

Comparing Plaque-Reducing Effectiveness of Green Tea-Propolis Toothpaste (Atomy®) and Dual Zinc Arginine Toothpaste (Colgate Total Advanced®) - A Randomized Clinical Trial

Dr. Vaishnavi Bandari¹, Dr. Ramadugu Ashish², Dr. Shivanand Aspalli³, Dr. Nagappa Guttiganur⁴

PG, Department of Periodontics and Oral Implantology, AME's Dental college and Hospital, Raichur, RGUHS

Corresponding Author Email: [bandari.vaishnavi2903\[at\]gmail.com](mailto:bandari.vaishnavi2903[at]gmail.com)

ORCID - 0009-0003-5709-380X

Intern, Department of Periodontics and Oral Implantology, AME's Dental college and Hospital, Raichur, RGUHS

Email: [ramadugu.ashish\[at\]gmail.com](mailto:ramadugu.ashish[at]gmail.com)

Head of the Department of Periodontics and Oral Implantology, AME's Dental College and Hospital, Raichur, RGUHS

Email: [drsaspalli\[at\]gmail.com](mailto:drsaspalli[at]gmail.com)

Position: Professor, Department of Periodontics and Oral Implantology, A.M.E.'s Dental College & Hospital, Raichur, RGUHS

Email: [nagunags\[at\]yahoo.co.in](mailto:nagunags[at]yahoo.co.in)

Abstract: ***Introduction:** Plaque is the chief precursor of many periodontal diseases, and its effective control is crucial for maintaining oral health. While mechanical plaque removal remains the cornerstone of oral hygiene, chemical adjuncts can enhance biofilm disruption and prevent microbial accumulation. Natural agents such as green tea, with its antioxidant, anti-inflammatory, antibacterial, anticariogenic, and anti-plaque properties, and propolis, a resinous substance with broad antimicrobial and anti-inflammatory activity, have shown promise as supportive measures in periodontal care. In contrast, zinc ions, known for their antimicrobial effects, and arginine, which potentiates zinc's antibacterial action, are widely incorporated into conventional oral hygiene products. Therefore, this study aimed to compare the effectiveness of toothpaste containing green tea and propolis with that of toothpaste formulated with dual zinc and arginine. **Aims and objectives:** To compare the antiplaque efficiency of toothpaste containing a combination of green tea and propolis (ATOMY®) with that of dual zinc arginine containing tooth paste (COLGATE TOTAL ADVANCED®). **Materials and methodology:** Single Blinded, Randomized controlled clinical trial, of 100 Patients, divided into 2 groups, patients within age group of 18 to 25, patients are randomly allotted into 2 groups _Group A – 50 (ATOMY®) and GROUP B – 50 (COLGATE TOTAL ADVANCED®) Patients were allotted based random sequence generator (random.org.) followed by chit method and adverse reactions if any were also noted, using adverse reaction reports. **Results:** A total of 100 patients were assessed at baseline and after 2 weeks using the plaque index and OHI-S index. In Group A, the average reduction from the baseline score is 0.51 (0.5), while in Group B, it is 0.74 (0.67). The decrease in OHI-S scores in Group A is 0.97 (0.88), compared to 1.55 (1.26) in Group B. **Conclusion:** In conclusion, both toothpaste formulations were effective in reducing plaque and improving oral hygiene within two weeks; however, the dual zinc–arginine toothpaste demonstrated greater reductions in Plaque index and OHI-S scores compared to the green tea–propolis toothpaste, indicating superior efficacy in biofilm control and oral hygiene improvement.*

Keywords: toothpaste, Green tea Tooth Paste, Propolis toothpaste, Dual zinc arginine toothpaste, Herbal toothpaste, Plaque

1. Introduction

Plaque is the primary reason for the development of periodontal diseases thus, keeping it in check becomes essential in the prevention of periodontal diseases. ⁽¹⁾ While thorough mechanical plaque removal remains the cornerstone of maintaining oral health, formulations such as toothpastes and mouth rinses containing active agents serve as valuable adjuncts in minimizing bacterial accumulation and controlling periodontal disease.⁽²⁾ However, compared to chemical formulations herbal formulations offer antibacterial, antioxidant, anti-inflammatory, and antiallergic properties, offering therapeutic benefits with fewer side effects especially with long term use. ⁽³⁾ Their primary advantage lies in being better suited for individuals with sensitive oral tissues or allergies to synthetic additives. Environmentally, these products often rely on biodegradable ingredients, thereby reducing ecological burden. Nonetheless, certain limitations exist, as their therapeutic efficacy depends on the

concentration and bioavailability of active constituents, necessitating precise formulation. Among notable examples, catechins—especially epigallocatechin gallate (EGCG) from green tea—exhibit potent antimicrobial and antioxidant activity, while propolis, a natural resinous bee product, provides broad-spectrum antibacterial effects that help curb microbial growth.⁽⁴⁾ Propolis also have been reported to exhibit various bioactivities, including antioxidant, anticancer, antibacterial, anti-inflammatory, and anti-fungal ⁽⁵⁾.

Conversely, metal salts such as zinc and tin have attracted considerable interest due to their recognized antibacterial activity and favourable safety profile. Numerous investigations have demonstrated that dentifrices containing zinc salts can effectively inhibit plaque formation, and these compounds are incorporated into a wide range of formulations either as standalone agents or in combination with other active ingredients.⁽⁶⁾

Volume 15 Issue 2, February 2026

Fully Refereed | Open Access | Double Blind Peer Reviewed Journal

www.ijsr.net

Dual Zinc Arginine (DZA) technology combines zinc citrate and zinc oxide to deliver a dual zinc effect with proven antibacterial activity. Arginine, an amino acid, plays a complementary role by helping regulate plaque biofilm and enhancing the overall efficacy of the formulation. Clinical evidence from a randomized, double-blind trial demonstrated that a toothpaste containing DZA technology (0.96% dual zinc and 1.5% arginine, together with 1450 ppm sodium fluoride) produced significantly greater reductions in plaque and gingivitis at both 3 and 6 months compared with a conventional sodium fluoride toothpaste containing the same fluoride concentration. (7) The present study was aimed to evaluate and compare the antiplaque effectiveness of a toothpaste containing green tea–propolis with that of a formulation based on dual zinc arginine technology

Aim and Objectives: To compare the antiplaque efficiency of toothpaste containing a combination of Green tea and propolis (ATOMY®) with that of Dual Zinc Arginine containing tooth paste (COLGATE TOTAL ADVANCED®)

2. Materials and Methods

Single-blinded, Randomised controlled clinical trial, A sample of 100 Patients, divided into 2 groups: Group A – 50 (ATOMY®), GROUP B – 50 (COLGATE TOTAL ADVANCED®). Patients were allotted based random sequence generator (random.org) and chits method. This study obtained ethical clearance from institutional ethical committee with reference number “AME/DC/302/24-25”

Sample size derivation by keeping Level of significance = 5%, Power = 80%, Formula for calculating sample size is: Sample size for clinical trial (outcome variable on ratio scale and testing null hypothesis

$$n = 2 \frac{S^2(Z1 + Z2)^2}{(M1 - M2)^2}$$

A power analysis was established by G*Power version 3.0.1(Franz Faul, Universität Kiel, Germany). Total calculated sample size of 100 subjects (50 subjects – Group A, 50 subjects – Group B).

All patients who expressed interest in participating in the study provided informed written consent. Patients were evaluated for Plaque index (Sillness and Loe) and OHI-S (Oral Hygiene index simplified given by Greene and Vermillion) at baseline and after 2 weeks. Plaque index was evaluated with the help of 2 tone dye. And the adverse event reporting questionnaire was also recorded. Tooth paste were wrapped with brown plaster for blinding purposes, and soft tooth brushes of the same brand and type were given to patients.



Figure 1: Representing commercially available toothpastes used in this study



Figure 2: Representing wrapped toothpaste along with soft bristled brushes which were randomly allotted to patients



Figure 3: Representing number coded chits which were randomly picked up by patient.

ADVERSE EVENT REPORTING QUESTIONNAIRE

PARTICIPANT ID- _____
 DATE- _____

1. Have you experienced any of the following symptoms since using toothpaste? (select all that apply)

- a) Oral irritation (e.g. mouth ulcers, redness, swelling)
- b) Gum bleeding and inflammation
- c) Tooth sensitivity
- d) Allergic reactions (e.g. hives, itching, difficulty in breathing)
- e) Digestive issues (e.g., nausea, vomiting, diarrhea)
- f) Others (please specify): _____
- g) None

2. If yes, please describe the symptoms in detail:

- a) Location (e.g. Mouth, gums, teeth)
- b) Severity (mild, moderate, severe)
- c) Duration (how long did the symptom last?)
- d) Any treatment or relief measures taken

e) None.

3. Have you experienced any serious adverse events (e.g., hospitalization, life threatening conditions)?

- a) Yes
- b) No

If yes, please provide details:

- a) Description of the event
- b) Date of the event
- c) Treatment received
- d) Outcome

4. Have you stopped using toothpaste due to any adverse events?

- a) Yes
- b) No

5. Additional comments or concerns: _____

SIGNATURE: _____

Figure 4: Representing adverse event report questionnaire

3. Results

In this current study, 100 patients were studied, allotted randomly into 2 Groups:

Group A: 50 patients Green tea – propolis containing toothpaste and Group B: 50 patients zinc -arginine containing toothpaste. Plaque index was evaluated at baseline and after 2 weeks with the help of two tone dye.

Mean plaque index in Group A at baseline was 0.79 (0.49) and post 2 weeks was 0.28 (0.21), the mean reduction post 2 weeks was 0.51 (0.5). Whereas in Group B, mean scores at baseline were 1.22 (0.71), and post 2 weeks was 0.48(0.41), the mean reduction in plaque index scores is 0.74 (0.67).

Mean OHIS in Group A, 1.17 (1.02) at baseline and post 2 weeks, 0.97 (0.88) and in Group B at baseline, 1.79 (1.3) and post 2 weeks, 0.24 (0.17). The mean reduction in Group A is 0.97 (0.88) and Group B is 1.55 (1.26).

Table 1: Comparison of Plaque Index (Silness and Loe, 1964) between Group A and Group B respectively

Plaque Index	Baseline	After 2 weeks	Difference/ Change in score
Group A	0.79 (0.49)	0.28 (0.21)	0.51 (0.5)
Group B	1.22 (0.71)	0.48 (0.41)	0.74 (0.67)
Unpaired t test	t= -0.714	t= -1.620	t= -1.067
P Value, Significance	p= 0.066	p= 0.048*	p= 0.028*

p>0.05- no Statistical significant difference
 *p<0.05- Significant

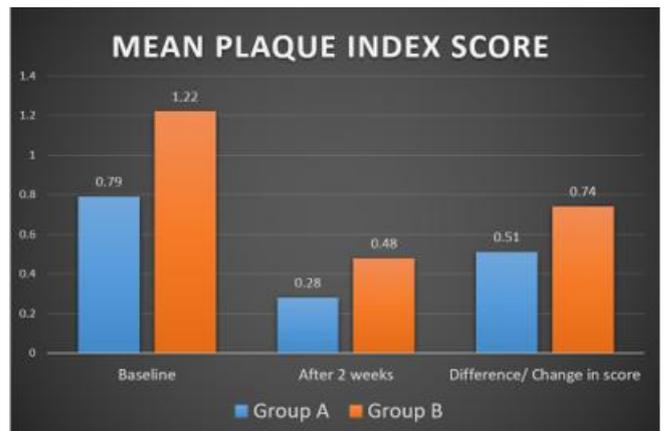


Figure 5: Representing graph comparing Plaque Index difference among groups between baseline and 2 weeks

Table 2: Comparison of OHI- S Score between Group A and Group B respectively

OHI- S	Baseline	After 2 weeks	Difference/ Change in score
Group A	1.17 (1.02)	0.19 (0.26)	0.97 (0.88)
Group B	1.79 (1.3)	0.24 (0.17)	1.55 (1.26)
Unpaired t test	t= -1.152	t= -0.608	t= -1.442
P Value, Significance	p= 0.158	p= 0.548	p= 0.041*

p>0.05- no Statistical significant difference
 *p<0.05- Significant

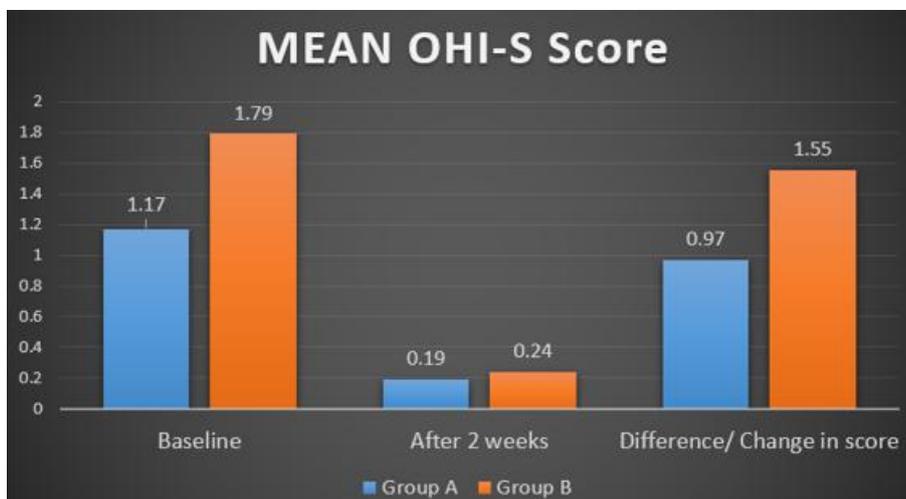


Figure 6: Representing graph comparing OHIS Index difference among groups between baseline and 2 weeks

4. Discussion

In the current study, 100 participants were divided into 2 groups, each group 50 patients. Group A - Green tea – propolis containing toothpaste, Group B – Dual zinc – arginine containing toothpaste, both have shown good efficiency in the reduction of Plaque and OHIS score. However, Dual zinc arginine have shown better reduction in the Plaque and OHIS scores. This study is unique in its approach, as it represents the first exploration of the combination of green tea and propolis toothpaste and also there is limited research available on the new formulation of Colgate Total Advanced toothpaste, particularly following the substitution of its primary ingredient, triclosan, with a dual zinc-arginine complex.

Green tea exhibits anti-inflammatory, antibacterial, and antioxidant properties. In a clinical study by T. S. Hrishi et al., 30 patients were divided into two groups to compare a green tea-based toothpaste with a fluoride–triclosan formulation. After four weeks post-SRP, the green tea toothpaste showed greater improvement in clinical and biochemical parameters of periodontitis than the fluoride–triclosan toothpaste.⁽⁸⁾

Propolis, a bee-derived product with antibacterial, anti-inflammatory, and antioxidant properties, has shown promise in dental applications. In a systematic review and meta-analysis, Magdalena Sycinska-Dziarnowska and colleagues evaluated the effectiveness of propolis-containing mouthwashes and toothpastes in reducing plaque and gingival inflammation. Seven randomized controlled trials were analyzed, assessing plaque index (PI) and gingival index (GI). The review concluded that propolis-based oral care products may serve as a valuable adjunct in preventive dental strategies by reducing plaque and supporting periodontal health.⁽¹⁰⁾

Formulations incorporating Dual Zinc Arginine (DZA), such as the new Colgate Total®, exert antibacterial effects by binding to oral tissues and interfering with bacterial nutrient metabolism, while also enhancing soft-tissue defences through barrier formation. In a double-blind study, Bernal Stewart et al. demonstrated the antimicrobial efficacy of DZA toothpaste over six months. Similarly, Kakarla V. V. Prasad et al. conducted a randomized, single-centre, three-cell, double-blind trial with 180 subjects, comparing DZA, zinc citrate/zinc oxide, and sodium fluoride formulations. Oral samples collected from multiple sites showed that the DZA group achieved statistically significant reductions in viable bacteria across teeth, tongue, cheeks, gums, and saliva compared with fluoride alone. These findings highlight the superior antimicrobial performance of dual zinc arginine.⁽⁹⁾

The study is well-structured for a short-term clinical comparison and provides useful insights into the relative efficacy of natural vs. conventional formulations. However, its limitations- particularly the short duration, narrow age group, and lack of microbiological data- mean that conclusions should be interpreted cautiously. It's a strong pilot study, but further long-term, multicentre, and microbiologically supported trials are needed to validate and expand these findings.

5. Conclusion

While both dentifrices showed potentiality in plaque reduction and improving oral hygiene, the zinc–arginine group achieved statistically significant improvements, highlighting the effectiveness of zinc ions combined with arginine in disrupting plaque biofilm. Green tea–propolis toothpaste, though less effective comparatively, still provided measurable plaque control, suggesting potential benefits for patients seeking natural alternatives. Overall, zinc–arginine toothpaste may be recommended as a more reliable option for routine plaque control, whereas green tea–propolis toothpaste could serve as an adjunct for patients preferring herbal formulations and sensitive to these chemical formulations.

References

- [1] Garg Y, Chowdhary Z, Garg K, Kshirsagar MM, Sharma A, Reddy JR, Paiwal K, Sharma IV A. Evaluation of anti-plaque and anti-gingivitis efficacy of two commercially available herbal and non-herbal toothpastes. *Cureus*. 2023 May 27;15(5).
- [2] Inchingolo AM, Marinelli G, Colonna V, Pennacchio BF, Giorgio RV, Inchingolo F, Di Venere D, Palermo A, Minervini G, Inchingolo AD, Dipalma G. Efficacy and Safety of Natural Versus Conventional Toothpastes and Mouthwashes in Gingivitis Management: A Systematic Review. *Hygiene*. 2025 Sep 4;5(3):38.
- [3] Suresh S, Arumugham IM, Doraikannan S, Rathinavelu PK, Prabakar J, Balasubramaniam A. Comparing the effectiveness of herbal and conventional dentifrices in reducing dental plaque and gingivitis: a systematic review. *Journal of International Society of Preventive and Community Dentistry*. 2021 Nov 1;11(6):601-8.
- [4] Inchingolo AM, Marinelli G, Colonna V, Pennacchio BF, Giorgio RV, Inchingolo F, Di Venere D, Palermo A, Minervini G, Inchingolo AD, Dipalma G. Efficacy and Safety of Natural Versus Conventional Toothpastes and Mouthwashes in Gingivitis Management: A Systematic Review. *Hygiene*. 2025 Sep 4;5(3):38.
- [5] Takeuchi-Hatanaka K, Ito M, Hayashi Y, Maruyama H, Kono H, Shinoda-Ito Y, Omori K, Takashiba S. Clinical and microbiological effects of a propolis toothpaste in patients with periodontitis under supportive periodontal therapy: a randomized double-blind clinical trial. *Clinical oral investigations*. 2025 Jul 9;29(8):379.
- [6] Sreenivasan PK, Nandlal B, Shashikumar P, Shivamallu AB. Oral Hygiene Improvements by a Novel Zinc Toothpaste—Results from a 6-Week Randomized Clinical Study amongst Community-Dwelling Adults. *Hygiene*. 2024 Sep 18;4(3):374-84.
- [7] Prasad KV, Therathi SG, Agnihotri A, Sreenivasan PK, Mateo LR, Cummins D. The Effects of Two New Dual Zinc plus Arginine Dentifrices in Reducing Oral Bacteria in Multiple Locations in the Mouth: 12-Hour Whole Mouth Antibacterial Protection for Whole Mouth Health. *J Clin Dent*. 2018 Sep;29(Spec No A): A25-32. PMID: 30620868.
- [8] Hrishi TS, Kundapur PP, Naha A, Thomas BS, Kamath S, Bhat GS. Effect of adjunctive use of green tea dentifrice in periodontitis patients—A Randomized Controlled Pilot Study. *International Journal of Dental Hygiene*. 2016 Aug;14(3):178-83.

- [9] Prasad KV, Therathil SG, Agnihotri A, Sreenivasan PK, Mateo LR, Cummins D. The Effects of Two New Dual Zinc plus Arginine Dentifrices in Reducing Oral Bacteria in Multiple Locations in the Mouth: 12-Hour Whole Mouth Antibacterial Protection for Whole Mouth Health. *J Clin Dent*. 2018 Sep;29(Spec No A): A25-32. PMID: 30620868.9
- [10] Sycińska-Dziarnowska M, Szyszka-Sommerfeld L, Bugajska M, Ziąbka M, Szućko-Kociuba I, Spagnuolo G, Woźniak K, Park HS. Propolis as a natural remedy in reducing dental plaque and gingival inflammation: A systematic review and Meta-Analysis. *Journal of functional biomaterials*. 2025 Sep 8;16(9):336