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Effect of Probiotic Chewable Tablets on Gingival Health and Salivary Biomarkers (IL-1β and MMP-8) in Iraq: A Clinical Trial

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Abstract

Aim of the study: To verify the effect of probiotic tablets on oral health status and to compare their effects on gingival health and potential salivary biomarkers by monitoring the levels of Interleukin-1β (IL-1β) and Matrix metalloproteinases-8 (MMP-8) in saliva of individuals with moderate gingivitis. **Materials and methods**: A randomized interventional trial was conducted over 28 days, which included 88 healthy male college students aged 18 to 25 years old from Al-Anbar University. The participants have randomly assigned to two groups: study group (A) and control group (B). The gingival health parameter GI has evaluated clinically, and the concentrations of IL-1β and MMP-8 have been quantified in both groups at baseline (0 days), 14 days, and 28 days. **Results**: GI significantly decreased in study group when compared to the control group. Fuethermore, IL-1β and MMP-8 showed significant reductions only at day 28. **Conclusion:** Probiotics may improve gingival health by positively affecting the oral flora and regulating the immune system.

Keywords: probiotics, oral health, gingivitis, Interleukin 1Beta, Matrix Metalloproteinase -8.

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Introduction

As per a 2001 definition by the World Health Organization, probiotics are microorganisms that endure gastric acidity and, when consumed in adequate amounts, enhance the host's health. A multitude of microorganisms have thus far fulfilled this criterion (Schlagenhauf and Jockel-Schneider, 2021).

Probiotic microorganisms offer numerous therapeutic advantages, including potential protection against oral infections, enhancement of the local immune system, and assistance in preserving a healthy equilibrium of oral bacteria that contribute to gum disease and tooth decay. Further investigation is necessary to thoroughly understand the long-term effects of probiotic bacteria on the oral cavity and their ability to colonize and establish biofilms, hence elucidating their influence on the local microbiota (Inchingolo et al., 2023).

The role of oral probiotics is to improve oral health by eradicating detrimental bacteria, reducing inflammation, and restoring microbial equilibrium; when used in conjunction with traditional treatments such as scaling and root planning, they can be beneficial in managing periodontal inflammation (Sachelarie et al., 2025).

An individual's total well-being and quality of life are significantly influenced by their oral health, which is an essential aspect of overall wellbeing. Issues with speaking, chewing, and swallowing may arise from inadequate dental health. Certain systemic illnesses and medical disorders can be affected by oral ailments (Karaaslan et al., 2019).

Gingivitis is a reversible inflammatory condition of the gingival tissues induced by the accumulation of dental plaque at the gum line, characterized by erythema, edema, and hemorrhage, however it does not lead to the loss of alveolar bone or periodontal attachment. This is the most prevalent kind of periodontal disease globally, commonly encountered in both adults and children (Gasner and Schure, 2025).

The prevalence of gingivitis varies significantly, with epidemiological statistics indicating rates of approximately 100% among certain adult populations. Pediatric surveys provide prevalence rates between 20% and over 90%, impacted by factors such as inadequate oral hygiene, dietary habits, socioeconomic position, and access to healthcare, rendering it a substantial worldwide health issue for preventive strategies (Elgasmi et al.,2025).

Scaling and root planing is the conventional treatment for periodontal disease aimed at diminishing dangerous microorganisms. Periodontal infections have the capacity to rapidly recolonize treated areas. The anti-inflammatory effects of probiotics have been proposed as novel methods for managing dental health by suppressing detrimental microbes (Sang-Ngoen et al., 2021).

Biomarkers must possess significant prognostic or predictive value and be

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assessable swiftly and accurately. They are increasingly indispensable in predictive and preventive medicine, which aims to identify risk factors or the early development and progression of disease (Cafiero et al., 2021).

Saliva comprises cytokines linked to inflammation, including TNF-α, IL-6, IL-8, and IL-1β. These salivary cytokines may function as biomarkers for diagnosing numerous dental illnesses, including gingivitis (Kim et al., 2021).

Recent research indicates that individuals with gingivitis exhibit elevated salivary levels of IL-6, IL-8, albumin, calprotectin, PGE2, and MMP-8 (Ebersole et al., 2015).

MMPs are proteolytic enzymes belonging to the zinc protease superfamily. They contribute to the physiological remodeling of basement membranes and matrix proteins. This family include MMP-8 (matrix metalloproteinase-8/collagenase-2), a constituent of the collagenase group with the distinctive ability to hydrolyze type I and III collagen (kamil and Ali, 2023).

Salivary biomarkers may be utilized in the future to formulate personalized therapies for precision dentistry and to discern unique salivary patterns in reaction to diverse stimuli. Real-time measurements conducted outside dental offices and their practical applications in daily life (Paqué et al., 2022).

The pro-inflammatory cytokine IL-1β, produced by neutrophils, monocytes, and macrophages, is crucial for initiating and amplifying the inflammatory response as it stimulates the production of growth factors and prostaglandins. Elevated IL-1β levels are directly associated with gingival inflammation and are predominantly observed in the initial phases of periodontal disease. Importance of salivary biomarkers (IL-1β and MMP-8) has demonstrated potential as non-invasive diagnostic tools for assessing periodontal health and disease. Saliva is an advantageous medium for disease detection and monitoring due to its accessibility as a biofluid, containing many inflammatory mediators and enzymes that reflect the host response to periodontal diseases (Sachelarie et al., 2025).

Their integrated assessment enhances diagnostic sensitivity and specificity, facilitating the differentiation between periodontitis, gingivitis, and health (Zhang et al., 2021).

A variety of preventive strategies have been proposed and integrated into public health campaigns to promote optimal oral hygiene. Interest in probiotics has surged as an attractive approach for avoiding oral infectious diseases (Meurman and Stamatova, 2018), Further work is required to determine whether probiotics are beneficial for boosting gingival health and improving oral hygiene.

This interventional study investigation the effect of probiotic chewable mint tablets on gingival health and potential salivary biomarkers; the levels of cytokine (IL-1β) and proteases Matrix

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metalloproteinases (MMP-8) in whole saliva of individuals with moderate gingivitis. Despite several studies investigating the use of probiotics in diverse situations, a review of the literature reveals a restricted applicability of probiotics in enhancing gingival health. Due to the dearth of research specifically examining probiotic consumption in Iraq, the current investigation aims to address this gap.

Materials and methods

This interventional, randomized controlled clinical trial received approval from the Research Ethics Committee of AL-Mustansiriyah University, College of Dentistry, reference number (REC163). The study protocol was registered under ID: NCT06910397 on the Clinical Trails.gov website on the date 27/3/2025. Saliva samples collection and the evaluation of (GI) scores were conducted between 30/ 3/ 2025 and 26/ 4/2025.

Participants

The study was conducted at AL- Anbar University, Iraq, among undergraduate student from the College of Medicine, Dentistry and Pharmacy. Written informed consent was obtained from all individuals prior to their participants, and involvement in the study was entirely voluntary.

The study's student participants were recruited through online advertisement distributed across Telegram channels for all academic stages in the College of Medicine, Dentistry and Pharmacy at AL-Anbar University, in collaboration with stage representatives, Recruitment was strictly guided by specific incorporating inclusion and exclusion criteria. The inclusion criteria including males aged 18 to 25 years who bleeding gingiva during brushing, having a dentition with ≥20 evaluable teeth (minimum of five teeth per quadrant), and of Iraqi ethnicity. The exclusion criteria included male smokers and females (the latter due to hormonal fluctuations associated with the 28-day menstrual cycle), individuals utilizing orthodontic and/ or prosthodontic appliance, those with a history of chronic and/ or systemic disease, subjects with autoimmune disorders, patients under antibiotic treatment, and those with a history of undergoing nonsurgical and surgical periodontal therapy in the last 6 months.

Following an examination of 220 students, 100 male participants aged 18 to 25 years were enrolled in the study. The sample size calculation was guided by the previous findings of Hammdallah et al. (2025), which evaluated another type of probiotics.The participants were divided randomly into two groups using the sealed envelope method. Study group (A) was administered an oral health probiotics chewable mint tablet, manufactured by NatureWis® dietary supplements company in the USA, one tablet daily for 28 days at night. Control group (B) was not administered probiotics, for ethical reasons and the

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inability to formulate a perfectly matching chewable probiotics tablet.

Clinical Evaluation

The participants in both groups underwent a full-mouth examination, and the gingival index (GI) (Löe and Silness, 1963) was recorded. The index was documented at various intervals at baseline prior to intervention and thereafter at 14 days and 28 days post-intervention for both groups in a case sheet proforma for each participant.

Salivary samples

Saliva samples were collected from both groups at different intervals: at baseline prior to intervention, and again at 14 days and 28 days post-intervention. Unstimulated saliva was obtained via the spitting method of saliva collection. Saliva was collected from both groups between 9 and 11 AM on day zero, and subsequently on days 14 and 28 post-intervention. Participants were instructed to rinse their mouths with water to eliminate any debris. Saliva samples were collected in disposable 5ml sterile plastic tubes and promptly stored in a cooler box until arrival at the laboratory within 3 to 4 hours, where they were centrifuged at 2000 rpm for 15 minutes. The supernatant was extracted using a micropipette into Eppendorf tubes and stored in the refrigerator at a temperature of 2-8℃ until analysis, which was conducted within three days.

Laboratory analysis of salivary samples

In this study, salivary biomarker levels of IL-1β and MMP-8 were quantified using enzyme-linked immunosorbent assays in accordance with the manufacturers' guidelines. The kits were manufactured by Reed Biotech Ltd in China, and were designated for research purposes only, not for therapeutic use.

Statistical Analysis

Data description, analysis, and presentation were performed using the Statistical Package for social Science (SPSS version -22, Chicago, Illionis, USA), line bar, frequency, percentage, Pearson Chi square, and mixed design two-way ANOVA with Bonferroni post-hoc test were utilized. The level of significance was at $p < 0.05$.

The Results

Twelve participants were subsequently excluded from the study, due to non-compliance with evaluation and follow-up appointments throughout the study period. During the three follow-up intervals eighty-eight participants were confirmed for clinical and laboratory assessment and subsequently included in statistical analysis. The statistical results indicated no significant difference regarding age distribution among the groups, as shown in Table (1).

Gingival Index (GI) Evaluation

The mean ±SD of GI scores at baseline was not statistically significant in either group. However, post-intervention, a significant difference ($P < 0.001$) was observed at evaluation times in group A compared to group B, as shown in Tables

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(2, 3) respectively and Figure (1), based on the findings of a two-way mixed-design ANOVA. Furthermore, group A exhibited highly significant differences ($P < 0.001$) in the mean over the three evaluations period, as determined by multiple pairwise comparisons using the Bonferroni post-hoc test for GI, as illustrated in Table (4).

Salivary biomarkers

I. **Interleukin 1 Beta (IL-1β)**

The analysis utilizing a Two Independent Sample T-test revealed that the mean ± SD of IL-1β (pg/ml) at baseline was not significant in either group. However, in group A, the IL-1β level peaked at 14 days without a significant effect, followed by the lowest mean ± SD at 28 days, which exhibited a significant effect difference ($P = 0.036$). The decrease in the mean at 28 days was significantly lower than at baseline (0 days). In contrast, the mean ±SD of IL-1β in group B exhibited a substantial rise at all evaluation intervals, as described in Tables (5 and 6) and illustrated in Figure (2). Multiple pairwise comparisons of IL-1β over time were conducted using the Bonferroni post hoc test. In group B, the assessment of mean differences in IL-1β levels across the follow-up periods revealed no significant difference between baseline and 14 days ($P=1.000$), but IL-1β levels increased during the evaluation period. The results indicated a highly significant difference ($P < 0.001$) between baseline and 28 days, as well as between 14 days and 28 days ($P < 0.001$). Conversely, in group A, following 28 days of administration of oral health probiotics in the form of chewable mint tablets, the level of IL-1β exhibited an increase from baseline to 14 days, with no statistically significant difference ($P= 0.374$). Subsequently, a decrease in mean values was observed during the assessment period, revealing a highly significant difference between baseline and 28 days ($P= 0.019$), as well as between 14 days and 28 days ($P< 0.001$), as illustrated in the Table (7).

II. Matrix metalloproteinases (MMP-8)

The statistical analysis utilizing the Two Independent Sample T-test revealed that the mean ± SD of MMP-8 (pg/ml) at baseline was not significantly different between two groups. In group A, MMP-8 levels peaked at 14 days without a significant impact, subsequently declining to their lowest mean ±SD at 28 days, exhibiting a significant difference ($P=0.023$); the mean decline at 28 days surpassed that of the baseline. In group B, the mean ±SD of MMP-8 increased during the evaluation period, as explained in Tables (8 and 9) respectively and Figure (3). Multiple pairwise comparisons of MMP-8 over time using the Bonferroni test indicated that group B exhibited no significant differences between baseline and 14 days ($P=1.000$), nor between baseline and 28 days ($P=0.083$). However, MMP-8 levels increased significantly between 14 and 28 days, demonstrating a significant difference ($P=0.032$). Conversely, with in group A, when

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participants commenced the intake of oral health probiotics in the form of chewable mint tablets for 28 days, the MMP-8 levels rose from baseline to 14 days without a significant difference (P= 1.000), followed by a significant decline in mean values from 14 days to 28 days. The results indicated a statistically significant differences between baseline and 28 days (P=0.010) as well as between 14 and 28 days (P<0.001), as detailed in Table (10).

Correlation between oral health status parameters and salivary biomarker levels during period of study

The correlation between GI and salivary biomarker levels (IL-1β, MMP-8) during study period showed a weak, non-significant, positive Pearson correlation (r<0.5), as described in Table (11).

Discussion

Currently, oral disorders are becoming more frequent due to contemporary lifestyle choices. Resulting in significant health hazards, augmented financial burdens, and diminished quality of life. Maintaining optimal oral hygiene is crucial to preventing periodontal diseases and controlling pathogenic biofilm (Chauhan et al., 2023).

This interventional study examined the efficacy of probiotics in treating gingivitis and enhancing gingival health. The results indicated a substantial reduction in the average scores of GI over time in group A compared to group B. Furthermore, this decrease in GI scores persisted at 28 days post-intervention in group A, signifying that probiotic supplementation successfully enhanced gingival health. These findings align with those of Modiri et al. (2023), who reported a significant enhancement in gingival health status following treatment with probiotic strains after evaluating clinical parameters at base line, two, and four weeks.

Similarly, the current study was in line with the research conducted by Hammdallah et al. (2025), which demonstrated that probiotic administration improved gingival health, as evidenced by a steady reduction in GI values over a 28-day period. Probiotics may contribute to gingival health benefits by disrupting pathogenic processes and competitively suppressing detrimental bacteria within the oral cavity.

The mechanism of action of probiotics in treating gingivitis involves modifying the receptors for bacterial toxins, there by indirectly reducing inflammation. Their ability to bind to receptors present in oral mucosal cells enables them to establish a stable colonization in the region. The genus *Lactobacillus* can adhere to various oral surfaces and create a protective biofilm due to the specific configuration of its cell membrane surface. Capsular polysaccharides, lipoteichoic acids, teichoic acids, surface proteins, and lipoproteins are key components of cell membranes that confer hydrophobicity and robust auto-aggregation properties to

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Lactobacillus strains, resulting in stable and durable colonies (Kaźmierczyk-Winciorek, et al., 2021).

The results of the current study indicate that IL-1β levels in group A increased from baseline to 14 days although this change did not reach statistical significance. This transient elevation may be ascribed to the capacity of specific probiotic strains, particularly *Lactobacillus* species such as *L. casei* and *L. rhamnosus*, to stimulate an immune response. This response recruits' lymphocytes, macrophages, and neutrophils to the site of inflammation, thereby modulating the release of the proinflammatory cytokine IL-1β following a brief period of probiotic intake. This finding aligns with prior research (Stolte et al., 2020, Mazziotta et al., 2023).

Conversely, IL-1β levels in group A significantly decreased from day 14 to day 28, with day 28 values lower than baseline measurements prior to the intervention. In contrast, IL-1β levels in group B increased over the entire assessment period. This divergence suggests that probiotic supplement was effective in group A. This outcome may indicate a restoration of immunological and inflammatory homeostasis within the gingival tissues and oral microbiota. The initial immunostimulatory effects of probiotics can enhance the innate immune system's response to infections, consistent with evidence reported by Rocha-Ramírez et al. (2017).

Furthermore, the current investigation observed a transient increase in salivary IL-1β on day 14 post-probiotic administration, succeeded by a notable decline by day 28. This biphasic action is consistent with recent clinical investigations into the immunomodulating impact of probiotics on oral markers of inflammation. A recent comprehensive review and meta-analysis of clinical data concluded that probiotic therapy markedly elevates salivary level of IL-1β compared to baseline measurements. This suggests an early stimulation of innate immune signals at the oral mucosa and biofilm interface. This increase is likely mediated by pattern recognition receptors (PRRs) expressed on resident immune and oral epithelial cells that at first sense the probiotic bacteria or their metabolites, resulting in stimulation of inflammation pathways like NF-κB and increment of pro-inflammatory cytokines' production. This is an example of immunological priming, where the host response to microbial stimuli is amplified upon prior exposure (Ebrahimpour-Koujan et al., 2020), Subsequently, as the oral mucosal immunity adapts to the probiotic strains and achieves homeostatic equilibrium, a resolution of the acute inflammatory signaling occurs. This adaptive phase accounts for the notable decline in IL-1β levels observed by day 28.

This is confirmed by broader investigations. Therefore, salivary IL-1β levels return to baseline or lower levels

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by day 28, indicating a shift from an inflamed state towards immunological homeostasis and a downregulation of inflammation.

Regarding the evaluated interventional trial, group A, a exhibited a non-significant elevation in MMP-8 levels from baseline to day 14, followed by a statistically significant reduction from day 14 to day 28. This effect of probiotics in reduction in MMP-8 may be due to inhibiting periodontopathogens and modulation in inflammatory response especially related to periodontal diseases. This reduction plays a favorable role in mitigating inflammation and improving biomarkers within gingival crevicular fluid (Alshareef et al., 2020).

Furthermore, evidence from a systematic review and meta-analysis demonstrates that probiotic therapy significantly diminishes MMP-8 levels in individuals with periodontal disease compared to healthy controls. The oral administration of probiotics can downregulate the inflammatory cascade linked with proteolytic markers, such as MMP-8, thereby effectively controlling dysbiosis within the oral microflora (Gheisary et al., 2022).

"A possible biological rationale for alterations in MMP-8 levels following probiotic administration involves a two-phase response. Initially, probiotic strains may temporarily alter the oral biofilm architecture and enhance neutrophil activity, elucidating the transient increase in salivary MMP-8 observed during the first two weeks of therapy (Cosseau et al., 2008).

Rather than a pathogenic inflammation, this spike represents a physiological adaptation. Subsequently, probiotic therapy facilitates a microbial equilibrium, limiting periodontal infections and downregulating pro-inflammatory mediators that trigger MMP-8 synthesis. This subsequent reduction in neutrophil activation leads to a significant decrease in salivary MMP-8 levels in the following weeks, aligning with comparable anti-inflammatory outcomes observed in prior research (Ince et al., 2015).

Mechanistically, probiotics attenuate periodontal inflammation by modulating key signaling pathways, including Toll-like receptors (TLRs), nuclear factor kappa-light-chain-enhancer of activated B cells (NF-κB), regulatory T cells (Tregs), and histamine signaling (Alasbily et al., 2025). This immunomodulatory cascade suppresses prime pro-inflammatory cytokines such as interleukin-1β (IL-1β), which indirectly downregulates downstream biomarkers like MMP-8 (Alasbily et al., 2025). While past literature has not established a direct pathway by which probiotics act on MMP-8, current evidence reinforces that short-term probiotic therapy (28 days) successfully drives probiotic proliferation within the dental biofilm, impedes pathogenic colonization, and mitigates the IL-1β/MMP-8 axis. This yield clear clinical benefits, including reduced gingival

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index and diminished gingival inflammation.

A limitation of this clinical trial is the absence of a third group of healthy control group for comparison and validation of the findings, short follow-up period, male-only sample, lack of placebo, and absence of microbiological assessment.

Future studies should incorporate follow-up assessments two weeks or longer post the completion of the probiotics regimen to evaluate its efficacy, determining whether the favorable effects are sustained or amplified over time, as well as evaluating the capacity of beneficial bacteria to colonize the oral cavity and the persistence of effects following the cessation of probiotic use.

Conclusion

Based on the findings of this study, the probiotic chewable tablets significantly reduced gingival inflammation. This is demonstrated by a decrease in gingival index scores and an improvement in salivary biomarker levels (Interleukin-1 Beta and Matrix Metalloproteinase-8).

Conflict of interest

The authors reported that they have no conflicts of interest.

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Table 1. Distribution of age among groups.

		Group A		Group B		Chi square	P value	Total	
		N.	%	N.	%			N.	%
Age	18-21y	22	50.00	26	59.09	0.733	0.392*	48	54.55
	22-25y	22	50.00	18	40.91			40	45.45

* p-value > 0.05, no significant.

Table 2. Descriptive statistics of GI among groups and time.

Time	Group A		Group B	
	Mean	±SD	Mean	±SD
Baseline	1.415	0.375	1.301	0.304
14-days	0.832	0.278	1.240	0.248
28-days	0.595	0.257	1.290	0.235

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Table 3. Main and interaction of groups and time on GI

Source	Type III Sum of Squares	Mean Square	F	P value
Groups	7.184	7.184	37.531	**0.000***
Time	8.361	4.180	151.727	**0.000***
Groups* Time	7.396	3.698	134.221	**0.000***

* p value <0.01, highly significant

Table 4. Multiple pairwise comparison of GI among time using Bonferroni

Group	Time		Mean Difference (I-J)	Std. Error	P value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
A	Baseline	14 days	0.582	0.036	**0.000***	0.493	0.671
		28 days	0.820	0.042	**0.000***	0.718	0.922
	14 days	28 days	0.238	0.026	**0.000***	0.174	0.301

* p value <0.01, highly significant

Table 5. Descriptive and statistical test of IL-1β **pg/ml** among groups and time.

Time	Group A		Group B	
	Mean	±SD	Mean	±SD
Baseline	4.780	1.326	4.411	1.713
14-days	5.174	1.234	4.457	2.232
28-days	3.872	2.243	6.300	2.280

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Table 6. Main and interaction of groups and time on IL-1β $_{pg/ml}$

Source	Type III Sum of Squares	Mean Square	F	P value
Groups	129.738	129.738	25.366	**0.000****
Time	10.579	10.579	4.550	**0.036***
Groups* Time	86.030	86.030	37.001	**0.000****

* p value < 0.05, significant

** p value < 0.01, highly significant

Table 7. Multiple pairwise comparison of IL-1β $_{pg/ml}$ among time using Bonferroni.

Groups	Time		Mean Difference (I-J)	Std. Error	P value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
A	Baseline	14 days	-0.394	0.254	0.374	-1.015	0.227
		28 days	0.908	0.325	**0.019***	0.114	1.702
	14 days	28 days	1.302	0.295	**0.000***	0.582	2.022
B	Baseline	14 days	-0.046	0.254	1.000	-0.666	0.575
		28 days	-1.889	0.325	**0.000***	-2.682	-1.095
	14 days	28 days	-1.843	0.295	**0.000***	-2.563	-1.123

* p value < 0.01, highly significant

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Table 8. Descriptive and statistical test of MMP-8 $_{pg/ml}$ among groups and time.

Time	Group A		Group B	
	Mean	±SD	Mean	±SD
Baseline	277.273	63.222	297.614	69.143
14-days	282.614	60.909	298.182	61.843
28-days	248.000	64.003	319.341	68.060

Table 9. Main and interaction of groups and time on MMP-8 $_{pg/ml}$

Source	Type III Sum of Squares	Mean Square	F	P value
Groups	212103.367	212103.367	20.770	**0.000 ****
Time	13916.051	13916.051	5.380	**0.023***
Groups* Time	75488.778	75488.778	29.183	**0.000****

∗ p value < 0.05, significant
∗∗ p value < 0.01, highly significant

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Table 10. Multiple pairwise comparison of MMP-8 $_{pg/ml}$ among time using Bonferroni.

Groups	Time		Mean Difference (I-J)	Std. Error	P value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
A	Baseline	14 days	-5.341	8.606	1.000	-26.355	15.673
		28 days	29.273	9.695	**0.010****	5.601	52.945
	14 days	28 days	34.614	8.107	**0.000****	14.819	54.409
B	Baseline	14 days	-0.568	8.606	1.000	-21.582	20.446
		28 days	-21.727	9.695	0.083	-45.399	1.945
	14 days	28 days	-21.159	8.107	**0.032***	-40.954	-1.364

* p value < 0.05, significant

** p value < 0.01, highly significant

Table 11. Correlation between Gingival Index and salivary biomarker levels among period of study

Time	Groups	IL1β$_{pg/ml}$		MMP8$_{pg/ml}$	
		r	p	r	p
Baseline	A	0.247	0.105	0.132	0.395
	B	0.217	0.158	0.037	0.812
2W	A	0.177	0.250	0.079	0.612
	B	0.102	0.511	0.032	0.838
4W	A	0.023	0.880	0.155	0.315
	B	0.114	0.463	0.050	0.746

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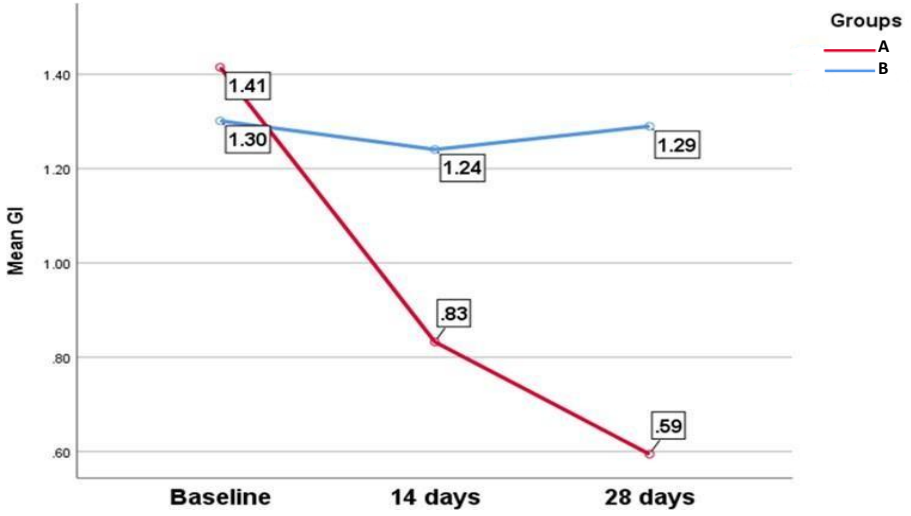

Figure 1. Comparison on mean GI values among groups and time

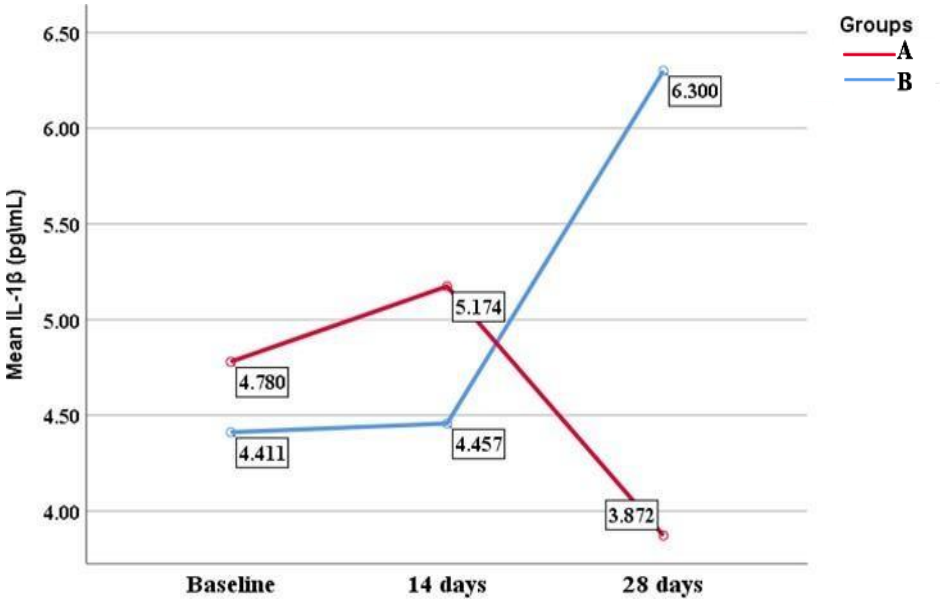

Figure 2. Comparison on mean of IL-1β $_{\mathbf{pg/ml}}$ among groups and time.

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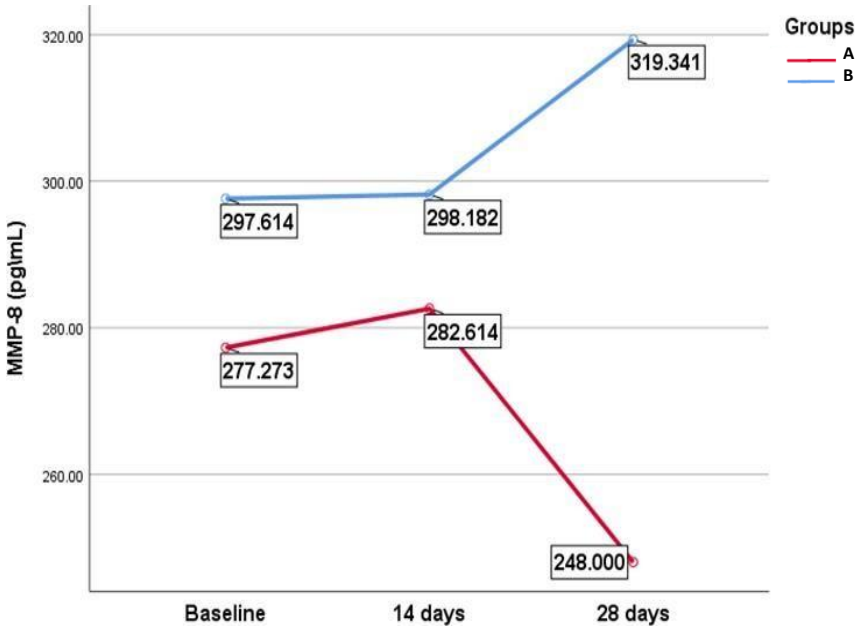

Figure 3. Comparison on mean of MMP-8 **pg/ml** among groups and time.