

## Research Article

# Awareness and Knowledge of the Role of Probiotics and Prebiotics in Periodontal Health Among Undergraduate Dental Students: A Cross-Sectional Survey

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### ABSTRACT:

**Background:** Periodontal diseases are highly prevalent and biologically based adjuncts such as probiotics and prebiotics are gaining interest as potential modulators of the oral microbiome. This cross-sectional, questionnaire-based survey aimed to assess the awareness, knowledge and attitudes regarding probiotics and prebiotics in periodontal health among undergraduate dental students.

**Materials & Methods:** A total of 236 students from first year to internship completed a validated, self-administered questionnaire comprising items on demographics, awareness and knowledge of probiotics and prebiotics, and perceptions about the need for scientific evidence.

**Results:** Most respondents had heard of probiotics (85.2%) and correctly defined them as live microorganisms that confer health benefits (79.2%). Over half recognised combined antimicrobial mechanisms and multiple delivery forms, and the majority acknowledged broad oral benefits and common probiotic food sources. However, only 42.4% correctly defined prebiotics as non-digestible fibres or carbohydrates, and uncertainty regarding their systemic effects remained considerable despite better recognition of dietary sources and commonly used oligosaccharides. Overall, 80.1% of students considered scientific evidence to be very or somewhat important for integrating probiotics and prebiotics into periodontal care.

**Conclusion:** The findings indicate that while basic awareness and attitudes towards probiotics are favourable, important gaps persist in detailed mechanistic understanding and in knowledge of prebiotics. Targeted curricular reinforcement on host-microbiome interactions and biologically based adjuncts is warranted to support evidence-based periodontal practice.

**KEY WORDS:** Probiotics; Prebiotics; Periodontal health; Dental students; Awareness.

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### INTRODUCTION:

Periodontal diseases are among the most prevalent chronic inflammatory conditions affecting the oral cavity and are a major cause of tooth loss worldwide<sup>[1,2]</sup>. They arise from a complex interplay between dysbiotic dental biofilms and the host immune response, influenced by behavioural, systemic and

environmental risk factors<sup>[3]</sup>. Conventional periodontal therapy has largely focused on mechanical plaque control and, where indicated, adjunctive antimicrobial agents<sup>[4]</sup>. However, concerns regarding antimicrobial resistance, disruption of the commensal microbiota and patient compliance have prompted increasing interest in biologically based strategies that modulate, rather

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than eradicate, the microbial ecosystem<sup>[5]</sup>.

In this context, probiotics and prebiotics have emerged as promising adjuncts in oral healthcare. Probiotics are defined as live microorganisms which, when administered in adequate amounts, confer a health benefit on the host<sup>[6,7]</sup>. In the oral cavity, specific probiotic strains have been shown to compete with pathogenic species, alter biofilm composition, produce antimicrobial substances such as organic acids, hydrogen peroxide and bacteriocins, and modulate local immune responses<sup>[8,9]</sup>. Clinical studies suggest that probiotic formulations delivered via tablets, lozenges, chewing gums or dairy products may reduce plaque accumulation, gingival inflammation and halitosis, and support periodontal therapy outcomes<sup>[8,9]</sup>. Prebiotics, on the other hand, are non-digestible food components that selectively stimulate the growth and activity of beneficial microorganisms<sup>[10,11]</sup>. Although their role is better established in gastrointestinal health, interest is growing in their potential systemic and oral benefits, including the creation of a more favourable ecological niche for health-associated bacteria<sup>[11,12]</sup>.

The successful integration of probiotics and prebiotics into periodontal care depends not only on the strength of scientific evidence, but also on the awareness, understanding and attitudes of future dental practitioners. Undergraduate dental students represent a critical group, as their knowledge and perceptions will shape their future clinical decision-making, patient counselling and acceptance of emerging biologically based therapies. Surveys from different settings indicate that, while many dental students and trainees have heard of probiotics and recognise their general health benefits, knowledge of specific indications, strains, delivery systems and the concept of prebiotics remains variable and often incomplete<sup>[13-16]</sup>. Yet, despite expanding literature on probiotics in dentistry, there appears to be limited information on how well dental students understand the concepts of probiotics, prebiotics and their application to periodontal health, and on where they obtain such information<sup>[13-16]</sup>. Against this background, the present study was undertaken to explore the awareness, knowledge and perceptions regarding the role of probiotics and prebiotics in periodontal health among undergraduate dental students. Understanding these baseline levels of awareness is essential to identify educational gaps and to inform curriculum planning and targeted teaching strategies that support evidence-based periodontal care.

## MATERIALS & METHODS:

**Study design and setting:** This was a descriptive,

cross-sectional, questionnaire-based survey conducted among undergraduate dental students enrolled in a dental teaching institution. The study was designed to assess awareness, knowledge and perceptions regarding the role of probiotics and prebiotics in periodontal health. Data were collected over a defined period during regular academic sessions to ensure that students from all years of study had an opportunity to participate.

**Study population and sampling:** The target population comprised Bachelor of Dental Surgery (BDS) students from first year to internship. All students who were present on the days of data collection, met the eligibility criteria and provided consent were invited to participate. Postgraduate students, teaching staff and auxiliary personnel were excluded. Incomplete or illegibly filled questionnaires were also excluded from analysis. A total of 236 undergraduate students with adequately completed questionnaires were included in the final dataset.

**Development of the questionnaire:** The structured questionnaire was developed after a review of the existing literature on probiotics, prebiotics and their applications in periodontal and general oral health, as well as previously used instruments assessing awareness of probiotics among dental professionals and students. The draft tool comprised four sections: (i) demographic details (age, gender, year of study), (ii) awareness and basic knowledge of probiotics, (iii) knowledge of prebiotics and their systemic and dietary aspects, and (iv) attitudes towards the importance of scientific evidence and open-ended comments. Items were primarily closed-ended, with single-best-answer multiple-choice questions and selected multiple-response items, along with one open-ended question to capture additional comments or suggestions.

Content validity was established by a panel of subject experts from periodontology and oral microbiology, who evaluated each item for clarity, relevance and appropriateness. Based on their feedback, minor modifications were made to wording and sequencing to improve comprehensibility and face validity. The questionnaire was then pilot-tested on a small group of undergraduate students who were not included in the main study, to ensure that item wording was clear and that the average completion time was acceptable. No major changes were required after pilot testing.

**Data collection procedure:** Data collection was carried out in classroom settings at the end of scheduled

lectures or clinical postings to minimise disruption of academic activities. The purpose of the study was explained to the students, and they were assured that participation was voluntary, responses would remain anonymous, and non-participation would not affect their academic standing. Students who agreed to participate provided informed consent and were given the self-administered paper questionnaire. They were instructed not to discuss their answers with peers while completing the form. The average time required to complete the questionnaire was approximately 10–15 minutes. Completed questionnaires were collected immediately to avoid loss or exchange of forms. Each questionnaire was checked for completeness before data entry.

**Ethical considerations:** The study protocol was reviewed and approved by the Institutional Ethics Committee of the host institution prior to commencement. All procedures adhered to the ethical principles of the Declaration of Helsinki. Participation was entirely voluntary, written informed consent was obtained from all respondents, and confidentiality was maintained by avoiding collection of personally identifying information. Data were stored securely and used solely for research and academic purposes.

**Statistical analysis:** Data from the completed questionnaires were coded and entered into a spreadsheet and then imported into a statistical software package for analysis (e.g. IBM SPSS Statistics). Descriptive statistics were used to summarise the data: categorical variables were

expressed as frequencies and percentages. Where applicable, associations between demographic variables (such as age group, gender and year of study) and key awareness/knowledge items were evaluated using the Chi-square test. A  $p$ -value of  $<0.05$  was considered statistically significant.

## RESULTS:

**Participant characteristics:** A total of 236 undergraduate dental students participated in the survey. The majority of respondents were in the 21–23 year age group, with smaller proportions in the 18–20 and 24–26-year categories, and very few students aged 27 years and above. Most participants were female, with males forming roughly one-quarter of the sample and only a small fraction identifying as other gender or preferring not to disclose. With respect to academic level, second-year students constituted the largest group, followed by third-year and final-year students, while first-year students and interns represented relatively smaller proportions of the cohort. This distribution reflects a broad representation across the undergraduate years, with a slight predominance of students in the early clinical phase of training Table 1.

### **Awareness and exposure to probiotics:**

Most undergraduate dental students reported prior awareness of probiotics, with over four-fifths indicating that they had heard of probiotics before. However, less than half of the respondents had ever been advised by a healthcare professional to use probiotics specifically for improving gum health. Around three-fifths believed that probiotics could help

**Table 1:** Demographic characteristics of the study participants (n = 236).

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–20	55	23.3
	21–23	149	63.1
	24–26	30	12.7
	27 and above	2	0.8
Gender	Male	59	25.0
	Female	173	73.3
	Other	3	1.3
	Prefer not to answer	1	0.4
Year of study*	First year	16	8
	Second year	85	36.0
	Third year	66	28.0
	Final year	49	20.8
	Internship	16	6.8

\*Totals for year of study may be slightly lower than 236 due to missing responses and rounding.

**Table 2:** Awareness, exposure and sources of information regarding probiotics among undergraduate dental students (n = 236).

Domain	Item/option	Response category	Frequency (n)	Percentage (%)	p-value*
Awareness / exposure	Have you heard of probiotics before?	Yes	201	85.2	0.004*
	Have you ever been advised by a healthcare professional to use probiotics for improving your gum health?	Yes	99	41.9	0.541 (NS)
	Do you think probiotics can help prevent or treat gum diseases such as gingivitis or periodontitis?	Yes	144	61.0	0.892 (NS)
Source of information	Social media (Instagram, YouTube, television)	–	88	37.3	
	Family/friends	–	34	14.4	
	University courses	–	64	27.1	
	Health professionals (dentist, doctor)	–	44	18.6	

\* $p < 0.05$  considered statistically significant; NS, non-significant ( $p > 0.05$ ).

in the prevention or treatment of gingival and periodontal diseases, reflecting a generally positive perception of their potential clinical role. When asked about their initial source of information, social media emerged as the most common channel, followed by university courses, health professionals and, to a lesser extent, family and friends. This pattern suggests that while formal dental education contributes to awareness, a substantial proportion of students are first exposed to the concept of probiotics through informal, non-academic platforms Table 2.

**Knowledge regarding probiotics:** Overall, students demonstrated relatively good conceptual knowledge of probiotics. The majority correctly identified probiotics as live microorganisms that provide health benefits, while only a small proportion considered them merely as types of bacteria, medications for digestive issues or were unsure of the definition. When asked about antimicrobial substances produced by probiotics, more than half of the respondents recognised that probiotics generate a combination of organic acids, hydrogen peroxide and bacteriocins, although a notable minority selected only one of these options or indicated none. Awareness of different delivery forms was moderate: while the largest group correctly acknowledged that

probiotics are available across all listed formats, including tablets, chewing gums, toothpaste, lozenges, gummies and mouthwash, a substantial number of students were aware of only a subset of these forms or reported no awareness of any, and a small group did not respond. These findings suggest that although the basic concept and mechanisms of probiotics are reasonably well understood, there remain gaps in detailed practical knowledge regarding their various formulations and routes of administration Table 3.

**Knowledge of probiotic benefits, food sources, species and side effects:** Students generally demonstrated favourable perceptions of the potential benefits of probiotics for oral health. More than half of the respondents believed that probiotics could simultaneously reduce gum inflammation, prevent tooth decay, improve overall immune function and freshen breath, whereas smaller proportions focused on only one cluster of benefits or were uncertain. Similarly, a majority correctly associated probiotics with a broad range of fermented foods, indicating an awareness that probiotic microorganisms are commonly present in multiple dietary sources rather than restricted to a single food group.

With regard to microbiological knowledge, many students recognised specific probiotic species

**Table 3:** Knowledge of concept, antimicrobial mechanisms and delivery forms of probiotics among undergraduate dental students (n = 236).

Domain	Question	Response option	Frequency (n)	Percentage (%)
<b>Concept of probiotics</b>	How would you define probiotics?	Live microorganisms that provide health benefits	187	79.2
		Only types of bacteria	14	5.9
		Medications for digestive issues	18	7.6
		I don't know	17	7.2
<b>Antimicrobial mechanisms</b>	What are the antimicrobial substances produced by probiotics?	Organic acids	49	20.8
		Hydrogen peroxide and bacteriocins	41	17.4
		All of the above	125	53.0
		None of the above	17	7.2
<b>Delivery forms</b>	What forms of probiotics are you aware of?	Tablets, chewing gums, toothpaste	35	14.8
		Lozenges, gummies, mouthwash	44	18.6
		All of the above	99	41.9
		None of the above	46	19.5
		No response	12	5.1

such as *Lactobacillus casei*, *Lactobacillus reuteri*, *Streptococcus salivarius* and *Bifidobacterium* spp., and a considerable proportion correctly identified that all of these could be involved in probiotic formulations. However, a notable fraction selected only a subset of these species or reported no awareness, suggesting that detailed understanding of strain diversity remains incomplete. Awareness of potential adverse effects was moderate: while nearly half of the respondents acknowledged that probiotics may be associated with gastrointestinal symptoms such as diarrhoea, bloating, discomfort and occasional allergic reactions, a sizeable group either identified only part of this spectrum or were unsure. These findings indicate that, although students broadly appreciate the beneficial role of probiotics in oral and systemic health, there are areas where more nuanced teaching on specific strains and safety considerations could be valuable Table 4.

**Knowledge regarding prebiotics:** Compared with probiotics, students' understanding of prebiotics appeared more limited and variable. Fewer than half of the respondents correctly identified a prebiotic as a non-digestible special form of fibre or carbohydrate that beneficially affects the host, while a notable

proportion misinterpreted prebiotics as live microorganisms, a type of probiotic, or reported that they were not sure. Nonetheless, many students showed some awareness of the broader health implications of prebiotics, with almost half recognising that they may contribute both to lowering blood cholesterol and reducing the risk of colorectal cancer, although a substantial minority selected only one of these benefits or expressed uncertainty.

Knowledge of dietary sources was relatively better developed: the majority of participants correctly acknowledged that commonly consumed Indian foods such as oats, whole wheat flour, green banana, cooked rice and maize flour may serve as prebiotic sources, while only a small fraction believed that none of these foods were relevant. When asked about commonly used prebiotic forms, more than half of the students recognised that fructo-oligosaccharides, galacto-oligosaccharides and trans-galacto-oligosaccharides are all employed as prebiotics, although a smaller proportion identified only one specific class. Overall, these findings suggest that while students have some familiarity with prebiotic-related concepts, particularly in relation to food sources and oligosaccharide forms, there remain important gaps in their conceptual and

**Table 4:** Knowledge of probiotic benefits, dietary sources, bacterial species and side effects among undergraduate dental students (n=236).

Domain	Question	Response option	Frequency (n)	Percentage (%)
Perceived benefits	Which of the following do you believe are the potential benefits of probiotics for oral health?	Reduce inflammation and prevent tooth decay	51	21.6
		Improve overall immune system function and freshen breath	47	19.9
		All of the above	133	56.4
		Not sure	5	2.1
Dietary sources	Which of the following foods do you associate with probiotics?	Yogurt, sauerkraut	74	31.4
		Kefir, cheese	22	9.3
		All of the above	124	52.5
		None of the above	11	4.7
Bacterial species	According to you, which are the possible bacterial species involved in probiotics?	<i>Lactobacillus casei</i> and <i>Lactobacillus reuteri</i>	106	44.9
		<i>Streptococcus salivarius</i> and <i>Bifidobacterium</i> species	30	12.7
		All of the above	90	38.1
		None of the above	10	4.2
Side effects	What are the possible side effects of probiotics?	Diarrhoea and bloating	29	12.3
		Discomfort in gastrointestinal tract and allergic reactions	50	21.2
		All of the above	104	44.1
		Not sure	48	20.3

mechanistic understanding that warrant targeted curricular emphasis Table 5.

**Attitudes towards evidence-based use of probiotics and prebiotics:** Students generally expressed a positive attitude towards the need for scientific validation of probiotics and prebiotics in periodontal health. Nearly half of the respondents considered it very important that the use of these agents be supported

by robust scientific evidence, and approximately one-third regarded such evidence as somewhat important. Only a small minority felt that scientific evidence was not important, while a comparable proportion selected “others” and provided additional comments, reflecting nuanced views or conditional acceptance. Overall, this pattern suggests that most undergraduate dental students value an evidence-based approach and are receptive to integrating probiotics and prebiotics into

**Table 5:** Knowledge of prebiotic definition, systemic benefits, dietary sources and commonly used forms among undergraduate dental students (n = 236).

Domain	Question	Response option	Frequency (n)	Percentage (%)
Concept of prebiotics	What do you understand by a prebiotic ?	Non-digestible special form of fibre/carbohydrate	100	42.4
		Live microorganism	43	18.2
		A type of probiotic	34	14.4
		Not sure	59	25.0
Systemic benefits	What do you think are the systemic benefits of prebiotics?	Reduction in blood cholesterol levels	28	11.9
		Reduced risk of colorectal cancer	41	17.4
		All of the above	110	46.6
		Not sure	57	24.2
Dietary sources	What are the possible Indian dietary sources of prebiotics?	Oats, whole wheat flour, green banana	28	11.9
		Cooked rice, maize flour	34	14.4
		Both a and b	151	64.0
		None	23	9.7
Common prebiotic forms	Which are the most commonly used prebiotic forms?	Fructo-oligosaccharides (FOS)	19	8.1
		Galacto-oligosaccharides (GOS)	40	16.9
		Trans -galacto-oligosaccharides (TOS)	29	12.3
		All of the above	134	56.8

**Table 6:** Attitudes towards the importance of scientific evidence for the use of probiotics and prebiotics in periodontal health (n = 236).

Question	Response option	Frequency (n)	Percentage (%)
How important is it to have scientific evidence supporting the use of probiotics and prebiotics for improving periodontal health?	Very important	112	47.5
	Somewhat important	77	32.6
	Not important	23	9.7
	Others	24	10.2

periodontal care, provided that their efficacy and safety are substantiated by high-quality research Table 6.

## DISCUSSION:

The present survey provides an overview of undergraduate dental students' awareness and knowledge regarding probiotics and prebiotics in the context of periodontal health. Overall, the findings

indicate a high level of basic awareness about probiotics, with the majority of students able to correctly define them as live microorganisms that confer health benefits and to recognise their broad oral-health-related advantages. This pattern is consistent with previous surveys among dental students and practitioners, which have reported that between two-thirds and over four-fifths of respondents are familiar with the term "probiotics" and acknowledge their

general health benefits<sup>[17-20]</sup>. Studies from India and elsewhere have similarly shown that most dental students recognise probiotics as live microorganisms and believe they can improve health, although detailed knowledge scores are often only in the “fair” range rather than excellent<sup>[17-19,21]</sup>. Our findings thus align with earlier work by Santhanam *et al.* among dental practitioners in Puducherry, where the majority demonstrated acceptable or higher levels of knowledge, suggesting that basic conceptual understanding of probiotics is now reasonably well established in the dental community<sup>[20]</sup>.

In the present study, students also demonstrated a good grasp of the potential benefits and dietary sources of probiotics. Most respondents recognised that probiotics could contribute simultaneously to reducing gingival inflammation, preventing dental caries, supporting immune function and improving breath, and were aware of multiple fermented foods as common probiotic carriers. Similar trends have been reported by Philip *et al.* and others, where large proportions of dental students agreed that probiotics improve health and expressed willingness to use them if recommended by professionals<sup>[17,21]</sup>. However, our data also reveal that knowledge becomes less robust when more detailed or mechanistic aspects are considered. Only around half of the students correctly identified all major antimicrobial substances produced by probiotics, and a substantial minority were unsure about specific probiotic species or potential adverse effects. This mirrors the observations of Babina *et al.*, who found that, although attitudes toward probiotics were highly positive among dental students and teachers, detailed factual knowledge remained only moderate, underscoring the need for more structured teaching on strain-specific actions and safety<sup>[19]</sup>.

The relatively lower level of understanding observed for prebiotics in this cohort is notable and has important curricular implications. Less than half of the students correctly defined prebiotics as non-digestible fibres or carbohydrates that beneficially affect the host, and many were uncertain about their systemic benefits, despite demonstrating better recognition of dietary sources and commonly used oligosaccharide forms. Recent KAP studies among dental undergraduates and dental trainees have similarly reported that, while awareness of probiotics is high, awareness and understanding of prebiotics remain limited in both groups<sup>[18,22]</sup>. This imbalance suggests that educational efforts in dentistry have so far focused more on probiotics as “active agents” than on the complementary concept of prebiotics as substrates that

selectively favour beneficial microbiota. Given emerging evidence that both probiotics and prebiotic substrates can modulate the oral and gut microbiomes, influence host immune responses and potentially support periodontal therapy, this gap warrants attention<sup>[23,24]</sup>.

The generally positive attitude towards evidence-based use of probiotics and prebiotics observed in this study is encouraging. Nearly four-fifths of the respondents considered scientific evidence to be very or somewhat important for the adoption of these agents in periodontal care, echoing earlier findings that dental students, postgraduates and academics are willing to recommend probiotics when their benefits are supported by peer-reviewed literature<sup>[18,19,22]</sup>. This mindset is particularly relevant in light of recent systematic reviews and meta-analyses, which, while suggesting that certain probiotic formulations may improve clinical periodontal parameters when used as adjuncts to mechanical therapy, also highlight heterogeneity across trials and the need for cautious interpretation<sup>[23,25,26]</sup>. Integrating up-to-date evidence on host-microbiome interactions and biologically based therapeutics into undergraduate curricula could therefore foster critical appraisal skills and prevent uncritical uptake of commercially driven claims.

This study has some limitations that should be considered when interpreting the findings. It was conducted in a single institution with a cross-sectional design, which may limit the generalisability of the results to other dental schools or regions. The use of a self-administered questionnaire introduces the possibility of social desirability and recall bias, and the assessment focused on self-reported knowledge rather than objective testing of competence or translation into clinical practice. In addition, while the questionnaire was content-validated, more extensive psychometric evaluation (for example, reliability testing and factor analysis) was not undertaken. Future research could involve multi-centre studies with larger and more diverse samples, incorporate longitudinal designs to assess the impact of targeted educational interventions on knowledge and behaviour, and explore how enhanced understanding of probiotics and prebiotics influences actual clinical decision-making and patient counselling in periodontal care.

## CONCLUSION:

The present study shows that undergraduate dental students possess good basic awareness and generally favourable perceptions of probiotics in relation to periodontal health, but their understanding of prebiotics and more detailed mechanistic and strain-

specific aspects remains limited. Social media and university teaching emerged as key sources of information, and most students expressed a strong preference for evidence-based use of probiotics and prebiotics in clinical practice. These findings highlight the need to strengthen and formalise curricular content on host–microbiome interactions, probiotics and prebiotics, with emphasis on indications, limitations and safety. Enhancing this knowledge at the undergraduate level may ultimately support more rational, evidence-based integration of biologically based adjuncts into periodontal care.

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### Conflicts of Interest

There are no conflicts of interest.

### REFERENCES:

1. Tonetti MS, Jepsen S, Jin L, Otomo-Corgel J. Impact of the global burden of periodontal diseases on health, nutrition and wellbeing: A call for global action. *J Clin Periodontol*. 2017 May;44(5):456-62. doi:10.1111/jcpe.12732.
2. Hoare A, Soto C, Rojas-Celis V, Bravo D. Chronic inflammation as a link between periodontitis and carcinogenesis. *Mediators Inflamm*. 2019;2019:1029857. doi:10.1155/2019/1029857.
3. Cugini C, Ramasubbu N, Tsiagbe VK, Fine DH. Dysbiosis from a microbial and host perspective relative to periodontitis. *Front Microbiol*. 2021 Mar 11;12:617485. doi:10.3389/fmicb.2021.617485.
4. Shaddox LM, Walker CB. Treating chronic periodontitis: current status, challenges, and future directions. *Clin Cosmet Investig Dent*. 2010 Aug 11;2:79-91. doi:10.2147/CCIDEN.S8520.
5. Ng E, Tay JRH, Boey SK, Laine ML, Ivanovski S, Seneviratne CJ. Antibiotic resistance in the microbiota of periodontitis patients: an update of current findings. *Crit Rev Microbiol*. 2024 May;50(3):329-40. doi:10.1080/1040841X.2023.2197481.
6. FAO/WHO. Guidelines for the evaluation of probiotics in food. Report of a Joint FAO/WHO Working Group on Drafting Guidelines for the Evaluation of Probiotics in Food. London (ON): FAO/WHO; 2002.
7. Binda S, Hill C, Johansen E, Obis D, Pot B, Sanders ME, et al. Criteria to qualify microorganisms as “probiotic” in foods and dietary supplements. *Front Microbiol*. 2020 Jul 10;11:1662. doi:10.3389/fmicb.2020.01662.
8. Hu D, Chen L, Bai Y, Huang D. Clinical efficacy of probiotics as an adjunctive therapy to scaling and root planing in the treatment of chronic periodontitis: A systematic review and meta-analysis. *J Evid Based Dent Pract*. 2021 Sep;21(3):101547. doi:10.1016/j.jebdp.2021.101547.
9. Hardan L, Bourgi R, Cuevas-Suárez CE, Zarow M, Kharouf N, Mancino D, et al. The use of probiotics as adjuvant therapy of periodontal disease: A systematic review and meta-analysis. *Pharmaceutics*. 2022 May 9;14(5):1017. doi:10.3390/pharmaceutics14051017.
10. Gibson GR, Roberfroid MB. Dietary modulation of the human colonic microbiota: Introducing the concept of prebiotics. *J Nutr*. 1995 Jun;125(6):1401-12. doi:10.1093/jn/125.6.1401.
11. Gibson GR, Hutkins R, Sanders ME, Prescott SL, Reimer RA, Salminen SJ, et al. The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of prebiotics. *Nat Rev Gastroenterol Hepatol*. 2017 Aug;14(8):491-502. doi:10.1038/nrgastro.2017.75.
12. Hutkins RW, Krumbeck JA, Bindels LB, Cani PD, Fahey G Jr, Goh YJ, et al. Probiotics: Why definitions matter. *Curr Opin Biotechnol*. 2016 Apr;37:1-7. doi:10.1016/j.copbio.2015.09.001.
13. Patait MR, Bhatia S, Patait P, Kulkarni P, Tambe V, Agrawal R. Assessment of knowledge and awareness of probiotics among the dental post-graduate students – A questionnaire study. *Ann Maxillofac Res*. 2022;12(4):1-6.
14. Babina K, Salikhova D, Polyakova M, Zaytsev A, Egiazaryan A, Novozhilova N. Knowledge and attitude towards probiotics among dental students and teachers: A cross-sectional survey. *Dent J (Basel)*. 2023 May;11(5):119. doi:10.3390/dj11050119.
15. Abdul Saheer P, Philip C, Sreedhar G, Mahesh PC, Ashique MP, Shanila AM. Knowledge and awareness of probiotics among the dental students in Thodupuzha – a questionnaire study. *Indian J Appl Res*. 2019 Mar;9(3):1-3. doi:10.36106/ijar.
16. Upasana K, Sandhu R, Kataria P, Sinha A, Vatsa R, Parveen N. Evaluating the awareness and knowledge about probiotics in postgraduate students of an Indian dental college. *J Pharm Bioallied Sci*. 2024 Dec;16(Suppl 4):S3956-S3958. doi:10.4103/jpbs.jpbs\_1020\_24.
17. Krishnan L, Poorni S, Nivedhitha MS, Srinivasan MR. Knowledge, attitude, and practice of probiotics for oral health among dental students: A cross-sectional study. *J Indian Assoc Public Health Dent*. 2022;20(3):230-235. DOI:10.4103/jiaphd.jiaphd\_23\_22
18. Rajeev G, Jacob A, Santhosh S, Babu J, Thomas B. A survey of the knowledge, attitude, and practice of using

- 
- probiotics for oral health among dental students in Kerala. *Int J Community Med Public Health*. 2024;11(4):1538-1542. <https://doi.org/10.18231/j.jds.81348.1759128217>
19. Babina K, Salikhova D, Polyakova M, Zaytsev A, Egiazaryan A, Novozhilova N. Knowledge and Attitude towards Probiotics among Dental Students and Teachers: A Cross-Sectional Survey. *Dent J (Basel)*. 2023 May 2;11(5):119. doi: 10.3390/dj11050119. PMID: 37232770; PMCID: PMC10217036.
  20. Santhanam V, Devi M, Aravindan R, Suganya R, Aroumugam S, Babu MA. Awareness of probiotics among dental practitioners of Puducherry-A cross-sectional questionnaire study. *J Oral Maxillofac Pathol*. 2022 Oct-Dec;26(4):597. doi: 10.4103/jomfp.jomfp\_422\_21. Epub 2022 Dec 22. PMID: 37082053; PMCID: PMC10112070.
  21. Philip C, Sreedhar G, Muhammed A, Majid SA. Knowledge and awareness of probiotics among the dental students in Thodupuzha – A questionnaire study. *Indian J Appl Res*. 2019;9(3):32-34.
  22. Raja N, Ganesan A, Swathi KV, Kannan A, Lakshmi KC. Awareness of prebiotics and probiotics in oral lesions among dental postgraduates – A questionnaire-based study. *Biomedicine (India)*. 2023;43(3):921-924. <https://doi.org/10.51248/v43i3.2716>
  23. Gheisary Z, Mahmood R, HarriShivanantham A, Liu J, Lieffers JRL, Papagerakis P, Papagerakis S. The Clinical, Microbiological, and Immunological Effects of Probiotic Supplementation on Prevention and Treatment of Periodontal Diseases: A Systematic Review and Meta-Analysis. *Nutrients*. 2022 Feb 28;14(5):1036. doi: 10.3390/nu14051036. PMID: 35268009; PMCID: PMC8912513.
  24. Chugh P, Dutt R, Sharma A, Bhagat N, Dhar MS. A critical appraisal of the effects of probiotics on oral health. *J Funct Foods*. 2020;70:103985. <https://doi.org/10.1016/j.jff.2020.103985>
  25. Hardan L, Bourgi R, Cuevas-Suárez CE, Flores-Rodríguez M, Omaña-Covarrubias A, Nicastro M, Lazarescu F, Zarow M, Monteiro P, Jakubowicz N, Proc P, Lukomska-Szymanska M. The Use of Probiotics as Adjuvant Therapy of Periodontal Treatment: A Systematic Review and Meta-Analysis of Clinical Trials. *Pharmaceutics*. 2022 May 9;14(5):1017. doi: 10.3390/pharmaceutics14051017. PMID: 35631603; PMCID: PMC9143599.
  26. Tan J, O'Connor A, Wang L, et al. The impacts of probiotics supplementation on the treatment of periodontitis: An umbrella meta-analysis. *Nutr Rev*. 2025; published online ahead of print. doi:10.1093/nutrit/nuae190.
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