

THE EFFECTS OF THE COMBINED USE OF SALEP AND LOCUST BEAN GUM WITH SOME STABILIZERS ON THE PROPERTIES OF KAHRAMANMARAS TYPE ICE CREAMS

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Abstract

In general, this study aimed to determine the suitability of using locust bean gum (LBG) with various types of stabilizers in the production of Kahramanmaraş-type ice creams: the physical, chemical and sensory properties which the ice creams produced with these stabilizers possess, and the stabilizer combination which would lead to the best quality ice cream production. The total amount of stabilizers being 1.0 %, the actual trial ice creams of four combinations containing different rates of locust bean gum, carboxymethyl cellulose (CMC), guar gum, salep and sodium alginate were produced and the changes in these properties were determined during the 6-month storage time. The ice creams produced only by using salep were treated as the control sample. It was observed that the ice creams produced by using only salep had a higher titration acidity, lower pH and viscosity values, were harder and less resistant to melting when compared with the other ice creams produced by using the stabilizer combinations. These differences were found to be statistically significant ($p < 0.05$). Starting from the 3rd month, the scores given to the sensory properties of these ice creams gradually decreased; and although not statistically significant they had lower values than the other ice creams. Among the physical properties examined, the stabilizer combinations had a significant effect ($p < 0.05$) on the viscosity values. When the effects of the storage period on the properties of the ice creams were examined, only the decrease in the penetrometer value of the physical properties was significant ($p < 0.05$). In other words, the ice creams became stiffer during the storage period. Except for the changes observed in the sensory scores starting from the 3rd month of the storage time in the ice creams produced by using only salep, the differences during the storage time were not found to be significant.

Key words: ice cream, stabilizer, locust bean gum, salep extract, storage period

1. INTRODUCTION

Ice cream is complex-colloidal systems which in their frozen state is comprised of ice crystals, air bubbles, partially-coalesced fat globules and aggregates, all in discrete phases surrounded by an unfrozen continuous matrix of sugars, proteins, salts, polysaccharides and water (Rossa, Burin & Bordignon-Luiz 2012). The ingredients used in ice cream can be classified into major ingredients, present in significant quantities, and minor ingredients such as emulsifiers, stabilizers, colors and flavors, present in amounts of less than about 1% by weight (Varela, Pintor & Fiszman 2014). What determine the quality of the ice cream apart from its taste is, its structure, mass and resistance to melting (Arbuckle 1986; Marshall & Arbuckle 1996). The superiority of the ice cream in terms of these properties and its potential to preserve its properties at low temperatures depends on the suitable levels of stabilizers and emulsifiers the mix contains (White 1971; Cottrell, Pass & Phillips 1980). The stabilizers play an important role in preventing the formation of bulky ice crystals during the production and storage of the ice cream by improving the mass and structure of the mix and in preserving the structure by retarding the melting during the consumption stage (Glicksman 1969; Keeney & Kroger 1974; Crichtett & Flack 1977; Akalin & Gonc 1995; Akcin 1997). The gums from

leguminous seeds (locust bean gum, LBG; guar gum, GG) and plant tubers (salep, from the Orchidaceae family) are classified as mannans (Kurt & Kahyaoglu 2014). Glucomannan is a polysaccharide consisting of linear monomers of β -D-mannose and α -D-glucose linked with β (1-4) bonds (Karaman et al. 2012). These high molecular weight polymers are known as hydrocolloids and interact strongly with water (Kurt & Kahyaoglu 2015). Hydrocolloids are used in the food industry for their thickening, gelling, stabilizing, texture-modification and film-forming properties (Kurt & Kahyaoglu 2014). Hydrocolloid stabilizers are added to ice cream mix for a number of reasons: to increase mix viscosity; to prevent separation of clear serum during meltdown; to produce a stable foam with easy cut-off and stiffness at the barrel freezer for packaging; to retard the growth of ice and lactose crystals during storage, especially when subjected to temperature fluctuation; to slow down moisture migration from the product to the package or the air; and to prevent shrinkage of product volume during storage (Bolliger et al. 2000; Regand & Goff 2003; Varela, Pintor & Fiszman 2014).

Kahramanmaraş-type is the most popular kind of ice cream in Turkey (Güven, Karaca & Kacar 2003) and named “Maras dondurması” produced in Turkey and it has geographical indication by Turkish patent Institute with the name “Maras ice-cream” (Hayaloglu & Karagul-Yuceer 2011). It possesses high sugar content, natural flavor and stick gummy body (Güven, Karaca & Kacar 2003). The distinctive characteristics of this type of ice cream are the hard texture, the longer melting time at room temperature and the use of goats’ milk (Güven, Karaca & Kacar 2003; Dogan & Kayacier 2007). It is hard served and commonly a knife should be used during consumption due to unique textural properties (Karaca et al. 2009).

Salep is a Turkish word (Greek ‘salapi’ Arabic Word ‘sahlab’) refers to the tubers of terrestrial orchids and it is a flour, made from grinding dried tubers of *Orchis mascula*, *Orchis militaris* and related species of orchids that grow naturally in various regions of Turkey (Hossain 2011). It constitutes the raw material of a traditional Turkish beverage and is used for giving hardness and elasticity to Kahramanmaraş-type of ice cream (Ayar, Sert & Akbulut 2009). Salep is responsible for the distinctive textural and sensory properties of Kahramanmaraş-type of ice cream (Karaca et al. 2009). Salep is also a water-soluble polysaccharide with high molecular weight. It has found recent applications in optimization of viscosity, production of gel-structures and enhancement of structural stability. It is also utilized as a thickener and stabilizing agent in food formulations because it provides a unique texture (Karaman et al. 2012). Salep contains glucomannans in high levels (16-55%) and its presence probably improves the physical characteristics of Kahramanmaraş ice cream (Hayaloglu & Karagul-Yuceer 2011), and these are natural neutral water soluble fibers which help to normalization of blood sugar, relieve stress and prevent blood sugar abnormalities like hypoglycaemia. It has also been reported that glucomannans reduce the risk of chronic diseases (Karaman, Yilmaz & Kayacier 2011). This polysaccharide, as obtained from *Orchis morio*, is known to consist of D-glycopyranosyl and D-mannopyranosyl residues at a ratio of 1:3.3, its backbone chain consisting of β (1-4)-linked glycosyl and mannosyl residues. In addition to glucomannans, salep extracts also contain starch and proteins at various concentrations (Georgiadis et al. 2012). It is commonly used as a stabilizer in ice cream production. Salep especially gives the special structure, taste and odor to the Maras- ice cream in Turkey (Ayar, Sert & Akbulut 2009). The official record of Turkey in 1993 was that they have exported 75 tons salep in different European countries for which it took approximately 150 million of orchids. Due to unavailability of huge tubers, production of salep has been reduced remarkably in Turkey. Nowadays Turkey is producing on an average 20 tons salep every year (Hossain 2011).

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 fluorescent stage, annually in Turkey. Since the lack of alternatives has led to the endangering of some orchid species, the export of salep in either tuber or drug form (powder or tablet) obtained from all *Orchidaceae* spp. was prohibited in 1995 (Tekinşen & Güner 2010). Among the stabilizers used in the production of ice cream in Turkey, salep plays an important role. The salep plant (*Orchis anatolica*) that is a kind of wild orchid is gradually decreasing in the natural flora due to the excessive use and is in danger of extinction. Therefore, there is a need to find a substituent stabilizer for salep. The locust bean gum, which is widely found in our region, suggested to be used as an alternative to salep. It is indicated that the locust bean gum production in our country is 15 000 tonnes. This plant which grows in limestone-rich

and rocky areas where the Mediterranean climate rules, is widely grown between Antalya-Adana and Demre-Datça.

Locust bean gum (LBG) is a non-digestible polysaccharide (Perrechil & Cunha 2010) and an important thickening polysaccharide composed of a main backbone of 1-4-linked β -D-mannopyranosyl units, with 1-6-linked α -D-galactopyranosyl units. Locust bean gum is compatible with other food polymers, widely used in dairy and frozen dessert products, due to the neutral character of this hydrocolloid (Farshchi, Ettelaie & Holmes 2013). LBG or E410 is widely used as a thickener, gel strengthening in the food industry due to its ability to form viscous solutions at relatively low concentrations, which are only slightly affected by pH, added ions, and heat processing (Haddarah et al. 2014). LBG's ability to bind water makes it an excellent choice for frozen applications, such as ice cream as it will slow down and reduces the size of ice-crystal formation as the moisture is retained within the ice cream (Barak & Mudgil 2014). From different hydrocolloids, LBG appeared to be more effective in limiting ice cream recrystallisation rate than other hydrocolloids (Camacho, Martinez-Navarrete & Chiralt 2001).

Alternative stabilizers to salep have been searched due to its high retailing prices and the danger posed by the possibility of the extinction of Orchids plants. On the other hand, salep consumption is not given up easily due to its characteristic flavor in ice creams (Güven, Karaca & Kacar 2003; Kurt, Cengiz & Kahyaoglu 2016). Researchers have indicated that the individual use of CMC, guar and locust bean gum caused serum separation and coagulated melting problems due to the coagulation of the milk proteins. In the meantime, it is stated that these problems could be eliminated by the combined use with other stabilizers (Tekinsen 1993; Gonc & Enfiyeci 1987; Barak & Mudgil 2014). While carboxymethyl cellulose, which easily dissolves in the mix and has a high capacity in retaining water (Cakmakci & Celik 1999; Altug 2001; Dickinson 2003), is used individually has a weak gel forming property; when used in combination with locust bean gum, carrageenan and guar gum has a potential of forming strong gels (Marshall & Arbuckle 1996). It is indicated that the locust bean gum solution should be boiled in order to have a maximum effect in the mix and that besides providing a perfect retaining of water and homogenous melting it also provides resistance to temperature shocks (Glicksman 1969). The combined use of different gums can contribute to improving the texture of structured foods, even when using lower amounts of stabilizers because of the synergistic effects developed in some systems (Camacho, Martinez-Navarrete & Chiralt 2005). In this sense, in order to eliminate the negative effects of the locust bean gum which were stated in the literature, the use of locust bean gum with different stabilizers were experimented and the ice creams produced using 4 different stabilizer combinations with a total stabilizer rate of 1 % were compared with the control sample which contained 1 % salep.

2. MATERIALS AND METHODS

2.1. Materials

The cows' milk and the cream used in the study were obtained from the Animal Husbandry Branch of Agriculture Faculty, Çukurova University. In the production of ice cream, the batch freezer was supplied by Uğur (5 kg, Nazilli, Turkey). Of the other constituents in the ice cream, skim milk powder was obtained from Pınar Co. (Izmir, Turkey), sugar from the markets, ice cream cups from Başer Plastic Co. (Adana, Turkey). Of the stabilizers used, salep extract was obtained from Mado Co. (Adana, Turkey), locust bean gum from INCOM Co. (Mersin, Turkey), sodium alginate and CMC from Özsezen Food Industry and Delivery Co. (Istanbul, Turkey), guar gum from Kutay Co. (Adana, Turkey).

2.2. Production of ice cream

Mixes were prepared by adjusting the milk solids nonfat (MSNF) to $11 \pm 0.1\%$, and that of fat to $7.0 \pm 0.1\%$ in final product. Then, sugar at a rate of 2 % and stabilizers totalling 1% were added to the mix. The stabilizers added to the ice creams, their rates, and codes are shown in Table 1. In addition, a

mix containing salep extract at a rate of 1% was prepared as the control sample. The prepared mixes were pasteurized for 20 minutes at 90 ± 1 °C, cooled to 25 °C, then held for 24 hours in the cold room at 4 ± 1 °C. Vanillin was added to each of the aged mixes at 0.03%. The ice cream freezing time was fixed at 15 minutes and the product stored at -15 °C.

Ice creams	Stabilizer Rate (%)				
	Salep	LBG [*]	CMC ^{**}	Guar Gum	S.Alginate ^{***}
A	1.00	-	-	-	-
B	0.10	0.25	0.25	0.20	0.20
C	0.10	0.30	0.30	0.15	0.15
D	0.10	0.35	0.35	0.10	0.10
E	0.10	0.40	0.40	0.05	0.05

^{*}LBG: Locust bean gum, ^{**}CMC:Carboxymethyl cellulose, ^{***}S.Alginate: Sodium Alginate

Table 1. The Stabilizers added to the produced ice creams and their rates

2.3. Analysis

Total solids were determined by a gravimetric method according to Turkish Standard TS 1018 (Anon. 1978), fat in the milk and cream by butyrometers according to the Gerber method (Anon. 1975; Anon. 1978), pH values in the milk and ice creams with Beckman-type pH meter (WTW, Weilheim, Germany) and titratable acidity in the milk and ice creams by an alkali titration method (Anon. 1983).

The penetrometer values of the ice creams were determined with Surberlin PNR 6 penetrometer (a conical spindle weighing 95.5 g and cone angle 2.5 cm, Berlin, Germany) and the percentage melting times based on the melting amounts of a 50 g sample in the 30th, 60th, and 90th minutes at 30 ± 1 °C in a waterbath (Cottrell, Pass & Phillips 1979). Overrun was measured according to the proportion of ice cream to the volume of mix (Cottrell, Pass & Phillips 1979; Karaca et al. 2009) and mix viscosity with a capillary tipped Oswald viscometer (Schott, Germany) (Güven & Akın 1997). To determine first dripping (second), the complete melting times (second) and melting rate (g/min) 25 g of ice creams samples were left to melt at 30 ± 1 °C on a 0.14-mm wire mesh screen above a preweighed beaker and the beaker was recorded at 10-min time intervals for 60-min. The sensory properties of the ice creams were evaluated on a 20-point scale by 7 experienced panel members according to Turkish Standard (TS) 4265 (Anon. 1992). Ice cream production was performed in triplicate. Data from each sampling stage were analysed statistically by one-way analysis of variance. Means with a significant difference ($p < 0.05$) were compared by the Duncan test (Duzgunes, Kesici & Gurbuz 1987).

3. RESULTS AND DISCUSSION

Ice cream A that were produced by using only salep had the highest acidity values and the lowest pH values (Table 2). When the differences between the titration acidity of the ice creams were analyzed, it was found out that the values of the 1st day and 1st month were not significantly different but starting from the 2nd month ice cream A had significantly different values than the others and especially on the 5th and 6th months, these differences had increased ($p < 0.05$). It was also observed that the pH values of the ice cream A had significant differences beginning from the 1st day of storage.

While ice cream A had the highest overrun, ice cream E which has the highest amount of locust bean gum had the lowest rate and the differences between these ice creams were found to be significant ($p < 0.05$). There were no significant differences between the overrun values of the other ice creams. Akın (1990) indicated that it would be difficult to increase the overrun over 35-40% in the soft and semi-soft ice creams produced in the batch-type freezers. Tekinsen & Karacabey (1984) reported 23.52-38.06% overrun in the Kahramanmaraş-type ice creams, which they prepared by ordinary and

modified stabilizer mixtures. Gursel, Gursoy & Ceylan (1997) found out that the average overrun in Kahramanmaraş-type ice creams was 44 %.

Property		Storage Time					
		1 st day	1 st month	2 nd month	3 rd month	5 th month	6 th month
Titratable Acidity (°SH)	A	6.7±0.37 ^{a*}	6.7±0.37 ^a	6.5±0.12 ^a	6.8±0.15 ^a	6.9±0.14 ^a	6.9±0.11 ^a
	B	6.5±0.41 ^a	6.5±0.41 ^a	6.3±0.30 ^b	6.1±0.10 ^b	6.2±0.00 ^{cb}	6.2±0.18 ^{cb}
	C	6.4±0.47 ^a	6.4±0.47 ^a	6.1±0.12 ^b	6.2±0.23 ^b	6.2±0.19 ^{cb}	6.3±0.10 ^b
	D	6.5±0.43 ^a	6.5±0.43 ^a	6.2±0.19 ^b	6.3±0.24 ^b	6.2±0.14 ^{cb}	6.2±0.08 ^{cb}
	E	6.4±0.47 ^a	6.4±0.47 ^a	6.2±0.00 ^b	6.4±0.08 ^b	6.1±0.09 ^c	6.1±0.21 ^{cb}
pH values	A	6.4±0.02 ^a	6.3±0.05 ^a	6.4±0.03 ^a	6.5±0.01 ^a	6.4±0.02 ^a	6.5±0.01 ^a
	B	6.4±0.01 ^{ab}	6.4±0.02 ^b	6.5±0.01 ^b	6.5±0.01 ^{ab}	6.5±0.01 ^{db}	6.5±0.01 ^{bc}
	C	6.4±0.03 ^{ab}	6.4±0.02 ^b	6.5±0.03 ^{ab}	6.5±0.01 ^{ab}	6.5±0.01 ^{db}	6.5±0.01 ^c
	D	6.4±0.04 ^{ab}	6.4±0.03 ^b	6.5±0.03 ^{ab}	6.5±0.01 ^{ab}	6.5±0.02 ^e	6.6±0.01 ^c
	E	6.4±0.01 ^b	6.4±0.02 ^b	6.5±0.02 ^{ab}	6.5±0.04 ^b	6.5±0.01 ^e	6.6±0.01 ^c
Overrun values (%)	A	42±5.7 ^a	45±4.9 ^a	45±2.3 ^a	44±3.9 ^a	44±2.3 ^a	44±7.6 ^a
	B	39±6.4 ^{ab}	41±5.3 ^{ab}	42±2.0 ^{ab}	43±8.0 ^a	44±7.0 ^b	43±10.2 ^b
	C	38±4.2 ^{ab}	38±4.2 ^{ab}	40±5.4 ^{ab}	42±4.4 ^a	42±7.3 ^b	41±6.2 ^b
	D	38±3.0 ^{ab}	37±4.1 ^{ab}	40±3.8 ^{ab}	41±3.5 ^a	41±2.2 ^{cb}	40±18.8 ^b
	E	34±2.1 ^b	35±2.6 ^b	38±2.8 ^b	38±4.3 ^a	39±0.0 ^c	38±8.6 ^b
Penetrometer values (1/10mm)	A	47±4.3 ^a	46±3.4 ^a	43±3.5 ^a	25±4.0 ^a	23±3.3 ^a	25±2.4 ^a
	B	55±5.9 ^{bc}	49±4.1 ^{ad}	40±2.5 ^b	25±4.5 ^a	23±2.4 ^{cba}	27±2.5 ^a
	C	56±4.6 ^{bc}	51±3.1 ^{bcd}	40±3.2 ^a	24±2.9 ^a	24±2.2 ^{dc}	28±3.2 ^a
	D	57±5.0 ^b	53±2.6 ^{bc}	41±3.7 ^{ab}	23±3.5 ^a	24±1.4 ^d	28±2.0 ^a
	E	48±6.2 ^a	48±3.3 ^{ae}	39±3.7 ^b	24±4.3 ^a	24±1.6 ^{dc}	26±2.3 ^a
Viscosity (mm ² /s)	A	11±0.9 ^a	11±1.7 ^a	11±0.9 ^a	10±0.6 ^a	11±1.4 ^a	11±1.0 ^a
	B	229±45 ^c	227±28 ^{ce}	227±19 ^{ce}	225±30 ^c	235±11.2 ^e	240±6.8 ^e
	C	128±19 ^e	131±17 ^d	123±15 ^f	124±14 ^d	126±8.8 ^a	129±6.1 ^{ad}
	D	127±23 ^e	121±16 ^d	117±16 ^f	115±17 ^d	116±3.1 ^a	115±1.7 ^a
	E	108±23 ^e	114±20 ^d	105±18 ^f	117±22 ^d	101±3.0 ^a	106±5.1 ^a

*Means in the same column followed by different letters were significantly different (p<0.05).

Table 2. The properties of the ice creams and the changes during storage (n=3)

The penetrometer values of the ice creams were between 47-57 x 1/10 mm on the first day and it was indicated that the penetrometer values of the ice creams had decreased during the storage period; in other words their stiffness had increased. Within the first month ice cream A had the lowest values, that is the hardest structure, while ice creams C and D had the softest structure; it was indicated that the penetrometre values of these ice creams were significantly different from ice cream A (p<0.05). It was found out that ice creams containing salep had the lowest penetrometer values during the six months storage time and on the 6th month ice cream C and D had the highest value, which is 28 x 1/10 mm. It was determined that the storage time had a significant effect on the penetrometer values of the ice creams (p<0.05).

Viscosity or resistance to dripping is one of the most important properties of the ice cream mixes. In order to hold the air given to the ice cream by its poundable quality, the mix should have a certain viscosity value (Güven & Akin 1997; Akin 1990).

Stabilizers promote viscosity development in the aqueous phase and control ice crystal growth (McGhee, Jones & Park 2015). In terms of viscosity, ice cream B was found to have the highest value of 240 mm²/s. During the storage time ice cream A that contained salep had the lowest viscosity value between 10-11 mm²/s. When all the viscosity values were examined it was reported that using a

combination of CMC+locust bean gum+guar gum+sodium alginate, compared to the individual use of salep as a stabilizer, had increased the viscosity of the ice cream more. A study of the apparent viscosity of mixed aqueous solutions comprising of salep and guar, xanthan, or alginate suggests a synergistic action between the orchid extracts and the commercial polysaccharides (Georgiadis et al., 2012). Kailasapathy & Sellepan (1998) determined that using a combined stabilizer (locust bean gum-guar gum-carrageenan) had improved the quality and increased the viscosity of the ice cream by improving both the sensory and textural properties. Kaya & Tekin (2001) reported that the increase in the viscosity values increased the resistance of the ice cream to melting, while on the other hand the elastic properties were decreased. Chang & Hartel (2002), in their study in which they used a commercial stabilizer mix (12% carrageenan, 33 % guar gum, 55 % CMC), indicated that using stabilizers had caused an increase in the viscosity and subsequently this had formed smaller air cells at the first stage of freezing. Minhas et al. (2002) found out that among the mixes containing various stabilizer sodium alginates had the highest viscosity and it was followed by gelatine, karaya and guar gum.

The melting properties of the Kahramanmaraş-type ice creams are given in Table 3. In terms of first dripping time, ice cream A containing salep started dripping first and at the end of the 3 months storage time it was followed by ice creams C and E. It was observed that ice cream A started dripping the earliest while the others dripped later and there was a difference between them ($p < 0.05$). The lower melting resistance of ice cream stabilized with salep than stabilizer combinations such as carboxymethylcellulose, Balangu seed and gum tragacanth were also reported by Bahramparvar, Khodaparast & Razavi (2009) and Kurt, Cengiz & Kahyaoglu (2016). This difference continued throughout the storage time and during the storage it was observed that the differences in the first dripping time of the ice creams were not significant ($p > 0.05$). It was considered that because the guar gum and sodium alginate rates of the ice creams D and E containing locust bean gum and CMC at a rate of 0.35-0.40 % were low, their first dripping time appeared in a shorter period. By leading to a lower overrun, the stabilizers increase the viscosity of the serum phase and at the same time the resistance of the ice cream to dripping (Stanley, Goff & Smith 1996). Guven, Karaca & Kacar (2003) notified no significant change in first dripping time of ice cream during storage time, while different combinations of selected hydrocolloids (salep, locust bean gum, CMC, guar gum, sodium alginate) altered this parameter significantly.

The melt-down rate of ice cream is affected by many factors, including the amount of air incorporated, the nature of the ice crystals and the network of fat globules formed during freezing (Campos et al. 2016). When the complete melting time of the ice creams were examined it was reported that ice cream A was the fastest melting ice cream and ice creams B, C, D and E containing salep supplemented mixes had the lowest levels of resistance to melting. At the same time, it was observed that as the guar gum and sodium alginate rates of the mixes increased, the resistance of the ice creams to melting had also increased. It was also found out that the differences between the complete melting times of the ice creams were significant ($p < 0.05$).

Regarding the melting rates of the ice creams it was reported that this rate was 26 ml/50 g on the 30th minute for ice cream A, and on the 75th minute it melted completely. For the other ice creams very little or no melting was observed at the 30th minute. In the last month of storage, the highest melting rate was observed respectively in the ice creams C, D and E that had the earliest first dripping time. On the last month, the melting rates of all the ice creams increased in general. Except for the sample A, in the first 30 minutes melting was slow in all the ice cream samples and after the 30th minute melting accelerated.

It was observed that again ice cream A had the highest melting rate on the 60th minute and on the 5th and 6th months it had melted completely. During the storage time it was seen that ice creams A and C had completely melted on the 90th minute. When the samples that melted completely were examined, no problems such as excessive foaming, coagulated melting, serum separation or not melting were observed. In other words, it was considered that the stabilizer combinations used had improved the melting qualities, therefore had retarded melting but was not in excessive amounts to inhibit melting. Tekinsen (1993) indicated that in case of using excessive rates of stabilizers the ice cream would have

a “gum-like” structure and its melting quality would be destroyed. Parvar, Tehrani & Razavi (2013) also found that melting rate of ice creams increased with storage as in this study. According to the statistical analyses it was found that using different stabilizer combinations in ice cream production had a significant effect on the % melting rates of the ice creams on the 30th, 60th and 90th minutes ($p < 0.05$).

		Storage Time					
		1 st day	1 st month	2 nd month	3 rd month	5 th month	6 th month
First dripping time(s)	A	471±99 ^{a*}	624±35 ^a	560±35 ^a	584±52 ^a	610±15 ^a	603±22 ^a
	B	1367±287 ^c	1413±169 ^{bcd}	1178±648 ^c	1260±20 ^{eg}	1298±108 ^{edc}	1373±123 ^{ce}
	C	1489±358 ^{bc}	1236±261 ^c	1905±133 ^c	1047±28 ^f	1157±109 ^e	1156±113 ^d
	D	1472±183 ^{bc}	1323±215 ^{cd}	1246±78 ^{cd}	1243±53 ^{de}	1388±306 ^{edc}	1211±70 ^{de}
	E	1123±52 ^c	1201±223 ^c	1248±72 ^{cd}	1278±18 ^g	1210±161 ^{ed}	1208±153 ^{de}
Complete melting time (s)	A	2393±45 ^a	3084±157 ^a	2251±33 ^a	2462±91 ^a	2923±91 ^a	2905±80 ^a
	B	3583±298 ^{bc}	3900±385 ^{bc}	2582±73 ^{ad}	2808±50 ^e	3823±392 ^{cb}	3849±349 ^{bd}
	C	3172±276 ^c	3808±388 ^b	2392±155 ^{ad}	2563±34 ^f	3550±270 ^c	3431±172 ^e
	D	3209±278 ^e	3678±476 ^{bd}	2629±207 ^d	2637±32 ^g	3615±482 ^c	3157±313 ^e
	E	3209±311 ^e	3301±316 ^{ad}	2460±64 ^{ad}	2664±34 ^g	3102±118 ^a	3043±15.7 ^a
30 minute	A	26±7.3 ^a	27±2.3 ^a	28±2.1 ^a	27±1.7 ^a	40±1.5 ^a	43±3.9 ^a
	B	3±4.9 ^b	0.0 ^b	0.0 ^b	0.0 ^b	5±0.5 ^{ed}	4±1.2 ^{dc}
	C	2±3.4 ^b	0.0 ^b	2±1.0 ^c	0.0 ^b	3±0.6 ^{ecb}	11±1.8 ^e
	D	2±3.2 ^b	0.0 ^b	4±2.4 ^d	0.0 ^b	2±2.3 ^{ecb}	10±4.5 ^{ef}
	E	2±3.7 ^b	0.0 ^b	0.0 ^b	2±3.7 ^d	4±3.4 ^{deb}	6±4.9 ^d
60 minute	A	61±2.7 ^a	59±1.0 ^a	61±1.3 ^a	58±1.9 ^a	cm ^a	cm ^a
	B	21±10.8 ^b	25±1.9 ^c	23±4.3 ^d	25±2.9 ^d	34±7.5 ^{edc}	33±2.9 ^{bc}
	C	41±13.6 ^c	44±4.8 ^c	45±5.1 ^f	41±1.4 ^d	41±2.0 ^e	39±2.0 ^{dc}
	D	31±20.1 ^b	33±4.9 ^c	29±2.5 ^f	34±3.0 ^c	39±5.6 ^{edc}	41±8.9 ^d
	E	33±16.3 ^b	35±4.7 ^c	32±1.8 ^c	33±16.3 ^c	32±6.7 ^{dc}	37±12.8 ^{dc}
90 minute	A	cm ^a	cm ^a	cm ^a	cm ^a	cm ^a	cm ^a
	B	40±11.8 ^b	51±0.8 ^{ce}	45±1.0 ^e	43±1.9 ^{ce}	43±3.0 ^{db}	42±2.9 ^c
	C	cm ^a	49±0.7 ^a	cm ^a	48±1.2 ^{ce}	cm ^b	cm ^c
	D	44±1.4 ^{ab}	42±5.3 ^e	cm ^a	47±2.2 ^e	47±4.0 ^b	51±7.5 ^d
	E	51±4.0 ^{ab}	52±2.7 ^e	56±1.8 ^{ce}	52±4.0 ^f	38±7.0 ^d	48±5.9 ^d

*Means in the same column followed by different letters were significantly different ($p < 0.05$).
cm: complete melting

Table 3. Melting properties of the ice creams during storage time (n=3)

The scores of the ice creams in terms of colour and appearance properties were between 3.6 and 4.9 during the storage time (Table 4). When the colour-appearance scores were examined it was observed that in general the scores were similar except for sample A. It was determined that ice cream A which received the lowest score of 4.6 on the first day had the lowest colour and appearance score throughout the storage compared to the other ice creams.

In terms of structure and consistency while ice cream C received the highest score of 4.5 on the first day, ice cream A received a similar score (4.5) and the for the others this was between 4.4-4.1. The structure and consistency values of ice cream A that contained salep individually had particularly decreased in the later months and even had the lowest scores on the 5th and 6th months. It is considered that this was due to the brittle and easily dissolving icy structure resulting from the ice crystals that are felt clearly while eating. In their study where they examined the effects of the stabilizers and sweeteners on the ice crystals in the ice cream, Miller-Livney & Hartel (1997) indicated that locust

bean gum and carrageenan were the most effective in retarding the growth of the ice crystals during storage.

Regarding the taste and smell properties, ice cream A received the lowest taste and smell score. It was observed that ice cream A had the most decreased during the storage time and it had the lowest approval that was 7.2 on the 6th month. Guar gum has been reported to be an agent that constrains wateriness and increases the perception of ice creams as gummy and greasy (Varela, Pintor & Fisman 2014).

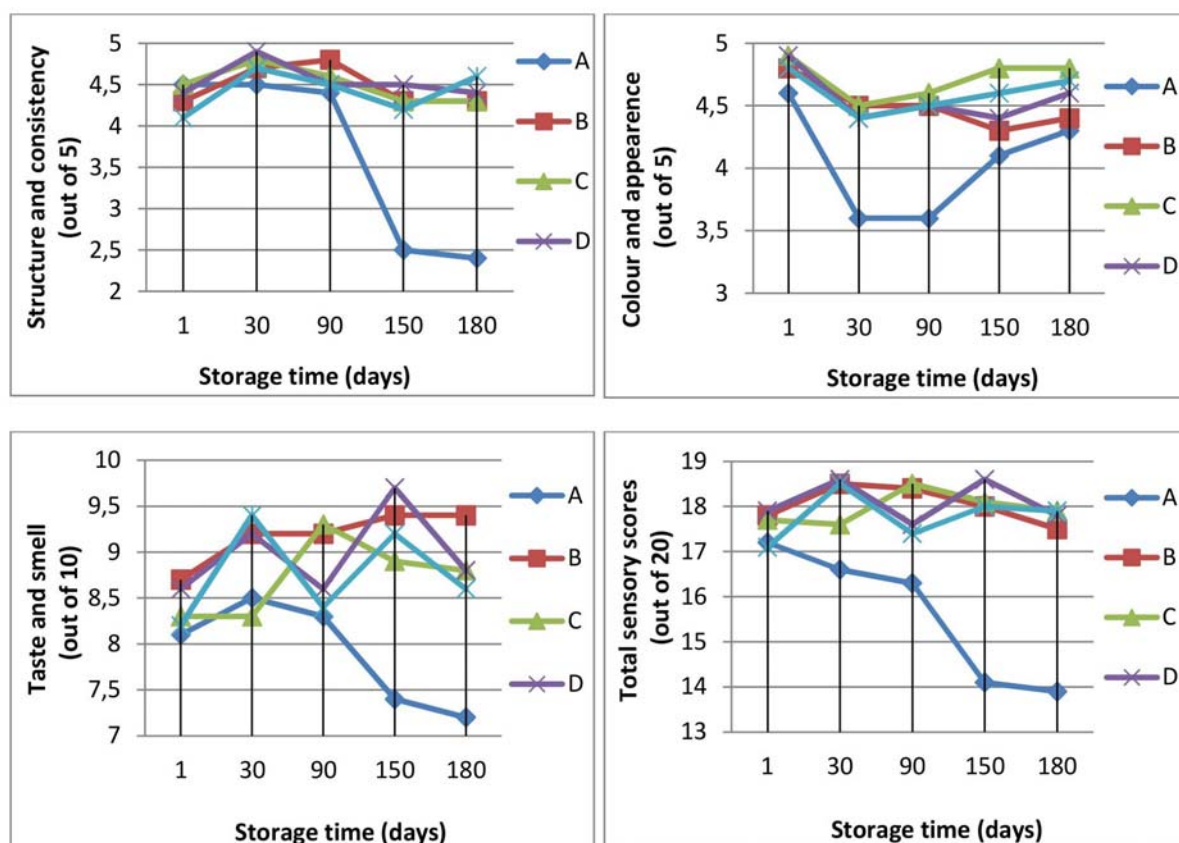


Figure 1. Changes in sensory scores of Kahramanmaraş type ice creams during storage time

When the total sensory scores were examined it was observed that ice creams B, C, D had the highest scores on the first day and 6th month of the storage. It was found out that the differences between the sensory properties score of the ice creams were not significant according to the Kuruskal-Wallis test and also the differences during the storage time were not significant ($p > 0.05$). Guven, Karaca & Kacar (2003) determined that ice creams produced using only salep extract received relatively low scores in terms of the total sensory scores. In addition, it was observed that especially starting from the 1st month of storage negative changes had occurred in the sensory properties of the ice creams. When the sensory properties were evaluated in general, it was concluded that compared to the individual use of salep in ice creams using stabilizer combinations would create a more positive effect.

4. CONCLUSION

An overall evaluation leads to the conclusion that instead of using only one stabilizer in the production of ice cream it would be more appropriate to use mixtures of suitable stabilizers and that locust bean gum could take place within this combination. As the locust bean gum is industrially cheaper this

would lead to a more economic dimension of the product and locust bean that is widely grown in the Mediterranean Region would receive the necessary economical value it deserves.

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