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Formulation and Evaluation of Herbal Toothpaste Using Natural Ingredients

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Abstract: *Oral hygiene plays an important role in maintaining overall health and preventing dental diseases such as dental caries, plaque formation, gingivitis, and bad breath. Herbal toothpaste has gained increasing attention due to its natural composition, reduced side effects, and therapeutic benefits compared to synthetic formulations. The present study was aimed at the formulation and evaluation of herbal toothpaste using natural ingredients, with ginger (Zingiber officinale) as the main active ingredient.*

The herbal toothpaste was prepared using ginger powder along with sodium lauryl sulfate, sodium benzoate, sodium saccharine, sodium chloride, calcium carbonate, coconut oil, peppermint oil, glycerine, and purified water. The formulation was prepared by simple trituration and mixing method to obtain a smooth and homogeneous paste. The prepared toothpaste was evaluated for various physicochemical parameters including colour, odour, taste, pH, spreadability, smoothness, homogeneity, and foamability.

The formulated toothpaste showed acceptable organoleptic properties with light brownish colour, pleasant mint-like odour, slightly sweet taste, smooth texture, and good spreadability. The pH of the formulation was found to be 9.76, indicating a slightly alkaline nature suitable for oral hygiene maintenance. The toothpaste also exhibited satisfactory foamability and consistency. Ginger present in the formulation provides antimicrobial, anti-inflammatory, and antioxidant activities which may help in reducing oral pathogens and maintaining healthy gums and teeth.

The results of the study indicate that the formulated herbal toothpaste possesses satisfactory physicochemical properties and can serve as a safe, effective, and economical alternative to conventional synthetic toothpaste. The study also highlights the potential of herbal ingredients in the development of natural oral care products with minimal side effects. Further antimicrobial and clinical studies are recommended to establish the long-term efficacy and safety of the formulation.

Keywords: *Oral hygiene*.

I. INTRODUCTION

Oral hygiene is a fundamental aspect of human health and plays a crucial role in maintaining overall well-being. The oral cavity acts as the primary gateway to the human body and is responsible for several essential physiological functions, including mastication, speech, taste perception, and the initial stages of digestion. The proper functioning of the oral cavity is therefore essential not only for nutrition but also for communication and social interaction. The oral cavity is a highly complex biological environment that supports a diverse range of microorganisms. It harbours a dynamic microbial ecosystem consisting of bacteria, fungi, viruses, and protozoa. More than 700 species of microorganisms have been identified in the oral cavity, forming a delicate balance between commensal (beneficial) and pathogenic (harmful) organisms. Under healthy conditions, this microbial balance contributes to maintaining oral homeostasis and protecting against infections. However, this balance can be easily disrupted by several factors, such as poor oral hygiene practices, high consumption of sugary foods, smoking, alcohol consumption, and inadequate dental

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care. When this balance is disturbed, pathogenic microorganisms proliferate, leading to the development of oral diseases.

Dental caries, also known as tooth decay, is one of the most prevalent chronic diseases affecting individuals of all age groups worldwide. It is primarily caused by acid-producing bacteria, especially Streptococcus mutants, which metabolize dietary sugars and produce acids. These acids gradually demineralize the tooth enamel, leading to cavity formation. If left untreated, dental caries can progress to severe tooth damage, pain, and infection.Gingivitis and periodontitis are inflammatory diseases affecting the gums and supporting structures of the teeth. Gingivitis is characterized by redness, swelling, and bleeding of the gums, while periodontitis involves deeper tissue destruction, including bone loss, which can ultimately result in tooth loss. These conditions are primarily caused by the accumulation of dental plaque—a biofilm composed of bacteria and their metabolic by-products.

In addition to local oral diseases, poor oral hygiene has been associated with several systemic conditions. Research has demonstrated links between oral infections and systemic diseases such as cardiovascular disorders, diabetes mellitus, respiratory infections, and adverse pregnancy outcomes. The oral cavity can act as a source of infection, allowing pathogenic microorganisms to enter the bloodstream and affect other organs.Therefore, maintaining proper oral hygiene is essential not only for preventing dental diseases but also for promoting overall systemic health. Effective oral hygiene practices, including regular brushing, flossing, and the use of appropriate oral care products, play a vital role in achieving this goal.

1.1 Role of Toothpaste in Oral Hygiene

Toothpaste is one of the most commonly used oral care products and plays a significant role in maintaining oral hygiene. It is a semi-solid preparation designed to be used in conjunction with a toothbrush to clean the teeth and oral cavity. The use of toothpaste enhances the mechanical action of brushing, making it more effective in removing food debris, plaque, and microorganisms.

The primary functions of toothpaste include:

- Removal of food particles and debris from the tooth surface
- Reduction of dental plaque and bacterial loa
- Prevention of tooth decay and gum disease;Maintenance of fresh breath
- Strengthening and protection of tooth enamel
- Toothpaste formulations are composed of various ingredients, each serving a specific function:

Abrasives: Abrasives such as calcium carbonate and silica help in the mechanical removal of plaque and stains from the tooth surface.

Humectants : Humectants such as glycerine and sorbitol prevent the toothpaste from drying out and maintain its consistency.

Binders: Binders like carboxymethyl cellulose help in stabilizing the formulation and preventing separation of ingredients.

Surfactants: Surfactants such as sodium lauryl sulfate (SLS) produce foam, which aids in the dispersion of toothpaste and enhances cleaning efficiency.

Flavoring Agents: Flavoring agents improve the taste and provide a refreshing sensation after brushing.

Therapeutic Agents: These include fluoride and antimicrobial agents that help in preventing dental diseases. The effectiveness of toothpaste depends on the proper combination of these ingredients and their ability to perform their intended functions without causing adverse effects.

1.2 Problems with Conventional Toothpaste

Although conventional toothpaste formulations are widely used and effective, they often contain synthetic chemicals that may pose potential health and environmental risks, particularly with long-term use.

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Fluoride:
Fluoride is one of the most commonly used therapeutic agents in toothpaste due to its ability to strengthen tooth enamel and prevent dental caries. It works by promoting remineralization and inhibiting the activity of acid-producing bacteria. However, excessive intake of fluoride, especially during childhood, can lead to dental fluorosis, which is characterized by discoloration and mottling of the teeth. In severe cases, skeletal fluorosis may occur, affecting bones and joints.

Triclosan:
Triclosan growth and prevent plaque formation. However, studies have raised concerns regarding its potential effects on human health, including endocrine disruption and antibiotic resistance. Additionally, triclosan is persistent in the environment and can accumulate in water bodies, posing ecological risks.

Artificial Additives:
Conventional toothpaste often contains artificial additive Sodium Lauryl Sulfate (SLS) ingredients that have been traditionally used for oral hygiene in various systems of medicine, including ASodium lauryl sulfate is a widely used surfactant that provides foaming action in toothpaste. While it enhances the cleaning experience, it has been associated with several adverse effects, including: Irritation of the oral mucosa ,Dryness of the mouth ,Increased incidence of mouth ulcers
Allergic reactions in sensitive individes such as: Synthetic sweeteners (e.g., saccharin) ,Preservatives ,Coloring agents These substances may cause hypersensitivity reactions and have raised concerns regarding their long-term safety.
Environmental Concerns :Many synthetic ingredients used in toothpaste are non-biodegradable and contribute to environmental pollution. The accumulation of these substances in water bodies can adversely affect aquatic life.

1.3 Shift Towards Herbal Toothpaste
In response to the limitations and potential risks associated with conventional toothpaste, there has been a growing shift toward herbal and natural formulations. Herbal toothpaste is prepared using plant-derived ingredintsy aurveda.

Herbal formulations offer several advantages:

- **Safety:** Reduced risk of side effects and toxicity
- **Biocompatibility**: Better compatibility with biological tissues
- **Eco-friendliness**: Biodegradable and environmentally sustainable
- **Cost-effectiveness**: Utilization of locally available resources
- **Cultural acceptance**: Strong traditional and historical usage

Herbal ingredients possess a wide range of therapeutic properties, including antimicrobial, anti-inflammatory, antioxidant, and healing effects. These properties make them effective in preventing and managing oral diseIn 2016, the World Health Organization (WHO) stated that the rate of dental caries in children worldwide were still high, at 60-90 %according to the 2015 Global Burden of Disease Study, caries afflicted 560 million children. The results of the 2018 Basic Health Research (Riskesdas) reported that the largest proportion of dental problems in Indonesia was dental caries reaching 88.8%, the national prevalence of tooth decay or diseased cavities in Indonesia is 45.3% but only 4.1% of teeth have been filled or filled because of cavities, the government through the ministry of health is targeting caries-free for Indonesian population by 2030.
Dental caries is a disease that can be said to be endemic in Indonesia, and caries does not directly cause death, but the presence of dental caries can interfere with comfort so that it affects eating and sleeping patterns,based on data from morbidity reports from various provinces on Indonesia's dental and oral health profile.
Indonesia has long been known as a spice-producing country with a diverse variety of spices and medicines. In Indonesia, there are many different cultures and ethnicities, including one in Java that practices traditional medicine

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with plants from the Zingiberaceae family. The giant ginger plant (Zingiber officinale var. Roscoe) belongs to the Zingiberaceae family. and it is one of the most frequently used spice plants due to its many efficacies.

Primary active substances contained in giant ginger include gingerols, with other gingerol analogues such as shogoals, paradol and zingerone. In addition to these substances, giant ginger also contains essential oil components. One way to prevent caries is to brush teeth with toothpaste.

II. MATERIAL AND METHOD

Formulation Table:

Ingredients For 10gm toothpaste:

Sr.no	INGREDIENTS	QUANTITY	QUANTITY FOR 10 GM	USES
1	GINGER POWDER 	5%	0.5gm	Main active ingredient
2.	SODIUM LAURYL SULFATE 	35%	3.5gm	Foaming agent
3	SODIUM BENZOATE 	20%	2gm	Preservative

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4	SODIUM SACHHARINE 	2%	0.2gm	Sweetening agent
5	SODIUM CHLORIDE 	10%	0.05gm	Lubricant
6	CALCIUM CARBONATE 	0.3%	0.3gm	Abrasive agent
7	COCONUT OIL 	1%	0.1gm	Emollient

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8	PEPPERMINT OIL 	5%	0.5gm	Flavoring Agent
9	GLYCERINE 	0.5%	1gm	Humectant
10	WATER 	q.s to 100%	Q.s to ml	Vehicle/Base

METHOD

Step 1: The solid ingredients ginger powder,calcium carbonate, sodium lauryl sulphate,, sodium benzoate, and sodium saccharine,sodium chloride were weighed accurately as mentioned in the formula and sieved with sieve no.80 to maintain the particle size

Step 2: Preparation of Premix Dissolve Sodium Lauryl Sulfate (SLS) in about 5 mL of water separately to form a foaming premix.Add to the morter pestle and trachurate all ingredients

Step 3: Wet Mixing:Gradually add 10 mL of coconut oil into the dry powder mix while continuously stirring with a glass rod to form a smooth paste.

Step 4: Addition of SLS Solution Slowly add the prepared SLS solution to the paste with continuous mixing to avoid lump formation.

Step 5: Adjustment of Consistency Add small quantities of water (q.s.) drop by drop to adjust the paste to a smooth and spreadable consistency.

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Evaluation parameters

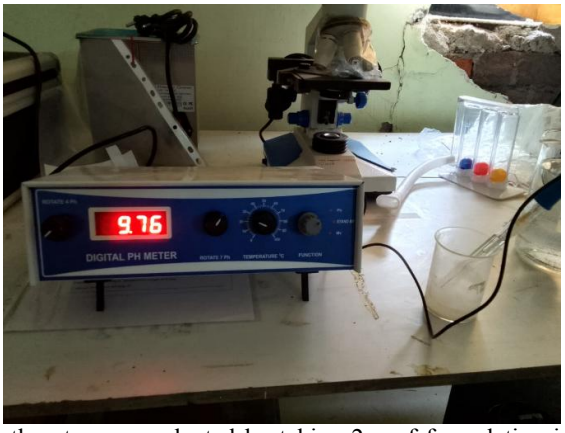
1. Physical Examination

Colour :light brownish
Odour :Like menta oil
Taste: Little sweet
Smoothness: smooth

2. pH :A sample quantity of 5 g was weighed precisely and placed in 50 ml water in a 150 mL beaker. Then boiled for some time at 27°C and allowed to cool. More distilled water was added to make the suspension. The pH of the suspension was measured using a digital pH meter, calibrating the meter with distilled water. The pH was recorded after 5 minutes of measurement.

Fig 12. pH test

2. Foamability



The foamability of formulated toothpaste was evaluated by taking 2 g of formulation in 50ml water in a measuring cylinder, the initial volume was noted, and then shaken for 10minutes. The final volume of foam was noted.

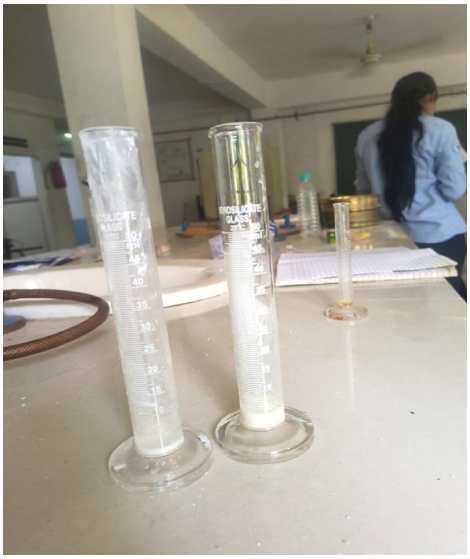


Fig 15. Foamability

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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.

HOMOGENEITY:

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

III. RESULT

Sr.No.	Parameters	Results
1	Colour	Light brownish
2	Odour	Like menta oil
3	Taste	Little Sweet
4	pH Value	9.76
5	Spreadability	Spreadable
6	Smoothness	Smooth
7.	Foamability	5

IV. DISSCUSSION

The present study was conducted to formulate and evaluate a herbal toothpaste using natural ingredients, mainly ginger powder, for maintaining oral hygiene and preventing dental problems. Herbal toothpaste is gaining importance because it contains natural ingredients with fewer side effects compared to synthetic toothpaste formulations. In this study, ginger was selected as the main active ingredient due to its antimicrobial, anti-inflammatory, and antioxidant properties.

The formulated toothpaste showed satisfactory physicochemical characteristics. The colour of the toothpaste was light brownish because of the presence of ginger powder, while the odour was pleasant and mint-like due to peppermint oil. The taste was slightly sweet because sodium saccharine was used as a sweetening agent. The toothpaste also showed smooth texture and good homogeneity, indicating proper mixing and uniform distribution of ingredients.

The pH of the toothpaste was found to be 9.76, which indicates a slightly alkaline nature. Alkaline pH helps neutralize acids produced by oral microorganisms and may reduce enamel demineralization and dental caries. Similar observations were reported in previous studies on herbal toothpaste formulations.

Foamability and spreadability are important properties of toothpaste because they influence cleaning efficiency and user acceptability. The formulated toothpaste showed satisfactory foamability due to the presence of sodium lauryl sulfate, which acts as a surfactant and foaming agent. Good spreadability indicated that the toothpaste can be easily applied on the toothbrush and spread uniformly during brushing.

Each ingredient used in the formulation played an important role. Ginger provided antimicrobial action against oral pathogens, calcium carbonate acted as a mild abrasive and polishing agent, sodium chloride contributed cleansing action, glycerine maintained moisture and smoothness, coconut oil provided soothing and antimicrobial effects, while peppermint oil improved freshness and flavour. Sodium benzoate acted as a preservative and increased the shelf life of the formulation.

The findings of the present study are supported by previously reported studies. Nagy et al. reported that ginger extract showed significant antimicrobial activity against common oral microorganisms. Kumar et al. also observed that herbal

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toothpaste formulations possess acceptable pH, spreadability, and cleaning properties comparable to commercial products.

The prepared herbal toothpaste showed good organoleptic and evaluation properties and may serve as a safer alternative to synthetic toothpaste formulations. However, further studies such as antimicrobial testing, stability studies, and clinical evaluation are required to confirm its long-term safety and effectiveness.

V. CONCLUSION

The present study successfully formulated and evaluated a herbal toothpaste using natural ingredients, with ginger powder as the main active ingredient. The objective of developing a safe, effective, and economical herbal toothpaste for oral hygiene maintenance was achieved successfully. The prepared formulation showed satisfactory physicochemical characteristics including acceptable colour, pleasant odour, slightly sweet taste, smooth texture, good spreadability, adequate foamability, and homogeneity.

The pH of the formulation was found to be alkaline and suitable for maintaining oral hygiene by helping neutralize acidic conditions in the oral cavity. The presence of ginger in the formulation contributed antimicrobial, anti-inflammatory, and antioxidant properties, which may help prevent dental caries, plaque accumulation, gum infections, and bad breath. Other ingredients such as calcium carbonate, peppermint oil, sodium chloride, glycerine, and coconut oil also played important roles in improving cleansing action, polishing ability, consistency, freshness, and overall acceptability of the toothpaste.

The study confirmed that herbal toothpaste formulations can serve as effective alternatives to conventional synthetic toothpaste preparations. Herbal formulations offer advantages such as reduced side effects, better biocompatibility, eco-friendliness, affordability, and improved patient acceptability. The prepared toothpaste was comparable to commercially available herbal toothpastes in terms of appearance and evaluation parameters.

The formulation process was simple, economical, and reproducible, indicating good scope for future development and commercialization. The use of natural herbal ingredients supports the growing demand for safer oral care products with minimal chemical exposure. The study also highlights the importance of medicinal plants such as ginger in the development of herbal dental preparations.

In conclusion, the formulated herbal toothpaste demonstrated good quality, acceptable physicochemical properties, and potential oral health benefits. The study suggests that ginger-based herbal toothpaste can be considered a promising natural oral care product for maintaining dental hygiene and preventing oral diseases. Further studies including antimicrobial analysis, stability studies, and clinical evaluations are recommended to establish the long-term safety, efficacy, and commercial applicability of the formulation.

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