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Comparative evaluation of flax seed gel and low-level laser therapy as an adjunct to scaling and root planing in the management of periodontitis: A randomized controlled trial

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Abstract
Introduction: SRP effectively removes biofilm but may not fully control inflammation. Adjunctive therapies such as local drug delivery and LLLT have shown potential in enhancing periodontal healing. Flax seed gel (FS) is rich in omega-3 fatty acids, lignans, and antioxidants, which exhibit anti-inflammatory, antimicrobial, and wound-healing properties. LLLT works by stimulating cellular metabolism, increasing ATP production, and reducing oxidative stress, leading to improved tissue repair and reduced inflammation.
Objective: To evaluate the efficacy of SRP, flax seed gel and LLLT in management of periodontitis.
Methodology: This split mouth, randomized controlled study included 10 subjects with chronic periodontitis having at least 2 sites with 5-6 mm PPD in all quadrants. The 4 quadrants of each subject were divided randomly in 4 groups; Group 1: SRP + FS gel, Group 2: SRP + LLLT, Group 3: SRP + LLLT + FS gel and Group 4: SRP only**.** The clinical parameters assessed were PI, GI, PPD and RAL examination was performed at baseline and 1 month.
Results: On intragroup comparison, all groups showed significant improvement over 1 month. However, Group 3 exhibited the most substantial reduction in probing pocket depth and relative attachment level, suggesting a synergistic benefit of combining SRP with both flax seed gel and LLLT (p=0.05). All the other groups except for SRP showed better results but the intergroup comparison was not statistically significant (p>0.05)
Conclusion: Flax seed gel and LLLT, as adjuncts to SRP, enhance periodontal healing. Their anti-inflammatory and antimicrobial properties make them promising therapeutic options.

Keywords: Low level laser therapy, flax seed extract, chronic periodontitis, adjunct therapy

Introduction
Periodontal disease is a long-standing inflammatory condition of the supporting tissues of the teeth, caused by microbial infection, host immune reactions, and environmental factors that lead to tissue damage. The microbial biofilm plays a central role in the onset and progression of periodontitis. Hence, periodontal treatment primarily focuses on controlling inflammation by reducing or eliminating microbial factors. While earlier research emphasized the role of specific bacterial species in disease causation, more recent evidence suggests that much of the tissue destruction results from an exaggerated host immune response rather than bacteria alone. Bacterial virulence factors activate arachidonic acid metabolism, leading to the formation of prostaglandins and leukotrienes through cyclo-oxygenase and lipo-oxygenase pathways. Among these, eicosanoids are considered major mediators of periodontal tissue breakdown.
Microbiological approaches to periodontal therapy focus on suppressing harmful bacteria while allowing recolonization with beneficial microbiota. Different delivery methods have been used, including rinses, irrigation, systemic drugs, and localized systems with sustained release. Local delivery allows small doses of drugs to be retained in the periodontal pocket at therapeutic levels for extended periods. Agents such as tetracycline, chlorhexidine,

doxycycline, and fluoroquinolones (e.g., ciprofloxacin, ofloxacin, norfloxacin) have been incorporated into gels, films, fibers, and other carriers for controlled release.

In addition to conventional antimicrobials, natural herbal agents like aloe vera, neem, tulsi, propolis, cocoa husk, pomegranate, and cranberry are gaining attention due to their effectiveness, affordability, and minimal side effects. Among these, flax seed has emerged as particularly valuable owing to its anti-inflammatory and antioxidant properties. Flax Seed Gel (FSG), derived from *Linum usitatissimum*, contains omega-3 fatty acids, lignans, mucilage, and antioxidants. Studies indicate that FSG can reduce pro-inflammatory cytokines (e.g., IL-1β, TNF-α), neutralize free radicals, inhibit bacterial growth, and enhance healing by promoting fibroblast activity and tissue regeneration. Clinical findings show improvements such as reduced probing pocket depth (PPD), increased clinical attachment level (CAL), decreased bleeding on probing (BOP), lower inflammatory markers, and minimal adverse effects.

Another adjunctive approach involves lasers, particularly the 980 nm diode laser, which exhibits bactericidal and detoxifying effects. When combined with scaling and root planing (SRP), diode lasers have demonstrated superior clinical, biochemical, and microbiological outcomes in advanced periodontitis compared to SRP alone. The laser enhances healing by effectively removing biofilm and inflamed tissue within periodontal pockets.

However, limited research directly compares the efficacy of flax seed gel, conventional SRP, and diode laser therapy in managing periodontitis. This study was therefore designed to assess and compare the effectiveness of SRP, FSG, and low-level laser therapy in the treatment of periodontal disease.

Materials and Methods

This study is a double-blind randomized controlled trial with a split mouth design.

Sample Size Determination

Sample size for the study was determined by using the difference between two groups means formula, from the previous study. Considering 95% confidence intervals, 80% power of study and 5% chance of error, a sample size of 10 patients was derived; considering split mouth technique; it accounted to a total sample size of 40 sites.

Eligibility Criteria

Patients attending the outpatient unit of the Department of Periodontology were screened for inclusion in the study. Eligibility criteria required participants to be ≥30 years old, diagnosed with chronic periodontitis, with at least two sites in all four quadrants showing probing pocket depths of 5-6 mm, and having a minimum of 24 natural teeth. Exclusion criteria included a history of systemic illness, allergies, deleterious oral habits (such as smoking, tobacco or alcohol use, or parafunctional habits like bruxism and tooth grinding), prior antibiotic or anti-inflammatory therapy within the last six months, pregnancy, or consumption of an omega fatty acid-rich diet. A total of 10 participants met the selection criteria.

Sampling Technique and Procedure

Only patients who voluntarily agreed to participate and provided written informed consent were included in the study. All individuals diagnosed with chronic periodontitis initially underwent non-surgical periodontal therapy consisting of scaling and root planing (SRP), followed by instructions on maintaining oral hygiene. After two weeks, patients with persistent probing pocket depths of 5-6 mm were considered eligible for further intervention.

For each participant, the four quadrants were randomly assigned to one of four treatment groups: Group 1: SRP + Flax Seed (FS) gel, Group 2: SRP + Low-Level Laser Therapy (LLLT), Group 3: SRP + FS gel + LLLT, Group 4: SRP alone

Custom occlusal stents were fabricated to standardize probe placement within the periodontal pockets and ensure measurement reproducibility at each visit. Baseline clinical parameters, including Plaque Index (Silness and Löe, 1964) [18], Gingival Index (Löe and Silness, 1964) [18], Probing Pocket Depth (PPD), and Relative Attachment Level (RAL), were recorded using a structured proforma.

Blinding and Randomization

The allocations were done using a simple randomization method. The patients and the statistician were blinded to the treatment groups allocated.

Preparation of Flax seed gel

A flaxseed extract-based gel was prepared using a 1:1 ratio of polymer to flaxseed oil. Specifically, 200 mg of Carbopol 934 polymer was weighed and transferred into a clean glass vial, followed by the addition of 200 mg of flaxseed oil extract. The mixture was then sonicated to achieve uniform dispersion, yielding a homogeneous gel.

Study Procedure

Following baseline measurements, all participants underwent full-mouth scaling and root planing (SRP) with ultrasonic scalers, along with oral hygiene instructions. In the flax seed group, 0.2 ml of the experimental gel was carefully delivered into the periodontal pocket using a syringe with a needle. Upon contact with the periodontal pocket epithelium, the gel formed a solid matrix, enabling the sustained release of the active agent over time. In the low-level laser therapy (LLLT) group, treatment was performed using a 980-nm diode laser in continuous contact mode at 2 watts, applied with a flexible glass fiber optic tip of 300 μm diameter. Clinical parameters for all groups were re-evaluated after one month.

Statistical Analysis

The recorded data were entered into Microsoft Excel 2013 and analyzed using IBM SPSS Statistics (Version 21.0). Frequency analysis was performed to assess the demographic characteristics of the participants. Mean and standard deviation values were calculated for salivary pH and colony-forming units (CFU). Intragroup comparisons between baseline and one month post-treatment were conducted using the paired *t*-test, while intergroup differences were evaluated using one-way ANOVA followed by the Bonferroni post hoc test. A significance level of $p<0.05$ was considered statistically significant, with 95% confidence intervals applied.

(a) (b)

(c)

(d) (e)

Fig 1: (a) Flax seed gel delivery in the periodontal pocket, (b) Low level laser therapy using diode laser, (c) Ultrasonic scaling, (d) and (e) Relative attachment level measurement using acrylic stent at baseline and 1 month respectively.

Results

This study evaluated and compared different clinical parameters amongst different groups at baseline and after 1 month.

When the intragroup comparison of plaque index and gingival index was done by using paired samples t-test, a statistically significant difference was noted between baseline and 1 month for all the groups (p value <0.05). Similarly, when the intragroup comparison of probing pocket depth and relative attachment level was done, a statistically significant difference was noted between baseline and 1 month for all the groups (p value <0.05). Thus, it can be interpreted that on intragroup comparisons, all groups showed significant improvement over 1 month. However, Group 3 exhibited the most substantial reduction in probing pocket depth and relative attachment level, suggesting a synergistic benefit of combining SRP with both flax seed gel and LLLT. (Table1, Table 2 and Table 3).

In our study the intergroup comparison between 4 groups; was done by One-way ANOVA followed by Bonferroni post hoc test for all the clinical parameters. This comparison did not show statistically significant differences (*p* value >0.05) at baseline as well as after 1 month between the 4 groups. This indicates that when the mean values of the clinical parameters are compared; except for the SRP group, all the other groups showed good results in terms of clinical outcomes and are found to be efficacious in the treatment of periodontitis. (Graph 1, Graph 2, Graph 3 and Graph 4)

Table 1: Intragroup Comparison of Plaque Index & Gingival Index

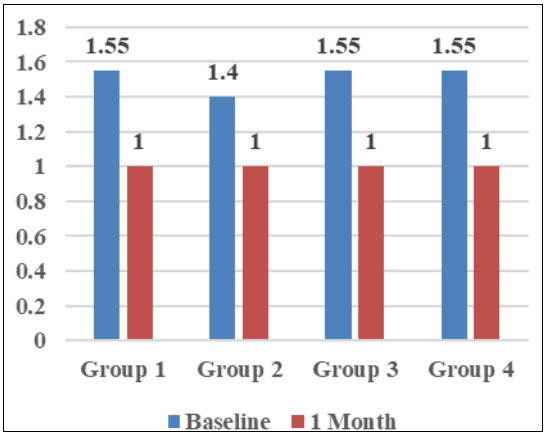
Group	Time Point	PI (Mean±SD)	PI Change	P-Value	GI (Mean±SD)	GI Change	P-Value
1 (SRP +FS Gel)	Baseline	1.55±0.50	0.55	0.006*	1.45±0.44	0.45	0.009*
	1 Month	1.00±0.00			1.00±0.00		
2 (SRP + LLLT)	Baseline	1.40±0.46	0.40	0.224	1.65±0.41	0.78	≤0.001*
	1 Month	1.00±0.00			0.88±0.21		
3 (SRP + LLLT + FS Gel)	Baseline	1.55±0.50	0.55	0.006*	1.45±0.44	0.80	≤0.001*
	1 Month	1.00±0.00			0.65±0.29		
4 (SRP only)	Baseline	1.55±0.50	0.55	0.006*	1.45±0.44	0.37	0.028*
	1 Month	1.00±0.00			1.08±0.32		

Table 2: Intragroup Comparison of Pocket Probing Depth & Relative Attachment Loss

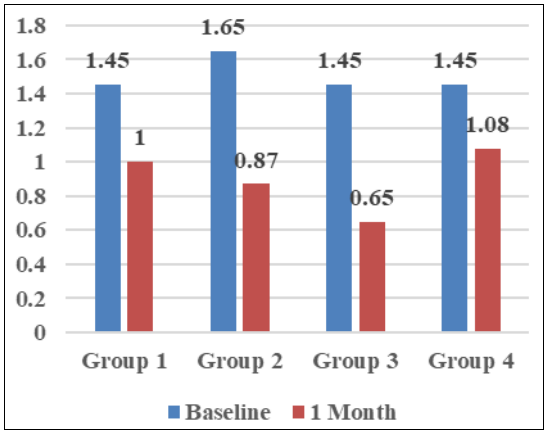
Group	Time Point	PPD (Mean±SD)	PPD Change	P-Value	RAL (Mean±SD)	RAL Change	P-Value
1 (SRP +FS Gel)	Baseline	4.25±0.47	1.15	0.001*	6.25±0.55	1.25	0.002*
	1 Month	3.10±0.72			5.00±0.82		
2 (SRP + LLLT)	Baseline	4.55±0.50	1.55	≤0.001*	6.55±0.55	1.60	≤0.001*
	1 Month	3.00±0.69			4.95±0.74		
3 (SRP + LLLT + FS Gel)	Baseline	4.45±0.50	2.30	≤0.001*	6.45±0.52	2.20	≤0.001*
	1 Month	2.15±0.30			4.25±0.79		
4 (SRP only)	Baseline	4.15±0.54	1.05	≤0.001*	6.10±0.90	0.90	0.005*
	1 Month	3.10±0.58			5.20±0.79		

Table 3: Intergroup Comparison of Plaque Index, Gingival Index, Pocket Probing Depth & Relative Attachment Loss At 1 Month

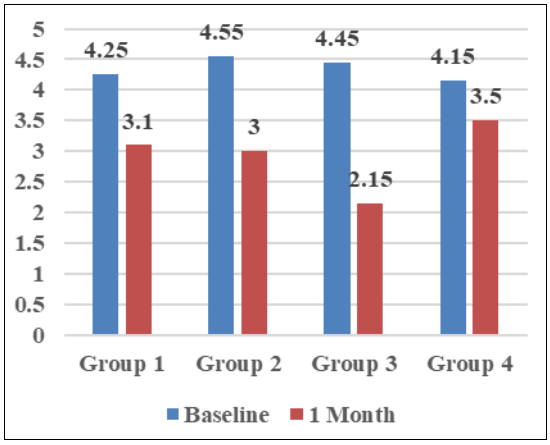
Comparison groups	PI		GI		PPD		RAL	
	Mean Diff.	p value	Mean Diff.	p value	Mean Diff.	p value	Mean Diff.	p value
Group 1 vs 2	0	1	0.12	0.09	0.1	0.88	0.05	0.88
Group 1 vs 3	0	1	0.35	0.84	0.95	0.05*	0.75	0.05*
Group 1 vs 4	0	1	0.08	0.45	0	0.58	0.20	0.58
Group 2 vs 3	0	1	0.22	0.06	0.95	0.05*	0.75	0.05*
Group 2 vs 4	0	1	0.20	0.10	0.1	0.475	0.15	0.47
Group 3 vs 4	0	1	0.43	0.005*	0.95	0.01*	1.05	0.01*



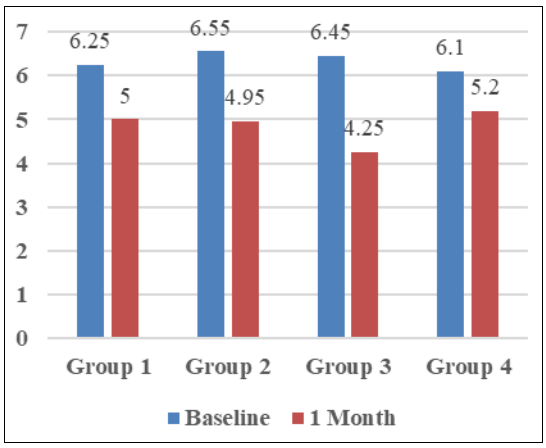
Graph 1: Comparison of PI mean scores



Graph 2: Comparison of GI mean scores



Graph 3: Comparison of PPD mean scores



Graph 4: Comparison of RAL mean scores

Discussion

Targeted delivery of antimicrobial agents into periodontal pockets represents an effective advancement over conventional treatment approaches. This method allows higher drug concentrations at the disease site, minimizes side effects, and improves patient compliance, thereby aiding in halting periodontal disease progression. The present parallel, double-blind clinical trial, conducted over one month, aimed to assess the efficacy of a herbal formulation (flax seed extract) used as an adjunct to scaling and root planing, and to compare its outcomes with those of low-level laser therapy.

Periodontal therapy is directed toward eliminating pathogenic bacteria while controlling and preventing the associated inflammatory processes. Scaling and root planing (SRP) remains the gold standard non-surgical treatment for periodontitis; however, due to the ability of bacteria to penetrate deep into periodontal tissues, SRP alone may not completely eradicate them [12-14].

Laser-assisted periodontal therapy has therefore been proposed as an adjunct or alternative to conventional mechanical treatment. Lasers offer several therapeutic advantages, including hemostasis, calculus removal, bactericidal action, and detoxification of root surfaces, which collectively enhance treatment outcomes. Moreover, laser irradiation has been reported to improve connective tissue attachment by de-epithelializing periodontal pockets, stimulating fibroblast and endothelial cell activity, enhancing collagen synthesis, and ultimately promoting wound healing [15-17].

Findings from the present study revealed significant intragroup improvements across all treatment groups over the one-month period. The greatest clinical gains in probing pocket depth (PPD) reduction and relative attachment level (RAL) were observed in the group receiving the combined regimen of flax seed (FS) gel and low-level laser therapy (LLLT) with SRP. This supports the therapeutic potential of FS extract, which is rich in omega-3 fatty acids, lignans, and antioxidants, and has demonstrated anti-inflammatory, antimicrobial, and wound-healing properties. Pappu *et al.* (2019) similarly reported that a biodegradable FS gel produced notable improvements in pocket depth reduction and attachment levels in chronic periodontitis patients.

Previous studies by Huang *et al.* (2010) highlighted the antimicrobial activity of omega fatty acids against several periodontal pathogens, including *S. mutans*, *S. gordonii*, *S. sanguis*, *C. albicans*, *A. actinomycetemcomitans*, *F. nucleatum*, and *P. gingivalis*. Beyond their antimicrobial effect, omega fatty acids also possess anti-inflammatory properties that may contribute to the observed therapeutic benefits. Sehran *et al.* (2008) further summarized that during the resolution phase of inflammation, lipid mediators derived from omega fatty acids accelerate healing processes. Their antioxidant activity also plays a protective role in controlling chronic inflammation. Similarly, Luostarinen and Saldeen (1996) demonstrated that fish oil supplementation reduced neutrophil superoxide production, suggesting that omega fatty acids confer antioxidant and protective effects in pathological conditions involving neutrophil dysfunction [18-22].

LLLT has also been widely studied for its regenerative potential. It has been shown to stimulate fibroblast proliferation, enhance collagen synthesis, and promote epithelial reattachment, thereby supporting periodontal regeneration. A meta-analysis by Ren *et al.* (2017) confirmed that LLLT used as an adjunct to SRP significantly improves clinical outcomes, including CAL gain and PPD reduction, compared with SRP alone. The present findings are consistent with these results, particularly in terms of reduced inflammation and tissue depth in the LLLT group.

To the best of the authors' knowledge, few studies to date have directly compared LLLT, FS extract, and their combination in chronic periodontitis management. The limitations of the cur*Ren*t study include a small sample size and a relatively short follow-up duration, which may have acted as confounding factors. Thus, further large-scale and long-term studies are warranted to substantiate these findings.

Conclusion

Within the limitations of this study, it may be concluded that both treatment approaches are effective in the management of periodontitis. However, considering the risk of bacterial resistance and flare-ups associated with repeated systemic antibiotic use, the combined approach of SRP, intra-pocket diode laser therapy, and flax seed gel demonstrated superior outcomes.

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Author's Contribution

Not available

Conflict of Interest

Not available

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Refe*Ren*ces

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