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REVIEW

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Application of probiotics as a constituent element of non-surgical periodontal therapy for cases with chronic periodontitis

Ilma Robo[1*], Saimir Heta[2], Vera Ostreni[2], Joana Hysi[3] and Nevila Alliu[2]

Abstract

Background Non-surgical periodontal therapy includes not only the local curettage of tartar and bacterial plaque, but also aims to remove "bubbling" bacteria in saliva or gingival fluid, which cause the creation of bacterial plaque and therefore also chronic periodontitis. In the final stage, the indication for giving or not prescribing antibiotics depends on the clinical course of the disease. Probiotics can serve as helpers in the "fight" against the causative pathogenic bacteria, but with the specificity of application in the intermediate stages and not in the final stage of non-surgical periodontal treatment.

Main body of the abstract The study is of the review type with the aim of selecting articles published in PubMed in a period of 5 years about the topic of probiotics and their application in non-surgical periodontal therapy for the treatment of chronic periodontitis. The selection of articles was carried out based on the combination of key words. The selected articles were 23 and then classified based on the clinical periodontal parameters that have been studied and the positive, positive/negative or negative attitude about the application or not of probiotics for the treatment of chronic periodontitis as a companion to non-surgical periodontal therapy. Non-concrete well-defined results are observed on the type of dosage and method of application of probiotics, being accompanied by non-concrete results both locally in the affected periodontal areas, but also systemic in the patient's serum.

Short conclusion Correct application protocols of probiotics for treatment of chronic periodontitis, but also of other periodontal pathologies, have "the advantage" of avoiding the prescription of systemic antibiotics, in the conditions of increased resistance to them. The effects of probiotics when applied even in the first stages of non-surgical therapy are mainly visible in the reduction of infection inflammation, the most mentioned and most visible results, based on the data published in the literature. More data are required in this regard.

Keywords Probiotics, Periodontitis, Non-surgical treatment, Antibiotics, *Lactobacillus reuteri*, Scaling and root planing

Background

Non-surgical periodontal therapy aims at the mechanical removal of the bacterial plaque and the fight with bacteriostatic or bactericidal antibiotics if necessary, of the bubbling bacterial flora in the affected gingival pocket or sulcus. Surgical periodontal therapy is indicated both for clinical cases of gingivitis and for clinical cases of periodontitis, classified based on the positioning of the bacterial plaque, as supra or subgingival plaque, the cause of periodontal pathologies in both cases. The primary contact of the bacterial plaque is the gingiva, and the initial reaction against the bacterial flora of the plaque is presented with the inflammation of the gingiva and the appearance of gingivitis. But if this bacterial plaque were to be created and further structured under conditions

*Correspondence:
Ilma Robo
ilmarobo@yahoo.com
[1] Faculty of Dental Medicine, University of Medicine, Tiranë, Albania
[2] Faculty of Medicine, University of Medicine, Tiranë, Albania
[3] Albanian University, Tiranë, Albania

of facultative or total lack of oxygen in the gingival sulcus, to appear with the typical structure of the bacterial plaque, the clinical picture would be nothing but periodontitis. The gingival regenerative ability and the impact of the tooth-bearing structures up to the transseptal fibers, make gingivitis a reversible pathology accompanied by no loss of the tooth-bearing structures. While periodontitis is associated with significant destruction of periodontal ligament fibers, it is understood that regeneration would not be the recovery phase of this pathology. Non-surgical periodontal surgery is not aimed at renewing and regenerating the lost periodontal structures due to the destructive action of periodontitis, but only at keeping this pathology under control, which, as its own characteristic, appears in two phases that can be combined with each other as phases active and inactive stages of the pathology. The activation of this pathology depends a lot on the immunity of the affected individual. In cases where the immunity of the host organism falls due to some other systemic pathology, even in the absence of bacterial plaque, i.e., only bubbling oral flora is sufficient, the pathology of chronic periodontitis is activated to destroy the existing periodontal structures. Individuals diagnosed with chronic periodontitis live with this pathology, suffering uncontrolled activations of this pathology in a conscious way (Haas et al. 2021; Vives-Soler and Chimenos-Küstner 2020; Ausenda et al. 2023; Mishra et al. 2021; Donos et al. 2020; Butera et al. 2022; Invernici et al. 2020).

Characteristic of chronic periodontitis is the combination of oral flora that causes this pathology. The main member is actinomyces actinomycetemcomitans, which is sensitive to tetracycline as a bacteriostatic antibiotic of this bacterium. So, we are in such conditions that even if there are attempts to remove this bacterium from the oral flora beyond the mechanical removal of the bacterial plaque, this bacterium cannot be definitively removed with antibiotics. There are studies that also show the application of tetracycline for long distances in patients with chronic periodontitis, up to six months of systemic antibiotic intake, it is still not possible for the patient to definitively recover from chronic periodontitis pathology, since the causative bacteria are still there in the oral cavity. Even this patient is also prone to side effects of the tetracycline that is taken for a long time, such as fluctuations in the sense of taste and the appearance of the tongue with black hairs (Vives-Soler and Chimenos-Küstner 2020; Donos et al. 2020; Invernici et al. 2020; Tay et al. 2022; Patyna et al. 2021; Bazyar et al. 2020; Özener et al. 2023; Ikram et al. 2019; Pudgar et al. 2021).

In these conditions, new treatment alternatives for chronic periodontitis with non-surgical periodontal therapy should probably be sought.

Main text

The study is of the review type with the aim of selecting articles published in the last 5 years, mainly in PubMed, on the role of probiotics in non-surgical periodontal therapy. The combination of keywords and their application in the online library led to the extraction of 23 articles on this topic. The articles selected prior to analysis were classified depending on whether they met the aims of the study. The articles were classified depending on the years of publication, where the division into 3-year periods was respected, with the aim of seeing the trend of scientific research in this field. The articles were classified based on the type of clinical periodontal parameter selected by the authors of the publications as an element of evaluating the efficacy or not of the application of probiotics as an adjunct to non-surgical periodontal therapy. Pocket depth, bleeding on probing, reduction of bacterial plaque, bacterial amount or reattachment were among the clinical periodontal parameters evaluated in the various articles extracted from the published literature. The articles were divided according to the classification of the conclusions drawn about the positive, positive–negative or purely negative effect of probiotics against periodontal clinical parameters. Each effect, regardless of the type or categorization mentioned above, was accompanied in the corresponding tables with the conclusion regarding the subject of the study (Pudgar et al. 2021; Corbella et al. 2021; Song and Liu 2020; Minić et al. 2022).

Results

Articles selected from the literature were classified in the following tables based on the classification criteria. Table 1 shows the distribution of articles in relation to the year of publication and the type of article published. The interval is 6 years and coincides exactly with the time when attention has been significantly increased regarding the application of probiotics for oral health and especially for the treatment of periodontal pathologies (Minić et al. 2022; Galofré et al. 2018; Ghasemi et al. 2020; Theodoro et al. 2019; Butera et al. 2022; Kumar et al. 2021; Pelekos et al. 2019, 2020).

Table 1 The division and classification of articles in relation to the year of publication and the type of study presented in the article

Articles	2018–2019	2020–2021	2022–2023	Total
Review	–	6–26%	2–9%	8–35%
In vivo	4–17%	7–30%	4–17%	15–65%
Total	4–17%	13–57%	6–26%	23–100%

In Tables 1 and 2, the articles are presented in number, accompanied by the percentage they occupy from the total of the selected articles, with the sole purpose of understanding the distribution of the articles against the types and ways of analyzing probiotics (Table 1) and the type of pathology periodontal (Table 2).

In certain columns, articles are missing because in these specific fields they have not been published by the authors about this topic. This was done on purpose to understand the trend of publishing articles about this field—probiotics and non-surgical periodontal treatment. This element is viewed and analyzed as a trend of the publication method in the discussion section of the article. Probiotics and their application in periodontology and not only, but also by dental specialists has been seen at the time as something that should be done, but as long as probiotics are succeeding in other fields of medicine, it seems as if dentistry has been left in the hands of second.

In vivo type studies predominate, compared to review ones in a ratio of 3:1. The orientation of scientific research about probiotics was higher in the period of 2020–2021 in almost half of the total articles. Exactly the years 2020–2021 have a 1:1 ratio of articles based on how probiotics are analyzed in review studies or in vivo application, while the phase of the years 2022–2023 orients these articles toward in vivo application and the results of these studies. In the 2018–2019 period, the articles are only of the in vivo application type to patients with the aim of obtaining clinical results and presenting them. In Table 2, the articles will be classified based on the way the study was conducted (review or in vivo in patients) and depending on the fact which periodontal pathology is being treated with probiotics by means of non-surgical periodontal therapy.

Table 3 summarizes data on the periodontal clinical record that evaluates the effect of probiotics when taken as an adjunct to non-surgical periodontal treatment.

Different authors have seen the effects of probiotics according to selected periodontal indicators as being effective (marked in the table with +), effective and not effective at the same time (marked in the table with ±) and have no effect (marked in the table with -). In the last row of Table 3, yes according to this order: effective, yes-/not to be avoided and not effective, the articles analyzed in this study are presented in number.

Table 4 shows the different positions in the results regarding the change of the depth index in the probe in the cases of the use of probiotics.

Table 5 summarizes the data from the articles based on the effect of probiotics on bleeding in the probe as another clinical element evaluated in cases of application of probiotics.

Table 6 presents the data regarding the effect of probiotics on the amount of bacterial plaque and the amount of bacteria accumulated in the gingival sulcus.

Table 7 shows data collected from articles on the achievement of reattachment after application of probiotics to affected teeth.

Table 8 shows the articles of Table 7 classified according to the years of publication of these articles and again according to the final opinion derived from the articles whether probiotics succeed in creating periodontal reattachment or not.

Table 9 shows the data on the effect of probiotics reflected in the blood. The number of articles that talk about measurable results in the blood of patients where probiotics have been applied is very reduced.

Table 2 Classification of articles depending on the type of study and periodontal pathology that is treated with probiotics as an additional element of non-surgical periodontal therapy applied

Articles—year of publication Type of periodontal pathology		Review	In vivo	Total by years	Total by pathology
Chronic periodontitis	2018–2020	3–13%	6–26%	6–26%	14–61%
	2021–2023	3–13%	8–35%	8–35%	
Halitosis	2018–2020	–	–	–	1–4%
	2021–2023	1–4%	1–4%	1–4%	
Risks factors + Chronic Periodontitis	2018–2020	–	2–8%	2–8%	3–13%
	2021–2023	1–4%	1–4%	1–4%	
Periodontal pockets	2018–2020	–	1–4%	1–4%	4–17%
	2021–2023	–	3–13%	3–13%	
Peri-implantitis	2018–2020	–	1–4%	1–4%	1–4%
	2021–2023	–	–	–	
Total		8–35%	23–100%	23–100%	23–100%

Table 3 Periodontal clinical evaluative elements of the effect of probiotics as an adjunct to non-surgical periodontal therapy

No	Articles	Pocket depth	Bleeding on probing	Plaque reduction	Bacterial amount	Attachment level	Blood
1	Vives-Soler and Chimenos-Küstner (2020)	+/−	+	+			
2	Ausenda et al. (2023)	+					
3	Mishra et al. (2021)	+				+	
4	Donos et al. (2020)	+					
5	Butera et al. (2022)				+		
6	(Invernici et al. (2020)		+	+	+		
7	Tay et al. (2022)				−		
8	Patyna et al. (2021)	−	+		+	+/−	
9	Bazyar et al. (2020)		+	+		−	+
10	Özener et al. (2023)	−				−	+
11	Ikram et al. (2019)	±	+	+			
12	Pudgar et al. (2021)		+		+	+	
13	Corbella et al. (2021)	−				+	
14	Song and Liu (2020)	+/−				+	
15	Minić et al. (2022)	+	+	-			
16	Galofré et al. (2018)	+	+/−		+		
17	Ghasemi et al. (2020)	+	+/−				
18	Theodoro et al. (2019)	+/−	+			+/−	
19	Butera et al. (2022)	+/−	+/−				
20	Kumar et al. (2021)			+			+
21	Pelekos et al. (2019)	−	−	−			
22	Pelekos et al. (2020)					+/−	
Total–Report		6/5/3	6/5/1	5/0/2	6/0/1	4/3/2	2/0/0

Discussions

Based on the data in Table 1, the trend of scientific research regarding probiotics and their application as an additional element for non-surgical periodontal treatment of various periodontal pathologies is noted. Probiotics were discovered for the first time in 1905, but the resumption of research on the effects of probiotics was much later and coincided with the year 1990, dating back to 2001 when the World Health Organization approved it as an element of treatment, but it was later years when various authors published data on the mechanisms of action of probiotics not only in the normalization of the intestinal flora, but also in the modulation of immunity and in the metabolic effects of probiotics, making possible the ISO 9001;2015 certification in 2015 and the definition of the best guides accuracy in the administration and dosage of probiotics in 2017. As such, this story indicates the date of the start of a research on the effects of the application of probiotics precisely in 2018. So, from this point of view, it is understandable that initially there would be the highest interest in in vivo application of probiotics and then it would be the tendency to review the literature of the collected results. There is more interest in in vivo studies than in those of the review type, regardless of the years selected in the study.

From Table 2 it can be seen that 60% of the articles analyze the effect of probiotics for the pathology of chronic periodontitis with increased interest to reflect this effect more according to in vivo studies in patients than according to those reviews in the ratio 1.5:1. According to the frequency, the second element in the row is the aptology of chronic periodontitis, but already caused by a systemic pathology or by other risk factors for the appearance of chronic periodontitis in 13%. The trend for 2018–2020 was the application of probiotics for the treatment of peri-implantitis, while for the years 2021–2023 it is for the treatment of halitosis. Regardless of the fact that these two directions have a reduced number of articles, they talk about the possibility of applying probiotics to these pathologies, which should probably be other areas of research and research.

Based on the data grouped and presented in Tables 3 and 4 as a summary of these results, it can be said that the application of probiotics in relation to their efficiency or not comes to the conclusion that there is no correct protocol of treatment with probiotics, starting from the

Table 4 Different attitudes based on the results of the change or not of the depth of probe in cases of application of probiotics

Evaluation	Results	Conclusions
Elementi +	Probiotics are given in the form of tablets 2 times a day and contain *L. reuteri* (Ausenda et al. 2023)	It is necessary to know which form of administration of probiotics is most effective (Ausenda et al. 2023)
	Oral application of probiotics in any type of administration is effective (Mishra et al. 2021)	Antimicrobial effects of probiotics need to be further investigated (Mishra et al. 2021)
	Reduction after 6 months of use in gel form of probiotics (Donos et al. 2020)	The long-term effect of probiotics and the modulatory host effect should be seen (Donos et al. 2020)
	Probiotics add to the positive effect of periodontitis treatment with non-surgical periodontal therapy (Minić et al. 2022)	The positive effect of probiotics is observed after 1 month of application (Minić et al. 2022)
	L.reuteri has a positive effect against *P.gingivalis*, even if it is taken in the form of tablets (Galofré et al. 2018)	*L. reuteri* should be applied as a tablet once a day for 30 days. Its effect on peri-implantitis should be checked (Galofré et al. 2018)
	The effects of probiotics as an oral cavity rinse are clearly observed after 1 month and after 3 months of application (Ghasemi et al. 2020)	Probiotics are effective even if they are used as rinses of the oral cavity (Ghasemi et al. 2020)
Element + / −	It only reduces the depth of the pockets by 4-6 mm (Vives-Soler and Chimenos-Küstner 2020)	Accurate application protocols are needed (Vives-Soler and Chimenos-Küstner 2020)
	Giving probiotics twice a day for 3 months has the same effects as giving systemic antibiotics for 7 days (Ikram et al. 2019)	*L.reuteri* is the probiotic as effective as antibiotics for the treatment of chronic periodontitis (Ikram et al. 2019)
	The application of the probiotic containing *L. reuteri* is effective for reducing pockets proven after 21 days and after 3 months of application (Song and Liu 2020)	The healing effect of the probiotic is short term (Song and Liu 2020)
	Application of *L. reuteri* reduces the depth of pockets when applied 2 tablets per day for 21 consecutive days (Theodoro et al. 2019)	Probiotics do not reduce the depth of moderate or severe deep pockets (Theodoro et al. 2019)
	Application of probiotics reduces the depth of pockets (20)	The reduction of pocket depth by probiotics is the same as with the application of chlorhexidine in Curasept Periodontal Gel (Butera et al. 2022)
Element −	The depth of the pockets varies in the same way as in the case of applying only gingival curettage (Patyna et al. 2021)	Further studies are needed to determine the added effects of probiotic treatment (Patyna et al. 2021)
	There is no difference in the reduction of pocket depth even after 3 months if we use *Bifidobacterium animalis* (Özener et al. 2023)	The administration of probiotics has shown limited clinical and microbiological effects in the treatment of patients with periodontitis (Özener et al. 2023)
	Probiotics can be used as host modulators, but the results are the same as applying other medicinal healing formulas (Corbella et al. 2021)	So far, there are conflicting data on the effect of probiotics for the treatment of chronic periodontitis (Corbella et al. 2021)
	L. reuteri with the application in the form of tablets 2 times a day for 28 days did not bring increased clinical efficacy compared to non-periodontal surgical therapy (Pelekos et al. 2019)	There are no statistically significant intergroup differences in the advantages recorded at different time points (Pelekos et al. 2019)

Table 5 The effect of probiotics on probing bleeding, as a parameter to evaluate the periodontal status of the teeth

Evaluation	Results	Conclusions
Element +	Probing bleeding is significantly reduced (Vives-Soler and Chimenos-Küstner 2020)	More reduced tendency in cases of peri-implantitis (Vives-Soler and Chimenos-Küstner 2020)
	The probiotic reduces the adhesion of *P. gingivalis* to the tooth walls, thus reducing bleeding on probing (Invernici et al. 2020)	*B.lactis* is one of the potential probiotics as an adjunct to non-surgical periodontal therapy (Invernici et al. 2020)
	The periodontal clinical parameter where the clinical improvements are significantly different after the application of probiotics is bleeding on probing (Patyna et al. 2021)	Probiotics are a supportive approach against inflammation and infection control of periodontal tissues (Patyna et al. 2021)
	The reduction of probing bleeding is significantly associated with the reduction of the bacterial plaque index after the application of probiotics as an adjunct to non-surgical periodontal therapy (Bazyar et al. 2020)	Probiotics bring advantages in improving the periodontal, inflammatory and antioxidant status of patients with chronic periodontitis (Bazyar et al. 2020)
	Seven days after the topical application of probiotics, the bleeding in the probe was significantly reduced, results that are supported even after 1 month after application (Minić et al. 2022)	Application of probiotics should be carried out topically as part of periodontal treatment (Minić et al. 2022)
	L.reuteri redukton gjakosjen në sondim duke kontrolluar inflamaciinin gingival (Theodoro et al. 2019)	Probing bleeding is significantly reduced 90 days after the application of probiotics (Theodoro et al. 2019)
Element + / −	The reduction of periodontal inflammation as an effect of the probiotics used is expressed by the reduction of bleeding on probing (Ikram et al. 2019)	*L. reuteri* has the same effect as the use of the indicated prescription of antibiotics for chronic periodontitis (Ikram et al. 2019)
	For the reduction of bleeding on probing, *L.brevis* and *L.plantarum* bring advantages for patients with chronic periodontitis (Pudgar et al. 2021)	The number of residual areas affected by chronic periodontitis after the application of probiotics is higher than in cases of traditional non-surgical periodontal treatment (Pudgar et al. 2021)
	Effective application of *L. reuteri* even in cases of peri-implantitis with a lasting effect even 90 days after application (Galofré et al. 2018)	The microbiological effect of probiotics in peri-implant cases is more limited (Galofré et al. 2018)
	There are significant differences in probing bleeding at different intervals but not between the group where the probiotic is applied and the control group (Ghasemi et al. 2020)	Probiotics have a positive effect on periodontal indices in patients with generalized periodontitis stage III, grade A (Ghasemi et al. 2020)
	Probing bleeding is significantly reduced after the application of oral gel with probiotics (Butera et al. 2022)	After application, gingival recession increases significantly, but without increasing the mobility of the affected tooth (Butera et al. 2022)
Element -	There are significant differences in probing bleeding after the application of probiotics, but these differences are not significant in the long-term effects or changes at later times after the application, regardless of the moment when the reassessment is done (Pelekos et al. 2019)	The use of probiotics did not show increased clinical effectiveness beyond the effect of non-surgical periodontal therapy (Pelekos et al. 2019)
Results	Seven articles with positive conclusions Five articles with positive/negative conclusions One article with negative conclusions	

Table 6 Presentation of data regarding the effects of probiotics on the amount of bacterial plaque and bacterial colonies accumulated in the gingival sulcus

		Bacterial load	
		Positive effect	**Negative effect**
Bacterial plaque index	Positive effect	Visible reduction that reduces the need for surgical intervention in pockets with a depth of 4–6 mm (Vives-Soler and Chimenos-Küstner 2020) Probiotics specifically act sensitively to the red periodontal complex (Butera et al. 2022; Invernici et al. 2020) The reduction of the bacterial load is also expressed in the reduction of mediators in the patient's blood where the probiotic is applied (Bazyar et al. 2020)	Limited effects on the microbial load even in cases where the plaque index is reduced. The sulcus are filled with Bifidobacterium species (Özener et al. 2023) The plaque index is taken as an accompanying element of other periodontal clinical indices, and not as a measure of the microbial load (Ikram et al. 2019)
	Negative effect	The plaque index has the same records as for patients who are treated only with non-surgical periodontal therapy, but the bacterial load of *P.gingivalis* and *T. forsythia* is significantly reduced (Patyna et al. 2021) It has an effect on *P. gingivalis* and sulcus bacteria but does not significantly reduce the diseased periodontal areas (Pudgar et al. 2021) Reduces *P. gingivalis*, but does not act much in periimplantitis (Ghasemi et al. 2020)	Halitosis of dental origin has no improvement as the microbiological load after 1 month after the application of probiotics (for 8 weeks or for 90 days of application) has no changes (Tay et al. 2022)
TOTAL		4/3	2/1

Table 7 Reattachment or regeneration of the periodontal ligament, seen from the point of view as a positive effect of the application of probiotics to periodontally affected teeth, based on the data of the selected articles

The effect of probiotics Articles	**Efekt +**	**Efekt +/−**	**Efekt -**
Mishra et al. (2021)	+		
Patyna et al. (2021)		+/−	
Bazyar et al. (2020)			−
Özener et al. (2023)			−
Pudgar et al. (2021)	+		
Corbella et al. (2021)	+		
Song and Liu (2020)	+		
Theodoro et al. (2019)		+/−	
Pelekos et al. (2020)		+/−	
Total	4/9	3/9	2/9

Table 8 Periodontal reattachment seen from the point of view of attitudes or conclusions and classified according to the years of publication of the articles

Year of publication Application effect	**2018–2020**	**2021–2023**	**Total**
Effect +	1–4%	3–13%	4–17%
Effect +/−	3–13%	–	3–13%
Effect −	1–4%	1–4%	2–8%
Total	5–	4–17%	9–39%

fact that they should be given in the form of tablets, gels or rinses of the oral cavity (Ausenda et al. 2023; Mishra et al. 2021; Galofré et al. 2018; Ghasemi et al. 2020). Among the most effective probiotics, the probiotic *Lactobacillus reuteri* has been evaluated, which acts against microflora with mainly *Porphyromonas gingivalis* content (Özener et al. 2023; Ikram et al. 2019; Galofré et al. 2018). There is no information about the long-term effects of *L. reuteri*; there are even studies where it is said that the results should be seen after 1 month of application, after 3 months, etc. (Song and Liu 2020; Minić et al. 2022). There are tendencies to single out the effect of reducing pockets, but not with moderate or aggravated depth (Özener et al. 2023; Theodoro et al. 2019).

Based on the data in Table 5, the periodontal clinical parameter where the clinical improvements after the application of probiotics are significantly different is bleeding on probing (Patyna et al. 2021); this is because probiotics have a high anti-inflammatory effect when used locally and significantly reduce gingival inflammation, or by reducing the index of the bacterial plaque (Patyna et al. 2021; Bazyar et al. 2020). Probiotics reduce the adhesion of *P. gingivalis* and consequently affect the severity of gingival inflammation, continued in the logic as high as possible (Özener et al. 2023; Ikram et al. 2019). Based on the data in Table 6, the studies show that probiotics have a significant clinical effect on the red periodontal complex with representatives of *P.gingivalis*, significantly reducing the microbial load of the affected sulci (Butera et al. 2022; Invernici et al. 2020; Bazyar

Table 9 Articles that speak and come to conclusions on the effect of probiotics expressed in the blood of the patient where they are applied and on the measured biochemical parameters

Evaluation	Results	Conclusions
Element +	Significant decrease in mean serum IL-1beta values (Bazyar et al. 2020)	Primary effect in patients with diabetes mellitus 2 (Bazyar et al. 2020)
	Significant reduction of matrix metalloproteinase 8 and nitric oxide NO, as biochemical parameters measured after 12 weeks of probiotic application and checked with the results of the control group (Kumar et al. 2021)	*L. reuteri* as a probiotic applied to cases with chronic periodontitis is successful in improving biotic parameters (Kumar et al. 2021)
Results	Two articles with positive conclusions	

et al. 2020). These studies even show a reduction-sensitive markers of periodontal inflammation in the blood of patients affected by chronic periodontitis in cases of application of probiotics. Another problem is the selection of the right probiotic, as in some cases it has been shown that the application of the right bacteria leads to the filling of the sulcus with other non-specific periodontal flora for which other treatments will have to be done (Özener et al. 2023). Another the problem that emerges from Table 6 is also the fact that the application of probiotics should be seen in the context of the total effect, not only in the periodontal tissues, of the effect that the probiotic has, regardless of the method of its application, such as gel, tablet or rinse of the oral cavity (Tay et al. 2022).

While Table 6 also emphasizes the methodology of periodontal studies that sometimes misleads by producing results that are not as valuable as the clinical approach and their application, the index of bacterial plaque as a parameter of periodontal assessment is evaluated in relation to other clinical periodontal indices such as bleeding on probing or pocket depth. It should be noted that the best combination to achieve deep results in the field of application of probiotics as part of non-surgical periodontal therapy, would be the combination of the bacterial plaque index with the microbial load of the affected gingival sulci (Ikram et al. 2019).

Based on the data in Table 7 on the achievement of reattachment after the application of probiotics, the few articles that talk about this periodontal parameter stand out. Despite the large number of articles, the position of whether the application of probiotics is effective or not, from different authors, is twofold, almost 50% for a positive effect and 50% for a negative effect, and in almost all the articles it is mentioned that studies are needed more about this topic (Theodoro et al. 2019; Pelekos et al. 2020). This is the most important periodontal parameter that shows the perfect healing of periodontal diseases, regenerating everything that has been destroyed by periodontal diseases, without the need of specific periodontal surgical interventions. Seen from this point of view, perhaps the approach over the years according to the years of publication of articles against this element is more important. If the data of Table 8 are analyzed, it is noted that the number of less than 39% of studies oriented around re-attachment shows that research in this direction is scarce and almost without concrete results. An almost 50% to 50% split of articles published by the bands 2018–2020 and 2021–2023 again indicates not a large growing interest, but constant interest against the periodontal parameter of reattachment. This emphasizes once again the fact that probiotics are not seen as the future for the perfect cure of periodontal diseases, but as an element that can replace antibiotics, despite the fact that even here the studies do not show a positive trend toward this approach (Ikram et al. 2019).

The need to see the results as positive or negative, not only clinically from the periodontal side, but also more widely expressed in biochemical parameters and in the serum level of the patient where they are applied, is what is required further in the field of research about the application of probiotics as a companion to non-surgical periodontal treatment (Bazyar et al. 2020; Kumar et al. 2021).

Conclusions

For periodontal treatments, as an adjunct to non-surgical periodontal therapy, based on the local nature of the latter (treatment), probiotics should be applied locally in gel form inside the periodontal pockets. It remains to be seen the systemic effect of the application of probiotics, expressed by biochemical parameters, since the systemic impact on the patient's health is already known, of concomitant periodontal diseases, diseases that cannot be cured, but with which we live together.

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IR and JH collected the scientific data and wrote the manuscript. SH and NA revised and edited the manuscript. Literature research was conducted by IR

and NA. SH and VO collected the scientific data. All authors read and approved the final manuscript.

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Availability of data and materials
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Declarations

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