Clove extract	4485 ± 56.789^{Aa}	2983.333 ± 47.258^{Be}	2983.333 ± 47.258^{Bf}	2937.333 ± 20.526^{Bb}
1% Clove extract	4464 ± 33.287^{Aa}	3047.667 ± 45.347^{Bd}	3047.667 ± 45.347^{Bef}	2934 ± 5.292^{Cb}
1.5% Clove extract	4484.333 ± 57.501^{Aa}	3241.667 ± 36.171^{Bc}	3241.667 ± 36.171^{Bbc}	2785 ± 54.083^{Cc}

The values of the same large letters in each row have no significant difference ($p > 0.05$).
The values of the same small letters in each column have no significant difference ($p > 0.05$).

Table 5. Melting resistance (percent) of the ice-cream samples during storage

Sample	First day	30th day	60th day	90th day
Control	58.223 ± 0.89^{Ah}	48.623 ± 1.068^{Bg}	23.96 ± 1.269^{Cf}	21.56 ± 0.528^{Ce}
0.5% Chicory extract	71.88 ± 0.984^{Ad}	61.213 ± 1.459^{Bb}	25.61 ± 0.725^{Ce}	22.937 ± 0.763^{Dd}
1% Chicory extract	74.523 ± 1.179^{Ac}	64.833 ± 0.289^{Ba}	25.817 ± 0.813^{Ce}	24.943 ± 0.569^{Cc}
1.5% Chicory extract	77.563 ± 0.612^{Ab}	66.21 ± 1.021^{Ba}	32.77 ± 0.733^{Cb}	26.813 ± 0.508^{Db}
0.5% Pomegranate peel extract	60.197 ± 0.918^{Ag}	50.63 ± 0.792^{Bgf}	27.93 ± 0.592^{Cd}	22.433 ± 0.095^{Dde}
1% Pomegranate peel extract	77.823 ± 0.712^{Ab}	53.62 ± 0.932^{Bed}	32.67 ± 0.797^{Cb}	26.783 ± 0.267^{Db}
1.5% Pomegranate peel extract	80.62 ± 0.798^{Aa}	51.653 ± 1.094^{Bef}	34.303 ± 1.035^{Ca}	27.697 ± 0.28^{Dab}
0.5% Clove extract	60.897 ± 0.786^{Afg}	54.667 ± 0.503^{Bd}	25.25 ± 0.728^{Cef}	22.36 ± 0.416^{Dde}
1% Clove extract	62.133 ± 0.371^{Af}	55.523 ± 1.698^{Bcd}	30.95 ± 1.212^{Cc}	26.8 ± 1.139^{Db}
1.5% Clove extract	64.207 ± 1.18^{Ae}	57.403 ± 1.943^{Bc}	32.907 ± 0.743^{Cab}	27.847 ± 0.78^{Da}

The values of the same large letters in each row have no significant difference ($p > 0.05$).
The values of the same small letters in each column have no significant difference ($p > 0.05$).

Table 6. Flavor score of the ice-cream samples during storage

Sample	First day	30th day	60th day	90th day
Control	4.6 ± 0.548^{Aa}	4.2 ± 0.447^{Aa}	4.2 ± 0.447^{Aa}	4.4 ± 0.548^{Aa}
0.5% Chicory extract	4.2 ± 0.447^{Aab}	4 ± 0^{Aa}	4 ± 0^{Aab}	4.2 ± 0.548^{Aa}
1% Chicory extract	4 ± 0.707^{Aab}	4.2 ± 0.447^{Aa}	4.2 ± 0.447^{Aa}	4 ± 0.707^{Aab}
1.5% Chicory extract	4 ± 0.707^{Aab}	4 ± 0.707^{Aa}	4 ± 0.707^{Aa}	4 ± 0.447^{Aab}
0.5% Pomegranate peel extract	3.8 ± 0.894^{Abc}	3.8 ± 0.837^{Aab}	3.8 ± 0.837^{Aab}	3.8 ± 0.548^{Aab}
1% Pomegranate peel extract	3.8 ± 1^{Abc}	3.8 ± 0.837^{Aab}	3.8 ± 0.837^{Aab}	4 ± 0.707^{Aab}
1.5% Pomegranate peel extract	3.8 ± 0.707^{Abc}	4 ± 1^{Aa}	4 ± 1^{Aa}	4 ± 0.548^{Aab}
0.5% Clove extract	3.2 ± 0.837^{Acd}	2.8 ± 0.447^{Ac}	2.8 ± 0.447^{Ac}	2.8 ± 0.447^{Ad}
1% Clove extract	2.6 ± 0.894^{Ad}	2.4 ± 0.548^{Ac}	2.4 ± 0.548^{Ac}	3 ± 0.707^{Acd}
1.5% Clove extract	3.2 ± 0.837^{Acd}	3.2 ± 0.837^{Abc}	3.2 ± 0.837^{Abc}	3 ± 0.707^{Acd}

The values of the same large letters in each row have no significant difference ($p > 0.05$).
The values of the same small letters in each column have no significant difference ($p > 0.05$).

The addition of chicory, clove and pomegranate peel extracts had a significant effect ($p<0.05$) on the color of ice-cream (Table 7). In terms on color score, the samples containing 0.5%, 1% and 1.5% chcory exreact and samples containing 0.5% and 1% pomegranate peel extract did not have significant difference with the control sample. Color score of ice cream samples containing different extracts remained unchanged during storage, due to the colorlessness of these extracts, and only the color variations related to the main ingredients of ice-cream such as milk, sugar, and etc. Some researchers in a similar study about the possibility of using three types of green tea, black tea and dissolved black tea in ice-cream production stated that all tea ice-cream samples had acceptable color characteristics (Baruah *et al*., 2012).

According to Table 8, the addition of chicory, clove and pomegranate peel extracts had a significant effect on the texture of ice-cream ($p<0.05$). The score of texture of the samples did not change during storage. The sample containing 1% clove extract had the lowest score of texture and the highest score was related to the sample containing 0.5% chicory extract. Viscosity is an important physical trait of ice cream, which in general has a significant effect on its sensory quality, and in particular sensory evaluation of texture. Viscosity is an important factor as a part of melted ice-cream, because it affects the way the mixture reacts in the mouth. The resistance of ice cream to mechanical forces created by the tongue, palate and teeth determines the overall understanding of the texture of ice-cream (Aime *et al*., 2001). Although it is not possible to indicate a certain amount of viscosity as a suitable viscosity for ice-cream mixture, usually increasing viscosity improves texture properties and the quality of the final product (Marshall and Arbuckle, 1996).

According to Table 9, the addition of chicory, clove and pomegranate peel extracts had a significant effect on the overall acceptance of ice-cream ($p<0.05$). The highest

Table 7. Color score of the ice-cream samples during storage

Sample	First day	30th day	60th day	90th day
Control	4.4 ± 0.548^{Aa}	4.4 ± 0.548^{Aa}	4.4 ± 0.548^{Aa}	4.4 ± 0.548^{Aa}
0.5% Chicory extract	4.2 ± 0.447^{Aa}	4.2 ± 0.447^{Aa}	4.2 ± 0.447^{Aa}	4.2 ± 0.447^{Aa}
1% Chicory extract	3.8 ± 0.447^{Aab}	4 ± 0^{Aab}	4 ± 0^{Aab}	4 ± 0.707^{Aab}
1.5% Chicory extract	3.8 ± 0.447^{Aab}	4 ± 0^{Aab}	3.8 ± 0.447^{Aab}	3.8 ± 0.447^{Aab}
0.5% Pomegranate peel extract	4.2 ± 0.837^{Aa}	4 ± 0.707^{Aab}	4 ± 0.707^{Aab}	4 ± 0.707^{Aab}
1% Pomegranate peel extract	3.8 ± 0.447^{Aab}	3.6 ± 0.548^{Ab}	3.6 ± 0.548^{Ab}	3.8 ± 0.447^{Aab}
1.5% Pomegranate peel extract	3.4 ± 0.548^{Ab}	3.6 ± 0.548^{Ab}	3.6 ± 0.548^{Ab}	3.4 ± 0.548^{Ab}
0.5% Clove extract	3.6 ± 0.548^{Ab}	3.6 ± 1.304^{Ab}	3.4 ± 0.548^{Ab}	3.4 ± 0.548^{Ab}
1% Clove extract	3 ± 0.816^{Ac}	2.6 ± 0.548^{Ac}	2.6 ± 0.548^{Ac}	2.4 ± 0.548^{Ac}
1.5% Clove extract	3.2 ± 0.447^{Abc}	3.2 ± 0.447^{Abc}	3.2 ± 0.447^{Abc}	3.2 ± 0.447^{Abc}

The values of the same large letters in each row have no significant difference ($p>0.05$).
The values of the same small letters in each column have no significant difference ($p>0.05$).

Table 8. Texture score of the ice-cream samples during storage

Sample	First day	30th day	60th day	90th day
Control	4.4 ± 0.5^{Aa}	4.4 ± 0.447^{Aa}	4.2 ± 0.447^{Aab}	4.4 ± 0.548^{Aab}
0.5% Chicory extract	4.4 ± 0.548^{Aa}	4.4 ± 0.447^{Aa}	4.4 ± 0.447^{Aa}	4.6 ± 0.548^{Aa}
1% Chicory extract	4.2 ± 0.447^{Aab}	4.2 ± 0.548^{Aab}	4.2 ± 0.548^{Aab}	4.2 ± 0.447^{Aab}
1.5% Chicory extract	3.8 ± 0.447^{Ab}	4 ± 0^{Aab}	4 ± 0^{Aab}	4 ± 0^{Aab}
0.5% Pomegranate peel extract	4 ± 0.707^{Aab}	4 ± 0^{Aab}	4 ± 0^{Aab}	4 ± 0.707^{Aab}
1% Pomegranate peel extract	3.8 ± 0.447^{Ab}	3.8 ± 0.447^{Ab}	3.8 ± 0.447^{Ab}	3.8 ± 0.447^{Abc}
1.5% Pomegranate peel extract	3.8 ± 0.447^{Ab}	3.6 ± 0.548^{Abc}	3.6 ± 0.548^{Acd}	3.4 ± 0.548^{Ad}
0.5% Clove extract	3.6 ± 0.548^{Ab}	3.6 ± 0.548^{Abc}	3.6 ± 0.548^{Acd}	3.4 ± 0.548^{Ad}
1% Clove extract	3.4 ± 0.548^{Ac}	3.2 ± 0.447^{Ac}	3.2 ± 0.447^{Ac}	2.4 ± 0.548^{Be}
1.5% Clove extract	4.4 ± 1.517^{Aab}	3.6 ± 0.548^{ABbc}	3.6 ± 0.548^{ABcd}	3.2 ± 0.447^{Bd}

The values of the same large letters in each row have no significant difference ($p>0.05$).
The values of the same small letters in each column have no significant difference ($p>0.05$).

score of overall acceptance was related to the control sample and the sample containing 0.5% chicory extract, respectively. The sample containing 1% clove extract obtained the lowest overall acceptance score. The reason for this can be attributed to the reduction in viscosity and astringent flavor caused by 1% clove extract in ice-cream. The reaction of the mixture of ice-cream in the mouth and resistance of ice-cream to mechanical forces created by the tongue, palate and teeth, general understanding and evaluation of the texture of ice-cream affected by viscosity (Aime *et al*., 2001). The study results confirm the positive effect of viscosity on overall acceptance, so that the treatments with the highest acceptance score were high-viscosity treatments. Some researchers reported that viscosity affected texture and body, and better buildings and texture improve overall acceptance of the product (Minhas *et al*., 2002). In a similar study on the use of three types of green tea, black tea and dissolved black tea, it was reported that all tea ice-cream samples had acceptable sensory characteristics and overall acceptance (Baruah *et al*., 2012). In another similar study, addition of 20% broccoli to ice-cream produced better overall acceptance (Neswati *et al*., 2014).

Conclusion

The addition of alcoholic extracts of chicory, clove and pomegranate peel increased the functional properties of the ice-cream samples by enhancing inhibitory effect on DPPH.The use of these extracts in ice-cream increased phenolic compounds content, acidity and melting resistance and decreased viscosity. The sample containing 0.5% chicory extract obtained the highest score of overall acceptance. Moreover, this sample had desirable viscosity and texture so it was selected as the best sample. Therefore, it is possible to produce the functional ice-cream with desirable physicochemical and sensory properties using 0.5% chicory extract.

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Table 9. Overall acceptance score of ice-cream samples during storage

Sample	First day	30th day	60th day	90th day
Control	4.55 ± 0.15^{Aa}	4.40 ± 0.20^{Aa}	4.44 ± 0.26^{Aa}	4.60 ± 0.20^{Aa}
0.5% Chicory extract	4.36 ± 0.26^{Aab}	4.20 ± 0.24^{Aab}	4.20 ± 0.24^{Aab}	4.40 ± 0.20^{Aa}
1% Chicory extract	4.00 ± 0.20^{Abc}	4.00 ± 0.31^{Ab}	4.16 ± 0.26^{Aab}	3.92 ± 0.22^{ABb}
1.5% Chicory extract	3.96 ± 0.16^{Abcd}	3.96 ± 0.08^{Ab}	4.00 ± 0.14^{Abcd}	3.96 ± 0.26^{Ab}
0.5% Pomegranate peel extract	4.12 ± 0.43^{Aab}	4.12 ± 0.26^{Aab}	4.08 ± 0.30^{Abc}	3.84 ± 0.21^{ABb}
1% Pomegranate peel extract	3.92 ± 0.17^{Abcde}	3.88 ± 0.22^{Ab}	3.80 ± 0.14^{Acd}	3.92 ± 0.30^{Ab}
1.5% Pomegranate peel extract	3.64 ± 0.51^{Acde}	3.80 ± 0.28^{Ab}	3.68 ± 0.22^{Ad}	3.80 ± 0.46^{Ab}
0.5% Clove extract	3.48 ± 0.17^{Aef}	3.32 ± 0.41^{Ac}	3.28 ± 0.30^{Ae}	3.36 ± 0.35^{Ac}
1% Clove extract	3.12 ± 0.33^{Af}	2.96 ± 0.43^{ABc}	2.84 ± 0.35^{ABf}	2.84 ± 0.43^{ABd}
1.5% Clove extract	3.52 ± 0.50^{Adef}	3.28 ± 0.22^{Ac}	3.28 ± 0.22^{Ae}	3.24 ± 0.21^{Ac}

The values of the same large letters in each row have no significant difference ($p > 0.05$).
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