Physicochemical, textural and sensory properties of orange pomace added tavukgöğsü ice cream

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ABSTRACT

In this study, the evaluation of freeze-dried orange pomace in ice cream production from tavukgöğsü dessert was investigated. The orange pomace, as a by-product from orange juice extraction, was dried and milled. It was added to the traditional Turkish dessert-tavukgöğsü as a dietary fiber source. Then, the dessert was introduced to ice cream. Ice cream samples were analyzed in terms of physico-chemical, textural and sensorial properties. Sensory scores obtained from the study showed that tavukgöğsü dessert could be processed into ice cream and have higher acceptance than that of orange pomace added sample. In addition, the dried orange pomace enhanced the textural properties of ice creams, and had acceptable sensorial scores.

Key words: by-product, dessert, ice cream, orange pomace, tavukgöğsü.

INTRODUCTION

Ice cream is a popular frozen dessert consumed in the world chiefly New Zealand, the United States, Canada, Australia, Belgium, Finland, and Sweden. In some other areas, lack of refrigerated distribution chain, economic struggles of cold chain distribution and cultural discrepancy limit the consumption of ice cream (Chandan et al., 2013). Besides ice cream, other frozen desserts are widely consumed with different nomenclatures like smoothies, mellorine, sherbet, etc. These desserts mainly include milk/water, sugar, thickeners, colorants and flavor substances. Especially the flavor determines their acceptability by consumer (Tarrega and Costell, 2007). Technomic’s Menu Monitor’s database reported top-three ice-cream flavors as vanilla, chocolate and strawberry, respectively (LaFave, 2014).

Unsterilized fresh dairy desserts take place in markets also with the developments in logistics. Turkish cuisine has many traditional fresh dairy desserts. Rice pudding-sütlaç is an example of these desserts and it is very similar to Iranian milk rice pudding-“Shirberenj” (Mohammadpour, 2016). Pudding with a caramel base-kazandibi, a type of milk pudding-muhallebi and chicken breast pudding-tavukgöğsü are some other common types of traditional Turkish desserts. These desserts are easy to digest and have higher nutritional values in comparison to syrupy desserts (Ayar, 2013). Tavukgöğsü is a dessert made with milk, sugar, rice flour, and butter. In ancient times, also white chicken breast meat was added, which gave the dessert its name. The meat had to be boiled and separated into fine fibers, then added to prepared dessert before molding and cooling step. Nowadays, in industrial productions, the dessert is produced without meat, or the meat could be added in powder form, instead of fibers. The production steps of tavukgöğsü dessert are given in Figure 1.

For the last decades, improvements on healthy diet increased considerably. Functional and natural products are more pronounced nowadays and, some regulations limit high levels of salt and sugar as well (WHO, 2014; TGK, 2014). The other important topic concerning food industry is waste management because of the biologically active component wastes. Waste management is a subject of environmental sciences; however, a new research subject is to recover by-products in new foods, to enrich their economical value and to label the product as a source of dietary fiber. Many researches in that issue have been
made by researchers (Nagarajaiah and Prakash, 2016; Górnáset al., 2015; O’Shea et al., 2015; Haghhi and Razaei, 2013; Figuerola et al., 2005). This innovative topic is the main subject of this research.

Orange is a good source of polyphenols, vitamin C and antioxidants (Klimczak et al., 2007). Orange juice is widely consumed and its pomace can be evaluated as a potential energy source (Erdoğan et al., 2015). However, orange peel has also a good potential for dietary fibre (Garauet al., 2007; Mira et al., 1999). Figuerola et al. (2005) determined the total dietary fibre (TDF) of Valencia orange as 64.3±0.3 g per 100 g of dry matter. Nassaret al. (2008) analyzed that orange peel and pulp had high amount of dietary fibre (78.87 and 70.64%) with more proportion of insoluble dietary fibre. There is a field of study that should focus on the usage of potential fibre sources in new product developments.

In this research, the orange juice by-products were aimed to be evaluated in an ethnic dessert of Turkey. For this purpose, tavukgöğsü desserts were made according to traditional methods, and some of them were flavored with orange juice by-products. Also, the dessert-tavukgöğsü was further processed into ice cream to carryon ethnic taste to a universally accepted flavor. The acceptance was measured with some physico-chemical, textural and sensorial analyses.

**MATERIALS AND METHODS**

**Materials**

Milk as raw material containing 11.5% total solids, 3% fat, 3.4% protein was obtained from BIM Ltd Turkey. Starch from Emin Ltd (Esenyurt-İstanbul) (0.4 g fat, 83 g CHO and 6 g protein in 100g), rice flour from Migros Ltd (Esenyurt-İstanbul) (0.1 g fat, 73.1g CHO, 0.25 g protein in 100 g). The other ingredients; salep (contains 34% glucomannan, 15% starch, 2.4% sucrose, 1.0% protein, 4.5% ash), butter (84% total solids and 82% fat), “Washington Navel” orange, egg and sugar were supplied from local markets in Sakarya, Turkey.

**Preparation of orange juice by-product as an ingredient**

Oranges were cut into two pieces and extracted by a citrus juicer (Arçelik, 40 Watt) simulating the plant based juices or juice concentrates. The by-products consisted of orange peel (flavedo, oil sacs and albedo) and orange pulp remaining after juicing. These two components containing 10.61 and 9.86% total solids, respectively, were freeze-dried for 72 h by Labconco Freezone-6 (Kansas City, MO). Then they were mixed and were ground into fine powder using a food blender (Waring 7011S, Torrington, US), and stored at -18°C for further use. The prepared mix of peel and pulp was called as "dried orange pomace" in this study. The dried orange pomace was analyzed for its total dietary fibre according to AACC (2000) and found to have 41.80% total dietary fibre per dry matter.

**Methods**

**Tavukgöğsü ice cream production**

Milk, dried orange pomace and all other ingredients except butter were mixed by a hand mixer (Braun, 400 Watt). The mix was pasteurized at 75°C for 10 min. After the addition of butter to the mixture at 75°C, it was stirred for 5 min by the mixer. Then, the mixture was molded and cooled to 4°C, and it was matured for 24 h at this temperature.
Finally, the mixture was treated into ice cream for 30 min at -18°C by a household ice cream machine (Gelataio SIMAC (GC 6000) brand). The ice cream obtained was allowed to harden at the same temperature. Analyses were carried out in the hardened ice cream. Formulations are given in Table 1. The amounts of orange pomace and other additives added to the tavukgöğsü ice cream samples were determined by preliminary sensorial analyses.

**Ice cream analyses**

1. **Physico-chemical analyses**: total solids, protein content (by Kjeldahl method), fat content (by Gerber method and Soxhlet extraction), acidity and pH of samples were determined in accordance with AOAC (2005) methods. Ash was determined according to AOAC(1995). The $a_w$ was then measured in triplicate at 21°C using an Aqualab Series 3TE dewpoint electronic water activity meter. The overrun value was determined according to the method described by Whelan et al. (2008). The overrun was calculated by the following equation:

$$\text{Overrun} \% = 100 \times (\text{mix weight} - \text{ice cream weight})/\text{ice cream weight}$$

2. **Melt-down rates**: of the ice cream samples were measured in a controlled temperature chamber (23 ± 2°C). The ice cream samples were stored at -25°C before carrying out the melting test. For melt-down rate, 75 g of ice cream were placed on a stainless-steel screen (mesh size 2.5 mm) under which a measuring cylinder was put for the melted ice cream collection. The timing of the melt-down rate began when the first drop of the melt touched the bottom of the cylinder. The weight of the material passing through the screen was recorded every 15 min for 75 min described by Bolliger et al (2000).

3. **Viscosity** was determined by a rotational viscometer (Fungilab, ALPHA H, Spain). The samples were analyzed after a period of aging (for 8 h at temperature 4°C) with spindle number R4, at 50 rpm, and at 14±1°C. Each result in triplicate was recorded in Poise (P) after 30 s rotation.

4. **Color analyses**: The instrument was calibrated using a white reference tile before the color measurement. The ice cream samples were analyzed by measuring of $L^*$ (brightness: 100 – white, 0 – black), $a^*$ (+ red, - green) and $b^*$ (+ yellow, -blue) parameters with a tintometer (Lovibond RT 300, England).

5. **Texture analyses**:of ice cream samples were performed by using TA4/1000 probe of Brookfield Model CT3 Texture Analyzer (Brookfield Engineering Laboratories, USA). Ice cream samples were analyzed after a period of aging (for 5 h at temperature 4°C) with the parameters of 4.5 g trigger force, 30 mm distance, 1 mm/s test speed.

6. **Sensorial analyses**: were done by a nine-point hedonic scale in which the evaluation scores of 1: “dis-liked extremely”, 5: “neither liked nor disliked” and 9: “liked extremely” were used by each participant (Meilgaard, 1999).

7. **Statistical analysis**: The data obtained from the physico-chemical, textural and sensory analyses and
comparisons were statistically evaluated by one-way analysis of variance followed with Duncan’s Multiple Range Test using SPSS (Ver.11.0, Chicago, IL, USA). Values of $P<0.05$ were regarded as statistically significant. All analyses were conducted twice.

**RESULTS AND DISCUSSION**

**Physico-chemical properties**

Some physico-chemical properties of tavukgöğsü ice cream samples are given in Table 2. As can be seen from the table, physico-chemical properties of dessert samples showed some differences depending on the additives. The increasing amount of orange pomace has increased the total solid content. Total solid, fat, protein and overrun ratios ranged between 41.6-43.3%, 5.63-5.81%, 1.96-2.27% and 9.11-22.60%, respectively. According to Table 2, the addition of 0.2% salep did not affect the physico-chemical properties of ice cream. However, the addition of egg yolk caused an increase in protein content (approximately 13%). Dried orange pomace addition in tavukgöğsü ice cream increased total solids content. That increase was directly proportional to the increase in the dried orange pomace concentrations. The results of this study are in agreement with the findings of Razavi et al. (2001), Abdullah et al. (2003), Ozdemiret et al. (2008), and Mann and Aggarwal (2013). These researchers showed that the total solids contents are higher in samples containing high amounts of dried additives.

The overrun capacities of tavukgöğsü ice cream are given in Table 2 and ranged between 9.11% (control) and 22.60% (salep, egg yolk and 1% dried orange pomace added sample). The low overrun values in this study could be related to the inefficiency of the ice cream maker in air incorporation and long time required for freezing. Overrun measurements showed that, salep and egg yolk did not affect the overrun capacity of tavukgöğsü ice cream mix, individually. However, the use of salep and egg yolk together increased the overrun, significantly ($P<0.05$).

Table 2. Some physico-chemical properties of tavukgöğsü ice cream.

<table>
<thead>
<tr>
<th>Sample name</th>
<th>Total solids (%)</th>
<th>Fat (%)</th>
<th>Protein (%)</th>
<th>Overrun (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>41.8 e</td>
<td>5.69 d</td>
<td>2.01 c</td>
<td>9.11 d</td>
</tr>
<tr>
<td>TS0</td>
<td>41.8 e</td>
<td>5.68 de</td>
<td>2.03 c</td>
<td>9.53 d</td>
</tr>
<tr>
<td>TSE0</td>
<td>41.6 f</td>
<td>5.63 f</td>
<td>2.25 a</td>
<td>14.76 c</td>
</tr>
<tr>
<td>TE0</td>
<td>41.6 f</td>
<td>5.63 f</td>
<td>2.27 a</td>
<td>11.45 d</td>
</tr>
<tr>
<td>TS1</td>
<td>42.4 c</td>
<td>5.73 c</td>
<td>2.02 c</td>
<td>18.97 b</td>
</tr>
<tr>
<td>TSE1</td>
<td>42.2 d</td>
<td>5.67 e</td>
<td>2.24 a</td>
<td>22.60 a</td>
</tr>
<tr>
<td>TS3</td>
<td>43.5 a</td>
<td>5.81 a</td>
<td>1.96 d</td>
<td>16.77 bc</td>
</tr>
<tr>
<td>TSE3</td>
<td>43.3 b</td>
<td>5.76 b</td>
<td>2.18 b</td>
<td>18.02 b</td>
</tr>
</tbody>
</table>

(T: tavukgöğsü ice cream, S: containing salep, E: containing egg, 0-% dried orange pomace)

It was found that, the overrun of ice cream samples were mainly based on formulation differences. The overrun capacity of TS0 sample increased from 9.53 to 18.97% in 1% dried orange pomace added TS1 sample, and to 16.77% in 3% dried orange pomace added TS3 sample. Similar results were measured in TSE samples. The average overrun capacities of TSE0, TSE1 and TSE3 were 14.76, 22.60 and 18.02%, respectively.

Stabilizers assist the incorporation of air bubbles in smaller sizes and lead to higher overrun capacities in ice creams or whipping creams (Soukoulis et al., 2008; BahramParvar et al., 2009). The effect of dried orange pomace on overrun can be because of its pectin. Pectin is widely used in the food industry as a thickener, stabilizer and gelling agent. O’Shea et al. (2015) extracted high levels of pectin (16.69-18.36% on fresh weight) from orange pomace. However, the results of El-Samahy et al. (2009) did not support our conclusion; they recorded that, overrun decreased with introducing cactus pear pulp (with a pectin content of 2.44% on dry basis) into ice cream. Another possible effect of dried orange pomace on the increase in overrun could be achieved by its dietary fiber content. The study of O’Shea et al. (2015) also revealed the dietary fiber content of orange pomace as 40.7% on fresh weight. Akalinet al. (2008) revealed the effect of dietary fiber-inulin on the fat reduced ice creams and measured higher overrun capacities when inulin was used. However, the results of Salem et al. (2016) illustrated that, some dietary fibers (wheat germ and oat) decreased the overrun capacities, when compared to control sample.

The pH values of tavukgöğsü ice cream samples were illustrated in Figure 2. According to Figure 2, the addition of dried orange pomace in tavukgöğsü ice cream affected the pH, significantly ($P<0.05$). The pH value of orange pulp was reported as 3.23 by Leahuet al. (2013) who explains the pH drop of ice cream samples with the increasing concentration of dried orange pomace.

Viscosity of tavukgöğsü ice cream samples increased with salep addition, significantly ($P<0.05$), while egg yolk...
did not cause a considerable change (Figure 3). The control groups TS0 and TSE0 had viscosity values of 111 and 128 P, respectively. The dried orange pomace added groups TS1-TS3 and TSE1-TSE3 had lower values of 70-52 P and 75-63 P, respectively. The overall results concluded that, dried orange pomace had an adverse effect on the increase of viscosity. This effect can be related to the increases in overrun capacities; more air was incorporated and the air caused a decrease in viscosity of dried orange pomace added samples. However, according to correlation analysis, there couldn’t be found any correlation between these two parameters (r = .49).

Color properties

The color properties of tavuk göğsü ice cream samples at the first day of the storage are given in Table 3. L* (luminosity) represents the brightness of the foods and L* value closer to 100 shows increasing whiteness in the samples. L* value of ice cream samples ranged between 68.2 (in TSE) and 78.5 (in T0). The increasing amount of orange powder led to a decrease in brightness. a* value of the samples changed from -1.48 to -0.07 according to the additives. The addition of 1% dried orange pomace (in TS1 and TSE1) did not cause a significant change (P>0.05) in a* values compared to control samples (TS0 and TSE0). On the other hand, the addition of 3% dried orange pomace caused significant increases in a* values of TS3 and TSE3 compared to controls (TS0 and TSE0). The most attractive change was determined in b* values of samples. Ayar et al. (2009) revealed a significant change in b* values of inciruyutması dessert with the addition of 0.7% salep. However, 0.2% addition of salep in our study did not affect
Table 3. Color characteristics of orange powder added tavukgöğsü ice cream samples.

<table>
<thead>
<tr>
<th>Sample name</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>78.5</td>
<td>-1.48</td>
<td>4.65</td>
</tr>
<tr>
<td>TS0</td>
<td>78.3</td>
<td>-1.14</td>
<td>4.76</td>
</tr>
<tr>
<td>TSE0</td>
<td>78.0</td>
<td>-0.58</td>
<td>10.23</td>
</tr>
<tr>
<td>TE0</td>
<td>76.6</td>
<td>-0.80</td>
<td>13.21</td>
</tr>
<tr>
<td>TS1</td>
<td>75.2</td>
<td>-1.20</td>
<td>21.48</td>
</tr>
<tr>
<td>TSE1</td>
<td>75.4</td>
<td>-0.53</td>
<td>25.58</td>
</tr>
<tr>
<td>TS3</td>
<td>71.1</td>
<td>-0.37</td>
<td>38.86</td>
</tr>
<tr>
<td>TSE3</td>
<td>68.2</td>
<td>-0.07</td>
<td>40.00</td>
</tr>
</tbody>
</table>

L* (brightness: 100 – white, 0 – black), a* (+ red; – green) and b* (+ yellow; – blue) (T: tavukgöğsü ice cream, S: containing salep, E: containing egg, 0-3: concentrations of dried orange pomaces)

Figure 4. The first drop times of ice cream samples during storage. (T: tavukgöğsü ice cream, S: containing salep, E: containing egg, 0-1-3: concentrations of dried orange pomaces)

b* value, while egg yolk increased the yellowish color of tavukgöğsü ice cream samples. 3% dried orange pomace addition resulted in the highest b* values (38.86 in TS3 and 40.00 in TSE3) among all of the samples. Manjarres-Pinzon et al. (2013) revealed that L*, a*, b* values of orange peel were not affected significantly by the drying temperatures (ranging from 30 to 60°C) and the air flow rates during the drying process (ranging between 1.75-3.25 m/s).

Textural properties

Meltdown results, in terms of the time required for the first drop of ice cream, were 14.65 min for sample TS0 and 18.16 min for sample TSE3 (Figure 4). In ice cream systems, meltdown can be influenced by many factors like total solids, ice crystals size, fat globule size, and low overrun (Trgo, 2003; Muse and Hartel, 2004). Comparison of Figure 3 and Figure 4 revealed the reverse relationship between viscosity and first dripping time; the samples TSE1, TS3, and TSE3 with relatively high viscosity dripped earlier from the other samples. However, according to the statistical analysis of the first dripping time data, there were irregular changes between the ice cream samples (P<0.05). In the study of Akin et al. (2007), ice cream machine with higher capacity was used and the first dripping times changed between 29.7 and 34.3 min, according to their sugar and inulin contents.

The hardness of ice cream samples are presented in Figure 5. Hardness decreased proportionally with the viscosity. Dried orange pomace decreased both the viscosity and the hardness. According to the statistical analysis on hardness, fiber-free samples (T0, TS0, TSE0,
and TE0) revealed similar hardness results, while hardness results of the dried orange pomace added samples (TS1, TSE1, TS3, TSE3) showed significant changes.

A positive correlation between hardness of ice cream and the amount of ice was also found by Wilbey et al. (1998). In another study, hardness was found to be influenced by ice phase volume, ice crystal size, overrun, fat destabilization, and the rheological properties of the mix (Hartel et al., 2004). Our study confirmed the effect of ice phase volume on hardness. Increasing overrun capacities was followed by the decrease in hardness.

**Sensorial properties**

Sensory attributes in different categories are illustrated in Figures 6 to 11. Colors of TS3 and TSE3 samples with 3% dried orange pomace revealed lower scores than that of others, while the other sample groups had similar points. Roughness scores of the fiber-free samples (T0, TS0, TSE0, and TE0) had been similar ($P>0.05$), while the addition of 1 and 3% dried orange pomace decreased the roughness scores, linearly with increasing concentration.

The icy structure was not affected from dried orange pomace addition, while the structure and consistency...
Figure 7. Roughness scores of ice cream samples.

Figure 8. Icy structure scores of ice creams.

Figure 9. Structure and consistency scores of ice creams. (T: tavukgöğsü ice cream, S: containing salep, E: containing egg, 0-1-3: concentrations of dried orange pomaces)
scores of dried orange pomace added samples decreased significantly. According to the statistical analysis of flavor scores, 1% dried orange pomace did not affect the flavor, while 3% dried orange pomace added ice creams (TS3 and TSE3) had significantly lower scores when compared to other groups. Also, the overall acceptability points decreased with the addition of dried orange pomace, and the decrease was found directly proportional to the concentration of the pomace. However, all of the desirable sensorial parameters were higher than the normal acceptance point which was evaluated as “5” points.

**Conclusion**

In this study, tavuk göğsü which is a traditional Turkish...
milk dessert was investigated to be processed in ice cream. In addition, the juice by-product orange pomace was added to the tavuk göğsü ice cream in order to provide functional characteristics besides the environmental benefits. According to the sensory scores, tavuk göğsü dessert could be processed into ice cream with higher acceptability. Ice cream, as a carrier, provided a traditional Turkish dessert to supply the universal extent.

The dried orange pomace increased the overrun and enhanced the melting properties of ice cream. In addition to textural benefits, 1% addition of dried orange pomace had similar sensorial properties (P<0.05) when compared to control samples, while concentration of 3% dried pomace was found still desirable but lower acceptable than the control. The study revealed that, 1% dried orange pomace addition can be an alternative method to enrich the dietary fiber contents of foods.

Conflict of interest
The authors declare that they have no conflict of interest.

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