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Research Paper / Araştırma Makalesi

Effect of Storage and Some Hydrocolloid Blends on Physicochemical, Textural and Sensory Characteristics of Keşkül, a Dairy Dessert

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ABSTRACT

In this study, the effect of different hydrocolloid combination and storage period on physicochemical, textural and sensory characteristics of keşkül, a dairy dessert, was determined. Guar gum-xanthan gum, carrageenan-guar gum and carrageenan-xanthan gum combinations were assessed as hydrocolloid combinations in keşkül production. Some physicochemical, textural, and sensory properties were determined on the days of 1, 5 and 10 of storage. Keşkül samples containing carrageenan had higher hardness and springiness values than the other samples at the end of storage. The highest water holding capacity was detected in keşkül samples with carrageenan and guar gum at the beginning of storage. Syneresis values of keşkül were determined between 18.65 and 28.49% during storage. The variation of storage period and different hydrocolloid combination on Hunter L, a and b values were insignificant ($p>0.05$). Keşkül including a guar and carrageenan combination received the highest general appreciation score at the beginning of storage. The results indicated that hydrocolloid combination utilization in keşkül production has commercial potential in overcoming the problems related to physicochemical, textural and sensory properties.

Keywords: Dairy dessert, Hydrocolloid, Guar gum, Keşkül, Carrageenan, Xanthan gum

Sütlü Bir Tatlı Keşkülün Fizikokimyasal, Tekstürel ve Duyusal Özellikleri Üzerine Depolamanın ve Bazı Hidrokolloid Karışımlarının Etkisi

ÖZ

Bu araştırmada farklı hidrokolloid kombinasyonları kullanımının keşkülün fizikokimyasal, tekstürel ve duyusal özellikler üzerinde etkisi araştırılmıştır. Keşkül üretiminde hidrokolloid kombinasyonları olarak guar-ksantan gamı, karragenan-guar gamı ve karragenan-ksantan gamı kombinasyonları değerlendirilmiştir. Bazı fizikokimyasal, tekstürel ve duyusal özellikler depolamanın 1., 5. ve 10. günlerinde belirlenmiştir. Karragenan içeren keşkül örneklerinin depolamanın sonunda diğer örneklere göre daha yüksek sertlik ve esneklik değerlerine sahip olduğu tespit edilmiştir. Depolamanın başında en yüksek su tutma kapasitesi karragenan ve guar gamı içeren keşkül örneğinde tespit edilmiştir. Keşkülün saklama süresi boyunca sinerez değerleri %18.65 ile 28.49 arasında belirlenmiştir. Hunter L, a ve b değerlerinde depolama süresi ve farklı hidrokolloid kombinasyonlarının değişimi önemli bulunmamıştır ($p>0.05$). Guar ve karragenan kombinasyonunu içeren keşkül, depolama başlangıcında en yüksek genel beğeni puanını aldığı tespit edilmiştir. Araştırma sonuçları, hidrokolloid kombinasyon kullanımının keşkül üretiminde fizikokimyasal, dokusal ve duyusal özelliklerle ilgili problemlerin önlenmesinde ticari potansiyele sahip olduğunu göstermektedir.

Anahtar Kelimeler: Sütlü tatlılar, Hidrokolloid; Guar gam, Keşkül, Karragenan, Ksantam gam

INTRODUCTION

Dairy desserts containing milk components have a wide variety. The consumption of dairy desserts has increased significantly especially in recent years with the spread of varieties and types. The reason for this increase can be attributed to the reasons such as nutritional value and sensorial qualities of the products, their prevalence, easy accessibility and consumption in every environment [1].

There are various types of milk desserts with different characteristics. Rice pudding, kazandibi, keşkül, pudding and custard desserts are lovingly consumed in Turkey [2]. Keskül, a dairy dessert, is composed of almond, milk, rice flour, sugar and another ingredient [3].

Hydrocolloids are preferred due to their properties such as thickener in the food industry, gelling in liquid solutions, inhibiting the formation of ice and sugar crystals, and controlled release of flavor materials. They dissolve in water or swells and connects free water and increases viscosity [4]. The action of hydrocolloids varies greatly depending on the concentration and structure [5].

In the food industry, carrageenan is used as a gelling and thickener agent. There are varieties such as kappa, lambda and iota carrageenan according to the degree of sulfation [6]. Guar gum (GG) is non-ionic polysaccharide extracted from the two plants, *Cyamopsis tetragonolobus* and *Cyamopsis psoralioides* [7]. This gum is used as a thickener and stabilizer in the majority of food products. It is highly soluble in the liquid phase and can provide high viscosity [8]. Guar gum is a galactomannan and consists of D-mannose and D-galactose units [9]. Xanthan gum is an extracellular polysaccharide from *Xanthomonas campestris*. It contains linear cellulosic backbone. There is β-D-mannopyranosyl-(1→4) D-glucuronopyranosyl-(1→2)-6-O-acetyl-β-D-mannopyranosyl in the side chains [7].

In the production of dairy products, hydrocolloids may be used alone or in mixtures of two or more hydrocolloids. Tárrega et al. [10] used a low and long chain inulin mixture in the production of low-fat prebiotic desserts. The researchers determined the influence of inulin blends on rheological and sensory features depending on the presence or absence of carrageenan in the prebiotic desserts. González-Tomás et al. [11] studied the effect of starch and carrageenan on rheological properties, aroma separation, density and perceived aroma in low-fat strawberry-flavored dairy dessert. Verbeken et al. [12] investigated the textural properties of puddings with κ-carrageenan and corn starch. The effects of stevia (*Stevia rebaudiana*) as a sweetener on keşkül production were determined by Özen et al. [13].

In this research, keşkül was manufactured by using different hydrocolloid combination. The changes in the physicochemical, textural, and sensory properties of dairy dessert were monitored on the 1, 5 and 10 days.

MATERIALS and METHODS

Materials

Pasteurized milk was obtained by Sumer. Dairy Company. Vanilla, sugar, rice flour, salt, egg, almond, sugar, rice, salt used in keşkül production were purchased from a local market in Denizli, Turkey. Guar gum, carrageenan and xanthan gum were provided from Smart Chemistry and Consulting Limited Company (İzmir, Turkey).

Keşkül Production

Recipe of keskul samples included milk (1 L), vanilla (5 g), sugar (250 g), rice flour (50 g), salt (1.5 g), egg (110 g), almond (100 g) and hydrocolloid combination. For the manufacture of keşkül, raw almonds were taken into a small pot, enough water was added to cover the almonds. Almonds were left to boil on the stove at medium heat. After waiting for 1-2 minutes at boiling temperature, excess water was removed. Roasted almonds were cooled with cold water and then their shells were peeled. This formulation was beaten egg yolk and milk. Then sugar was added into this mixture. This mixture was heated up to 40°C. Hydrocolloid and rice flour were dissolved in the pre-heated mixture in a separate bowl. Production was separated into 4 groups with respect to hydrocolloid-based types. The first group was a control dairy dessert without hydrocolloid. The second group was made using guar gum (0.5 g/L milk) and (xanthan gum 0.5 g/L milk). The third group was prepared by adding carrageenan (0.5 g/L milk) and guar (0.5 g/L milk). The fourth group was produced by adding carrageenan (0.5 g/L milk) and xanthan gum (0.5 g/L milk). When temperature of milk mixture was reached 80°C on a stove at medium heat, the hydrocolloid-rice flour solution was added into milk mixture. Boiling mixture was manually stirred constantly. After the mixture was boiled for 2-3 min, it was mixed with almond, vanilla, salt. Then keşkul was transferred into cups and cooled at room temperature [3]. Samples were stored in a refrigerator.

Physicochemical Analysis

For syneresis analysis, about 10 g of samples were weighed in a centrifuge tube. Then samples were centrifugated by at 6300*g* for 30 min at 4°C [14].

Water holding capacity was measured according to Granato et al. [15]. A portion of sample was weighed in a centrifuge tube. After the tube was placed in centrifuge (Nüve 1200R, Ankara, Turkey), the tube was centrifuged by at 2767*g* for 40 minutes. A supernatant was removed, a pellet was weighed. Water holding capacity was established according to Equation 1.

Water holding capacity=Pellet weight*100/Initial sample weight (1)

Hunter L (brightness, 100=white, 0=black), a (+, red; -, green) and b (+, yellow, - a, blue) values of sample were evaluated by using to Hunter Lab Mini Scan XE model (Hunter Associates Laboratory, Reston, VA, USA)

colorimeter. Samples were placed in a glass container. After the glass plate was placed to flatten the surface, the reading was taken at room temperature.

Textural Analysis

Various textural properties were established by using Texture Analyzer (Brookfield CT3, Brookfield Engineering Laboratory, Middleboro, MA, USA) with a cylinder probe (12.7 mm diameter). This analysis was performed with using a 4.5 kg load cell and 12.7 mm diameter cylinder prob. Test speed and trigger force were assessed 2 mm/s and 0.05 N, respectively. Samples were compressed in two consecutive cycles [16].

Sensory Analysis

Sensory properties of keşkül samples were evaluated by 30 panelists from Food Engineering Department of Pamukkale University (58% female, 42% male, aged from 19 to 45). Keşkül samples were graded for their appearance, color, taste, visual consistency and general acceptability using a 9 point hedonic scale (1=dislike extremely, 9=like extremely). Before each sample was tasted, the unsalted cracker and water were served [3,17].

Statistical Analysis

Statistical analysis was evaluated using SPSS computer program for Windows, version 16 (SPSS Inc., Chicago, IL, USA). The statistical data were shown as average ± standard deviation (SD). The experimental production was carried out with replications. The effects of storage period and various formulation on the sensory, physical, and textural properties of samples were assessed by the general linear model. Statistically significant differences were established using Duncan Test at $p<0.05$ level.

RESULTS and DISCUSSION

Physicochemical Properties

Due to the water-binding property of hydrocolloids, they are also very effective in preventing syneresis, providing viscosity and / or providing a thicker, richer mouth feel [12]. Hydrocolloids have the ability to strengthen the gel structure by reacting with milk proteins [18].

Control keşkül sample had a lower water holding capacity value than that of other keşkül samples. The sample K2 (keşkül containing guar gum and carrageenan) had the highest water holding capacity at the beginning of storage period (Table 1). Water holding capacity values is related to serum syneresis. Syneresis, which is the removal of water from the structure of the food, is an undesirable property [19]. Syneresis varies depending on the factors affecting the polymer-polymer and water-polymer interactions, such as the level of heat treatment, type and amount of solids, pH, and salt additions [20].

Table 1. Physicochemical properties of keşkül during storage

Parameters	Storage Period (day)	Sample code K	K1	K2	K3
Water holding capacity	1	74.76 ± 0.98^{Ca}	84.76 ± 0.63^{Ab}	87.74 ± 1.20^{Bc}	84.71 ± 0.59^{Bb}
	5	73.26 ± 0.64^{Ba}	84.74 ± 0.69^{Ac}	84.94 ± 0.13^{Ac}	80.60 ± 0.51^{Ab}
	10	71.79 ± 0.60^{Aa}	85.36 ± 0.85^{Ac}	84.18 ± 0.69^{Ac}	80.72 ± 1.28^{Ab}
Syneresis (%)	1	23.80 ± 0.38^{Ac}	21.77 ± 0.69^{Bb}	18.65 ± 0.75^{Aa}	18.80 ± 0.32^{Aa}
	5	25.95 ± 0.54^{Bc}	22.93 ± 0.72^{Cb}	20.33 ± 0.21^{Ba}	20.09 ± 0.56^{Ba}
	10	28.49 ± 0.49^{Cb}	19.52 ± 0.45^{Aa}	20.10 ± 0.83^{Ba}	19.74 ± 0.28^{Ba}
L	1	73.16±0.96	68.89±0.36	66.68±1.51	71.11±0.04
	5	72.62±0.77	69.63±0.91	68.53±0.52	68.13±1.71
	10	71.61±0.87	69.75±0.42	67.76±2.15	68.07±0.73
a	1	-0.35±0.30	-0.64±0.45	-0.78±0.62	-0.72±0.16
	5	-1.06±0.81	-0.83±0.04	-0.43±0.01	-0.97±0.34
	10	1.13±0.80	-0.60±0.42	-0.76±0.55	-1.38±0.25
b	1	13.99±0.94	12.16±0.49	12.08±0.79	12.33±0.54
	5	13.38±1.35	12.65±0.59	14.19±0.17	11.61±0.16
	10	12.63±0.38	13.05±0.27	13.11±1.31	12.02±0.41

K: Control sample; K1: keşkül including a guar gum and xanthan gum combination; K2, keşkül including a guar gum and carrageenan combination; K3, keşkül containing a carrageenan and xanthan gum combination. Means with different letters $^{(A-C)}$ within each parameter in the same column indicate statistical significance ($p<0.05$). Means with different letters $^{(a-c)}$ within each parameter in the same row indicate statistical significance ($p<0.05$).

Keşkül sample produced with guar gum-carrageenan combination had a lower syneresis value than other samples at the beginning of storage. The syneresis value of keşkül was affected by storage and different hydrocolloid combination. Moin et al. [19] reported that syneresis was not detected in puddings prepared with hydroxy propylated starches and native basmati starch. Dogan et al. [21] studied the creep-recovery properties of pudding samples prepared with 4 different gums (carrageenan, alginate, guar and xanthan gum) and their combinations. They found that 59.5% carrageenan and 40.5% guar gum or 52.7% carrageenan, 33.8% guar gum and 13.5% xanthan gum could be appropriate suitable to prevent deformation of the pudding samples.

Color is another physicochemical property. Hunter L, a and b values weren't influenced significantly by storage period and different formulation ($p>0.05$). The Hunter L

value of samples ranged from 66.68 to 73.16. It has been determined that the samples had generally negative a value (green color). The b values of this study display positively values. The color values of vanilla dairy dessert prepared from different colorants and different hydrocolloids were measured by Tárrega and Costell [22]. *L**, *a** and *b** ranges of their study were detected between 76.6-88.5, (-4.70)- (+6.8) and 30.4-41.00, respectively. Özen et al. [13] reported that the L*, a* and b* ranges of keşkül production using stevia were 81.40-85.41, -3.361-4.955 and 17.915-22.631, respectively.

Textural Properties

Rheological properties ensure the acceptability of dairy desserts. κ-Carrageenan is one of the hydrocolloids often used as a gelling agent in dairy desserts [23]. The effects of different formulation and storage period on textural properties were significant ($p<0.05$).

Texture is a quality criterion in which the structural, mechanical and surface properties of foods are determined by sight, hearing, touch and kinesthetic means. There is a close relationship between textural parameters and sensory parameters. Hardness is a property related to the strength of the gel structure and the maximum force required to compress the food between the molar teeth [24]. Hardness is one of the most important textural properties that give information about the quality of dairy products and acceptability of the product [25].

The highest hardness and gumminess were determined sample K3 (carrageenan and xanthan gum) at the beginning of storage. The control sample had the highest springiness and gumminess values. The highest cohesiveness value was obtained for dessert with guar gum and xanthan gum on the 1st and 5th days of the storage period (Table 2).]. Samples prepared containing carrageenan had a higher hardness value compared with other samples. Carrageenan creates a thickening effect by interacting with the casein micelles in milk, and this effect in milk has an effect up to 10 times more than in water [26]. Szwajgier and Gustaw [27] found that the hardness and adhesiveness value of milk dessert prepared from different concentration malt were 0.16-0.34 N and 0.11-0.49 mJ. The hardness value of keşkül sample was in agreement with data obtained by and Zarzycki et al. [26] and Szwajgier and Gustaw [27].

Table 2. Textural properties of keşkül during storage period

Analysis	Storage Period (day)	Sample Code			
		K	K1	K2	K3
Hardness (N)	1	0.086 ± 0.01^{Aa}	0.205 ± 0.02^{Bb}	0.345 ± 0.03^{Bc}	0.510 ± 0.01^{Bd}
	5	0.089 ± 0.01^{Aa}	0.218 ± 0.01^{Bc}	0.245 ± 0.04^{Ac}	0.165 ± 0.02^{Ab}
	10	0.090 ± 0.02^{Aa}	0.154 ± 0.01^{Aa}	0.338 ± 0.05^{Bb}	0.381 ± 0.13^{Bb}
Springiness (mm)	1	7.16 ± 0.40^{Ba}	12.26 ± 0.77^{Bb}	12.56 ± 0.40^{Ab}	12.76 ± 0.15^{Bb}
	5	7.84 ± 0.03^{Ca}	11.53 ± 0.35^{Bb}	12.73 ± 0.75^{Ac}	12.83 ± 0.40^{Bc}
	10	5.64 ± 0.26^{Aa}	9.60 ± 0.60^{Ab}	11.86 ± 0.74^{Ad}	10.86 ± 0.06^{Ac}
Gumminess (N)	1	0.045 ± 0.01^{Ba}	0.125 ± 0.02^{Cb}	0.207 ± 0.02^{Bc}	0.269 ± 0.01^{Cd}
	5	0.058 ± 0.01^{Ca}	0.098 ± 0.01^{Bb}	0.106 ± 0.01^{Ab}	0.217 ± 0.01^{Bc}
	10	0.033 ± 0.01^{Aa}	0.073 ± 0.01^{Ab}	0.123 ± 0.04^{Ac}	0.096 ± 0.01^{Abc}
Cohesivenes	1	0.52 ± 0.01^{Ca}	0.63 ± 0.01^{Bb}	0.55 ± 0.04^{Ba}	0.55 ± 0.01^{Ba}
	5	0.49 ± 0.01^{Ba}	0.58 ± 0.04^{Bb}	0.52 ± 0.01^{Aa}	0.51 ± 0.01^{Aa}
	10	0.43 ± 0.01^{Aa}	0.49 ± 0.01^{Ab}	0.49 ± 0.01^{Ab}	0.51 ± 0.01^{Ab}

K: Control sample; K1: keşkül including a guar gum and xanthan gum combination; K2, keşkül including a guar gum and carrageenan combination; K3, keşkül containing a carrageenan and xanthan gum combination. Means with different letters $^{(A-C)}$ within each analysis in the same column indicate statistical significance ($p<0.05$). Means with different letters $^{(a-d)}$ within each analysis in the same row indicate statistical significance ($p<0.05$).

Wang et al. [28] reported that the hardness, chewiness, resilience and adhesiveness of κ-carrageenan gel increased with an increase of κ-carrageenan concentration. They determined that medium hardness, chewing and flexibility can be acquired by using 1.5 g/kg carrageenan-konjac gum mixture for milk pudding. Hardness, springiness, gumminess and cohesiveness values of keşkül varied in the ranges 0.086-0.510N, 5.64-12.83 mm, 0.033-0.269N and 0.43-0.63, respectively. Zarzycki et al. [26] found that the hardness, cohesiveness, gumminess and chewiness value of milk dessert were 0.320-0.557 N, 0.491-0.647, 20.1-30.23 N and 16.7-28.38 J. The textural properties of keşkül samples mostly decreased during storage period. In a study, Özen et al. [13] reported that the hardness, fracturability, adhesiveness, chewiness values in keşkül with stevia decreased on the 10th day of storage, while resilience and cohesiveness increased when compared to the 1st day.

Sensory Properties

The effects of storage period and different treatment on the sensory properties of samples were found to be significant in the present study ($p<0.05$). The highest color score was obtained for carrageenan-xanthan gum combination in keşkül production on the 5th and 10th days of storage. Control keşkül showed the lower taste score among all the keşkül samples at the beginning of storage (Table 3). Visual consistency of sample slightly decreased at the 5th day, it decreased significantly at the 10th day of storage. While the sensory scores of samples were over 7 at the beginning of storage, their sensory

scores were over 6 (except color scores of K2 coded sample) at the end of storage.

At the end of storage, sample using guar and carrageenan gum had the highest appearance score. Keşkül produced with guar-xanthan gum combination exhibited the highest general acceptability score, followed by that produced with guar–carrageenan combination at the 5th day.

Table 3. Sensory properties of keşkül during storage period

Parameters	Storage period (day)	Sample code[b]			
		K	K1	K2	K3
Color	1	7.50±1.10^{Ba}	8.20±0.41^{Cbc}	8.00±0.64^{Cb}	8.50±0.68^{Ac}
	5	7.70±0.80^{Ba}	7.80±0.41^{Ba}	7.40±0.82^{Ba}	8.80±0.41^{Ab}
	10	6.45±0.82^{Ab}	6.60±0.68^{Ab}	5.80±0.76^{Aa}	8.80±0.41^{Ac}
Appearance	1	7.70±0.86^{Ba}	7.75±0.85^{Bab}	8.10±0.64^{Cb}	8.15±0.74^{Bb}
	5	7.35±0.74^{Ba}	7.50±0.68^{Ba}	7.30±0.92^{Ba}	7.70±0.80^{Ba}
	10	6.30±0.86^{Aa}	6.10±0.55^{Aa}	6.20±0.61^{Aa}	7.00±0.85^{Ab}
Taste	1	7.80±0.76^{Ba}	8.40±0.60^{Bb}	8.10±0.71^{Cab}	8.35±0.54^{Bb}
	5	7.40±0.60^{Ba}	8.10±0.71^{Ab}	7.40±0.68^{Ba}	8.00±0.79^{Bb}
	10	6.20±0.83^{Aa}	6.70±0.92^{Aa}	6.35±0.74^{Aa}	6.60±0.59^{Aa}
Visual Consistency	1	8.15±0.67^{Ca}	8.30±0.65^{Bab}	8.00±0.45^{Ba}	8.60±0.50^{Cb}
	5	7.90±0.55^{Bb}	8.10±0.71^{Bb}	7.70±0.65^{Bb}	7.25 ±0.55^{Ba}
	10	6.30±0.80^{Aa}	6.20±0.76^{Aa}	6.70±0.92^{Aa}	6.15±0.87^{Aa}
General Appreciation	1	7.85±0.67^{Ca}	8.30±0.65^{Cbc}	8.50±0.51^{Cc}	8.05±0.60^{Cab}
	5	6.85±0.93^{Ba}	7.75±0.44^{Bc}	7.40±0.50^{Bbc}	7.15±0.87^{Bab}
	10	6.00±0.79^{Aa}	6.00±0.65^{Aa}	6.00±0.65^{Aa}	6.05±0.99^{Aa}

K: Control sample; K1: keşkül including a guar gum and xanthan gum combination; K2, keşkül including a guar gum and carrageenan combination; K3, keşkül containing a carrageenan and xanthan gum combination. Means with different letters $^{(A-C)}$ within each parameter in the same column indicate statistical significance ($p<0.05$). Means with different letters $^{(a-c)}$ within each parameter in the same row indicate statistical significance ($p<0.05$).

General acceptability of samples was similar at the end of storage. General acceptability of sample without hydrocolloid was lower than that of samples with hydrocolloid. Consistent with the present study results, Krasaekoopt and Cabraal [29] reported that sensory features of fermented whey beverage were positively influenced by using hydrocolloid. Rezaei et al. [30] found that guar and arabic gum had a significant impact on sensory parameters (flavor, texture and acceptability) of frozen yoghurt.

CONCLUSION

The use of hydrocolloid combination caused a significantly rise in water holding capacity of the keşkül samples, but reduced their syneresis value. The keşkül samples containing carrageenan (K2 and K3) had a higher springiness value on the 5th and 10th days of storage. The highest scores were given to samples with carrageenan and xanthan gum combination for hardness and gumminess value at the beginning of the storage period. The samples had generally negative color a value (green color) and positive color b (yellowness) value. The lowest general acceptability score was evaluated at the control sample through storage period.

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CONFLICTS of INTEREST

The authors declare no conflict of interest.

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