RESEARCH PAPER

Whole-Fruit Amla (Phyllanthus Emblica) As an Adjunct to Scaling and Root Planing In Generalized Periodontitis- An Exploratory Randomized Controlled Trial

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ABSTRACT

Background: Amla possesses potent antioxidant, anti-inflammatory, and immunomodulatory properties and has been proposed as a potential adjunct in the management of generalized periodontitis.

Objectives: To assess the effectiveness of whole fruit amla as an adjunct to scaling and root planing (SRP) versus SRP alone in generalized periodontitis patients.

Materials and Methods: The blinded randomized controlled trial enrolled 30 patients aged 25-60 years with generalized periodontitis. Following SRP at baseline, 15 participants each were randomly assigned to either group I (SRP + amla) or group II (SRP alone).Primary outcomes considered were clinical parameters, plaque index, gingival index, bleeding index, probing pocket depth, and clinical attachment loss, at baseline, 1, 3, and 6 months. Surrogate outcomes were salivary and serum levels of tumor necrosis factor-alpha (TNF-α), C-reactive protein (CRP), malondialdehyde (MDA), and reduced glutathione (GSH), at baseline and 6 months. Twenty three patients (fourteen in group I and nine in group II) completed the study.

Results: Clinical and biochemical parameters improved in both groups over 6 months, however between-group differences were not statistically significant for either parameter ($p > 0.05$). Within-group analyses revealed significant reductions in salivary TNF-α ($p = 0.012$) and CRP ($p = 0.005$) in group I, while salivary GSH increased significantly in group II ($p = 0.010$).

Conclusion: Adjunctive short-term whole fruit amla supplementation did not provide statistically significant differences over SRP alone in this exploratory trial. We suggest using a longer amla intervention in a larger sample and optimized delivery design, to provide more robust and reliable evidence.

Keywords: Periodontitis, Phyllanthus emblica, Scaling and root planing, Antioxidants, Inflammation, Randomized controlled trial.

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INTRODUCTION

Periodontitis is a chronic inflammatory disease affecting the supporting structures of the tooth and initiated by a dysbiotic dental plaque biofilm.[1, 2] The gold standard of non-surgical periodontal therapy is scaling and root planing (SRP). However, residual microorganisms, host-mediated inflammation, and oxidative stress have limited SRP as a stand-alone therapy.[3] Consequently, adjuncts that modulate oxidative stress and inflammation have been used to improve treatment outcomes.[4-7]

Natural products, with anti-inflammatory, antioxidant and immune-modulatory properties have been evaluated as potential adjuncts.[7]Among these, amla (*Phyllanthus emblica*) is a functional food, rich in tannins, polyphenols and vitamin C. Evidence suggests that amla possesses

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these potent properties, which can effectively combat periodontal disease.[8-10] Previous periodontal studies have evaluated amla in locally delivered preparations, such as gels, irrigants, and mothrinses showing benefits. [11,12] The potential benefits of whole-fruit amla consumption in a chew-and-swallow form, as an adjunct to SRP remains insufficiently investigated. This approach could confer a local exposure to the gingival and mucosal tissues, as well as systemic anti-inflammatory and antioxidant benefits. Hence whole-fruit amla could serve as a functional food and dietary adjunct to periodontal therapy.

It remains unclear whether short-term whole-fruit amla consumption provides additional clinical or biochemical benefits beyond SRP alone. There is also limited evidence of this approach on the serum and salivary markers of oxidative stress and inflammation, in periodontitis patients, and whether these changes could result in maintain periodontal stability long term.

Therefore, the present exploratory randomized controlled trial was undertaken to evaluate the clinical and biochemical effects of whole-fruit amla consumption as an adjunct to SRP in patients with generalized periodontitis, compared with SRP alone.

MATERIAL AND METHODS

Study design and Setting

It was a prospective, double-arm, single blinded randomized controlled study conducted from March 2020 to September 2022 at the outpatient facility, Department of Periodontics, in a dental college in South India.Male and female participants, aged between 25 to 60 years, diagnosed with generalized periodontitis, were recruited in the study.

The study protocol was reviewed and approved by the Institute Ethics Committee (No. 417/ MGPGIDS/ IEC/ 2020/ MDS) and was conducted in accordance with the latest Good Clinical Practices (GCP) guidelines. The trial was registered retrospectively with https://clinicaltrials.gov/ (Registration No. NCT07531823), dated 21/04/2026.

Inclusion criteria

The participants included were diagnosed with stage 2 grade A generalized periodontitis according to the 2017 World Workshop classification (published in 2018).[13]

Exclusion criteria

Participants excluded were medically compromised patients, smokers, pregnant and lactating women, those who had received any antimicrobial therapy within the previous 2 months, or were currently on antimicrobial therapy, those who had undergone any periodontal surgery in the past 6 months, and those having severe tooth hypersensitivity.

Study Procedure

The study protocol was explained to all the selected participants and written informed consents were obtained from them.

At baseline, detailed case histories were recorded for all participants.

The thirty patients finally selected were then randomly allocated to group I and group II, of 15 patients each. Randomization was performed using a computer–generated randomization sequence prepared by an independent statistician to ensure unbiased group allocation. Following baseline evaluation of clinical parameters, approximately 3 ml of unstimulated saliva and 2 ml of venous blood from the antecubital fossa were collected for biochemical evaluations. All participants subsequently underwent scaling and root planing (SRP) using ultrasonic scalers (EMS^{TM}) and Gracey curettes (Hu-Friedy^{TM}). Saliva and blood samples were processed within one hour of collection by centrifugation, following which the supernatants were aliquoted and stored at -80^0 C until analysis. Standard oral hygiene instructions were given to all participants. Each participant in group I received 28 whole fruit amla and were instructed to consume one whole raw fruit, twice daily, for 2 weeks, after the first and last meals of the day. The administration protocol involved rinsing the mouth with plain water, thoroughly chewing the berry to facilitate the release and mixing of the juice with saliva, swishing it throughout the oral cavity for 30-60 seconds to enhance mucosal contact, and subsequently swallowing it. Participants were advised to refrain from eating or drinking for at least one hour after consumption to minimize washout effects. We monitored compliance of amla consumption by patient self-report. Any unused amla was returned at the next follow-up visit. Group II patients underwent SRP alone without any additional intervention. Follow-up visits for both groups were scheduled at 1, 3 and 6 months, with assessment of clinical parameters at all time points, and biochemical parameters at baseline and at 6 months. Regular periodontal maintenance was performed at all time intervals. An investigator blinded to the intervention, performed recall evaluations, adherence percentage to the intervention, and adverse effects or intolerance to amla in the participants.

Outcome measures

Primary outcome measures

They included assessment of the changes in the clinical periodontal parameters, such as plaque index (PI),[14] gingival index (GI),[14] bleeding index (BI),[15] probing pocket depth (PPD) and clinical attachment level (CAL) at baseline and at 1, 3 and 6 months follow-up visits. PPD and CAL were measured to the nearest millimetre using a University of Michigan “O” probe with William’s markings. Measurements were recorded at six sites per tooth, and the average value for each participant at each scheduled visit was considered for analysis.

Surrogate outcome measures

In order to provide complementary information on the inflammatory and oxidative stress pathways involved in periodontal disease, we assayed TNF- α, CRP, GSH, and MDA. TNF- α represents a pro-inflammatory cytokine involved in periodontal disease, while CRP is a systemic

acute phase inflammatory marker that reflects the inflammatory burden of periodontal disease. MDA is an indicator of lipid oxidative damage and GSH is an important endogenous antioxidant that reflect the antioxidant defense status. We assayed both saliva and serum, to evaluate both local and systemic anti-inflammatory/antioxidant effects of amla.

Estimation of biochemical parameters

Estimation of Malondialdehyde (MDA) - Lipid peroxidation (LPO) was determined by using MDA as the product of lipid peroxidation, using the TBARS method. The method lacks specificity.Briefly, 50 µl of serum or saliva samples were mixed with 0.1 ml of sodium dodecyl sulfate, followed by the addition of 0.375 ml of acetic acid. Subsequently, 375 µl of thiobarbituric acid was added to the mixture and incubated at 95 °C for 1 hour. The development of pink chromophore marked the completion of the reaction. The absorbance was measured spectrophotometrically against the reagent blank, and the obtained values obtained were expressed in µg/ml.[16]

Estimation of Reduced Glutathione– Reduced Glutathione (GSH) levels were estimated using 0.125 ml of serum or saliva samples. An equal volume of ice-cold 5% trichloroacteic acid was added to the samples, followed by centrifugation at 4000 rpm for 10 minutes. The resulting supernatant was then mixed with 0.125 ml of phosphate buffer and 0.25 ml of dithiobis-(2-nitrobenzoic acid) (DTNB). The absorbance was measured at 412 nm using a multimode reader. GSH concentrations were subsequently determined by interpolation from the standard glutathione calibration curve.[16]

High sensitivity C-reactive protein (hs-CRP) and tumour necrosis factor-α (TNF-α) -

CRP and TNF-α levels in serum or saliva samples collected from the study participants were quantified using specific enzyme-linked immunosorbent assay (ELISA) kits (Calbiotech Inc., California, USA, and Diaclone, Biomol GmbH, Hamburg, Germany, respectively) in accordance with the manufacturer's instructions.

The methodology and kits used in the biochemical assays are provided in the supplemental file.

Sample Size and Statistical Tests

Owing to the exploratory nature of the study, a pragmatic sample size of 15 participants per group was selected based on feasibility considerations to generate preliminary evidence on treatment effects and to inform the design of future adequately powered trials.

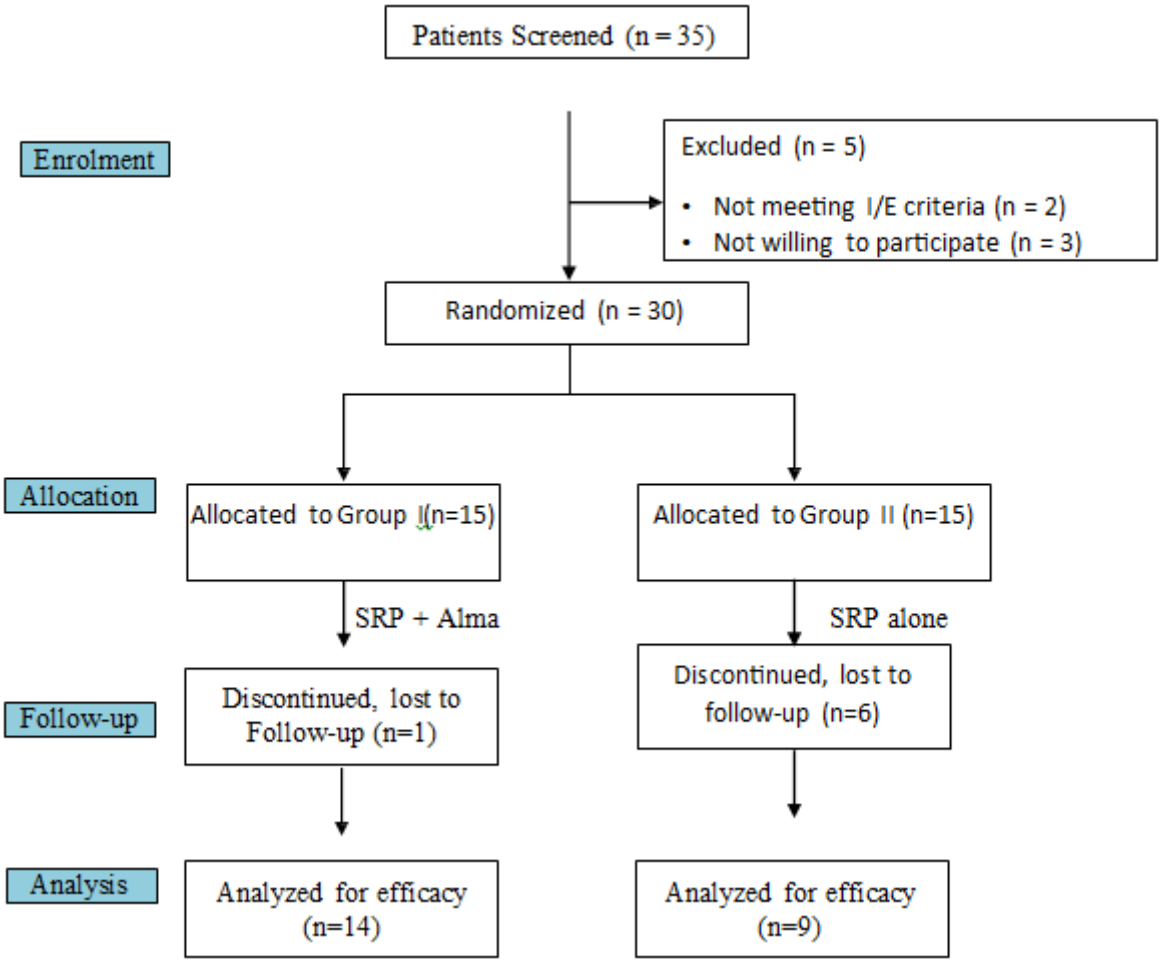
Data normality was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Quantitative variables were presented as mean ± standard deviation (SD) for normally distributed data. Between-group comparisons for categorical variables were performed using the chi-square test or Fisher's exact test, as appropriate. For continuous variables, the unpaired t-test was used for normally distributed data, whereas the Mann–Whitney U test was applied for non-normally distributed data. Within-group comparisons of repeated measurements were performed using the paired t-test or the Wilcoxon signed-rank test. All statistical tests were two-sided, and a p-value <0.05 was considered statistically significant.

As there was significant post-randomization attrition, we felt analysis restricted to participants completing the trial would compromise randomization, hence data was also analyzed according to the intention-to-treat (ITT) principle, with participants analyzed in their originally assigned groups.[17]

Statistical analysis was performed using IBM SPSS Statistics version 23.0 (IBM Corp., NY, USA).

RESULTS

Among the 35 patients screened for eligibility, 2 did not meet the inclusion/ exclusion criteria, and 3 of them declined participation. Consequently, 30 patients were recruited into the study. Of these, in group I, 4 lost interest in the study and 2 had out of station job relocations. In group II, one lost interest in the study and was lost to follow-up. Overall, 23 patients completed the study. All participants were included in the final analysis. The flow of participants throughout the study is shown in Figure 1.



Participants in group I showed a 90% adherence percentage of amla consumption, and none of them had any adverse effects or intolerance.

Baseline demographic characteristics of study participants are summarized in Table 1.

Table 1: Baseline demographic characteristics

	Group I (n=15)	**Group II (n=15)**
Age		
25-35 years	3 (20%)	4 (26.67%)
36-45 years	7 (46.66%)	6 (40%)
46-55 years	4 (26.67%)	3 (20%)
56-60 years	1 (6.67%)	2 (13.33%)
Gender		
Male	7 (46.67%)	9 (60%)
Female	8 (53.33%)	6 (40%)
Education level		
Primary School	10 (66.67%)	8 (53.33%)
Secondary School	4 (26.67%)	5 (33.33%)

Pre University	1 (6.66%)	2 (13.34%)
Family Income		
Economically weaker section (< INR 3,00,000)	5 (33.33%)	7 (46.67 %)
Low-income group (INR 3,00,001-6,00,000)	9 (60%)	6 (40%)
Middle-income group-I (INR 6,00,000- 12,00,000)	1 (6.67%)	2 (13.33%)
Smoking Status		
Never	12 (80%)	10 (66.67%)
Former	3 (20%)	5 (33.33%)
Religion		
Hindu	10 (66.66%)	8 (53.33%)
Muslim	4 (26.67%)	4 (26.67%)
Christian	1 (6.67%)	3 (20%)
Food Habits		
Vegetarian	5 (33.33%)	7 (46.67 %)
Non-Vegetarian	10 (66.67%)	8 (53.33 %)
Frequency of brushing in a day		
Doesn't brush	2 (13.33%)	-
Once a day	8 (53.33%)	9 (60%)
Twice a day	4 (26.67%)	5 (33.33%)
More than twice a day	1 (6.67%)	1 (6.67%)
Use of dental prosthesis		
Yes	4 (26.67%)	6 (40%)
No	11 (73.33%)	9 (60%)
Data represented as N (%)		

Primary outcome measures (Clinical Parameters)

The clinical parameters were assessed at baseline, 1 month, 3 months and 6 months; and are presented in table 2.

Table 2: Clinical parameters at study time points

Parameters	Time point	Group I	Group II	p-value*
		Mean ± SD	Mean ± SD	
Plaque Index (PI)	0 mon	1.51 ± 0.82	1.14 ± 0.24	0.518
	1 mon	0.66 ± 0.65	0.53 ± 0.35	0.909
	3 mon	0.52 ± 0.39	0.51 ± 0.25	0.676
	6 mon	0.51 ± 0.42	0.68 ± 0.41	0.119
Gingival Index (GI)	0 mon	1.91 ± 0.45	2.55 ± 2.33	0.550
	1 mon	0.75 ± 0.64	0.98 ± 0.50	0.425
	3 mon	0.83 ± 0.52	0.94 ± 0.48	0.569
	6 mon	0.75 ± 0.35	1.04 ± 0.61	0.270
Bleeding Index (BI)	0 mon	1.04 ± 0.42	1.19 ± 0.38	0.265
	1 mon	0.49 ± 0.57	0.57 ± 0.40	0.382
	3 mon	0.56 ± 0.55	0.51 ± 0.34	0.790

	6 mon	0.59 ± 0.58	0.67 ± 0.68	0.761
Probing pocket depth (PPD)	0 mon	3.64 ± 1.77	3.61 ± 0.55	0.447
	1 mon	2.77 ± 1.17	2.63 ± 0.96	0.470
	3 mon	2.63 ± 0.97	2.45 ± 0.88	0.621
	6 mon	2.50 ± 0.69	2.59 ± 0.61	0.569
Clinical Attachment Level (CAL)	0 mon	3.86 ± 1.42	4.18 ± 0.48	0.184
	1 mon	3.17 ± 0.90	3.15 ± 0.91	0.970
	3 mon	2.89 ± 0.90	2.98 ± 0.91	0.820
	6 mon	2.91 ± 0.81	3.25 ± 0.61	0.543
* Mann-Whitney U test mon: months.				

The PI showed a significant reduction from baseline to 6 months in group I (1.51 ± 0.82 to 0.51 ± 0.42). In group II, PI decreased from baseline to 3 months (1.14 ± 0.24 to 0.51 ± 0.25), followed by a slight increase at 6 months (0.68 ± 0.41). However, intergroup differences were not statistically significant at any study time point (p >0.05).

Similarly, the GI showed substantial improvement in both groups. In group I, GI decreased from 1.91 ± 0.45 at baseline to 0.75 ± 0.35 at the 6th month, with minor fluctuations during follow-up. Group II exhibited a reduction from 2.55 ± 2.33 at baseline to 0.94 ± 0.48 at 3 months, followed by a slight increase to 1.04 ± 0.61 at 6 months. No statistically significant differences were observed between the groups at any evaluation period (p >0.05).

BI scores improved in both groups. Group I showed a reduction from 1.04 ± 0.42 at baseline to 0.49 ± 0.57 at 1 month, with marginal increases thereafter. In group II, BI steadily declined from 1.19 ± 0.38 at baseline to 0.51 ± 0.34 at 3 months, followed by a slight increase at 6 months (0.67 ± 0.68). The between-group comparisons were comparable at all time points (p >0.05).

With respect to the PPD, both groups demonstrated progressive reductions throughout the study period. Group I exhibited a decrease from 3.64 ± 1.77 mm at baseline to 2.50 ± 0.69 mm at 6 months. Likewise, group II showed a reduction from 3.61 ± 0.55 mm at baseline to 2.45 ± 0.88 mm at 3 months, with a slight increase to 2.59 ± 0.61 mm at 6 months. Despite the overall improvement observed in both groups, the differences between groups were not statistically significant at any of the follow-up visits (p > 0.05).

CAL also improved in both groups. In group I CAL decreased from 3.86 ± 1.42 mm at baseline to 2.89 ± 0.90 mm at 3 months, and remained stable at 6 months (2.91± 0.81 mm). Similarly, group II demonstrated a reduction from 4.18 ± 0.48 mm at baseline to 2.98 ± 0.91 mm at 3 months, followed by a slight increase to 3.25 ± 0.61 mm at 6 months. Intergroup comparisons were comparable, but not statistically significant (p > 0.05).

Biochemical Parameters

The results for the analysis for salivary and serum biomarkers, namely TNF-α, CRP, LPO, and GSH, at baseline and 6 months are presented in table 3.

Table 3: Comparison of salivary and serum biomarkers

Biomarker	Time point	Saliva		p-value*	Serum		p-value*
		Group I Mean ± SD	Group II Mean ± SD		Group I Mean ± SD	Group II Mean ± SD	
TNF-α	0 mon	39.57 ± 18.85	29.13 ± 12.08	0.172	21.77 ± 9.69	20.40 ± 2.16	0.325
	6 mon	23.05 ± 4.56	20.90 ± 1.57	0.404	16.07 ± 6.04	18.42 ± 5.12	0.272
	p-value^	0.012	0.054	-	0.130	0.336	-
CRP	0 mon	0.67 ± 0.32	2.85 ± 6.51	0.226	14.83 ± 8.55	17.01 ± 7.02	0.762
	6 mon	0.31 ± 0.06	0.31 ± 0.04	0.999	16.16 ± 5.58	17.35 ± 5.90	0.545
	p-value^	0.005	0.250	-	0.672	0.833	-
MDA	0 mon	2.59 ± 1.36	3.60 ± 3.04	0.543	13.02 ± 14.87	10.00 ± 4.73	0.677
	6 mon	2.41 ± 1.41	2.24 ± 1.40	0.969	6.51 ± 4.26	8.32 ± 6.78	0.211
	p-value^	0.775	0.074	-	0.204	0.599	-
GSH	0 mon	9.73 ± 4.11	8.81 ± 3.47	0.762	14.70 ± 1.34	14.97 ± 1.38	0.545
	6 mon	12.17 ± 1.58	11.82 ± 2.31	0.821	15.29 ± 2.45	16.08 ± 2.61	0.45
	p-value^	0.087	0.010	-	0.515	0.216	-

* Mann-Whitney U test
^ Paired-samples T-test
TNF-α, tumour necrosis factor-alpha; CRP, C-reactive protein; MDA, malondialdehyde; GSH, reduced glutathione.

For the salivary biomarkers, no statistically significant differences were observed between the groups at either the baseline or at the 6 month follow-up (all $p > 0.05$). Similarly, serum biomarker levels did not differ significantly between the groups the study time points (all $p > 0.05$). While group I exhibited numerically higher baseline serum levels of TNF-α and MDA, the intergroup differences were comparable throughout the study period.

A significant reduction in salivary TNF-α and CRP levels was observed from baseline to 6 months (39.57 ± 18.85 pg/mL to 23.05 ± 4.56 pg/mL, $p = 0.012$; and 0.67 ± 0.32 mg/L to 0.31 ± 0.06 mg/L, $p = 0.005$, respectively) in group I. In contrast, changes in salivary MDA and GSH levels in group I were not statistically significant ($p = 0.775$ and $p = 0.087$, respectively). In group II, salivary GSH levels increased significantly from baseline to 6 months (8.81 ± 3.47 to 11.82 ± 2.31; $p = 0.010$), indicating an improvement in antioxidant status. Although reductions were observed in salivary TNF-α and MDA levels, these changes did not reach statistical significance ($p = 0.054$ and $p = 0.074$, respectively). Salivary CRP levels also showed no significant change during the study period ($p = 0.250$). The serum biomarkers, showed no statistically significant within-group changes in either group I or group II over 6 months.

The results of the ITT analysis, did not show significant between group differences and have been submitted as a supplementary file.

DISCUSSION

This exploratory randomized controlled trial evaluated the adjunctive effect of whole fruit amla consumption in patients with generalized periodontitis undergoing SRP. The clinical parameters were assessed to determine the impact of the intervention on periodontal inflammation, tissue destruction and healing, while biochemical markers were analyzed to explore the underlying local and systemic biological responses.

The intervention period of 2 weeks was consistent with a randomized controlled trial using an herbal mouthwash containing amla as one of the ingredients, as an adjunct to SRP, for 2 weeks, in the management of periodontitis.[12] We also felt there would be better patient compliance with a 2 week amla consumption.

In this study, the endeavor was to explore the additional systemic benefits of amla as a functional food, and see if the initial changes were able to sustain long-term periodontal stability, with regular maintenance therapy. Hence we followed up patients up to 6 months.

Both study groups demonstrated improvements in clinical periodontal parameters over the 6 month follow-up period. Similar changes were observed in the salivary and serum biomarkers. While favorable changes were observed in both groups, the salivary and serum biomarkers evaluated did not reveal statistically significant differences between the amla plus SRP group vs. SRP-alone group, suggesting limited sensitivity in detecting the additional therapeutic effects of the intervention in this small exploratory trial. Also the significant within-group changes cannot be interpreted as evidence that amla was responsible for the improvement.

However, the biological plausibility of amla as a therapeutic adjunct cannot be overlooked. Its rich phytochemical composition enhances antioxidant and antiinflammatory properties, with the potential to contribute to periodontal health.[7,8] These properties have led to its traditional and contemporary use in the management of several systemic diseases, as well as oral diseases such as dental caries, oral ulcers, desquamative gingivitis and periodontal disease.[9-11]

Earlier studies have used amla in delivery forms, such as powders, liquids, toothpastes, gels, mouth rinses, and subgingival irrigants.[12,18, 19] These findings support the therapeutic potential of amla when delivered directly to periodontal tissues. Recent studies have linked periodontal disease with several non-communicable systemic diseases, and therapy targeting systemic inflammation and oxidative stress, in order to improve periodontal health.[20] Hence, we used whole fruit amla, for both local and systemic benefits. To our knowledge, previous studies have not simultaneously evaluated these potential local and systemic effects of whole-fruit amla, through the assessment of both salivary and serum biomarkers.

Despite this novel rationale, the adjunctive use of amla did not confer significant benefits over SRP alone. Several factors may explain these findings. We realized the short duration of amla consumption would not have been sufficient to achieve sustained biological effects. The study was not adequately powered, with a substantial attrition rate, possibly resulting in a type II error. Hence a larger adequately powered sample, with the intervention given for a month or more, may be necessary to observe measurable changes in periodontal and systemic parameters. Second, unlike locally delivered formulations, the active phytoconstituents in the fruit were unlikely to reach the base of the periodontal pocket, which represents the primary site of disease activity. Future studies may explore alternative delivery strategies to maximize the therapeutic potential by incorporating amla phytoconstituents in biodegradable inserts, and facilitating sustained release directly within periodontal pockets. Combining such localized delivery with systemic consumption of the fruit may offer synergistic topical and systemic benefits. Overall, while whole-fruit amla consumption was associated with improvements in clinical and biochemical parameters, these effects were not

significantly different from those achieved with SRP alone.

CONCLUSION

Both group I and II demonstrated improvements in clinical and biochemical parameters over the study period; however, no significant differences were observed between the groups. While the findings do not support a clear adjunctive benefit of short-term whole fruit amla consumption, its established antioxidant and anti-inflammatory properties warrant further investigation. Larger studies with longer intervention periods and optimized delivery strategies are needed to evaluate the potential role of amla in the management of periodontitis.

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AUTHOR CONTRIBUTION

GTP: Methodology, Conceptualization, Supervision, Project administration, Writing original draft and review; SPKKB: Methodology, Conceptualization, Supervision, Project administration, Manuscript review and editing; HRV: Methodology, Biochemical investigations, Manuscript review and editing; SR and PS: Biochemical investigations, Manuscript review and editing; RH: Methodology, Conceptualization, Statistical analysis, Manuscript review and editing.

GTP is the guarantor of this article. All authors reviewed, revised, and approved the final version of the manuscript.

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DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE MANUSCRIPT PREPARATION

During the preparation of this work, the author(s) have not used generative AI or any AI tool.

REFERENCES

1. Könönen E, Gursoy M, Gursoy UK. Periodontitis: A Multifaceted Disease of Tooth-Supporting Tissues. J Clin Med. 2019;8(8):1135. Published 2019 Jul 31. doi:10.3390/jcm8081135.
2. Graves DT, Li J, Cochran DL. Inflammation and uncoupling as mechanisms of periodontal bone loss. J Dent Res. 2011;90(2):143-153. doi:10.1177/0022034510385236.
3. Cobb CM. Clinical significance of non-surgical periodontal therapy: an evidence-based perspective of scaling and root planing. J Clin Periodontol. 2002;29 Suppl 2:6-16..
4. Amato M, Santonocito S, Polizzi A, et al. Local Delivery and Controlled Release Drugs Systems: A New Approach for the Clinical Treatment of Periodontitis Therapy. Pharmaceutics. 2023;15(4):1312. Published 2023 Apr 21. doi:10.3390/pharmaceutics15041312.
5. Rosa EP, Murakami-Malaquias-Silva F, Schalch TO, et al. Efficacy of photodynamic therapy and periodontal treatment in patients with gingivitis and fixed orthodontic appliances: Protocol of randomized, controlled, double-blind study. Medicine (Baltimore). 2020;99(14):e19429. doi:10.1097/MD.0000000000019429.
6. Maj A, Kusiak A, Garbacz K, Cichońska D, Świetlik D. Photodynamic therapy in non-surgical treatment of periodontitis. Sci Rep. 2025;15(1):5903. Published 2025 Feb 18. doi:10.1038/s41598-025-89563-3.
7. Lin X, Shi B, Ye L, Liang L, Gao Y, Qin Y, Tao R, Yong XZ. Phytochemicals in Treatment of Periodontal Disease: A Review of Mechanisms and Roles. Med Sci Monit. 2025 Oct 11;31:e949388. doi: 10.12659/MSM.949388. PMID: 41074401; PMCID: PMC12523117.
8. G Singh P, S Jain A, B Sridhara Setty P, Bv S, S Patil S, P A, Ts G, Suresh KP, Dugganaboyana GK, Murugesan K, Gnanasekaran A, Shivamallu C, Kollur SP, Srinivasa C, Hl R, Rudrapathy P, M Basalingappa K. Antimicrobial, antioxidant and anti-inflammatory activities of seeds from *emblica officinalis* (Gaertn.). Bioinformation. 2022 Aug 31;18(8):683-691. doi: 10.6026/97320630018683. PMID: 37323557; PMCID: PMC10266361.
9. Kapoor MP, Suzuki K, Derek T, Ozeki M, Okubo T. Clinical evaluation of Emblica Officinalis Gatertn (Amla) in healthy human subjects: Health benefits and safety results from a randomized, double-blind, crossover placebo-controlled study. Contemp Clin Trials Commun. 2019;17:100499. Published 2019 Nov 27. doi:10.1016/j.conctc.2019.100499.
10. Gul M, Liu ZW, Iahtisham-Ul-Haq, et al. Functional and Nutraceutical Significance of Amla (Phyllanthus emblica L.): A Review. Antioxidants (Basel). 2022;11(5):816. Published 2022 Apr 22. doi:10.3390/antiox11050816.
11. Madan, Suman & Kashyap, Seema & Mathur, Prof & Scholar, Research & Professor, Assistent. (2019). Amla: A boon for Periodontal health. 6. 1-3.
12. Kumar RR, et al. Efficacy of a herbal mouthwash for management of periodontitis and radiation-induced mucositis: a consolidated report of two randomized controlled clinical trials. J Ayurveda Integr Med. 2023;14(6):100791. doi:10.1016/j.jaim.2023.100791.
13. Papapanou PN et al. Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the

Classification of Periodontal and Peri-Implant Diseases and Conditions(*J Periodontol*. 2018;89 Suppl 1:S173-S182).

14. Löe H. The Gingival Index, the Plaque Index and the Retention Index Systems. J Periodontol. 1967 Nov-Dec;38(6):Suppl:610-6. doi: 10.1902/jop.1967.38.6.610. PMID: 5237684.
15. Ainamo J, Bay I. Problems and proposals for recording gingivitis and plaque. Int Dent J. 1975;25 (4):229-235..
16. V. Sekar, S. Mani, R. Malarvizhi, P. Nithya, and H. R. Vasanthi, "Antidiabetic effect

of mangiferin in combination with oral hypoglycemic agents metformin and gliclazide," Phytomedicine, vol. 59, no. March, p. 152901, 2019, doi:10.1016/j.phymed.2019.152901.

17. Hopewell S, Chan AW, Collins GS, Hróbjartsson A, Moher D, Schulz KF, et al. CONSORT 2025 statement: updated guideline for reporting randomised trials. *BMJ*. 2025;388:e081123.
18. Grover S, Tewari S, Sharma RK, Singh G, Yadav A, Naula SC. Effect of Subgingivally Delivered 10% Emblica officinalis Gel as an Adjunct to Scaling and Root Planing in the Treatment of Chronic Periodontitis - A Randomized Placebo-controlled Clinical Trial. Phytother Res. 2016 Jun;30(6):956-62. doi: 10.1002/ptr.5600. Epub 2016 Feb 24. PMID: 26914986.
19. Tewari, S., Grover, S., Sharma, R. K., Singh, G., & Sharma, A. Emblica officinalis Irrigation as an Adjunct to Scaling and Root Planing: A Randomized Controlled Clinical Trial. J Dent Indones. 2018;25(1): 15-23.
20. Alsalleeh F, Alhadlaq AS, Althumiri NA, AlMousa N, BinDhim NF. Public Awareness of the Association between Periodontal Disease and Systemic Disease. Healthcare (Basel). 2022 Dec 28;11(1):88. doi: 10.3390/healthcare11010088. PMID: 36611548; PMCID: PMC9818634.