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Comprehensive review on formulation and evaluation of herbal toothpaste

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Abstract
Introduction: Oral hygiene has become increasingly important globally in recent years. In conjunction with utilizing a toothbrush, toothpaste serves to keep the esthetics and dental health.
Scope: This study examined the global significance of oral hygiene, emphasizing the integral role toothpaste plays in upholding both the esthetic appeal and health of teeth. This investigation extends beyond the conventional focus on plaque and debris removal, considering additional facets, such as combating bad breath and preventing tooth decay and gum disease through active ingredients. The purpose of this investigation was to compare the effects of herbal products on gum health and tooth enamel roughness with those of conventionally formulated toothpaste.

Keywords: Antimicrobial, periodontal diseases, herbs, plague, wet gum, dry gum

Introduction

Herbal products have gained considerable popularity and are experiencing a global resurgence. Compared to synthetic substances, which are often perceived as dangerous for the environment and people, herbal medicines are now viewed as symbols of safety. Botanically, a herb is defined as a plant without woody tissue, that is a characteristic of trees or bushes. Plants are called herbs that utilized for medicinal, flavoring, or fragrance qualities [1]. Herbal extracts have proven successful in dentistry as tooth cleaning and antimicrobial plaque agents, and their global use is growing effectively reduce microbial plaques in periodontitis and gingivitis, which boosts immunity [3]. Herbs are among the remedies that God has provided for such as Ayurveda, Unani, and Siddha have acknowledged their therapeutic benefits for thousands of years. Of the 2,500 plant species that traditional healers in India employ, 100 are consistently used as sources of medication. Studying medicinal plants and their traditional uses across the world has gained popularity in the past several decades [4]. The World Health Organization estimates that approximately 80% of the global population relies on traditional medicines, including herbal remedies, for primary healthcare. The treatment of various diseases with indigenous medicines, such as medicinal plants, can provide significant economic benefits. In developed countries, approximately one-fourth of the medical drugs are derived from herbal sources [5, 6]. Oral care is often performed using natural toothbrushes made from healed plants. Primitive twig brushes are effective and provide natural bristles with healing ingredients that are incorporated into plants. Herbalist Lesley Tierra recommends using twigs containing volatile oils, tannins, and vitamins to stimulate blood circulation, clean gum tissue, and maintain healthy gums [7].

Oral health is an integral part of general well-being, and maintaining proper oral hygiene is essential for preventing common dental problems such as dental caries, gingivitis, periodontal diseases, and halitosis. Toothpaste is one of the most widely used oral hygiene products worldwide, traditionally formulated using synthetic ingredients such as detergents, preservatives, fluoride compounds, and artificial flavoring agents. Although these ingredients are effective in plaque removal and caries prevention, continuous and prolonged use has raised concerns related to side effects including mucosal irritation, enamel abrasion, allergic reactions, and microbial imbalance within the oral cavity. These limitations have increased global interest in safer, more natural, and holistic alternatives. Herbal toothpaste has emerged as a promising substitute due to its incorporation of medicinal plants that possess antimicrobial, anti-inflammatory, antioxidant, analgesic, and astringent properties.

Traditional systems of medicine such as Ayurveda, Unani, and Siddha have long recognized the benefits of herbs like Neem (*Azadirachta indica*), Clove (*Syzygium aromaticum*), Turmeric (*Curcuma longa*), *and Aloe vera*, Mint, and Guava leaves for oral care. These botanicals contain phytochemicals such as flavonoids, tannins, terpenoids, alkaloids, and phenolic compounds that inhibit oral pathogens, strengthen gums, reduce inflammation, and promote overall oral health. As a result, herbal toothpaste is gaining popularity not only for its therapeutic potential but also for being environmentally friendly, biodegradable, and culturally acceptable.

The formulation of herbal toothpaste involves scientific selection and processing of plant materials, suitable extraction methods, and incorporation of natural excipients to achieve optimal texture, pH, abrasiveness, stability, and cleansing ability. To ensure safety and efficacy, rigorous evaluation using physico-chemical tests, organoleptic analysis, antimicrobial assays, and stability studies is required. Recent research has demonstrated that properly formulated herbal toothpastes can be as effective or in some cases superior to conventional synthetic dentifrices in controlling plaque and reducing oral microbial load.

Despite these advantages, variability in herbal composition, lack of standardization, limited clinical trials, and challenges in large-scale formulation still pose significant limitations. Therefore, a comprehensive review of existing herbal toothpaste formulations and their evaluation parameters is essential to understand current trends, scientific evidence, challenges, and future prospects.

Herbal Toothpaste

Herbal toothpaste is an oral hygiene formulation that uses natural plant-based ingredients instead of synthetic chemicals to clean the teeth, freshen breath, and promote overall oral health. Unlike conventional toothpastes that rely on artificial preservatives, detergents, and chemical antibacterial agents, herbal toothpastes contain extracts, powders, or oils obtained from medicinal plants known for their therapeutic properties. Herbs such as Neem (*Azadirachta indica*), Clove (*Syzygium aromaticum*), Turmeric (Curcuma longa), Mint (Mentha spp.), Aloe vera, and Guava leaves (*Psidium guajava*) are commonly included due to their antimicrobial, anti-inflammatory, antioxidant, astringent, and healing activities.

The increasing popularity of herbal toothpaste is largely due to growing public awareness of the side effects associated with long-term use of chemical-based dentifrices. Some synthetic ingredients such as sodium lauryl sulfate (SLS), triclosan, synthetic colors, and high-abrasive agents have been linked to oral irritation, allergic reactions, enamel erosion, and disruption of the natural oral microbiome. Herbal toothpaste is therefore considered safer, biocompatible, and gentler for daily use, making it particularly suitable for people with sensitive gums, ulcer-prone mouths, or those seeking natural alternatives.

Diseases of teeth caused by conventional toothpaste

Common dental diseases

The oral cavity harbors a multitude of bacterial cells, comprising both beneficial and detrimental bacterial strains. The latter is principally responsible for a plethora of oral diseases that can affect various areas of the mouth.

Some of the most common dental diseases include but are not limited to

- Periodontal disease
- Tooth decay and cavities
- Mouth abscess
- Tooth abscess

Periodontal disease

Commonly referred to as gum disease, this dental condition typically arises from neglect of regular flossing. Over time, the accumulation of bacteria that form plaques leads to the development of gingivitis or periodontitis, which are the initial stages of periodontal diseases [15].

Symptoms of periodontal disease

Periodontal disease symptoms include bleeding gums during oral care, tender and swollen gums, widening spaces between teeth, and recurrent mouth sores [16].

Undoubtedly, the most encouraging news is that periodontal disease can be successfully treated within a handful of dental appointments. To eliminate plaque and tartar build-up around the gum line, thorough deep dental cleaning is necessary. While some individuals may experience temporary discomfort during the procedure, it is typically administered in multiple sessions [17, 18].

Tooth decay and cavities

Tooth decay is a prevalent dental condition affecting a significant number of individuals globally, including both children and adults. This condition leads to the formation of cavities, which are brought about by the neglect of tooth brushing following the ingestion of substantial amounts of sugary and acidic foodstuffs and beverages. These substances penetrate the enamel, enabling the growth of bacteria that cause the cavities to thrive [19, 20].

Symptoms of tooth decay

Tooth decay symptoms include sharp localized pain, grey/ brown spots on teeth, swollen gums, and difficulty chewing due to sensitivity. Cavities can be treated by removing bacteria from the surface of the tooth through scraping or drilling and then filling the area with composite or amalgam material to restore the appearance of the natural tooth. In cases in which cavities have progressed to the interior pulp, a root canal procedure performed by an endodontist may be necessary. In severe cases, tooth extraction is the only treatment option [19].

Mouth ulcers

Canker sores typically manifest as small, painful lesions on the mouth or gums, causing discomfort during eating, drinking, and speaking. Those who are female, young, or have a family history of mouth ulcers are more likely to develop these symptoms [21].

Symptoms of mouth ulcer

Mouth ulcer symptoms may arise from minor injuries, use of sodium lauryl sulfate in oral care products, sensitivity to acidic foods, deficiencies in vitamins (B-12, zinc, folate, iron), and allergic responses to mouth bacteria [22, 23].

Tooth abscess

Untreated dental cavities, injuries, or previous dental work can lead to the formation of periapical tooth abscesses.

Dentists typically treat this condition by draining the abscess and eradicating infection. If left untreated, tooth abscesses can cause severe and potentially life-threatening complications [24].

Symptoms of tooth abscess

Tooth abscess symptoms encompass a severe, throbbing toothache sensitive to temperatures, pain during chewing, facial swelling, tender lymph nodes, a potential foul-smelling discharge upon rupture, and difficulty in breathing and swallowing [25].

Materials and Methods

One formulation of herbal toothpaste is prepared by using different ingredients like Fenugreek Powder for its Anti-inflammatory, Clove Oil as a Dental Analgesic, Neem Powder which has Antimicrobial property, Aloe Vera gel to prevent infections for its Antifungal, Anti-Viral and Anti-inflammatory, Trikatu Powder as Anti-caries, Anti-Microbial, Pomegranate Peel for its Antifungal, Anti-inflammatory etc. of this mixture is prepared and other preparation used and base containing, Calcium Carbonate as abrasive, Sodium Fluoride as anti caries agent, Sorbitol as humectant, Sodium Lauryl Sulphate as a detergent and foaming agent, Sodium CMC as a binding agent, Methyl Paraben and Sodium Benzoate used as a preservative, Sodium Saccharine as a sweetening agent, Peppermint Oil as a flavoring agent. This prepared formulation is compared and evaluated with marketed herbal toothpaste. A method used for the formulation of herbal toothpaste is homogenization by using mortar and pestle for formation base of toothpaste.

Sr. No.	Ingredients	Quantity Given	Uses
1	Fenugreek Powder	2.5 gm	Anti-inflammatory
2	Clove oil	0.02 gm	Dental Analgesic
3	Neem Powder	0.05 gm	Antimicrobial
4	Aloe Vera gel	6 gm	Antifungal, Anti-Viral, Anti-inflammatory
5	Trikatu Powder	0.03 gm	Anti-caries, Anti-Microbial
6	Pomegranate peel	1.6 gm	Antifungal, Anti-inflammatory

Base

Sr. No	Ingredients	Quantity	Uses
1	Calcium Carbonate	41 gm	Abrasive
2	Sodium Fluoride	0.9 gm	Anti-caries agent
3	Sorbitol	44 gm	Humectant
4	Sodium lauryl Sulphate	1.5 gm	Detergent and foaming agent
5	Sodium CMC	1.8 gm	Binding agent
6	Methyl paraben	0.2 gm	Preservative
7	Sodium benzoate	0.1 gm	Preservative
8	Sodium saccharine	0.2 gm	Sweetening agent
9	Peppermint oil	Q.S	Flavoring agent

Materials

The weight of every each ingredient was decided by review previous study formulation of Herbal toothpaste. The combination of percentage by weight of all the ingredients of this is 100%, which means the sum of quantity of toothpaste will formulate 100gm of toothpaste formulation. The ingredients of all toothpaste formulations are given in table 1 and Marketed Herbal tooth pastes Patanjali Dant Kanti, Dabar Red, Colgate Vedshakti, and Dabur Meswak were used 9. Method of formulation:

There are two types of methods for formulation of toothpastes, *viz*

- Dry gum method.
- Wet gum method.

Dry Gum Method

Preparation of base

- The solid ingredients calcium carbonate, sodium fluoride, SLS, sodium CMC, methyl paraben, sodium benzoate, sodium saccharine were weighed accurately as mentioned in the formula and sieved with sieve no 80 so as to maintain the particle size.
- Further, these chemicals were subjected to mixing in mortar and pestle and triturated with accurately weighed sorbitol until semisolid mass formed.

Addition of herbal ingredients

- Accurately weighed herbal extract in form of powders were sieved and added to the base along with Aloe Vera gel and clove oil.
- Peppermint oil was added as a flavoring at the end [12, 13].

Evaluation and comparison of herbal toothpaste [9, 10]

Physical Examination (Colour, odour, taste, smoothness, relative density)

Formulated toothpaste was evaluated for its colour, visually colour was checked. Odour was found by smelling the product. Taste was checked manually by tasting the formulation. The Smoothness was tested by rubbing the paste formulation between the fingers.

Inertness of tube

The container used for herbal toothpaste was not produce any corrosion or deterioration in normal storage conditions like heating temperature at 45±2 0C for ten days. Inertness of tube was observed by cutting the internal surface, open it and observing whether any sign of deterioration or chemical reactions occurred in the container.

pH

Dispense 10 gm of the toothpaste from the container in a 50 mL beaker and add 10 mL of freshly boiled and cooled

water (at 270C) to make50 percent aqueous suspension. Stir well to make a thorough suspension.

Determine the PH of the suspension within 5 min, using a PH meter

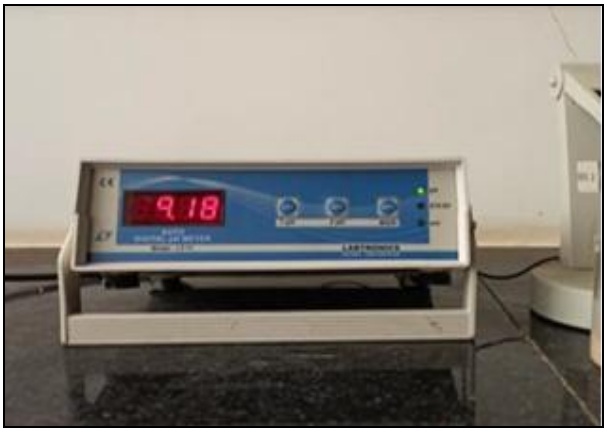


Fig 1: pH meter

Homogeneity

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

Determination of sharp and edge abrasive particles

The contents on to the finger and scratched on the butter paper for 15-20cm long to check for the presence of any sharp or abrasive particles. Repeated the same process for at ten times. No sharp or edge abrasive particles were found.

Foamability

The foaming power (Foamability) of herbal toothpaste was determined by taking 2g of toothpaste with 5ml water in measuring cylinder initial volume was noted and then shaken for 10 times. Final volume of foam was noted.

Fig 2: Foamability testing

Determination of moisture and volatile matter

Moisture and volatile matter was determined by using 5gm of herbal toothpaste was placed in a porcelain dish of about 6-8cm in diameter and 2-4cm in depth. Dried in an oven at 1050C. Calculations:

- % by mass = 100Ml / M
- Ml-Loss of mass (g) on drying
- M-Mass (g) of the material taken for the test.

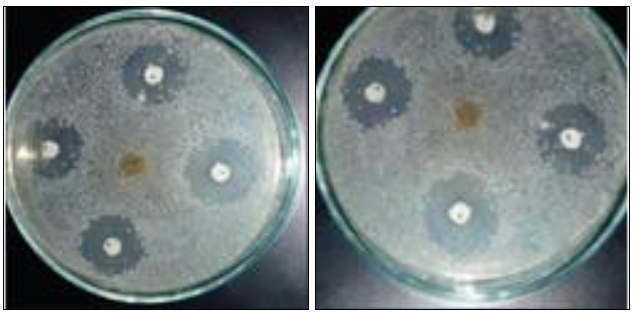
Determination of Spreadability

For determination of Spreadability method slip and drag characteristic of paste involve. The about 1-2g of herbal toothpaste was weighed and placed between two glass slides (10 x 10cm) one over each other (sliding, shall not take place), and the slides were pulled in opposite direction. Measure the spreading (in cm) of the toothpaste after 3 minutes. Repeating the experiment and noted the average value of three readings.

Fig 3: Determination of moisture and volatile content

Anti-microbial activity

In vitro anti-bacterial study of formulated paste was performed by disc diffusion method by using Soyabean casein digest medium against a pathogenic bacterial strain E coil. *E coil* was initially cultured cells were tend to multiple in the agar plates. Initially plates were streaked with inoculum, bores were made with 5mm diameter into the medium using a sterile cork borer. The surface of the agar plate was rotated to ensure an equal distribution of inoculums present around the bore. Then the formulated paste and marketed formulations were placed in the bores on the cultured plates. The plates were wrapped with paraffin, labelled, and incubated at 37 °C for the 24 hour. Each plate was examined after incubation for 24 hrs. The diameter of zone of inhibition (ZOI) was measured in millimeters (mm) with a ruler.



A B

Fig 4: Zone of inhibitions showing comparative antimicrobial activity of formulated herbal toothpaste in Figure A and zone of marketed herbal preparation shown in Figure

Results and Discussion

The formulated herbal toothpaste evaluation tests were carried out according to standard specified by bureau of Indian standard IS 6356-1993 for herbal toothpaste sample (Vedshakti, Dabur Red, Patanjali, Dantakanti, Meswak and

Formulated toothpaste sample). All the samples were complied with BIS and they found to be good quality. Formulated herbal toothpaste evaluation tests were carried out to compare different properties of formulated herbal and marketed toothpastes.

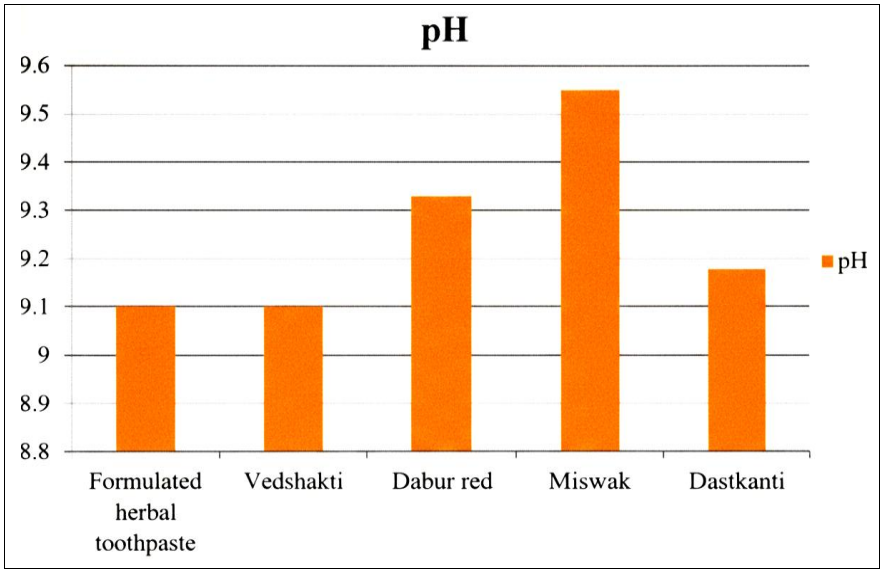


Fig 5: pH of formulated herbal toothpaste and marketed herbal toothpaste

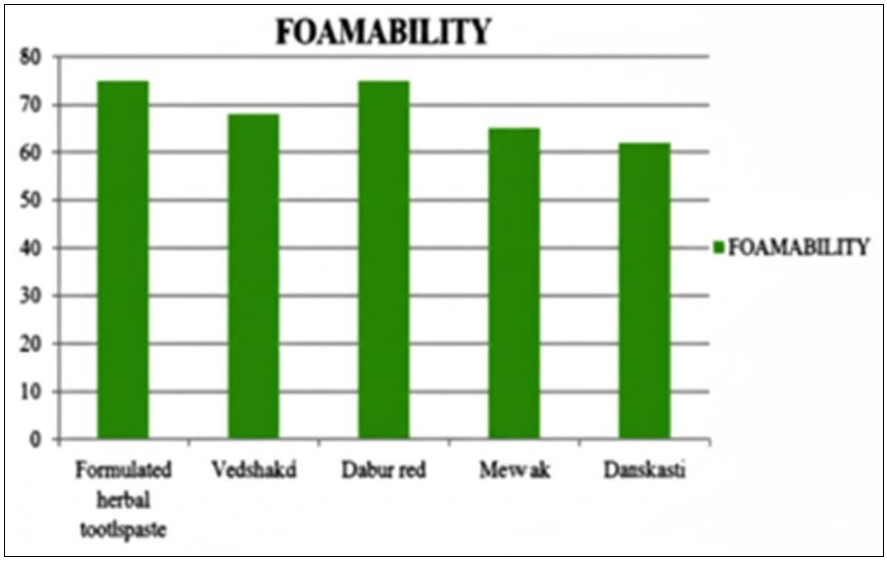


Fig 6: Foamability of formulated herbal toothpaste and marketed herbal toothpaste.

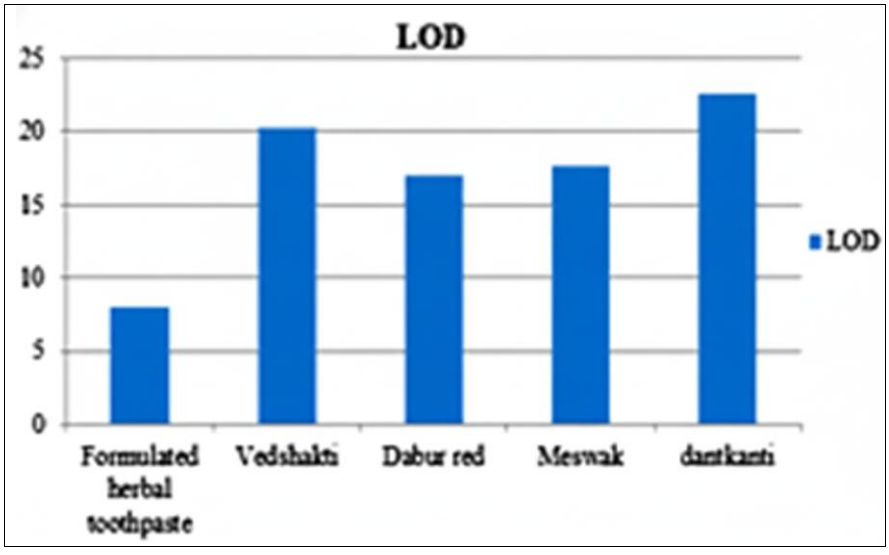


Fig 7: Loss on drying (LOD) of formulated herbal toothpaste and marketed herbal toothpaste.

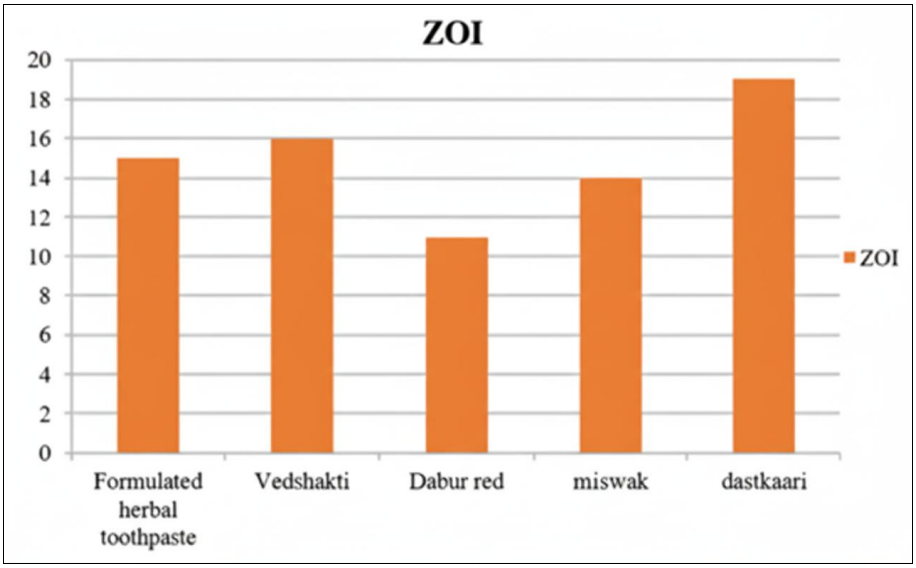


Fig 8: Zone of inhibition (ZOI) of formulated herbal toothpaste and marketed herbal toothpaste

All the results of evaluating parameters were given in table in the present study, comparatively equal and rarely better result have been observe with the form ulated herbal toothpaste than the marketed herbal toothpastes. Formulated herbal toothpaste was evaluated visually for its colour i.e. Yellowish brown. Odour was found by smelling the product i.e. aromatic and characteristic. Taste was checked manually by testing the formulation.

We found that all the toothpastes were having good consistency and smooth texture and also shown no symptoms for deterioration such as phase separation, gassing, fermentation when all samples were place at temperature of 34 +/-30 °C for period of 30 days. It confirmed that the toothpaste is stable.

The internal part of all collapsible tubes have given no sign of corrosion or damage during normal storage conditions at a temperature of 45±20 °C for 10 days. So it was confirmed that the containers of formulated herbal toothpaste as well as all marketed herbal toothpaste i.e. Colgate Vedshakti, Dabur Red, Dabur Meswak and Patanjali Dantkanti have shown good tube inertness.

The Smoothness was tested by rubbing the paste formulation between the fingers. The pH of formulated herbal toothpaste was compared to other herbal marketed formulations and it was found to be 9.10 and therefore it complied with BIS limit given in Figure 5.

The foamability of formulated herbal toothpaste is more than commercial formulation. Loss on drying of formulated herbal toothpaste was found to be minimum than other marketed herbal formulation. While zone of inhibition of formulated herbal toothpaste was found to be 15mm Figure 6. The activity increases in terms of abrasiveness and spreadability. Comparison of abrasiveness of marketed pastes with formulated herbal toothpaste suggests that formulated herbal toothpaste has more abrasiveness than the marketed pastes.

The loss on drying of formulated herbal toothpaste as compare to other marketed toothpaste is less and is observed that formulated herbal toothpaste decreases chances of loss than other Figure 7.

Antimicrobial activity of formulated herbal toothpaste were compared with marketed herbal toothpaste. It was observed that, formulated herbal toothpaste has good antimicrobial activity and same efficacious with that of marketed one.

Conclusion

Following conclusion can be drawn from the results obtained in the present work of investigation. This herbal toothpaste is having prominent function in the maintaining the oral hygiene and preventing dental caries and are safer with minimum side effect than chemical based synthetic toothpaste. All the marketed herbal toothpaste and lab-made had been evaluated and compared with the standards specified by Bureau of Indian standards. Formulated toothpaste is capable to maintain the tooth and oral hygiene and shows antimicrobial activity against microbes like E. coli. Evaluation and comparison of results with commercial Herbal toothpaste are demonstrated that formulated herbal toothpaste is having equal helpful and fascinating over the marketed formulations (Colgate Vedshakti, Dabur Meswak, Patanjali Dantkanti and Dabur red). This preliminary in-vitro study demonstrated that Herbal toothpaste was equally efficacious as marketed popular toothpastes in terms of all evaluation properties of toothpaste. The formulated herbal toothpaste has good scope in the future by increasing natural ingredients for manufacturing more and safer natural remedies, in the research and health of dental care of public, society and nation. It is concluded that formulated Herbal toothpaste was found to be of good quality.

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