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RESEARCH ARTICLE

The effect of the stabilizer mixture containing konjac gum on the some quality properties of Kahramanmaraş type ice cream

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Konjak sakızı içeren stabilizatör karışımlarının Kahramanmaraş tipi dondurmanın bazı kalite niteliklerine etkisi

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Öz

Amaç: Araştırma, konjak sakızı içeren stabilizatör karışımlarının Kahramanmaraş tipi dondurmanın bazı kalite niteliklerine etkisini belirlemek amacıyla yapıldı.

Gereç ve Yöntem: Araştırmada, salep karışımı (% 0.7) kullanılan bir kontrol grubu ve konjak sakızını % 10, 15 ve 20 oranında içeren stabilizatör karışımının % 0.55 düzeyinde kullanıldığı 3 deneme grubu oluşturuldu. Dondurma karışımları üretimden önce, dondurma numuneleri ise üretimden sonra muhafazalarının 1., 15. ve 30. günlerinde analizlere tabi tutuldu.

Bulgular: Dondurma karışımlarında konjak sakızının viskozite değerlerini katılma oranına paralel olarak arttırdığı (P<0.05) belirlendi. Konjak sakızını % 10 oranında içeren stabilizatör karışımının, dondurma karışımının hacim genişlemesini salep içeren karışıma göre önemli düzeyde (P<0.05) yükselttiği, konjak sakızını % 15 ve 20 oranında içeren stabilizatör karışımlarında ise hacim genişlemesinin salep içeren karışımla benzer düzeyde olduğu tespit edildi. Dondurma numunelerinin tamamen erime süreleri incelendiğinde konjak sakızını % 20 oranında içeren stabilizatör karışımının salepli gruba göre yaklaşık 3 dakika daha geç eridiği, % 15 düzeyinde bulunmasının ise salep içeren karışımla benzer duruma getirdiği saptandı. Duyusal analizler sonucunda toplam puanlar değerlendirildiğinde, konjak sakızını % 15 oranında içeren stabilizatör karışımıyla yapılan grubun salep karışımı içeren grup ile diğer gruplardan önemli düzeyde (P<0.05) iyi olduğu belirlendi.

Öneri: Kahramanmaraş tipi dondurma üretiminde % 0.55 düzeyinde, konjak sakızını % 15 oranında içeren sodyum karbosimetil selüloz, keçiboynuzu sakızı ve karragenan kombinasyonu stabilizatör karışımı kullanımının salep karışımına alternatif olabileceği kanaatine varıldı.

Anahtar kelimeler: Kahramanmaraş tipi dondurma, Konjak sakızı, Salep, Nitelik

Abstract

Aim: The research was carried out to determine the effect of stabilizer mixtures containing konjac gum on some qualities of Kahramanmaraş type ice cream.

Materials and Methods: This study consisted of a control group which included a salep mix (0.7%) and trial groups including 0.55% stabilizer mix (with 10%, 15% and 20% konjac gum) were created. The ice cream mixes were analyzed before production; the ice cream samples were analyzed on days 1, 15, and 30 of storage period after production.

Results: Konjac gum increased the viscosity levels of the ice cream mixes (P<0.05) in direct proportion to the amount in the mix. It was determined that the stabilizer mix containing 10% of konjac gum increased the overrun of the ice cream mix significantly (P<0.05) compared to the mix containing salep, while the overrun levels for the stabilizer mixes with 15% and 20% konjac gum were similar to the salep mix. Total melting times of the ice creams revealed that the stabilizer mix containing 20% konjac gum melted approximately 3 minutes later than the salep group, and that the 15% mix produced similar results with salep. An evaluation of all the scores after sensory analyses determined that the group produced with the stabilizer mix containing 15% konjac gum was significantly better (P<0.05) than the mix containing salep.

Conclusion: It was determined that the use of a stabilizer mixture of sodium carboxymethyl cellulose, locust bean gum and carrageenan combination with 15% konjac gum, at 0.55% level, in Kahramanmaraş type ice cream could be an alternative to salep mixture.

Keywords: Kahramanmaraş type ice cream, Konjac gum, Salep, Characteristic

Introduction

Salep, as an ice cream stabilizer, is preferred in Turkey due to the good qualities it imparts the ice cream (e.g. chewy elastic -hard, flexible- texture, melting-resistance, and ability to keep for long periods at low temperatures). It is used on its own or with other stabilizers (e.g. sodium carboxymethyl cellulose, locust bean gum, carrageenan) (Tekinsen and Tekinsen 2008). Salep's use as a food additive is unique to Turkey. Its chemical composition and qualities differ, especially according to species, which affects the qualities of the ice cream. High-quality salep, in other words, glucomannan-rich salep, is generally used in ice cream manufacturing at a ratio of 7-8 g per liter of milk (Tekinsen and Karacabey 1984, Tekinsen and Tekinsen 2008).

Salep has an important role in the production of Kahramanmaraş type ice cream, but the fact that it is not suitable to be used alone, both economically and because of its different functional character (Tekinsen and Karacabey 1984, Kayaciger and Dogan 2006, Tekinsen 2006), forced scientists to reduce production costs and to conduct research to improve quality, especially in terms of body-texture, mass, and melt-resistance.

As a result of research conducted by Tekinşen and Karacabey (1984) with TUBITAK's support, stabilizer ingredient mixes and ice cream mix formulas that contained salep, which has an important role in increasing the reputation of Kahramanmaraş type ice cream, were determined. By implementing this knowledge, a contribution was made to the development of the ice cream industry in Kahramanmaraş and other provinces (Tekinsen 2006). The wild orchid species that are collected to obtain salep are endangered. To protect the species, the collection and trade of salep must be regulated (Sezik 1984, Kreutz 2002). Thus, it is necessary to cultivate and encourage the use of plants that contain glucomannan, which is the active ingredient of salep (Tekinsen et al 2011).

Konjac gum is used in the food industry of many countries in recent years, due to its high levels of glucomannan and the fact that the plant it is obtained from can be cultivated (Renewable Bioproducts Research in Europa 2001, Chan 2003, Zhang el al 2005, Yhang and Zhu 2006). Commercial salep contains 12-44% glucomannan, based on the species and location (Sezik 1967). Konjac gum, which is a food additive of natural origin and produced on an industrial scale [E 425(i)] contains ⍰75% glucomannan (Turkish Food Codex 2002).

Konjac gum, is a natural polysaccharide obtained from the dried tubers of konjac plants (A. konjac K. Koch, A. bulbifer Bl., A. oncophyllus Prain ex Hook. f., A. variabilis Blume) that are cultivated in southeastern Asian countries, Japan, and southeastern China (Takigami 2000, Bryan 2005, Hongu et al 2005). Konjac gum, which is obtained in powder form through extraction from konjac flour and also known as konjac, konjac mannan, and konnyaku (Food Chemicals Codex 2004), is an important part of konjac products, and is used on its own or with other hydrocolloids to impart viscosity and textural features in the food industry, in the production of various foods due to its rich glucomannan content. Konjac gum is a white, odorless, tasteless, amorphous and neutral polysaccharide (Renewable Bioproducts Research in Europa 2001, Chan 2003, Huang and Lin 2004).

Konjac gum is generally used for various functions in the production of various foodstuffs at a ratio of 0.2-0.5% (Renewable Bioproducts Research in Europa 2001, Chan 2003). The FAO/WHO food additives expert committee published a report (Codex Alimentarius Commission 2003) stating that konjac gum has gelifying, thickening, and stabilizing properties. When konjac gum is used on its own or with other stabilizer materials (sodium carboxymethyl cellulose, locust bean gum, carrageenan, xanthan gum), it is reported to increase viscosity to protect ice cream against melting and softening. In addition to its physical properties, it also contributes to sensory characteristics (Renewable Bioproducts Research in Europa 2001, Akesowan 2008, Tekinsen et al 2011).

There is only a limited body of research about suitable stabilizer substances and / or mixes that can be used instead of salep (Tekinsen and Karacabey 1984, Guven et al 2002, Guven et al 2003a, Guven et al 2003b, Keceli and Konar 2003, Tekinsen et al 2011). This study was conducted to determine the possibility of using suitable mixes of konjac gum [E 425(i)], which contains the same active ingredient as salep (glucomannan) with some stabilizer ingredients (sodium carboxymethyl cellulose [E 446], locust bean gum [E 410] and carrageenan [E 407]), and their effects on ice cream properties.

Material and Methods

Manufacturing of the ice cream samples

Ice cream sample production was carried out using the Kahramanmaraş type ice cream formula (Table 1) (Tekinsen and Karacabey 1984) in a vertical batch freezer (Ugur C-40) and manufactured by the method specified by Tekinsen and Tekinsen (2008) at the Prof. Dr. O. Cenap Tekinsen Meat and Milk Products Research, Development and Application Unit of Veterinary Science Faculty of Selcuk University. Whole raw cow's milk, cream, sugar, non-fat dry milk, emulsifier (glycerol monostearate [E471]), and salep and konjac gum [E 425 (i)] mixtures (with sodium carboxymethyl cellulose [E 466], locust bean gum [E 410], carrageenan [E 407]) were used as stabilizers in the preparation of ice cream mixes. The amounts of the materials to be used in preparing the ice cream mixture were calculated by "Serum Spot Method" (Tekinsen and Tekinsen 2008) according to the percent composition

Table 1. Kahramanmaraş type ice cream formula*.

Ingredient	Amount (%)
Milk Fat	8.0
Non-fat milk dry matter	10.4
Sugar	18.0
Emulsifier	0.3

**: Out of the amount of stabilizer.*

of the mixture. In the ice cream production, 4 groups (control and experimental groups) were formed according to the stabilizer mixtures (Table 2). The contents and quantities of salep and konjac gum mixtures used in the ice cream making have been adjusted based on the information in the literature (Renewable Bioproducts Research in Europa 2001, Chan 2003, Tekinsen and Tekinsen 2008, Tekinsen et al 2011) and confirmed with the results obtained in pre-project experiments. The experimental production was conducted three times in 10 kg batches each. The ice cream samples were placed in 200-250 g polystyrene boxes for analysis.

Analyses of the samples

Analysis of the ice cream mixes before the production and ice cream samples after the production at 1, 15 and 30 th day of the stroge (-25 °C) period were done.

Viscosity values of the ice cream mix samples: Viscosity values of the samples were determined in the vis-cosity 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±0.5 °C (A&D Company Limited 2005).

Overrun levels of the ice cream mix samples: 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 follows (Marshall et al 2003).

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

Melting ratios o the ice cream samples: To determine the melting ratio, a small plastic container was weighed when empty and when filled with ice cream, and the weight of the ice cream was determined. Ice cream was 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 6, 30, 60, and 90 minutes the parts of the ice cream that melted were weighed along with the measurement cylinder, and the weight of the melted product was found. The melting ratio was calculated according to the following formula (Tekinsen and Tekinsen 2008). The first dripping and complete melting durations of the samples with equal volumes were detected during determination of the melting ratio.

$$\text{Melting ratio (\%)} = \frac{\text{weight of the melted portion}}{\text{weight of ice cream}} \times 100$$

Sensory evaluation of the ice cream samples: The sensory analyses of ice cream samples were conducted under the principles recommended by the American Dairy Science Association (2009), in terms of color-appearance, body-texture and flavor-smell qualities using the quantitative descriptive analysis (Clarke 2004) according to the 15-point scoring card specified in the Ice Cream Standard TS 4265 (Turkish Standards Institute 1992).

Statistical analysis

All the results for the samples was analyzed statistically by analysis of variance with Duncan's multiple range test. Significance was reported at $P<0.05$ in the tables (Steel and Torrie 1981). SPSS Statistic Package Programme (10.0; SPSS Inc., Chicago, IL, USA) was used.

Table 2. Stabilizer mixture groups and amounts

Group	Stabilizer mixture		Amount (%)
Control*	Salep	(30)	0.70
	Sodium carboxymethyl cellulose.	(49)	
	Locust bean gum	(12.5)	
	Carrageenan	(8.5)	
Experimental I	Konjac gum	(10)	0.55
	Sodium carboxymethyl cellulose	(69)	
	Locust bean gum	(12.5)	
	Carrageenan	(8.5)	
Experimental II	Konjac gum	(15)	0.55
	Sodium carboxymethyl cellulose	(64)	
	Locust bean gum	(12.5)	
	Carrageenan	(8.5)	
Experimental III	Konjac gum	(20)	0.55
	Sodium carboxymethyl cellulose	(59)	
	Locust bean gum	(12.5)	
	Carrageenan	(8.5)	

( ) in the figures indicate the percentage of the stabilizer mixture.
**: Kahramanmaras type ice cream stabilizer mixture*

Results

Studies concerning the suitable stabilizer and / or mixtures which may be used in Kahramanmaras type ice cream production are very rare. Viscosity values and overrun levels of ice cream mixes prepared with salep and konjac mixtures are presented in Table 3. The melting ratios and sensory evaluation findings are presented in Table 4 and 5, respectively.

Discussion

The viscosity levels of ice cream mix samples were significantly lower (P<0.05) in groups containing 10%, 15%, and 20% konjac gum (I, II, III) (548, 590, and 786 cP, respectively) compared to group containing salep mix (848 cP). Additionally, increasing the amount of konjac gum in stabilizer mixes in the trial groups increased the viscosity levels (P<0.05) (Table 3). The results are consistent with research suggesting that as the amount of konjac gum, which has higher viscosity imparting characteristics than any other natural hydrocolloid, in combination with sodium carboxymethyl cellulose, is increased, the viscosity will increase (Takigami 2000). The fact that the viscosity level of the control group was higher than all other groups (848 cP) may be due to the higher amount of salep mix used compared to the konjac gum mixes. Indeed, researchers also report that as the stabilizer ratio increases, the viscosity of the ice cream mix increases (Marshall et al 2003, Tekinsen and Tekinsen 2008). The group using the stabilizer mix that contains 10% konjac gum (I) exhibited significantly higher (P<0.05) overrun (19.68%) than the control group (16.93%). Adding 15% and 20% konjac gum to the stabilizer mix (groups no II and III) brought the overrun levels to the group that contains the salep mix (Table 3). The fact that the overrun in group I was higher than other groups may be associated with the lower viscosity of the mix prepared with this combination. The dry matter levels of the mix that is processed in batch freezers, and the strength of the stabilizer ingredient (high gel strength and viscosity-imparting properties) makes the structure gummy and heavy, which causes overrun to be reduced (Tekinsen and Tekinsen 2008). Moreover, Takigami (2000) reports that viscosity levels decrease as the amount of konjac gum is decreased in stabilizer mixes containing konjac gum. The results were different from the results of researchers (Guven et al 2003a, Keceli and Konar 2003, Tekinsen et al 2011) who studied the effects of various stabilizer ingredients and / or combinations against salep. As reported by some researchers (Tekinsen and Karacabey 1984, Guven et al 2002, Marshall et al 2003, Tekinsen and Tekinsen 2008), this is probably due to the fact that stabilizer ingredients are used in different amounts and / or combinations in ice cream production, the total dry matter levels of the mix added to the ice cream, and the use of different ice cream machines.

Table 3. Viscosity values and overrun levels of ice cream mixes

Group	Viscosity (cP)	Overrun (%)
Control	847.66±3.93^{a*}	16.93±1.50^{b*}
Experimental I	547.66±7.54^{d}	19.68±0.35^{a}
Experimental II	590.00±6.56^{c}	17.83±0.95^{ab}
Experimental III	786.67±6.96^{b}	17.46±0.94^{b}

*a-d Values in a column which do not share a common superscript are statistically different. *: P<0.05*

The results for the first drop and 30-minute melting ratios for ice cream samples in storage (Table 4) revealed that the first drop times in groups II and III containing 15 and 20% konjac gum were significantly higher (P<0.05) than the salep group. The 30-minute melting ratio was lower, proportional to the first drop times (P<0.05). It was observed that the stabilizer mix containing 10% konjac gum (I) brings the first drop time and 30-minute melting ratio to the same level as the salep mix containing group. The 60-minute melt ratios revealed that in group III, the melting ratio was low during storage, as it was at the 30-minute melt ratios; it was high in groups I and II (P<0.05) or similar to the control group containing salep. Total melting durations had a similarity and difference trend like the first dripping times (Table 4). Changes in the melting periods and ratios of the groups revealed that this characteristic is particularly associated with the viscosity and overrun properties of the mix used to prepare the groups (Table 3). The melt-resistance of ice cream depends on the amount of dry matter, low overrun and gelation concerning stabilizer systems (Marshall et al 2003, Muse and Hartel 2004, Tekinsen and Tekinsen 2008). General evaluation of the results: The fact that trial groups II and III melted less and much later may be associated with the increased viscosity-imparting capabilities that increase with the amount of konjac gum (Takigami 2000). While the melting ratios of ice cream samples at 30 and 60 minutes are consistent with the modified ice cream samples produced by some researchers (Tekinsen and Tekinsen 2008, Tekinsen et al 2011), they were lower or higher than the melting properties of experimental ice cream mixes prepared by others (Guven et al 2002, Guven et al 2003a, Guven et al 2003b, Keceli and Konar 2003, Simsek et al 2006). This may be associated with the fact that the experimental ice cream mixes of Tekinşen and Karacabey (1984) and Tekinşen et al (2011) used the same ice cream mix with synergic stabilizer ingredient combinations, while others prepared their ice cream with different total dry matter levels using different stabilizers.

Sensory evaluations revealed that the group made with the stabilizer ingredient mix with 15% konjac gum (II) scored significantly higher (P<0.05) than the group containing salep mix on day 30 of storage, while it scored similarly to salep on days 1 and 15 (Table 5). On day 30 of storage, the mixes

Table 4. Melting rates of ice cream samples

Day	Group	First dripping (min)	Melting ratios (%) 30. min	60. min	Total melting (min)
1.	Control	16.24±0.51^{c*}	11.55±0.56^{a*}	65.08±1.20^{b*}	85.65±0.60^{b*}
	Experimental I	14.61±0.60^{c}	12.07±0.11^{a}	68.93±0.35^{a}	81.95±0.26^{c}
	Experimental II	20.60±0.52^{b}	7.80±0.18^{b}	67.92±0.14^{a}	85.57±0.92^{b}
	Experimental III	25.46±1.04^{a}	6.87±0.31^{b}	61.65±0.46^{c}	88.66±0.44^{a}
15.	Control	17.48±0.30^{c*}	10.93±0.54^{a*}	64.99±0.90^{b*}	85.77±1.05^{b*}
	Experimental I	15.02±0.46^{d}	11.92±0.73^{a}	68.55±0.22^{a}	82.40±0.46^{c}
	Experimental II	21.26±0.74^{b}	7.74±0.18^{b}	67.36±0.29^{a}	86.10±1.60^{b}
	Experimental III	25.92±1.18^{a}	6.75±0.34^{b}	60.88±0.52^{c}	88.93±0.77^{a}
30.	Control	17.60±0.20^{c*}	10.86±0.56^{a*}	65.53±1.32^{b*}	85.96±0.66^{b*}
	Experimental I	15.33±0.42^{c}	11.92±0.21^{a}	68.43±0.32^{a}	82.58±0.44^{c}
	Experimental II	21.40±0.67^{b}	7.66±0.21^{b}	67.22±0.29^{ab}	86.61±0.84^{b}
	Experimental III	26.06±1.20^{a}	6.67±0.35^{b}	60.77±0.47^{c}	88.84±0.08^{a}

*a-d Values in a column which do not share a common superscript are statistically different. *: P<0.05*
Note: None of the ice cream samples melted in six minutes.

containing 15 and 20% konjac gum (II and III) significantly improved (P<0.05) the color-appearance characteristics. The results are different than those of ice cream samples prepared with salep and / or combinations or with different stabilizer ingredients (Tekinsen and Karacabey 1984, Guven et al 2003a, Guven et al 2003b, Tekinsen et al 2011). As reported by the researchers (Tekinsen and Karacabey 1984, Tekinsen and Tekinsen 2008, Tekinsen et al 2011), this may be associated with the fact that the dry matter level of the ice cream mix, the quality of salep and other stabilizers, the level

Table 5. Sensory evaluation of ice cream samples

Day	Group	No Criticism: 5 / Normal Score: 1-5 Color-Appearance	Body-Texture	Flavor-Smell	Total score
1.	Control	4.86±0.03^{ab*}	4.40±0.06^{c*}	4.40±0.06^{b*}	13.66±0.14^{b*}
	Experimental I	4.76±0.03^{b}	4.26±0.03^{d}	4.70±0.06^{a}	13.73±0.06^{b}
	Experimental II	4.96±0.06^{a}	4.63±0.03^{b}	4.50±0.06^{ab}	14.10±0.06^{a}
	Experimental III	4.90±0.06^{ab}	4.80±0.01^{a}	3.80±0.12^{c}	13.50±0.06^{b}
15.	Control	4.90±0.06^{a*}	4.33±0.03^{b*}	4.13±0.22^{b*}	13.36±0.18^{b*}
	Experimental I	4.60±0.01^{b}	4.30±0.06^{b}	3.96±0.03^{b}	12.86±0.03^{c}
	Experimental II	4.86±0.03^{a}	4.70±0.06^{a}	4.80±0.06^{a}	14.36±0.14^{a}
	Experimental III	4.20±0.06^{c}	4.60±0.06^{a}	3.90±0.06^{b}	12.70±0.17^{c}
30.	Control	4.66±0.03^{b*}	3.80±0.06^{b*}	3.50±0.06^{c*}	11.96±0.14^{c*}
	Experimental I	4.20±0.06^{c}	3.86±0.03^{b}	4.23±0.03^{b}	12.30±0.12^{c}
	Experimental II	4.96±0.33^{a}	4.56±0.03^{a}	4.70±0.06^{a}	14.22±0.08^{a}
	Experimental III	4.86±0.06^{a}	3.80±0.06^{b}	4.10±0.06^{b}	12.76±0.13^{b}

*a-d Values in a column which do not share a common superscript are statistically different. *: P<0.05*

of use, and the interaction between stabilizer ingredients affect some sensory properties.

The body-texture scores of ice cream samples revealed that the group made with the stabilizer ingredient mix with 15% konjac gum (II) scored significantly higher ($P<0.05$) than the group containing salep mix on day 30 of storage, while it scored similarly to salep on days 1 and 15 (Table 5). The mix containing 20% konjac gum (III) significantly improved ($P<0.05$) the body and texture properties on days 1 and 15 of storage; however, 10% konjac gum decreased ($P<0.05$) the body and texture properties on day 1 of storage, but brought them to similar levels on other days (Table 5). This may be associated with the use of konjac gum with suitable amounts of synergistic stabilizer ingredients (Imeson 2000, Takigami 2000) and the fact that salep has a much lower (<50%) gluco-mannan content than konjac gum (Tekinsen et al 2011).
The evaluation of ice cream samples in terms of flavor-smell scores during storage revealed that 15% konjac gum in the stabilizer ingredient mix (II) made significant improvements ($P<0.05$) compared to the salep mix group, and that the flavor-smell characteristics were differently affected in groups with 10% and 20% konjac gum (II, III) (Table 5). Other researchers (Tekinsen and Karacabey 1984, Tekinsen et al 2011, Guven et al 2003b, Keceli and Konar 2003) have also reported that ice cream samples made with salep scored lower than other ice cream samples made with stabilizers of plant origin and / or combinations.

Sensory analyses revealed that the group prepared with the stabilizer ingredient mix containing 15% konjac gum was perceived to be better ($P<0.05$) in terms of total sensory score throughout storage. This may be associated with the fact that group II was perceived to be better in other qualities as well, throughout storage.

Conclusion

In conclusion, it was determined that the ice cream mix that contains 0.55% of a stabilizer mix combining sodium carboxymethyl cellulose, locust bean gum and carragenan with 15% konjac gum makes the overrun level and total melting duration of the ice cream mix similar with the control group, and that it significantly improves its sensory properties. This stabilizer mix can be used in Kahramanmaraş type ice cream production as an alternative to salep, to protect the orchid species that are endangered and randomly collected today.

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