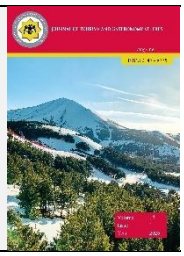
JOURNAL OF TOURISM AND GASTRONOMY STUDIES

ISSN: 2147 – 8775

Journal homepage: www.jotags.net



# The Effect of Using Slaked Limewater (Calcium Hydroxide) on Sensory Perception in Traditional Pumpkin Dessert

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**Article History**

*Received: 22.12.2025*

*Accepted: 07.03.2026*

**Keywords**

Food perception

Pumpkin dessert

Slaked limewater

Sensory evaluation

Food emotional response

***Article Type***

*Research Article*

**Abstract**

There are various desserts in Turkish cuisine prepared with different techniques. Fruit desserts are among these varieties as a part of the richness of this cuisine. Pumpkin dessert is traditionally made with two different techniques in the district of Sındırgı, Balıkesir province (Türkiye). One of them is the recipe in which the chopped pumpkin is kept with sugar for some time and then cooked at low heat. The other technique is steeping the chopped pumpkin in slaked limewater (calcium hydroxide) and cooking the pumpkin after this step. This study aims to determine the sensory perception of pumpkin desserts prepared using slaked limewater. For this purpose, two desserts, with and without slaked limewater, were presented to a total of 94 semi-trained panelists. Analyses were made with the paired comparison test texture-taste, scoring test, and hedonic test. At the end of the testing process, it is determined that the plain pumpkin dessert without slaked limewater was scored higher by the participants in all sensory properties except foreign odor and crispness. In addition to sensory features, plain pumpkin dessert also has high scores in terms of traditionalism, naturalness, and health perception, in addition to the overall impression.

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*DOI: 10.63556/jotags.2026.1798*

## INTRODUCTION

The origin of the pumpkin dates back to 4000 BC and it is known that it took thousands of years for this plant to reach Asia and Europe from the continent of America. As there is rich climate diversity in Anatolia today, different pumpkin species can be grown (Balkaya et al., 2010). The geographical movement and localization of foods can also be understood through Fischler's concept of food identity, which suggests that foods become embedded in cultural identity as they are integrated into local culinary systems (Fischler, 1988). Turkish cuisine has an important position among world cuisines in terms of food variety and taste due to the historical culture and geographical richness of Anatolia (Şanlıer, Cömert, Durlu-Özkaya, 2008). There are numerous desserts in the rich Turkish cuisine. As is known, cuisines are shaped throughout history by the impacts of different cultures. This historical layering of culinary practices also relates to what Fischler describes as modern food anxiety, where rapid changes in food systems increase the symbolic value of traditional foods as sources of familiarity and trust (Fischler, 1990). It is important to note that there are desserts in Anatolia made with the use of fruit sugar (molasses), which is a practice brought from Central Asia, the homeland of the Turks; on the other hand, there are desserts shaped by the effects of milk consumption culture (Güler, 2010; Ertaş and Gezmen-Karadağ, 2013). However, halva, pastes, compotes, and sherbet desserts have become important parts of Turkish culinary culture over time (Samancı, 2008). The variety of desserts, which developed as a result of the influence of Arab culture in Turkish cuisine, is maintained in today's Turkish cuisine; sugar, honey, and molasses are some of the ingredients that indicate this culture. On the other hand, many desserts made with flour, dough, milk, and fruit are made in this culture. There are many deserts such as baklava, kadayif, revani, tulumba, şekerpare, künefe, kazandibi, keşkül, rice pudding, ashura, quince, and pumpkin dessert in today's Turkish culinary culture (Yerasimos, 2014). Pumpkin dessert, like other traditional desserts, continues to be widely prepared and consumed in Turkish cuisine. From a psychological perspective, this continuity aligns with Rozin's work on the naturalness bias, which shows that foods perceived as traditional or less technologically altered are intuitively associated with being safer and healthier (Rozin, 2005). Although there are slight differences in terms of preparation, there is traditional consumption in many provinces such as Antalya, Bartın, Bolu, Giresun, Hatay, Isparta, Kütahya, Rize, Sakarya, Sivas (Üçer, 1998; Öztürk, 2008; Çoşan and Seçim, 2010; Babat et al., 2016; Başaran, 2017; Ceylan and Güven, 2018). In this study, the preparation methods in Sındırgı district of Balıkesir province are regarded as the basis. One of the traditional preparation methods in the region is the method in which sugar and pumpkin are used, while the other is the method in which slaked limewater is also used. Even the use of a substance such as slaked lime can remain compatible with perceptions of "naturalness," since, as Rozin notes, such judgments are often culturally framed rather than strictly based on chemical properties (Rozin, 2005). Slaked lime (calcium hydroxide) is an additive used in the food industry as an acidity regulator and destroyer of bacteria and some viruses (Çiçek, 1999; Han et al., 2012; Toyofuku et al., 2017). However, the effect of non-industrial use of this substance on the visual and texture of pumpkin dessert is the reason why it is analyzed in the scope of this study. Beyond its technological role, the use of slaked limewater may also influence consumer perception in terms of naturalness and processing.

### Materials and Methods

Participants ranged between the ages of 22 and 64. Self-identified smokers were excluded from the study. All participants were nonsmokers, and they had no deficits in terms of taste or smell; they were asked to stop eating or

drinking for at least one-hour before their scheduled session. Informed consent was obtained.

**Participants**

Participants for the emotional response were recruited from the Anadolu University community. The participants were recruited using posted advertisements, social media, and word of mouth. All participants were asked if they regularly consumed pumpkins. If so, they were invited to participate in the study. Before the data collection, all panelists participated in a training process about the use of the general labeled magnitude scale (Johnson, 2021). All participants were informed about the experimental protocol and provided written informed consent following the Declaration of Helsinki before participation. Ethical approval for the involvement of human subjects in this study was granted by Anadolu University Research Ethics Committee, with Reference number 306500, 05/25/2022. Participants gave informed consent via the statement "I am aware that my responses are confidential, and I agree to participate in this survey". Also informed consent was obtained from all participants for the use of their images in Figure 1. An affirmative reply was required to participate in the survey. They were able to withdraw from the survey at any time without stating a reason. The products tested were safe for consumption. The participants' demographics were assessed in a questionnaire (Table 1). Administration of the questionnaires were conducted face-to-face. A total of 94 participants completed the emotional response trial.

**Table 1.** Demographics of the participants

| | **Mean** | **Standard Deviation** |
|---|---|---|
| **Age** | 39,68 | 9,359 |
| **Gender** | **n** | **%** |
| Female | 54 | 57,4 |
| Male | 40 | 42,6 |
| **Total** | 94 | 100 |
| **Educational status** | **n** | **%** |
| High school | 10 | 10,6 |
| Associate degree | 11 | 11,7 |
| Undergraduate | 21 | 22,3 |
| Master | 22 | 23,4 |
| Doctorate | 30 | 31,9 |
| **Total** | 94 | 100 |
| **Profession** | **n** | **%** |
| Academician | 51 | 54,3 |
| R&D Lab Team Leader | 1 | 1,1 |
| R&D Kitchen Chef | 2 | 2,1 |
| Cook | 2 | 2,1 |
| Worker | 8 | 8,5 |
| Officer | 26 | 27,7 |
| Cooking performance lab. team leader | 1 | 1,1 |
| Designer | 1 | 1,1 |
| Technician | 2 | 2,1 |
| **Total** | 94 | 100 |

**Hedonic and sensory evaluation**

Pumpkin, limestone, and sugar used for this study were obtained from a local market in Balıkesir province. The participants completed a consent form containing information about the study and its purpose. After this step, they were asked to taste the two desserts. All samples were blind-coded and served under standardized conditions in terms

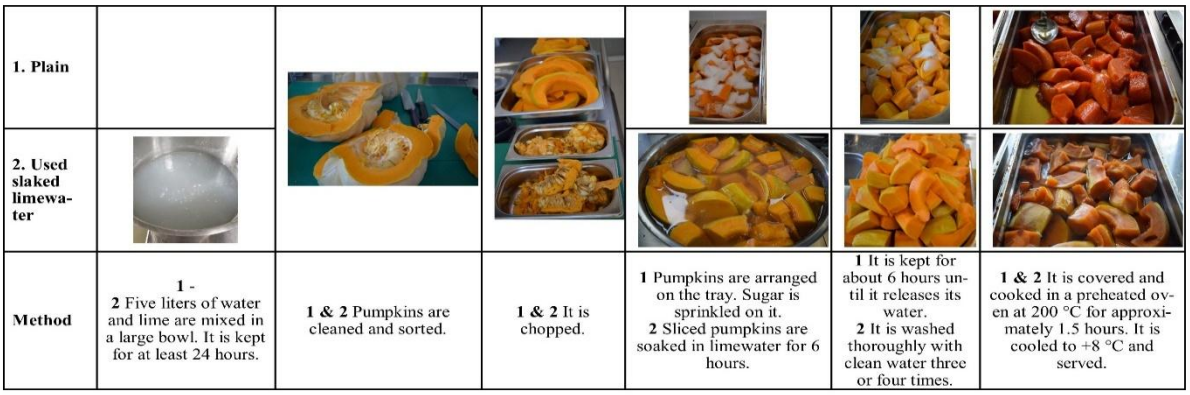
of portion size, temperature, serving time, and holding duration. Samples were presented to participants under blind-coded conditions. To prevent ordering bias, the sequence of tasting the plain and limewater-treated samples was randomized across participants. (Figure1). During the tasting, they were asked to score the forms placed on their table. The measures used under the 'Emotional response' section reflect hedonic and sensory evaluations rather than a discrete emotion scale such as EsSense. The hedonic evaluation was conducted using a 0–100 scale, where higher scores indicated greater liking.



| Layout of two desserts, water, empty glass, napkin and forms. | Front view of the tasting environment. | Back view of the tasting environment. |
|---|---|---|

**Figure 1.** Presentation of pumpkins and tasting environment

One of the desserts is plain (PP); the other is prepared by being kept in limewater (PL). The process is summarized and presented in Figure 2.



| | | | | | | |
|---|---|---|---|---|---|---|
| **1. Plain** | | | | | | |
| **2. Used slaked limewater** | | | | | | |
| **Method** | **1** - **2** Five liters of water and lime are mixed in a large bowl. It is kept for at least 24 hours. | **1 & 2** Pumpkins are cleaned and sorted. | **1 & 2** It is chopped. | **1** Pumpkins are arranged on the tray. Sugar is sprinkled on it. **2** Sliced pumpkins are soaked in limewater for 6 hours. | **1** It is kept for about 6 hours until it releases its water. **2** It is washed thoroughly with clean water three or four times. | **1 & 2** It is covered and cooked in a preheated oven at 200 °C for approximately 1.5 hours. It is cooled to +8 °C and served. |

**Figure 2.** Preparation method of the desserts

The ingredients and recipe for PP are presented in Figure 3.

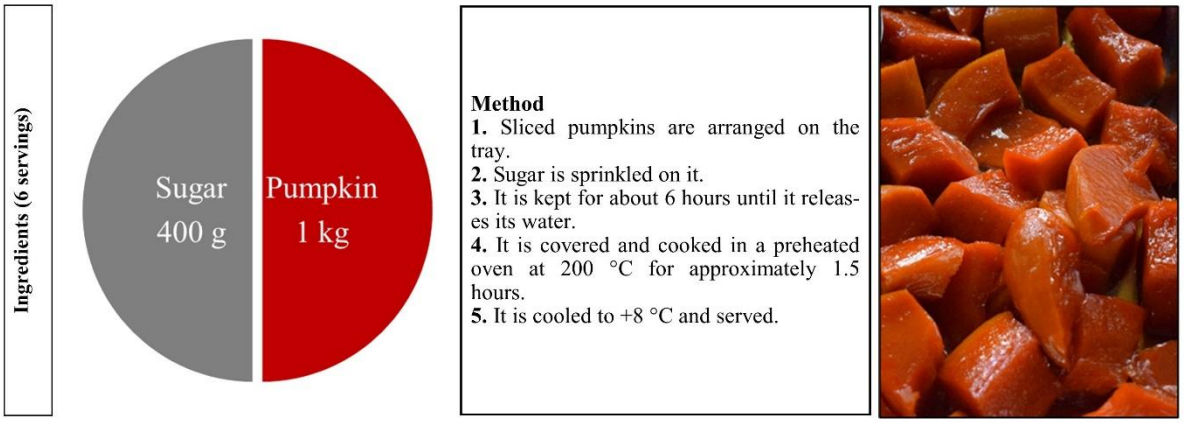



**Figure 3.** Plain pumpkin dessert recipe

The ingredients and recipe for PL are presented in Figure 4.

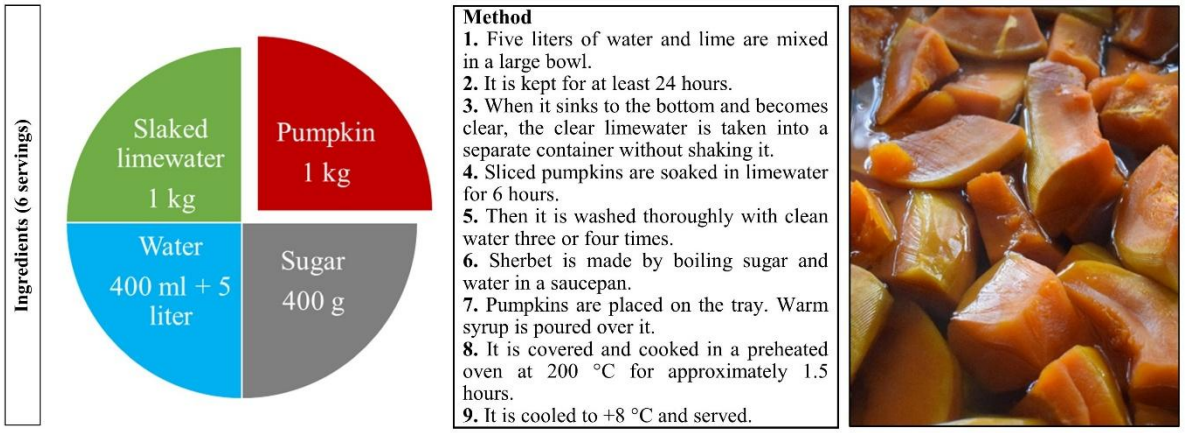



**Figure 4.** Pumpkin dessert recipe soaked in slaked limewater

### Color Measurement

Color measurements of both desserts were repeated three times with MiniScan® EZ (Hunter Associates Laboratory Inc., USA). Firstly, dessert samples were selected that were at least 25 mm (1 in) thick. The instrument was standardized with white calibrated tile and black glass placed at the sample port to set the top and bottom of the scale for the neutral axis. During standardization, the bottom of the scale was set first by placing the black glass. Then standardization was completed using the white calibrated tile. MiniScan's nose cone was placed on the sample, ensuring that the sample was in solid contact with the port. A single-color reading of the dessert was completed. The observer moved to another angle and a second reading was made. The dessert was turned over and one more reading in different areas on the sample surface was completed. The average of three readings was determined as the representative of the dessert sample.

Browning assessment was carried out by calculating formula: Browning Index (BI) = [100 (x - 0.31)] / 0.17, where x = (a* + 1.75L*) / (5.645L* + a* – 0.3012b*) (Ruangchakpet and Sajjaanantakul, 2007).

### Statistical Analysis

Although each participant evaluated both samples, statistical comparisons were conducted at the distribution level between the two product conditions. The Shapiro–Wilk test was used to assess the normality of continuous variables. Descriptive statistics are presented as mean ± standard deviation, while categorical variables are reported as n (%). Sensory score distributions of the two dessert conditions were compared using the Mann–Whitney U test. The Spearman correlation test was conducted to examine the association between hedonic score patterns of the plain (PP) and limewater-treated samples. According to this analysis, the correlation coefficient was −0.098 and the p-value was 0.345. Statistical analyses were performed using SPSS (IBM Corp., 2012, Version 21.0), and $p < 0.05$ was considered statistically significant.

### Results

In the study, taste and scoring tests (Table 2, Table 3), and color measurement (Table 4), were carried out for two different pumpkin dessert samples traditionally made in Sındırgı with and without limewater. The results show that the browning index of the dessert prepared without using limewater is higher than the one made by keeping it in

limewater. Although the mean hedonic score of PP was higher than that of the PL, this difference was not statistically significant (p = 0.345), indicating a trend rather than a definitive preference. In the scoring test, the crispness and foreign odor perception of the sample prepared using limewater had higher scores. In addition, the test shows that the pumpkin dessert prepared without using limewater stands out in terms of color, aroma, pumpkin smell, textural features, naturalness, traditionality, taste, and health perception.

**Table 2.** Hedonic scale evaluation

| | **Plain** | **With limewater** | **r** | **P** |
|---|---|---|---|---|
| **Mean±standard deviation*** | 74,71±16,622 | 58,01±22,898 | -0,098 | *0,345* |

*Variables are given as mean±SD. Spearman correlation test was used.

Spearman correlation test was performed to compare PP and PL using the hedonic scale form. According to the result of this test, the correlation coefficient was -0.098 and the p-value was 0.345. No statistically significant difference was detected between the two desserts in the hedonic scale evaluation (p > 0.05).

**Table 3.** Scoring test

| **Variables*** | **Plain** | **With limewater** | **Z** | **P** |
|---|---|---|---|---|
| **Color** | 4,13±0,964 | 3,80±1,113 | -2,067 | **0,039** |
| **Visuality** | 3,86±0,968 | 4,01±1,073 | -1,429 | 0,153 |
| **Texture (on the fork)** | 3,87±1,090 | 3,01±1,426 | -4,383 | **<0,001** |
| **Texture (in the mouth)** | 3,97±1,168 | 2,78±1,567 | -5,406 | **<0,001** |
| **Crispness** | 2,63±1,653 | 3,77±1,402 | -4,791 | **<0,001** |
| **Typical pumpkin flavor** | 4,16±1,040 | 3,26±1,252 | -5,218 | **<0,001** |
| **Pumpkin fragrance** | 3,98±1,352 | 3,24±1,508 | -3,690 | **<0,001** |
| **Sweetness** | 3,87±1,119 | 3,61±1,157 | -1,664 | 0,096 |
| **Bitterness** | 0,47±0,980 | 0,82±1,368 | -1,678 | 0,093 |
| **Sourness** | 0,54±1,170 | 0,66±1,169 | -0,885 | 0,376 |
| **Foreign odor** | 0,51±1,124 | 1,27±1,497 | -4,238 | **<0,001** |
| **Healthiness** | 3,85±1,107 | 3,49±1,251 | -2,029 | **0,042** |
| **Calorie** | 3,53±1,104 | 3,51±1,124 | -0,141 | 0,888 |
| **Taste** | 4,19±1,060 | 3,20±1,590 | -4,403 | **<0,001** |
| **Naturalness** | 4,28±0,848 | 3,61±1,346 | -3,513 | **<0,001** |
| **Traditional** | 4,36±0,982 | 3,34±1,514 | -5,049 | **<0,001** |
| **Overall Impression** | 4,13±0,895 | 3,19±1,322 | -4,972 | **<0,001** |

*Variables are given as mean±SD. Mann-Whitney U test was used.

Mann-Whitney U test was used to evaluate the difference between the scoring test elements of PL and the PP. According to the results of the test (Table 3), there is a statistical difference in terms of color between the PP and PL (p=0.039). The color of PP received a higher score (4.13±0.964). According to the scoring test; The texture on the fork of PP received a higher score (3.87±1.090). The texture in the mouth of PP received a higher score (3.97±1.168). The crispness of PL received a higher score (3.77±1.402). The typical pumpkin flavor (aroma) of PP received a higher score (4.16±1.040). The smell of PP received a higher score (3.98±1.352). PL received a higher score in terms of foreign odor (1.27±1.497), and PP received a higher score in terms of healthiness (3.85±1,107). The taste of PP received a higher score (4.19±1.060), and the naturalness of PP received a higher score (4.28±0.848). The traditionalism of PP received a higher score (4.36±0.982), and PP received a higher score in terms of overall impression (4.13±0.895). No statistically significant differences were detected between PP and PL in terms of visual

appearance, sweetness, bitterness, sourness, and perceived caloric intensity ($p > 0.05$). The browning index (BI) analysis revealed that PP exhibited significantly higher values than PL (52.23 vs 45.57), indicating a more intense color development in the plain samples (Table 4).

**Table 4.** Color measurement

| Variables* | 1. Measurement | 2. Measurement | 3. Measurement | Mean |
|---|---|---|---|---|
| | | ***Plain*** | | |
| **L*** | 36,69 | 39,34 | 39,73 | **38,59** |
| **a*** | 24,28 | 25,96 | 26,51 | **25,58** |
| **b*** | 30,54 | 33,68 | 34,63 | **32,95** |
| | | | **BI:** | **52,23** |
| | | ***With limewater*** | | |
| **L*** | 40,84 | 42,94 | 41,92 | **41,90** |
| **a*** | 22,30 | 23,13 | 22,84 | **22,76** |
| **b*** | 36,49 | 38,92 | 37,19 | **37,53** |
| | | | **BI:** | **45,57** |

*Variables are given as mean. L* for perceptual lightness. a* and b* for the four unique colors of human vision: red, green, blue and yellow. BI: Browning index.

## Discussion

The tests carried out within the scope of the research show that the sample prepared without using limewater is preferred in terms of almost all criteria. The participants gave a higher score to the plain pumpkin (PP) dessert; it was also calculated that it has a higher browning index (BI) with MiniScan® EZ. The data obtained from both the browning index (52.23 for PP vs. 45.57 for PL) and the scoring test reveal that the pumpkin dessert prepared without using limewater is more attractive to the participants in terms of color and appearance. Although the same participants evaluated both dessert samples (paired design), the Mann–Whitney U test was applied to compare the scoring test elements due to the non-normal distribution of the data; due to the non-parametric nature of the specific datasets the Wilcoxon signed-rank test would have been the conventional choice for paired data, but given the sample size and non-parametric nature of the measurements, this approach provides a reasonable and conservative estimation of differences, so the statistical interpretations should be considered indicative rather than definitive. Visuality and texture are very important in the sensory evaluation of foods. Visual satisfaction significantly affects food preference and taste (Ding & Ling, 2014). The demographic profile of the participants reveals a high level of academic attainment, with 55.3% of the panel holding either a Master's or Doctorate degree. This characteristic is particularly relevant when interpreting the significantly higher scores for naturalness and healthiness assigned to the PP dessert. Highly educated cohorts often demonstrate a stronger preference for minimally processed foods and may perceive traditional chemical additives—such as calcium hydroxide—as a deviation from the 'natural' essence of the product. This 'clean label' inclination likely explains why the PP version was preferred, as participants prioritized perceived health benefits over the textural enhancements provided by the limewater.

Slaked limewater in the food industry is traditionally used as an antimicrobial and pH stabilizer, especially to provide visual and textural appeal. In this respect, the results in question reflect the opposite of the general expectation. Although the PL samples were rated as significantly crispier (3.77 vs. 2.63), they also received notably higher scores for foreign odor (1.27 vs. 0.51). For a panel composed largely of academicians and professionals, these subtle off-notes may have negatively impacted the overall impression (3.19 for PL vs. 4.13 for PP), as sensory purity

often correlates with higher quality perception in educated focus groups.

The fact that the participants in the research represent different socio-demographic characteristics eliminates the possibility of a one-way representation. In addition, the prevalence of both preparation methods in the geography of Türkiye and the high awareness of these recipes by Turkish consumers reduce the risk of prejudice against the sample prepared using limewater. It is possible that the differences between the preparation stage of the recipes of Sındırgı and others created a new perception of experience by the participants. Specifically, differences based on the period pumpkin slices are kept in limewater may be influential. Similar methods are observed globally, such as Lutefisk in Nordic countries, nixtamalization in Central America, and laugengebäck in Europe (Lunestad et al., 2018; Ramírez-Araujo et al., 2019; Schaarschmidt and Fauhl-Hassek, 2019; Keller and Roller, 2021).

This study has several limitations, including the limited number of participants and the focus on a single local recipe. On the other hand, the strengths of the study include sensory analysis with highly educated panel participants and the application of colorimetric comparison to a local recipe. In addition, since more than half of the participants consist of academics and individuals with postgraduate education, the findings may reflect the perceptions of a relatively educated and professional group rather than the general consumer population.

**Conclusion**

In the study, two different pumpkin desserts prepared traditionally in Sındırgı were subjected to the browning index, hedonic test, and scoring test. As a result, pumpkin dessert prepared without using limewater was scored higher in all sensory properties except foreign odor and crispness. In addition to its sensory properties, it was also preferred in terms of authenticity, naturalness, health perception and general impression. In further studies, developing recipes with creative applications where pumpkin is used as the main ingredient, and conducting consumer tests with more and different focus groups will be beneficial in terms of bringing local cuisine to the food sector and sustainability.

**Declaration**

All authors have contributed equally to the article process. The authors declare that there are no conflicts of interest to report. The experimental procedures of this study were approved by the involvement of human subjects in this study was granted by Anadolu University Research Ethics Committee, with Reference number 306500, 05/25/2022.

**Acknowledgments**

This research was funded by Scientific Research Coordination Unit of Anadolu University (Grant No. 2107E178). This article was written from the paper titled “The effect of using slaked limewater (calcium hydroxide) on taste perception in pumpkin dessert”, whose poster was presented at the EuroSense (13th – 16th September 2022, Turku, Finland). We would like to present our thanks to Anadolu University, Eskisehir Vocational School staff, R. Berna Aykanat Demirel, and all the volunteers who participated in this project.

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**Appendix 1.** Ethics Committee Permission

| Evrak Kayıt Tarihi: 21.04.2022 | Protokol No: 306500 |
|---|---|

Tarih: 25.05.2022

ANADOLU ÜNİVERSİTESİ
SOSYAL VE BEŞERÎ BİLİMLER BİLİMSEL ARAŞTIRMA VE YAYIN ETİĞİ KURULU
**KARAR BELGESİ**

| | |
|---|---|
| **ÇALIŞMANIN TÜRÜ:** | Bilimsel Araştırma |
| **KONU:** | Sosyal Bilimler |
| **BAŞLIK:** | Kabak Tatlısında Sönmüş Kireç Suyu Kullanımının Tat Algısına Etkisi |
| **PROJE/~~TEZ~~ YÜRÜTÜCÜSÜ:** | Dr. Öğr. Üyesi Osman GÜLDEMİR |
| **TEZ YAZARI:** | - |
| **ALT KOMİSYON GÖRÜŞÜ:** | - |
| **KARAR:** | Olumlu |