The European Research Journal 2026;12(7):760-769 Research Article

DOI: https://doi.org/10.18621/eurj.1829545 *Public Health*

Awareness, Knowledge and Consumption of Postbiotics Among Students at Two Different Universities in Türkiye: A Cross-Sectional Survey

Ayşe Nur Kahve[1], Yağmur Yıldız[1]

[1]*Department of Field Sports and Health, Aksaray University, Aksaray, Türkiye*

Abstract:

Objective: Postbiotics, defined as non-viable microbial cells or their components that provide health benefits, are emerging as an important topic in functional food research. However, awareness and consumption among young adults remain limited. This study aimed to evaluate the awareness and knowledge levels of postbiotics among university students.

Methods: The study population included 346 students who completed a questionnaire consisting of 17 demographic and lifestyle questions and a 20-item postbiotic knowledge scale adapted from a validated tool. Descriptive statistics were used to analyze the data.

Results: It was revealed that 86.1% (n=298) of the students included in this study had never heard of postbiotics and 96.2% (n=333) had never used postbiotic supplements. Overall, 48.8% (n=169) of participants had a poor, 39.0% (n=135) a moderate, and 11.8% (n=41) a good knowledge level. Female students demonstrated significantly higher knowledge scores than males ($P<0.05$).

Conclusion: The findings indicate that university students have limited awareness and consumption of postbiotics. Contributing factors may include insufficient promotion, inadequate understanding of health benefits, and limited market availability of postbiotic products. To improve awareness, it is recommended that educational activities be organized in universities to enhance students' understanding of postbiotics and encourage their inclusion in health-promoting dietary habits.

Keywords: Functional Foods, Health Behavior, Knowledge, Postbiotics, Students

Functional foods can be defined as products specifically designed to meet any requirements in terms of functionality, nutrition, suitability, and medicinal properties [1]. The importance of biotics in the development of functional foods is widely recognized. Probiotics in supplement form are the most prominent component among functional foods in terms of their health effects. It has long been known that non-viable microorganisms, their cellular components, and metabolites can also influence health [2]. A variety of different terms, such as non-viable probiotics, heat-killed probiotics, cell lysates, paraprobiotics, and postbiotics, have begun to be addressed in various studies [3]. The term postbiotic originates from the Greek words "post," meaning after, and "bios," meaning life. It belongs to the

Submitted: November 24, 2025 **Accepted:** January 28, 2026 **Published Online:** January 31, 2026

How to cite this article: Kahve AN, Yıldız Y. Awareness, Knowledge and Consumption of Postbiotics Among Students at Two Different Universities in Türkiye: A Cross-Sectional Survey. *Eur Res J.* 2026;12(7):760-769. doi: 10.18621/eurj.1829545

Corresponding author: Ayşe Nur Kahve, PhD., Phone: +90 382 288 32 57, E-mail: aysenurkahve@aksaray.edu.tr

Available Online at https://www.eurj.org.tr

broader "biotic" family encompassing probiotics, prebiotics, synbiotics, and postbiotics all of which are associated with microorganisms or their substrates. Accordingly, postbiotics are defined as products that remain once microorganisms are no longer viable, meaning they are dead, inactive, or non-living [2]. These substances generally consist of a heterogeneous mixture of microbial cell components and metabolites, including teichoic acids, exopolysaccharides, peptidoglycans, bacteriocins, among others.

The effectiveness of postbiotics is primarily driven by three mechanisms: providing protection against pathogens, strengthening the epithelial barrier, and regulating both inflammatory and immune processes [4]. At present, their use extends beyond the field of fermented foods, as they are also being explored as a potential therapeutic option for various health issues, especially gastrointestinal problems like bloating and diarrhea. Consequently, postbiotics are expected to play a pivotal role in complementing probiotics and advancing the broader health industry [5]. Although the mechanisms related to the health-improving effects of postbiotics are not fully understood, they are believed to positively influence microbiota homeostasis and/or signaling pathways in the host. It has been reported that postbiotics can provide potential effects such as anti-inflammatory, antimicrobial, anti-obesity, immunomodulatory, anti-cancer, antihypertensive, antioxidant, and hypocholesterolemic effects [6, 7].

Recent studies have highlighted the potential health benefits of postbiotics across various physiological systems. Postbiotics have been associated with improved gut barrier integrity, modulation of immune responses, and regulation of inflammatory pathways [8]. In addition, evidence suggests that postbiotics may exert beneficial effects in conditions such as irritable bowel syndrome, metabolic disorders, obesity, and infections by enhancing host–microbiota interactions [9]. Compared to live probiotics, postbiotics offer advantages including improved safety, longer shelf life, and stability, making them promising candidates for functional food and therapeutic applications [10].

A review of the literature shows that awareness of the postbiotic concept is increasing, and there has been a rise in scientific studies conducted in recent years [11, 12]. However, there is a lack of sufficient studies indicating the consumption status of postbiotics and the knowledge levels within the community. This study aims to evaluate the postbiotic knowledge level and consumption status of postbiotics among university students.

METHODS

The research is a cross-sectional study designed to determine university students' postbiotic knowledge levels and consumption.

Population and Sample of the Study

The study population consisted of undergraduate students enrolled in the Faculties of Health Sciences, Tourism, and Sports Sciences at Aksaray University and Gazi University during the 2023-2024 academic year. A convenience sampling method was used due to voluntary participation and accessibility constraints. Students who met the inclusion criteria and agreed to participate were included in the study. Inclusion criteria were being aged 18 years or older and being enrolled in one of the specified faculties during the data collection period. Exclusion criteria included incomplete questionnaires and refusal to participate. The minimum required sample size was determined by reviewing similar cross-sectional studies conducted among university students investigating nutrition-related knowledge and behaviors. [13, 14]. Based on these studies, a sample size exceeding 300 participants was considered sufficient to ensure adequate representation and statistical power. A total of 346 students participated in the study. Participants were recruited proportionally from the Faculties of Health Sciences, Tourism, and Sports Sciences to reflect faculty-based distribution at both universities.

Data Collection Tools

A questionnaire consisting of 17 questions about gender, height, age, chronic diseases, family income, and the frequency of probiotic food consumption, along with a 20-item scale assessing postbiotic knowledge, was administered to university students. The postbiotic knowledge level was modeled from a validated scale by Batmaz [15]. The Cronbach's alpha

reliability coefficient of the modeled scale was found to be 0.72. The items in the modeled scale were developed by the team members to gather information about postbiotic knowledge and preferences, and they were tested for validity among several microbiologists and participants before the start of the study. The questionnaire was administered by evaluating team members to ensure that it was presented and interpreted in a similar manner. The questions in this section were evaluated using a 5-point Likert scale, with response options ranging from "strongly disagree," "disagree," "neutral," "agree," to "strongly agree." The maximum score that can be obtained under the knowledge level category is 80. The scores obtained from the scale were categorized as poor, moderate, good, and very good. A score of 65 or higher from the section was considered very good. The frequency of consumption of foods that could increase postbiotic production among students was measured using a modified food frequency questionnaire. When determining the frequency of consumption of foods that could increase postbiotic production, certain references were taken into account. Since postbiotics can be obtained from probiotics or their inactivation, and because postbiotics are produced biotechnologically through fermentation, yogurt, kefir, cabbage, and pickled vegetables have been identified as relevant foods.

Ethical Aspect of the Research

The research was conducted in accordance with ethical guidelines, and all procedures were carried out in compliance with the principles of the Helsinki Declaration. Ethical approval for the study was obtained from the Aksaray University Human Research Ethics Committee (number: 2024/01-41). Before starting the research, students were given the necessary explanations about the study and its procedures. Afterward, verbal consent was obtained from the students, and the questionnaire was administered.

Statistical Analysis

The statistical analysis of the data obtained in the study was conducted using SPSS 26 (IBM SPSS, IBM Corporation, USA) software. Descriptive statistics, including frequencies and percentages, were used to present the demographic data and the postbiotic knowledge levels of university students. Some percentage rates presented in the tables were calculated based on the total number of participants who responded to that question. In other sections of the study, Chi- squared test, t-tests and one-way analysis of variance (ANOVA) were conducted based on the characteristics of the variables. In the one-way analysis of variance (ANOVA), Tukey analysis was used for significance testing. In the tables, the arithmetic mean

TABLE 1. Basic Information About Students

	Numbers (n)	Total (%)
Gender		
Female	173	50.0
Male	173	50.0
Departments		
Recreation	18	5.2
Nursing	42	12.1
Recreation anagement	52	15.0
Physical education eaching	37	10.7
Coaching education	152	43.9
Sports management	45	13.1
Class		
1	55	15.9
2	133	38.4
3	57	16.5
4	101	29.2
Chronic Disease		
Yes	12	3.5
No	334	96.5
Family or personal financial status		
Poor	24	6.9
Moderate	209	60.4
Good	106	30.6
Very good	7	2.1
	Average	**Min-Max**
Age (years)	21.55	17-42
BMI (kg/m^2)	22.26	15-41

BMI, body mass index; Min, minimum; Max, maximum

(x), standard deviation (sd), and P-value are provided. A P-value less than 0.05 was considered statistically significant for testing differences.

RESULTS

Sociodemographic Characteristics of Students

The mean age of the 346 participants was 21.55 years (range: 17-42). The gender distribution was equal, with 173 (50.0%, n=173) females and 173 (50.0%, n=173) males. Regarding academic disciplines, 12.1% (n=42) were enrolled in Health Sciences, 72.8% (n=252) in Sports Sciences, and 15.0% (n=52) in Tourism-related programs. Table 1 summarizes the demographic characteristics.

Students Postbiotic Consumption Status and Behaviors

When asked whether they had heard of the term "postbiotics," only 13.9% (n=48) of students responded affirmatively, while 86.1% indicated they had never heard of it. A total of 3.8% (n=13) of participants reported having used postbiotic supplements (4.0% n=7 of females vs. 3.5%, n=6 of males). Among those who had used postbiotics, the primary motivations included health-related concerns (30.8%, n=4), recommendations from others (46.2%, n=6), and advertisements (23.0%, n=3). The frequency of postbiotic supplement use was significantly lower among female students compared to males (P<0.001). Table 2 presents a detailed breakdown of students' awareness and consumption behaviors.

Consumption Frequency of Postbiotic-Enhancing Foods

Among foods associated with postbiotic production, yogurt was the most frequently consumed. Specifically, 24.6% (n=85) of students reported daily consumption, and 42.8% (n=148) consumed it twice weekly. Kefir had the lowest consumption rate, with 43.1% (n=149) of students reporting no intake at all. Sauerkraut was most often consumed biweekly 28.6%, (n=99), while 26.6% (n=92) of students reported never consuming pickled vegetables. Overall, pickled vegetables and sauerkraut were consumed more frequently than kefir. No statistically significant differences in food consumption patterns were observed between genders (Table 3).

Postbiotic Knowledge Levels of Students

Postbiotic knowledge was predominantly low

TABLE 2. Consumption Status and Behaviors of Students Regarding Postbiotics Products

	Total n (%)	Female n (%)	Male n (%)	P-value[a]
Have you ever heard of the term "postbiotics"?				
Yes	48 (13.9)	29 (16.8)	19 (11.0)	0.161
No	298 (86.1)	144 (83.2)	154 (89.0)	
Have you ever used a postbiotic supplement before?				
Yes	13 (3.8)	7 (4.0)	6 (3.5)	0.222
No	333 (96.2)	166 (96.0)	167 (96.5)	
If yes, what factors influence your consumption?				
Health Issues	4 (30.8)	4 (57.1)	-	0.097
Advice	6 (46.2)	1 (14.3)	5 (83.3)	
Advertisements	3 (23.0)	2 (28.6)	1 (16.7)	
If you use it, how often do you take postbiotic supplements?				
Frequently	5 (38.5)	2 (28.6)	3 (50.0)	**<0.001**
Rarely	8 (61.5)	5 (71.4)	3 (50.0)	

[a]Fisher's Exact test. Statistically significant P-value is shown in bold.

TABLE 3. Frequency of Consumption of Foods that May Increase Postbiotic Production

	Total n (%)	Male n (%)	Female n (%)	P-value*
Yogurt				
Once a day	85 (24.6)	43 (24.9)	42 (24.3)	X^2=1.384 0.926
2-3 times a day	23 (6.6)	13 (7.5)	10 (5.8)	
Twice a week	148 (42.8)	75 (43.4)	73 (42.2)	
Once every 15 days	65 (18.8)	29 (16.8)	36 (20.8)	
Once a month	20 (5.8)	10 (5.8)	10 (5.8)	
I never consume	5 (1.4)	3 (1.7)	2 (1.2)	
Kefir				
Once a day	26 (7.5)	15 (8.7)	11 (6.4)	X^2=7.200 0.206
2-3 times a day	11 (3.2)	3 (1.7)	8 (4.6)	
Twice a week	24 (6.9)	8 (4.6)	16 (9.2)	
Once every 15 days	88 (25.4)	48 (27.7)	40 (23.1)	
Once a month	48 (13.9)	27 (15.6)	21 (12.1)	
I never consume	149 (43.1)	72 (41.6)	77 (44.5)	
Sauerkraut				
Once a day	31 (9.0)	16 (9.2)	15 (8.7)	X^2=4.052 0.542
2-3 times a day	16 (4.6)	9 (5.2)	7 (4.0)	
Twice a week	92 (26.6)	38 (22.0)	54 (31.2)	
Once every 15 days	99 (28.6)	54 (31.2)	45 (26.0)	
Once a month	61 (17.6)	32 (18.5)	29 (16.8)	
I never consume	47 (13.6)	24 (13.9)	23 (13.3)	
Pickled vegetables				
Once a day	29 (8.4)	15 (8.7)	14 (8.1)	X^2=2.132 0.831
2-3 times a day	25 (7.2)	10 (5.8)	15 (8.7)	
Twice a week	66 (19.1)	33 (19.1)	33 (19.1)	
Once every 15 days	87 (25.1)	43 (24.9)	44 (25.4)	
Once a month	47 (13.6)	27 (15.6)	20 (11.6)	
I never consume	92 (26.6)	45 (26.0)	47 (27.2)	

*Pearson's chi-square test

among participants. According to categorized scale scores, 48.8% (n=169) had poor knowledge, 39.0% (n=135) moderate knowledge, 11.8% good knowledge, and only 0.4% (n=1) very good knowledge. Gender-based comparison revealed that 52.0% (n=90) of female students and 45.7% (n=79) of male students fell into the "poor" knowledge category (Table 4). The mean postbiotic knowledge score for female students was 45.99±7.54, while the mean score for male students was 45.91±7.88. Although the scores were close, the difference was statistically significant (P<0.001), suggesting higher awareness among female participants. Knowledge levels across academic departments showed no statistically significant differences suggesting higher awareness among female participants (Table 5). Knowledge levels across academic departments showed no statistically significant differences (P=0.291) (Table 6).

TABLE 4. Distribution of Participants Postbiotic Knowledge Levels by Gender

Postbiotic knowledge level	Female (n=173)		Male (n=173)		Total (n=346)	
Basic nutrition (Total score: 80)	**n**	**%**	**n**	**%**	**n**	**%**
Poor (<45)	90	52.0	79	45.7	169	48.8
Moderate (45-55)	64	37.0	71	41.0	135	39.0
Good (56-65)	18	10.4	23	13.3	41	11.8
Very Good (>65)	1	0.6	-	-	1	0.4

DISCUSSION

This study investigated postbiotic awareness, consumption behaviors, and knowledge levels among university students from diverse academic disciplines. Despite the growing scientific interest in postbiotics and their potential health benefits, our findings indicate a substantial gap in student knowledge and usage. The International Scientific Association for Probiotics and Prebiotics (ISAPP) defined postbiotics in 2021 as "a preparation of inanimate microorganisms and/or their components that confers a health benefit to the host." This definition proposed by ISAPP is comprehensive enough to allow for the development of postbiotics from various microorganisms and their application to different body sites. Beneficial effects can be evaluated or validated in humans, animals, and other target organs [2].

A study conducted among university students has shown that the average score regarding students' knowledge and perception of probiotics is good [16]. In a study that included healthcare personnel, it was found that 88% of the participants were familiar with the term "probiotic," while 22% were familiar with the term "prebiotic" [17]. In another study conducted with students, 56% of the participants were aware of the definition of probiotics; however, no student was able to answer questions related to the types of bacteria known as probiotics correctly [18]. In a study involving medical students, 57.3% of the students reported that they had never heard the definition of probiotics before [19]. Based on these results, it can be stated that students are familiar with definitions they may have heard in class or through casual conversations, but there is a need to increase their level of knowledge on this topic. In this study, it was found that 86.1% of the students had never heard of the concept of postbiotics (Table 2). It can be said that students' awareness of postbiotics may be low due to the fact that postbiotics is a relatively new concept and postbiotic supplements are not yet widely available on the market [20, 21]. However, this study concluded that only 3.8% of all students use postbiotics (Table 2). Based on this, it is anticipated that the usage rate will increase as awareness of the concept grows. When evaluated alongside the existing probiotic literature, the findings of this study are consistent with previous research demonstrating limited awareness and inconsistent consumption patterns of microbiota-related functional foods among university students.

TABLE 5. Average Postbiotic Knowledge Levels of University Students by Gender

Gender	n	Mean±SD	t	P-value
Male	173	45.91±7.88	0.096	**<0.001**
Female	173	45.99±7.54		

SD, standard deviation. Statistically significant P-value is shown in bold.

TABLE 6. Postbiotic Knowledge Averages of University Students by Academic Departments

Departments	n	Mean±SD	P-value
Recreation	18	47.55±6.98	0.291*
Nursing	42	44.95±7.16	
Recreation management	52	43.90±8.13	
Physical education teaching	37	45.10±6.78	
Coaching education	152	46.92±8.00	
Sports management	45	46.04±6.89	

SD, standard deviation.
*Tukey Test

Similar to studies on probiotics, knowledge levels regarding postbiotics were higher among female students, suggesting that gender-related differences observed in probiotic awareness may also extend to emerging concepts such as postbiotics. These parallels support the notion that postbiotics represent a natural extension of probiotic research rather than an isolated concept.

In this study, no literature was found regarding the frequency of postbiotic consumption, and instead, the studies on the frequency of probiotic food consumption were addressed due to the ability of probiotics to enhance postbiotics. Yalçın *et al*. [22] found in their study that yogurt was the most consumed probiotic food at 90.9%, followed by buttermilk at 59.6% and pickles at 55.6%, while kefir was not preferred. In a study consisting of athletes, the proportion of those who never consumed kefir was found to be 50%, while those who consumed kefir daily were limited to 3.3% [23]. In a study investigating the frequency of probiotic food consumption, the most frequently consumed probiotics among students were yogurt (82.4%), followed by Greek yogurt (55.9%), probiotic-added yogurt (42.4%), and kefir (9.3%) [15]. In this study, the proportion of those who consumed kefir daily was limited to 7.5%, which was lower than the daily consumption rates of other probiotic foods (Table 3). Based on these results, it can be said that individuals prefer products like yogurt and pickles more frequently. When the frequency of consumption of foods that may increase postbiotic production is analyzed, 32.4% of men and 30.1% of women consume yogurt daily. A study conducted by Aydın *et al*. [24], a statistically significant difference was found between the frequency of probiotic food consumption and gender, with women exhibiting a higher frequency of probiotic food consumption compared to men. Another study conducted with adult individuals found that yogurt consumption was significantly higher among female participants compared to male participants [25]. However, in our study, no significant difference was observed based on gender (Table 3). In their research, Sevim *et al*. [23] found that the frequency of pickle consumption was similar to our study, with a consumption rate of 46.6% for 1-2 times a week. The low frequency of sauerkraut consumption has been attributed to limited access, as products like yogurt and ayran are more frequently preferred over sauerkraut in school and dormitory cafeterias. The low consumption frequency of foods other than yogurt may be primarily attributed to university students' lack of awareness regarding the importance of improving health and lifestyle, as well as the fact that a large majority have not heard of the concept of postbiotics.

In a study investigating probiotic knowledge levels, it was observed that 364 participants scored an average of 6.16 out of a maximum of 8 points, indicating that they have a good level of knowledge about probiotics [26]. Özgür and Dinçoğlu [27] stated in their research that university students have some knowledge about probiotics; however, they do not possess sufficient information regarding current developments in the field. However, since the sample group consists of Nutrition and Dietetics students, it can be assumed that they possess knowledge about probiotics. In a study that included medical students, it was found that they had low to moderate levels of knowledge about probiotics and that the students needed more educational programs on the topic. In a study involving 1,126 participants, the level of knowledge about probiotics was investigated, and it was found that 76.4% of the participants had insufficient knowledge, 21.1% had average knowledge, and 2.5% had good knowledge [28]. In our study, the percentage of university students with a very good level of knowledge about postbiotics was found to be 0.4%, while the percentage of those with poor knowledge was 48.8%. Factors contributing to this situation include the fact that the concept of postbiotics is relatively new in our country, insufficient advertising for products containing postbiotics, and low awareness regarding these products (Table 4). When examining the average postbiotic knowledge levels of university students by gender, it was found that females have a higher knowledge level compared to males (Table 5). Horasan *et al*. [29], in their study aimed at determining the probiotic knowledge levels and consumption patterns of university students, found that females consumed probiotic foods at a higher rate, and the difference between genders was statistically significant. Additionally, similar to the findings of this research, there are studies that support the notion that women consume probiotic foods more than men [30, 31]. The reasons for women having a higher level of

knowledge about postbiotics may include their greater attention to health, nutrition, and body image compared to men [32, 33].

Strengths and Limitations

The research is limited to students continuing their education in specific departments of two state universities. Therefore, more comprehensive scientific studies can be conducted on broader sample groups regarding postbiotics. When the strengths of this study are evaluated, the fact that it is one of the first studies to examine the level of postbiotic awareness and knowledge among university students in Turkey and that the subject is relatively new in the literature increases the scientific value of the research. In addition, by selecting participants from Health, Sports and Tourism faculties, comparison of students from different academic fields was made possible and the research results were not limited to health sciences students only.

CONCLUSION

Despite the increasing number of studies demonstrating the positive health effects of postbiotics, it has been found that the knowledge levels and consumption frequencies of postbiotics among students, who are expected to have higher awareness, are not at the anticipated levels. Possible reasons for this situation include the limited promotion and advertising activities regarding postbiotics, a lack of understanding of the health benefits of postbiotics, the infrequent availability of postbiotic products in the market, and uncertainties surrounding their consumption. Therefore, it is recommended to organize training sessions in faculties about postbiotic foods to raise awareness among students. Students who will become future coaches, teachers, and healthcare personnel should first become knowledgeable about this concept, which is recognized for its positive effects on the maintenance and preservation of a healthy lifestyle, and integrate it into their dietary routines. Although there are currently no widespread commercial products or supplements available, postbiotics have the potential to become significant players in the functional food market in the next decade. Therefore, scientists are encouraged to conduct more scientific studies on postbiotics. Therefore, it is anticipated that the consumption frequency of postbiotic foods will increase in light of the scientific studies conducted. Finally, the research is limited to students continuing their education in specific departments of two state universities. Therefore, more comprehensive scientific studies can be conducted on broader sample groups regarding postbiotics.

Ethics Approval and Consent to Participate

This study was approved by the Aksaray University Human Research Ethics Committee (Decision No: 2024/01-41; date: 28.02.20254. All procedures were conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments. Written informed consent was obtained from all participants.

Data Availability

All data generated or analyzed during this study are included in this published article. The data that support the findings of this study are available on request from the corresponding author, upon reasonable request.

Authors' Contribution

Study Conception: ANK; Study Design: ANK, YY; Supervision: ANK, YY; Funding: ANK, YY; Materials: ANK; Data Collection and/or Processing: ANK, YY; Statistical Analysis and/or Data Interpretation: ANK; Literature Review: ANK, YY; Manuscript Preparation: ANK, YY; and Critical Review: ANK, YY.

Conflict of Interest

The author(s) disclosed no conflict of interest during the preparation or publication of this manuscript.

Financing

The author(s) disclosed that they did not receive any grant during the conduction or writing of this study.

Acknowledgments

The authors have no acknowledgments to declare.

Generative Artificial Intelligence Statement

The author(s) declare that an artificial intelligence-based tool or application was used for grammar editing in the preparation of this article. All content of this work was produced by the author(s) in accordance with scientific research methods and academic ethical principles.

Editor's Note

All statements made in this article are solely those of the authors and do not represent the views of their affiliates or the publisher, editors, or reviewers. Any claims made by any product or manufacturer that may be evaluated in this article are not guaranteed or endorsed by the publisher.

REFERENCES

1. Granato D, Barba FJ, Bursać Kovačević D, Lorenzo JM, Cruz AG, Putnik P. Functional Foods: Product Development, Technological Trends, Efficacy Testing, and Safety. Annu Rev Food Sci Technol. 2020;11:93-118. doi: 10.1146/annurev-food-032519-051708.
2. Vinderola G, Sanders ME, Salminen S. The Concept of Postbiotics. Foods. 2022;11(8):1077. doi: 10.3390/foods11081077.
3. Salminen S, Collado MC, Endo A, et al. The International Scientific Association of Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of postbiotics. Nat Rev Gastroenterol Hepatol. 2021;18(9):649-667. doi: 10.1038/s41575-021-00440-6.
4. Ma L, Tu H, Chen T. Postbiotics in Human Health: A Narrative Review. Nutrients. 2023;15(2):291. doi: 10.3390/nu15020291.
5. Li L, Fu H. China's health care system reform: Progress and prospects. Int J Health Plann Manage. 2017;32(3):240-253. doi: 10.1002/hpm.2424.
6. Sharma M, Shukla G. Metabiotics: One Step ahead of Probiotics; an Insight into Mechanisms Involved in Anticancerous Effect in Colorectal Cancer. Front Microbiol. 2016;7:1940. doi: 10.3389/fmicb.2016.01940.
7. Tomasik P, Tomasik P. Probiotics, Non-Dairy Prebiotics and Postbiotics in Nutrition. Appl Sci. 2020;10(4):1470. doi: 10.3390/app10041470.
8. Eraghieh Farahani H, Pourhajibagher M, Asgharzadeh S, Bahador A. Postbiotics: Novel Modulators of Gut Health, Metabolism, and Their Mechanisms of Action. Probiotics Antimicrob Proteins. 2025 Nov 10. doi: 10.1007/s12602-025-10832-8.
9. Li S, Sohouli MH, Li Z. The effect of postbiotics supplementation on obesity and metabolic health: a systematic review and meta-analysis of randomized control trials. Nutr Metab (Lond). 2025;22(1):140. doi: 10.1186/s12986-025-01037-5.
10. Al-Habsi N, Al-Khalili M, Haque SA, Elias M, Olqi NA, Al Uraimi T. Health Benefits of Prebiotics, Probiotics, Synbiotics, and Postbiotics. Nutrients. 2024;16(22):3955. doi: 10.3390/nu16223955.
11. Collado MC, Vinderola G, Salminen S. Postbiotics: facts and open questions. A position paper on the need for a consensus definition. Benef Microbes. 2019;10(7):711-719. doi: 10.3920/BM2019.0015.
12. Wegh CAM, Geerlings SY, Knol J, Roeselers G, Belzer C. Postbiotics and Their Potential Applications in Early Life Nutrition and Beyond. Int J Mol Sci. 2019;20(19):4673. doi: 10.3390/ijms20194673.
13. Cigdem A, Emre N. Nutrition literacy status of university students, influencing factors, and its relationship with healthy nutrition attitudes. Pamukkale Med J. 2025;18(1):105-116. doi: 10.31362/patd.1532810.
14. Elmas N, Bayraktar DZ, Yılmaz B, Çimen F, Özdemir U, Türkel U. Investigating the Relationship Between Nutritional Knowledge and Microbiota Awareness: A Cross-Sectional Study Among University Students. Sağlık Bilimlerinde Değer 2025; 15(3): 367-376. doi: 10.33631/sabd.1600538.
15. Batmaz H. Development of A Nutrition Knowledge Level Scale For Adults and ValidationReliability Study [Master's Thesis]. Istanbul: Marmara University; 2018.
16. Pradito IY, Wardana AA, Waspodo P, Surono IS. Determinants of knowledge and perception of probiotic by Jabodetabek college students. Food Research. 2020;4(5), 1815-1819. doi: 10.26656/fr.2017.4(5).133.
17. Oliver L, Rasmussen H, Gregoire MB, Chen Y. Health care provider's knowledge, perceptions, and use of probiotics and prebiotics. Top Clin Nutr. 2014;29(2), 139-149. doi: 10.1097/01.TIN.0000445898.98017.eb.
18. Al Hossan AA, Syed W, Babelghaith SD, Al Arifi MN. Knowledge, Attitude, and Practice of Probiotics Among Saudi Health Care Students-A Cross-Sectional Study From Saudi University in Riyadh Saudi Arabia. Inquiry. 2024;61:469580231224821. doi: 10.1177/00469580231224821.
19. Chukwu EE, Nwaokorie FO, Yisau JI, Coker AO. Assessment of the Knowledge and Perception of Probiotics Among Medical Science Students and Practitioners in Lagos State. Br J Med Med Res. 2014;5(10)1239-1246. doi: 10.9734/BJMMR/2015/13676.
20. Nataraj BH, Ali SA, Behare PV, Yadav H. Postbiotics-parabiotics: the new horizons in microbial biotherapy and functional foods. Microb Cell Fact. 2020;19(1):168. doi: 10.1186/s12934-020-01426-w.
21. Aggarwal S, Sabharwal V, Kaushik P, Joshi A, Aayushi A, Suri M. Postbiotics: From emerging concept to application. Front Sustain Food Syst. 2022;6,887642. doi: 10.3389/fsufs.2022.887642.
22. Çelik Şahin S, Pasin T, Ankaralı S. The Effect of Probiotic Consumption Status and Quality of Life in Patients with Fibromyalgia. Value Health Sci. 2023;13(3):446-450. doi: 10.33631/sabd.1346342.
23. Sevim Y, Onur Öztürk HN, Ergün M. Knowledge and consumption frequency of probiotics and fermented foods in elite volleyball players - A Pilot Study. J Res Pharm. 2023;27(2):12-21. doi: 10.12991/jrp.2019.00.
24. Aydın İ, Gülsünoğlu Konuşkan Z, Ersoy B. Yetişkin Bireylerin Probiyotik Besinler Hakkında Bilgi Düzeyleri ve

Tüketim Durumlarının Belirlenmesi [The Determination of Probiotic Foods Knowledge Level and Consumption Status of Adults]. Aydın Gastronomy. 2024;8(1):129-141. doi: 10.17932/IAU.GASTRONOMY.2017.016/gastronomy_v08i100. [Article in Turkish]
25. Pehlivan B. Yetişkin Bireylerin Probiyotik Besinleri Tüketim Sıklıklarının ve Bilgi Düzeylerinin Belirlenmesi [Evaluation Frequency of Adults Probiotic Food Consumption and Levels of Knowledge]. Bilimsel Tamamlayıcı Tıp, Regülasyon ve Nöralterapi Dergisi. 2020;14(3):69-79. [Article in Turkish]
26. Mejia WB, Barrion ASA, Abacan SF, Israel KAT. Knowledge and Consumption of probiotic Foods of Selected Students in Laguna, Philippines. EC nutrition. 2019;14(5):452-459.
27. Özgür M, Dinçoğlu AH. Knowledge Levels and Attitudes of Nutrition and Dietetics Department Students Towards Probiotic Products: The Example of Burdur Mehmet Akif Ersoy University: Cross-Sectional Study. J Tradit Complem Med. 2023;6(1):11-23. doi: 10.5336/jtracom.2022-90629.
28. Rajab BS, Jahlan RA, Mobarki AM, et al. Assessment of knowledge, attitudes, and practices regarding microbiota composition and influencing factors among the general population in Jazan province: A cross-sectional study. J Adv Vet Anim Res. 2023;10(4):773-781. doi: 10.5455/javar.2023.j733.
29. Horasan B, Sevinç Ö, Çelikyürek NA. Üniversite Öğrencilerinin Probiyotik Bilgi Düzeyi ve Tüketim Durumlarının Belirlenmesi [Determination of Probiotic Knowledge Level and Consumption Status of University Students]. Avrupa Bilim ve Teknoloji Dergisi. 2021;31(Suppl 1):446-453. doi: 10.31590/ejosat.999946. [Article in Turkish]
30. Yabancı N, Şimşek I. Üniversite Öğrencilerinin Probiyotik Ürün Tüketim Durumları [Status of Probiotic Product Consumption of University Students]. TSK Koruyucu Hekimlik Bülteni. 2007;6(6):449-454. [Article in Turkish]
31. Aydın M, Açıkgöz İ, Şimşek B. Isparta Süleyman Demirel Üniversitesi Öğrencilerinin Probiyotik Ürün Tüketimlerinin ve Probiyotik Kavramının Bilinme Düzeyinin Belirlenmesi [Determination of Probiotic Product Consumption and Probiotic Concept Knowledge Level in Students of Isparta Süleyman Demirel University]. Gıda Teknolojileri Elektronik Dergisi. 2010;5(2):1-6. doi: 10.15237/gida.GD18104. [Article in Turkish]
32. Yücelşengün İ, Kırmızıgül A, Özaydın İ, Yarım H. Tüketicilerin Probiyotik ve Prebiyotik Gıdalara Yönelik Bilgi Düzeyleri ve Tüketim Durumlarının Belirlenmesi: İzmir/Bornova Örneği [Determinatıon of Knowledge Level and Consumptıon Status of Consumers on Probiotıc and Prebiotic Foods: A Sample of Izmır/Bornova]. GIDA. 2020;45(1),103-114. doi: 10.15237/gida.GD19123. [Article in Turkish]
33. Aslan Ş, Kara R, Yaman H. Probiyotik Ürünlerin Tüketim Alışkanlıklarının Belirlenmesi [Determining the Consumption Habits Related to Probiotic Products]. Türk Tarım Gıda Bilim ve Teknoloji Dergisi. 2019;7(6): 861-865. doi: 10.24925/turjaf.v7i6.861-865.2428.