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FORMULATION AND EVALUATION OF HERBAL TOOTH POWDER FOR ANTI MICROBIAL ACTIVITY AGAINST ORAL PATHOGENS

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ABSTRACT

The increasing awareness of the side effects associated with synthetic oral care products has led to a growing interest in herbal alternatives for maintaining oral hygiene. In this study, an herbal tooth powder was formulated using a blend of natural ingredients with documented antimicrobial, anti-inflammatory, and astringent properties, traditionally employed in Ayurveda and other indigenous systems of medicine. The formulation aimed to provide a safe, effective, and affordable product that could prevent dental issues such as plaque formation, gingivitis, and bad breath, while promoting overall oral health. The evaluation of the formulated herbal tooth powder was carried out through a comprehensive set of parameters, including physical characterization (color, odor, taste, texture, moisture content, and flowability), microbiological analysis, and sensory evaluation. Physical properties were assessed to ensure product stability, consistency, and consumer appeal. The antimicrobial activity of the tooth powder was tested against common oral pathogens using standard agar diffusion methods. The formulation exhibited promising antimicrobial efficacy, indicating its potential to inhibit the growth of harmful oral microbes responsible for dental caries and periodontal diseases. Sensory evaluation was conducted through a structured panel of volunteers to assess parameters such as taste, freshness, mouthfeel, and overall acceptability. Results from the sensory analysis demonstrated a high level of consumer satisfaction, further supporting the potential commercial application of the product. Overall, the study concludes that the formulated herbal tooth powder not only meets acceptable physical and sensory standards but also possesses significant antimicrobial activity. These findings support its potential as an effective herbal alternative to conventional toothpastes and powders, promoting oral health while minimizing adverse effects associated

with chemical formulations.

KEYWORDS: Natural Ingredients, Oral Hygiene, Dental Care, and Microbial analysis.

INTRODUCTION

Oral health is a fundamental component of overall well-being, yet dental caries and periodontal diseases remain among the most prevalent infectious diseases globally. Poor oral hygiene, dietary sugars, and microbial biofilms are key contributors to these conditions. As antibiotic resistance rises and synthetic oral care products often raise concerns about side-effects and cost, there is increasing interest in herbal alternatives that are safe, affordable, and effective.[1]

Figure 01: Teeth and Gums.

If the infection is not treated, it will spread and eventually result in tooth loss. Opportunistic bacteria, which are typically not harmful, make up the mouth's natural flora. This situation's imbalance leads to tooth decay and infection. Tooth decay is caused by the acid-producing bacteria *Streptococcus mutans*, which ferments carbohydrates.[2]

Additionally, oral health professionals must be empowered to identify early signs of systemic diseases, creating a bidirectional flow of referrals between dentists and physicians. Ultimately, prioritizing oral health not only enhances individual well-being but also serves the greater public health good.[3]

Traditional plants have been used for centuries in preventive and therapeutic health care. Their importance lies not only in cultural practices but also in their rich phytochemical profile that provides antimicrobial, anti-inflammatory, antioxidant, and healing properties.[4]

The main purpose of toothpowder is to clean the available surfaces. Finding an effective herbal dental care formulation could be a good alternative to using antibiotics to treat oral infection diseases like dental caries because the majority of representative human

Carcinogenic bacteria are moderately resistant to antibiotics.[5] The aim of the formulation and evaluation of herbal tooth powder is to provide a natural and effective alternative to conventional toothpaste, promoting oral health and hygiene while minimizing the use of synthetic ingredient.

MATERIALS AND METHODS

COLLECTION OF HERBAL INGREDIENTS AND EXCIPIENT PROFILE

Herbal ingredients and excipient profile were collected from the local market of Kalaburagi and authenticated by Dr. Rasika S Kapale, Department of Botany, SVGWC. College for Women, Kalabuiragi. A Voucher is stored with Specimen no. 18.

SELECTION OF HERBAL INGREDIENTS

The formulation should involve a careful selection of herbal ingredients known for their health benefits. These may include herbs like Cinnamon, Clove, Miswak, Indian Gooseberry, and Curcuma longa.

SELECTION OF EXCIPIENT PROFILE

Select an appropriate base material that will provide a mild abrasive action for cleaning teeth without being too harsh on the enamel. These may include Menthol crystals, Himalayan rock salt and Bentonite clay.

PREPARATION OF THE TOOTH POWDER

The herbal ingredients were dried under shade and powdered using mixer. The powdered herbs are then passed through sieve apparatus with very fine pore diameter which can be easily mix and stored in air tight container. The powdered herbal ingredients is summarized in formulation of herbal tooth powder.

FORMULATION OF THE TOOTH POWDER

HERB 01: *CINNAMON*[6]

Figure 02: Cinnamon.

- **Common name:** *Cinnamon.*
- **Family:** *Lauraceae.*
- **Scientific name:** *Cinnamon verum.*
- **Parts used:** Bark.
- **Role:** Analgesic, Germicide, Antimicrobial.
- **Treatment:** Toothache, Halitosis.

HERB 02: *CLOVE*[7]

Figure 03: Clove.

- **Common name:** *Clove, Lavang.*
- **Family:** *Myrtaceae.*
- **Scientific name:** *Eugenia caryophyllus.*
- **Parts used:** Dried flower buds.
- **Role:** Analgesic, Antioxidant, Anti-inflammatory.
- **Treatment:** Caries cavities, Dentrifice.

HERB 03: *MISWAK*[8]

Figure 04: Miswak.

- **Common name:** *Miswak stick*
- **Family:** *Salvadoraceae.*
- **Scientific name:** *Salvadora persica.*

- **Parts used:** Stem.
- **Role:** In Plague and gum disease, Also as Protection.
- **Treatment:** Antibacterial.

HERB 04: *INDIAN GOOSEBERRY*[9]

Figure 05: Indian Gooseberry.

- **Common name:** *Amla, Indian gooseberry.*
- **Family:** *Euphorbiacea*.
- **Scientific name:** *Phyllanthus emblica* Linn.
- **Parts used:** Pericarp of dried matured fruits.
- **Role:** Antibacterial.
- **Treatment:** Periodontal diseases.

DRUG 05: *MENTHOL POWDER*[10]

Figure 06: Menthol powder.

- **Common name:** Mint crystal.
- **Family:** Lamiaceae.
- **Scientific name:** Mentha arvensis.
- **Extract:** Mint essential oil.
- **Role:** Antimicrobial.
- **Uses:** Refreshing, Cooling, Flavouring agents.

DRUG 06: *HIMALAYAN ROCK SALT*[11]

Figure 07: Himalayan Rock Salt.

- **Common name:** Pink salt, Halite, Sendha namak
- **Treatment:** Prevent the buildup of plaque and tartar
- **Uses:** Flavouring agents

DRUG 07: *BENTONITE CLAY*[12]

Figure 08: Bentonite Clay.

- **Common name:** Montmorillonite
- **Uses:** Remove stains on teeth, Polish enamel, Whiten teeth

PROPORTIONS AND MIXING

The required quantities of herbal ingredients and other excipient profile were weighed according to the table-1. Mix all the ingredients thoroughly to ensure uniform distribution throughout the tooth powder. Then tooth powder is packed in to the sterile air tight container in cool and dry place.

Table 01: Proportions of herbal tooth powder with quantities.

Ingredients	Quantities (gm)
Indian gooseberry powder	25
Cinnamon powder	6
Clove powder	6
Miswak Powder	15
Menthol crystals	3
Himalayan pink salt	15
Bentonite clay	30

Mixing the all powdered ingredients of measured composition thoroughly is essential to achieve a homogeneous blend.

Figure 09: Homogenous Powder.

EVALUATION OF HERBAL TOOTH POWDER

The prepared herbal toothpowder was subjected to under mentioned evaluation.

ORGANOLEPTIC EVALUATION

Distinct parameters were studied such as: Color, Odour, Taste, Texture and Appearance.

Color

The color of the formulated and evaluated herbal tooth powder is shown brown. The prepared herbal tooth powder's colour matches the findings of (Dakhurkar, S. P, *et al*.)[13] quite well. Similar findings were found in a study by, which found that tooth powder formulations were brown in colour. The herbal dentifrice made from achyranthes aspera Linn (apamarga) leaves according to a study by (Asnotikar. G, *et al*.)[14], has a greenish-brown colour. According to a study by, tooth powder's colour is greenish black because the herbal substances employed in this investigation were different. In order to increase the stability of the tooth powder, incorporated chemical components, which resulted in yellowish green.

Odour

The formulated tooth powder is pleasant odour because in this study prefered using menthol crystals which act as flavouring and freshening agent produced an aromatic scent as a result of using Cinnamomum camphora as a flavouring agent. An aromatic scent was produced in a study by since the majority of the ingredients were aromatic flavours. A study by demonstrates features of scent due to the incorporation of chemical components in the ingredients. According to a study, there was a little scent. The results of a study by (Dakhurkar et al, 2019)[13] revealed certain characteristics of scent.

Taste

The prepared tooth powder is astringent taste. According to a study by (Dakhurkar, S. P, *et al*)[13] the application of the sweetening agent stevia leaf produced a sweet flavour. According to a study by (Asnotikar. G, *et al*.)[14], sweet and spicy components were present. The use of saccharin sodium, a sweetening ingredient, in a study by, produced a sweet flavour. Sweet and bitter tastes were noted in a study by (Dakhurkar, S. P, *et al*)[13]

Texture

The texture of the product is fine. A study by produced a fine powder as a consequence. According to a study, fine texture was produced.

Appearance

Appearance of the product is powdered form. A study was powdered appearance. A study by (Mamatha et al, 2022)[15] the acceptable appearance was observed.

Table 02: Organoleptic Evaluation.

Parameters	Result
Color	Brown
Odour	Pleasant
Taste	Astringent
Texture	Fine
Apperance	Powder

PATCH TEST

Doing a patch test before implementing it completely. Check for allergic responses by applying a tiny amount of tooth powder scrub to a small area. The patch test includes Swelling, Redness and Irritation.

Swelling

Does not show any swelling effect for the formulated ingredients. A study by the results were same, which has a negative effect on swelling.

Redness

Redness was not found for prepared herbal tooth powder. The results of the study were same, and thus led to the conclusion that redness is negative.

Irritation

Irritation causing ingredients was not formulated. So, the product is free from irritation. A study by the results were the same, which has negative irritation on teeth powder formulations.

Table 03: Irritation.

Parameters	Result
Swelling	Negative
Redness	Negative
Irritation	Negative

PHYSICO-CHEMICAL EVALUATION

Determination of pH

Using a digital pH meter, the pH of the prepared herbal tooth powder was determined. Add 5g of tooth powder in 50ml of beaker. To this freshly boiled and cooled distilled water was added. Stir vigorously and make a mixture and its pH was measured.

The pH of the formulation was found to be 5.19. Similar findings to those of pH 5 were seen in a study by (Dudhe et al, 2020).[13] The pH value is 6. The pH level of tooth powder was 4.75, according to a study by (Asnotikar et al, 2020).[14] The pH value was 7 according to a study by (Mamatha et al, 2020).[15]

Figure 10: pH

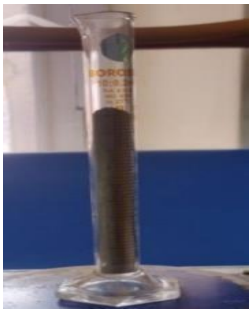
Determination of Bulk Density

It is the weight of a powder volume unit. Expressed in g/ml. In a dried graduated measuring cylinder (10ml), approximately 5g of sample was weighed. The volume occupied by the powder was given in the formula for calculating the bulk density.

$$D = M/V$$

D = Bulk density, M = Mass of particles, V = Total volume occupied.

Mass of the particles is 5g and total volume occupied is 10ml. The powder has 0.5g/ml of bulk density. According to a study by (Asnotikar et al, 2020),[14] bulk density was determined to be 3.70, and the study's entire volume was 100ml.



A study by (Dudhe et al, 2020)[13] resulted the powder has 4gm/ml of bulk density.

Figure 11: Bulk density.

Determination of Tapped Density

The increase in bulk density that results from mechanically tapping a container containing a powder sample is known as tapped density**.** 5g weighed formulation was taken and slowly added to the graduated cylinder (10ml). After that initial volume was noted and the sample is then tapped until no further volume reduction occurred. The value obtained after tapping was noted. Continued tapping until no further change in volume was observed. Tapped density

was calculated by given formula.

Tapped density = Weight of powder (g) / Tapped density (ml)

Weight of the powder is 5g and tapped density is 6.9. The powder has 0.724g/ml of tapped density. The results were found to be similar by the study of (Bharathi et al, 2020)[5], which found that tooth powder formulations have a tapped density of 0.601. According to a study by (Asnotikar et al, 2020),[14] tapping density is 0.39g/ml.

Figure 12: Tapped Density.

Determination of Angle of repose [Flow property]

The funnel was taken and fixed with a burette stand. The graph paper was placed below the funnel and distance between lower tip of the funnel and sheet was adjusted to height of 2cm. Add 25 g of powder and poured into funnel and it started following down onto the graph paper. Sample was poured in funnel from top till a heap of powder formed and touched the lower tip of the funnel. Then the circle was drawn around the graph paper. The average diameter and radius of the circle followed by height was recorded and calculated by using given formula

$$\Theta = \tan^{-1} h/r$$

h=Height of the powder cone, r=Radius of the powder cone

Angle of repose determined to find out the flow property of herbal tooth powder and it value is 27.83 which shows excellent flow property. The results were similar with the results of (Mamatha et al, 2022),[15] with a 30.62 observed value which shows the excellent flow property of herbal toothpowder. According to a study by (Asonotikar et al, 2020),[14] produced herbal dentifrice has a 43.8-degree angle of repose. A study by (Bharathi et al, 2020)[5] reported good flow property.

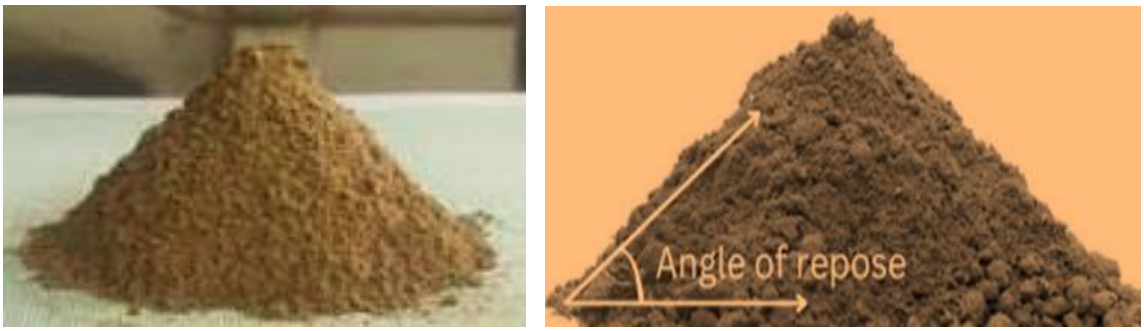


Figure 13: Angle of Repose.

Determination of Foaming property of powder

50 ml of water was added to 2 g of tooth powder that had been placed in a measuring cylinder. After noting the initial volume, shaking was done ten times. The final volume of foam was measured and calculated using the given formula.

Foaming power = V1-V2

V1 = Volume in ml of foam with water, V2 = Initial volume with water.

Foaming power of the herbal tooth powder is 10ml which shows good foamability. Similar outcomes of the foaming power are shown in a study by (Asnotikar et al, 2022),[14] where the value is 4ml. Foaming power is 0.9 ml, according to a study by (Bharathi et al., 2020).[5] Foaming power was determined to be 0.7 ml in a study by (Mamatha et al, 2022).[15] Good foamability was reported in a study by (Dakhurkar et al, 2019).[13] (Dudhe et al, 2020)[16] demonstrated the presence of foam.

Figure 14: Foaming property of powder.

Determination of Spreading property of powder

About 0.6 g of sample was weighed and placed at the center of the glass slide and another glass slide was placed over it carefully. To prevent sliding, a 1.13 kg weight was positioned in the middle of the plate above the glass slide. After 30 minutes, the sample diameter (in centimeter) was measured.

Spreadability of the tooth powder was found to be 3.5cm. Developed formulation was easily spreadable and which help to clean the teeth. The results were 3 cm, which was identical to the findings of (Bharathi et al, 2020).[5] The Spreadability of teeth powder was shown to be 4.7 cm in a study by (Asonotikar et al, 2020).[14] Easily spreadable according to a study by (Dakhurkar *et al*, 2019).[13]

Figure 15: Spreading property of powder.

Determination of Abrasiveness

The fineness of the powder was measured using the abrasiveness parameter. A fingertip was used to quantify, 1g of sample and rub it on a glass slide for 15 minutes. It was noted that the slide's surface had scratches. The findings were arbitrarily expressed as "positive" and "negative" indicators in order to show the scratches on the glass slide. More positive signs indicated abrasiveness that was greater.

Scratches is present on the glass slide which shows positive indications of tooth powder has good abrasiveness. A study shows similar results with (Asnotikar et al, 2020)[14] the formulated tooth powder has indicated positive sign. Good abrasive according to a study by (Dakhurkar et al, 2019).[13]

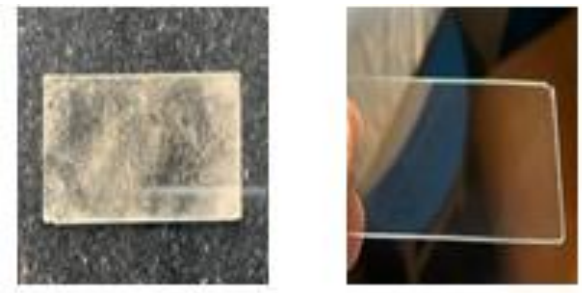


Figure 16: a) Rubbed sample slide. b) Scratches on slide.

Table 04: Physico-chemical Evaluation.

Parameters	Result
pH	5.19
Bulk density	0.5g/ml
Tapped density	0.724g/ml
Angle of repose	27.83 (Excellent)
Foaming power	10ml (Good)
Spreadability	3.5cm (Easily spreadable)
Abrasiveness	+ + (Good abrasive)

ANTIBACTERIAL ACTIVITY

Agar well diffusion method was used to determine the antimicrobial activity which was recorded by measuring the zone of inhibition using the radius scale appeared after the incubation period of the organisms. In this study the antibacterial activity of formulated herbal tooth powder was investigated against Gram positive bacteria (*Staphylococcus sp., Streptococcus sp.,*) and Gram negative bacteria (*Escherichia sp., Pseudomonas sp.,*). The zone of inhibition against selected bacterial pathogens against formulated tooth powder was compared with the standard antibiotic penicillin and the results were presented in (Table-5, 6 and7), Fig-19, 20, 21 and 22) shows the zone of inhibition of selected bacterial pathogens against formulated tooth powder.

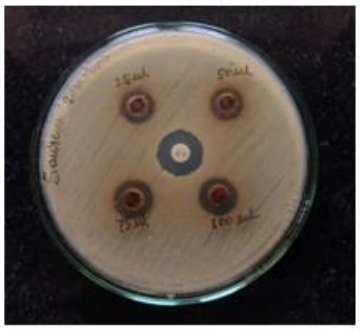


Figure 17: *Staphylococcus*

Figure 18: *Pseudomonas*

Figure 19: *Streptococcus sp.*

Figure 20: *Escherichia*

Table 05: Zone of Inhibition of *Staphylococcus sp.*

Concentration of sample (µg/ml) & Antibiotic	Zone of Inhibition (mm)	Result
25	11	Resistant
50	12	Sensitive
75	13	Sensitive
100	14	Sensitive
Penicillin	15	Sensitive

Table 6: Zone of Inhibition of *Pseudomonas sp.*

Concentration of sample (µg/ml) & Antibiotic	Zone of Inhibition (mm)	Result
100	15	Sensitive
Penicillin	17	Sensitive

Zone of Inhibition of *Streptococcus sp.*, and *Escherichia sp.*

Table 07: Zone of Inhibition of *Streptococcus sp.*, and *Escherichia sp.*,

Test organisms	Zone of Inhibition	Result
Streptococcus sp.,	No	Resistant
Escherichia sp.,	No	Resistant

In the present study, antibacterial activity of formulated herbal tooth powder exhibited the significant inhibition against the tested pathogens and observed higher activity against *Staphylococcus sp.,* and *Pseudomonas sp.,* compared with all other bacteria. Hence, it was confirmed that the prepared tooth powder possesses the great antibacterial potential and it could be applicable for the bacteria causing oral infection. The study by (Bharathi et al, 2020),[5] which discovered that the antibacterial activity of *Escherichia sp.,* and *Staphylococcus sp.,* resulted in sensitive to the oral infection, found that the results were similar. According to a study by (Dudhe et al, 2020),[16] Escherichia sp., was found to be sensitive to anti-microbial activity. The prepared product is efficient against the *Streptococcus sp.,* according to a study by (Mamatha et al, 2022)[15]

SUMMARY

Herbal tooth powder is a natural oral hygiene product made from a blend of medicinal herbs, minerals, and other organic substances traditionally used to clean teeth, freshen breath, and maintain overall oral health.

This alternative to chemical-based toothpastes is gaining popularity due to its minimal side effects, eco-friendliness, and historical use in Ayurveda and traditional medicine**. Studies

and user feedback have shown that herbal tooth powders can help reduce plaque, strengthen gums, prevent bad breath, and even help in managing gingivitis and tooth sensitivity when used consistently.

CONCLUSION

Herbal tooth powder offers a safe, effective, and natural alternative to conventional toothpaste. Its use not only promotes good oral hygiene but also aligns with sustainable and holistic health practices. While more scientific research is needed to standardize formulations and confirm long-term benefits, the growing interest in herbal oral care reflects a broader shift towards natural wellness solutions. With proper formulation and regular use, herbal tooth powder can serve as a valuable addition to daily oral hygiene routines.

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