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"FORMULATION AND EVALUATION OF AN ANTIMICROBIAL HERBAL TOOTHPASTE UTILIZING GUAVA LEAF EXTRACT, LEMONGRASS OIL, AND CLOVE OIL FOR ENHANCED ORAL HEALTH"

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ABSTRACT

Oral health significantly impacts overall well-being, with dental diseases being a leading global health concern. This study aimed to formulate and evaluate an antimicrobial herbal toothpaste incorporating guava leaf extract, lemongrass oil, and clove oil, leveraging the medicinal properties of these natural ingredients. The toothpaste was developed using a combination of key ingredients and evaluated for physical properties, pH, foamability, stability, and antimicrobial efficacy against common oral pathogens, including Staphylococcus aureus and Escherichia coli. The results indicated that the herbal toothpaste exhibited favorable physical characteristics. Antimicrobial tests has done by cup plate method. Overall, this research highlights the potential of herbal toothpaste as an effective, natural alternative for enhancing oral health, presenting an innovative approach to preventive dental care.

KEYWORDS: antimicrobial activity, herbal toothpaste, clove oil, lemongrass oil, guava extract, oral health.

INTRODUCTION

Oral health is an integral component of overall well-being, significantly influencing physical and mental health. Globally, dental diseases such as caries, periodontal disease, and oral cancers rank among the most prevalent health issues, prompting the need for effective preventive measures (WHO, 2022). Oral hygiene is crucial for the prevention of dental diseases, including dental caries, periodontal disease, and halitosis. Poor oral hygiene can lead to significant

morbidity, including systemic complications such as cardiovascular disease and diabetes.[1] The World Health Organization (WHO) emphasizes the necessity of maintaining oral health, highlighting its integral role in overall well-being.[2] Conventional toothpastes are predominantly used for oral hygiene, yet increasing consumer awareness of the adverse health impacts of synthetic chemicals has fueled a shift towards more natural alternatives. Toothpaste, a fundamental tool in oral hygiene, plays a crucial role in the prevention of these dental disorders. Traditional toothpastes typically contain fluoride, abrasives, and various chemical additives aimed at combating plaque, tartar, and other oral ailments.[3] However, increasing awareness of the potential health risks associated with synthetic chemicals has led consumers to seek safer alternatives.

In recent years, herbal toothpastes have gained popularity as natural alternatives to conventional formulations. These products leverage the medicinal properties of plant-derived ingredients, which have been utilized in traditional medicine for centuries. Many herbs possess natural antibacterial, anti-inflammatory, and antioxidant properties that can effectively contribute to oral health.[4] Herbs such as neem (Azadirachta indica), clove (Syzygium aromaticum), and guava leaves (Psidium guajava) have all shown promising results in promoting oral hygiene and preventing dental diseases.[5] Guava leaf extract has been found to have significant antimicrobial activity against pathogenic microorganisms commonly associated with oral infections.[6] Its rich composition of flavonoids and tannins provides beneficial effects on gum health and dental cleanliness.[7] Similarly, clove oil is revered for its analgesic and antiseptic properties, providing relief from toothaches and inflammation in gums.[8]

As consumer preferences shift towards natural products, herbal toothpastes are becoming increasingly relevant in the market. According to market research, the global herbal toothpaste market is projected to grow considerably, driven by the rising demand for eco-friendly and chemical-free dental care products.[9] Healthcare professionals and researchers are emphasizing the importance of evaluating the safety, efficacy, and stability of these products to meet regulatory standards and consumer expectations.[10]

This study aims to formulate a herbal toothpaste using key natural ingredients, including guava leaf extract, lemongrass oil (Cymbopogon citratus), and clove oil, and evaluate its effectiveness in addressing common oral health issues. The research will assess various parameters, including antimicrobial efficacy, physical properties, and stability, ultimately positioning herbal toothpaste as a viable alternative to conventional products.

Table 1: Types of Toothpaste.

Type	Key Ingredients	Primary Use / Purpose	Common Examples
Fluoride Toothpaste	Sodium fluoride, stannous fluoride	Prevents cavities and strengthens enamel	Colgate, Sensodyne Daily Protection
Whitening Toothpaste	Hydrogen peroxide, baking soda, silica	Removes surface stains and whitens teeth	Colgate Optic White, Crest 3D White
Tartar Control	Pyrophosphates, zinc citrate	Prevents tartar (calculus) buildup	Crest Tartar Protection, Colgate Tartar Control
Sensitivity Toothpaste	Potassium nitrate, strontium chloride, arginine	Reduces tooth sensitivity to hot/cold	Sensodyne, Colgate Sensitive
Herbal/Natural	Neem, clove, miswak, mint, charcoal	Natural cleansing and breath freshening, fewer chemicals	Dabur Red, Himalaya Herbal, Patanjali Dant Kanti
Children's Toothpaste	Lower fluoride, mild flavors	Safe for kids, prevents early cavities	Colgate Kids, Pigeon, Chicco
Smoker's Toothpaste	Strong abrasives, strong mint	Removes tobacco stains and neutralizes odors	Vicco Vajradanti, Closeup Red Hot
Charcoal Toothpaste	Activated charcoal	Claims to detoxify and whiten teeth	Hello Activated Charcoal, Colgate Charcoal Clean
Antibacterial Toothpaste	Triclosan, zinc, chlorhexidine	Reduces plaque and gingivitis	Colgate Total, Parodontax
Enzyme Toothpaste	Papain, bromelain	Breaks down plaque biologically	Biotene, Zendium

Herbal toothpaste refers to formulations that primarily use natural plant-based ingredients instead of synthetic chemicals. These pastes aim to maintain oral hygiene by leveraging the medicinal properties of herbs traditionally used in various systems like Ayurveda, Unani, and Traditional Chinese Medicine. The ingredients (Table 2) are usually extracted in the form of oils, powders, or decoctions and incorporated into a base like calcium carbonate, glycerin, and natural sweeteners.



Fig. 1: Picture of lemon grass, clove and guava leaf.

Table 2: Herbs and their oral herbal benefits.

Herb	Scientific Name	Oral Health Benefits
Neem	*Azadirachta indica*	Antibacterial, plaque control, anti-inflammatory
Clove	*Syzygium aromaticum*	Antiseptic, analgesic, fights toothache and gum pain
Turmeric	*Curcuma longa*	Anti-inflammatory, antimicrobial, whitens teeth

Aloe Vera	*Aloe barbadensis*	Soothing, healing for gums, anti-inflammatory
Babool	*Acacia arabica*	Strengthens gums, antimicrobial
Mint	*Mentha spp.*	Refreshes breath, cooling effect
Holy Basil	*Ocimum sanctum*	Antibacterial, strengthens gums
Licorice	*Glycyrrhiza glabra*	Prevents cavities, reduces plaque

MATERIALS AND METHODS

Materials

calcium carbonate, sodium benzoate, sodium chloride, sodium lauryl sulfate was obtained from loba chemical. Honey, clove oil and lemon grass oil was purchased from market. Other chemicals and solvents were of high quality and were chemically rated.

Collection and Preparation of extract of guava leaves

The fresh leaves were collected from the medicinal garden of Department of Pharmacy, SGSITS.

Fresh guavas leaves were thoroughly washed with water to eliminate any dirt or impurities. After that, the guava leaves were allowed to dry in a shady spot. A mortar and pestle were used to grind the leaves into a fine powder after they had dried. A 250 ml beaker filled with distilled water was filled with this powder, and the mixture was heated to a boil while being constantly swirled. The mixture was boiled, and the leaf extract was separated by filtering and dried. The dried extract stored in container.

Preparation of herbal toothpaste

The herbal formulation 1 was prepared by mixing calcium carbonate, sodium benzoate, sodium chloride, sodium lauryl sulfate, honey, and glycerine (listed in table 3) with water, this solution was added to the mortar that contained the herbal constituents and acacia added drop by drop to it. Triturating the mixture sufficiently resulted in a paste-like consistency. After then, drops of lemon grass oil were added to the mixture. In the herbal formulation 2, the clove oil added instead of lemon grass oil. The final paste was preserved appropriately and stored in a sterile, airtight container.

Table 3: Ingredients of toothpaste.

INGREDIENTS	QUANTITY
Honey (Reduce plaque building)	1.5 ml
Calcium Carbonate (Abrasive)	10.5 gm
Glycerine (Humectant)	6ml
Sodium lauryl sulphate(Surfactant)	1.5 gm

Sodium Benzoate (Preservative)	1.0 gm
Acacia (Binding agent)	1 gm
Distilled water	q.s.
Guava leaves extract powder (Anti microbial action)	1.5 gm
Clove oil	1 ml
Lemon grass oil	1 ml

Evaluation parameters

Evaluation parameters are the specific tests, measurements, and criteria used to assess the quality, safety, stability, and effectiveness of a product—in this case, herbal toothpaste. These parameters help ensure that the final product performs as expected, is safe for consumer use, and maintains consistent quality across batches. Evaluating herbal toothpaste formulations is essential to ensure quality, safety, effectiveness, and consumer acceptability. Herbal products can vary in composition due to the natural origin of ingredients, so proper evaluation ensures consistency, stability, and therapeutic efficacy**.**

Following are the evaluation parameters to be considered after formulation of herbal tooth-paste:

1. Physical examination

Formulated toothpaste was evaluated for its colour. Then visually colour of the formulated toothpaste was checked. Odour was checked by smelling the product. The Smoothness was tested by rubbing the paste formulation between the fingers.

2. PH test

A pH test evaluates the acidity or alkalinity of a substance, with a scale ranging from 0 (strongly acidic) to 14 (strongly alkaline), and 7 being neutral. It is commonly used in medical, environmental, and chemical testing to assess conditions such as blood pH, soil quality, or water safety. The test can be done using litmus paper, pH strips, or a digital pH meter for more accurate readings.

3. Foamability test

Foam ability refers to a substance's capacity to produce foam when agitated, usually in liquids like shampoos, soaps, or detergents. It is evaluated by measuring the volume and stability of foam formed after shaking or stirring under standardized conditions. Key parameters include initial foam height, foam stability over time, and drainage rate. It helps assess product quality and user satisfaction in cosmetic and cleaning formulations.

The foam-ability of formulated toothpaste evaluated by taking small amount of formulation with water in measuring cylinder and they were shacked for sometimes to check the presence of foam formation in the measuring cylinder.

4. Stability studies

A stability study evaluates how the quality of a product (such as a drug or cosmetic) changes over time under the influence of factors like temperature, humidity, and light. Key parameters assessed include appearance, pH, potency (active ingredient content), microbial limits, and degradation products. The results help determine shelf life, storage conditions, and expiration date.

5. Sharp and abrasive particle test

The sharp and abrasive particle test is used to detect the presence of particles in a product (typically topical or cosmetic formulations) that may cause skin irritation or damage due to their sharp edges or abrasive nature. The test involves visual and tactile examination, often under magnification, and sometimes includes passing the product through a fine mesh or applying it on the skin or synthetic surface to feel for grittiness. It ensures product safety and smoothness for consumer use.[11]

6. Anti-microbial test

Anti-microbial test using cup and plate method

Anti-microbial test was performed for S. aureus and E. coli bacterial strains.

The cup plate method is a simple and widely used agar diffusion technique to evaluate the antimicrobial activity of herbal formulations.

Agar plate preparation involves filling Petri dishes with sterile nutritional agar that has typically been inoculated with a test microorganism. A sterile borer is used to create tiny wells or cups in the agar.

The test sample, was put into each well. then plates was incubated for 24 to 48 hrs at 35.1°C.

Evaluation was done by measuring the zone of inhibition, or the clear region surrounding the well where microorganisms did not proliferate.

RESULT AND DISCUSSION

The present study focused on the formulation and evaluation of a herbal toothpaste using three key natural ingredients: lemongrass oil (*Cymbopogon citratus*), clove oil (*Syzygium aromaticum*), and guava leaf extract (*Psidium guajava*). These components were selected due to their well-documented pharmacological activities and their traditional use in oral care. Lemongrass oil is rich in citral and limonene, compounds known for their potent antimicrobial, anti-inflammatory, and antioxidant properties. In toothpaste formulation, lemongrass oil contributes to bacterial control in the oral cavity, freshens breath, and helps prevent gingivitis and plaque build up.[12] Clove oil contains eugenol, a natural compound with strong analgesic, antibacterial, and anti-inflammatory effects. Its inclusion in the formulation aids in relieving toothache, reducing microbial growth, and controlling bad breath.[13] It is especially effective against *Streptococcus mutans* and other cariogenic bacteria. Guava leaf extract is known for its flavonoids, tannins, and essential oils, which have been shown to exhibit antibacterial, antifungal, and astringent activities. These compounds help in tightening gums, reducing inflammation, controlling microbial load, and healing oral ulcers.[14,15] The formulated toothpaste was evaluated based on several key parameters, including organoleptic properties, pH, foamability, spreadability, and stability. The results showed that the herbal toothpaste had a pleasant aroma and taste, acceptable consistency, and a neutral to slightly alkaline pH suitable for oral use. The foaming ability was moderate, indicating gentle cleansing without harsh surfactants. The paste remained physically stable over time, with no evidence of phase separation, microbial contamination, or colour change. The antibacterial activity results indicate that HF1 exhibits a strong inhibitory effect against the E. coli strain, producing a 1.2 cm zone of inhibition. In contrast, HF2 demonstrates a weaker potency against E. coli, with only a 0.5 cm zone of inhibition. Additionally, while HF2 shows some slight inhibitory effect on S. aureus, HF1 does not produce any zone of inhibition against this bacterium. In conclusion, the formulated herbal toothpaste containing lemongrass oil and guava leaf extract demonstrates excellent inhibitory potential against E. Coli, but not to S. Aureus.

Table: Summary of results of evaluation parameters.

EVALUATION PARAMETERS	Herbal formulation 1	Herbal formulation 2
1.Physical examination	It appeared to be light brown in colour. along with a sweet and pleasant odour. It has a smooth texture.	It appeared to be dark brown in colour along with a pleasant odour. It has a smooth texture.
2.PH test	PH of 7.12.	It has a PH of 7.06.
3.Foamability test	Both the formulations passed the foamability test. They developed	

	foam when they were taken in measuring cylinder and shaken with distilled water.
4.Stability studies	Stability was achieved at room temperature. No contamination was seen after 10-12 days. The colour changed slightly to a darker colour over a period of 10 days.
5.Sharp and abrasive particle test	No sharp and abrasive particles were seen in both the formulations.

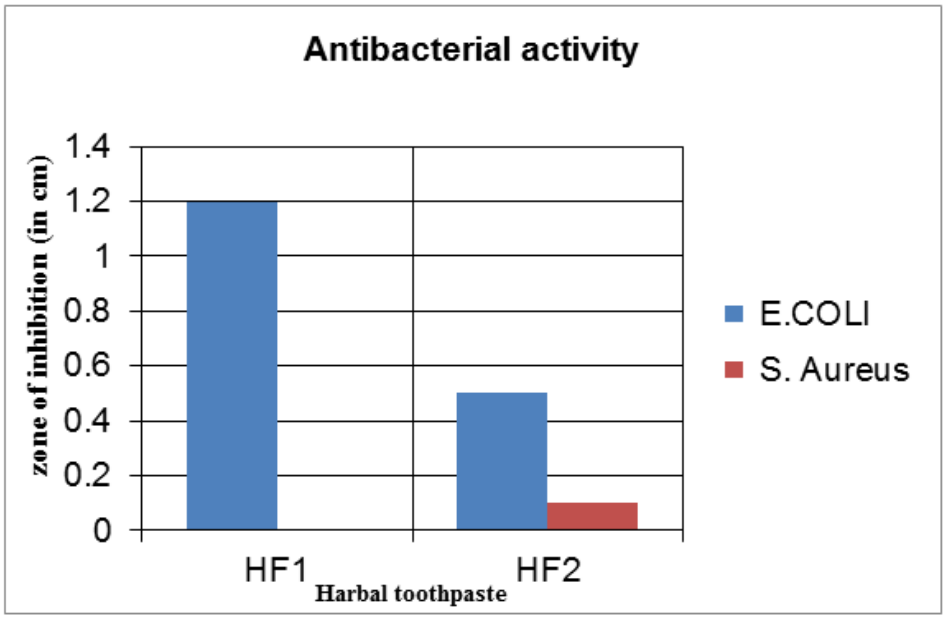


Fig. 2: Graph of antibacterial activity.

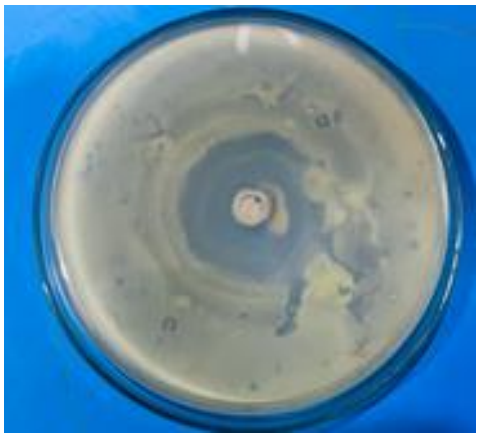


Fig. 3: Zone of inhibition by hf1 on ecoli culture plate.

CONCLUSION

The formulated herbal toothpaste demonstrates effective cleaning, antimicrobial, and antioxidant properties, primarily due to the presence of natural ingredients such as clove, neem, and guava leaf extracts. The formulation meets basic quality parameters and offers a promising alternative to commercial toothpastes, emphasizing the benefits of natural, chemical-free oral care.

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