ISSN: 2147-5121 / E-ISSN: 2717-7610

İstanbul Nişantaşı Üniversitesi
Sosyal Bilimler Dergisi

Bilimsel Hakemli Dergi

Yıl: 2024 Cilt: 12 Sayı: 1

İSTANBUL NİŞANTAŞI UNIVERSITY NEW

NUSBD

Yayın Aralığı: Yılda 2 Sayı - Başlangıç: 2013

İstanbul Nişantaşı University
Journal of Social Sciences

Scientific Refereed Journal

Year: 2024 Vol.: 12 No: 1

ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

DOI: 10.52122/nisantasisbd.1436189

THE IMPACT OF USING DIFFERENT YEAST SPECIES IN BREAD PRODUCTION ON CONSUMER PREFERENCES: A COMPARATIVE ANALYSIS OF TASTE

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ABSTRACT

This research aims to investigate the sensory properties of different yeast strains in bread production. The study explores the effects of bread prepared with three different yeast types on perceived taste and overall acceptability by consumers, aiming to assist food producers in aligning their products with consumer expectations. Conducted using an experimental design, the study tested the products in a real sales environment.
For the evaluation of bread prepared with three visually similar but content-wise different yeast strains, a panel of 22 participants was utilized. Panelists were asked to assess the breads based on criteria such as "appearance," "taste," "texture," "aroma," and "overall acceptability" using a sensory analysis-designed questionnaire post-tasting, and the data were collected accordingly. These data were then analyzed using statistical package programs, employing Friedman and Wilcoxon Signed-Rank Test analyses. The research findings indicate differences in consumer preferences concerning taste, texture, aroma, and overall acceptability. Panelists expressed a greater preference for bread obtained with sourdough yeast.

Keywords: Gastronomy, Sensory Analysis, Experimental Study and Bread Yeast

Jel Codes: L26, O18, R11, B21.

FARKLI MAYA TÜRLERİNİN EKMEK ÜRETİMİNDE KULLANILMASININ TÜKETİCİ TERCİHLERİ ÜZERİNDEKİ ETKİSİ: LEZZETTE KARŞILAŞTIRMALI İNCELEME

ÖZ

Bu araştırma, ekmek üretiminde farklı maya türlerinin duyusal özelliklerini incelemeyi amaçlamaktadır. Çalışma, gıda üreticilerinin ürünlerini tüketici beklentilerine uygun hale getirmelerine yardımcı olmak için üç farklı maya türüyle hazırlanan ekmeklerin tüketiciler tarafından algılanan lezzet ve genel kabul edilebilirlik üzerindeki etkilerini araştırmaktadır. Deneysel bir tasarım kullanılarak gerçekleştirilen çalışmada, ürünler gerçek satış ortamında test edilmiştir.
Araştırma, görsel olarak benzer ancak içerik açısından farklı üç maya ile hazırlanan ekmekleri değerlendirmeleri için 22 kişilik bir panelist grubunu kullanmıştır. Panelistlere, duyusal analizler için tasarlanmış bir anket yöntemi kullanılarak tadım sonrasında "görüntü," "lezzet," "doku," "koku" ve "genel kabul edilebilirlik" kriterlerine dayalı olarak değerlendirme yapmaları istenmiş ve veriler toplanmıştır. Bu veriler, istatistiksel paket programları kullanılarak Friedman ve Wilcoxon İşaretli Sıra Testi analizleri ile incelenmiştir. Araştırma sonuçları, tüketici tercihlerinde lezzet, doku, koku ve genel kabul edilebilirlik açısından farklılıklar olduğunu göstermektedir. Panelistler, ekşi maya ile elde edilen ekmekleri daha fazla tercih ettiklerini belirtmişlerdir.

Anahtar Kelimeler: Gastronomi, Duyusal Analiz, Deneysel Çalışma ve Ekmek Mayası

Jel Kodları: L26, O18, R11, B21.

Geliş Tarihi/Received: 24.02.2024	**Kabul Tarihi/Accepted:** 24.04.2024	**Yayım Tarihi/Printed Date:** 30.06.2024

Kaynak Gösterme: Ercik, C. (2023). "Farklı Maya Türlerinin Ekmek Üretiminde Kullanılmasının Tüketici Tercihleri Üzerindeki Etkisi: Lezzette Karşılaştırmalı İnceleme". *Nişantaşı Üniversitesi Sosyal Bilimler Dergisi,* 12(1) 76-93.

INTRODUCTION

The food industry is constantly undergoing innovation and development to offer products that meet the changing preferences of consumers. In this context, the design and development of products to meet consumer expectations are of vital importance to the industry (MacFie, Bratchell, & Vickers, 1989: 110). Research conducted for this purpose emphasizes the importance of the sensory attributes perceived by consumers.

Within this scope, this study examines the effects of three different types of yeast commonly used in the food sector on the perceived taste and overall acceptability of bread produced. The research was conducted with a panel of 22 participants aged between 20 and 55 with a moderate level of education. Panelists were instructed to evaluate breads prepared with different types of yeast based on criteria such as "appearance," "taste," "texture," "odor," and "overall acceptability."

The main question of the study was formulated as "What are your opinions on the taste, texture, odor, and overall acceptability of three different types of yeast commonly used in the bread industry in recent years?" and included the panelists' evaluations of the sensory characteristics and overall acceptability of the yeast varieties. This method is considered a reliable approach to examining consumer perceptions and preferences of food products.

The sensory analysis method used in the research collected evaluations from panelists using the 9-point hedonic scale scoring test scale developed by Peryam and Pilgrim (1957). Analyses were conducted between 10:00 and 13:30 to ensure data reliability and to avoid subjective effects, following "blind tasting" and "reverse coding" strategies (Stolzenbach et al., 2013).

Blind tasting is a method that requires evaluators to assess products without knowing their identities. In this method, numbered or coded samples are presented to evaluators, who are unaware of which product each sample belongs to. This reduces evaluators' biases and makes the evaluation process more objective (Smith & Johnson, 2010). For example, blind tasting can be used to evaluate the taste of bread produced by a baker using different types of yeast. Evaluators may be asked to identify differences among numbered samples based on characteristics such as taste, texture, and aroma (Jones, 2015).

Reverse coding is a method that requires evaluators to interpret positive statements as negative and negative statements as positive when making evaluations. This method is used to reduce evaluator bias and balance the evaluation process (Brown & Smith, 2012). For instance, when using reverse coding to evaluate a baker's products, evaluators may be instructed to "assign a score of 1 (positive) when you dislike the taste and a score of 5 (negative) when you enjoy the taste" (Robinson, 2018). This allows evaluators to express their true feelings about products more openly.

Sensory analysis methods are powerful tools used in the food industry to evaluate product quality. These methods are essential for assessing whether products meet consumer expectations and for making improvements in the product development process (White & Garcia, 2019).

Various studies on bread can be found in the literature. Some of these studies have examined the use of different dough conditioners with sourdough and have explored different methods for sourdough bread (Dığrak & Özçelik, 1991; Paslı, 2015; Ertop & Hayta, 2016; Hayıt & Gül, 2017; Şenol et al., 2019; Koca & Yazıcı, 2014; Şen, 2018; Bircan et al., 2017). Additionally, studies have been conducted on bread developed using sourdough. Some of these studies include:

- Cömert & Gün (2020) investigated the potential health benefits of purple bread production.
- Ataç (2016) evaluated the use of yeasts found in kefir for sourdough production and their effects on the dough.

- Karapınar Keserli (2022) improved and evaluated the sensory properties of sourdough breads made with einkorn wheat flour.
- Demir (2020) researched the health and bread effects of traditional sourdough production.
- Martinez et al. (2014) evaluated the nutritional values of sourdough wheat and rye bread.
- Özdemir (2021) developed and evaluated bread formulations enriched with medicinal plant flours.
- Banu et al. (2011) evaluated the effects of different proportions of sourdough use in rye bread production on bread properties.
- However, there are gaps in evaluating the taste performance of breads obtained using different yeast types through sensory analysis.
- In this context, this review aims to summarize the effects of various yeast types on the taste performance of breads obtained through sensory analysis and to examine their effects on consumer perception and preferences. This review aims to provide a basis for more in-depth research on the functionality of yeast cells in bread dough.

1. Conceptual Framework

1.1. Yeast and Types Used in Bread Making

Yeast, which is a key component in bread production, belongs to the species Saccharomyces cerevisiae, a single-celled eukaryotic organism classified within the kingdom Fungi. These microorganisms are commonly used in the fermentation process of bakery products (Cauvain & Young, 2007). Particularly, the S. cerevisiae species stands out as the main actor in bread making (Filo, 2007).

Yeast production is typically carried out through a process called aerobic fed-batch cultivation. This process involves the enlargement of yeast cells, followed by their separation, washing, and finally the removal of extracellular and intracellular fluids (Randez-Gil et al., 1999). Additives such as emulsifiers and antioxidants may be used during yeast production to prevent cell damage. Optimal growth conditions for yeast include ideal temperature (25–30 °C), humidity, and nutrients such as starch and sugars (Attfield, 1997).

Yeast used in bread making comes in various formats. These formats include fresh yeast, active dry yeast, and instant active dry yeast. The different physical properties of these products, especially differences in moisture content, can affect fermentation intensity (Loponen & Gobbetti, 2008).

- Fresh yeast: Also known as compressed yeast, fresh yeast has a high moisture content of around 70%. Therefore, it is usually stored at +4 degrees Celsius, and its shelf life is approximately 3-4 weeks from the production date.
- Active dry yeast: Obtained by reducing the water percentage of fresh yeast, active dry yeast has a longer shelf life. When stored in a cool and dry environment, dry yeast maintains its leavening properties for an extended period. When using active dry yeast, the yeast is dissolved in warm water with sugar at least four times its quantity and then allowed to stand for 15 minutes, which accelerates yeast activation.
- Instant dry yeast: Requiring no preparation, instant dry yeast consists of very fine granules and contains only 4% water due to special drying technology. It can be stored in a cool and dry environment and has a shelf life of 2 years (Şahin Perçin & Uçuk, 2020: 97).

Recommended yeast amounts for bread flours are as follows: 5% of the flour for fresh yeast, 2.5% for dry yeast, and 1.65% for instant yeast. When comparing industrial yeast ratios, 100 grams of fresh yeast can be replaced with approximately 50 grams of active dry yeast or 33 grams of instant yeast (Şahin Perçin & Uçuk, 2020). In terms of fermentation rate, a general ranking can be made as follows: fresh yeast > active dry yeast > instant dry yeast (Hui, 2006).

Commonly used yeasts in bread production are usually of the S. cerevisiae species, and their commercial production is carried out through the aerobic fed-batch cultivation method. The presence of yeasts in different formats and their adaptation to growth conditions can affect their performance in bread production (Delcour & Hoseney, 2010). Additionally, the potential positive effects of alternative yeast species on bread quality should be considered.

In recent years, sourdough bread production has gained popularity. The production of sourdough bread is a biotechnological process widely practiced worldwide (Gobbetti & Gänzle, 2013; Shevchenko et al., 2014). Despite modern technological developments, sourdough bread making has been traditionally maintained, and some sourdough breads have been legally protected (Cappelle et al., 2013; Minervini et al., 2012).

The sourdough matrix is a microbial structure consisting of a mixture of flour and water fermented by lactic acid bacteria (LAB) and yeast communities. Additional components may be added at the beginning of fermentation, and different microorganisms may be present, but usually, these components do not define the sourdough matrix and ecosystem (Minervini et al., 2016; Ripari et al., 2016).

2. Material and Methods

One critical factor that plays a pivotal role in determining consumer preferences in the food sector is considered to be the sensory characteristics of products (Almli et al., 2019: 1245-1268). These sensory features constitute vital elements for evaluating and preferring food products. The methodology of sensory analysis represents an approach that aims to examine the visual qualities (appearance, color, texture), taste, aroma, and textural attributes of products by utilizing individuals' sensory perceptions of food items. These factors critically influence how consumers assess and prefer food products. Particularly, taste is acknowledged as one of the most crucial sensory features of food products, playing a determinant role in consumers' product preferences (Barnett, 2009: 28). Aroma, another significant factor, provides information about the quality of food products and is considered a desirable characteristic by consumers (Lawless & Heymann, 2010: 376). Textural attributes also have a significant impact on consumers' preferences for food products; for instance, specific textural qualities like the smell, taste, or texture of bread are highlighted as favored features by consumers (Szczesniak et al., 1963: 402).

Food producers are required to design and develop their products in accordance with consumer expectations (MacFie, Bratchell, & Vickers, 1989: 110). In this context, this research adopts a sensory analysis method to examine the effects of three different types of yeast commonly used in the food industry on the perceived taste and overall acceptability of bread. The study includes a panelist group of 22 individuals ranging in age from 20 to 55, with a moderate level of education. This panel was presented with visually similar but content-wise different breads prepared with three different types of yeast, and they were asked to evaluate these products rigorously based on criteria such as "appearance," "taste," "texture," "smell," and "overall acceptability."

In this regard, the fundamental question posed to the panelists in the research is formulated as follows: "What are your opinions on the taste, texture, smell, and overall acceptability of breads prepared with these three different types of yeast commonly used in the bread sector in recent years?" This question encompasses the panelists' evaluations of the sensory characteristics of the mentioned yeast types and their opinions on the overall acceptability. The main objective of

the study is to understand and assess the sensory perceptions and general preferences of breads prepared with these yeast types by analyzing the responses given by the panelists to this question. This method represents an approach widely used in examining consumer perceptions and preferences for food products, providing an important source of data.

The evaluations of the panelists were collected using a 9-point hedonic scale scoring test developed by Peryam and Pilgrim (1957), which is commonly used in many studies. The evaluations on this scale are classified as follows: 1- Extremely bad, 2- Very bad, 3- Bad, 4- Below average, but above bad, 5- Average, 6- Below good, above average, 7- Good, 8- Very good, and 9- Excellent. The analysis process was conducted during the most effective hours for sensory tests, between 10:00 and 13:30. The breads prepared for sensory analysis were produced in 60 grams, as shown in photograf 1.

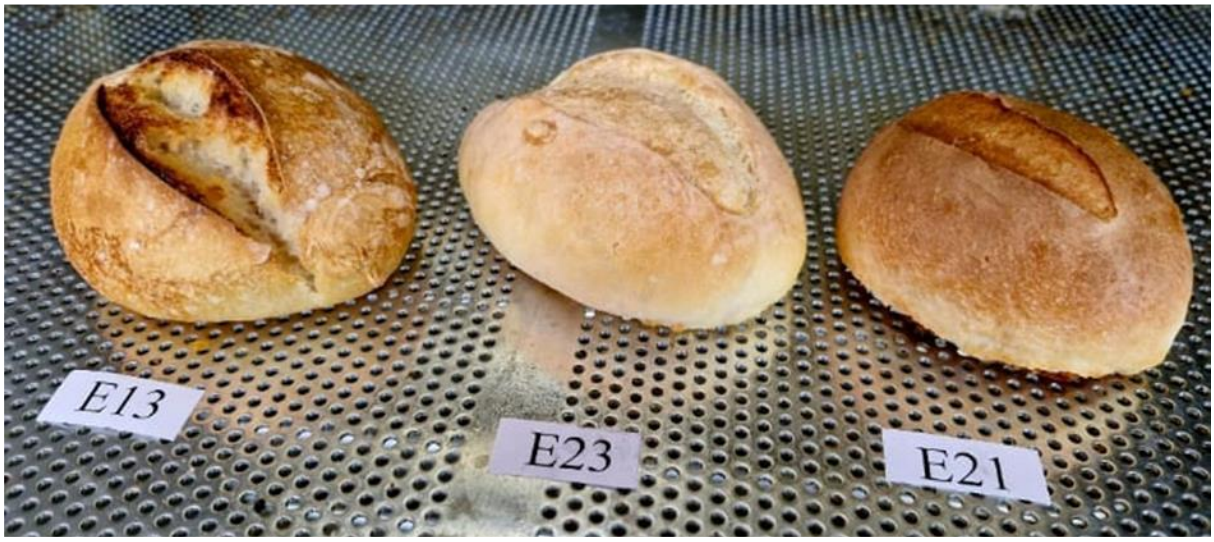

Photo 1: Product Shapes

The breads obtained with three different types of yeast were arranged as shown in Figure 2, and evaluations were conducted by the panelists. Throughout the research process, "blind tasting" and "reverse engineering" strategies were implemented to ensure reliable data collection without exposure to subjective influences. Blind tasting is defined as a methodology requiring product evaluators to assess products solely based on sensory characteristics such as appearance, taste, smell, texture, etc., without knowing the identities of the products. This approach prevents evaluators from making assessments based on any biases or pre-existing knowledge. Particularly prevalent in the evaluation of food or beverage products, this method allows for an objective assessment of products in terms of taste and quality (Stolzenbach et al., 2013: 95).

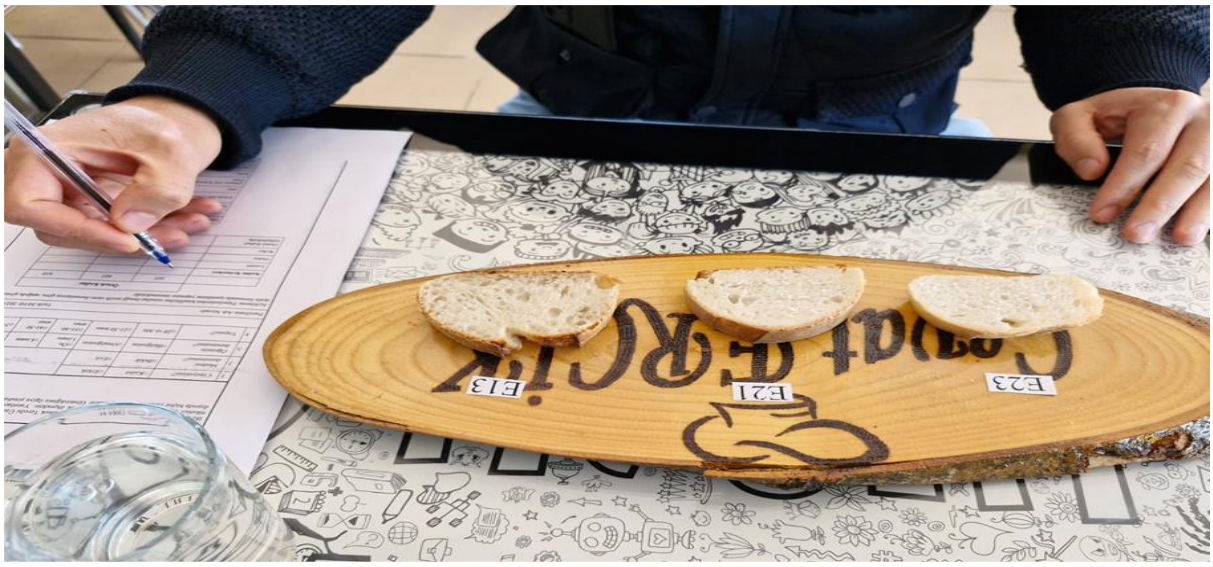

Photo 2: Product Evaluation

Another sensory analysis method is known as "reverse engineering." Reverse engineering is a process conducted through sensory analysis to understand the original characteristics of a food product, with the aim of determining its content or components (Brown & Smith, 2020). The focus of this method is to dissect and comprehend the sensory features of a product, such as taste profile, aroma, and texture. Reverse engineering is frequently employed to understand product formulations and contents. The primary goal in this technique is to minimize disparities between the first and last tasted samples, ensuring the most accurate data acquisition (Brown & Smith, 2020).

Both of these methods are widely used in processes such as product development, quality control, and designing products that align with consumer demands in the food industry (Jones et al., 2019; White, 2021). This approach provides a scientific and reliable foundation for evaluations, enhancing the credibility of research outcomes. By employing these strategies, the reliability and objectivity of data have been ensured, thereby increasing the scientific validity of the research (Stolzenbach et al., 2013).

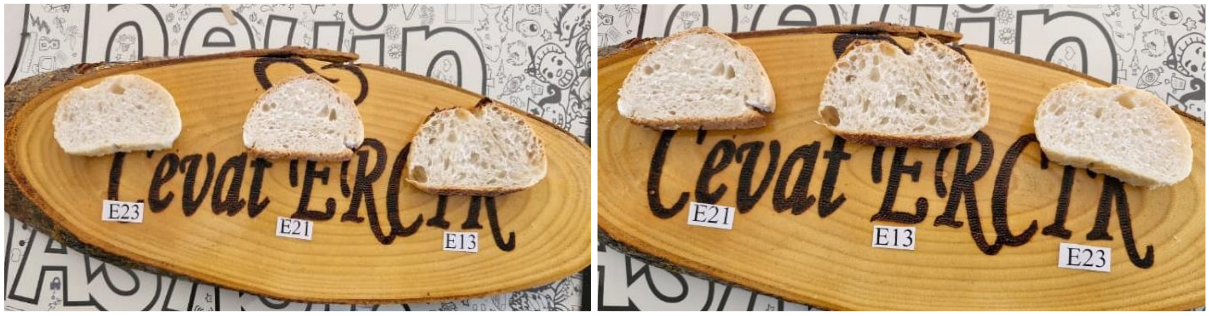

Photo 3: Reverse Engineering

During the execution of sensory analyses, crucial decisions must be made, including the selection of the participant profile, the number of products to be tested, and the test methods aligned with the research objectives. In this context, factors such as the preferred test method, the type of panel used, the number of panelists, sample size, and data analysis approach are detailed in Table 1.

In the scope of this study, the hedonic test method has been adopted as the preferred methodology. The hedonic test method is a widely used approach to assess the perceived taste, appearance, and overall likability features of products. This method serves the purpose of measuring consumers' emotional and sensory responses to products.

The selection of the hedonic test method has been made in accordance with the study's objectives and the specific requirements of the data collection process. These decisions are of critical importance to enhance the reliability of the research and ensure the scientific validity of the obtained results.

Table 1. Analysis Conditions According to Sensory Analysis Test Type and Number of Panelists

Test Type	Panel Type and Number of Panelists	Sample Size	Data Analysis
Hedonic	Semi-Trained (8-25), Untrained (80+)	1-18	Analysis of Variance (ANOVA) or Rank Analysis

References: (Altuğ Onoğur & Elmacı, 2019: 31).

In the study, tests were conducted after obtaining informed consent from volunteers, and an ethics committee application was submitted in this context.

The necessary ethical approval for the research was obtained from the Mersin University Social Sciences Ethics Committee on January 29, 2024 (Decision No: 22).

3. Findings

Based on the results of sensory evaluations, Friedman's S test was applied to determine the rank averages and standard deviation values of bread prepared with three different types of yeast. The results indicate a statistically significant difference in taste among breads prepared with different yeast types. Therefore, the Wilcoxon signed-rank test was used to examine the taste differences in more detail. Breads were represented by codes such as E21 (instant dry yeast), E13 (sourdough bread), and E23 (bread obtained with fresh yeast) and tested. The frequency analysis results of sensory criteria are detailed in Table 2. These results demonstrate that the sensory characteristics of bread are influenced by different yeast types, and these effects are statistically significant.

According to the table; in terms of appearance, breads prepared with instant dry yeast had an average score of 7.31, sourdough breads had an average score of 8.09, and breads prepared with fresh yeast had an average score of 6.95. In terms of taste, breads prepared with instant dry yeast had an average score of 6.09, sourdough breads had an average score of 8.68, and breads prepared with fresh yeast had an average score of 3.54. When examined in terms of aroma, breads prepared with instant dry yeast scored an average of 5.80, sourdough breads scored an average of 8.81, and breads prepared with fresh yeast scored an average of 3.65. In terms of texture, breads prepared with instant dry yeast scored an average of 5.72, sourdough breads scored an average of 8.77, and breads prepared with fresh yeast scored an average of 3.40. Finally, in terms of overall acceptability, breads prepared with instant dry yeast scored an average of 5.95, sourdough breads scored an average of 8.90, and breads prepared with fresh yeast scored an average of 3.63. These results indicate a significant impact of different yeast types on the sensory characteristics of bread.

Table 2. Frequency Analysis Results of Sensory Criteria (n=22 individuals)

Mean		Standard Deviation	Minumum	Maksimum
(E21- Instant Dry Yeast)				
Appearance	7,31	0.77	6	9
Taste	6,09	0.92	4	8
Aroma	5,80	0.66	5	7
Texture	5,72	0.63	5	7
Overall Acceptance	5,95	0.72	5	7
(E13- Sourdough Yeast)				

Appearance	8.09	0.61	7	9
Taste	8.68	0.47	8	9
Aroma	8.81	0.35	8	9
Texture	8.77	0.42	8	9
Overall Acceptance	8,90	0.29	8	9
(E23- Bread Obtained with Fresh Yeast)				
Appearance	6.95	0.89	5	9
Taste	3,54	0.80	5	8
Aroma	3,65	0.67	2	5
Texture	3,40	0.73	2	5
Overall Acceptance	3,63	0.65	3	5

Table 3 presents the evaluation of three different types of bread (bread prepared with instant dry yeast, bread prepared with sourdough, and bread prepared with fresh yeast) in terms of visual criteria. Average scores and standard deviations are provided for each type of bread. Additionally, Friedman Test statistics are presented.

The Friedman Test indicates statistically significant differences among the three types of bread (Chi-square = 21.478, Df = 2, Asymp. Sig = .000). This signifies that at least one type of bread is statistically different from the others. To elucidate this difference further, the Wilcoxon Signed Ranks Test was conducted.

The Wilcoxon Signed Ranks Test allows for comparisons between different types of bread. For instance, in the comparison between E13 (bread prepared with sourdough) and E21 (bread prepared with instant dry yeast), as the sum of negative ranks exceeds the sum of positive ranks ($Z = -3.690$, $p < .001$), it indicates that the bread prepared with sourdough has a higher visual value compared to the bread prepared with instant dry yeast.

Similar comparisons (E23-E21 and E23-E13) also indicate that each type of bread has different visual values compared to the others.

In conclusion, Table 3 demonstrates that different types of bread have distinct visual values, with bread prepared with sourdough having a higher visual value compared to the others.

Table 3. Analysis Findings of Friedman and Wilcoxon Signed Ranks Test for Appearance Criteriaof Breads Prepared with Three Different Types of Yeast

Appearance Type Average Rankings and Statistics						
Appearance Type			**Average**	**Mean**	**Standard**	
Appearance (E21 - Instant Dry Yeast)			1.75	7.31	0.77	
Appearance (E13 - Sourdough)			2.75	8.09	0.61	
Appearance (E23 - Fresh Yeast)			1.55	6.95	0.89	
Friedman Test Statistics			**Value**			
N			22			
Chi-Square			21.478			
df (Degrees of Freedom)			2			
Asymp. Sig			0.000			
Wilcoxon Signed Ranks Test (Appearance Pair Comparisons)						
Appearance Pair	**Rank Type**	**N**	**Average Rank**	**Total Rank**	**Z-Score**	**P-Value**
E13-E21	Negative Order	0	0.00	0.00	-3.690	0.000
	Positive Order	15	8.00	120.00		

	Equal	7				
	Total	22				
E23-E21	Negative Order	8	6.75	54.00	-1.198	0.231
	Positive Order	4	6.00	24.00		
	Equal	10				
	Total	22				
E23-E13	Negative Order	18	10.89	196.00	-4.165	0.000
	Positive Order	2	7.00	14.00		
	Equal	2				
	Total	22				

Based on the data in Table 4, three different types of bread (bread prepared with instant dry yeast, bread prepared with sourdough, and bread prepared with fresh yeast) were evaluated for taste based on sensory criteria. Average scores and standard deviations are provided for each type of bread. Additionally, Friedman Test statistics indicate statistically significant differences in taste among the three types of bread (Chi-square = 44.000, Df = 2, Asymp. Sig = .000). This suggests that at least one type of bread is statistically different from the others. To further elucidate this difference, the Wilcoxon Signed Ranks Test was conducted.

The Wilcoxon Signed Ranks Test allows for comparisons between different types of bread. For example, in the comparison between E13 (bread prepared with sourdough) and E21 (bread prepared with instant dry yeast), as the sum of negative ranks exceeds the sum of positive ranks ($Z = -4.149$, $p < .001$), it indicates that the bread prepared with sourdough has a higher taste value compared to the bread prepared with instant dry yeast.

Similar comparisons (E23-E21 and E23-E13) also indicate that each type of bread has different taste values compared to the others.

In conclusion, these findings indicate that participants perceive the bread prepared with sourdough to have a higher quality taste compared to the other types of bread.

Table 4. Analysis Findings of Friedman and Wilcoxon Signed Ranks Test for Taste Criteria ofBreads Prepared with Four Different Types of Yeast

Taste Type Average Rankings and Statistics						
Taste Type			**Average**	**Mean**	**Standard**	
E21 Taste (Bread Prepared with Instant Dry			2.00	6.09	0.92	
E13 Taste (Bread Prepared with Sourdough)			3.00	8.68	0.47	
E23 Taste (Bread Prepared with Fresh Yeast)			1.00	3.54	0.80	
Friedman Test Statistics			**Value**			
N			22			
Chi-Square			44.000			
df (Degrees of Freedom)			2			
Asymp. Sig			0.000			
Wilcoxon Signed Ranks Test (Taste Pair Comparisons)						
Taste	**Rank Type**	**N**	**Average Rank**	**Total Rank**	**Z-Score**	**P-Value**
E13-	Negative Order	0	0.00	0.00	-4.149	0.000
	Positive Order	22	11.50	253.00		
	Equal	0				

	Total	22				
E23-	Negative Order	22	11.50	253.00	-4.165	0.000
	Positive Order	0	0.00	0.00		
	Equal	0				
	Total	22				
E23-	Negative Order	22	11.50	253.00	-4.165	0.000
	Positive Order	0	0.00	0.00		
	Equal	0				
	Total	22				

Table 5 presents the evaluation of three different types of bread (bread prepared with instant dry yeast, bread prepared with sourdough, and bread prepared with fresh yeast) in terms of aroma. Average scores and standard deviations are provided for each type of bread. Additionally, Friedman Test statistics indicate statistically significant differences in aroma among the three types of bread (Chi-square = 44.000, Df = 2, Asymp. Sig = .000). This indicates that at least one type of bread is statistically different from the others. To further clarify this difference, the Wilcoxon Signed Ranks Test was conducted.

The Wilcoxon Signed Ranks Test allows for comparisons between different types of bread. For example, in the comparison between E13 (bread prepared with sourdough) and E21 (bread prepared with instant dry yeast), as the sum of negative ranks exceeds the sum of positive ranks ($Z = -4.183$, $p < .001$), it indicates that the bread prepared with sourdough has a higher aroma value compared to the bread prepared with instant dry yeast.

Similar comparisons (E23-E21 and E23-E13) also indicate that each type of bread has different aroma values compared to the others.

In conclusion, these findings indicate that participants perceive the bread prepared with sourdough to have a higher quality aroma compared to the other types of bread.

Table 5. Analysis Findings of Friedman and Wilcoxon Signed Ranks Test for Aroma Criteria of Breads Prepared with Three Different Types of Yeast

Aroma Type Average Rankings and Statistics						
Aroma Type			**Average Rank**	**Mean**		**Standard Deviation**
E21 Aroma (Bread Prepared with Instant Dry Yeast)			2.00	5.80		0.66
E13 Aroma (Bread Prepared with Sourdough)			3.00	8.81		0.35
E23 Aroma (Bread Prepared with Fresh Yeast)			1.00	3.65		0.67
Friedman Test Statistics			**Value**			
N			22			
Chi-Square			44.000			
df (Degrees of Freedom)			2			
Asymp. Sig			0.000			
Wilcoxon Signed Ranks Test (Aroma Pair Comparisons)						
Aroma Pair	**Rank Type**	**N**	**Average Rank**	**Total Rank**	**Z-Score**	**P-Value**
E13-E21	Negative Order	0	0.00	0.00	-4.183	0.000
	Positive Order	22	11.50	253.00		
	Equal	0				
	Total	22				
E23-E21	Negative Order	22	11.50	253.00	-4.194	0.000
	Positive Order	0	0.00	0.00		
	Equal	0				
	Total	22				

E23-E13	Negative Order	22	11.50	253.00	-4.171	0.000
	Positive Order	0	0.00	0.00		
	Equal	0				
	Total	22				

Based on the data in Table 6, three different types of bread (bread prepared with instant dry yeast, bread prepared with sourdough, and bread prepared with fresh yeast) were evaluated for texture. Average scores and standard deviations are provided for each type of bread. Additionally, Friedman Test statistics indicate statistically significant differences in texture among the three types of bread (Chi-square = 44.000, Df = 2, Asymp. Sig = .000). This indicates that at least one type of bread is statistically different from the others. To further clarify this difference, the Wilcoxon Signed Ranks Test was conducted.

The Wilcoxon Signed Ranks Test allows for comparisons between different types of bread. For example, in the comparison between E13 (bread prepared with sourdough) and E21 (bread prepared with instant dry yeast), as the sum of negative ranks exceeds the sum of positive ranks ($Z = -4.165$, $p < .001$), it indicates that the bread prepared with sourdough has a higher texture value compared to the bread prepared with instant dry yeast.

Similar comparisons (E23-E21 and E23-E13) also indicate that each type of bread has different texture values compared to the others.

In conclusion, these findings indicate that participants perceive the bread prepared with sourdough to have a higher quality texture compared to the other types of bread.

Table 6. Analysis Findings of Friedman and Wilcoxon Signed Ranks Test for Texture Criteria ofBreads Prepared with Three Different Types of Yeast

Texture Type Average Rankings and Statistics						
Texture Type			**Average Rank**	**Mean**		**Standard Deviation**
E21 Texture (Bread Prepared with Instant Dry Yeast)			2.00	5.72		0.63
E13 Texture (Bread Prepared with Instant Dry Yeast)			3.00	8.77		0.35
E23 Texture (Bread Prepared with Fresh Yeast)			1.00	3.65		0.67
Friedman Test Statistics			**Value**			
N			22			
Chi-Square			44.000			
df (Degrees of Freedom)			2			
Asymp. Sig			0.000			
Wilcoxon Signed Ranks Test (Texture Pair Comparisons)						
Texture Pair	**Rank Type**	**N**	**Average Rank**	**Total Rank**	**Z-Score**	**P-Value**
E13-E21	Negative Order	0	0.00	0.00	-4.165	0.000
	Positive Order	22	11.50	253.00		
	Equal	0				
	Total	22				
E23-E21	Negative Order	22	11.50	253.00	-4.177	0.000
	Positive Order	0	0.00	0.00		
	Equal	0				
	Total	22				
E23-E13	Negative Order	22	11.50	253.00	-4.155	0.000
	Positive Order	0	0.00	0.00		
	Equal	0				
	Total	22				

According to Table 7, three different types of bread (bread prepared with instant dry yeast, bread prepared with sourdough, and bread prepared with fresh yeast) were evaluated for overall acceptability. Mean scores, standard deviations, and Friedman Test statistics are

provided for each type of bread.

The Friedman Test indicates statistically significant differences among the three types of bread (Chi-square = 44.000, Df = 2, Asymp. Sig = .000). This suggests that at least one type of bread is statistically different from the others.

The Wilcoxon Signed Ranks Test allows for comparisons between different types of bread. For instance, in the comparison between E13 (bread prepared with sourdough) and E21 (bread prepared with instant dry yeast), as the sum of negative ranks exceeds the sum of positive ranks ($Z = -4.183$, $p < .001$), it indicates that the bread prepared with sourdough has a higher overall acceptability level compared to the bread prepared with instant dry yeast.

Similarly, in other comparisons (E23-E21 and E23-E13), it is observed that each type of bread has different levels of acceptability compared to the others.

In conclusion, Table 7 demonstrates statistically significant differences in the overall acceptability levels of different types of bread, with the bread prepared with sourdough showing a higher level of acceptability compared to the others.

Table 7. Analysis Findings of Friedman and Wilcoxon Signed Ranks Test for OverallAcceptability Criteria of Breads Prepared with Three Different Types of Yeast

Overall Acceptability Average Rankings and Statistics						
Overall Acceptability			**Average Rank**	**Mean**	**Standard Deviation**	
E21 Overall Acceptability (Bread Prepared with Instant Dry Yeast)			2.00	5.95	0.72	
E13 Overall Acceptability (Bread Prepared with Sourdough)			3.00	8.90	0.29	
E23 Overall Acceptability (Bread Prepared with Fresh Yeast)			1.00	3.65	0.65	
Friedman Test Statistics			**Value**			
N			22			
Chi-Square			44.000			
df (Degrees of Freedom)			2			
Asymp. Sig			0.000			
Overall Acceptability Pair Comparisons (Wilcoxon Signed Ranks Test)						
Acceptability Pair	**Rank Type**	**N**	**Average Rank**	**Total Rank**	**Z-Score**	**P-Value**
E13-E21	Negative Order	0	0.00	0.00	-4.183	0.000
	Positive Order	22	11.50	253.00		
	Equal	0				
	Total	22				
E23-E21	Negative Order	22	11.50	253.00	-4.177	0.000
	Positive Order	0	0.00	0.00		
	Equal	0				
	Total	22				
E23-E13	Negative Order	12	7.50	90.00	-4.165	0.016
	Positive Order	2	7.50	15.00		
	Equal	8				
	Total	22				

In Table 8, the averages scored by 22 panelists on a 9-point Likert scale for all sensory attributes are provided. These data encompass consumer evaluations of breads prepared with three different types of yeast in terms of taste, aroma, texture, and overall acceptability. According to the data obtained in Table 8:
Appearance: Bread prepared with sourdough received the highest score (8.09) in terms of appearance. Bread prepared with instant dry yeast (7.31) and fresh yeast (6.95) received relatively lower scores.

Flover: Bread prepared with sourdough obtained the highest score (8.68) for taste. This indicates that consumers preferred the taste of bread prepared with sourdough more than the others. In the case of bread prepared with instant dry yeast (6.09) and fresh yeast (3.54), lower taste scores were observed.
Aroma: Bread prepared with sourdough received the highest score (8.81) in terms of aroma. Bread prepared with instant dry yeast (5.72) and fresh yeast (3.65) received relatively lower scores.
Texture: Bread prepared with sourdough received the highest score (8.77) for texture. In the case of bread prepared with instant dry yeast (5.72) and fresh yeast (3.40), lower texture scores were observed.
Overall Acceptability: Bread prepared with sourdough obtained the highest score (8.90) for overall acceptability. Bread prepared with instant dry yeast (5.95) and fresh yeast (3.63) received relatively lower scores in terms of overall acceptability.

Table 8. Average Scores and Standard Deviation Obtained from Sensory Criteria for ThreeDifferent Breads

Sensory Criteria	Instant Dry Yeast (E21)	Sourdough Yeast (E13)	Fresh Yeast (E23)
Appearance	7.31 ± 0.77	8.09 ± 0.61	6.95 ± 0.89
Taste	6.09 ± 0.92	8.68 ± 0.47	3.54 ± 0.80
Aroma	5.80 ± 0.66	8.81 ± 0.35	3.65 ± 0.67
Texture	5.72 ± 0.63	8.77 ± 0.42	3.40 ± 0.73
Overall Acceptance	5.95 ± 0.72	8.90 ± 0.29	3.63 ± 0.65

According to the obtained data, the bread prepared with sourdough (E13) has received the highest scores in all sensory criteria. It is significantly superior in terms of appearance, taste, aroma, texture, and overall acceptability compared to the other two types of yeast. The bread prepared with instant dry yeast (E21) is generally rated at a moderate level, while the bread prepared with fresh yeast (E23) has received lower scores. These results indicate that the use of sourdough may enhance bread quality and could be more preferred among consumers.

Furthermore, it is evident that taste, aroma, and texture factors have a significant impact on consumer preferences in terms of overall acceptability. These findings can serve as valuable insights for the improvement and marketing of yeast types used in breadmaking.

RESULTS and RECOMMENDATIONS

The results of this study clearly demonstrate that different yeast types significantly influence the sensory characteristics of bread. Particularly, the use of sourdough has been observed to be superior to other yeast types in terms of taste, aroma, texture, and overall acceptability of bread.

Based on sensory evaluations, breads produced with sourdough consistently received significantly higher scores in taste, aroma, texture, and overall acceptability compared to other yeast types. These findings suggest that the use of sourdough may enhance bread quality and could be more preferred by consumers.

Breads produced with instant dry yeast generally received moderate evaluations, while those made with fresh yeast received low scores. These results indicate that the yeast variety plays a crucial role in determining the sensory qualities of bread.

In conclusion, it has been concluded that sensory factors such as taste, aroma, and texture significantly influence consumer preferences, highlighting the importance of considering these factors in the development and marketing of yeast types used in breadmaking. These findings provide valuable guidance for increasing product variety in the bread industry and ensuring consumer satisfaction.

Recommendations for Businesses

In light of these findings, it is crucial for businesses in the food industry engaged in bread production to consider consumer preferences when selecting yeast types. Particularly, the utilization of sourdough is believed to enhance the overall acceptability of bread, and therefore, its inclusion in product portfolios is deemed advantageous.

Increasing the use of sensory analysis methods can establish a solid foundation for understanding product quality and consumer preferences within the food industry. Therefore, it

is recommended to conduct further research to achieve more comprehensive and reliable results in future studies.

Moreover, it is suggested that efforts be made to increase research on the potential health benefits of sourdough and to organize informative campaigns for consumers in this regard. This approach not only considers consumer preferences but also emphasizes the importance of considering health trends for businesses.

Challenges and Limitations

This research has certain limitations that need to be considered, as they may impact the interpretation of the findings. Firstly, one limitation is the restricted nature of the sample used. Studies conducted with a broader participant pool may yield results that are more generalizable compared to the findings of this study.

Secondly, the research solely focused on the sensory characteristics of bread. This approach did not take into account other important attributes of bread, such as nutritional value and texture stability. This limitation has constrained the scope of the study and could affect the overall assessment. Future studies could expand the scope of the research by incorporating these factors to contribute further to the field.

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EXTENDED ABSTRACT

GENİŞLETİLMİŞ ÖZET

FARKLI MAYA TÜRLERİNİN EKMEK ÜRETİMİNDE KULLANILMASININ TÜKETİCİ TERCİHLERİ ÜZERİNDEKİ ETKİSİ: LEZZETTE KARŞILAŞTIRMALI İNCELEME

Giriş ve Çalışmanın Amacı: Bu araştırma, gıda sektöründe tüketicilerin ürün tercihlerini belirleyen önemli faktörlerden biri olan duyusal özellikleri detaylı bir şekilde incelemeyi amaçlamaktadır. Çalışmanın temel amacı, gıda üreticilerinin ürün portföylerini tüketici beklentilerine daha etkin bir şekilde uyumlu hale getirebilmeleri için duyusal analiz yöntemini kullanarak farklı maya türleriyle üretilen ekmeklerin tüketiciler üzerindeki algılanan lezzet ve genel kabul edilebilirlik üzerindeki etkilerini araştırmaktır.

Kavramsal/kuramsal çerçeve: Bu bölümde, yapılan çalışmanın konusuyla ilgili literatür taraması detaylı bir şekilde sunulmuştur. Gıda sektöründe duyusal analizlerin önemi ve bu analizlerin ürün geliştirme süreçlerindeki rolü vurgulanarak, mevcut literatürdeki çalışmaların özeti yapılmıştır. Ayrıca, bu araştırmanın literatürdeki boşlukları nasıl doldurabileceği ve alanındaki bilgiye ne gibi katkılar sunabileceği açıklanmıştır.

Yöntem ve Bulgular: Araştırmanın yöntemolojik çerçevesi, deneysel bir tasarımı benimsemekte olup, üç farklı maya türü ile hazırlanan ekmeklerin tüketiciler tarafından algılanan özelliklerini değerlendirmek amacıyla duyusal analiz yöntemi kullanılmıştır. Duyusal analizler için kullanılan veriler, panelistlerin "görüntü," "lezzet," "doku," "koku" ve "genel kabul edilebilirlik" kriterlerine dayalı değerlendirmelerini içeren bir anket aracılığıyla toplanmıştır.

Araştırma kapsamında, 22 kişilik bir panelist grubu, görsel olarak benzer ancak içerik açısından farklı üç farklı maya türü ile hazırlanan ekmekleri değerlendirmek üzere seçilmiştir. Bu panelistler, yaşları 20 ile 55 arasında değişen ve eğitim düzeyi yarı eğitimli olan bireylerden oluşmaktadır.

Panelistlerden elde edilen duyusal analiz verileri, Friedman S ve Wilcoxon İşaretli Sıra Testi analizleri kullanılarak değerlendirilmiştir. Bu istatistiksel yöntemler, farklı maya türleri arasında lezzet, doku, koku ve genel kabul edilebilirlik açısından anlamlı farklılıkları belirlemek için uygulanmıştır. Analiz sonuçları, tüketicilerin tercihleri ve algıları üzerindeki etkileri anlamak adına kapsamlı bir bakış sunmaktadır.

Sonuç ve Öneriler:

Araştırmanın sonuçları, fırın sektöründe kullanılan farklı maya türlerinin ekmeklerde kullanılmasının tüketici tercihleri üzerinde önemli bir etki oluşturduğunu göstermektedir. Bu sonuçlar, ekmeklerin görüntü, lezzet, doku, koku ve genel kabul edilebilirlik açısından farklı maya seçeneklerine bağlı olarak farklılık gösterdiğini ortaya koymaktadır.

Görüntü açısından, ekşi maya ile hazırlanan ekmek diğer iki maya ile hazırlanan ekmeklere göre daha iyi durumda olduğu bulgulanmıştır.

Lezzet açısından, ekşi maya ile hazırlanan ekmek diğer iki maya ile hazırlanan ekmeklere göre önemli ölçüde daha yüksek puan aldığı görülmüştür. Bu, tüketicilerin lezzet konusundaki tercihlerinin belirgin bir şekilde bu maya türüne yöneldiğini göstermektedir.

Koku değerlendirmesinde de benzer bir eğilim gözlemlenmiştir. Ekşi maya ile hazırlanan ekmek diğerlerine göre daha yüksek puan aldığı görülmüştür. Bu, koku özelliklerinin tüketici memnuniyeti üzerindeki etkisinin göz ardı edilemeyeceğini vurgulamaktadır.

Doku açısından incelendiğinde, yine ekşi maya ile hazırlanan ekmek en yüksek puanı aldığı görülmüştür. Bu, ekmeklerde doku özelliklerinin tüketiciler için önemli bir faktör olduğunu göstermektedir.

Son olarak, genel kabul edilebilirlik değerlendirmesinde de ekşi maya ile hazırlanan ekmek en yüksek puanı aldığı görülmüştür. Bu, tüketicilerin bu maya türü ile elde edilen ekmeklerin tatlarına olumlu bir yaklaşım sergilediklerini göstermektedir.

Sonuç olarak, fırın işletmeleri için farklı maya türlerinin seçimi, ekmeklerde tüketici tercihleri ve memnuniyeti üzerinde belirleyici bir rol oynadığı görülmektedir. Bu çalışmanın sonuçlarına göre tüketiciler tarafından en çok tercih edilen ekşi maya türüdür. Bu nedenle, fırın işletmelerinin ürünlerini daha çekici hale getirmek ve tüketicileri memnun etmek için bu maya seçeneklerini değerlendirmeleri önerilmektedir. Ayrıca, tüketicilerin duyusal tercihlerini anlamak ve ürünlerini bu tercihlere uygun şekilde tasarlamak, fırın işletmeleri için rekabet avantajı sağlayabilir.

Bu Alanda Hizmet Veren İşletmelere Öneriler:

- Ekşi Maya Kullanımını Vurgulayın: Müşteri tercihleri doğrultusunda, ekşi maya ile hazırlanan ekmekleri ön plana çıkarın. Menünüzde bu özel ekmekleri belirgin bir şekilde tanıtın ve müşterilere lezzet, koku ve doku açısından farkları hakkında bilgi verin.
- Lezzet Deneyimini Pazarlayın: Ekşi maya ile üretilen ürünlerin lezzetini vurgulayın. Müşterilere, bu ürünlerin farklı ve zengin lezzet profillerine sahip olduğunu anlatarak, lezzet deneyimini öne çıkarın.

Doku ve Koku Profiline Dikkat Çekin: Ekşi maya ile hazırlanan ekmeklerin özellikle doku ve koku açısından üstün olduğunu vurgulayın. Bu özellikleri müşterilere tanıtmak, ürünlerinizin öne çıkmasını sağlayabilir.

- Deneme Paketleri Sunun: Müşterilere farklı maya türlerini içeren deneme paketleri sunarak, çeşitli lezzetleri deneme fırsatı verin. Bu, müşterilerin kendi tercihlerini keşfetmelerini sağlayarak daha bilinçli alışveriş yapmalarına olanak tanır.
- Ekşi Maya Eğitimleri ve Tadım Etkinlikleri: Müşterilere ekşi mayanın kullanımı hakkında bilgi veren eğitimler düzenleyin. Ayrıca, düzenli olarak ekşi maya ekmek tadım etkinlikleri düzenleyerek müşterilerin bu ürünler hakkında daha fazla bilgi sahibi olmalarını sağlayın.

Bu öneriler, araştırmanın bulgularına dayanarak müşteri memnuniyetini artırmak ve ekşi maya ile hazırlanan ekmekleri vurgulayarak fırın işletmenizin tercih edilme oranını yükseltmek için sunulmaktadır.

KATKI ORANI BEYANI VE ÇIKAR ÇATIŞMASI BİLDİRİMİ

Sorumlu Yazar *Responsible/Corresponding Author*	Cevat ERCİK
Makalenin Başlığı *Title of Manuscript*	Farkli maya türlerinin ekmek üretiminde kullanılmasınıntüketici tercihleri üzerindeki etkisi: lezzette karşılaştırmalı inceleme
Tarih *Date*	30.06.2024
Makalenin türü (Araştırma makalesi, Derleme vb.) Manuscript Type (Research Article, Review etc.)	Araştırma Makalesi

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1	Cevat ERCİK	%100	-	Araştırmaya katılanlara teşekkür ediyorum.