

# Formulation and Evaluation of Poly-Herbal Toothpaste for Pediatrics Use

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**Abstract:** Pediatric dental health is crucial for overall well-being. Herbal toothpaste formulations offer a promising avenue for safe and effective oral care in children. This study aimed to develop and evaluate a poly-herbal toothpaste tailored for pediatric use. A toothpaste formulation was developed using natural ingredients known for their oral health benefits, including neem extract, clove, peppermint, black pepper, amla, and turmeric. Excipients such as calcium carbonate, glycerine, and sodium lauryl sulphate were incorporated to enhance texture and efficacy. Evaluation parameters included physical examination, abrasiveness, spreadability, pH determination, homogeneity, foaming ability, stability, and microbial growth. Phytochemical analysis confirmed the presence of bioactive compounds in the herbal ingredients, aligning with their traditional medicinal uses in oral care. The formulated toothpaste exhibited favorable sensory attributes, including pleasant color, odor, taste, and smooth texture. Evaluation results demonstrated optimal pH (7.76), good foaming ability (13 ml), moisture content (15.46%), spreadability (3.5 cm/sec), homogeneity, and stability, with no microbial growth observed. The developed poly-herbal toothpaste formulation holds promise for pediatric oral care, offering safe and effective protection against oral bacteria, plaque, and gum disease. Further studies on efficacy and clinical trials are warranted to validate its suitability for pediatric use.

**Keywords:** Poly-herbal toothpaste, pediatric oral care, herbal ingredients, formulation, evaluation

## I. INTRODUCTION

Pediatric oral health is integral to overall well-being, influencing aspects such as nutrition, speech development, and social interaction. Maintaining optimal oral hygiene in children is vital for preventing dental caries, gum disease, and other oral health issues. Traditional toothpaste formulations often contain synthetic chemicals and artificial ingredients, raising concerns about potential adverse effects, especially in pediatric populations. In this context, the development of herbal toothpaste formulations tailored for pediatric use presents an attractive alternative.[1,2]

Herbal toothpaste formulations harness the therapeutic properties of natural ingredients to provide effective oral care while minimizing potential risks associated with synthetic additives. Ingredients such as neem extract, clove, peppermint, black pepper, amla, and turmeric are renowned for their antibacterial, antiseptic, and anti-inflammatory properties, making them suitable candidates for pediatric toothpaste formulations. These natural compounds not only combat oral bacteria and plaque but also promote gum health and freshness, addressing the unique oral care needs of children.[3,4]

This study focuses on the formulation and evaluation of a poly-herbal toothpaste specifically designed for pediatric use. The formulation process involves blending herbal extracts with excipients to achieve desirable texture, consistency, and efficacy. Evaluation parameters include physical examination, abrasiveness, spreadability, pH determination, homogeneity, foaming ability, stability, and microbial growth. Through comprehensive evaluation, this study aims to assess the safety, efficacy, and suitability of the poly-herbal toothpaste formulation for pediatric oral care.[5,6]

The significance of this research lies in its potential to offer a safe, natural, and effective oral care solution for children, addressing concerns about synthetic additives in conventional toothpaste formulations. By leveraging the therapeutic properties of herbal ingredients, this poly-herbal toothpaste formulation has the potential to contribute to improved pediatric oral health outcomes. Additionally, this study underscores the importance of evidence-based approaches in developing oral care products tailored to specific population needs, highlighting the value of natural remedies in modern dentistry.[7,8]

**II. MATERIALS**

In this study, we developed a toothpaste formulation using a blend of natural ingredients renowned for their oral health benefits. These ingredients, including neem extract, clove, peppermint, black pepper, amla, and turmeric, were chosen for their antibacterial, antiseptic, and anti-inflammatory properties. Calcium carbonate and sodium chloride were included as mild abrasives to aid in plaque removal and teeth polishing, while glycerine and sodium lauryl sulphate helped maintain moisture and create foam for effective cleaning. Acacia gum served as a binder, sodium saccharin as a sweetener, and para hydroxide benzoic acid as a preservative, ensuring stability and taste enhancement. This formulation aimed to offer comprehensive oral care, combating oral bacteria, plaque, and gum disease while promoting overall gum health and freshness.

**Formulation of Toothpaste**

All herbal ingredients were dried and grounded using domestic mixer. The required quantity of Ingredients was weighed and taken in mortar. Calcium carbonate, Sodium lauryl sulfate, methyl Cellulose, honey and Glycerine were mixed in water. Acacia were added into the above mixture. This solution was added drop wise into mortar containing herbal ingredients and triturated well until a paste consistency is formed.[9,10]

Table 1: Formulation of Toothpaste

S.No.	Excipients	Quantity in (gm)		
		F1	F2	F3
1	Neem extract	2	3	1
2	Clove	2	2	2
3	Peppermint	1	2	1
4	Black paper	1	1	2
5	Amla	2	3	2
6	Turmeric	1	2	2
7	Calcium Carbonate	20	20	20
8	Glycerine	5	5	5
9	Sodium lauryl sulphate	1	1	1
10	Acacia gum	0.5	0.5	0.5
11	Sodium Chloride	0.5	0.5	0.5
12	Sodium Saccharin	0.5	0.5	0.5
13	Para hydroxide benzoic acid	1	1	1
14	Distilled water (60-80ml)	60-80ml	60-80ml	60-80ml

**Evaluation of Toothpaste**

**Physical Examination**

- Colour- Formulated toothpaste was evaluated for its colour.
- The visually colour was checked.
- Odour- Odour was found by smelling the product.
- Taste- Taste was checked manually by tasting the formulation [11,12]

**Evaluation Parameters**

**Abrasiveness**

Extrude the content 15-20 cm long on the butter paper, repeat the same process for at least ten collapsible tubes. Press with the contents of the entire length with fingertip for the presence of sharp and hard edged abrasive particles. Toothpaste shall not contain such particles. [13]

**Determination of spreadability**

In this method slip and drag characteristic of paste involve. Formulated paste (2g) placed on the ground slide under study. The formulated paste placed like sandwich between this slide and another glass slides for 5min to expel air and to provide a uniform film of the paste between slides. Excess of the paste was scrapped off from the edges. The top plate was then subjected to pull of 80g with the help of string attached to the hook and time (sec) required by the top slide to cover a distance of 7.5cm was noted. A short interval indicated better spreadability[14]

**pH determination**

pH of formulated herbal toothpaste was determined by using pH meter. 10g of toothpaste placed in 150ml of beaker. Allow the 10ml of boiled and then cooled water. Stir vigorously to make a suspension.[15]

**Homogeneity**

The toothpaste shall extrude a homogenous mass from the collapsible tube or any suitable container by applying of normal force at 27±20C. in addition bulk of contents shall extrude from the crimp of container and then rolled it gradually.[16]

**Foaming**

The foamability of formulated toothpaste evaluated by taking small amount of formulation with water in measuring cylinder initial volume was noted and then shaken for 10 times. Final volume of foam was noted [17]

**Stability**

The stability study was performed as per ICH guideline. The formulated paste was filled in collapsible tube and stored at different temperature and humidity conditions, 25°C ± 2°C / 60% ± 5% RH, 30° C ± 2°C / 65% ± 5% RH, 40°C ± 2°C / 75% ± 5% RH for the period of three months and studied for appearance, pH and spreadability. • Determination of moisture and volatile matter 5 g of formulation placed in a porcelain dish containing 6- 8 cm in diameter and 2-4 cm depth in it. Dry the sample in an oven at 105°C [18]

**III. RESULTS**

**Phytochemical Test**

Based on the phytochemical test results conducted on the herbal ingredients used in the toothpaste formulation, several compounds were detected in each ingredient. Here's a discussion of the results:

Table 2: Phytochemical Test

Test	Neem	Turmeric	Clove	Peppermint	Black paper	Amla
Alkaloid	+	+	+	+	+	+
Saponin	+	+	+	+	+	-
Tannin	+	+	+	+	+	+
Flavanoid	+	+	+	+	+	-
Protein	-	+	+	-	-	+
Terpenoid	+	-	+	-	+	-
Carbohydrates	+	+	-	-	+	+
Coumarin	-	-	+	-	+	+
Quinones	-	+	+	-	-	-
Starch	+	+	+	-	+	

**Neem:**

Alkaloids, saponins, tannins, flavonoids, carbohydrates, and starch were detected in neem extract. These compounds have various pharmacological properties, including antimicrobial, antioxidant, and anti-inflammatory effects. They contribute to the therapeutic benefits of neem in oral care, such as fighting oral bacteria, reducing inflammation, and promoting overall gum health.

**Turmeric:**

Turmeric showed the presence of alkaloids, flavonoids, proteins, carbohydrates, and starch. Turmeric is well-known for its anti-inflammatory, antimicrobial, and antioxidant properties, primarily attributed to its active compound, curcumin. These phytochemicals can help alleviate gum inflammation, prevent bacterial growth, and promote oral health.

**Clove:**

Clove demonstrated the presence of alkaloids, saponins, tannins, proteins, terpenoids, carbohydrates, and coumarins. Clove is commonly used in oral care products due to its analgesic, antiseptic, and antibacterial properties. The detected compounds contribute to clove's ability to relieve toothaches, reduce oral bacteria, and promote overall oral hygiene.

**Peppermint:**

Peppermint tested positive for alkaloids, saponins, tannins, and flavonoids. Peppermint oil is widely used in oral care products for its refreshing flavor and antimicrobial properties. The detected compounds may contribute to peppermint's ability to freshen breath, inhibit bacterial growth, and soothe oral tissues.

**Black Pepper:**

Black pepper exhibited the presence of alkaloids, flavonoids, proteins, carbohydrates, and starch. While less common in toothpaste formulations, black pepper may provide mild antibacterial effects and contribute to the overall flavor profile of the toothpaste.

**Amla (Indian gooseberry):**

Amla showed positive results for alkaloids, flavonoids, proteins, terpenoids, carbohydrates, coumarins, and starch. Amla is rich in vitamin C and antioxidants, offering potential benefits for oral health, including strengthening gums, reducing inflammation, and preventing microbial growth.

Overall, the phytochemical composition of the herbal ingredients used in the toothpaste formulation aligns with their traditional medicinal uses in oral care. These natural compounds offer a range of therapeutic effects that may contribute to the efficacy of the herbal toothpaste in promoting oral health and hygiene[19].

**Evaluation of herbal toothpaste**

Based on the evaluation of the herbal toothpaste, the following observations were made:

Table 3: Evaluation of herbal toothpaste

S. No.	Parameters	Observation
1	Colour	Mud green
2	Odour	Pleasant
3	Taste	Better
4	Smoothness	Smooth
5	Relative density	10.2

- **Colour:** The colour of the toothpaste was described as "Mud green." This indicates that the toothpaste likely contains natural herbal ingredients, as opposed to artificial colorants.
- **Odour:** The odour of the toothpaste was noted as "Pleasant," suggesting that the aroma of the herbal ingredients used in the formulation was appealing.

- **Taste:** The taste of the toothpaste was perceived as "Better," indicating that it may have a more palatable flavor compared to other toothpaste formulations.
- **Smoothness:** The texture of the toothpaste was described as "Smooth," suggesting that the formulation likely achieved the desired consistency for ease of application.
- **Relative density:** The relative density of the toothpaste was measured as "10.2," which indicates the density of the toothpaste relative to water. This measurement provides information about the concentration of solids in the toothpaste formulation.

Overall, these observations suggest that the herbal toothpaste formulation yielded favorable results in terms of its sensory attributes and physical characteristics. The pleasant odour, taste, and smooth texture indicate that the toothpaste may offer a pleasant user experience, while the measured relative density provides insight into the formulation's composition [20].

### Evaluation Result

Based on the evaluation results of the herbal toothpaste, the following observations were made:

Table 4: Evaluation Result

S. No.	Parameters	Observation
1	pH determination	7.76
2	Foaming determination	13 ml (good)
3	Moisture content	15.46 %
4	Spreadability	3.5 cm/sec
5	Homogeneity	Good
6	Abrasiveness	Good abrasives
7	Stability	Stable
8	Microbial growth	No microbial growth

- **pH determination:** The pH of the toothpaste was measured as 7.76. This indicates that the toothpaste is slightly alkaline, which is within the acceptable range for oral care products.
- **Foaming determination:** The toothpaste produced 13 ml of foam, which was described as "good." This suggests that the toothpaste has satisfactory foaming properties, which can contribute to effective cleaning and distribution of the product in the mouth.
- **Moisture content:** The moisture content of the toothpaste was measured at 15.46%. This measurement provides information about the water content in the formulation, which can impact its stability and texture.
- **Spreadability:** The spreadability of the toothpaste was measured at 3.5 cm/sec. This indicates how easily the toothpaste can be spread over the teeth and gums during brushing, with higher values indicating better spreadability.
- **Homogeneity:** The toothpaste was found to have "Good" homogeneity, indicating that the ingredients are well mixed and distributed evenly throughout the formulation.
- **Abrasiveness:** The toothpaste exhibited "Good" abrasiveness, suggesting that it contains suitable abrasive particles for effective cleaning without being overly abrasive on the tooth enamel.
- **Stability:** The toothpaste was observed to be "Stable," indicating that it maintains its physical and chemical properties over time under the specified storage conditions.
- **Microbial growth:** No microbial growth was detected in the toothpaste, indicating that it meets microbial quality standards and is safe for use.

Overall, these evaluation results suggest that the herbal toothpaste formulation meets quality criteria in terms of pH, foaming properties, moisture content, spreadability, homogeneity, abrasiveness, stability, and microbial safety.

**Extrudability**

The extrudability of the toothpaste formulation was evaluated using the following parameters:

Net weight of formulation in tube: 13.5 g

Weight of toothpaste extruded: 12.2 g

Using these values, the extrudability amount percentage can be calculated as follows:

Extrudability amount percentage =  $\frac{\text{Weight of toothpaste extruded}}{\text{Net weight of formulation in tube}} \times 100\%$   
 Extrudability amount percentage =  $\frac{12.2}{13.5} \times 100\% = 90.32\%$

Table 5: Extrudability

Parameter	Value
Net weight of formulation in tube (g)	13.5
Weight of toothpaste extruded (g)	12.2
Extrudability amount percentage	90.32%

Substituting the given values:

Extrudability amount percentage =  $\frac{12.2}{13.5} \times 100\% = 90.32\%$

Extrudability amount percentage =  $0.9032 \times 100\% = 90.32\%$

Extrudability amount percentage = 90.32%

Therefore, the extrudability amount percentage of the toothpaste formulation is 90.32%. This indicates that 90.32% of the total formulation weight was successfully extruded from the tube during the evaluation.

**Stability**

Stability testing is crucial to assess the shelf-life and quality of a product over time. For the herbal toothpaste formulation, stability testing involves subjecting the product to various storage conditions to monitor its physical, chemical, and microbiological stability.

Table 6: Stability testing

At 25°C ±2°C/ 60% ± RH (3rd month)

Colour	Appearance	Spreadability	pH
Mud green	Homogeneous	3.5	7.76

At 35°C ±2°C/ 65% ± RH (3rd month)

Colour	Appearance	Spreadability	pH
Mud green	Homogeneous	3.45	7.25

At 35°C ±2°C/ 65% ± RH (3rd month)

Colour	Appearance	Spreadability	pH
Mud green	Homogeneous	3.45	7.25

**IV. CONCLUSION**

The developed herbal toothpaste formulation, comprising natural ingredients like neem extract, clove, peppermint, black pepper, amla, and turmeric, demonstrates promising potential for oral health benefits. The formulation process involved blending these ingredients with excipients like calcium carbonate, glycerine, and sodium lauryl sulphate to achieve desired texture, consistency, and efficacy. Physical examination of the toothpaste revealed satisfactory color, odor, taste, and smoothness, while evaluation parameters such as pH determination, foaming ability, moisture content, spreadability, homogeneity, abrasiveness, stability, and microbial growth indicated favorable attributes. Phytochemical

analysis further confirmed the presence of bioactive compounds in the herbal ingredients, aligning with their traditional medicinal uses in oral care. Extrudability testing demonstrated efficient dispensing of the toothpaste from the tube, with a high extrudability amount percentage of 90.32%. Stability testing will provide essential insights into the shelf-life and quality maintenance of the product under different storage conditions. Overall, the comprehensive evaluation of the herbal toothpaste formulation suggests its potential as an effective and safe option for promoting oral health and hygiene.

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