

Formulation and Evaluation of Golden Heart's Toothpaste of *Piper betel*

Pratik C. Shirsath¹, Sangita P. Shirsath¹, Bhupendra Mahale², Akshata M. Girase^{2,*}, Neha R. Jaiswal³

Abstract

Toothpaste is a multifunctional oral care product composed of abrasives, surfactants, fluoride-based anticaries agents, and pH buffers. Herbal toothpaste formulations have gained significant attention for the treatment of gingivitis, an inflammatory disease of the gums. Generally, toothpaste formulations maintain a pH range of 5–6 to ensure stability and compatibility with the oral environment. Traditional medicinal plants have long been used by communities for oral healthcare due to their antimicrobial and anti-inflammatory activities, supporting their incorporation into modern herbal toothpaste formulations. The herbal toothpastes formulated which can satisfy all required conditions to keep the mouth fresh and prevent the tooth decay by bacteria. During our physical or chemical characteristics of all the formulation with the range have pH, viscosity, spreadability. Periodontal disease is primarily caused by infection and inflammation of the gums and supporting tissues of the teeth. The formulated herbal product was greenish in color, smooth in texture, and had a pH range of 5–6. Physical evaluation indicated good stability, and the formulation showed promising potential in the control of dental plaque and gingivitis.

Keywords: Toothpaste, extraction oil, gingivitis, herbal ingredients, dental caries

INTRODUCTION

Toothpaste has been an essential part of oral hygiene for centuries and remains one of the most important products for maintaining healthy teeth and gums. The earliest toothpaste formulations are believed to have originated in ancient China and India between 300 and 500 BC. These early preparations were developed to clean teeth, freshen breath, and promote overall oral health, laying the foundation for the modern toothpastes used today. People used crushed bones, ground-up eggs, and clam shells as abrasives to clean their teeth back then. In the 19th century, modern toothpastes were made. Later, those mixtures were made with chalk and soap.

After 1945, significant advancements were made in toothpaste formulations. One of the major developments was the incorporation of improved detergent systems, including the use of sodium lauryl sulfate (SLS) as a surfactant and foaming agent. This ingredient helped enhance the cleaning efficiency of toothpaste by improving the removal of food debris and plaque, resulting in better oral hygiene and a more pleasant brushing experience.

In the past few years, there has been more focus on releasing active ingredients during the development of formulations to stop and/or treat oral illness. Toothpaste is a type of dentifrice that cleans, protects, and makes teeth healthier. Toothpaste is mostly used to keep your mouth clean. It also

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works as an abrasive to keep plaque and food particles from sticking to your teeth, helps get rid of bad breath, and releases active ingredients, like fluoride, to help stop tooth and gum disease (like gingivitis).

Toothpastes are made up of a lot of different things, including abrasives and surfactants, fluoride to fight cavities, ingredients to control tartar, pH buffers, humectants to keep the mouth from drying out and make it feel good, and binders to give the paste a consistent shape. Binders keep the solid part of the toothpaste from separating from the liquid part by keeping them both in the same place. They also add body to the dentifrice, especially after it comes out of the tube and onto the toothbrush. It is the duty of the oral care professional to comprehend the components in toothpaste and to guide patients towards various products according to their specific requirements [1].

The chemical agent that could replace patient-dependent mechanical plaque control and reduce and prevent oral disease. Self-performed mechanical plaque removal is one of the most common ways to get rid of plaque and gingivitis. It takes a lot of time to control plaque mechanically, and some people may not be motivated to do these things. Plants have been good for oral health for thousands of years all over the world because of their healing properties. Traditional medicine has more benefits than problems like allergies. There is a stronger link between tartar, calculus, and periodontal disease.

The extract is used in different ways, such as Neem – Antibacterial, Guava – Anti-inflammatory, Babul – Astringent, Kalmi – Flavoring agent, and other ingredients like Camphor – Antiseptics, Honey – Sweetening agent, Glycerin – Humectant, CalCarbonate – Abrasive, SLS – Detergent, and sodium chloride and distilled water. The goal of the study was to compare the effectiveness of an herbal-based product with that of a conventionally marketed formulated toothpaste, assessing various parameters such as color, spreadability, foamability, extrudability, and antibacterial activity. However, there is a way to make a formula for making herbal dental products that are good for the environment [2]. People have been using toothpaste since 5,000 B.C. Back then, the Egyptians and Greeks used toothpaste to clean their teeth, but the ingredients were different from what we use today. To help combat bad breath, the Romans enhanced their toothpaste by adding fragrant herbs and finely powdered charcoal. These ingredients were believed to freshen the breath and improve oral hygiene, making toothpaste more effective for daily dental care. To make toothpaste, the Chinese used salt, herbs that smelled good, and ginseng.

The toothpaste changed little by little. In the 1800s, toothpaste was made of plaster and soap and was powdered. The jar was filled with toothpaste in 1850. In 1873, Colgate began making toothpaste in jars on a large scale. In 1890, he started making toothpaste in tubes. At first, soap powder was used to make toothpaste, but by 1945, it had been replaced with sodium Laureth sulfate, which made the toothpaste soft and doughy. During the early 20th century, toothpaste began to be manufactured on an industrial scale, making it more widely available to the public. In 1914, fluoride was introduced into toothpaste formulations, marking a significant advancement in oral health by helping to prevent tooth decay. Over time, toothpaste formulations have evolved considerably. Today, a wide variety of soft toothpaste products are available, each designed to address specific oral care needs, including teeth whitening, cavity prevention, gum disease management, plaque control, and the reduction of bad breath [3].

The main objective of brushing teeth with a dentifrice (from the Latin dens – tooth, and fricare – to rub) is to remove dental plaque, stains, and leftover food particles from the surfaces of teeth. The practice of cleaning teeth with dentifrices has a history spanning over 2000 years, while the use of toothbrushes and picks is even older. Abrasive materials in dentifrices became essential when it was discovered that brushes, although effective at removing softer deposits, were insufficient for eliminating harder stains and deposits. Dentifrices come in various forms, including powders, pastes, and gels, with pastes and gels being the most widely used, amounting to over 5 billion tubes consumed globally each year. Numerous studies indicate that toothpaste plays a crucial role in effectively eliminating dental plaque, which is the primary contributor to dental caries and periodontal diseases. In addition to directly facilitating the cleaning of teeth, toothpaste arguably serves its most significant purpose by motivating

individuals to maintain their oral hygiene. In many developed countries, people predominantly use toothpaste for aesthetic reasons. Recent advancements in toothpaste formulation have introduced various agents that offer both therapeutic and cosmetic advantages. Regular use of modern toothpaste plays an important role in maintaining oral health. It helps prevent the development of dental caries (tooth decay) and reduces the accumulation and reformation of dental plaque, thereby contributing to healthier teeth and gums. The precise makeup of a specific toothpaste differs among manufacturers, but a usual formula includes 10–40% abrasive, 20–70% humectant, 5–30% water, 1–2% binder, 1–3% detergent, 1–2% flavor, 0.05–0.5% preservative, and 0.1–0.5% therapeutic agent [4].

Nature continues to serve as a powerful example of the remarkable phenomenon of symbiosis, while also acting as a vast reservoir of medicinal resources for treating human diseases. For many years, a wide range of medicinal plants have been utilized in traditional healthcare systems, where they function as natural health promoters. According to the World Health Organization, nearly 80% of the population depends on plant-based medicines for primary healthcare needs. Despite the existence of approximately 350,000 plant species, less than 0.5% have been thoroughly evaluated for their pharmacological and phytochemical properties. In contrast, synthetic chemicals used in mouthwashes and toothpastes may lead to undesirable side effects such as altered taste, staining of teeth, and hypersensitivity reactions. The use of natural ingredients that are free from artificial sweeteners, fragrances, and preservatives is considered safer for the buccal cavity and helps avoid potential harm. Neutrophils are specialized white blood cells that play a crucial role in the body's immune defense. They circulate throughout the bloodstream and rapidly move to areas of infection or injury, where they help destroy invading microorganisms and protect the body from infection.

The concentration of these cells in gingival exudate reflects the severity of inflammation; therefore, their number in the gingival sulcus increases during gingivitis. Additionally, children under six years of age are advised to avoid fluoride-containing toothpaste, as it may lead to dental caries and fluorosis. Considering these factors, there is growing emphasis on the use of herbal dentifrices, which are associated with fewer adverse effects [5].

TYPES OF TOOTHPASTES

- Liquid.
- Jelly.
- Pastry.
- Powder.

MODERN-DAY TOOTHPASTE INGREDIENTS

- Abrasives are a key component of toothpaste formulations. Their concentration must be carefully controlled, as excessive abrasiveness can lead to tooth sensitivity and enamel damage, while insufficient levels may result in ineffective cleaning of the teeth.
- 2 Applying flavors and fresh enter inside the toothpaste.
- Using soap, which produces foam and more effortless brushing movement on the teeth.
- Applying the Color inside the toothpaste.
- Using glycerin to make the toothpaste past enough.
- Use of drugs such as hexachlorophene, fluoride, and chlorophyll [3].

Oral infections are among the most prevalent types of infections. Dental caries, a contagious condition, leads to the deterioration and infection of enamel and dentin. If left untreated, the condition can progressively worsen over time, leading to severe damage to the supporting structures of the teeth and, eventually, tooth loss. The oral cavity normally contains a variety of microorganisms, including opportunistic bacteria that are generally harmless under balanced conditions. However, when this natural balance is disrupted, harmful microorganisms can multiply, increasing the risk of oral infections and the development of tooth decay.

Streptococcus mutans is recognized as the primary microorganism responsible for dental caries, as it produces acids through the fermentation of carbohydrates, contributing to the demineralization of teeth.

Oral hygiene products, including toothpaste, toothbrushes, and mouthwashes, often contain antimicrobial agents that help control the growth of harmful microorganisms and promote good oral health. The use of such products has a long history, dating back to ancient civilizations, and they continue to play an essential role in modern oral care practices. Toothpaste, a gel or paste dentifrice used along with a toothbrush, plays a vital role in daily oral care by cleaning teeth and supporting overall dental health.

Dental caries has become a major global health concern, primarily due to the formation of dental plaque, which contributes to various oral diseases. It leads to the gradual destruction of the outer tooth structure, including enamel erosion, caused by acids produced during the metabolic activity of cariogenic bacteria acting on food residues in the mouth. Since teeth are essential for proper digestion, poor oral health can result in digestive issues and malnutrition. Therefore, controlling the activity of cariogenic microorganisms is crucial to prevent dental diseases. Microorganisms – such as *Streptococcus mutans*, *Staphylococcus aureus*, *Streptococcus mitis*, and *Candida albicans* – are commonly associated with dental infections [6].

Physiology of Teeth

Humans develop two successive sets of teeth during their lifetime: the primary (deciduous) dentition and the permanent dentition. The primary dentition consists of 20 teeth, with 10 located in the upper jaw (maxillary arch) and 10 in the lower jaw (mandibular arch). As a child grows, these primary teeth gradually exfoliate and are replaced by the permanent dentition. The permanent set comprises 32 teeth, including 16 teeth in the maxillary arch and 16 in the mandibular arch, and is designed to serve throughout adulthood.

HUMAN TEETH CLASSES: FORM AND FUNCTION

Based on their shape and function, human teeth are divided into several classes. Both primary and permanent dentitions include incisors, canines, and molars, while premolars are present only in the permanent set. The shape of each tooth determines its function, and specific features, known as class traits, help classify teeth into their functional groups. Since humans consume both plant and animal-based foods, their dentition is described as omnivorous.

Incisors

Incisors are positioned at the front of the oral cavity and primarily serve to cut or shear food (Figure 1). When viewed from the proximal aspect, their crowns appear roughly triangular, featuring a narrow incisal edge and a broader cervical region. During mastication, they play a key role in slicing food. In addition to their functional importance, incisors contribute significantly to the aesthetics of the smile, support of facial soft tissues, such as the lips, and proper speech articulation.

Canines

Canine teeth are located at the corners of the dental arches and have the longest roots of any tooth. They are crucial for holding, penetrating, tearing, and chopping food. When viewed from the side (proximal view), the crown appears triangular and features a thick incisal ridge. Because of their strong crown structure and long roots, canines provide excellent support and stability for both fixed and removable dental prostheses. In addition to their functional role, canines are essential in guiding proper occlusion due to their firm anchorage and strategic position in the dental arch. They also contribute significantly to facial aesthetics by supporting the lips and, along with the incisors, enhancing the appearance of the smile.

Premolars

Premolars play a versatile role in the mouth, combining the functions of both canines and molars. They help tear food, like canines, and also grind it, like molars, making them essential for efficient

chewing. The first premolars usually have a more pointed, angular appearance, with outer (facial) cusps that resemble canines. In contrast, the inner (lingual) cusps of upper premolars and molars are smoother and more rounded. Their chewing surfaces are not flat but shaped with natural curves – both dips (concavities) and raised areas (convexities). These features are important for proper biting and should be maintained throughout life to ensure effective chewing and healthy tooth contact. Even though premolars are less noticeable than the front teeth, they still contribute to the overall look of the smile and play a subtle but important role in dental aesthetics.

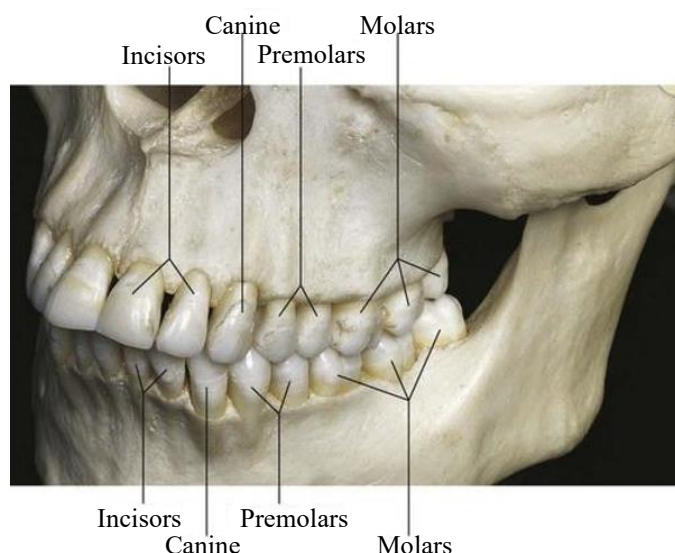


Figure 1. Maxillary and mandibular teeth in maximum inter carpal position.

Molars

Molars are large, multi-cusped teeth that are firmly anchored in the jaw and located close to the temporomandibular joint (TMJ), which acts as a pivot during chewing. Their primary job is to break down food into smaller, easier-to-swallow pieces by crushing and grinding it. They are well adapted for this role because of their wide chewing (occlusal) surfaces and strong support within the jaw. Together with premolars, molars play a vital role in efficient chewing and maintaining proper function of the teeth [7].

The classes of teeth are incisors, canines, premolars, and molars. Cusps of mandibular (lower) teeth are one-half cusp width anterior to the corresponding cusps of the maxillary (upper) teeth (arch).

STRUCTURES OF TEETH

Teeth are made up of three main parts: enamel, the pulp–dentin complex, and cementum (Figure 2). Each of these components has its own structure and function, and they will be explained individually.

1, enamel; 1a, gnarled enamel; 2, dentin; 3a, pulp chamber; 3b, pulp horn; 3c, pulp canal; 4, apical foramen; 5, cementum; 6, periodontal fibers in the periodontal ligament; 7, alveolar bone; 8, maxillary sinus; 9, mucosa; 10, submucosa; 11, blood vessels; 12, gingiva; 13, lines of Retzius; 14, dentine name junction.

Enamel

Enamel is formed through a process called amelogenesis, which is carried out by specialized cells known as ameloblasts. One of the embryonic germ layers, the ectoderm, is the source of these cells. The tooth's anatomical crown is covered in enamel, which varies in thickness depending on the location. It is firmly attached to the underlying dentin at the dentinoenamel junction (DEJ) (Figure 2). The enamel layer is thickest at the incisal edges and occlusal (chewing) surfaces of the crown, where it needs to

withstand the most force. As it extends toward the cemento-enamel junction (CEJ), near the neck of the tooth, it gradually becomes thinner. The thickness of enamel also differs among various types of teeth. It is typically 2 mm at the incisal edge of incisors, 2.3 to 2.5 mm at the premolar cusps, and 2.5 to 3 mm at the molar cusps. The cusps on the chewing (occlusal) surfaces of posterior teeth develop from separate centers of formation, which grow into structures called developmental lobes. As these lobes enlarge, they gradually come together and fuse. During this process, grooves and fossae are formed in the areas where the lobes join.

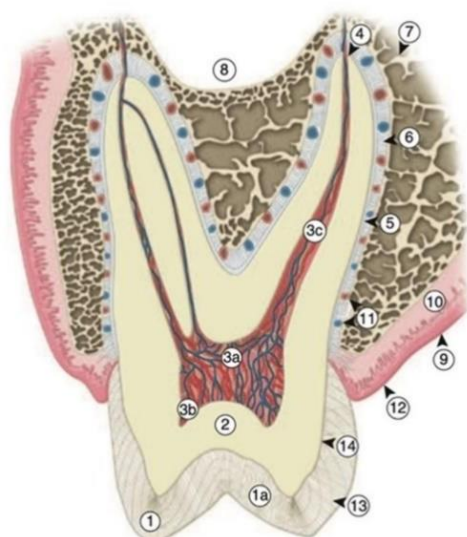


Figure 2. Cross section of the maxillary molar and its supporting structures.

These grooves and fossae are not random – they are positioned in a way that works efficiently with the opposing teeth. This arrangement helps guide food toward the cheek (facial) and tongue (lingual) sides during chewing. Functional cusps from opposing teeth fit against these grooves or fossae, making contact along the inclined surfaces of the enamel rather than directly in the deepest part of the groove, ensuring smooth and effective mastication. This arrangement creates a V-shaped space between a cusp and its opposing groove, allowing food to escape easily during chewing (Figure 2). The thickness of enamel in these areas can vary and may even become extremely thin, depending on how well the adjacent developmental lobes have fused together.

If this fusion (coalescence) is incomplete or weak, it can lead to the formation of a deep narrow defect in the groove area, known as a fissure. Similarly, when there is no proper enamel formation at the deepest part of a fossa, it is called a pit. As mentioned earlier, the cusps on the chewing surfaces of posterior teeth develop from separate centers that grow into developmental lobes. These lobes gradually enlarge and fuse with each other, and the areas where they join give rise to grooves and fossae as the cusps fully form (Figures 3 & 4) [7–10].

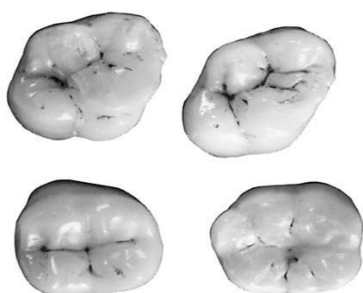


Figure 3. Occlusal surfaces of maxillary and mandibular first and second molar after several years of use, showing rounded curved surfaces and minimal wear.

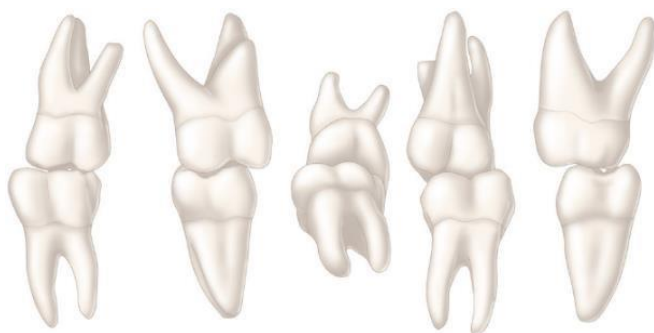


Figure 4. Maxillary and mandibular first molars in maximum intercausal contact. Note the grooves for escape of food.

TOOTHPASTE USE IN ADULTS AND CHILDREN

Advertisements for toothpaste in the 1940s frequently featured a toothbrush that was entirely coated in toothpaste. This gave the impression that a lot was required for thorough cleaning. But we now see that this goes much beyond what is required.

Dental professionals advise brushing twice a day and using fluoride toothpaste to help prevent cavities and other dental issues. Adults may efficiently clean their teeth with just a pea-sized amount of toothpaste each time they brush. In reality, many people tend to use more toothpaste than required, and using the correct amount can make a tube last much longer.

For children, the guidelines are even more careful. Parents should consult a dental professional to decide the appropriate use of toothpaste based on the child's risk of tooth decay. For children aged 3 years and under, brushing should be done by an adult to ensure safety and to prevent them from swallowing too much fluoridated toothpaste.

If a child is not at risk for tooth decay, dental guidelines suggest brushing their teeth with just a toothbrush moistened with water – without toothpaste. For children between the ages of 3 and 6, brushing should always be supervised, especially when toothpaste is used, and this supervision should continue until the child develops good control and brushing skills.

At this age, only a very small amount of toothpaste – less than a pea-sized amount – is recommended. Both children and adults should use fluoridated toothpaste in moderation. This helps reduce the risk of dental fluorosis while still providing the protective benefits of fluoride. Dental fluorosis is not a disease and does not weaken the teeth. However, it may cause mild changes in appearance such as faint white streaks or slight discoloration. In most cases, these changes are very subtle and are usually only noticeable to a dental professional.

Different Types of Toothpastes

Fluoridated Toothpaste

This is the most used type of toothpaste, and it's likely the one you already have at home. In fact, it accounts for over 90% of all toothpaste sales. It is highly effective in protecting against tooth decay and cavities.

Because it contains fluoride, this type of toothpaste not only strengthens the enamel but also helps repair early stages of tooth decay by remineralizing the affected areas.

Herbal Toothpaste

If you prefer to avoid too many chemicals in your toothpaste, you might consider a more natural option like herbal toothpaste. These are often a better choice for people who are sensitive to certain additives, as they usually contain fewer synthetic ingredients compared to regular toothpaste.

Herbal toothpastes are made from natural ingredients and are generally biodegradable, making them more environmentally friendly. However, if you choose this type, it's important to pick one that still contains a small amount of fluoride. Completely fluoride-free toothpaste may not provide enough protection against tooth decay.

Toothpaste with Sensitivity

Consider a more natural alternative, such as herbal toothpaste, if you would rather not have too many chemicals in your toothpaste. Because they typically contain fewer synthetic compounds than traditional toothpaste, these are frequently better options for those who are sensitive to particular additives.

Herbal toothpastes are more ecologically friendly because they are composed of natural ingredients and are typically biodegradable. However, if you choose this type, it is important to pick one that still contains a small amount of fluoride. Completely fluoride-free toothpaste may not provide enough protection against tooth decay.

Whitening Toothpaste

Many toothpastes available today include mild whitening agents designed for everyday use. They can help remove surface stains and gradually increase the brightness of your teeth, but they are not as effective as professional whitening procedures. These toothpastes usually contain fluoride along with certain enzyme or polishing compounds. However, they may sometimes increase tooth sensitivity, so they might not be the best choice for people who already have sensitive teeth.

Tartar Control Toothpaste

When tooth plaque is not promptly cleaned and solidifies, tartar develops. It can cause issues, like gum disease and tooth decay, if it accumulates. A professional dental cleaning is the most efficient technique to get rid of tartar.

Tartar-control toothpastes are available in stores, nevertheless. These have unique components that make it simpler to maintain improved oral health by lowering plaque accumulation and preventing it from solidifying into tartar.

Smokers Toothpaste

This type of toothpaste is specially formulated to deal with stains caused by frequent smoking. It contains stronger cleaning agents (abrasives) than regular fluoride toothpaste, which helps remove the dark stains that build up on teeth from tobacco use.

Children's Toothpaste

Children's toothpaste is usually formulated with a lower amount of fluoride to reduce the risk of excessive intake if swallowed. It also contains fewer abrasives, making it gentler on young, sensitive teeth. To encourage regular brushing, these toothpastes often come in fun and pleasant flavors that children enjoy.

A key component of maintaining proper oral hygiene is selecting the appropriate toothpaste. It is simpler to choose the type that best meets your needs once you are aware of the various options [8].

THE ADVANTAGES OF TOOTHPASTE

Gum disease and tooth decay are primarily caused by plaque. It can solidify the teeth and become tartar if it is not routinely removed, creating the perfect conditions for germs to proliferate.

Brushing your teeth correctly is the best approach to managing plaque. Practically speaking, toothpaste is not always required for cleaning; plaque can be successfully removed with a soft-bristled toothbrush and the right technique. This keeps your teeth healthy and clean when combined with frequent flossing, avoiding sugary foods and beverages, and routine dental examinations.

Why do we use toothpaste, then? because it provides more advantages than merely cleaning. Toothpaste lowers the chance of more severe dental issues by preventing cavities and tooth decay.

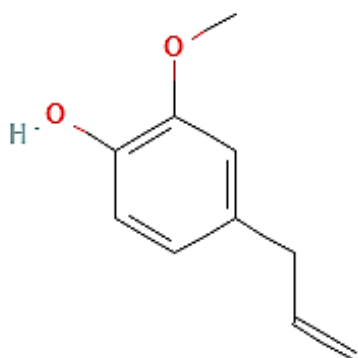
- It comes in a range of flavors, and after brushing, your breath will be pleasant, and your mouth will feel fresh. Additionally, it can help cover up strong culinary smells like those of onions or garlic.
- Most toothpastes contain fluoride, which fortifies tooth enamel and aids in preventing early decay, increasing teeth's resistance to cavities [9].

MATERIAL AND METHODOLOGY

Drug Profile

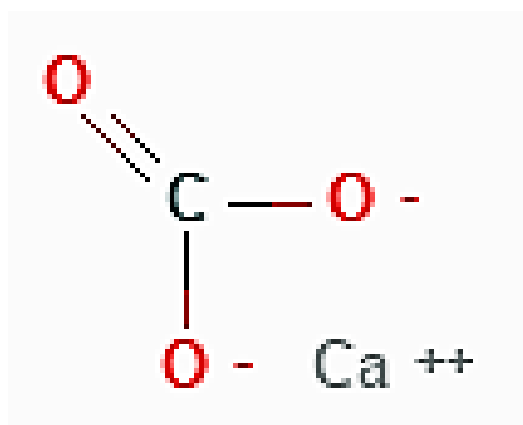
Eugenol [10]

- *Boiling Point*: 254°C.
- *Phytochemical Profile*: Structure.
- *IUPAC Name*: 2-methoxy-4-prop-2-enylphenol.
- *Molecular Formula*: C₁₀H₁₂O₂.
- *Molecular Weight*: 164.20.
- *Solubility*: Miscible with alcohol, chloroform, ether, oils.
- *Appearance*: Eugenol appears as clear colorless pale yellow or amber-colored liquid.
- *Storage*: Stored below +30°C.



Mechanism of Action

Eugenol relieve Spain inflammation through variety of mechanism and addition exerts stimulate or effects on cartilage matrix synthesis.



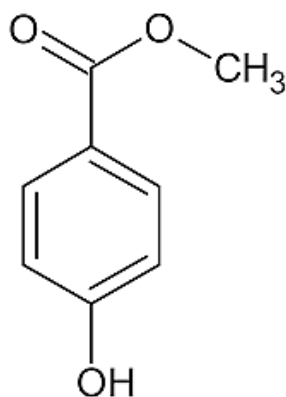
Calcium Carbonate [11]

- *Melting Point*: 825°C.
- *Synonym*: Calcite.

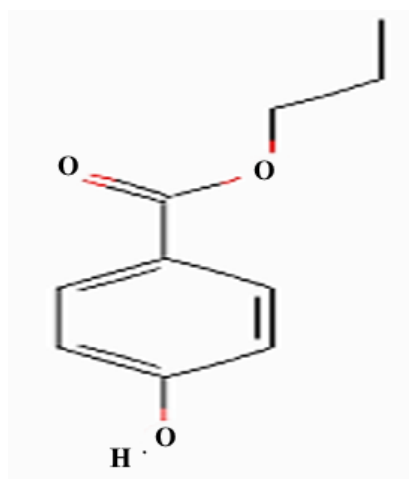
- *Phytochemical Profile:* Structure.
- *IUPAC Name:* Calcium Carbonate.
- *Molecular formula:* CaCO_3 .
- *Molecular Weight:* 100.09.
- *Solubility:* Soluble in water.
- *Appearance:* White, odorless powder.
- *Storage:* Store in a cool, dry place.

Methylparaben [12]

- *Melting Point:* 131.0°C.
- *Synonym:* Methyl 4-hydroxybenzoate.
- *Phytochemical Profile:* Structure.
- *IUPAC Name:* Methyl paraben.

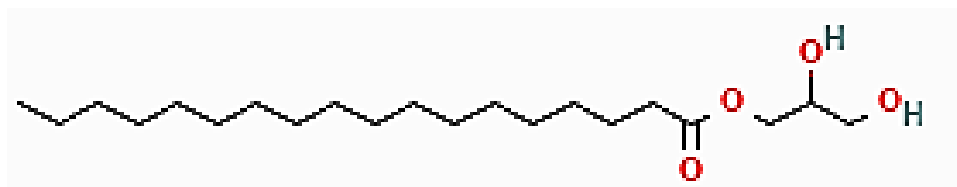


- *Molecular Formula:* $\text{C}_8\text{H}_8\text{O}_3$.
- *Molecular Weight:* 152.15.
- *Solubility:* Soluble in water.
- *Appearance:* Colorless crystals powder odorless or have faint characteristic odor.
- *Storage:* Store in a cool, dry place.

**Propyl Paraben** [13]

- *Melting Point:* 203 to 208°F.
- *Synonym:* Propyl 4-hydroxybenzoate.
- *Phytochemical Profile:* Structure.

- *IUPAC Name:* Propyl paraben.
- *Molecular Formula:* C₁₀H₁₂O₃.
- *Molecular Weight:* 180.20.
- *Solubility:* Soluble in water.
- *Appearance:* White crystals Odorless or has faint odor.
- *Storage:* Store in a cool, dry place.



Glyceryl Mono Stearate [14]

- *Melting Point:* 74.0°C.
- *Synonym:* Monostearin.
- *Phytochemical Profile:* Structure.
- *IUPAC Name:* Glyceryl monostearate.
- *Molecular Formula:* C₂₁H₄₂O₄.
- *Molecular Weight:* 358.6.
- *Solubility:* Insoluble in water.
- *Appearance:* Dry Powder White waxy solid.
- *Storage:* Store in a cool, dry place.

Sodium Chloride [15]

- *Melting Point:* 1474°F.
- *Synonym:* Salt.
- *Phytochemical Profile:* Structure.



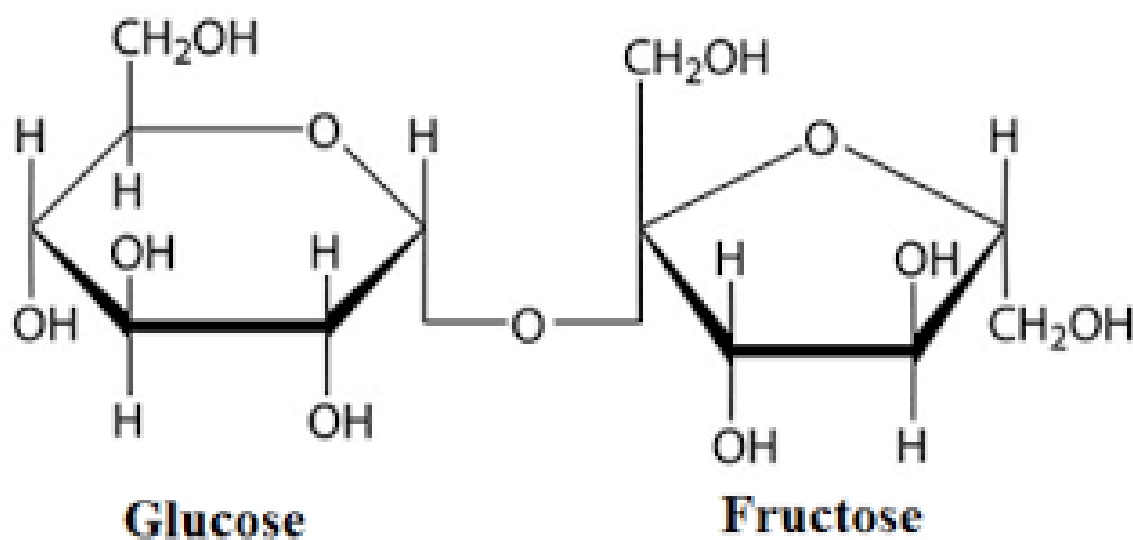
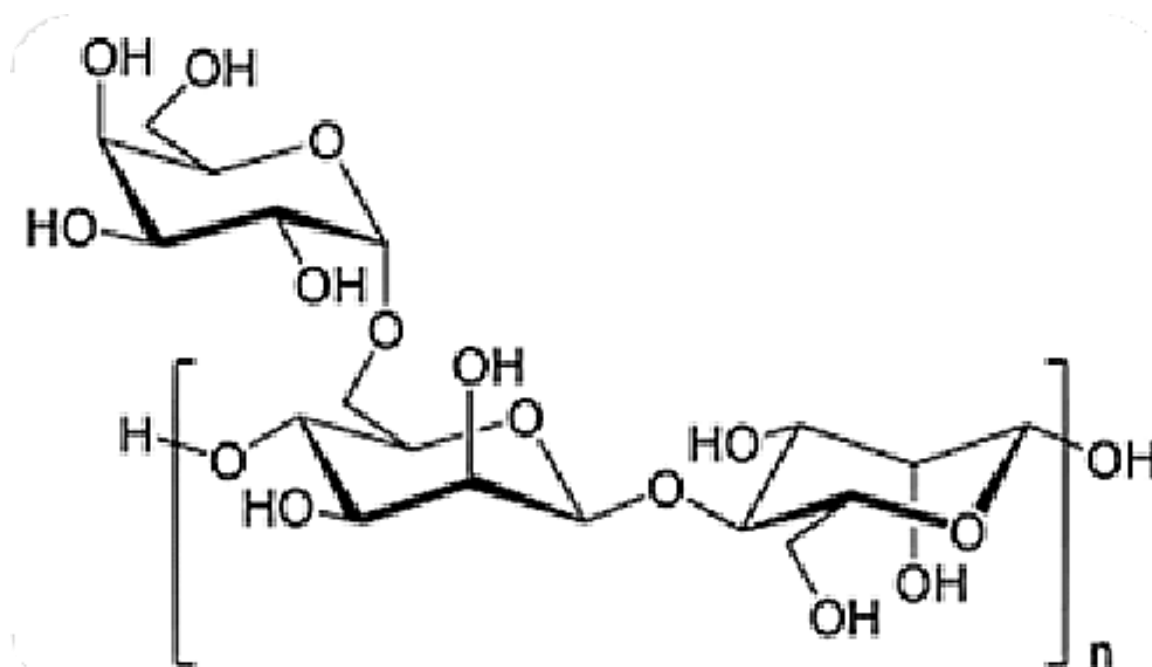
- *IUPAC Name:* Sodium Chloride.
- *Molecular Formula:* ClNa or NaCl.
- *Molecular Weight:* 58.44.
- *Solubility:* Soluble in water.
- *Appearance:* Colorless, transparent crystals or white.
- *Storage:* Store in a cool, dry place.

Gum acacia [16]

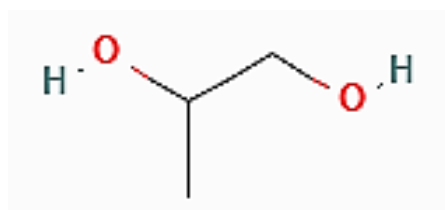
- *Melting Point:* 0–100°C.
- *Synonym:* Gum wood.
- *Phytochemical Profile:* Structure.
- *IUPAC-Name:* Sodium2-[(7-carboxyheptyl)-C-hydroxy carbonimidoyl] benzen-1-olate.
- *Molecular Formula:* C₁₂H₃₆.
- *Molecular Weight:* 180.41.
- *Solubility:* Soluble in hot water.
- *Appearance:* Odorless, glassy appearance.
- *Storage:* Store in a cool, dry place.

Propyl Glycol [17]

- *Melting Point*: -76°F .
- *Boiling Point*: 3.
- *Synonym*: 1,2-propanediol.



- *Phytochemical Profile*: Structure.
- *IUPAC Name*: Propane-1,2-diol.
- *Molecular Formula*: $\text{C}_3\text{H}_8\text{O}_2$.
- *Molecular Weight*: 76.09.
- *Solubility*: Soluble in water, ethanol, and acetone.
- *Appearance*: Clear, colorless, viscous liquid.
- *Storage*: Store in a dry, cool and well-ventilated place.



Sucrose [18]

- *Melting Point:* 320 to 367°F.
- *Synonym:* Cane sugar.
- *Phytochemical Profile:* Structure.
- *IUPAC Name:* Sucrose.
- *Molecular Formula:* C₁₂H₂₂O₁₁.
- *Molecular Weight:* 342.30.
- *Solubility:* Soluble in hot water.
- *Appearance:* Odorless crystalline masses.
- *Storage:* Store in a cool, dry place.

Rose [19]

- *Solubility:* Soluble in hot water.
- *Appearance:* Good fragrance pale red.
- *Storage:* Store in a cool & dry place.

Chemicals

All chemicals used were of analytical reagent grades (Tables 1 & 2).

Table 1. List of chemicals used and supplier.

S. N.	Chemicals	Suppliers
1	Calcium carbonate	Pune Chemicals.
2	Methylparaben	Pune Chemicals.
3	Propylparaben	Pune Chemicals.
4	Glycerol monostearate	Pune Chemicals.
5	Gum acacia	Pune Chemicals.
6	Sodium Chloride	Pune Chemicals.
7	Propylene glycol	Pune Chemicals.
8	Sucrose	Pune Chemicals.
9	Rose oil	Local Market.
10	<i>Piper betel</i> leaf	Local Market.

Equipments

Table 2. List of instruments used with manufacturers.

S. N.	Instrument	Source/manufacturer
1	UV-Visible Spectrophotometer	Systronics 2201, Ahmedabad.
2	Electronic Balance	Shimadzu, Japan.
3	Digital pH Meter	Shimadzu, Japan.
4	Heating mantle	Labtronics, India.
5	Electronic microscope	Remi, India.
6	Soxhlet apparatus	SpaceLab, Nasik, India.
7	Viscometer	Fungilab, India.

METHODS [20]**Preparation *Piper betel* Powder**

The “*Piper betel*” leaves are first purchased from a local market and thoroughly washed with tap water to remove any dirt or impurities. They are then spread out and left to dry at room temperature for about one week until completely moisture-free. A home mixer is used to grind the leaves into a fine powder when they have completely dried. This powdered material is then used for the extraction process (Figure 5).

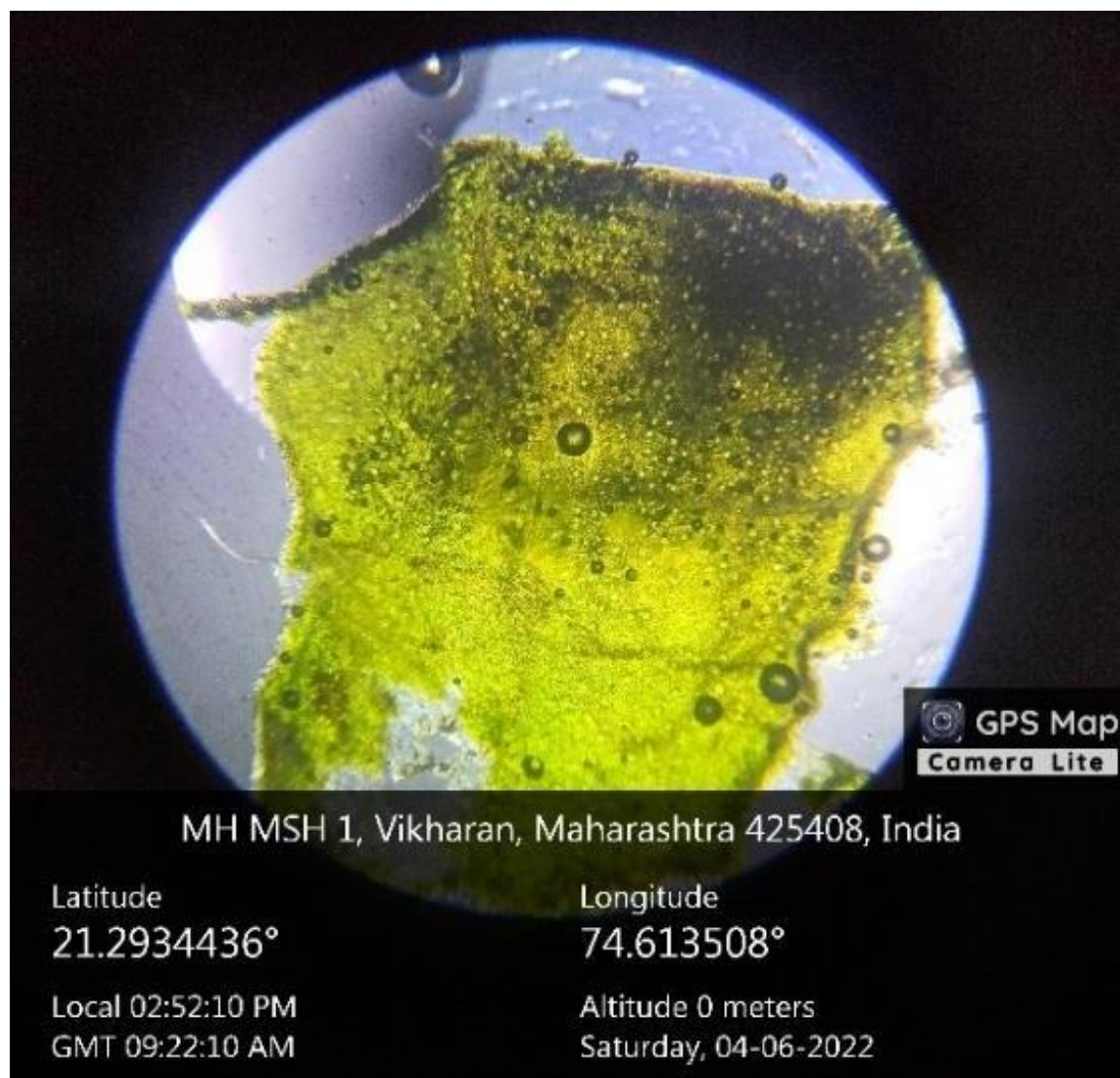


Figure 5. TS of *Piper betel* leaf.

Extraction Process***Soxhlet Extraction***

The drug was extracted using the Soxhlet extraction method. In this process, the dried powder of *Piper betel* leaves was first wrapped in filter paper and securely sealed. This wrapped sample was then placed inside a thimble, which was inserted into a reflux flask with a capacity of 250 ml. A suitable organic solvent, such as acetone, was used in the Soxhlet apparatus to carry out the extraction of eugenol. The system was allowed to run until sufficient extraction was achieved. Finally, the obtained extract was concentrated by heating it at a temperature of about 60–70°C using a heating mantle, resulting in a more concentrated form of the extract (Figure 6).



Figure 6. Soxhlet apparatus.

CHARACTERIZATION OF RAW MATERIALS

Test for Alkaloids

- *Mayer's Test:* Add a few drops of Mayer's reagent. To 1 ml of the extract, a yellowish Color or white ppt precepted was from indicated the presence of alkaloids
- *Drag end Orff's Test:* Add a few drops of Drag end Orff's reagent. To 2 ml of extract an orange red color was formed indicated the presence of alkaloids.
- *Wagner's Test:* Add few drops of Wagner reagent in 1 ml of extract a sample presence of brownish to yellow color precipitate.
- *Marine's Test:* In 1 ml extract add few drops of reagent. Then the sample presence whitish yellow ppt occurred.

Test for Flavonoids

One drop of concentrated HCl (hydrochloric acid) were added to little amount of extract NaOH were added a yellow color at ion in dictates the presence of flavonoid [21].

Piper betel Leaf:

- *Common Name:* *Piper betel*.
- *Binomial Name:* *Piper betel* L.
- *Family:* Piperaceae.
- *Origin:* Malaysia.
- *Kingdom:* Plantae.
- *Order:* Piperales.
- *Genus:* Piper.
- *Species:* Betel.
- Trans verse section of leaves.

Preparation for Toothpaste [22]

The required quantities of all ingredients were accurately weighed and placed in a mortar. Components – such as glyceryl monostearate, methyl paraben, propyl paraben, sucrose, glycerin, sodium chloride, sodium hydroxide, and benzoic acid – were then combined and mixed properly. Acacia was added to the mixture as a stabilizing agent.

Water was gradually added drop by drop to the mortar containing all the ingredients, and the mixture was triturated thoroughly until a smooth paste-like consistency was obtained. The composition of the formulation, including the plant extract, is presented in Table 3.

Table 3. Formulation and composition toothpaste.

Formulation code	F1	F2	F3
Calcium carbonate	15 g	20 g	25 g
Methyl Paraben	0.015 mg	0.015 mg	0.015 mg
Propyl paraben	0.018 g	0.018 g	0.018 g
Glycerol monostearate	0.2 g	0.3 g	0.4 g
Gum acacia	0.5 g	0.6 g	0.7 g
Sodium chloride	0.5 g	0.6 g	0.7 g
Propyl glycol	0.18 g	0.19 g	0.20 g
Sucrose	0.5 mg	0.5 mg	0.5 mg
Rose oil	0.03	0.03	0.03
<i>Piper betel</i> leaf (extracted eugenol)	1 ml	2 ml	3 ml
Water	q.s	q.s	q.s

Characterization of Toothpaste: Physical Appearance

- *Color*: Color of the prepared toothpaste was evaluated for its Color. The Color was checked visually.
- *Odor*: Odor was found by smelling the product.
- *Taste*: Taste was checked manually by tasting the product
- *Determining pH*: Put 1 gram of toothpaste and 10 milliliters of freshly boiled and cooled water (at 27 degrees Celsius) in a 150 milliliter beaker.

To create a complete suspension, thoroughly stir. used a digital pH meter to determine the suspension's pH in five minutes.

- *The Capacity to Foam*: A tiny amount of the preparation was combined with water in a measuring cylinder to assess the product's capacity to foam. The mixture was shaken ten times after the initial volume was noted. After that, the foam's final volume was measured and recorded.
- *Viscosity Determination*: Viscosities of the formulated toothpaste were determined using rotational Viscometer.
- *Spread Ability*: The spreadability of the formulations was evaluated using an apparatus based on the method suggested by Mutimer, which was fabricated in the laboratory for this purpose. The setup consisted of a wooden block with a fixed glass slide and a movable glass slide. One end of the movable slide was connected to a weight pan through a pulley system, allowing it to move horizontally along the level of the fixed slide.

RESULT AND DISCUSSION**Drug**

- *Authentication*:
- *Appearance*: Appearance of the Drug is pale yellow greenish oily liquid.
- *Color*: Yellow Greenish.
- *Boiling Point*: BP –254°C.
- *Melting Point*: MP –7.5.

Characterization of Raw Materials**Test for Alkaloids Mayer's Test**

Add a few drops of Mayer's reagent. To 1 ml of the extract, a yellowish color or white ppt precepted was from indicated the presence of alkaloids.

Drag End Orff's Test

Add a few drops of Dragendorff's reagent. To 2 ml of extract an orange red color was formed indicated the presence of alkaloids.

Wagner's Test

Add few drops of Wagner reagent in 1 ml of extract a sample presence of brownish to yellow Color precipitate.

Marine Test

In 1 ml extract add few drops of reagent. Then the sample presence whitish yellow ppt occurred.

Test for Flavonoids

One drop of concentrated HCl (hydrochloric acid) were added to little amount of extract NaOH were added a yellow color action in dictates the presence of flavonoids (Figures 7 & 8).

Characterization of Toothpaste

- **Color:** Color of the formulates toothpaste was evaluated for its Color. The Color was checked visually.
- **Odor:** Odor was found smelling the product.
- **Taste:** There was checked manually by tasting the product.



Figure 7. Result of characterization test.



Figure 8. Formulated toothpaste.

pH of Formulation

Take 1 gm of toothpaste in 150 ml beaker and add 10 ml of freshly boiled and cooled water (at 27°C). Stir well to make a thorough suspension. Determined the pH of the suspension within 5 minutes (Figure 9).



Figure 9. pH of toothpaste formulation.

pH of Toothpaste Formulation

S. N.	Ph
F1	5TO7
F2	6TO7
F3	4TO6

Foam Ability

The foam ability of the product was evaluated by taking small amount of preparation with water in measuring cylinder initial volume was noted and then shaken for 10 times. Final volume of foam was noted as shown in Figure 10.

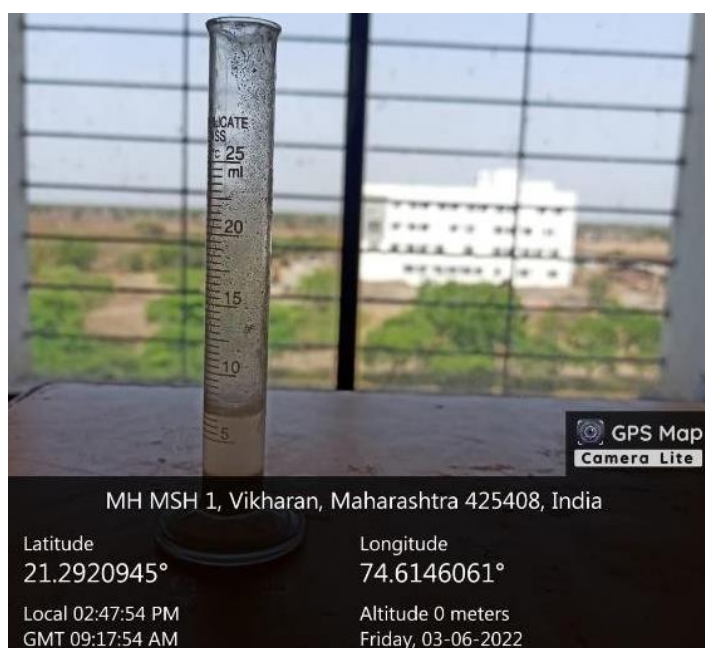


Figure 10. Foam ability of toothpaste.

Viscosity

Determination Viscosities of the formulated toothpaste were determined using rotational viscometer.

Spreadability

The spreadability of the formulation was measured using an apparatus based on the method suggested by Mutimer, which was fabricated in the laboratory for this study. The setup included a wooden block with a fixed glass slide and a movable glass slide. One end of the movable slide was attached to a weight pan through a pulley system, allowing it to move horizontally in line with the fixed slide.

CONCLUSION

The study successfully formulated a stable herbal toothpaste using *Piper betel* extract with acceptable physicochemical properties such as pH, viscosity, and spreadability. The presence of bioactive compounds supports its potential antimicrobial and anti-inflammatory effects. Overall, the formulation is a safe and effective alternative for maintaining oral hygiene, with further studies needed for clinical validation.

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