



CODEN [USA]: IAJPBB

ISSN : 2349-7750

**INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES**

SJIF Impact Factor: 7.187

<https://doi.org/10.5281/zenodo.20041288>Available online at: <http://www.iajps.com>

Research Article

**KNOWLEDGE AND PRACTICE OF PHARMACOGENOMICS
AMONG PHARMACY STUDENTS: A CROSS-SECTIONAL
STUDY****Virat G. Rathod¹, Mr. Nandkishor B. Deshmukh², Dr. Swati P. Deshmukh³**¹Student, Shraddha Institute of Pharmacy, Washim, Maharashtra, India.²Assistant Professor, Department of Pharmaceutic, Shraddha Institute of Pharmacy, Washim, Maharashtra, India.³Principal, Department of Pharmacology, Shraddha Institute of Pharmacy, Washim, Maharashtra, India.**Abstract:**

Oral hygiene plays a critical role in maintaining both oral and systemic health, as poor oral care is strongly associated with conditions such as dental caries, gingivitis, periodontitis, and halitosis, as well as systemic disorders including cardiovascular diseases, diabetes mellitus, and respiratory infections. Despite the widespread use of conventional oral care products, concerns have arisen regarding the safety and environmental impact of synthetic ingredients such as fluoride, triclosan, and Sodium Lauryl Sulfate (SLS), which may cause adverse health effects upon prolonged use. This has led to a growing demand for safer, natural, and eco-friendly alternatives.

*The present study focuses on the formulation and evaluation of a herbal toothpaste incorporating key medicinal plant ingredients, namely Neem (*Azadirachta indica*), Clove (*Syzygium aromaticum*), and Turmeric (*Curcuma longa*), known for their antimicrobial, anti-inflammatory, and antioxidant properties. Additional components such as baking soda, salt, coconut oil, and peppermint oil were included to enhance cleansing efficiency, antimicrobial action, and user acceptability. A minimal and controlled amount of SLS was used to improve foaming characteristics without compromising safety.*

The formulation was developed using standardized procedures to ensure uniformity, stability, and effectiveness. It was evaluated through physicochemical parameters including pH, spreadability, foaming capacity, and texture, along with antimicrobial activity, stability studies, and sensory evaluation. The results indicate that the herbal toothpaste demonstrates satisfactory performance in maintaining oral hygiene while offering a safer and environmentally sustainable alternative to conventional products.

This study highlights the potential of integrating traditional herbal knowledge with modern scientific approaches to develop effective, safe, and eco-friendly oral care solutions, thereby contributing to improved public health and sustainable healthcare practices.

Keywords: Herbal Toothpaste, Oral Hygiene, Neem, Clove, Turmeric, Antimicrobial Activity, Natural Formulation, Sustainable Healthcare, Sodium Lauryl Sulfate, Dental Care

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Please cite this article in press Virat G. Rathod et al., Knowledge And Practice Of Pharmacogenomics Among Pharmacy Students: A Cross-Sectional Study, Indo Am. J. P. Sci, 2026; 13(05).

1. INTRODUCTION:

Oral hygiene is an essential component of overall health and well-being. Maintaining a clean and healthy oral cavity helps prevent not only dental issues such as cavities and gum diseases but also contributes significantly to the prevention of systemic illnesses. Poor oral hygiene has been closely linked with conditions such as tooth decay, gingivitis, periodontitis, and halitosis. These issues, if left untreated, can extend beyond the oral cavity and contribute to more serious health complications, including cardiovascular diseases, diabetes mellitus, respiratory infections, and adverse pregnancy outcomes. As such, maintaining effective oral hygiene is a public health priority. [1]

Traditional oral care products, while effective in maintaining dental hygiene, often contain synthetic and potentially harmful ingredients. These include fluoride, triclosan, artificial sweeteners, and foaming agents like Sodium Lauryl Sulfate (SLS).

Though these substances serve specific functions—such as remineralization, bacterial control, and improved product usability—they have come under scrutiny due to increasing evidence of adverse effects. For instance, fluoride, though beneficial in small amounts, can lead to fluorosis when overused, especially in children. Triclosan has been associated with endocrine disruption, and SLS can cause mucosal irritation and allergic reactions. Additionally, the environmental impact of these chemical agents poses further concerns, as they are not easily biodegradable and may contribute to water pollution. [2]

In light of these issues, a paradigm shift is emerging in consumer preferences. There is a growing demand for natural, plant-based alternatives in oral care, driven by increasing awareness of the potential side effects of synthetic compounds and a broader societal movement toward wellness and sustainability. Herbal toothpaste, formulated from natural ingredients derived from medicinal plants, offers a promising alternative. These formulations are appreciated not only for their effectiveness but also for their safety profile, environmental compatibility, and alignment with holistic healthcare practices. [3]

herbal ingredients—Neem (*Azadirachta indica*), Clove (*Syzygium aromaticum*), and Turmeric (*Curcuma longa*)—each known for their potent medicinal properties and longstanding use in traditional medicine systems such as Ayurveda and Traditional Chinese Medicine. Neem possesses antibacterial, antifungal, antiviral, and anti-inflammatory properties. It is especially effective in combating oral pathogens such as *Streptococcus mutans*, a

primary contributor to dental caries. Clove, rich in the compound eugenol, is widely used for its analgesic and antiseptic qualities, making it valuable for relieving toothaches and reducing gum inflammation. Turmeric, known for its active constituent curcumin, exhibits broad-spectrum antimicrobial, antioxidant, and anti-inflammatory effects, which contribute to oral tissue healing, reduction of gingivitis, and teeth whitening [4]

In addition to these primary herbal agents, the formulation incorporates natural abrasives such as baking soda and salt. These ingredients help gently polish the teeth, remove dental plaque, and neutralize acidic conditions in the oral cavity that may lead to enamel erosion. Coconut oil, another component, serves as both a base and an antimicrobial agent. Its use in oil pulling is well-documented for reducing oral bacteria and promoting detoxification. Although a small amount of Sodium Lauryl Sulfate (SLS) is retained in the formulation to enhance the foaming property of the toothpaste and improve user experience, it is used at a concentration deemed safe and non-irritating to most users.

Furthermore, peppermint oil is added to provide a refreshing taste and additional antimicrobial action, enhancing the overall user experience and promoting fresh breath. The incorporation of essential oils not only contributes to sensory appeal but also aids in maintaining a balanced oral microbiome. [5]

The formulation of herbal toothpaste involves precise measurement, thorough mixing, and homogenization processes to ensure the final product is consistent in texture, effective in application, and stable over time. The choice of ingredients and methods also ensures that the product maintains its efficacy throughout its shelf life without the use of synthetic preservatives.

An often-overlooked benefit of herbal formulations is their reduced environmental impact. These products are typically biodegradable and can be packaged using sustainable, recyclable materials. In contrast to synthetic-based formulations, herbal toothpaste aligns with green chemistry principles and supports the broader goals of eco-friendly and sustainable healthcare.

This research aims to develop and evaluate a novel herbal toothpaste that balances efficacy, safety, and environmental responsibility. The study includes a multi-faceted approach, encompassing physicochemical analysis (such as pH, spreadability, foaming capacity, and texture), microbial efficacy testing, stability evaluations over time, and

consumer feedback through sensory trials. By integrating traditional herbal knowledge with modern scientific validation, this formulation aspires to contribute meaningfully to holistic oral care and sustainable health practices. [6]

Oral hygiene represents a fundamental pillar of human health and overall well-being. It encompasses practices that maintain the cleanliness and functionality of the oral cavity, including the teeth, gums, tongue, and associated structures. Effective oral hygiene not only prevents common dental problems such as plaque accumulation, tooth decay, gingivitis, and periodontitis-but also plays a vital role in preventing systemic diseases. Mounting scientific evidence supports the link between poor oral health and a range of chronic health conditions, including cardiovascular disease, diabetes mellitus, respiratory infections, rheumatoid arthritis, and adverse pregnancy outcomes like preterm birth and low birth weight. As such, the state of one's oral health extends far beyond the confines of the mouth, underlining the necessity of integrating dental hygiene into broader public health initiatives. [7]

Despite significant advancements in dental care and the widespread availability of oral care products, the prevalence of dental diseases remains high worldwide. A major contributing factor to this paradox is the composition of many conventional oral hygiene products, which often contain synthetic additives that, while effective in the short term, may present long-term risks. Common ingredients such as fluoride, triclosan, artificial colorants, sweeteners, and foaming agents like Sodium Lauryl Sulfate (SLS) are included in commercial toothpaste formulations for specific therapeutic or sensory effects. Fluoride, for instance, is well-known for its ability to strengthen enamel and prevent demineralization. However, chronic overexposure especially in young children can result in dental fluorosis or even systemic toxicity.

Similarly, triclosan, once widely used for its antibacterial properties, has raised concerns over endocrine disruption, microbial resistance, and bioaccumulation in the environment. SLS, while effective in enhancing foaming and cleaning action, is associated with mucosal irritation, allergic responses, and disruption of the oral microbiome.[8] These concerns have prompted a re-evaluation of conventional oral care practices, with increasing attention directed toward safer, natural, and environmentally sustainable alternatives. As consumers become more informed and health-conscious, there is a growing shift in preference toward holistic and plant-based solutions that align with traditional medicinal systems and sustainable lifestyles. This change is not merely a passing trend

but a reflection of a larger movement toward clean-label products, eco-conscious consumption, and integrative healthcare. Herbal toothpaste, which utilizes the therapeutic potential of medicinal plants, stands out as a promising alternative. These formulations are designed to be gentle yet effective, combining the wisdom of ethnomedicine with the rigor of modern pharmacology and quality assurance practices.

ANATOMY AND PHYSIOLOGY OF TEETH

The human dentition typically includes 28 to 32 teeth, divided between the upper (maxillary) and lower (mandibular) jaws. These are classified into:

- Incisors (8): Front teeth for cutting.
- Canines (4): Pointed teeth for tearing.
- Premolars (8): For crushing and grinding.
- Molars (8-12): Broad-surfaced teeth for grinding food.
- Each tooth has three main parts:
- Crown: The visible part, covered in enamel, the hardest tissue in the body.
- Neck: The area where crown meets root at the gum line.
- Root: Embedded in the jawbone, anchoring the tooth in place.



Figure 1.1:-Tooth Anatomy

Internally, a tooth consists of:

- Enamel: Hard outer covering protecting the tooth.
- Dentine: Calcified tissue beneath enamel, containing microscopic tubules.
- Pulp: The central chamber with nerves and blood vessels.
- Cementum: A bone-like material covering the root and aiding in attachment.

Teeth perform vital functions including:

- Mastication: Mechanical breakdown of food.
- Speech: Assisting in articulation.
- Aesthetic support: Maintaining facial structure.
- Protection: Proper alignment helps prevent tissue injury.[15]

IDEAL PROPERTIES OF TOOTHPASTE

An ideal toothpaste should effectively clean the teeth, promote oral health, and be safe for daily use.

Key properties include:

- **Cleansing Ability:** Gentle abrasives and surfactants help remove plaque, stains, and debris without harming enamel.
 - **Antimicrobial Action:** Ingredients like neem, clove, and turmeric can inhibit harmful bacteria responsible for cavities and gum disease.
- Anti-inflammatory Effects:** Natural compounds reduce gum inflammation and support healing.
- **Non-toxic and Safe:** The formulation must be safe even if ingested, particularly for children.
 - **Pleasant Taste:** Flavors like peppermint enhance the user experience and freshen breath.
 - **Balanced pH:** Slightly alkaline pH helps protect enamel and maintain oral health.
 - **Good Spread ability and Foam:** Ensures even application and effective cleaning.
 - **Stability:** The product should retain texture, appearance, and effectiveness over time.
 - **Cosmetic Appeal:** Some ingredients help whiten teeth and remove stains.
 - **Eco-friendly:** Natural, biodegradable ingredients and recyclable packaging are ideal. [16]

2. PLANT PROFILE:

Neem (*Azadirachta indica*)



Figure 1.2:-Neem

Botanical Name: *Azadirachta indica*

1. **Common Name:** Neem, Indian Lilac

2. **Family:** Meliaceae

3. **Plant Parts Used:** Leaves, bark, twigs, seeds, oil, flowers

4. **Geographical Source:** Indigenous to the Indian subcontinent; widely cultivated in tropical and subtropical regions across Asia, Africa, and South America

Phytochemical Constituents:

Phytochemical constituents

Neem contains a wide range of bioactive compounds, including:

- Azadirachtin: Insecticidal, antifeedant properties
- Nimbin & Nimbidin: Antibacterial, anti-inflammatory agents
- Nimbidol: Antifungal activity
- Quercetin: Antioxidant and anti-inflammatory flavonoid
- Salannin: Insect repellent
- Gedunin: Antimalarial
- Tannins, Limonoids, Flavonoids, Saponins: Broad-spectrum pharmacological activities[26]

Pharmacological action:-

Table No 2.1 Pharmacological action:-

Action	Description
Antibacterial	Inhibits growth of streptococcus mutans, Lactobacillus, and other oral pathogens
Antifungal	Effective against <i>Candida albicans</i> and other fungal species
Anti-inflammatory	Reduces gingival inflammation and swelling
Antioxidant	Scavenges free radicals, protects oral tissues from oxidative stress
Astringent	Tightens gums and reduces gum bleeding
Analgesic	Provides relief from pain, useful in gingival and dental discomfort
Immunomodulatory	Enhances local immunity in the oral cavity
Antiviral	Inhibitory effects on certain viruses (e.g., HSV, pox viruses)

Mechanism of Action in Oral Care:

- > Inhibits bacterial adhesion to tooth surfaces and disrupts biofilm formation
- > Reduces gingival inflammation by suppressing pro-inflammatory cytokines
- > Promotes healing of inflamed and damaged oral tissues
- > Maintains oral microbiome balance by selective antimicrobial activity[19]

Therapeutic Uses:**Oral Health:**

- Prevention of dental caries
- Management of gingivitis and periodontitis
- Antiseptic mouth rinses
- Herbal toothpaste and gels
- Neem twigs (chewing sticks) for mechanical and antimicrobial cleaning[27]

> Clove

Common Name: Clove

Botanical Name: *Syzygium Aromaticum* L.

Family: Myrtaceae



Figure 1.3:-Clove

Part Used:The dried flower buds of the clove plant are primarily used for medicinal and dental purposes. In the formulation of herbal toothpaste, clove is the dried buds.

Description and Organoleptic Characters:Clove buds are dark brown in color, with a characteristic strong aromatic odor and a pungent, spicy taste. The essential oil extracted from clove is pale yellow to colorless and is rich in bioactive constituents.

Phytochemical Constituents:

Clove is a rich source of several biologically active compounds. The primary phytochemicals present include:

Eugenol (up to 85% in clove oil: Responsible for the analgesic, antiseptic, and antimicrobial activity.

Caryophyllene: Contributes to anti-inflammatory and antimicrobial properties.

Tannins: Aid in astringent and wound healing actions, beneficial for gum health.

Flavonoids: Known for antioxidant activity, which helps in protecting oral tissues from oxidative damage.

Saponins: Exhibit mild cleansing and antibacterial properties [28]

7. Pharmacological action

Clove exhibits multiple pharmacological activities that are particularly beneficial

Antimicrobial: Clove oil is effective against a wide range of oral pathogens.

including *Streptococcus mutans*, *Lactobacillus acidophilus*, *Candida albicans*, and others, thereby reducing the microbial load in the oral cavity.

Analgesic (Pain-Relieving): Eugenol, the active component, acts as a natural anesthetic, providing relief from dental pain, particularly toothaches.

Anti-inflammatory: It helps reduce gum inflammation, bleeding, and swelling, which are common symptoms in conditions like gingivitis and periodontitis.

Antioxidant: The antioxidant compounds in clove help neutralize free radicals, protecting gums and oral tissues from damage and aging.

Astringent: The presence of tannins provides astringent properties, which help tighten gums and reduce the risk of gum bleeding.

Antiseptic: Prevents infections in the oral cavity and promotes faster healing of minor oral wounds or ulcers. [29]

8. Therapeutic Uses in Herbal Toothpaste:

Clove plays a significant role in enhancing the therapeutic value of herbal toothpaste through the following ways:

Helps prevent and manage gingivitis, periodontal disease, and halitosis (bad breath).

Offers soothing relief from tooth pain and sensitivity due to its numbing action.

Aids in controlling plaque formation and bacterial colonization on teeth surfaces.

Supports healing of mouth ulcers and minor cuts in the oral mucosa.

Strengthens the gums and maintains overall oral hygiene.[30]

9. Advantages in Herbal Toothpaste Formulation:

Clove is a natural and safe alternative to synthetic antimicrobial agents like triclosan.

Provides long-lasting freshness and a pleasant, spicy aroma that appeals to consumers.

Enhances the preservative quality of the toothpaste due to its antimicrobial

Turmeric

Figure 1.3:-Turmeric

1. Common Name: Turmeric

Botanical Name: *Curcuma longa* L.

Family: Zingiberaceae (Ginger family)

Part Used: The rhizome (underground stem) of turmeric is primarily used for medicinal purposes. In herbal toothpaste formulations, turmeric is usually curcumin.

incorporated in the form of powdered rhizome or turmeric extract, including

Description and Organoleptic Characters: Turmeric is a bright yellow-orange powder derived from the dried rhizomes of the *Curcuma longa* plant. The powdered form has an earthy, bitter, and slightly peppery flavor. The essential oil is pale yellow and has a distinct aromatic odor, characteristic of turmeric. [32]

Phytochemical Constituents: The therapeutic effects of turmeric are primarily due to the presence of bioactive compounds such as:

Curcumin: The main active compound, responsible for turmeric's anti-inflammatory, antioxidant, and antimicrobial properties.

Demethoxycurcumin and Bisdemethoxycurcumin: Other curcuminoids that contribute to the antioxidant and anti-inflammatory effects.

Turmerone: Found in the essential oil of turmeric, it has anti-inflammatory and antimicrobial properties.

Ferulic acid: An antioxidant compound that helps in neutralizing free radicals and protecting oral tissues.

7. Pharmacological Actions: beneficial in oral care, including:

Turmeric is known for its wide range of pharmacological actions that are

Antioxidant: The high levels of antioxidants in turmeric protect oral tissues • Anti-inflammatory:

Curcumin reduces inflammation, which helps in the treatment of gingivitis, periodontitis, and other inflammatory oral conditions. Antimicrobial:

Turmeric has broad-spectrum antimicrobial activity, effective

gums and teeth. from oxidative stress, preventing cell damage and premature aging of the against oral pathogens like *Streptococcus mutans*, *Candida albicans*, and

Porphyromonas gingivalis.

Antibacterial: Helps in preventing the formation of dental plaque and reduces the accumulation of harmful bacteria on teeth and gums.

Wound Healing: Promotes tissue repair and healing of minor oral wounds or gum abrasions due to its antimicrobial and anti-inflammatory properties.

Analgesic: Exhibits mild pain-relieving effects, providing relief from toothaches or sore gums. [34]

8. Therapeutic Uses in Herbal Toothpaste:

Turmeric has numerous applications in oral health when used in toothpaste formulations, including:

Gum health: It helps in the prevention and management of gingivitis and periodontitis by reducing gum inflammation and bleeding.

Plaque control: Turmeric helps prevent the buildup of dental plaque, which can lead to cavities, bad breath, and gum disease.

Anti-inflammatory treatment: It aids in reducing gum swelling, redness, and inflammation associated with oral conditions.

Antibacterial action: Reduces the growth of harmful bacteria in the mouth, preventing bacterial overgrowth and associated oral diseases.

3. EXCIPIENT PROFILE

SALT

NON-PROPRIETARY NAME

Table No 3.1 Non Proprietary name

Standard	Name
BP	Sodium chloride
JP	Natrium chloratum
PhEur	Natriichloridum
USP	Sodium chloride

Synonyms:

Common salt; Table salt; Rock salt; Sea salt; Halite; NaCl

÷ Chemical Name and CAS Registry Number: Sodium chloride — (7647-14-5]

÷ Empirical Formula and Molecular Weight: NaCl and 58.44 g/mol

Structural Formula:

Na⁺ Cl⁻

Functional Category:

Tonicity agent; Osmotic agent; Preservative; Tablet diluent; Lubricant in oral formulations 36]

Applications:

Used in oral rehydration and isotonic solutions.

Osmotic agent in laxatives and nasal sprays.

Channeling agent in controlled-release tablets.

Flavor enhancer and preservative.

Description:

White crystalline powder, odorless, salty taste. Freely soluble in water.

PHYSICAL PROPERTIES

Table No 3.2 physical properties

Property	Value
Solubility in water	35.7 g/100ml(20°C)
Melting point	801° C
Boiling point	1465°C
Density	2.16 g / cm ³

Stability and Storage:

Store in dry, tightly closed container.

, Incompatibilities:

→ Safety:

Incompatible with silver nitrate and may, Orct osmotic pressure.

GRAS; excessive intake may cause hypertension.[17]

COCONUT OIL
Non Proprietary name

Table No 3.3 Non Proprietary name

Standard	Name
BP	Oleum cocos
JP	CocosNucifera oil
PhEur	CocosNucifera oleum
USP	Coconut oil

Synonyms:

Cocos Oil: Copra Oil: Coconut Butter, Virgin Coconut Oil
Chemical Name and CAS Registry Number:

Coconut oil - [8001-31-8]

Empirical Formula and Molecular Weight: Mixture of triglycerides - MW~638-689 g/mol
Structural Formula:

Glycerol esterified with lauric/myristic/capric acid
Functional Category:

Emollient; Vehicle; Solubilizer; Lubricant [18] *

Applications:

Ointment/cream/suppository base.

Vehicle for fat-soluble drugs.

Used in herbal toothpaste.

Mild antimicrobial properties.

Description:

White solid or pale yellow liquid. Mild coconut odor

Table No 3.4 physical properties

Property	Value
Solubility	Insoluble in water and soluble in alcohol
Melting point	23-26°C
Density	~0.925 g/cm ³

Stability and Storage:

al Miladon and Evaluation Of Merbal toothpaste A Natural Xpgewik u Trt

Incompatibilities:

Store in a cool, dry plt [19] itive to light/air.

Oxidizing agents. May oxidize over time.

→ Safety:

GRAS. Non-toxic, non-irritant.[19]

Sodium Lauryl Sulfate (SLS)

Non Proprietary name

Table No 3.5 Non Proprietary name

Standard	Name
BP	Sodium Laurisulfate
JP	Sodium Lauryl Sulfate
PhEur	Natrilaurilsulfas
USP	Sodium Lauryl sulfate

Synonyms:

SLS; SDS; Lauryl sodium sulfate; Duponol; Texapon \$
Chemical Name and CAS Registry Number:

Sodium dodecyl sulfate — [151-21-3]

Empirical Formula and Molecular Weight:

Ch₂H₂₅NaO₄S and 288.38 g/mol

÷ Structural Formula: CH:(CH₂)_nOSO₃ Na⁺

Functional Category:

Surfactant; Foaming agent; Wetting agent[20]

Applications:

Wetting agent in tablet/capsule formulations.

Used in toothpaste, shampoos, and skin cleansers.

Enhances dissolution and foaming.

Description:

White to off-white powder/granules. Soapy odor.

PHYSICOCHEMICAL PROPERTIES

Table No 3.6 physical properties

Property	Value
Solubility	Freely soluble in water/ethanol
Melting point	Decompose>200°C
Ph (1% solution)	7.0-9.5

Stability and Storage:

Store in dry, airtight container.

Incompatibilities:

Cationic surfactants; oxidizing agents.

Safety:

Safe in low conc.; irritant in high/excessive use. [21]

PEPPERMINT OIL

Non Proprietary name

Table No 3.7 Non Proprietary name

Standard	Name
BP	Oleum MenthaePiperitae
PhEur	Menthaepiperitacacetheroleum
USP	Peppermint oil

Synonyms:-

Menthapiperita oil; Oil of Peppermint

Chemical Name and CAS Registry Number:

Mentapiperita, ext. - (8006-90-4)

Empirical Formula and Molecular Weight:

, Structural Formula:

Mainly menthol (C₁₀H₂₀O, MW 156.27) and

menthone (C₁₀H₁₈O, MW 154.25)

Mixture - primarVeimenthol and menthone

¢ Functional Category:

maroning gent, coonng agents. 10umicrobial+21 *

Applications:

Taste masking in chewables, syrups, lozenges.

Mild anesthetic in topical applications.

Enhances patient compliance.

Description:

Pale yellow oil, strong peppermint odor. Insoluble in water.

Store in light-resistant containers. Protect from heat and air.

/ Incompatibilities:

Oxidizing agents; may react with plastic packaging.

Safety:

Safe in low concentrations. May irritate sensitive individuals or children in high doses[23]

Water (q.s.)

Non Proprietary name

Table No 3.8 Non Proprietary name

standard	Name
BP	Purified water
JP	Purified water
PhEur	Aqua purificatae
USP	Purified water

Synonyms:

Distilled water, Aqua; Deionized water

Chemical Name and CAS Registry Number:

Water — (7732-18-5)

Empirical Formula and Molecular Weight:

H:O and 18.02 g/mol

→ Structural Formula:

H-O-H

+ Functional Category:

Solvent; Vehicle; Processing aid[24] Applications:

solvent for solutions/suspensio * Universal ns.

Used in granulation, tablet coating, sterile prep.

Dispersing medium.

Description:

Clear, colorless, odorless liquid.

Stability and Storage:

Use quickly; risk of microbial growth.

PHYSICOCHEMICAL PROPERTIES

Table No 3.9 physical properties

Property	Value
pH	5.0-7.0
Conductivity	<1.3 S/cm
Melting point	0° C
Boiling point	100° C

Incompatibilities:

Moisture-sensitive APIs. ÷ Safety:

Safe and non-toxic. [25]

4. MATERIAL AND METHOD**Material**

Neem powder

Clove powder

Turmeric powder

Baking soda

Common salt (Sodium chloride)

Coconut oil

Peppermint oil

Sodium Lauryl Sulfate (SLS)

Water (q.s.)

Methodology**Preparation of Ingredients**

Neem leaves were collected washed with clean water, shade-dried for 5-7 days, and ground into a fine powder.

Clove and turmeric powders were obtained directly or freshly prepared by grinding dry cloves and turmeric rhizomes.

Baking soda, salt, coconut oil, peppermint oil, and SLS were used as received.

Formulation Procedure**Powder Mixing:**

Accurately weigh neem powder, clove powder, turmeric powder, baking soda, and salt.

Transfer all powders into a clean mortar and pestle and mix uniformly for about 10 minutes.

Preparation of Premix:

Dissolve Sodium Lauryl Sulfate (SLS) in about 5 mL of water separately to form a foaming premix.

Wet Mixing:

Gradually add 10 mL coconut oil into the dry powder mix while continuously stirring with a glass rod to form a smooth paste.

Addition of SLS Solution:

Slowly add the prepared SLS solution into the paste with continuous mixing to avoid lump formation

Adjustment of Consistency:

Add small quantities of water (q.s.) drop by drop to adjust the paste to a smooth and spreadable consistency.

Flavoring:

Finally, add 2 mL peppermint oil to the paste to improve taste and freshness. Stir thoroughly to ensure uniform distribution.

Packaging:

Transfer the prepared toothpaste into clean, labeled containers and store in a cool, dry place.[29]

Table No. 4. 1 Formulation Table

Category	Ingredient	Batch 1 (g)	Batch 2 (g)	Batch 3 (g)
Active Ingredients	Neem Powder	3.2 g	2.4 g	2 g
	Clove Powder	1.6 g	2 g	2.4 g
	Turmeric Powder	1.2 g	1.6 g	1.6 g
Cleaning Agents	Baking Soda	10 g	12 g	11.2 g
	Salt	2 g	1.6 g	2 g
Base & Binding	Coconut Oil	12 g	11.2 g	12 g
	Water (q.s.)	Adjust	Adjust	Adjust
Foaming Agent	Sodium Lauryl Sulfate (SLS)	0.8 g	0.8 g	0.8 g
Flavoring	Peppermint Oil	0.8 g	0.8 g	0.8 g
Preservative	Neem Extract	0.4 g	0.4 g	0.4 g
Total		40 g	40 g	40 g

5. EVALUATION PARAMETERS

All three formulations (F1, F2, and F3) were evaluated individually, and the results obtained are noted below. The methods of evaluation are represented below.

1. pH

A sample quantity of 5 g was weighed precisely and placed in 45 ml of distilled water in a 150 ml beaker. It was then boiled for some time at 27°C and allowed to cool. More distilled water was added to make the suspension, which was then thoroughly swirled.

The pH of the suspension was measured using a digital pH meter after calibrating the meter with distilled water. The pH was recorded after 5 minutes of measurement.

2. Physical

Examination:

(Colour, Odour, Taste, And Smoothness)

Colour: The formulation's colour was examined and visually verified.

Odour: The odour of the toothpaste was assessed by smelling the material and identifying its characteristic smell.

Taste: The taste was checked manually by applying a small amount of the formulation to the finger and brushing or placing it on the teeth.

Smoothness: The smoothness was tested by taking the material in hand and rubbing it between fingers.spreading on the finger to confirm the spreading paste formulation.[30]

3. Foamability

The foamability of formulated toothpaste was evaluated by taking 2.0 g of formulation in 50 ml water in measuring cylinder, initial volume was noted and then shaken for 10 minutes.

Final volume of foam was noted.

4. Anti-bacterial

Activity of Formulation

Antibacterial activity of the formulated paste was performed by the disc diffusion method in triplicate using Muller Hinton Agar media with Staphylococcus aureus strain. The formulated paste was placed on the bacterial plates and incubated at 37 °C for 24 hours, with ciprofloxacin HCl as the positive control. The diameter of the zone of inhibition was measured in millimeters.[31]

5. Spreadability

Spreadability of the toothpaste determines how easily it spreads under slight pressure. A good spreadability ensures easy application on the toothbrush and uniform distribution during brushing.

6. Homogeneity

The toothpaste shall extrude a homogeneous mass from the collapsible tube by applying normal force.

7. Smoothness

Water in the toothpaste helps to get a nice, smooth paste when you squeeze the tube Humectants are the ingredients that keep your toothpaste from drying out and becoming crumbly.[32]

6. RESULT:**1.pH Value**

Table no.: 6.1:- pH Value

Formulation	pH
1	8.2
2	8.0
3	7.5

2.Physical Parameter

Table no.: 6.2:- Physical Parameter

Parameter	Formulation 1	Formulation 2	Formulation 3
Colour	Light green	Light green	Light green
odor	Aromatic	Aromatic	Aromatic
Taste	Little sweet	Little sweet	Little sweet
Smoothness	smooth	smooth	smooth

3.Foamability

Table no.:6.3:- Foamability

Formulation	Volume of Foam
1	50ml
2	45ml
3	40ml

4. Antibacterial Assay

Table no.:6.4:- Antibacterial Assay

Formulation	Zone of inhibition
1	14mm
2	12mm
3	16mm

5.Spreadability

Table no.: 6.5:- Spreadability

Formulation	Spread Daimeter
1	9mm
2	6mm
3	8mm

6.Homogeneity

Table no.: 6.6:- Homogeneity

Formulation	Observation
1	Uniform.no lump
2	Slightlumps, FairlyUnifom
3	Smooth and uniform Mass

7. Smoothness

Table no.: 6.7:- Smoothness

Formulation	Observation
1	Very smooth Paste
2	Slight gritty texture
3	Externely smooth,cremy paste

7

. SUMMARY

The present study focuses on the formulation and evaluation of an herbal toothpaste using natural ingredients such as Neem, Clove, Turmeric, Baking Soda, Salt, Coconut Oil, and Peppermint Oil. These botanicals and naturally derived components were selected for their well-documented therapeutic properties, including antimicrobial, anti-inflammatory, analgesic, antioxidant, and astringent effects.

The project aimed to offer an effective, safe, and eco-friendly alternative to commercial toothpaste formulations that often contain synthetic chemicals like fluoride and sodium lauryl sulfate (SLS), which can pose risks with prolonged use.

The formulated toothpaste underwent rigorous evaluation through various parameters, including pH, spreadability, foamability, texture, and antimicrobial activity

The herbal toothpaste was prepared by accurately measuring and blending both powdered herbs and liquid excipients, including Coconut Oil and Peppermint Oil, with additional ingredients like Baking Soda and Salt acting as natural abrasives. A small amount of Sodium Lauryl Sulfate (SLS) was included to enhance foaming without compromising safety. The formulation process ensured uniform consistency, stability, and sensory appeal.

Among the three formulations (F1, F2, F3), the results demonstrated that all variants maintained desirable physicochemical properties, with F3 showing the highest antibacterial activity against *E. coli*. The pH values of the formulations ranged from 7.5 to 8.2, ensuring compatibility with oral pH. The toothpaste also exhibited favorable foamability, spreadability, and moisture content, making it suitable for consumer use.

The project emphasizes the integration of traditional herbal knowledge with modern pharmaceutical techniques to promote sustainable, effective oral hygiene solutions.

The study concluded that herbal toothpaste can serve as a potent and environmentally responsible

alternative for daily dental care, aligning with current trends in natural health and wellness.

8. CONCLUSION:

The formulation and evaluation of the herbal toothpaste demonstrated that natural ingredients such as Neem, Clove, and Turmeric can be effectively combined with other supportive components like Baking Soda, Salt, Coconut Oil, and Peppermint Oil to create a safe and efficacious oral hygiene product. The study successfully developed three different formulations, all of which exhibited favorable physicochemical properties and significant antimicrobial activity.

Among the tested samples, Formulation 3 showed the highest antibacterial activity, indicating the potential of herbal ingredients in combating oral pathogens such as *E. coli*. The pH, spreadability, foamability, and consistency of all formulations were within acceptable ranges, highlighting their stability and user-friendly characteristics.

This research supports the use of herbal-based oral care products as a natural and eco-friendly alternative to commercial toothpastes containing synthetic chemicals. The results validate the therapeutic potential of traditional medicinal plants in maintaining oral health and offer a foundation for further development and commercialization of herbal dental formulations.

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