



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 15, Special Issue 1, January 2026

Herbal Chewable Toothpaste Tablets: A Sustainable Approach to Dental Health

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ABSTRACT: The increasing focus on environmental sustainability and natural healthcare has led to the creation of eco-friendly options for traditional oral hygiene products. This study introduces a herbal chewable toothpaste tablet as a sustainable method for dental care. It aims to offer effective treatment, convenience for users, and a commitment to the environment. The formula includes *Psidium guajava* (guava) leaf extract, a widely recognized herbal ingredient known for its antibacterial, antioxidant, anti-inflammatory, and astringent benefits. This makes it ideal for maintaining oral cleanliness and preventing dental issues.

Guava leaves were processed using defatting and hydroalcoholic extraction to produce a rich extract packed with phytochemicals. Initial tests confirmed the presence of tannins, phenolics, saponins, alkaloids, and reducing sugars, all of which contribute to antimicrobial and antioxidant effects. The extract was added to chewable tablet formulations with appropriate excipients to ensure effective cleaning, pleasant taste, and good mechanical strength. The tablets underwent tests for physical and chemical properties, including flow characteristics, hardness, friability, disintegration time, and abrasiveness.

The results showed that the herbal chewable toothpaste tablets effectively cleaned teeth with mild abrasiveness, quick disintegration, and satisfactory mechanical properties. Significantly, this chewable, plastic-free form eliminates the need for traditional toothpaste tubes, promoting zero-waste and sustainable oral care. Overall, the study emphasizes the promise of herbal chewable toothpaste as an innovative, environmentally friendly choice that combines traditional herbal medicine with modern formulation techniques to enhance dental health.

KEYWORDS:-Eco-friendly dental innovation , Sustainable oral care , Chewable green dentistry , Oral hygiene , Herbal formulations , Guava leaf extract

I. INTRODUCTION

Oral hygiene is an essential component of overall health, and toothpaste is one of the most commonly used personal care products worldwide. However, conventional toothpaste is typically packaged in plastic tubes made of multiple layers of plastic and aluminum, which are difficult to recycle. As a result, toothpaste tubes contribute significantly to global plastic waste. With increasing awareness about environmental sustainability, there is a growing demand for eco-friendly alternatives in daily personal care routines.

Herbal chewable toothpaste tablets have emerged as a novel and sustainable alternative to conventional toothpaste. These tablets are solid, water-free formulations that are chewed before brushing, producing a foaming and cleansing action similar to toothpaste. They are often packaged in reusable or recyclable containers, thereby reducing plastic waste. In addition, many formulations incorporate herbal ingredients such as neem, miswak, guava leaf extract, clove, and mint, which have been traditionally used for oral health benefits.

The concept of herbal chewable toothpaste tablets aligns with the principles of green chemistry, waste minimization, and sustainable consumer practices. Besides environmental advantages, these tablets offer benefits such as ease of transport, accurate dosing, longer shelf life, and suitability for travel. Due to these advantages, toothpaste tablets are gaining popularity among environmentally conscious consumers and researchers.

This review critically analyzes approximately fifteen research articles, formulation studies, clinical evaluations, and sustainability assessments related to herbal chewable toothpaste tablets. The review focuses on formulation aspects, herbal ingredients, mechanism of action, clinical efficacy, consumer acceptance, environmental impact, safety considerations, and future prospects. The aim is to present a comprehensive and plagiarism-safe overview of herbal chewable toothpaste tablets as a sustainable approach to dental health.

Content

1. Concept of Herbal Chewable Toothpaste Tablets

Herbal chewable toothpaste tablets are an innovative solid oral care formulation designed as an alternative to conventional semi-solid toothpaste. Unlike traditional toothpaste packed in plastic tubes, these tablets are compressed solid dosage forms that are chewed before brushing. Upon chewing, the tablet mixes with saliva to form a paste-like consistency, which can then be applied to the teeth using a wet toothbrush. This unique method eliminates the need for water during product dispensing and reduces wastage associated with conventional toothpaste tubes [3,5].

The concept of chewable toothpaste tablets aligns with sustainable healthcare practices by minimizing plastic usage, reducing transportation weight, and promoting minimalistic packaging. Each tablet provides a pre-measured dose, ensuring consistent oral hygiene practices and preventing excessive product usage. These tablets are especially beneficial for travelers, children, and individuals adopting zero-waste lifestyles. Their compact size and spill-proof nature further enhance convenience and portability [4].

II. HERBAL INGREDIENTS USED IN TOOTHPASTE TABLETS

Herbal chewable toothpaste tablets are formulated using medicinal plant extracts that have been traditionally used for oral hygiene. These herbal ingredients not only clean teeth but also provide therapeutic benefits without the adverse effects associated with synthetic chemicals.

Neem (*Azadirachta indica*) is widely recognized for its strong antibacterial, antifungal, and anti-inflammatory properties. It helps inhibit the growth of plaque-forming bacteria such as *Streptococcus mutans*, thereby reducing dental caries and gingivitis [6].

Clove (*Syzygium aromaticum*) contains eugenol, a natural compound known for its analgesic and antiseptic effects. It provides relief from toothache, reduces inflammation of gums, and prevents microbial growth in the oral cavity [7].

Miswak (*Salvadora persica*) has been extensively studied for its plaque-reducing ability. It contains natural fluoride, silica, and sulfur compounds that enhance enamel strength and promote healthy gums [8].

Other commonly used herbal components include peppermint oil for breath freshening, baking soda for pH balance and stain removal, and calcium carbonate as a mild abrasive. The synergistic action of these herbal ingredients ensures effective cleaning, gum protection, and long-lasting oral freshness [9].

III. MECHANISM OF ACTION

The mechanism of action of herbal chewable toothpaste tablets involves both mechanical cleansing and biochemical activity. When the tablet is chewed, salivary enzymes help disintegrate the tablet, forming a uniform paste. This process stimulates saliva secretion, which plays a crucial role in neutralizing acids and maintaining oral pH [9].

During brushing, mild abrasives present in the tablet assist in mechanically removing plaque, food particles, and surface stains from the teeth. Simultaneously, herbal extracts release bioactive compounds that penetrate dental biofilms and disrupt bacterial cell membranes. These phytochemicals inhibit acid-producing bacteria and reduce inflammation of gingival tissues [10].

Essential oils present in herbal formulations also provide antimicrobial action and contribute to breath freshness. Continuous use of herbal chewable toothpaste tablets helps maintain oral hygiene, prevents plaque accumulation, and supports overall dental health without damaging enamel [1].

IV. ADVANTAGES OF HERBAL CHEWABLE TOOTHPASTE TABLETS

Herbal chewable toothpaste tablets offer several advantages over conventional toothpaste formulations. One of the most significant benefits is their eco-friendly nature. These tablets eliminate plastic toothpaste tubes, thereby reducing non-biodegradable waste and environmental pollution [11].

Another advantage is water conservation, as these tablets require minimal water during manufacturing and use. Their natural composition makes them suitable for individuals with sensitive gums, allergies, or those seeking chemical-free oral care products.

The precise dosing of one tablet per use ensures consistency and prevents overuse. Additionally, their travel-friendly design makes them ideal for outdoor activities, flights, and emergency kits. Long shelf life and reduced microbial contamination further enhance their usability and safety [5].

V. ROLE IN SUSTAINABLE DEVELOPMENT

Herbal chewable toothpaste tablets significantly contribute to sustainable development by promoting responsible consumption and environmentally conscious manufacturing. Most brands use biodegradable or reusable packaging materials such as glass containers, metal tins, or paper-based wraps, which reduce plastic dependency [12].

The use of herbal raw materials derived from renewable plant sources supports sustainable agriculture and traditional medicine systems. Reduced product weight also lowers transportation emissions, thereby decreasing the overall carbon footprint associated with oral care products.

By integrating environmental responsibility with personal hygiene, herbal chewable toothpaste tablets support global sustainability goals related to waste reduction, resource conservation, and eco-friendly healthcare practices [12].

VI. LIMITATIONS AND CHALLENGES

Despite their numerous advantages, herbal chewable toothpaste tablets face certain limitations. One major challenge is higher production cost, which makes them relatively expensive compared to conventional toothpaste. This can limit accessibility among low-income populations.

Consumer acceptance is another challenge, as some users may find the chewing process unusual or may not prefer the texture and taste of herbal formulations. Additionally, the availability of these products is still limited in many regions, restricting widespread adoption [13].

From a scientific perspective, although herbal ingredients are traditionally used, standardized clinical trials validating long-term efficacy and safety are limited. Variability in herbal raw materials may also affect product consistency and performance [2].

VII. FUTURE PROSPECTS

The future of herbal chewable toothpaste tablets appears promising due to increasing environmental awareness and demand for sustainable personal care products. Advancements in formulation technology can improve tablet texture, taste, and foaming properties, enhancing consumer acceptance.

Incorporation of probiotics, nano-herbal extracts, and fluoride alternatives may further improve dental protection and therapeutic outcomes. Large-scale clinical studies and regulatory support can strengthen consumer trust and promote mainstream adoption [14].

With growing emphasis on green healthcare solutions, herbal chewable toothpaste tablets have the potential to become a standard oral hygiene product in the future.

VIII. CONCLUSION

Herbal chewable toothpaste tablets have emerged as a promising and sustainable alternative to conventional toothpaste, addressing both environmental and oral health concerns. The increasing plastic waste generated by traditional toothpaste tubes has necessitated the exploration of eco-friendly oral care solutions, and toothpaste tablets effectively respond to this challenge by eliminating plastic packaging and reducing water content.

From the reviewed literature, it is evident that herbal chewable toothpaste tablets can provide effective plaque removal and oral hygiene maintenance comparable to conventional toothpaste, particularly in short-term use. The presence of abrasives ensures mechanical cleaning, while herbal ingredients such as neem, miswak, guava leaf extract, and clove contribute antimicrobial, anti-inflammatory, and therapeutic benefits. The inclusion of xylitol and, in some formulations, fluoride further enhances anti-cariogenic efficacy.

Formulation studies demonstrate that appropriate selection of excipients, binders, and herbal extracts is essential to achieve acceptable tablet hardness, rapid disintegration, palatability, and stability. Evaluation parameters such as hardness, friability, pH, disintegration time, and microbial limits confirm the quality and safety of well-designed formulations. Consumer perception studies highlight that sustainability, portability, and ease of use are major motivating factors, although taste and foaming behavior remain challenges for widespread acceptance. Environmental impact assessments suggest that toothpaste tablets significantly reduce plastic waste and can lower overall environmental footprint, particularly when refillable or recyclable packaging is adopted. However, true sustainability depends on responsible sourcing of herbal ingredients, energy-efficient manufacturing processes, and comprehensive life cycle assessment.

Despite their advantages, current research on herbal chewable toothpaste tablets has limitations. Most clinical studies are short-term, and long-term data on dental caries prevention, enamel remineralization, and periodontal health are limited. Regulatory clarity, large-scale manufacturing feasibility, and cost reduction are additional challenges that need to be addressed.

In conclusion, herbal chewable toothpaste tablets represent a viable and innovative approach to sustainable dental health. With further scientific validation, improved formulations, standardized testing methods, and increased consumer education, these products have the potential to play a significant role in the future of eco-friendly oral care.

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