International Journal of Pharmaceutical research and Applications
Volume 11, Issue 1, Jan - Feb 2026, pp:298-305 www.ijprajournal.com ISSN: 2456-4494

Formulation And Evaluation of Herbal Toothpaste: A Natural Approach to Oral Hygiene

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Date of Submission: 10-01-2026 Date of Acceptance: 22-01-2026

ABSTRACT

Toothpaste is a semi-solid formulation used with a toothbrush to maintain oral hygiene and remove dental plaque. The primary cleaning action is achieved through the mechanical movement of the toothbrush along with the functional role of excipients present in the formulation. The present study aimed to develop and evaluate an herbal toothpaste using natural ingredients such as clove, black pepper, cinnamon, ajwain, ginger, and eucalyptus oil, which have been traditionally used for oral care.

Although synthetic chemical agents are effective in preventing plaque and oral diseases, they may cause undesirable effects such as tooth discoloration and taste alteration. Herbal alternatives are considered safer and more acceptable for long-term use. The formulated herbal toothpaste was assessed for its organoleptic and physicochemical properties according to the standards prescribed by the Bureau of Indian Standards (BIS). The results were compared with commercially available herbal toothpastes.

The laboratory-prepared herbal toothpaste showed satisfactory stability and acceptable quality characteristics. Comparative evaluation demonstrated that the formulated product exhibited equal or better performance than marketed brands such as Dant Kanti, Himalaya, Babul, and Colgate. This preliminary in vitro study confirms that the developed herbal toothpaste possesses good quality, effectiveness, and consumer acceptability.

KEYWORDS-Herbal toothpaste, Oral hygiene, antimicrobial activity, Natural ingredients, Physicochemical evaluation.

I. INTRODUCTION

Toothpastes are widely used as a primary preventive measure for maintaining oral health. Although many commercially available dentifrices claim antimicrobial activity, limited scientific evidence is available to substantiate these claims. Hence, the present study was undertaken to assess the effectiveness of various toothpaste formulations in reducing oral microbial levels. The results demonstrated that the selected toothpaste formulations were capable of lowering microbial load and thereby supporting oral hygiene maintenance. Nevertheless, proper oral hygiene practices, including correct brushing techniques and regular use, play a more significant role in preserving oral health than the individual active ingredients present in toothpaste formulations.[1]

Medicinal plants have been utilized for maintaining oral health for thousands of years across different cultures worldwide. Traditional systems of medicine offer several advantages, including better patient acceptance and fewer adverse effects such as allergic reactions. Among these medicinal plants, Azadirachtaindica (Neem) is one of the most extensively studied tropical trees due to its wide range of therapeutic properties. The active constituents of neem extracts have been scientifically investigated over the past few decades, highlighting its potential in oral health care applications. [2]

Herbal toothpaste formulations have gained considerable attention due to the presence of naturally occurring bioactive compounds such as polyphenols, alkaloids, glycosides, and gums, which contribute to antimicrobial, anti-inflammatory, and antioxidant activities.

Scientific investigations have demonstrated that herbal dentifrices exhibit multiple biological activities, thereby expanding the scope for developing and evaluating novel herbal toothpaste formulations as alternatives to conventional marketed products.[3]

Herbal toothpowders formulated using medicinal plants such as Indian nettle, Tulsi, coconut spathe, black pepper, liquorice, camphor,

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and peppermint have demonstrated significant antimicrobial, anti-inflammatory, and antioxidant properties. These phytoconstituents contribute to improved gingival health, reduction of dental plaque, and prevention of periodontal diseases.

Several herbal ingredients contain bioactive compounds including flavonoids, alkaloids, tannins, saponins, and terpenoids, which exhibit antibacterial activity against oral pathogens and support overall oral health. Additionally, natural abrasives such as activated charcoal and rock salt aid in effective cleaning of teeth without causing damage to enamel. Due to their non-toxic nature, cost-effectiveness, and prolonged refreshing effect, herbal dentifrices have gained widespread acceptance as suitable alternatives to synthetic toothpaste and toothpowder formulations. These properties provide a strong rationale for the formulation and evaluation of herbal dentifrices using traditional medicinal plants.[4]

Common Dental Diseases

The mouth contains many types of bacteria. Some are helpful, while others can cause dental problems. Poor oral hygiene and use of conventional toothpaste may lead to common dental diseases such as gum disease, tooth decay, mouth ulcers, and tooth abscess.

1. Periodontal (Gum) Disease

Gum disease occurs due to poor flossing and plaque buildup. It starts as gingivitis and can progress to periodontitis.

Symptoms: Bleeding, swollen and tender gums, gaps between teeth, and mouth sores.

Treatment: Deep dental cleaning by a dentist.

2. Tooth Decay and Cavities

Tooth decay is caused by bacteria growing on sugary and acidic foods left on teeth.

Symptoms: Tooth pain, dark spots, swollen gums, and sensitivity.

Treatment: Fillings, root canal, or tooth extraction in severe cases.

3. Mouth Ulcers

Mouth ulcers are small painful sores that make eating and speaking difficult.

Causes: Minor injury, sodium lauryl sulphate in toothpaste, acidic food, vitamin deficiency, or allergy.

4. Tooth Abscess

A tooth abscess is a pus-filled infection caused by untreated cavities or injuries.

Symptoms: Severe tooth pain, swelling, fever, bad smell, and difficulty chewing or swallowing.

Treatment: Drainage and infection control by a dentist.[5]

II. MATERIAL & METHOD

1.MATERIAL:

Herbal plants used in the formulation of herbal toothpaste for treatment of the oral problems are shown in the Table

Sr. No.	Ingredient	Active constituents	Activity
1.	Clove	Eugenol	Antibacterial, Analgesic,
2.	Cinnamon	Cinnamaldehyde	Antioxidant, Anti-inflammatory
3.	Ajwain	Thymol, Carvacol	Antimicrobial, Carminative
4.	Black paper	Piperine, essential oils	Antioxidant
5.	Eucalyptus oil	eucalyptol	Antiseptic, Deoderizing
6.	Ginger	Gingerol, shagoal	Anti-inflammatory, Soothing agent
7.	Mint	Menthol	Antibacterial, Cooling effect
8.	Neem	Azadirachtin, Nimbin	Antibacterial, Plaque control
9.	Guava	Quercetin	Astringent, Promote gum health

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10.	False black paper	Embelin	Antimicrobial, Anti-inflammatory
11.	Betel	Chavicol, Eugenol	Antibacterial, Astringent

2.Additive/Excipient:

Sr.No.	Excipient	Role
1.	Calcium Carbonate	Mild abrasive
2.	Gum Tragacanth	Natural binder & thickening agent
3.	Sodium lauryl sulphate	Surfactant & foaming agent
4.	Glycerine	Humectant
5.	Sodium saccharin	Artificial sweetener
6.	Methyl paraben	Preservative

3.Apparatus & Equipment:

Apparatus	Equipment
Beaker, measuring cylinder, weighing balance, mortar pestle, spatula, sieve, glass rod.	PH meter, spreadiability apparatus, hot air oven, autoclave, incubator.

FORMULATION TABLE:

Sr.No.	Ingredients	Batch 1	Batch 2	Batch 3	Batch 4
1.	Clove powder	1 gm	1.5 gm	0.5 gm	1 gm
2.	Cinnamon powder	1 gm	1 gm	1.5 gm	0.5 gm
3.	Ajwain powder	1 gm	0.5 gm	1.5 gm	1 gm
4.	Black paper	1 gm	1 gm	0.5 gm	1.5 gm
5.	Eucalyptus oil	1 ml	1.5 ml	1 ml	0.5 ml
6.	Ginger powder	1 gm	0.5 gm	1 gm	1.5 gm
7.	Mint	1 gm	1.5 gm	0.5 gm	1 gm
8.	Betel powder	1 gm	0.5 gm	1.5 gm	1 gm
9.	Neem powder	1 gm	1 gm	1.5 gm	0.5 gm
10.	Guava leaves	1 gm	1.5 gm	0.5 gm	1 gm
11.	False black paper powder	1 gm	0.5 gm	1 gm	1.5 gm
12.	Calcium carbonate	28 gm	30 gm	26 gm	29 gm
13.	Gum Tragaccanth	0.75 gm	1 gm	0.5 gm	0.75 gm
14.	Sodium lauryl sulphate	0.5 gm	0.75 gm	0.25 gm	0.5 gm
15.	Glycerin	9.5 gm	9 gm	10 gm	9.5 gm
16.	Sodium saccharine	0.05 gm	0.07 gm	0.07	0.05
17.	Methyl paraben	Q.s	Q.s	Q.s	Q.s

METHOD OF PREPARATION:

- All the dry components were weighed as per the requirement
- All the dry components for toothpaste preparation were passed through sieve no 80.

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- Gum tragacanth was triturated with glycerine in mortar and pestle to produce mucilage for toothpaste. In ¼ quantity of purified water methyl Paraben were readily dissolved and slowly in drop wise manner were added into mucilage.
- After vigorous trituration calcium carbonate and all the active ingredients were combined. And, finally sodium lauryl sulphate was added to the mixture.
- The formulated paste was accurately weighed and filled in to the tube. The tube was sealed with the help of the manual sealing machine by folding 2 times lower end of the tube.

EVALUATION PARAMETERS:

1. Physical Examination

a. Colour

Approximately 1 g of the herbal toothpaste was placed on a watch glass and observed against a white background under white light. The colour was visually assessed without the use of instruments.

b. Odour

About 1 g of the toothpaste was smelled individually. A gap of two minutes was maintained between successive evaluations to avoid interference from the previous smell.

c. Taste

A small quantity of the final herbal toothpaste was applied to the tongue, and the taste sensation was examined using the taste buds.[6]

2. Sharp and Abrasive Particle Test

The toothpaste was extruded (15–20 cm) onto butter paper. The sample was then pressed between the fingers to check for the presence of any hard or sharp-edged particles that could cause irritation.[7]

3.Spreadability Test

1 g of toothpaste was placed between two clean glass slides. A 500 g weight was applied on the upper slide for one minute. After removing the weight, the diameter of the spread sample was measured using a ruler or calliper. A larger spread diameter indicates better spread ability and easier application during brushing.[8]

4. pH Determination

10 g of toothpaste was mixed with 90 mL of distilled water to prepare a 10% w/v solution. The mixture was stirred until uniformly dispersed. The pH meter was calibrated using standard buffer solutions (pH 4, 7, and 10). The electrode was dipped into the sample solution, and the stable pH value was recorded. The acceptable pH range for toothpaste is 6.5–10.5.[9]

5.Foaming Capacity

10 g of herbal toothpaste was mixed with 10 mL of distilled water and transferred into a 100 mL graduated cylinder or conical flask. The mixture was shaken vigorously for 10 seconds and allowed to stand for 5 minutes. The height or volume of the foam was measured. The test was repeated three times, and the average foam volume was calculated.[10]

Foaming Power = $V_1 - V_2$

6. Antimicrobial Activity

1. Preparation of Microbial Culture

Selected microorganisms were inoculated into nutrient broth and incubated at 37°C for 18–24 hours.

2. Preparation of Inoculated Agar Plates

Sterile Mueller-Hinton agar was poured into Petri plates and allowed to solidify. The agar surface was uniformly swabbed with the microbial culture.

3. Preparation of Toothpaste Sample

The herbal toothpaste was diluted with sterile distilled water (1:1 or 1:2 w/v) to facilitate diffusion through the agar medium.

4. Agar Well Formation

Wells of 6–8 mm diameter were made in the agar using a sterile cork borer, and the agar plugs were carefully removed.

5. Application of Sample

A fixed volume (e.g., 100 µL) of the diluted toothpaste was added to each well. Positive and negative control solutions were placed in separate wells for comparison.

6. Incubation

The plates were incubated at 37°C for 24 hours.

7. Observation and Measurement

The diameter of the zone of inhibition (clear area around the well indicating microbial growth inhibition) was measured in millimetres.[11]

III. RESULTS & DISCUSSION:

1.Physical Examination:

Sr. No	Properties	Batch 1	Batch 2	Batch 3	Batch 4
1.	Colour	Yellowish Brown	Yellowish Brown	Yellowish Brown	Yellowish Brown

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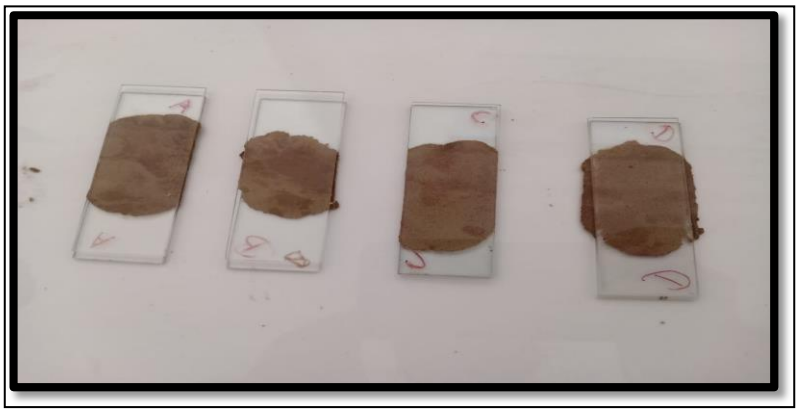
2.	Odour	Aromatic	Aromatic	Aromatic	Aromatic
3.	Taste	Characteristic	Characteristic	Characteristic	Characteristic

2.Spreadability:

Sr.No	MASS(M)	Length(L)	Time(T)	Spredability(S)
1	1 gm.	4.5 cm	20 sec	0.22
2	1 gm.	3.5 cm	20 sec	0.17
3	1 gm.	5.0 cm	20 sec	0.25
4	1 gm.	4.7 cm	20 sec	0.23



3.pH Determination:

Property	Std. Range	Batch 1	Batch 2	Batch 3	Batch 4
pH	**7.30-8.10**	**7.51**	**7.50**	**7.44**	**7.5**

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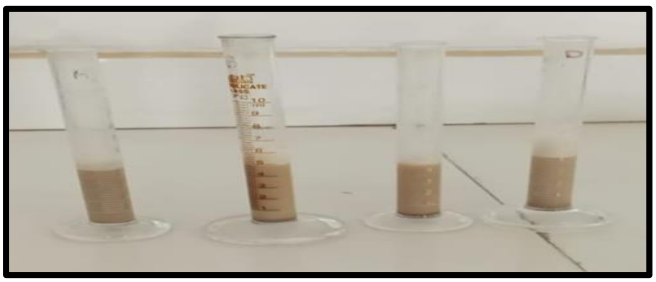
4.Foamability:

Property	Batch 1	Batch 2	Batch 3	Batch 4
Foamability	4	5.2	3.3	4.1



5.Sharp And Abrasive Particles Test: No sharp edged and hard particles found (Good Abrasive).

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5.Anti-Microbial Activity:

Batch	E. coli	S. aureus
1	+++	+++
2	+++	+++
3	++	+++
4	+++	+++

(+= < 5 mm, ++= >5 &<10 mm, +++= >10 &< 18 mm)

•Batch 1, 2,3 and 4 showed highest inhibition towards *E.coli*and *S. aureus.*

IV. SUMMARY AND CONCLUSION:

CONCLUSION

The developed herbal toothpaste was successfully assessed using various standard evaluation parameters, including antimicrobial activity. The formulation demonstrated notable inhibitory effects against both Gram-positive and Gram-negative microorganisms. Compared to completely synthetic toothpaste formulations, the herbal toothpaste may offer a safer alternative. However, additional investigations are required to further establish its safety and therapeutic effectiveness. The findings also indicate that the polyherbal formulation produced a larger zone of inhibition when compared to toothpaste containing a single herbal ingredient as well as commercially available formulations.

SUMMARY

The formulated herbal toothpaste was evaluated for its organoleptic properties and stability. Sensory evaluation revealed that the toothpaste possessed a light brown color, a pleasant odor, and a slightly rough texture. The spreadability was found to be satisfactory, and the pH value of 7.1 was within acceptable limits. Moisture content and foaming capacity also fell within standard ranges. Stability studies conducted over a period of one month showed no significant changes in the physical characteristics of the formulation. Antimicrobial activity was assessed using the disc diffusion method, and the herbal toothpaste exhibited an effective zone of inhibition when compared with the marketed toothpaste formulation.

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