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Development and Characterization of Neem, Guava and Clove-Based Herbal Toothpaste: A Comparative Study with Commercial Products

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Abstract

Background: Growing concerns over the adverse effects of synthetic components in toothpaste, such as fluoride and peroxide, have intensified the search for natural alternatives. Herbal bio actives, including neem, guava, and clove, possess antimicrobial, antioxidant, and anti-inflammatory properties suitable for oral care applications.

Objective: This study aimed to formulate, evaluate, and compare a herbal toothpaste incorporating neem (Azadirachta indica) leaves, guava (Psidium guajava) leaves, and clove (Syzygium aromaticum) oil with two commercially available herbal formulations.

Methods: The toothpaste was prepared using a standardized trituration method and assessed for morphological (colour, odour, texture) and physicochemical parameters (homogeneity, abrasiveness, solubility, pH, foamability, moisture content, viscosity, spreadability, and detection of sharp particles). Comparative analysis was conducted against marketed formulations- Colgate Salt Neem and Dant Kanti under identical laboratory conditions. Results were tabulated and further illustrated through comparative graphs.

Results: The formulated toothpaste exhibited desirable organoleptic features, including a greenish-brown colour, characteristic herbal odour, and smooth texture. Physicochemical properties were within acceptable limits, with neutral pH (7.3), complete solubility, and effective abrasiveness. However, viscosity (32,159 cP) and foamability (30%) were significantly lower than Colgate Salt Neem (61,502 cP; 60%) and Dant Kanti (68,302 cP; 70%), potentially influencing spreadability (10.8 vs. 11.6–12.0) and user perception. Moisture content (24%) was slightly higher compared to commercial samples (13.4–14.8%), which may impact shelf stability.

Conclusion: The study demonstrates the potential of neem, guava, and clove-based toothpaste as a natural, safe, and effective oral care product. While the formulation exhibited satisfactory performance, optimization of viscosity, foamability, and moisture regulation is warranted to match commercial standards. Future work should include microbial stability studies, long-term storage analysis, and clinical validation to enhance product development for large-scale production.

Keywords: Herbal toothpaste, neem, guava, clove oil, physicochemical evaluation, comparative analysis, natural oral care.

1. INTRODUCTION

Oral diseases are widespread across the globe and include conditions such as dental caries, periodontal (gum) disease, oral mucosal lesions, halitosis (mouth odour), endodontic (root canal) infections, and oral cancers (1)(2). Microorganisms are recognized as the primary contributors to these conditions. They metabolize starchy food substances into acids, which in turn cause the demineralization of tooth structures, erosion of enamel, gum deterioration, and create favourable conditions for opportunistic human pathogens. The importance of oral health to overall human well-being cannot be overstated, as numerous illnesses, including diabetes, hypertension, and cardiovascular disorders, have been linked to oral health complications(3).

Various commercial toothpaste formulations are produced using synthetic chemicals such as fluoride, peroxide, chlorhexidine, amine fluorides, and cetylpyridinium chloride to prevent or treat a wide range of oral health issues (4). While these agents are effective in reducing microbial growth and maintaining oral hygiene, they are not free from drawbacks. For instance, peroxide compounds, which are commonly incorporated as whitening agents to remove stains and brighten teeth, have been reported to cause an unpleasant burning sensation in the mouth, leading to discomfort for many users (5). Similarly, several preservatives added to toothpaste formulations, including ethylene diamine tetra-acetic acid (EDTA) and formaldehyde, raise serious safety concerns, as these substances are potentially harmful to human health when used over extended periods (6)(7).

Although fluoride-based toothpaste is widely recognized for its strong protective action against oral pathogens and its ability to strengthen enamel, excessive or prolonged exposure to fluoride has been linked to adverse effects such as dental staining (fluorosis), nausea, and in severe cases, an increased risk of oral cancer (8). Additionally, other commonly used antimicrobial agents like chlorhexidine, amine fluorides, and cetylpyridinium chloride have also been associated with undesirable side effects, including tooth discoloration, taste alteration, and irritation of oral tissues. These limitations highlight the need for safer, biocompatible alternatives, possibly derived from natural or herbal sources, to minimize potential health risks while maintaining effective oral care(2)(7).

Researchers are increasingly investigating the use of safe, effective, and cost-efficient natural raw materials for the formulation of toothpaste aimed at preventing and managing oral diseases and their associated complications. Among these, plant-based extracts have attracted considerable interest due to their diverse pharmacological properties, including anti-inflammatory, antibacterial, analgesic, and antimicrobial effects (9). Traditionally, a wide range of botanicals such as Azadirachta indica (neem), Aloe barbadensis (aloe vera), Hibiscus sabdariffa, Punica granatum Linn, and several others have been utilized in toothpaste preparations owing to their notable therapeutic potential. For example, formulations containing aloe vera and wild strawberry extracts, as well as toothpaste enriched with neem extract, have shown significant antimicrobial action against Streptococcus mutans, a primary causative agent of dental caries. Likewise, toothpaste prepared with Rosmarinus officinalis Linn has been reported to effectively minimize bacterial plaque formation and reduce gingival bleeding, further highlighting the promising role of herbal ingredients in oral care products(2)(9)(10).

In the present study, focus is placed on neem (Azadirachta indica) leaves, guava (Psidium guajava) leaves, and clove (Syzygium aromaticum) oil. Neem, a well-established medicinal plant from the family Meliaceae, has long been used in dentistry as a chewing stick and exhibits antiplaque, anticaries, antibacterial, anti-inflammatory, and antifungal properties. Its phytochemicals, including tannins, saponins, flavonoids, phenols, and alkaloids, contribute to its wide pharmacological activities (11)(12).

Guava leaves are rich in bioactive constituents such as flavonoids, tannins, and essential oils, which are known for their antimicrobial, antioxidant, anti-inflammatory, and wound-healing potential, making them suitable for oral health care applications(12) (13). Clove oil, a traditional remedy in dentistry, contains eugenol as its principal bioactive component, which exhibits strong analgesic, antiseptic, and antibacterial activity, particularly against oral pathogens (14)(15).

Therefore, this study seeks to investigate the phytochemical properties and volatile constituents of neem leaves, guava leaves, and clove oil extracts. Additionally, it aims to develop and characterize toothpaste formulations containing these plant extracts and compare their effectiveness with selected commercial toothpaste products.

2. Materials and methods

2.1. Materials

Herbal ingredients such as fresh Neem (Azadirachta indica) leaves and Guava (Psidium guajava) leaves were collected from domestic household gardens and clove oil was purchased from Dabur India Ltd. (Sahibabad, Uttar Pradesh). Calcium carbonate was purchased from Thermo Fisher Scientific India Pvt. Ltd (Mumbai, India). Glycerin was purchased from Dabur India Ltd. (Sahibabad, Uttar Pradesh). Sodium Lauryl Sulphate and Sodium benzoate were purchased from Himedia laboratories pvt ltd (Mumbai, India). Sodium Chloride was purchased from Central Drug House (Delhi, India). Sucrose was purchased from Loba Chemie Pvt. Ltd. (Mumbai, India).

2.2. Preparation of herbal toothpaste

The selected herbal ingredients were thoroughly dried to remove residual moisture and subsequently pulverized into a fine powder using a domestic mixer grinder. Accurately weighed quantities of the powdered ingredients were transferred into a clean porcelain mortar for processing. Separately, an aqueous base solution was prepared by dissolving calcium carbonate, sodium lauryl sulfate, sodium chloride, sucrose, and glycerin in purified water with continuous stirring to ensure complete solubilization of the components. This aqueous solution was then incorporated gradually into the herbal powder by dropwise addition, with continuous trituration using a pestle, until a smooth and homogeneous paste of desirable consistency was obtained. Finally, sodium benzoate was added as a preservative, and the formulation was mixed thoroughly to achieve uniform distribution of all components (10)(16). The details of plant extracts and the composition of chemicals used in the formulation are presented in Table 1.

Table 1: Composition of ingredients in the formulated herbal toothpaste (10 g Batch) and their functional roles

Sl No.	Ingredients	Amount (For 10 g formulation)	Role of the ingredients
1	Neem Leaf	1.5 gm	Antibacterial property, anti-inflammatory effects.
2	Clove oil	0.5 ml	Analgesic, antibacterial & antifungal properties.
3	Guava Leaf	1.0 gm	Antiseptic, antioxidants
4	Calcium carbonate	2.5 gm	Mild abrasive for plaque removal, polishes and brightness teeth.
5	Glycerin	1.5 gm	Humectant, stabilizer.

6	Sodium Lauryl Sulphate	0.5 gm	Foaming agent, surfactant (cleansing agent)
7	Sodium chloride	0.5 gm	Promotes gum health, pH balance & alkalinity
8	Sodium benzoate	0.5 gm	Preservative function, enhance stability.
9	Sucrose	0.5 gm	Sweetening Agent
10	Water	q.s.	Used as solvent.

3. Morphological evaluation of herbal toothpaste

The formulated toothpaste was examined for its organoleptic properties, including colour, odour, and texture. Visual inspection was performed under adequate lighting to evaluate colour uniformity, while odour was assessed by direct smelling to ensure acceptable fragrance. Texture was determined by extruding a small amount of the formulation and assessing smoothness by gentle rubbing between fingers. The formulation was considered satisfactory if it exhibited a uniform colour, pleasant odour, and smooth, non-gritty texture.

4. Physicochemical evaluation parameters of herbal toothpaste

The prepared herbal toothpaste was subjected to various physicochemical evaluation parameters to ensure its quality, safety, and efficacy.

4.1. Homogeneity: To assess uniformity, the formulation was stored at 27 ± 2 °C for 24 h and then extruded by gentle pressure. The bulk contents were examined visually for phase separation, clumps, or non-uniformity in color and texture by rolling the tube from the crimped end. A smooth, well-mixed appearance without separation was considered acceptable (17).

4.2. Abrasiveness: The abrasivity was determined by applying a small quantity of toothpaste on a clean glass/acrylic plate and rubbing with a soft toothbrush or cotton swab under uniform pressure. The surface was visually inspected for scratches or dullness and compared with standard abrasivity values. An acceptable formulation demonstrated moderate abrasiveness, effective in debris removal without enamel damage (18).

4.3. Solubility: To evaluate solubility, 5 g of toothpaste was dispersed in 50 ml distilled water in a 100 ml beaker, stirred vigorously for 2–3 min, and observed for residues. Complete dissolution without visible particles indicated satisfactory solubility.

4.4. pH measurement: A 10% w/v suspension of toothpaste was prepared by dispersing 1 g of sample in 10 ml distilled water. The pH was determined using a calibrated digital pH meter with standard buffer solutions. Values within the range of 6.2–7.6 were considered optimal, ensuring enamel safety and oral compatibility (17).

4.5. Foamability: Foamability was tested by dispersing 10 g of toothpaste in 30 ml water in a measuring cylinder and shaking for 15 min. Foam volume was recorded, and foam power exceeding 30% was considered satisfactory (19).

4.6. Moisture content: Moisture content was determined by weighing 10 g of toothpaste, drying in a hot air oven at 105 °C for 30 min, and reweighing. The percentage weight loss was calculated, with an acceptable range of 20–40% w/w (20).

4.7. Viscosity: Viscosity was measured using a Brookfield digital viscometer (spindle no. 3) at 20 rpm and 25 °C. The values obtained were used to assess consistency and flow behavior of the formulation (21).

4.8. Spreadability: Spreadability was determined by placing 2 g of toothpaste between two glass slides, applying a 100 g weight on the upper slide, and recording the spreading diameter after a fixed time. Spreadability (S) was calculated using the formula:
$S = M \times L / T$, where M = applied weight (g), L = length of spread (cm), and T = time (s).
A spreading radius of 5–7 cm was considered acceptable (22).
4.9. Detection of sharp and edge abrasive particles: Approximately 15–20 cm of toothpaste was extruded onto butter paper and pressed along its length with fingertips to detect sharp or hard abrasive particles. The absence of such particles confirmed the smoothness of the formulation (23).

5. Comparative studies with marketed formulation:

The formulated herbal toothpaste was compared with two commercially available herbal toothpastes, Colgate Salt Neem and Dant Kanti, to assess its quality and performance. Comparative evaluation was carried out based on morphological parameters (colour, odour, texture) and physicochemical properties (solubility, viscosity, moisture content, foamability, pH and spreadability).
Equal quantities of each toothpaste sample were subjected to the same evaluation protocols under identical laboratory conditions, as described in the methodology section. Standardized instruments, such as the Brookfield digital viscometer for viscosity and calibrated digital pH meter for pH measurement, were employed to ensure accuracy. Organoleptic assessments (colour, odour, texture) were conducted visually and by direct sensory examination. Results from the formulated toothpaste were then compared with those obtained for the two marketed formulations to determine relative performance and overall acceptability.

6. Results and discussion

6.1. Morphological evaluation

The formulated herbal toothpaste exhibited a distinct greenish-brown colour, indicative of the presence of natural herbal ingredients such as neem and guava, which are known for their therapeutic and antimicrobial properties. The characteristic odour reflected the inclusion of natural essential oils and herbal constituents, contributing to a sense of freshness and supporting oral hygiene benefits. The texture of the formulation was smooth, with no grittiness or particulate matter detected, ensuring ease of application, pleasant mouthfeel, and uniform distribution during brushing. These morphological attributes confirm that the formulation possesses desirable organoleptic properties, enhancing consumer acceptability while reflecting the presence of bioactive herbal components.

6.2. Homogeneity:

The formulated toothpaste exhibited good homogeneity, with no visible signs of phase separation, clumping, or non-uniformity. This indicates effective mixing of all ingredients, resulting in a consistent product with uniform texture and appearance, which is essential for maintaining quality and performance during storage and use.

6.3. Abrasiveness:

The abrasiveness test indicated "good abrasive" properties, meaning that the formulation effectively removes plaque and surface stains while being gentle enough to prevent enamel wear or irritation to oral tissues. The balance between cleaning efficiency and enamel safety is a critical parameter in toothpaste formulations.

6.4. Solubility:

The toothpaste showed complete solubility in distilled water, leaving no visible residue after stirring. High

solubility ensures that the product can be easily rinsed from the oral cavity, enhancing user comfort and acceptability while contributing to overall cleaning efficiency.

6.5. pH:

The pH of the formulation was determined as 7.3, which is close to neutral and ideal for oral care products. A near-neutral pH ensures that the toothpaste is non-irritating to oral tissues, maintains enamel integrity, and contributes to maintaining a healthy oral environment.

6.6. Foamability:

The foamability value was recorded at 30%, indicating moderate foam formation. This level of foaming is desirable as it enhances debris removal and imparts a clean-mouth feel, while avoiding excessive foaming, which could lead to discomfort during brushing.

6.7. Moisture content:

The moisture content was found to be 24%, which falls within the recommended range (20–40% w/w). This value ensures that the paste maintains its desired consistency, prevents drying or hardening during storage, and supports good spreadability while maintaining overall product stability.

6.8. Viscosity:

The viscosity of the formulation was measured as 32,159 cP, indicating an optimal level of thickness suitable for extrusion and application without being runny or too hard. Proper viscosity is crucial to ensure adequate adhesion to the toothbrush and even spreading on the teeth surfaces, which directly influences cleaning efficiency.

6.9. Spreadability:

The spreadability value of 10.8 confirmed excellent ease of application and uniform coverage on tooth surfaces. Higher spreadability facilitates effective cleaning action, improves user experience, and ensures even distribution of active herbal ingredients during brushing.

All the evaluation results of the formulated toothpaste are shown in table 2.

Table 2: Morphological and physicochemical evaluation parameters of the formulated herbal toothpaste

Sl No.	Evaluation parameters	Results
1	Color	Greenish Brown
2	Odour	Characteristic
3	Texture	Smooth Paste
4	Homogeneity	Good
5	Solubility	Soluble in water
6	Viscosity	32,159cP
7	Moisture Content	24%
8	Foamability	30
9	pH	7.3
10	Spreadability	10.8
11	Abrasiveness	Good Abrasive

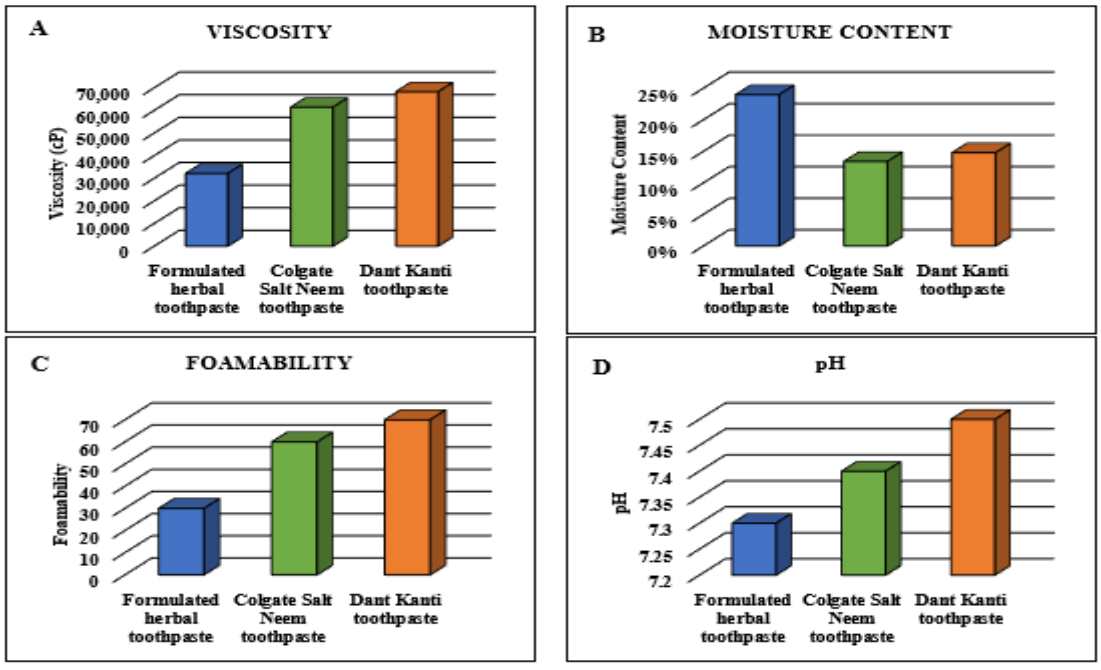
6.10. Comparative studies:

The comparative evaluation between the formulated herbal toothpaste and the marketed formulations (Colgate Salt Neem and Dant Kanti) demonstrated similarities in odour, texture, solubility, and pH, with

all samples exhibiting a characteristic herbal smell, smooth consistency, complete water solubility, and near-neutral pH (7.3–7.5), ensuring safety for oral tissues and enamel. However, notable differences were observed in colour, viscosity, moisture content, foamability, and spreadability. The formulated paste exhibited a greenish-brown colour indicative of raw herbal ingredients, whereas Colgate and Dant Kanti showed whitish-green and brownish-red shades, respectively, suggesting the use of processed extracts or added colorants. The viscosity (32,159 cP) and foamability (30%) of the formulated paste were considerably lower than those of the marketed products (61,502–68,302 cP and 60–70%, respectively), which may influence spreadability (10.8) and overall cleaning efficiency compared to higher values in commercial brands (11.6–12.0). Moisture content was slilghtly higher in the formulated sample (24%) than in Colgate (13.4%) and Dant Kanti (14.8%), imparting a softer texture but potentially reducing shelf stability. Overall, the formulated toothpaste displayed satisfactory performance across all parameters, with results presented in table 3 and illustrated through comparative graphs, highlighting areas where formulation optimization could further align product characteristics with commercial standards.

Table 3: Comparative Study Between Formulated Herbal Toothpaste & Marketed Herbal Toothpaste

Sl No.	Evaluation parameters	Formulated Herbal toothpaste	Colgate salt Neem toothpaste	Dant Kanti Toothpaste
1	Color	Greenish Brown	Whitish green	Brownish red
2	Odour	Characteristic	Characteristic	Characteristic
3	Texture	Smooth Paste	Smooth Paste	Smooth Paste
4	Viscosity	32,159cP	61,502cP	68,302cP
5	Solubility	Soluble in water	Soluble in water	Soluble in water
6	Moisture Content	24%	13.40%	14.80%
7	Foamability	30	60	70
8	pH	7.3	7.4	7.5
9	Spreadability	10.8	11.6	12



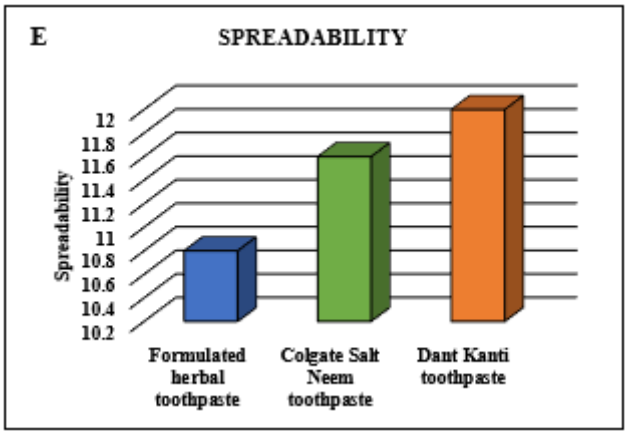


Figure 1: Bar Diagrams Showing Comparative Evaluation Of Physicochemical Properties Of Herbal And Commercial Toothpaste Formulations

7. Conclusion

The present study successfully formulated, evaluated, and compared a herbal toothpaste prepared using neem leaves, guava leaves, and clove oil, with minimal use of synthetic components such as sodium benzoate and basic excipients. The systematic formulation process resulted in a smooth, homogeneous paste exhibiting desirable morphological characteristics, including a greenish-brown colour, smooth texture, and characteristic herbal odour, reflecting its natural composition and product uniformity.

Physicochemical evaluation confirmed favourable attributes, including complete solubility, enamel-safe pH (7.3), and effective yet gentle abrasiveness, ensuring safety and cleaning efficacy. However, the formulation exhibited relatively high moisture content (24%), which may compromise microbial stability and reduce shelf life. Viscosity (32,159 cP) and foamability (30%) were significantly lower than those of commercial formulations such as Colgate Salt Neem (61,502 cP; foamability 60) and Dant Kanti (68,302 cP; foamability 70), potentially affecting extrusion behaviour, handling, and user perception. The taste was mildly bitter, characteristic of herbal ingredients, and could be improved using natural sweeteners or flavouring agents like stevia or mint. Spreadability (10.8) was slightly below commercial standards but remained within an acceptable range for practical use.

The comparative analysis highlights that while the formulated herbal toothpaste meets essential safety and efficacy requirements, further optimization is necessary to achieve commercial viability. Refinement strategies may include the incorporation of natural thickeners (e.g., xanthan gum), moisture regulators (e.g., sorbitol, glycerol), and flavour enhancers to improve viscosity, stability, foamability, and sensory attributes without compromising the natural composition of the product.

Future research should focus on microbial stability testing, accelerated stability studies, long-term storage evaluations, and clinical trials to establish efficacy and safety in diverse populations. Additionally, large-scale production and cost-effectiveness analyses will be essential to ensure economic feasibility for commercial manufacturing. With these refinements, the formulated toothpaste has strong potential as a safe, eco-friendly, and effective alternative to marketed herbal formulations, aligning with growing consumer demand for natural and sustainable oral care products.

References

1. Peres MA, Macpherson LMD, Weyant RJ, Daly B, Venturelli R, Mathur MR, et al. Oral diseases: a

global public health challenge. Lancet (London, England). 2019 Jul;394(10194):249–60.
2. Oluwasina OO, Idris SO, Ogidi CO, Igbe FO. Production of herbal toothpaste: Physical, organoleptic, phyto-compound, and antimicrobial properties. Heliyon. 2023 Mar;9(3):e13892.
3. Spatafora G, Li Y, He X, Cowan A, Tanner ACR. The Evolving Microbiome of Dental Caries. Microorganisms. 2024 Jan;12(1).
4. Ucuncu MK, Guven K, Yazicioglu O. Investigation of the constituents of commercially available toothpastes. Int J Dent Hyg [Internet]. 2024 Nov 1;22(4):913–32. Available from: https://doi.org/10.1111/idh.12805
5. Epple M, Meyer F, Enax J. A Critical Review of Modern Concepts for Teeth Whitening. Dent J. 2019 Aug;7(3).
6. Rajendiran M, Trivedi HM, Chen D, Gajendrareddy P, Chen L. Recent Development of Active Ingredients in Mouthwashes and Toothpastes for Periodontal Diseases. Molecules. 2021 Apr;26(7).
7. Yazicioglu O, Ucuncu MK, Guven K. Ingredients in Commercially Available Mouthwashes. Int Dent J [Internet]. 2024;74(2):223–41. Available from: https://www.sciencedirect.com/science/article/pii/S0020653923004379
8. Lubojanski A, Piesiak-Panczyszyn D, Zakrzewski W, Dobrzynski W, Szymonowicz M, Rybak Z, et al. The Safety of Fluoride Compounds and Their Effect on the Human Body-A Narrative Review. Mater (Basel, Switzerland). 2023 Jan;16(3).
9. Anwar MA, Sayed GA, Hal DM, Hafeez MSA El, Shatat AAS, Salman A, et al. Herbal remedies for oral and dental health: a comprehensive review of their multifaceted mechanisms including antimicrobial, anti-inflammatory, and antioxidant pathways. Inflammopharmacology. 2025 Mar;33(3):1085–160.
10. Mr. Ganesh M. Kashte, Mr. Akshay G. Rajguru, Mr. Vishalsingh Solanki. Formulation Development and Evaluation of Herbal Toothpoaste. Int J Adv Res Sci Commun Technol. 2024;645–58.
11. Shareef, M, Sohail Akhtar M. Neem (Azadirachtaindica) and Its Potential for Safeguarding Health, Prevention and Treatment of Diseases. Matrix Sci Medica. 2018;2(1):04–8.
12. Gloria-Garza MA, Reyna-Martínez GR, Jiménez-Salas Z, Campos-Góngora E, Kačániová M, Aguirre-Cavazos DE, et al. Medicinal Plants Against Dental Caries: Research and Application of Their Antibacterial Properties. Vol. 14, Plants. 2025.
13. Sahal A, Chaudhary S, Hussain A, Arora S, Dobhal A, Ahmad W, et al. A comprehensive review on the nutritional composition, bioactive potential, encapsulation techniques, and food system applications of guava (Psidium guajava L.) leaves. Grain Oil Sci Technol [Internet]. 2025;8(1):64–74. Available from: https://www.sciencedirect.com/science/article/pii/S2590259824000670
14. Pandey VK, Srivastava S, Ashish, Dash KK, Singh R, Dar AH, et al. Bioactive properties of clove (Syzygium aromaticum) essential oil nanoemulsion: A comprehensive review. Heliyon. 2024 Jan;10(1):e22437.
15. Kumar Pandey V, Shams R, Singh R, Dar AH, Pandiselvam R, Rusu AV, et al. A comprehensive review on clove (Caryophyllus aromaticus L.) essential oil and its significance in the formulation of edible coatings for potential food applications. Front Nutr. 2022;9:987674.
16. Rathi NM, Sirsat S V, Toshniwal SS, Zagare NT, Fazil S, Mahamad S. Formulation and Evaluation Study on Herbal Toothpaste : A Review. 2022;7(4):2456–4184. Available from: www.ijnrd.org
17. Fragrantia C, Nurkolis F, Idrus E, Yusuf T, Vivo C, Subali D, et al. Physicochemical characterization of novel toothpaste from Caulerpa racemosa and Thunnus fish bone: Antibacterial potency against

colonization of selected cariogenic-periodontal bacteria. Pharmacia. 2024 Jan 24;71:1–8.
18. Enax J, Meyer F, Schulze Zur Wiesche E, Fuhrmann IC, Fabritius HO. Toothpaste Abrasion and Abrasive Particle Content: Correlating High-Resolution Profilometric Analysis with Relative Dentin Abrasivity (RDA). Dent J. 2023 Mar;11(3).
19. Shinde A, Nanda R, Khare N, Nandgude T. FORMULATION AND EVALUATION OF A HERBAL MEDICATED TOOTHPASTE USING QBD APPROACH Rabindra K. Nanda Design (QBD), analytical methods for evaluation of a herbal toothpaste. 2024 Jan 1;6:1–11.
20. Ogboji J, Chindo I, Jauro A, Boryo DEA, M. L. Formulation, physicochemical evaluation and antimicrobial activity of green toothpaste on streptococcus mutans. Int J Adv Chem. 2018 Jun 5;6:108.
21. Pal R, Pandey P. **Physical Pharmaceutics Experiments**: Determination of Viscosity of Semisolid by using Brookfield Viscometer. 2023.
22. Deshmukh P, Telrandhe R, Gunde M. Formulation and Evalua-tion of Herbal Toothpaste: Compared With Marketed Preparation. Int J Pharm DRUG Anal. 2017 Oct 26;5:406–10.
23. Sastiya K, Malviya K, Dwivedi S, Malviya S, Kharia A. Formulation and physicochemical evaluation of toothpaste formulated with Bay leaf extract and compared with Commercial Herbal Toothpastes Modern institute of pharmaceutical sciences Gram Alwasa, behind revati range, Indore. Asian J Pharm Educ Res. 2018;7(1):122–30.