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# The effect of saleps obtained from various Orchidacease species on some physical and sensory properties of ice cream

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**Abstract**

The study was aimed to investigate the effect of different salep properties on ice cream quality parameters. Therefore, salep samples obtained from six different *Orchidaceae* spp. were examined for glucomannan and starch contents. Statistically significant differences were observed between the glucomannan and starch levels, viscosity values (between 23.90 cP and 430.90 cP), and overrun levels (between % 32.62 and % 42.46) of ice cream mixes and melting qualities of ice cream samples according to species of the salep sample ($p < 0.05$). It is concluded that high-glucomannan (> 40%) containing salep samples, which were obtained from the species (*O. mascula* ssp. *pinetorum*, *S. vomeracea* ssp. *vomeracea*) have significantly desired effects on the viscosity values and overrun levels and contributes to the sensory qualities of Kahramanmaras type ice cream. Abundant production of good quality salep depends on the cultivation of high-glucomannan species in particular.

**Keywords:** glucomannan; starch; viscosity; overrun value.

**Practical Application:** Consistency adjustment of ice cream using high-glucomannan (> 40%) containing salep samples.

## 1 Introduction

Salep is obtained by grinding the dried root tubers of the wild orchid species in the *Orchidaceae* family after certain operations. Salep is a plant-based polysaccharide in the form of yellowish or pale dark colored, spherically shaped, rough, hard grains (Baytop & Sezik, 1968; Sezik, 1967).

In Turkey, salep was traditionally used in various pharmaceutical preparations as an expectorant or chest softener. It is used in a traditional drink and in the food industry, especially in the production of Kahramanmaras type ice cream as a food additive (Sezik, 1984; Tamer et al., 2006; Tekinşen, 2006). Salep gives ice cream a smooth, viscous and homogenous structure; adds mass to the ice cream; prevents large ice crystals from forming during its manufacture and storage; and delays partial melting (Tekinşen & Karacabey, 1984; Tekinşen & Tekinşen, 2008).

Its widespread use and its physico-chemical functions stem from its main ingredient, glucomannan. Glucomannan is a hydrocolloid polysaccharide, one gram of which absorbs 200 mL of water. Salep is generally used as a powder, in a ratio of 0.50-1.00 g/100 mL depending on the amount of glucomannan in ice cream production and affects the qualities of the ice cream (Sezik,1984; Tekinşen & Karacabey, 1984; Tekinşen & Tekinşen, 2008).

Although at least 30 species belonging to the family *Orchidaceae* are used in salep production in Turkey, tubers of the species of *Orchis* are preferred (Kreutz, 2002; Sezik, 1984). Sezik (1967) reported that, depending on the species, 100 g salep contained 7-61 g of glucomannan, 1-36 g of starch, 0.5-1 g of nitrogenous substances, 0.2-6 g of ash in the form of dry material and 6-12 g moisture. Salep's quality is determined by the amount of glucomannan it contains. High quality salep must contain more than 40 g/100 g glucomannan. If the tubers contain more starch, they are evaluated as second grade salep. Although many salep species grow in the same region, their glucomannan and starch amounts may vary. *Orchis* and *Anacamptis* species contain more glucomannan than starch (Sezik, 1967, 1984).

Turkey is the largest salep producer in the world (Tekinşen & Guner, 2010). Salep is obtained from the tubers of orchids that have grown in Turkey for centuries and these were both used domestically and exported. For 1 kg of salep, 1000-4000 dried tubers, each of which weighs 0.25-1.00 g, are required. For this reason, around 120 million wild orchid plants are damaged at the florescent stage annually in Turkey (Kreutz, 2002). Due to high levels of destruction, salep's exports have been totally banned since 1995 (in powder, tablet, and other forms) (Turkey, 1995). However, it can be sold domestically (Yaman, 2013).

The study was conducted to determine the effects of glucomannan and starch contents of salep obtained from six orchid species on the basic qualities of the ice cream mixes and ice creams.

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## 2 Materials and methods

### *2.1 Collection and preparation of the salep samples*

Salep tubers were obtained from different locations in Turkey (Table 1) between March-June 2012 / 2013. For this purpose, approximately 1 kg tubers from each of six different species (*Orchis palustris*, *Orchis morio* ssp. *picta*, *Orchis mascula* ssp. *pinetorum*, *Anacamptis coriophora* ssp. *fragrans*, *Himantoglossum affine*, *Serapias vomeracea* ssp. *vomeracea*) were collected. The orchid species from which salep samples were obtained determined in Departments of Biology of Kocaeli and Karadeniz Technical Universities.

Salep powder was obtained by the traditional method from of each species (Tekinşen & Guner, 2010; Tekinşen & Tekinşen, 2008). For this purpose, the tubers were washed with cold water and cleaned from dirt and mud and boiled for 10-15 minutes in milk; then the samples was dried at 21 ± 2 °C until it hardened (7-10 days). The dried samples were first cut into small pieces, then powdered into flour by milling. 3 parallel analyses were carried out according to this experimental procedure.

### *2.2 Manufacturing of the ice cream samples*

Whole raw cow's milk, sugar, non-fat dry milk, emulsifier (glycerol monostearate [E471and salep samples obtained from six species were used as a stabilizer in the preparation of ice cream mixes. Ice cream production was carried out using the Fatty Kahramanmaras type ice cream formula (in 100 g Fatty Kahramanmaras type ice cream; milk fat: 5 g, non-fat milk dry matter: 10 g, sugar: 18 g, stabilizer: 0.7 g, emulsifier: 0.2 g) in a vertical batch freezer (Ugur C-40, Turkey) and manufactured by the method specified by Tekinşen & Tekinşen (2008) at the Prof. Dr. O. Cenap Tekinşen Meat and Milk Products Research, Development and Application Unit of Veterinary Science Faculty of Selcuk University. 250 g of milk fat, 500 g of skimmed milk powder, 900 g of sugar, 35 g of salep, 10 g of emulsifier are mixed with milk at 50-60 °C in a total volume of 5 kg. It is then cooked at 69 °C with stirring for 30 minutes. The cooked mixture is cooled to 4 °C and rested at this temperature for 17 hours. The mixture is then stirred at about -5.5 °C for freezing. The resulting ice cream is placed in packages weighing 25 grams and subjected to hardening at -25 °C. The experiments were conducted three times in 5 kg batches each. Analyses were conducted on the first day of storage at -25 °C after production.

### *2.3 Analyses of the samples*

*Glucomannan and starch contents of the salep samples*

The samples were prepared according to procedures specified for glucomannan and starch using glucomannan and total starch assay kits, respectively (Megazyme International Ireland Limited, 2004a, b). The glucomannan and starch contents of the samples were determined by measurement of absorbance values of prepared blind and sample solutions (for glucomannan A1, A2, A3; for starch ΔA, F) in a UV–Vis Spectrophotometer (Shimadzu – UV Mini 1240) at 340 nm (for glucomannan) and 510 nm (for starch) and using the following Formula 1 and 2 (Megazyme International Ireland Limited, 2004a, b):

$$\Delta A_{glucomannan} = (A_3 - A_1)_{sample} - (A_3 - A_1)_{blank}\ x 36.8[g/100g] \quad (1)$$

$$Starch = \Delta A\ x(F\ /\ W)\ x\ 90[g/100g] \quad (2)$$

where ΔA = absorbance value of sample solution compared to blind solution; F = 100 (μg of glucose control)/absorbance value of glucose control (1.03); and W = the weight of the sample (100 mg).

*Viscosity values and overrun levels of the ice cream mix samples*

Viscosity values of the samples were determined in the viscosity meter (AND – SV-10 Sine-Wave Vibro) which functions by the newly-developed tuning-fork vibration method, based on the detection of electric flow required for the tinkle of sensor plates at the fixed 30 Hz frequency, at 25 °C (A&D Company Limited, 2005).

Overrun measurement was taken per sample by comparing the weight of ice cream mix and ice cream in the same volume container. Overrun was calculated as the following Formula 3 (Marshall et al., 2003).

$$Overrun\ (\%) = \frac{weight\ of\ mix\ -\ weight\ of\ ice\ cream}{weight\ of\ ice\ cream} X\ 100 \quad (3)$$

*Melting rates and sensory evaluation of the ice cream samples*

To determine the melting rate, ice cream was weighed in a plastic container and taken from the plastic container, and placed on a 2.5 mm pored wire filter, standing on a glass funnel. A measurement cylinder of known weight was placed under the funnel. At 22 ± 1 °C, within 30, 60, and 90 minutes the parts of the ice cream that melts were weighed along with the measurement cylinder, and the weight of the melted product was calculated according to the following Formula 4 (Tekinşen & Tekinşen, 2008). The first dripping and complete melting durations of the samples with equal volumes were detected during determination of the melting rate.

$$Melting\ rate\ (\%) = \frac{weight\ of\ the\ melted\ portion}{weight\ of\ ice\ cream} \times 100 \quad (4)$$

The sensory analysis of the ice cream samples was carried out according to the 15-point evaluation card method (Turkish Standards Institute, 1992) in terms of color-appearance, texture-consistency and taste-smell qualities. This evaluation was made by 15 randomly selected panelists.

### *2.4 Statistical analysis*

All the results for the samples were analyzed statistically by analysis of variance with Duncan's multiple range test. Significance was reported at $p < 0.05$ in the tables. SPSS Statistic Package Programme (10.0; SPSS Inc., Chicago, IL, USA) was used.

## 3 Results and discussion

Studies concerning the chemical composition of salep obtained from the wild orchid species in Turkey and its use in ice cream production are very rare. However, there are no studies concerning the effects of the glucomannan and starch contents of the salep obtained from these species on the quality in ice cream production. Glucomannan and starch contents of salep obtained from six different orchid species are presented in Table 1.

As seen in Table 1, it was observed that the glucomannan and starch contents of salep samples varied significantly ($p < 0.05$) between 7.84-47.36 g/100 g and 12.24-40.21 g/100 g according to the species of *Orchidaceae*. The findings show that salep obtained from *O. mascula* ssp. *pinetorum* and *S. vomeracea* ssp. *vomeracea* contained more than 40% glucomannan, which can be considered as high quality (Sezik,1967). These findings confirm the results of (Sezik, 1967), (Sezik & Ozer, 1983) who reported some variations in glucomannan (11.60-44.00 g/100 g, 31.10-46.70 g/100 g, respectively) and starch (8.40-20.0 g/100 g, 7.31-15.20 g/100 g, respectively) contents of commercial salep samples obtained from various parts of Turkey, and those of (Farhoosh & Riazi, 2007), who found, on average, 58.20 g/100 g glucomannan and 1.67 g/100 g starch in palmete-type tubers, and 22.10 g/100 g glucomannan and 6.15 g/100 g starch in round-type tubers in Iran. Moreover, the glucomannan and starch levels that (Sezik, 1967) and (Tekinşen & Guner, 2010) determined in saleps produced from different *Orchidaceae* species were found similar with the present study. The data also pointed out a negative relationship between glucomannan and starch contents; thus the higher the starch the lower was the glucomannan content. All these findings indicate that glucomannan and starch contents of salep were highly depended on the *Orchidaceae* species.

As shown in Table 2 viscosity values and overrun levels of the ice cream mix samples, ranged from 23.90 to 430.90 cP, and 32.62 to 42.46 mL/100 mL depending on the species and the differences were found to be statistically significant ($p < 0.05$). The results are different from the viscosity values and overrun levels found by some authors for ice cream mixes prepared using salep (Kayacier & Dogan, 2006; Tekinşen et al., 2011; Tekinşen & Karacabey, 1984). This may be explained by the different levels of use of commercial salep that were obtained from mixed orchid species, and the total dry matter level of the mix used for ice cream production, and different ice cream machine types (Güven et al., 2002; Marshall et al., 2003; Tekinşen & Karacabey, 1984; Tekinşen & Tekinşen, 2008). Some investigator (Karaman et al., 2011; Kaya & Tekin, 2001; Kayacier & Dogan, 2006; Tekinşen et al., 2011) state that as the amounts of salep, in which glucomannan is the active ingredient increase, generally the viscosity levels increase depending on the glucomannan level. However, overrun is affected by the synergistic or antagonistic interaction of salep with other stabilizers. Indeed, the results in Table 1 and 2 show that the glucomannan contents and viscosity values of the samples are correlated. Some researchers (Farhoosh & Riazi, 2007; Tekinşen & Guner, 2010) also stated that the viscosity of solution rises as the glucomannan content of salep samples increased. Moreover, viscosity was also affected by the increase in starch levels.

There were statistically significant differences ($p < 0.05$) in the melting properties of ice cream samples based on the orchid species from which the salep sample was obtained (Table 3). The first dripping durations were determined as 17.40-23.06 minutes, consistent with their 30 minute melting ratios, and their complete melting durations ranged between 80.48 and 87.32 minutes, consistent with their 60 minute melting ratios. The effects of overrun on this quality are shown in Table 2. Indeed, the earliest dripping duration was exhibited by sample VI which had the largest overrun value, and sample II exhibited the latest full melt and had the lowest overrun value. The melt-resistance of ice cream depends on the amount of dry matter, low overrun, and gelation concerning stabilizer systems (Marshall et al., 2003; Tekinşen & Tekinşen, 2008). The results were consistent with the authors (Güven et al., 2010; Muse &

**Table 1**. Glucomannan and starch contents [g/100g] of salep samples.

| Samples | Species | Locations | Glucomannan | Starch |
|---|---|---|---|---|
| I | *O. palustris* | Malazgirt/Mus | $7.84 \pm 2.21^{f*}$ | $12.24 \pm 0.08^{f*}$ |
| II | *O. morio* ssp. *picta* | Akkus/Ordu | $19.14 \pm 0.95^{e}$ | $40.21 \pm 0.12^{a}$ |
| III | *O. mascula* ssp. *pinetorum* | Bozuyuk/Bilecik | $43.67 \pm 0.95^{b}$ | $21.92 \pm 0.19^{c}$ |
| IV | *A. coriophora* ssp. *fragrans* | Gebze/Kocaeli | $25.08 \pm 2.54^{d}$ | $13.50 \pm 0.08^{e}$ |
| V | *H. affine* | Niksar/Tokat | $36.64 \pm 0.77^{c}$ | $35.00 \pm 0.07^{b}$ |
| VI | *S. vomeracea* ssp.*vomeracea* | Tuzla/Istanbul | $47.36 \pm 0.95^{a}$ | $15.07 \pm 0.09^{d}$ |

Values in a column which do not share a common superscript are statistically different; $^*p < 0.05$.

**Table 2**. Viscosity values and overrun levels of ice cream mixes.

| Samples | Viscosity (cP) | Overrun (mL/100mL) |
|---|---|---|
| I | $23.90 \pm 1.46^{f*}$ | $36.12 \pm 0.49^{c*}$ |
| II | $88.25 \pm 18.25^{e}$ | $32.62 \pm 0.29^{d}$ |
| III | $428.85 \pm 0.25^{b}$ | $42.19 \pm 0.32^{a}$ |
| IV | $161.40 \pm 15.57^{d}$ | $40.26 \pm 0.45^{b}$ |
| V | $282.95 \pm 10.31^{c}$ | $41.83 \pm 0.35^{a}$ |
| VI | $430.90 \pm 0.38^{a}$ | $42.46 \pm 0.27^{a}$ |

Values in a column which do not share a common superscript are statistically different; $^*p < 0.05$. 3 repetitions were conducted for ice cream production with 5 kilograms. Two different samples from each production were analyzed.

**Table 3**. Melting rates of ice cream samples.

| Samples | First dripping (min) | Melting rates (g/100 g) | | Complete melting (min) |
|---|---|---|---|---|
| | | 30. min | 60. min | |
| I | 18.78 ± 0.14$^{c*}$ | 4.67 ± 0.08$^{a*}$ | 57.10 ± 1.14$^{d*}$ | 85.23 ± 0.12$^{c*}$ |
| II | 21.48 ± 0.04$^{b}$ | 2.16 ± 0.27$^{d}$ | 60.37 ± 0.09$^{c}$ | 87.32 ± 0.14$^{a}$ |
| III | 21.43 ± 0.06$^{b}$ | 2.19 ± 0.23$^{d}$ | 60.58 ± 0.17$^{bc}$ | 80.48 ± 0.15$^{f}$ |
| IV | 23.06 ± 0.09$^{a}$ | 3.70 ± 0.18$^{c}$ | 61.34 ± 0.22$^{a}$ | 85.56 ± 0.10$^{b}$ |
| V | 23.02 ± 0.10$^{a}$ | 3.74 ± 0.21$^{c}$ | 60.41 ± 0.12$^{bc}$ | 81.12 ± 0.21$^{e}$ |
| VI | 17.40 ± 0.17$^{d}$ | 4.51 ± 0.07$^{b}$ | 60.92 ± 0.11$^{ab}$ | 81.88 ± 0.19$^{d}$ |

Values in a column which do not share a common superscript are statistically different; *p < 0.05. Each sale was made of 3 repetitive ice creams of 5 kilograms. Two different samples from each production were analyzed.

**Table 4**. Sensory evaluation of ice cream samples.

| Samples | Color-Appearance | Body-Texture | Flavor-Smell |
|---|---|---|---|
| | (No Criticism: 5 / Normal Score: 1-5) | | |
| I | 4.64 ± 0.40$^{a}$ | 4.00 ± 0.30$^{a}$ | 4.00 ± 0.20$^{a}$ |
| II | 4.64 ± 0.20$^{a}$ | 4.09 ± 0.20$^{a}$ | 4.00 ± 0.30$^{a}$ |
| III | 4.82 ± 0.30$^{a}$ | 4.55 ± 0.30$^{a}$ | 4.36 ± 0.20$^{a}$ |
| IV | 4.73 ± 0.20$^{a}$ | 4.36 ± 0.40$^{a}$ | 3.82 ± 0.40$^{a}$ |
| V | 4.55 ± 0.30$^{a}$ | 4.36 ± 0.40$^{a}$ | 3.73 ± 0.30$^{a}$ |
| VI | 4.64 ± 0.40$^{a}$ | 4.55 ± 0.30$^{a}$ | 4.45 ± 0.20$^{a}$ |

Values in a column which do not share a common superscript are statistically different (p < 0.05). Each sale was made of 3 repetitive ice creams of 5 kilograms. Two different samples from each production were analyzed.

Hartel, 2004; Tekinşen et al., 2011) who determined that ice creams with low overrun were more resistant to melting.

As seen in Table 4, there were no statistically significant differences ($p > 0.05$) between the sensory examination findings of ice cream samples. The results suggest that salep from different species do not have different effects on sensory qualities of ice cream, or that this quality cannot be sensed. This may be explained by the fact that the ice cream samples contain the same amounts of fat, non-fat milk dry matter, sugar, stabilizer, and emulsifier ratios because they are based on the same formula. Indeed, the fact that the sensory properties of ice cream are affected by the use of flavoring materials, fat, non-fat milk dry matter, and stabilizer amounts confirms this point (Güven et al., 2002, 2003; Marshall et al., 2003; Tekinşen & Tekinşen, 2008). However, samples III and VI made with high-glucomannan salep were more frequently preferred in terms of sensory qualities. This may be explained by the fact that samples III and VI, which exhibited similar overrun levels (42.19% and 42.46 mL/100 mL, respectively), had the highest viscosity values (428.85 cP and 430.90 cP, respectively), and thus, their sensory qualities were better sensed. Researchers (Güven et al., 2002, 2003; Marshall et al., 2003; Tekinşen & Tekinşen, 2008) agree that an effective stabilizer that can contribute to high consistency in ice cream making improves the sensory qualities of ice cream.

## 4 Conclusions

In conclusion, salep from high-glucomannan (> 40 g/100 g) species (*O. mascula* ssp. *pinetorum* and *S. vomeracea* ssp. *vomeracea*) has a significant and positive effect on the viscosity values and overrun levels and contributes to the sensory qualities of the ice cream, and thus is suitable for Kahramanmaras type ice cream making. Abundant production of high-quality salep depends on the cultivation of high-glucomannan containing species in particular. In this context, it is important to support the studies that were conducted to grow wild orchid species in orchard conditions. Glucomannan allows the unique properties of Kahramanmaras type ice cream to emerge which has an perfect melting stability.

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