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Use of oriental spruce gum (*Picea orientalis* (L.) Link) in gluten-free milk-based dessert

Berrak DELIKANLI KIYAK[1,*], Tulay OZCAN[2]

[1] *Bursa Uludag University, Department of Food Processing, Vocational School of Iznik, Bursa.*
[2] *Bursa Uludag University, Department of Food Engineering, Bursa*

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Abstract

In this research, the usability of oriental spruce gum (Picea orientalis (L.) Link) as a texture improver in the production of gluten-free milk-based custard was investigated. The produced custards were investigated in terms of color, texture, and sensory properties. As a result, it was detected that oriental spruce gum usage in the production of milk-based custard was not liked due to sensorial acceptability despite the development of the technological properties of the product in terms of physical and chemical properties. Moreover, it was detected that the product's attractiveness in terms of taste and visual is less than the control sample. However, the addition of subye in production in innovation studies can contribute to increasing awareness in the literature and providing product diversity, especially for celiac patients.

Keywords: *Picea orientalis* (L.) Link*, gluten-free food, dairy dessert, oriental spruce gum.*

Glutensiz süt bazlı tatlıda Çam sakızının (*Picea orientalis* (L.) Link) kullanımı

Öz

Bu araştırmada, çam sakızının (Picea orientalis (L.) Link) glutensiz süt bazlı muhallebi üretiminde tekstür geliştirici olarak kullanılabilirliği araştırılmıştır. Üretilen muhallebiler renk, tekstür ve duyusal özellikler açısından incelenmiştir. Sonuç olarak süt

[*]Berrak DELİKANLI-KIYAK, bdelikanli@uludag.edu.tr, http://orcid.org/0000-0001-8093-3369
Tülay Özcan, tulayozcan@uludag.edu.tr, http://orcid.org/0000-0002-0223-3807

bazlı muhallebi üretiminde çam sakızı kullanımının fiziksel ve kimyasal özellikler açısından ürünün teknolojik özelliklerini geliştirmesine rağmen duyusal kabul edilebilirlik açısından beğenilmediği tespit edilmiştir. Ayrıca ürünün hem dış görünüş hem de lezzet açısından beğeninin kontrol örneğine kıyasla daha az olduğu da saptanmıştır. Ancak üretimde subye ilavesinin inovasyon çalışmalarında kullanımı ile literatürde farkındalığın artmasına ve özellikle çölyak hastalarına yönelik ürün çeşitliliğinin sağlanmasına katkı sağlayabileceği düşünülmektedir.

Anahtar kelimeler: *Picea orientalis* (L.) Link*, glutensiz gıda, sütlü tatlı, çam sakızı.*

1. Introduction

Nowadays, consumers' preferences in food consumption have changed depending on the differentiation in their lifestyles and more conscious consumption habits are formed. Societies show different tendencies towards functional foods [1]. This is why they are not seen as a single, well-defined, or strictly defined foods; many foods can be considered functional. Among the studies on functional food products, those related to dairy products have an essential place. Dairy desserts, evaluated within the scope of dairy products, constitute the invariable flavors of traditional Turkish cuisine. Custard, rice pudding, and kazandibi are the most well-known and preferred milk desserts [1,2].

Custard is a dispersed milk dessert consisting of oil globulins and starch granules stabilized by membrane-containing proteins and water [2]. A starch-based milk dessert, custard is widely consumed in the dairy dessert category in various parts of the world. Nowadays, with the widespread production of varieties of industrial milk desserts, there is an excellent increase in custard consumption. This increase is likely due to the acquiring new sensory properties using various colorants, probiotics, and aromas [3].

Although the nutritional habits of every society in the world differ, cereal products are the most fundamental source of all these nutrition types. However, they also play a critical role in the forming of some diseases. With the consumption of cereals containing gluten, reactions arising from this protein occur in the digestive system, and food intolerances occur due to the difficulty of absorption in the intestine. One of these food intolerances is celiac disease. Celiac disease is an absorption disorder that occurs when consuming foods containing gluten [4]. Nowadays, reasons such as advances in the diagnosis of disease make ready-made food products that can be used in gluten-free diet applications a potential market [5,6].

The dairy industry, in particular, is where it is expected to turn it into functional products. In this context, milk desserts in the dairy industry are considered a product group in which only little research has been done. However, the production conditions' physical, chemical, and textural properties must be investigated. It is possible to gain new functional qualities by changing the primary raw materials used in custard production, one of the simplest types of milk desserts. For this purpose, making the thickening process in industrial custard production with rice pulp called "subye" instead of starch is becoming increasingly common nowadays [3]. In addition, one of the main factors taken into consideration during new product development in order to increase product diversity and add functional quality to the product; is to provide solutions to be taken to eliminate serum separation that directly affects consumer preference. It is known that various gums

and hydrocolloids are used due to their water-binding properties in custard production to reduce serum separation and improve their textural properties. However, while improving the textural features, gaining new sensory qualities is also among the targets. An example of custard developed for this purpose is custard with mastic gum. Using spruce gum in custard production to develop alternative products and increase product diversity is suitable for gaining new sensory properties in terms of taste and color and for improving textural properties.

Oriental spruce (*Picea orientalis* (L.) Link), one of the leading tree species of our country, naturally spreads in the Eastern Black Sea Region and the Caucasus Mountains. In our country, spruce forests start from the Melet Stream in the east of Ordu Province and extend to Posof along the northern slopes of the Eastern Black Sea Mountains [7]. In general, the gum and resin parts are used and these parts contain tannin and their own essence [8]. It is known that spruce gum, which has a sticky feature obtained from the slits in the trunks of spruce trees, has a yellow honey color and dark consistency, sharp smell, bitter, crystalline appearance, softens when heated, dissolves easily in turpentine and many other solvents (Figure 1). In addition, the high nutritional properties of spruce gum, with its rich chemical composition, allow it to be used to treat many diseases, such as bruises, skin diseases, wounds, diabetes, and stomach ulcers [9].

Figure 1. Oriental Spruce (*Picea orientalis* (L.) Link) gum

In this research, custard was produced to investigate the usability of spruce gum as a textural agent. Subye was used in its production to boost custard to reach a more preferable level in terms of health. Afterward, gum custards were produced using oriental spruce gum (*Picea orientalis* (L.) Link), and the desserts were examined in terms of color, texture, and sensory properties. The statistical evaluation of the data obtained at the end of the study ensured that the critical differences between the control and spruce gum custard samples in terms of the examined properties were revealed, and the applicability of spruce gum in custard production was investigated.

2. Material and method

Pasteurized cow's milk, rice, sugar, and eggs used as raw materials in production were commercially available from the market; spruce gum was obtained from Gursu Baharat

Caravan (Bursa, Türkiye). In the production of control and spruce gum custard, 200 g plastic container packages were used as packaging material.

In this research, the production of custard samples was carried out in Unpa Patisseries (Bursa, Turkey) according to flow diagram given in Figure 2. Five different custards, including the control, were produced by adding 0.2%, 0.35%, 0.5% and 1% spruce gum.

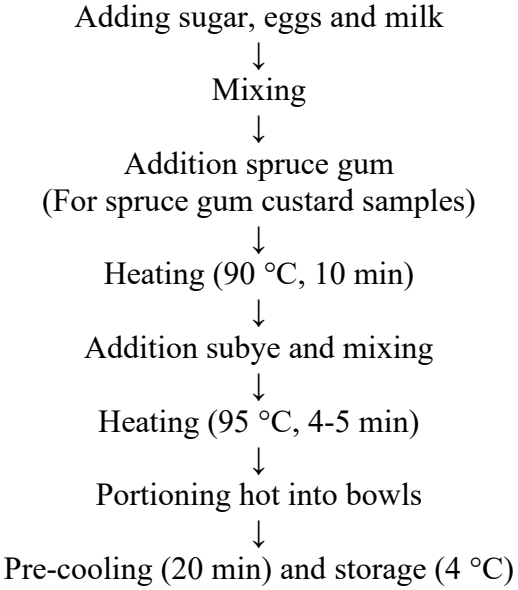

Figure 2. Custard production flow chart

Color determination analyzes of samples were performed with MSEZ-4500L HunterLab (Virginia, USA) device by making separate measurements in 3 different repetitions. Hunter color values are expressed as a triple scale of "*L, a, b*". These values were expressed as *L*=100: white, *L*=0: black; +*a*: red, -*a*: green; +*b*: yellow, and -*b*: blue.

Instrumental textural properties of the samples were reported by Dokoohaki et al. [10] method was determined by modification. The method was based on texture profile analysis (TPA) and was carried out using a Texture-Analyzer-TA-Plus (Lloyd Instruments) device, using a 5 kg load cell and a specific cylinder-probe. Each sample was filled into 200 g plastic cups with a depth of 5 cm and the analysis was carried out at 25°C. In the analysis in which two suppressions were applied, the suppression process was achieved by immersing the 20 mm diameter cylinder probe into the sample at a rate of 75% at a crosshead speed of 0.1 mm/s. Calculation of parameters that give information about the textural properties of samples from the power-time graphs obtained according to the TPA technique was made by Texture Exponent 32 (2007) software (Stable Micro Systems, Godalming, UK). Evaluated parameters were measured as hardness (g), cohesiveness, adhesiveness (gs), and gumminess.

A group of 7 trained panelists conducted a sensory analysis to test the consumption quality of samples [11]. Custard samples, which were kept at 4ºC for sensory analysis, were taken from this temperature and presented to the panelists in plastic-cups. Custard samples were examined in terms of "Appearance", "Taste", "Smell", "Texture", and "General Acceptability" and 1-5 points system was used for each analysis.

Analysis of variance (ANOVA) was applied to determine the differences in the data obtained as a result of analyses applied to investigate the use of gum in custard production. A comparison of the significant differences between the means taken for the sources of variation was performed with the Fisher LSD test. A value of $p<0.05$ was used for differences between groups (control and custard varieties with different gum ratios).

3. Results and discussion

Color value is an essential parameter affecting consumers' food preferences [12]. Three different mathematical measurement criteria such as *L, a,* and *b* were used to determine the color values of the samples, and when the variance analysis results were evaluated in line with the applied statistical analysis, the difference between the *L, a,* and *b* values of the custard samples was determined to be at the level of $p<0.01$ statistically in terms of the interaction of the custard variety with different gum ratios (Figure 3). The white color of milk is the result of the presence of colloidal particles, such as milk fat globules and casein micelles, that can diffuse light within the visible spectrum [13]. If the *L* value, considered as a brightness measurement criterion, is 100, it indicates white color and 0 indicates black color [14]. The high *L* value of the control sample compared to the custard varieties with different gum ratios shows that its whiteness and brightness are higher compared to the other samples. It is thought that this is because the original color of the dessert is close to white. When the control and gum custard samples were examined as two different groups, it was determined that custard-containing spruce gum had lower *L* values compared to the control sample. It is thought that this is due to the dark color of the added gum and the low *L* values are an expected result. When the control and spruce gum custard samples were examined as two different groups, it was determined that custard-containing gum had lower a and higher b values compared to the control sample. It is thought that this is due to the color pigments in the added gum's composition, which is an expected result.

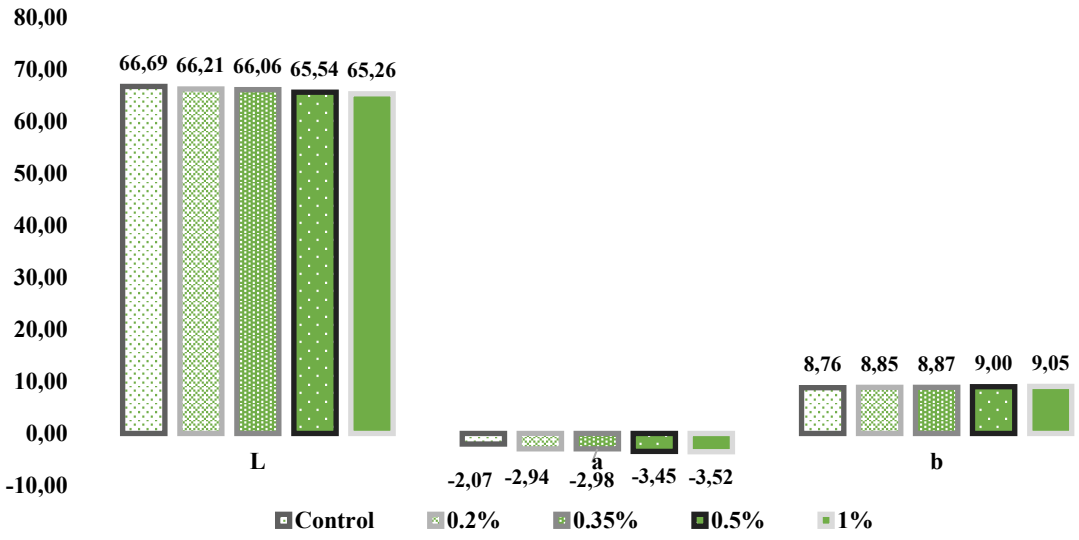

Figure 3. Color values of control and spruce gum custard samples

Textural properties are a quality criterion in which foods' structural, mechanical, and surface properties are determined by sight, hearing, touch, and kinesthetic means; they also determine the type and quality level of food [15].

Hardness can resist any effect applied to foods [16]. The hardness value is considered as the most critical texture parameter that provides information about the quality of dairy products and the acceptability of the product [17]. When the applied statistical analysis evaluated the hardness value of the samples, the hardness value of the samples was found to be statistically significant at the $p<0.01$ level in terms of the interaction of the custard samples (control and custard varieties with different gum ratios) (Figure 4). It has been determined that the hardness value of the samples also tends to increase depending on the increase in the gum ratio. This is because gum thickens by interacting with the casein micelles in milk [18]. Nunes et al. [19] in their study in which they examined the textural properties of 8 different combinations of milk desserts produced using milk and pea, lupine and soy protein isolates, and κ-carrageenan and gellan gum and found that the gel formed by milk and κ-carrageenan showed higher hardness properties than plant-based ones. In addition, the researchers stated that the gelation process involves a highly specific interaction with the formation of an electrostatic bridge between κ-carrageenan and κ-casein. On the other hand, Garayev [20] emphasized that increasing gum concentrations increase the firmness of dairy desserts in his study on the development of lactose-free milk desserts.

The cohesiveness is defined as the ratio of the positive area after the second compression applied in the texture analysis to the positive area after the first compression [21]. The high cohesiveness value in the texture analysis indicates that the food has a stronger structure [22]. When the applied statistical analysis evaluated the cohesiveness values of samples, the cohesiveness value of the custard samples was found to be statistically significant at the $p<0.01$ level in terms of the interaction of the custard samples (control and custard varieties with different gum ratios) (Figure 4). It was determined that the cohesiveness value of the samples also tended to increase depending on the increase in the gum ratio. It is thought that this situation is due to the effect of the textural properties of samples due to the interactions between the gum and milk proteins used in production. Gupta et al. [23] determined that the using modified amaranth starch in pudding production caused an increase in the internal stickiness, chewiness, and flexibility values of puddings. Garayev [20] on the other hand, in his study on the development of lactose-free milk dessert, determined that increasing gum concentrations increased the bond formation between starch and gum, resulting in a more branched structure and stronger gel formation. In another study conducted by Kadagan [24], the effect of storage time and different formulations on the internal cohesiveness values of the keskul samples was found to be statistically significant. In addition, Depypere et al. [25] examined the rheological properties of milk desserts containing κ-carrageenan (0.05-0.05-0.50-0.50-0.27%), skimmed milk powder (5-10-5-9.55-7.39%), corn starch (5.5-0.5-5.05-0.5-2.89%), water, sucrose at different concentrations; they found that the cohesiveness values of desserts varied in the range of 0.41-0.68. The values obtained in this study are similar to those determined in our study.

Adhesiveness is defined the negative force field after the first compression [26]. When the applied statistical analysis evaluated adhesiveness value of the samples, the adhesiveness value of the samples was found to be statistically significant at the $p<0.01$ level in terms of the interaction of the custard samples (control and custard varieties with

different gum ratios) (Figure 4). It was determined that the adhesiveness value of the samples also tended to decrease depending on the increase in the spruce gum ratio. This is thought to be due to the hydrophobic and electrostatic interaction between the added spruce gum and the other ingredients used in the formulation. In addition, high adhesiveness values reflect more relationship with the probe surface and thus provide information about the bonding properties of desserts [27]. Cardarelli et al. [28] determined the adhesiveness values of chocolate mousse dessert enriched with inulin between 0.792-0.956. Tester and Sommerville [29] investigated the effects of gums on starch gelatinization, water absorption and enzymatic hydrolysis, and found that water molecules that prevent gelatinization showed less mobilization and attributed this to the water binding capacity of gums.

Gumminess is the breaking force required to make a semi-solid food ready to be swallowed and is considered an important parameter only in semi-solid foods [30]. When the gumminess values of samples were evaluated in accordance with the applied statistical analysis, the gumminess value of the samples was found to be statistically significant at the $p<0.01$ level in terms of the interaction of the custard samples (control and custard varieties with different gum ratios) (Figure 4). It was determined that the gumminess value of the samples also tended to increase depending on the increase in the gum ratio. This is thought to be due to the interaction between custard components. In addition, the gumminess value; since it is obtained by multiplying the cohesiveness and hardness values, it shows a similar change with the hardness values. In the study conducted by Kadagan [24], the effect of different formulations and time on the gumminess results of the keskul samples was determined to be statistically significant ($p<0.05$). Milani and Koocheki [31], on the other hand, in their study examining the addition of date syrup and guar gum in low-fat frozen yogurt in terms of physicochemical, rheological, and sensory properties, found that the control (without gum) sample showed less gumminess than the samples containing gum.

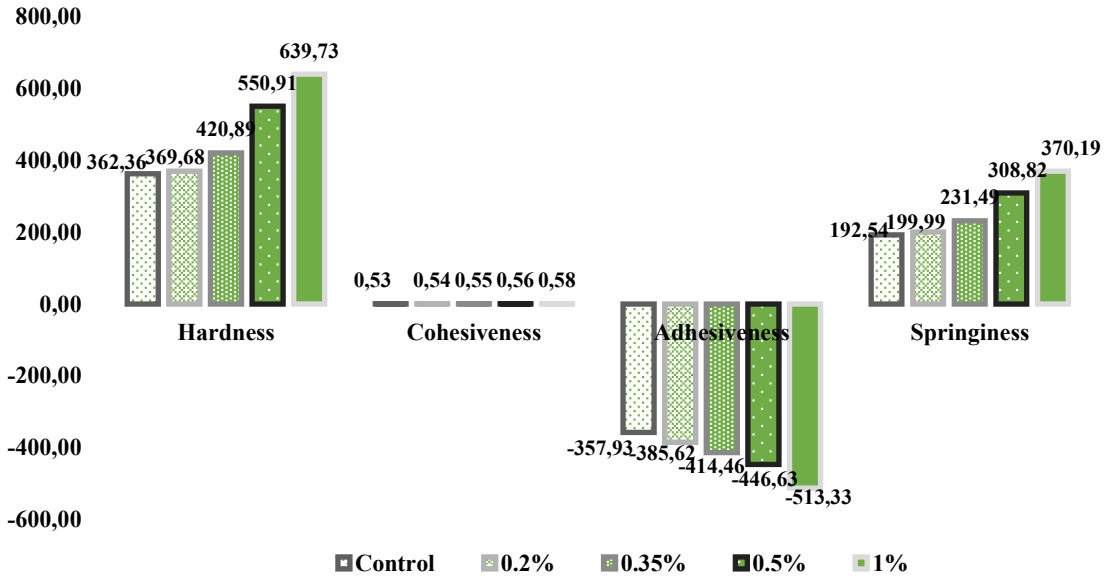

Figure 4. Texture values of control and spruce gum custard samples

Sensory analysis is a method that enables the grading of food's color, odor, consistency, etc. properties of foods through our basic five sense organs [32].

All samples were evaluated according to their natural color intensity and brightness, smooth surface area, and homogeneous consistency. The appearance values of the samples were found to be statistically significant at the $p<0.01$ level depending on the interaction of the custard samples (control and custard varieties with different gum ratios) (Table 1). Researchers think that the appropriate appearance and color value in foods increases the consumption and purchasing potential of foods [33]. In this context, when the examples are evaluated, the panelists determined that as the gum concentration increased, lower scores were given to the custard samples. Non-homogeneous color distributions were detected on the dessert surface. It is thought that this is because the added spruce gum does not meet the expected characteristics of custard, depending on its unique color.

All samples were evaluated considering the unique taste and aroma of the custard, the presence of dominant vegetable oil and cream, and its cooked and bland taste. The taste values of samples were found to be statistically significant at the $p<0.01$ level depending on the interaction of the custard samples (control and custard varieties with different gum ratios) (Table 1). Compared to the control group, samples with spruce gum were found to have lower taste values. It is thought that this is because the existing aroma of the added spruce gum is not liked due to the suppression of the unique flavor of the custard. The biochemical composition of the custard, the additives used, and the production method affect the sensory quality, especially the taste value. In this context, spruce gum has its unique flavor feature and can cause differences in the flavors of the products it is added to its composition. It was determined by the panelists that lower evaluation scores were given with the increase in the amount of concentration in the taste values of the spruce gum custard samples. It was also emphasized that custard samples with spruce gum left a bitter taste in the throat together with a dominant spruce aroma in the mouth.

Samples were evaluated considering the unique odor of custard as odor value. When the variance analysis results were evaluated, the difference between the odor values of the samples was found to be statistically significant at the $p<0.01$ level depending on the interaction of the custard samples (control and custard varieties with different gum ratios) (Table 1). It was determined that spruce gum custard samples had lower odor values compared to the control group. It is thought that this is because the unique sharp smell of the added spruce gum is not liked. After all, it suppresses the unique smell of custard.

Samples were evaluated according to their texture (feel in the mouth), full consistency, smooth structure, stickiness, sandiness, creaminess, and homogeneity in the mouth section. When the analysis of variance results was evaluated, the difference between the texture (feel in the mouth) values of the samples was found to be statistically significant at the $p<0.01$ level, depending on the interaction of the custard samples (control and custard varieties with different gum ratios) (Table 1). Compared to the control group, it was determined that the spruce gum custard samples had lower scores, and as the concentration ratio increased, the samples were rougher, stickier and had no creamy structure.

Samples were evaluated for general acceptability by considering all sensory parameters. When the analysis of variance was evaluated, the difference between the general

acceptability values of the samples was found to be statistically significant at the p<0.01 level, depending on the interaction of the custard samples (control and custard varieties with different gum ratios) (Figure 5). In addition, it was determined that samples had a lower overall acceptability value compared to the control sample. Consumers may find acceptability of custard samples low due to the decrease in the average scores of the general acceptability value, especially when the spruce gum content is higher than 0.2%.

Table 1. Sensory evaluation results of control and spruce gum custard samples

Custard Type	Appearance	Taste	Smell	Texture
Control	5,00[a]	5,00[a]	5,00[a]	5,00[a]
0.2%	5,00[a]	4,50[b]	5,00[a]	4,93[b]
0.35%	5,00[a]	3,50[c]	5,00[a]	4,73[b]
0.5%	4,97[b]	3,00[d]	4,67[b]	4,50[c]
1%	4,63[c]	3,00[d]	4,67[b]	4,17[d]
ANOVA Custard Type	**	**	**	**

(**) Significant at the p<0.01 level
(*) Means marked with the same lowercase letter are not statistically different from each other

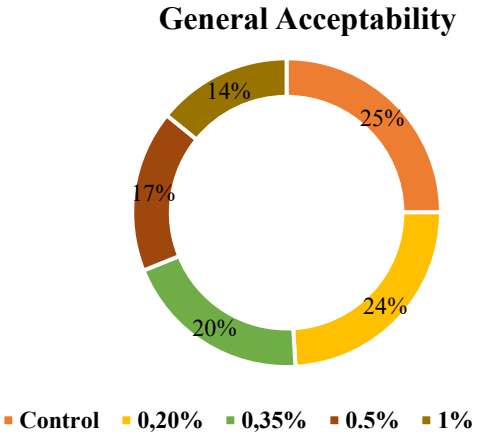

Figure 5. General acceptability values of control and spruce gum custard samples

As a result, it is thought that although the use of spruce gum in the production of custard is evaluated in terms of appearance, taste, smell, visual consistency, consistency in the mouth, stickiness and general taste, it is advantageous in terms of physical, chemical and technological properties, but it may be insufficient in terms of sensory acceptance. For this reason, it is possible to say that the attractiveness of the product in terms of both visual and taste is lower than competing products. Consistent with the present study results, Qasem et al. [34] stated that when the pudding samples prepared by adding okra gum extract at different rates (0, 2, 4, 6 and 8%) were evaluated in terms of sensory, lower scores were given with the increase in the amount of okra gum added to the dessert samples. Rahim and Ova [35] on the other hand, stated that as the amount of saffron added in the pudding samples they produced by adding saffron increased, the general taste from sensory properties increased. Similarly, in the study conducted by Kadagan [24], it was determined that the experiments they conducted on milk dessert samples had a

statistically significant effect on the taste and odor scores. In the study carried out by Ayar et al. [36] the effect of salep, which is gum in fig dessert, on the storage stability was investigated. In the sensory evaluation made in the study, it was determined that the sweets with added salep have higher taste values than the sweets without salep; however, it was found that this effect was not statistically significant. According to Santonico et al. [37] to evaluate the flavor characteristics of custard produced using skimmed and whole milk, it was determined that strawberry flavor was perceived more intensely in the skimmed custard sample.

4. Conclusion

Milk-based desserts are actually not much-researched in the field; however, they are seen as a sector that needs to be examined in terms of production conditions, especially in terms of physical, chemical and textural properties. It is thought that the most common problems in milk desserts offered for consumption in the market are related to textural properties. In order to eliminate these problems, many texture agents have been included in the research. For this purpose, in our research, custard with spruce gum was produced in order to investigate its usability as a textural agent in custard in this direction to ensure that custard, which has an important place in milk desserts, becomes preferable in terms of health; in its production, it was ensured that it did not contain gluten by using subye, and afterward, the custard was produced using spruce gum. In addition to providing product diversity with this addition; it is thought that the use of the subye technique, which is more widely known in the Black Sea Region, in innovation studies can also contribute to increasing the awareness of this technique by taking its place in the literature. This situation may effectively provide product diversity, especially for celiac patients.

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