

**FORMULATION AND EVALUATION OF AN EGGSHELL AND TULSI
(*OCIMUM SANCTUM*) BASED TOOTHPASTE****Rathod Vivek Vinod*, Rathod Suresh Mohan, Rathod Bhagyashri Suryakant,
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Attribution 4.0 International license.**ABSTRACT**

The present study focuses on the formulation and evaluation of a herbal toothpaste incorporating eggshell powder and *Ocimum sanctum* (Tulsi). Eggshell, a natural source of calcium carbonate, was utilized for its mild abrasive and remineralizing properties, while Tulsi was selected for its well-known antimicrobial, anti-inflammatory, and antioxidant activities. The objective of this research was to develop an effective, safe, and economical herbal toothpaste as an alternative to conventional formulations containing synthetic ingredients. The toothpaste was prepared using standard formulation techniques with varying concentrations of eggshell powder and Tulsi extract in three different batches. The prepared formulations were evaluated for various physicochemical parameters including organoleptic properties, pH, spreadability, abrasiveness, foamability. In

addition, antimicrobial activity was assessed to determine the effectiveness of Tulsi against oral pathogens. The results indicated that all formulations exhibited acceptable physical characteristics, with pH values within the suitable range for oral use. The abrasiveness was found to be moderate, confirming the suitability of eggshell powder as a natural abrasive agent. The presence of Tulsi contributed to significant antimicrobial activity. Among the batches, the optimized formulation showed the best balance of consistency, stability, and efficacy. In conclusion, the formulated eggshell and Tulsi-based toothpaste demonstrated promising results as a natural, cost-effective, and eco-friendly oral care product. This study supports the potential use of herbal and natural materials in developing safe and effective dental formulations.

✓ **KEYWORDS:** Eggshell, *Ocimum sanctum* (Tulsi), Herbal toothpaste, Anti-microbial activity, Abrasiveness, Oral hygiene.

1) INTRODUCTION

Toothpaste is defined as a dentifrice in the form of a smooth, semisolid, homogeneous mass containing acceptable ingredients such as abrasives/polishing agents, surface active agents, Humectants, binding agent, and other appropriate substances for oral health maintenance.

The product can be opaque, transparent or combination thereof, coloured or white, packed in a suitable container from which it can be extruded in the form of a continuous mass.



Fig. 1: Toothpaste.

Toothpaste is a paste or gel dentifrice used with a toothbrush as necessary to clean and maintain the aesthetics and health of teeth. Toothpaste is used to promote oral hygiene it serves as a abrasive that aids in removing dental plaque and food from the teeth, assists in suppressing halitosis, and deliver active ingredients (most commonly fluoride) to health prevent tooth and gum disease.^[1]

Dentin hypersensitivity (DH) is a major health care problem affecting both younger and older populations. It is characterized by a short, sharp pain of unexplained reason that might occur in response to chemical (e.g., excessive acidic drinks or bleaching) or mechanical factors (e.g., vigorous tooth brushing). In older population, DH can be associated with root exposure especially after periodontal treatment.^[7]

Calcium plays active role in remineralization of enamel and eggshell powder has a very high percentage of bio-available calcium. For treatment of dental caries and tooth hypersensitivity many formulations are commercially available but eggshell based toothpaste seems to be

most effective and economic product. The composition of an eggshell is very similar to that of our bones and teeth.

In recent years, there has been a growing interest in finding new sources of calcium carbonate (CaCO₃). Early studies on the composition of eggshell showed that it is made up by approximately 97% of CaCO₃. Moreover, eggshell can also provide a great protective barrier against the penetration of microorganisms, and at the same time it is constituted by numerous porous layers permeable to water and gases, which allow the embryo to breathe. In addition, eggshell is composed of a bioceramic composite material to guarantee the calcium necessary for the skeletal formation.^[8]

Disease Condition

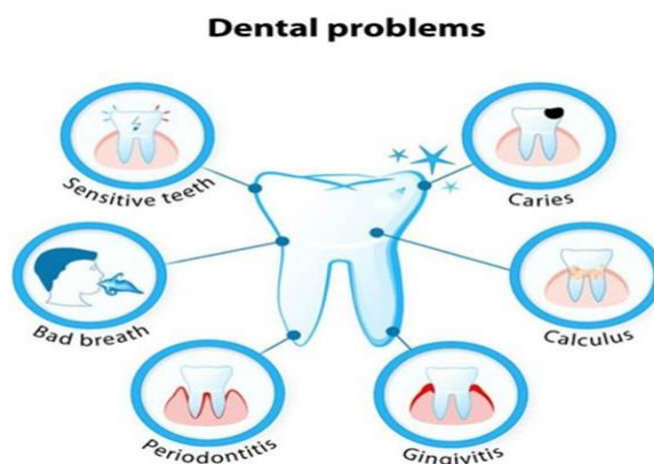


Fig 2: Dental Problem.

Table no. 1: Dental Problems.

| Sr.no. | Disease | Description |
|--------|--------------------------|---|
| 1) | Dental caries (cavities) | Deminceralization of enamel and dentin by acid forming bacteria |
| 2) | Gingivitis | Inflammation gums |
| 3) | Periodontitis | Advanced gum disease affecting bone |
| 4) | Tooth erosion | Loss of enamel due to acid |
| 5) | Tooth sensitivity | Discomfort from hot cold substances |
| 6) | Tartar (calculus) | Hardened plaque on teeth |

❑ THE EGGSHELL

Egg shells are one of the best sources of calcium, which is absorbed by organism in approximately 90% and it is easier for your body to digest and absorb. One whole medium sized eggshell makes about one teaspoon of powder, which yields about 750 – 800 mgs of

elemental calcium plus other microelements, i.e. magnesium, boron, copper, iron, manganese, molybdenum, sulphur, n, zinc, etc.



Fig. 3: Eggshell.

Eggshells are an abundant agro-waste, with over 100 billion eggs produced annually worldwide generating millions of tons of eggshell waste. Discarded eggshells pose environmental challenges, yet they consist primarily of calcium carbonate (~94– 95% CaCO_3) along with minor organic and inorganic components. Notably, the crystalline calcium matrix of eggshell closely resembles the mineral component of human teeth and bone, suggesting its suitability for promoting enamel remineralization. Prior studies have explored eggshell powder as a natural abrasive and remineralizing agent in toothpaste, finding improved enamel hardness and effective cleaning without harsh abrasives. Utilizing eggshell powder in oral care aligns with waste valorization and provides bioavailable calcium to strengthen teeth.^[4]

❖ COMPOSITION OF EGGSHELL

Eggshells primarily consist of.

- i) Calcium carbonate (CaCO_3): ~94–97%.
- ii) Organic matrix (proteins, glycoproteins): ~1–3%.
- iii) other minerals: Magnesium, phosphorus, strontium, and trace elements.

🌈 METHOD OF PREPARATION OF EGGSHELL POWDER

- Collecting Eggshells
- Cleaning of Eggshells
- Drying of Eggshells
- Powder the Eggshells by grinding and passing through suitable sieve.
- Storage of Eggshell powder.

- A) Collection of Eggshells Egg shells were collected.
- B) Cleaning of Eggshells The eggshells were cleaned in distilled water then the eggshells were kept in a hot water bath At 100°C for 10 minutes followed by removing the membrane.
- C) Drying of Eggshells Egg shells were air dried.
- D) Powdering of Eggshells Then the eggshells were crushed using a mortar, pestle and sieved to collect the fine powder Through 150 μ I.S sieve.
- E) Storage of Eggshell Powder Powdered Eggshell was stored in air tight container²

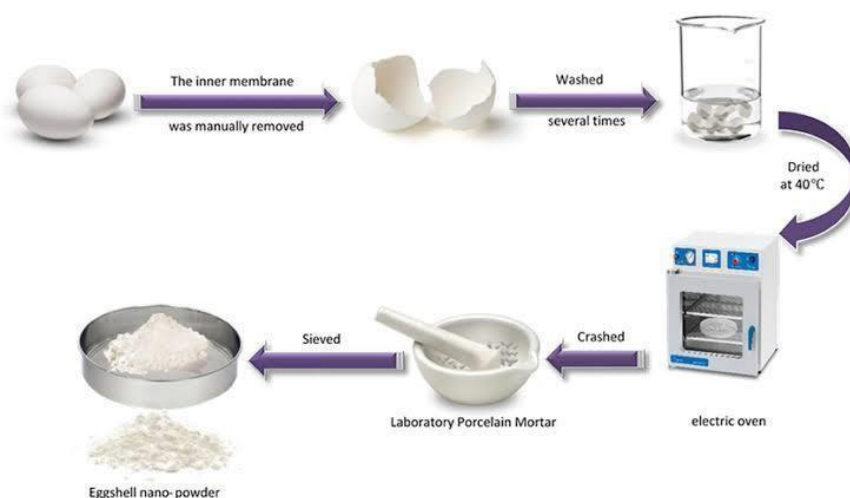


Fig. 3: Preparation of eggshell powder.

2) PLANT PROFILE

➤ TULSI



Fig. 4: *Ocimum sanctum*.

It is a holy plant that has both medicinal and spiritual properties. In Ayurveda, it is known by different names such as "Mother Medicine of Nature" and "The Queen of Herbs". Tulsi is

beneficial in relieving cough and cold symptoms due to its antimicrobial, anti-inflammatory, antitussive (cough-relieving) and anti-allergic properties.

Taking a few leaves of Tulsi along with honey helps relieve cough and flu as it improves immune health. Taking Tulsi tea on a daily basis has a calming effect and helps reduce stress. According to Ayurveda, Tulsi helps reduce asthmatic symptoms due to its Kapha-balancing property. Tulsi is also useful in managing ringworm infection. Applying a paste of Tulsi leaves on the affected area helps prevent infection and also relieves inflammation as well as pain.

1. **Common name:** - Tulsi, holly Basil
2. **Botanical Name:** - *Ocimum sanctum*
3. **Family:** - Liliaceae
4. **Plant Type:** - Perennial shrub, aromatic
5. **Leaves:** - Green or purple depending on the variety oval with slightly toothed margins
6. **Flower:** - small purple or white arranged in terminal spikes

☐ **Variety Tulsi**

- i. **Rama tulsi (*Ocimum sanctum*):** - Green leaves, mild aroma
- ii. **Krishna Tulsi (*Ocimum Tenuiflorum*):** - Dark purple leaves, stronger test aroma
- iii. **Vana Tulsi (*Ocimum Gratissimum*):** - wild variety large green leaves, lemony scent

☐ **Phytochemical constituents**

Tulsi contains a range of biologically active compounds.

- 1) **Essential Oils:** - Eugenol, Methyl Eugenol, Caryophyllene, linalool
- 2) **Flavonoids:** - Apigenin, luteolin, orientin, vicenin
- 3) **Phenolics:** - Orosmarinic acid, caffeic acid
- 4) **Triterpenoids:** - Ursolic acid, Oleanolic acid

These Compounds contribute to its antimicrobial, anti-inflammatory, antioxidant, and adaptogenic properties.

☐ **Pharmacological Properties**

Tulsi has a wide spectrum of therapeutic activities.

1. **Adaptogenic:** Helps the body adapt to stress
2. **Antioxidant:** Neutralizes free radicals
3. **Anti-inflammatory:** Reduces inflammation

4. **Antimicrobial:** Active against bacteria, fungi, viruses
5. **Immunomodulatory:** Enhances immune response
6. **Hepatoprotective:** Protects the liver
7. **Antidiabetic:** Lowers blood glucose levels
8. **Anticancer:** Cytotoxic effects on certain cancer cells (under research)
9. **Cardioprotective:** Reduces cholesterol and blood pressure



Fig.5: tulsi powder.

Medicinal Uses

- A. **Common Cold and Cough:** Used in teas or decoctions.
- B. **Asthma and Bronchitis:** Acts as an expectorant and bronchodilator.
- C. **Fever:** Especially helpful in viral and malarial fever.
- D. **Stress and Anxiety:** Acts as a natural adaptogen.
- E. **Skin Disorders:** Used in creams or pastes for acne, wounds, and infections.
- F. **Dental Health:** Tulsi extracts used in toothpaste and mouthwashes.

Side Effects

- i. Generally safe when used in moderate amounts
- ii. May lower blood sugar; caution in diabetics
- iii. Avoid during pregnancy (insufficient data)
- iv. May interfere with blood clotting due to eugenol content.

3) MATERIALS AND METHODS

MATERIALS

1. Raw Material

- a. Eggshells
- b. Tulsi Powder

2. Excipients

- a. Reetha
- b. Sorbitol
- c. Clove oil
- d. Sodium lauryl Sulphate

□ METHODS

Procedure

Step 1 - Sieving

Sieve

8 gm eggshell powder

1.75 gm tulsi powder

0.75 gm reetha powder through #60 mesh.

Step 2 - Dry Mixing

Triturate all three powders in mortar for 10-15 minutes.

Step 3 - Liquid Base Preparation

Take 5 gm glycerin in beaker.

Warm slightly and dissolve 0.05 gm methyl paraben.

Add 2.5 gm sorbitol and mix.

Step 4 - Incorporation

Slowly add dry mixture into liquid base with continuous stirring.

Step 5 - Flavor Addition

Add 0.125 ml clove oil and mix gently.

Step 6 - Consistency Adjustment

Add 6.825 gm distilled water gradually and mix until smooth paste forms.

Step 7 - Homogenization & Filling

Mix thoroughly and transfer to labeled container

4) PREFORMULATION STUDIES

- a) Bulk density
- b) Tapped density

- c) Carr's index
- d) Hausner's ratio
- e) Angle of repose
- f) Ash value
- g) Solubility

I. Bulk density

Bulk Density is the ratio between the given mass of a powder and its bulk volume. Required amount of the powder is dried and filled in a 50 ml measuring cylinder up to 50 ml mark. Then the cylinder is dropped onto a hard wood surface from a height of 1 inch at 2 second intervals. The volume of the powder is measured. Then the powder is weighed. This is repeated to get average values. The Bulk Density is calculated by using the below given formula.

$$\text{Bulk Density} = \frac{\text{Mass}}{\text{Bulk Volume}}$$

II. Tapped density

Tapped density is an increased bulk density attained after mechanically tapping a container containing the powder sample. After observing the initial powder volume or mass, the measuring cylinder or vessel is mechanically tapped for 1 min and volume or mass readings are taken until little further volume or mass change was observed.

$$\text{Tapped density} = \frac{\text{Mass}}{\text{Tapped volume}}$$

III. Carr's index

Carr's Index is a pharmaceutical and industrial measure of powder compressibility and flowability, calculated as 100. Carr's index is calculated by using following formula.

$$\text{Carr's Index} = \frac{\text{Tapped Density} - \text{Bulk Density}}{\text{Tapped Density}} \times 100$$

IV. Hausner's ratio

It is the ratio between tapped density and bulk density. The major function of the Hausner's ratio is to check the powder's flow ability since it is the primary phenomenon of flow property. If the Hausner ratio is falling the powder has great properties, if it is increasing, the powder's flow ability decreases. It's also reported that the flow is good.

It is calculated by using following formula

$$\text{Hausner's ratio} = \frac{\text{Tapped Density}}{\text{Bulk Density}}$$

V. Angle of repose

The angle of repose is the steepest possible angle at which a granular material will remain stable and at rest on an inclined plane, without any external support. This is the largest angle that can exist between the powder pile's surface and the horizontal flow. This is the most crucial approach since it provides the precise result of whether your powder flows well or poorly. This approach mostly depends on the powder's angle, as the pile's angle grows, the flow properly decreases. The following formula is provided to determine the angle of repose.

$$\text{Angle of repose } (\theta) = \tan^{-1} \frac{H}{R}$$

VI. Ash value

Ash value or ash content, is the inorganic residue remaining after a substance is incinerated. It serves as a measure of the total mineral content and inorganic impurities in a material and is used as a key quality control parameter to assess the purity, authenticity, and quality of raw materials and finished products, especially in herbal medicines and pharmaceuticals.

$$\text{Ash Content (\%)} = \frac{\text{Weight of Ash Residue}}{\text{Weight of Original Sample}} \times 100$$

VII. Solubility

Solubility is the maximum amount of a solute that can dissolve in a given amount of solvent at a specific temperature and pressure to form a saturated solution. It is a physical property that indicates a substance's ability to dissolve, and it depends on the type of solute and solvent, the temperature, and the pressure.

❖ PREFORMULATION TEST

The preformulation studies are carried out on various sieve size batch of powder of all drugs and result of that studies are shown in following table.

Table No. 2: preformulation study.

| TEST | EGGSHELL | | | TULSI | | |
|-----------------------|----------|------|-------------|-------|------|-------------|
| Seive | 80# | 100# | 120# | 80# | 100# | 120# |
| Bulk density | 0.65 | 0.69 | 0.71 | 0.34 | 0.36 | 0.38 |
| Tapped Density | 0.79 | 0.83 | 0.86 | 0.41 | 0.45 | 0.44 |

| | | | | | | |
|------------------------|------------------|-----|-------------|------------------|------|-------------|
| Carr's index | 18 | 17 | 17 | 0.17 | 18 | 15 |
| Housnr's ratio | 1.21 | 1.2 | 1.21 | 1.12 | 1.22 | 1.18 |
| Angle of repose | 30 | 28 | 27 | 29 | 31 | 27 |
| Ash value | 95% | | | 97% | | |
| solubility | Soluble in water | | | Soluble in water | | |

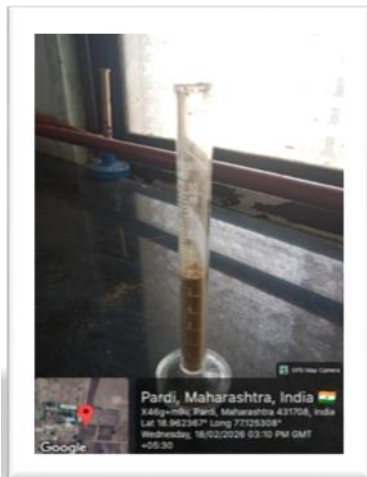


Fig.6: Angle of repose.

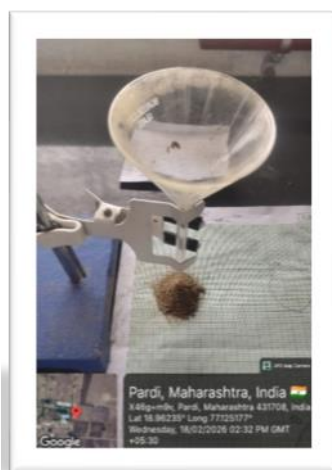


Fig.7: Ash value.



Fig.8: Tapped density.

❖ PHARMACOGNOSTIC TEST

I) Dilute Acid Test (Carbonate Test)

Procedure: Take powdered eggshell in a test tube, Add dilute Hydrochloric acid.

Observation: Brisk effervescence (bubbling) occurs, Gas evolved is CO₂,

Inference: Confirms presence of carbonate (CaCO₃)

II) Ammonium Oxalate Test (Calcium Test)

Procedure: Dissolve eggshell in dilute HCl, Add Ammonium oxalate solution

Observation: Formation of white precipitate

Inference: Formation of calcium oxalate → confirms calcium

III) Ferric Chloride Test (Phenols)

Procedure: Take Tulsi powder in a test tube, add distilled water, shake, then add a few drops of 5% FeCl₃.

Observation: Greenish-black color appears → confirms phenolic compounds

IV) Fluorescence Test

Procedure: Observe Tulsi powder under light (254 nm or 365 nm)

Observation: Shows greenish/yellow fluorescence → confirms fluorescent compounds

❖ EVALUATION TEST

- a) Physical appearance test
- b) pH test
- c) Foamability test
- d) Spreadability test
- e) Abrasiveness test
- f) Moisture content test

a) Physical appearance test

The physical appearance test is a preliminary and essential evaluation parameter used to assess the overall quality and acceptability of the toothpaste formulation. It involves visual and sensory examination of the product to ensure that it possesses desirable aesthetic and physical characteristics. A well-formulated toothpaste should exhibit a uniform color, smooth texture, and consistent appearance without any phase separation or grittiness.

b) pH test

The pH of toothpaste is a critical parameter that determines its compatibility with oral tissues, teeth enamel, and dentin. Toothpaste should neither be too acidic nor too alkaline, as extreme pH values can lead to enamel erosion, tooth sensitivity, or irritation of oral mucosa.

c) Foamability test

Foamability is an important functional property of toothpaste that reflects the presence and effectiveness of surfactants such as sodium lauryl sulfate. It indicates the ability of the toothpaste to produce foam during brushing, which aids in the dispersion of active ingredients and removal of debris.

d) Spreadability test

Spreadability determines the ease with which toothpaste can be applied onto the toothbrush and spread over the tooth surface. It is directly related to the viscosity and consistency of the formulation.

e) Abrasiveness test

Abrasiveness is a measure of the cleaning ability of toothpaste, specifically its capacity to remove stains, plaque, and debris from the tooth surface. However, excessive abrasiveness can damage enamel and dentin, leading to tooth sensitivity.

f) Moisture content test

Moisture content analysis determines the amount of water present in the toothpaste formulation. It is an important factor affecting the product's stability, texture, microbial growth, and shelf life.

5) RESULT AND DISCUSSION

1) Collection and Authentication of sample

the sample was collected from the local market of loha and authenticate form science collge nanded under the supervision of Dr. Marathe sir.

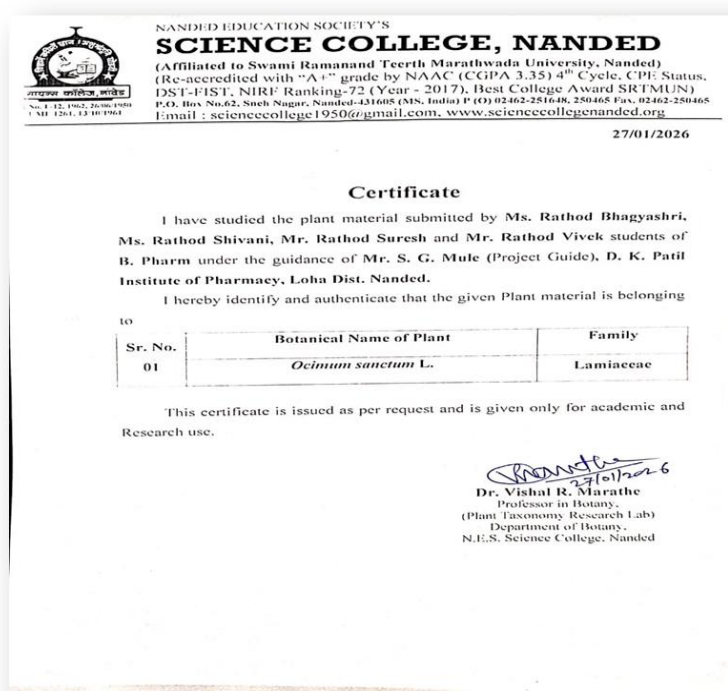


Fig.9: Authentication letter.

2) Pharmacognostic test

Table No. 2: pharmacognostic test.

| Test | Observation | inference |
|-----------------------|------------------------------------|-------------------------|
| Dilute Acid Test | lime water milky | Carbonate is present |
| Ammonium Oxalate Test | Formation of white precipitate | Calcium is present |
| Ferric Chloride Test | Greenish-black color appears | Phenol is present |
| Fluorescence Test | Shows greenish/yellow fluorescence | Fluorescence is present |



Fig.10: Pharmacognostic test.

3) Formulation of toothpaste

Formulation of 3 batches of toothpaste is done by using following formulation table.

Table No. 3: Formulation table.

| INGREDIENTS | QUANTITY GIVEN | | |
|-----------------|----------------|---------|----------------|
| | BATCH A | BATCH B | BATCH C |
| Eggshell powder | 8gm | 7.5gm | 7gm |
| Tulsi powder | 1.75gm | 1.75gm | 1.75gm |
| Reetha powder | 0.75gm | 1.25gm | 1.75gm |
| Glycerine | 5gm | 5gm | 5gm |
| Sorbitol | 2.5gm | 2.5gm | 2.5gm |
| Methyl paraben | 0.05gm | 0.05gm | 0.05gm |
| Clove oil | 0.125gm | 0.125gm | 0.125gm |
| Distilled water | 6.825gm | 6.825gm | 6.825gm |



Fig.11: Formulation of toothpaste.

4) Evaluation Tests

Table no. 4: Evaluation test.

| TEST | | BATCH A | BATCH B | BATCH C |
|------------------------------------|-----------------|-------------------|---------------------|-----------------------|
| Organoleptic test | Colour | Light green | Pale green | Greenish-brown |
| | Odor | Mild herbal aroma | Strong herbal aroma | Fresh tulsi aroma |
| | Taste | Slightly bitter | Slightly bitter | Mild bitter |
| | Texture | Smooth | Smooth | Smooth |
| | Appearance | Homogenous paste | Even, no lump | Uniform, glossy paste |
| pH | 6.43 | 6.8 | 7.2 | |
| Foamability test (cm) | 2.5 | 3.0 | 2.3 | |
| Spreadability test (cm) | 4.2 | 4.5 | 4.0 | |
| Abrasiveness test(μm) | 24 | 27 | 22 | |
| Moisture content test(%) | 7.4 | 7.5 | 7.3 | |
| Consistency | Smooth, uniform | Slightly thicker | Soft | |



Fig.12: Foamability.



Fig.13: pH.



Fig. 14: Abrasiveness.



Fig.15: Spreadability.

6) CONCLUSION

The present study focused on the formulation and evaluation of eggshell and Tulsi-based toothpaste, aiming to develop a natural, safe, and effective dental care product.

Formulation: Toothpaste was successfully prepared using eggshell powder as a natural

abrasive and Tulsi powder for its antimicrobial and therapeutic properties. All three batches showed good homogeneity, smooth texture, and acceptable color and odor.

Abrasiveness: All batches exhibited mild to moderate abrasiveness, safe for daily use, with Batch 2 showing slightly higher cleaning efficiency without damaging enamel.

Foamability and Spreadability: The toothpaste demonstrated moderate to good foam formation and smooth spreadability, ensuring user-friendly application. Batch 2 had the best foam stability and spread, while Batch 3 was gentler for sensitive users.

Consistency: All batches were extrudable with a uniform and acceptable texture, providing ease of use and stability in packaging.

Overall Evaluation: The eggshell and Tulsi-based toothpaste proved to be safe, effective, and acceptable in organoleptic and functional properties. Batch 2 emerged as the most optimal formulation in terms of cleaning efficiency, foamability, spreadability, and consistency, while Batch 3 is suitable for users preferring a softer paste.

Final Remark: This study demonstrates the potential of natural ingredients like eggshell and Tulsi in formulating a safe, herbal toothpaste, providing a cost-effective, eco-friendly, and therapeutically beneficial alternative to commercial chemical toothpaste. Further studies on long-term oral health effects and antimicrobial activity are recommended to enhance the product's clinical application.

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