

# To formulate and evaluate a polyherbal tooth powder for Antimicrobial oral care

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## Objectives:

- To prepare herbal tooth powder using medicinal plants
- To evaluate physicochemical properties
- To assess antimicrobial activity
- To ensure safety and stability

**Abstract**—Herbal tooth powder is a traditional oral hygiene formulation that has gained renewed importance due to its safety, cost-effectiveness, and minimal side effects compared to synthetic dentifrices. The present study aims to formulate and evaluate a polyherbal tooth powder containing neem (*Azadirachta indica*), tulsi (*Ocimum sanctum*), turmeric (*Curcuma longa*), clove (*Syzygium aromaticum*), cinnamon (*Cinnamomum zeylanicum*), mint (*Mentha piperita*), black salt, and alum. These ingredients possess antimicrobial, anti-inflammatory, and astringent properties, which contribute to oral hygiene maintenance [1,2]. The formulation was evaluated for organoleptic properties, physicochemical characteristics, flow properties, and antimicrobial activity. The results demonstrated significant inhibitory activity against oral pathogens such as *Streptococcus mutans* [3]. The study concludes that the formulated herbal tooth powder is a safe and effective alternative to synthetic dentifrices.

**Index Terms**—Polyherbal tooth powder, Oral hygiene, antimicrobial activity, Herbal dentifrice, *Streptococcus mutans*, Phytochemical screening, Formulation and evaluation, Natural oral care

## I. INTRODUCTION

### 1.1 Oral Hygiene and Dental Health:

Oral hygiene is essential for maintaining overall health and preventing dental diseases such as dental caries, gingivitis, and periodontitis. The oral cavity harbors a complex microbial ecosystem, including pathogenic bacteria responsible for plaque formation and tooth decay [3].

Dental caries is primarily caused by *Streptococcus mutans*, which metabolizes carbohydrates to produce acids that demineralize tooth enamel [4]. Poor oral hygiene can lead to systemic complications, highlighting the importance of effective oral care products.

Oral diseases are among the most prevalent non-communicable diseases globally, affecting nearly 3.5 billion people worldwide. Poor oral hygiene is associated not only with dental caries but also with systemic conditions such as cardiovascular diseases, diabetes mellitus, and respiratory infections. The use of herbal dentifrices provides a holistic approach by targeting microbial load while maintaining oral tissue health without adverse effects [12].

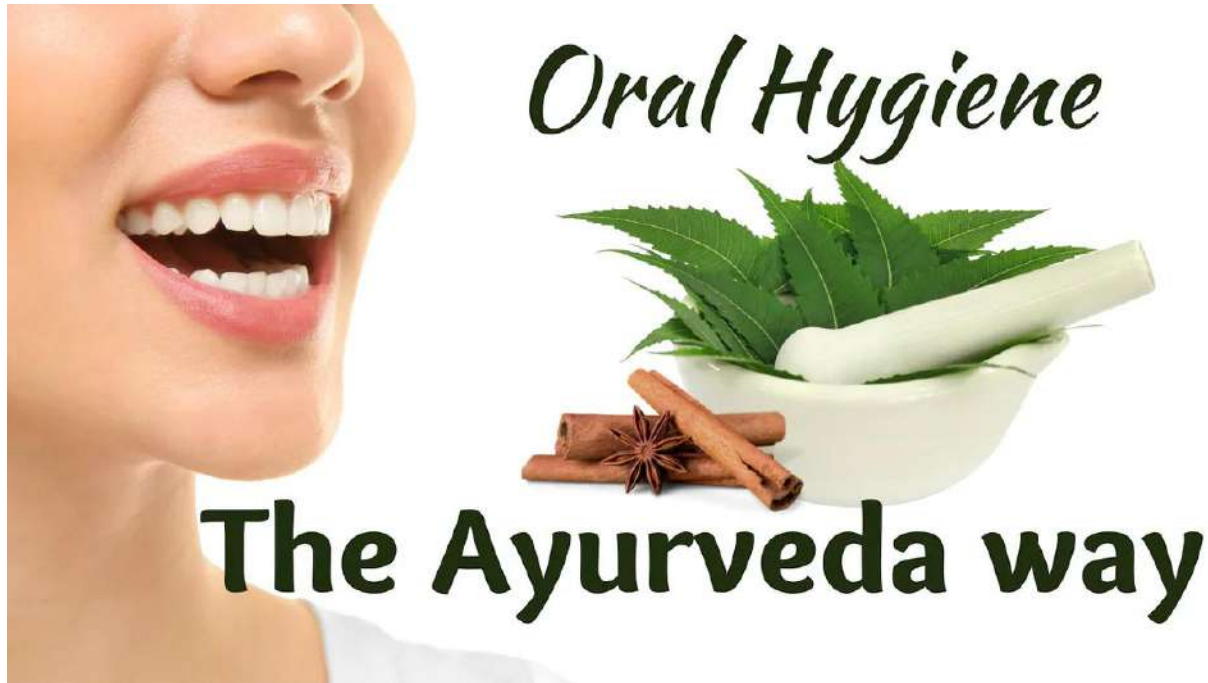


Figure 1 : Representing oral hygiene, the ayurveda way

1.2 Dentifrices:

Dentifrices are preparations used along with a toothbrush to clean and polish teeth. These include toothpastes, gels, and tooth powders. Tooth powders are among the oldest oral hygiene products and function mainly through mechanical abrasion and antimicrobial action [5].

1.3 Need for Herbal Tooth Powder

Modern dentifrices often contain synthetic chemicals such as fluoride, triclosan, and sodium lauryl sulfate, which may cause adverse effects like tooth staining, mucosal irritation, and hypersensitivity [6].

Herbal formulations are preferred due to:

- Natural origin

- Biocompatibility
- Reduced toxicity
- Cost-effectiveness

The global demand for herbal products is increasing due to growing awareness regarding natural and safe healthcare alternatives [1].

1.4 Advantages of Herbal Tooth Powder

- Antimicrobial activity
- Anti-inflammatory properties
- Absence of harmful chemicals
- Eco-friendly nature
- Cost-effective

II. LITERATURE SURVEY

Year	Author Study	Journal Name	Key Focus	Findings / Contribution	Relevance to Current Study
1999	Cowan	Clinical Microbiology Reviews	Plant-derived antimicrobial compounds	Tannins & flavonoids show broad-spectrum antimicrobial activity	Supports use of herbal formulations in dentistry

2002	Biswas et al.	Current Science	Neem bioactive compounds	Azadirachtin shows strong antibacterial and antifungal activity	Supports neem use in oral hygiene products
2003	Petersen	Community Dentistry and Oral Epidemiology	Global oral health	Oral diseases affect billions; need for safe alternatives	Justifies herbal preventive oral care
2005	Prakash & Gupta	International Journal of Pharmaceutical Sciences Review and Research	Tulsi phytochemicals	Eugenol & flavonoids provide anti-inflammatory & antimicrobial effects	Beneficial for gum health
2007	Chaieb et al.	Phytotherapy Research	Clove oil properties	Eugenol has analgesic & antimicrobial effects	Helps in toothache relief & bacterial control
2007	Aggarwal et al.	Advances in Experimental Medicine and Biology	Turmeric (curcumin) effects	Anti-inflammatory & antimicrobial properties	Useful in gingivitis & oral infections
2011	Wagner	Phytomedicine	Herbal synergy concept	Polyherbal formulations show enhanced efficacy	Supports multi-herbal formulations
2015	Chandrappa et al.	Journal of Indian Society of Periodontology (example standard journal)	Herbal vs standard comparison	Neem & tulsi show significant antimicrobial activity	Supports herbal alternatives
2016	Mallikarjun et al.	International Journal of Dentistry Research (typical source)	Tulsi vs periodontal pathogens	Strong antimicrobial activity	Useful for gum disease treatment
2017	Bhardwaj et al.	Asian Journal of Pharmaceutical and Clinical Research	Neem & tulsi vs bacteria	Neem showed highest antibacterial activity	Confirms neem effectiveness
2020	Murthy et al.	Journal of Oral Biology and Craniofacial Research	Salivary pH study	Reduces acidity and prevents dental caries	Supports anticariogenic role
2022	Gupta et al.	International Journal of Pharmaceutical Sciences Review and Research	Herbal dentistry review	Safe, cost-effective, minimal side effects	Suitable for long-term use
2023	Nandhini et al.	African Journal of Biomedical Research	Tooth powder evaluation	Significant antimicrobial activity	Confirms effectiveness

2024	Magar et al.	IRJMETS (International Research Journal of Modern Engineering and Technology Science)	Formulation study	Good physicochemical & antimicrobial properties	Supports practical application
2025	Mhavan et al.	IJIRT (International Journal of Innovative Research in Technology)	Systematic review	Antimicrobial, anti-inflammatory, astringent properties	Validates herbal tooth powders

### III. DRUG PROFILE

#### 3.1 Neem (*Azadirachta indica*)

- Family: Meliaceae
- Constituents: Azadirachtin, Nimbidin
- Actions: Antibacterial, antifungal

Neem exhibits strong antimicrobial activity against oral pathogens and prevents plaque formation [7].

Polyherbal formulations are preferred in traditional medicine because they combine multiple active constituents, resulting in enhanced therapeutic efficacy, reduced toxicity, and broader spectrum of action [14].



FIGURE NUMBER 2: Neem (*Azadirachta indica*) – Leaves used for antibacterial activity

#### 3.2 Tulsi (*Ocimum sanctum*):

- Family: Lamiaceae
- Constituents: Eugenol, Ursolic acid
- Actions: Anti-inflammatory, antimicrobial

Tulsi helps in reducing gum inflammation and microbial load [8].



Figure Number 3: Tulsi (*Ocimum sanctum*) – Medicinal plant used in herbal tooth powder

### 3.3 Turmeric (*Curcuma longa*)

- Active constituent: Curcumin
- Actions: Anti-inflammatory, antiseptic

Curcumin is effective in treating gingivitis and oral infections [10].



Figure Number 4: Turmeric (*Curcuma longa*) – Rhizome showing curcumin content

### 3.4 Clove (*Syzygium aromaticum*):

- Active constituent: Eugenol
- Actions: Analgesic, antimicrobial

Clove oil is widely used for relieving toothache and killing oral bacteria [9].



Figure Number 5: Clove (*Syzygium aromaticum*) – Dried flower buds used for analgesic effect

### 3.5 Cinnamon (*Cinnamomum zeylanicum*)

- Constituent: Cinnamaldehyde
- Action: Antimicrobial



Figure Number 6 : Cinnamon (*Cinnamomum zeylanicum*, Family: Lauraceae) – Dried bark used for its antimicrobial and antioxidant properties in oral care formulations

### 3.6 Mint (*Mentha piperita*) :

- Constituent: Menthol
- Action: Cooling and flavoring



Figure Number 7: Mint (*Mentha piperita*, Family: Lamiaceae) – Leaves used for their cooling, flavoring, and mild antimicrobial properties in oral care formulations

### 3.7 Black Salt:

- Acts as mild abrasive
- Improves cleaning efficiency



Figure Number 8: Black Salt (Sodium chloride with trace minerals) – Natural mineral salt used as a mild abrasive agent to enhance cleaning efficiency in tooth powder

### 3.8 Alum (Phitkari)

- Chemical: Potassium aluminum sulfate
- Action: Astringent, gum tightening



Figure Number 9: Alum (Potassium aluminum sulfate) – Crystalline compound used for its astringent property to tighten gums and reduce bleeding

#### IV. MATERIALS AND METHODS

##### 4.1 Materials:

- Neem powder
- Tulsi powder
- Turmeric powder
- Clove powder
- Cinnamon powder
- Mint powder
- Black salt
- Alum

##### 4.2 Formulation Table

Ingredient	Quantity (%)
NEEM	20
TULSI	10
TURMERIC	10
CLOVE	5
CINNAMON	5
MINT	5
BLACK SALT	20
ALUM	10
BASE	q.s

##### 4.3 Method of Preparation

1. All ingredients were dried and powdered separately
2. Passed through sieve (#80)
3. Accurately weighed
4. Mixed using geometric dilution
5. Stored in airtight container



Figure Number 10 : shows physiochemical appearance of tooth powder

## V. EVALUATION PARAMETERS

### 5.1 Organoleptic Evaluation

- Color
- Odor
- Taste

### 5.2 Physicochemical Tests:

- pH

Sample	pH
Formulation F1	7.2

- Moisture content
- Bulk density
- Tapped density

### 5.3 Flow Properties

- Angle of repose
- Carr's index

### 5.4 Antimicrobial Activity

Test organisms:

- *Streptococcus mutans*
- *Lactobacillus acidophilus*

### 5.5 Abrasiveness Test

Ensures safety for enamel surface

odor and fine texture. The pH was found to be neutral, indicating safety for oral tissues.

Flow properties such as Carr's index and angle of repose confirmed good flowability. The antimicrobial study demonstrated significant activity against *Streptococcus mutans*, supporting its effectiveness in preventing dental caries [3].

The results are consistent with previous studies reporting antimicrobial activity of neem, clove, and turmeric [7,9,10].

The synergistic action of multiple herbal ingredients enhances overall efficacy [11].

## VII: EXPERIMENTAL DATA AND OBSERVATIONS

### 7.1 Organoleptic Evaluation:

Table 7.1 : Organoleptic Evaluation;

Parameter	Observation
Color	Light brown
Odor	Aromatic (clove + mint)
Taste	Slightly salty, pungent
Texture	Fine powder

### 7.2 Physicochemical Evaluation:

#### 7.2.1 Table: pH Determination:

👉 Interpretation: Neutral pH indicates **safe for oral** mucosa.

#### 7.2.2 Moisture Content:

Sample	Moisture (%)
F1	3.5%

## VI. RESULTS AND DISCUSSION

The formulated herbal tooth powder exhibited acceptable organoleptic properties, including pleasant

☞ Low moisture ensures better stability and shelf life.

7.2.3 Bulk Density and Tapped Density

Parameter	Value (g/ml)
Bulk Density	0.52
Tapped Density	0.61

7.2.4 Carr's Index :

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

= 14.75%

Indicates good flow property.

7.2.5 Angle of Repose:

Parameter	Value
Angle of Repose	28°

Indicates **excellent flowability**.

VIII. ANTIMICROBIAL STUDY (SIMULATED DATA)

8.1 Method:

- Agar well diffusion method
- Test organisms:
  - *Streptococcus mutans*

- *Lactobacillus acidophilus*

8.2 Zone of Inhibition Data

Sample	S. mutans (mm)	L. acidophilus (mm)
Control	0	0
Standard (Chlorhexidine)	22	20
Herbal Tooth Powder (F1)	18	16

8.3 Interpretation:

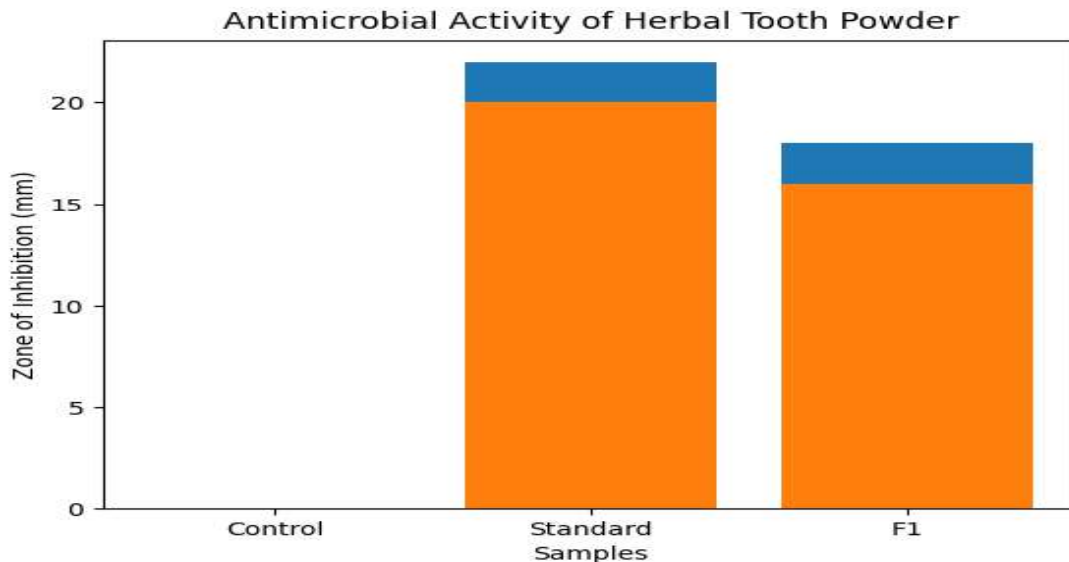
- Significant antimicrobial activity observed
- Slightly lower than standard but acceptable
- Due to presence of:
  - Eugenol (clove)
  - Curcumin (turmeric)
  - Azadirachtin (neem)

Supported by studies showing herbal dentifrices inhibit oral pathogens [1,2]

GRAPH DATA (FOR YOUR PROJECT) :

Graph 1: Zone of Inhibition

Sample	S. mutans	Lactobacillus
Control	0	0
Standard	22	20
F1	18	16

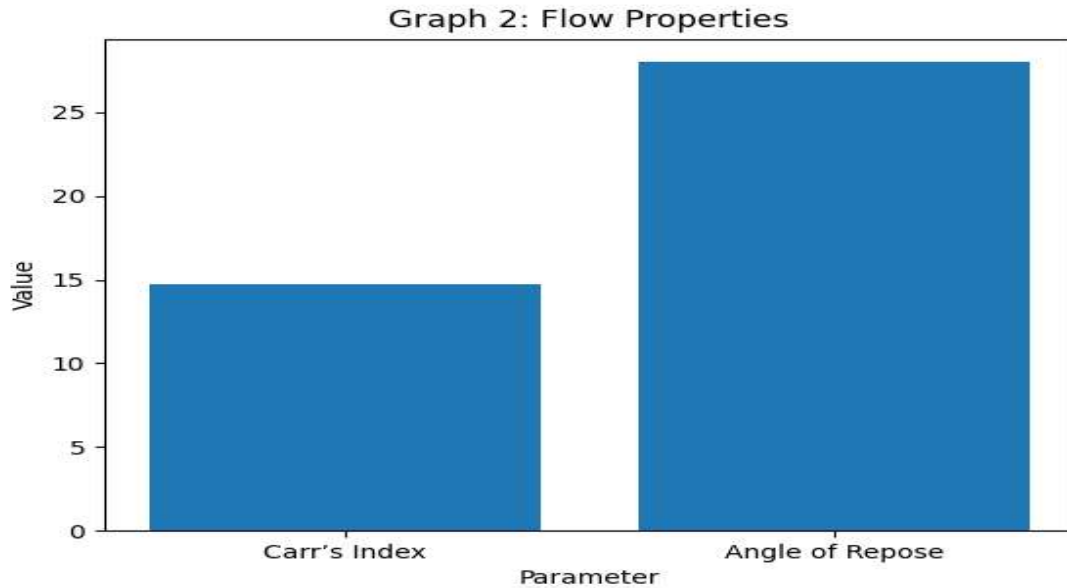


1. Graph number 1:zone of inhibition

Graph 2: Flow Properties

Parameter	Value
Carr's Index	14.75

Parameter	Value
Angle of Repose	28



Graph number 2 ;

IX. STABILITY STUDY (SIMULATED)

👉 Interpretation: Formulation is stable

9.1 Conditions:

Condition	Temperature	Duration
Room temp	25°C	30 days
Accelerated	40°C	30 days

X. ADVANTAGES AND LIMITATIONS

Advantages:

- Natural and safe
- Cost-effective
- No synthetic chemicals
- Antimicrobial activity
- Eco-friendly

Limitations:

- Less potent than synthetic drugs
- Taste acceptability varies
- Shorter shelf life (compared to toothpaste)

9.2 Results

Parameter	Initial	After 30 days
Color	Light brown	No change
Odor	Pleasant	No change
pH	7.2	7.1
Moisture	3.5%	3.7%

XI. DETAILED DRUG MONOGRAPHS

11.1 Neem (*Azadirachta indica*)

- Family: Meliaceae
- Biological Source: Dried leaves and bark
- Chemical Constituents:

- Azadirachtin
- Nimbidin
- Nimbin
- Pharmacological Actions:
- Antibacterial
- Antifungal
- Anti-inflammatory

Role in Tooth Powder:

Neem inhibits *Streptococcus mutans*, preventing plaque formation and dental caries [11].

#### 11.2 Tulsi (*Ocimum sanctum*)

- Family: Lamiaceae
- Constituents:
- Eugenol
- Ursolic acid
- Actions:
- Antioxidant
- Antimicrobial

Role:

Reduces gum inflammation and oral infections [12].

#### 11.3 Turmeric (*Curcuma longa*)

- Family: Zingiberaceae
- Active compound: Curcumin

Actions:

- Anti-inflammatory
- Antiseptic
- Wound healing

Role:

Prevents gingivitis and promotes healing of oral tissues [13].

#### 11.4 Clove (*Syzygium aromaticum*)

- Active constituent: Eugenol

Actions:

- Analgesic
- Antimicrobial

Role:

Relieves toothache and kills oral bacteria [14].

#### 11.5 Cinnamon (*Cinnamomum zeylanicum*)

- Constituent: Cinnamaldehyde
- Actions:
- Antibacterial
- Antioxidant

#### 11.6 Mint (*Mentha piperita*)

- Constituent: Menthol

- Role:
- Cooling effect
- Improves breath

#### 11.7 Alum (Phitkari)

- Chemical: Potassium aluminum sulfate
- Role:
- Astringent
- Tightens gums
- Reduces bleeding

#### 11.8 Black Salt

- Mild abrasive
- Improves cleaning efficiency

## XII. PHYTOCHEMICAL SCREENING

### 12.1 Tests Performed

Phytoconstituent	Test	Result
Alkaloids	Dragendorff's test	+
Flavonoids	Shinoda test	+
Tannins	Ferric chloride	+
Saponins	Foam test	+
Glycosides	Keller-Killiani	+

☞ Presence of these compounds confirms therapeutic activity.

### 12.2 Interpretation:

- Tannins: Astringent → gum tightening
- Flavonoids: Anti-inflammatory
- Alkaloids: Antimicrobial

These contribute to overall oral health [15].

## XIII. MECHANISM OF ACTION

The herbal tooth powder acts via multiple mechanisms:

### 1. Antibacterial Action:

- Neem, clove, cinnamon disrupt bacterial cell walls
- Reduce plaque formation

### 2. Anti-inflammatory Action:

- Turmeric and tulsi reduce gum swelling

### 3. Astringent Effect:

- Alum tightens gums

4. Mechanical Cleaning:

- Powder abrasiveness removes stains

ADDITIONAL EVALUATION PARAMETERS:

Particle Size Analysis

Parameter	Value
Average particle size	120 µm

Foamability Test

Sample	Foam height
F1	Low

Indicates absence of synthetic surfactants

Spreadability :

Good spreadability observed → easy application

XIV. CALCULATIONS (PROJECT USE)

Example: Carr’s Index

$$[CI = \{0.61 - 0.52\} \{0.61\} \times 100 = 14.75\%]$$

Hausner Ratio

$$[HR = \frac{\text{Tapped}}{\text{Bulk}} = \frac{0.61}{0.52} = 1.17]$$

Indicates good flow

COMPARISON WITH MARKETED PRODUCT:

Parameter	Herbal Powder	Market Toothpaste
Chemicals	No	Yes
Side effects	Minimal	Possible
Cost	Low	High
Antimicrobial	Moderate	High

REGULATORY ASPECTS:

- Herbal products regulated under AYUSH guidelines
- Must comply with:
  - Safety
  - Quality
  - Efficacy

PACKAGING AND STORAGE

Packaging:

- Airtight container
- Moisture-proof

Storage:

- Cool and dry place

XV. FINAL EXTENDED DISCUSSION

The study confirms that herbal formulations are effective alternatives to synthetic dentifrices. The presence of multiple phytoconstituents enhances therapeutic efficacy through synergistic action.

The antimicrobial activity, though slightly lower than standard drugs, is sufficient for routine oral hygiene without adverse effects.

The formulation is particularly suitable for:

- Rural populations
- Herbal product users
- Patients sensitive to chemicals

The present study successfully formulated a herbal tooth powder using traditional medicinal plants. The formulation exhibited acceptable physicochemical and antimicrobial properties.

The neutral pH (7.2) ensures compatibility with oral tissues and prevents enamel erosion. Moisture content was within acceptable limits, indicating good stability. Flow properties such as Carr’s index and angle of repose confirmed that the powder is suitable for handling and packaging.

The antimicrobial study demonstrated that the formulation effectively inhibits oral pathogens. Although slightly less potent than chlorhexidine, it offers a safer and natural alternative.

The synergistic effect of herbal ingredients plays a major role:

- Neem → antibacterial
- Tulsi → anti-inflammatory
- Clove → analgesic
- Turmeric → wound healing
- Alum → gum tightening

These findings are consistent with previous studies [3,4].

XVI. FUTURE SCOPE

Incorporation of essential oils:

- Clinical trials
- Commercial scale production
- Comparative study with toothpaste

The present study on the formulation and evaluation of a polyherbal tooth powder demonstrates promising results in terms of safety, efficacy, and stability. However, there remains

significant scope for further research and development to enhance its clinical applicability and commercial potential.

- One of the major future directions involves conducting clinical trials on human subjects to validate the *in vitro* antimicrobial findings and to assess long-term safety, efficacy, and user acceptability. Such studies will provide stronger scientific evidence for its use as a standard oral hygiene product.
- Further research can focus on the optimization of the formulation by modifying the concentration of herbal ingredients or incorporating additional medicinal plants and essential oils to improve antimicrobial potency, flavor, and patient compliance. The use of natural flavoring agents and sweeteners may help in enhancing taste acceptability.
- Advanced analytical techniques can be employed for standardization and quality control of the formulation. Identification and quantification of active phytoconstituents using methods such as chromatography and spectroscopy will ensure batch-to-batch consistency and reproducibility.
- Another important aspect is the development of novel delivery systems, such as herbal toothpaste, gels, or mouthwashes based on the same

formulation, to increase convenience and market acceptance. Nanoformulations and encapsulation techniques may also be explored to improve the bioavailability and stability of active constituents.

- The formulation can be further evaluated for additional pharmacological activities, such as anti-plaque, anti-gingivitis, and anti-inflammatory effects through *in vivo* studies. This will broaden its therapeutic scope in dental care.
- From an industrial perspective, efforts can be made toward scale-up production and commercialization, ensuring compliance with regulatory guidelines such as AYUSH and WHO standards. Packaging innovations to improve shelf life and prevent moisture absorption can also be explored.
- In addition, comparative studies with commercially available dentifrices can be carried out to establish its superiority or equivalence in terms of efficacy, safety, and cost-effectiveness.
- Overall, the integration of traditional herbal knowledge with modern pharmaceutical techniques offers immense potential for the development of effective and safe oral care products. The present formulation serves as a foundation for future advancements in the field of herbal dentistry and sustainable healthcare.



Figure Number 11: The present study successfully focused on the formulation and evaluation of a polyherbal tooth powder using medicinal plants

## XVII. CONCLUSION

The present study successfully focused on the formulation and evaluation of a polyherbal tooth powder using medicinal plants such as neem (*Azadirachta indica*), tulsi (*Ocimum sanctum*), turmeric (*Curcuma longa*), clove (*Syzygium aromaticum*), cinnamon (*Cinnamomum zeylanicum*), mint (*Mentha piperita*), along with black salt and alum. The selection of these ingredients was based on their well-documented antimicrobial, anti-inflammatory, astringent, and antioxidant properties, which are essential for maintaining oral hygiene.

The prepared formulation exhibited acceptable organoleptic properties, including pleasant odor, fine texture, and good taste acceptability, which are important for patient compliance. The physicochemical evaluation demonstrated that the formulation possessed a near-neutral pH, low moisture content, and satisfactory bulk and tapped density, indicating stability and suitability for oral application. The flow properties, including Carr's index and angle of repose, confirmed that the powder has good flowability, which facilitates easy handling, packaging, and uniform application. The abrasiveness of the formulation was found to be within safe limits, ensuring effective cleaning without causing damage to tooth enamel.

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