Level of Knowledge and Awareness of Consumers About Food Additives in Türkiye

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Geliş tarihi / *Received*: 02.12.2024 **Kabul tarihi / *Accepted:* 22.03.2025**

Abstract

In modern times, individuals' health is significantly influenced by their consumption habits and behaviors. This study was designed to examine the knowledge levels and awareness of consumers in different regions of Türkiye regarding food additives. A stratified sampling method focusing on the seven geographical regions of the country was employed. Using a correlational design, the study examined relationships between acceptability, risk perception, and benefit perception, as well as key factors influencing consumer behavior. The findings revealed no significant difference between genders and the perception of food additives. Additionally, no significant relationship was found between consumers' regions of residence and their acceptability of additives, risk perception, trust in legal regulations, or knowledge of these regulations. Participants residing in the Mediterranean region showed greater sensitivity to natural products, highlighting the importance of considering regional differences in product ingredients and production processes. The study results indicated colorants were the most well-known additives, while starch, agar-agar, and gelatin were recognized as the most familiar thickeners. Furthermore, the study concluded that participants perceived corn starch, agar-agar, pectin, and BHA as harmful additives, while aspartame was regarded as the least harmful additive. Findings underscore the need for consumer education on food additives to foster informed decision-making.

Keywords: *Food additives, colorants, sweeteners, consumer, perception, awareness*

DOI: 10.17932/IAU.GASTRONOMY.2017.016/gastronomy_v09i2002

Introduction

In the 21st century, with the increased accessibility of food, individuals can easily meet their nutritional needs (Fanti et al., 2021). The involvement of many food components in various production processes has increased food diversity and emphasized the importance of food additives (Zavitsanou & Drigas, 2021). Food additives are substances that, when consumed alone, have no nutritional value; however, when incorporated into the production process, they enhance the flavor, color, texture, and safety of the food (Chazelas et al., 2020; Kwon et al., 2023; Zang et al., 2023). Although food additives have been used for centuries for food preservation and flavor enhancement, they began to be widely used in the food industry at the beginning of the 20th century. Due to technological advancements and the growing demand for food, food additives that have lost their natural properties have become a potential health risk for consumers. When assessing the health impacts of food additives, it is acknowledged that while differing opinions exist, the appropriate use of additives in controlled amounts is not likely to pose any harm (Kwon et al., 2023; Zang et al., 2023).

According to the United Nations Population Fund's 2020 report, the global population, around 8 billion and continuing to grow, poses a significant challenge to maintaining the food supply chain. Studies emphasizing the harmfulness of food additives have led to the banning of certain additives or negative perceptions among consumers (Miao et al., 2020; United Nations Population Fund, 2020). In Türkiye, the Turkish Food Codex Regulation has been prepared to ensure the safe use of food additives (Topçu et al., 2005). However, the unconscious use of food additives can pose health risks, making effective inspection and consumer education essential. Additionally, research on artificial food colorants and sweeteners has revealed that accurate information and preferences for natural products play a significant role in shaping consumer attitudes (Bearth et al., 2014; Gültekin, 2011). Studies on the consumption rates of food additives have shown that various additives are used extensively (Chazelas et al., 2021). However, consumers' lack of knowledge about additives often indicates their inability to distinguish between risky and appropriate additives (Borda et al., 2021). Labeling additives on food packaging is mandatory, and manufacturers are required to list the name and function of each additive. Nonetheless, it has been observed that consumers are unaware of the functions and benefits of additives, with some even perceiving them as more dangerous to food safety than microorganisms (Shim et al., 2011).

This research was conducted to improve the processes related to consumers' food choices and to enable consumers to make informed decisions. In addition, it was aimed to examine consumers' prejudices, knowledge levels and awareness of food additives.

Literature Review

The use of food additives dates back to early periods in human history, and these substances have been employed to enhance the appearance, taste, and shelf life of foods. In ancient Egypt, as early as 1500 BC, natural extracts were used to improve the color and brightness of sugars. In later periods, spices and other plant extracts were commonly used to add color, aroma, and flavor to foods (Sun & Wang, 2017). From the 18th century onwards, additives became more widespread, with natural and synthetic substances being utilized. Today, food additives are used to maintain the safety and freshness of foods and improve their taste and appearance. However, the potential adverse effects on health must not be overlooked. While food additives significantly benefit the food industry, they also require toxicological evaluations and toxicity testing. In the European Union and Türkiye, the use of food additives is regulated through various laws, and these substances are identified by

E-numbers (Baydan & Ceyhun Sezgin, 2021; Küşümler & Özgün, 2020; Sarıcan et al., 2024; Ünlü & Bayır, 2022).

Since food additives are used during food production, processing, storage, and packaging, they have become integral to modern technology. These additives include enhancing nutritional value, preventing microbiological spoilage, improving physical structure, and boosting overall quality (Yurttagül, 1991). They are substances added to foods to improve their appearance and taste and prevent spoilage, often without contributing any nutritional value. These substances preserve or enhance the taste, smell, appearance, and other properties of foods during processing and storage (Grujić et al., 2013; Gül et al., 2023; Martins et al., 2019; Yörük & Danyer, 2016). In a competitive global market, cost-effective preservation methods are prioritized, and food additives are typically chosen due to their ability to efficiently meet market and regulatory demands (Carocho et al., 2015). Synthetic additives have emerged in response to the needs of the food industry and are now widely used. As of the 21st century, over 1500 additives are used in the European Union, 2000 in China, and more than 4000 in the United States (Zhou et al., 2023).

Food additives fulfill technological functions such as pH control, viscosity regulation, stabilization, and homogenization, as well as sensory functions like enhancing color, smell, and taste (Martins et al., 2019). These additives, categorized into 25 classes and encompassing around 230 different compounds, aim to improve food quality, prevent spoilage, and enhance aesthetic properties (Küşümler & Özgün, 2020). Clear and prominent messaging on food packaging and labels is crucial for raising consumer awareness. Furthermore, educating parents on health and nutrition regarding their children's diets is critical in protecting public health (Karatepe & Ekerbiçer, 2017).

The potential adverse health effects of food additives necessitate their inclusion only in quantities prescribed by legal regulations and by technological requirements (Eroğlu & Ayaz, 2018). Even the long-term consumption of low doses of risky additives can cause health problems, thus necessitating careful monitoring (Batiha et al., 2021; Saraiva et al., 2020). Awareness of the negative health effects of food additives can significantly influence consumer perception. Consumers may develop different attitudes based on the names of additives, with terms like "E-numbers" often leading to perceptions of additives as more artificial and harmful (Evans et al., 2010; Siegrist & Sütterlin, 2017). This perception can affect consumer trust and purchasing behavior (Miao et al., 2020). Additionally, there is a more positive perception of additives derived from natural sources, while prejudices exist against chemicals (Varela & Fiszman, 2013). Some food additives have been associated with headaches, depression, sleep disorders, aggressive behavior, behavioral problems, or even cancer (Awuchi et al., 2020). Although food additives play an important role in the food industry, their use must be approached cautiously due to their potential adverse effects on health. Addressing consumers' knowledge gaps about additives and continuously evaluating their health impacts is critical for food safety. Furthermore, the proper use of additives in compliance with legal regulations and the enhancement of consumer awareness is fundamental to promoting healthy food consumption habits (Bilgin et al., 2022; Bosi et al., 2007; Martins et al., 2019).

Consumer perceptions of food additives and processed foods tend to be negative. Names of additives that heighten perceptions of health risks and the positive image of natural ingredients can influence consumer attitudes (Varela & Fiszman, 2013). While most additives pose minimal health risks, certain substances cause concern due to potential acute intolerances, al-

lergic reactions, or long-term health risks such as cancer (Mepham, 2011). The foods, medicines, and food additives consumed can positively and negatively affect gut microbiota health. To maintain beneficial bacteria levels in the gut and increase microbiota diversity, attention should be paid to the foods and medicines consumed (Mendeş & Arslan, 2024).

Method

This study aims to examine consumers' knowledge levels and perceptual differences regarding food additives. It employs a relational design, which is a type of quantitative research design. Relational design is a research method used to identify the relationships between two or more variables and to determine the direction and degree of these relationships (Creswell, 2014). Since this design focuses on understanding existing relationships rather than cause-and-effect relationships between variables, it is ideal for analyzing complex and multidimensional constructs such as consumer perception (Kavlak & Aksu, 2023). For instance, it is critical in this study to understand the relationships between variables such as acceptability, risk perception, and benefit perception and to reveal the fundamental dynamics influencing consumer behavior. The relational design allows researchers to interpret findings by directly analyzing them and increasing the generalizability of results, thus catering to a broader audience. Therefore, it is considered that the relational design is the most suitable approach for this study analyzing consumer perceptions.

The ethical approval required for the data collection in this study was obtained from the Ankara Hacı Bayram Veli University Ethics Committee, with the decision/number 16.12.2022-149105.

Study population and sample

In this study, the entire country of Türkiye is considered the study population. The sample was constructed using the stratified sampling method, one of the probability sampling techniques. Stratified sampling involves treating each stratum (region) as a homogeneous subgroup and selecting random samples from each stratum while considering the population's heterogeneous nature (Neuman, 2014).

Each region of Türkiye was considered a stratum, and a specified number of cities from each stratum were selected as part of the sample. The main criterion for selecting regions was considering cities with the highest population density within each region for the research scope. The regions and the selected cities are listed below:

Mediterranean Region: Adana, Antalya, Burdur, Hatay, Isparta, Mersin, Kahramanmaraş, Osmaniye
Eastern Anatolia Region: Ağrı, Hakkâri, Muş, Tunceli, Van
Aegean Region: Afyon, Aydın, Denizli, İzmir, Kütahya, Manisa, Muğla
Southeastern Anatolia Region: Adıyaman, Batman, Gaziantep, Mardin, Şanlıurfa
Central Anatolia Region: Aksaray, Ankara, Eskişehir, Kırıkkale, Konya, Nevşehir, Yozgat
Black Sea Region: Giresun, Ordu, Samsun, Trabzon
Marmara Region: Balıkesir, Bursa, Çanakkale, İstanbul, Tekirdağ, Zonguldak

This approach allows for comprehensive coverage of Türkiye's diverse geographic and demographic landscape, ensuring that the sample reflects regional variations in consumer perceptions of food additives.

The results of the descriptive analysis of the participants are presented in Table 1.

Table 1
Descriptive analysis results of participants

Parameters	Groups	n	%
Gender	Male	228	58.6
	Female	161	41.4
	Total	389	100
Perceived income	Low	52	13.4
	Middle	193	49.6
	High	144	37.0
	Total	389	100
Region of residence	Mediterranean	144	37.0
	Central Anatolia	164	42.2
	Other regions	81	20.8
	Total	389	100

Data collection
In this study, (1) the participant form created by the researchers, (2) the 'Consumers' perceptions of artificial food additives' questionnaire developed by Bearth et al. (2014), and (3) the 'Consumers' knowledge and perceptions of hydrocolloids used in foods' questionnaire developed by Varela & Fiszman (2013) were used as data collection tools. The participant form created by the researchers included information on the gender, region of residence, and perceived income levels of the individuals included in the study.

Survey on consumers' perceptions of artificial food additives
The questionnaire used as a data collection tool in the study is the "Consumers' perceptions of artificial food additives" questionnaire developed by Bearth et al. (2014). The questionnaire was designed to examine the consumers' knowledge and perceptions about artificial food additives. The questionnaire consists of six sub-dimensions: acceptability, risk perception, benefit perception, trust in regulators, preference for natural products, and information about regulations. The questionnaire was designed to examine the level of knowledge and awareness of consumers in different regions of Türkiye about food additives. Qualitative and quantitative analysis methods evaluated the data obtained.
Acceptability: Consists of seven items, with a Cronbach's alpha coefficient of .84 for colors and .81 for sweeteners.

Risk perception: Consists of six items, and Cronbach's alpha value for both versions is .93.

Benefit perception: Consists of three general and three specific items with a single-factor solution for tastes (Cronbach's Alpha: .79) and six items with a two-factor structure for colors (Cronbach's Alpha: .70).

Trust in Regulations: Consists of three items, and Cronbach's alpha value for both versions is .94.

Natural Product Preference: Consists of six items, with a Cronbach's alpha of .87 for colors and .89 for sweeteners.

Consumers' Knowledge of Regulations: Consists of ten items and is scored according to the correct or incorrect answers given by the respondents.

Table 2
Reliability results of the study

Consumer perception of artificial food additives questionnaire sub-dimensions		
	Cronbach's Alpha Value	n
Acceptability	0.70	11
Risk perception	0.71	8
General and specific risk perception	0.83	16
Trust in regulations (Codex, Legislations)	0.88	5
Natural products preference	0.93	12
Consumers' knowledge on regulations	0.87	16
Total	0.91	68

The reliability coefficients (Cronbach's Alpha) obtained in this study are presented in Table 2. Analysis results greater than 0.70 indicate the reliability of the measurement tool (George & Mallery, 2010).

Survey on consumers' knowledge and perceptions of additives and hydrocolloids used in foods

The questionnaire used as a data collection tool in the last part of the study was developed by Varela & Fiszman (2013) to measure consumers' knowledge and perceptions about food additives and hydrocolloids. The questionnaire consists of six questions, including 13 different additives: corn starch, gelatin, agar-agar, carrageenan, and guar gum. The internal consistency of the questionnaire was checked by reliability tests. The questionnaire was used to collect data from 140 participants aged 22-66 years and adapted for this study.

Data analysis

The data obtained in the research was analyzed through the 'Jamovi' package program. Jamovi is an open-source and user-friendly statistical analysis software. Designed for both academic and professional users, Jamovi offers a variety of statistical tests, data visualization tools, and reporting features (www.jamovi.org). In the first data analysis stage, homogeneity analysis was performed to decide which analysis to conduct. Homogeneity analysis is a technique used to assess the distribution of the data set and whether the variance between groups is equal (Tabachnick et al., 2013). This analysis is particularly critical to ensure the validity of parametric tests such as analysis of variance (ANOVA). The skewness and kurtosis test measured the homogeneity results for this data set (Table 3).

Table 3
Homogeneity results

	Gender	Perceived income	Region of residence
n	389	389	389
Skewness	0.351	-0.317	-0.216
Error margin	0.124	0.124	0.124
Kurtosis	-1.89	-0.803	-1.54
Error margin	0.247	0.247	0.247

The fact that the skewness and kurtosis test results are within ±2 is stated as a prerequisite for a homogeneous data set (George & Mallery, 2010). In this context, parametric tests were applied. Firstly, the difference between gender, one of the independent variables, and the dependent variable, 'Consumers' perceptions towards artificial food additives', was analyzed through a t-test. The 'Significance Test' (One Way ANOVA) was used to analyze whether there is a significant difference between the other independent variables, the region and economic status of the person, and the perception towards artificial food additives. In addition, a 'Pearson Correlation' test was performed for the participants' perception of artificial food additives. In the other stage of the analysis, open-ended questions prepared for "Consumers' knowledge and perceptions about additives and hydrocolloids used in foods" were evaluated by the content analysis method, and the answers given by the consumers were presented as word clouds. In the last stage of the analysis, consumers' perceptions of the harmfulness of additives were quantitatively evaluated.

Results and Discussion

A t-test was conducted to determine the difference between the participants' gender variable and their perception of artificial food additives (Table 4).

Table 4

Difference analysis results in terms of gender

Dimension	Gender	n	x	ss	t	p
Acceptability	Male	228	2.73	0.51	-1.479	0.14
	Female	161	2.82	0.65		
Risk perception	Male	228	3.15	0.61	1.483	0.14
	Female	161	3.05	0.76		
General and specific risk perception	Male	228	2.79	0.57	-0.595	0.55
	Female	161	2.82	0.67		
Trust in regulations (Codex, Legislations)	Male	228	2.84	0.86	-0.398	0.69
	Female	161	2.88	0.91		
Natural products preference	Male	228	3.74	0.86	1.553	0.12
	Female	161	3.6	0.90		
Consumers' knowledge on regulations	Male	228	3.08	0.57	0.699	0.49
	Female	161	3.04	0.67		

According to the independent sample t-test results between the gender variable and perception towards artificial food additives (t (-1.479) = P >0.05; t (1.483) = P >0.05; t (-0.595) = P >0.05; t (-0.398) = P >0.05; t (1.553) = P >0.05; t (0.699) = P >0.05), no significant difference was found between men and women (Table 4). Bärebring et al. (2020) reported that women avoid more additives, such as preservatives and colorings than men due to their perceived greater unhealthiness towards food additives. It was also found that women were more concerned about an unhealthy diet than men. In this study, gender did not affect the perception of artificial food additives. This can be evaluated within cultural, socioeconomic, educational, and social differences between countries. A one-way analysis of variance (ANOVA) was performed to determine the difference between the perception of artificial food additives and the region where the participants lived (Table 5).

Table 5

Analysis results for region of residence variable

Dimension	Region of residence	n	x	sd	df	f	P
Acceptability	Mediterranean,	144	2.77	0.53	2-203	0.037	0.964
	Central Anatolia,	164	2.76	0.59			
	Eastern Anatolia, Southeastern Anatolia, Aegean, Black Sea, Marmara	81	2.78	0.64			
Risk perception	Mediterranean,	144	3.05	0.64	2-203	1.786	0.170
	Central Anatolia,	164	3.19	0.69			
	Eastern Anatolia, Southeastern Anatolia, Aegean, Black Sea, Marmara	81	3.06	0.63			
General and specific risk perception	Mediterranean,	144	2.77	0.61	2-203	0.392	0.676
	Central Anatolia,	164	2.83	0.63			
	Eastern Anatolia, Southeastern Anatolia, Aegean, Black Sea, Marmara	79	2.79	0.60			
Trust in regulations (Codex, Legislations)	Mediterranean,	144	2.85	0.83	2-203	0.008	0.992
	Central Anatolia,	164	2.86	0.92			
	Eastern Anatolia, Southeastern Anatolia, Aegean, Black Sea, Marmara	81	2.86	0.89			
Natural products preference	Mediterranean,	144	3.89	0.85	2-203	6.419	**0.002**
	Central Anatolia,	164	3.56	0.87			
	Eastern Anatolia, Southeastern Anatolia, Aegean, Black Sea, Marmara	81	3.58	0.89			
Consumers' knowledge on regulations	Mediterranean,	144	2.99	0.56	2-203	2.107	0.124
	Central Anatolia,	164	3.12	0.62			
	Eastern Anatolia, Southeastern Anatolia, Aegean, Black Sea, Marmara	81	3.10	0.68			

P >0.05

According to the result of the "ANOVA" test: No significant difference was found between the region of residence and acceptability (f (0.037), 0.964 = *P* >0.05), risk perception (f (1.786), 0.170 = *P* >0.05), general and specific risk perception (f (0.392), 0.676 = *P* >0.05), trust in regulations (codex, legislations) (f (0.008), 0.992 = *P* >0.05) and consumers' knowledge of regulations (f (2.107), 0.124 = *P* >0.05). However, a significant difference was found between regions in terms of preference for natural products (f (6.419), 0.002 = *P* <0.05). The post-hoc Games Howell test was conducted to determine the significant difference between regions.

A significant difference was found between all other regions, favoring the Mediterranean re-

gion. The Mediterranean region is the dominant geography where the Mediterranean diet was born. This diet is based on minimally processed organic foods (Guasch-Ferre & Willett, 2021). The data obtained in this study show that participants living in the Mediterranean region are more sensitive about their preference for natural products. The Mediterranean diet is based on the consumption of fresh and natural products, and it can be interpreted that the people of the region are more sensitive about preferring natural products thanks to the health awareness provided by this diet. One-way analysis of variance (ANOVA) was performed to determine the difference between the perceived income variable and the perception towards artificial food additives (Table 6).

Table 6
Analysis results of perceived income status variable

Dimension	Perceived income status	n	x	sd	df	f	P
Acceptability	Low	52	2.90	0.63	2-137	1.428	0.243
	Middle	193	2.73	0.56			
	High	144	2.77	0.57			
Risk perception	Low	52	3.08	0.77	2-137	2.180	0.117
	Middle	193	3.18	0.62			
	High	144	3.03	0.71			
General and specific risk perception	Low	52	2.84	0.63	2-137	0.140	0.87
	Middle	193	2.81	0.56			
	High	144	2.78	0.68			
Trust in regulations (Codex, Legislations)	Low	52	2.90	0.94	2-137	0.082	0.922
	Middle	193	2.86	0.86			
	High	144	2.84	0.89			
Natural products preference	Low	52	3.76	0.82	2-137	0.355	0.702
	Middle	193	3.66	0.83			
	High	144	3.70	0.96			
Consumers' knowledge on regulations	Low	52	3.15	0.62	2-137	2.011	0.138
	Middle	193	3.11	0.57			
	High	144	2.98	0.66			
P >0.05							

According to the results of the "ANOVA" test: No significant difference was found between perceived income variable and acceptability (f (1.428), 0.243 = P >0.05), risk perception (f (2.180), 0.117 = P >0.05), general and specific risk perception (f (0.140), 0.87 = P >0.05), trust in legal regulations (codex, legislations) (f (0.082), 0.922 = P >0.05), natural product preferences (f (0.082), 0.702 = P >0.05), and consumers' knowledge about legal regulations (f (2.011), 0.138 = P >0.05). This indicates no relationship between the perceived economic status variable and the perception towards artificial food additives. Grujic et al. (2013) reported that economic status significantly affects food preferences, especially among young individuals. Although this does not affect the level of knowledge and awareness about food additives,

it is a known fact that young people, especially those with low economic status, generally prefer affordable food products. These products are usually low-cost, mass-produced foods with high levels of additives.

Table 7

Correlation test results for participants' perception of artificial food additives

	n		1	2	3	4	5	6
1. Acceptability	389	Pearson's r	-					
		P value						
2. Risk perception		Pearson's r	0.164	-				
		P value	0.001					
3. General and specific risk perception		Pearson's r	0.332	0.238	-			
		P value	<.001	<.001				
4. Trust in legal regulations (codex, legislations)		Pearson's r	0.302	0.130	0.285	-		
		P value	<.001	0.010	<.001			
5. Natural products preference		Pearson's r	0.054	0.421	0.06	0.133	-	
		P value	0.289	<.001	0.244	0.009		
6. Consumers' knowledge of legal regulations (codex, legislations)		Pearson's r	0.248	0.38	0.355	0.297	0.411	
		P value	<.001	<.001	<.001	<.001	<.001	-
Pearson Correlation Test								

According to the relationship test results for participants' perception of artificial food additives, a low positive relationship was found between acceptability and risk perception (r = .164, *P* <.001). A low positive relationship was also observed with general and specific risk perception (r = .332, *P* <.001), trust in legal regulations (codex, legislations) (r = .302, *P* <.001), and consumers' knowledge of legal regulations (r = .248, *P* <.001). However, no significant relationship was found between acceptability and natural product preferences (r = .0548, *P* >.05).

A moderate positive relationship was found between risk perception and general and specific risk perception (r = .238, *P* < .001), trust in legal regulations (codex, legislations) (r = .130, *P* < .010), natural product preferences (r = .421, *P* < .001) and consumers' knowledge of legal regulations (r = .355, *P* < .001). In terms of trust in legal regulations (codex, legislations), a low positive relationship was observed between general and specific risk perception (r = .285, *P* < .001) and consumers' knowledge of legal regulations (r = .355, *P* < .001). A moderate positive relationship was found between natural product preferences and consumers' knowledge of legal regulations (r = .411, *P* < .001) (Table 7).

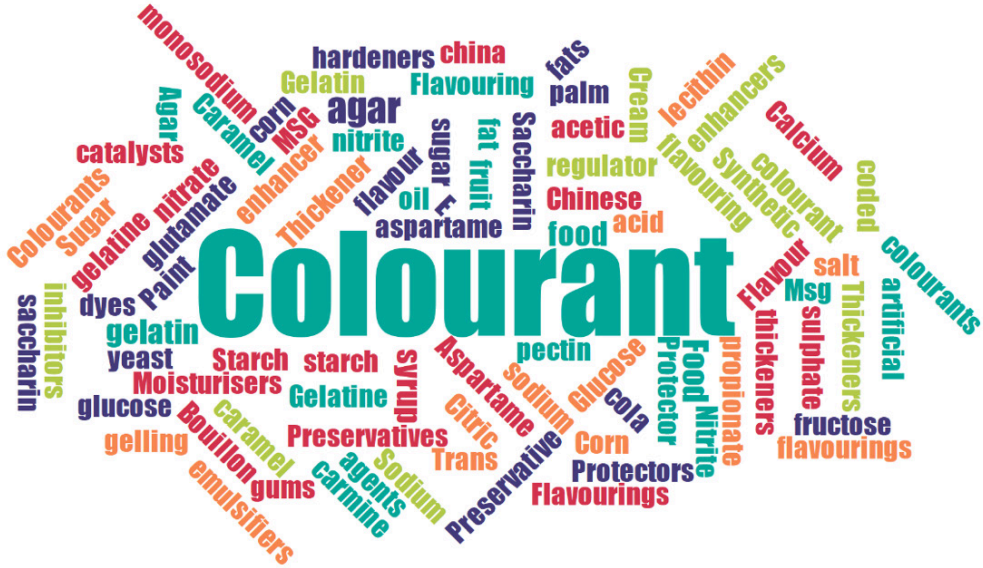
Figure 1

Word cloud on consumers' perception levels of food additives

Within the scope of the study, the participants were asked the following question: "Indicate the first words, definitions, associations, thoughts, or feelings that come to mind when you think of food additives." A total of 229 participants answered this question. The percentage of respondents who characterized food additives as "harmful" was 20% (60 people). In addition, 40% of the participants (120 people) used the terms "colorants," "sweeteners," and "unhealthy." This shows many participants with negative feelings about food additives (Figure 1). The data reveals a generally negative perception of food additives and the subconscious concerns of consumers. Research shows that factors such as lack of information and misunderstandings, conspiracy theories, past scandals, and media inaccuracies combine to form consumer biases (Le Bouthillier et al., 2021; Tsai et al., 2016).

Figure 2

Word cloud on consumers' perception levels of various food additives



In the study, participants were asked, "List all food additives you know." A total of 280 responses were received. Of the more than 50 additives in the list, "colorants" were the most commonly mentioned additive (30% - 84 respondents). On the other hand, "agar-agar," "gelatin," and "sweeteners" were mentioned by 5% - 12 people (Figure 2). Colorants and thickeners are among the most widely known and recognized food additives by the general consumer population (Varela & Fiszman, 2013).

Figure 3

Consumers' level of knowledge about thickening additives

The participants were asked, "What are the thickening additives you know?" A total of 154 people responded to this question, and the most frequently mentioned thickeners were "starch" (51%, 78 people), "agar" (38%, 59 people), and "gelatin" (27%, 42 people) (Figure 3).

Figure 4

Word cloud for thickening foods

Within the scope of the study, participants were asked, "List the foods you normally buy that you think to contain thickeners." A total of 188 participants responded to this question, and the most common ingredients were starch (19%, 35 people), agar (17%, 32 people), soups (7%, 13 people), and sauces (6%, 11 people) (Figure 4). In the study, participants were asked whether 13 additives with various functions were healthy or not, and the results obtained were analyzed descriptively (Table 8).

Table 8
Findings on the harmfulness perception of food additives

	Additives	n (389)	x	sd
1	Agar-agar		2.51	1.01
2	Carmine		2.27	0.93
3	Acetic acid		2.28	1.04
4	Corn starch		2.92	1.10
5	Gelatin		2.30	1.06
6	Ascorbic acid		2.39	1.06
7	Monosodium glutamate		2.30	1.01
8	Saccharine		2.40	0.96
9	Pectin		2.47	1.03
10	BHA		2.45	1.03
11	Tocopherol		2.44	1.08
12	Anthocyanin		2.35	0.97
13	Aspartame		2.25	1.01

As a result of the analysis, it was concluded that corn starch (x=2.92), agar-agar (x=2.51), pectin (x=2.47), and BHA (x=2.45) were perceived as harmful additives, whereas aspartame (x=2.25) was perceived as the least harmful additive with the lowest average. In this part of the study, very interesting results were obtained about the participants' perceptions of the harmfulness of food additives. Corn starch, agar-agar, and pectin are generally derived from natural and plant sources and are widely used in food production. However, a lack of knowledge about these ingredients may have contributed to the perception of these additives as harmful. In particular, the association of "starch" with processed and refined foods may contribute to the perception of corn starch as harmful. Similarly, the widespread use of sweeteners such as aspartame in diet products or for health problems such as diabetes and promoting these products as healthy may have led participants to perceive aspartame as less harmful than other additives. Consumers may also perceive sweeteners as harmless because they do not contain calories. BHA has a negative public perception due to its potentially harmful effects (Anand & Sati, 2013). Therefore, it is understandable that BHA is perceived as harmful. These additives have been recognized as safe by many international health authorities. Still, it is recommended to avoid excessive consumption of foods containing these additives and to pay attention to a balanced and natural diet (Yeung et al., 2021).

Conclusion

This study analyzed the knowledge and awareness of consumers living in different regions of Türkiye about food additives. The study contains interesting results in parallel with the scientific studies. As a result of the study, no significant difference was found between the gender variable and the perception of food additives. This may indicate that awareness and perception of food additives are at similar levels regardless of gender. These data emphasize the importance of general knowledge and awareness-raising studies rather than focusing on gender differences for future research and training programs. Another important result of the study is that there is no relationship between the acceptability of additives, risk perception, trust in legal regulations, knowledge about legal

arrangements, and the region where consumers live. In other words, the geographical region where consumers live does not determine their attitudes on these issues.

A significant difference was found in the preference for natural products according to the region of residence. Consumers living in the Mediterranean region were found to be more sensitive. It is important to develop and manage products in line with local consumer preferences and to consider regional differences in product components and production processes. For example, in the Mediterranean region, education and information campaigns can be organized to market natural and organic products, while in other regions, education and information campaigns can be organized to provide accurate information on additives, risk perception, and trust in legal regulations, and to increase positive sentiment towards natural products.

The result that economic status does not affect consumers' perception of artificial food additives shows that the level of awareness is shaped independently of economic conditions. The fact that "harmful" and "unhealthy" are the first expressions that come to consumers' minds regarding food additives shows a general negative perception of food additives. This may indicate that consumers are conscious and sensitive about this issue. Factors such as health concerns, preference for natural food, and nutritional quality may be the main reasons behind this negative perception. The food industry must adopt approaches such as reducing additives and emphasizing natural ingredients to meet consumer demands. The fact that the majority of respondents focused on color in food additives suggests that consumers care about the perceptual and visual effects of colors in food products and are more knowledgeable about these additives. Few respondents listed the names of food additives, indicating a low awareness of specific or less commonly used additives. This suggests that consumers have limited knowledge about popular or frequently used additives.

The findings suggest that consumers should have more knowledge about food additives. Participants' answers about thickening additives generally contain accurate and consistent information. According to the participants, corn starch, agar-agar, pectin, and BHA additives are considered more harmful than others. This perception may be influenced by media reports, lack of information, or unconsciously disseminated information. Public disclosure by regulators of fraudulent food businesses contributes significantly to consumer awareness. These disclosures help consumers to improve their label reading habits and choose more trustworthy brands, while at the same time increasing regulatory oversight over companies by creating public pressure on food safety. This process not only protects consumers from health risks by partially preventing the use of additives with proven or as yet unknown side effects, but also prevents unfair competition, supports honest producers, and contributes to the development of a more transparent and reliable food market.

One of the prominent aspects of the study is that it provides strategic recommendations for consumer education and the food industry, particularly by identifying the most and least known types of additives. Additionally, while colorants and thickeners like agar-agar are widely recognized, awareness of specific additives remains low, highlighting the need to examine consumers' information sources and how their perceptions are shaped. However, the fact that agar-agar, pectin, and BHA are perceived as the most harmful additives, while aspartame is considered the least harmful, offers valuable insights into how consumers are influenced by scientific studies and media discourses. The study’s findings provide important data for developing consumer education and food labeling policies and

underscore the need for more effective awareness campaigns involving the food industry, health authorities, and the media. In this context, the study may contribute to future research and serve as a foundation for studies exploring in greater detail the factors that shape consumer perception.

Consumers should be provided with robust and reliable information about the real effects of additives. The low level of perceived harmfulness of aspartame can be attributed to the different opinions reported by some scientific studies and health authorities. Reports and articles from media and communication channels that emphasize that aspartame is safe or its dangers are exaggerated can create a positive perception among consumers. Furthermore, aspartame is widely used as a low-calorie sweetener in many foods and beverages. Consumers may perceive a substance they frequently encounter as harmless or low-harm in everyday life. There is a need for clear and scientifically based information on the safety of such additives. Better communication and collaboration between the food industry, health authorities, and consumers can address concerns and gaps.

Declaration

All authors of the article contributed equally to the article process. The authors have no conflicts of interest to declare.

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