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Review Article on Herbal Toothpaste

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Abstract: *The global oral care market is undergoing a transformative shift, with herbal and plant-based toothpastes rapidly gaining ground against conventional synthetic formulations. Driven by heightened consumer awareness, growing concerns over the long-term safety of chemicals such as fluoride, sodium lauryl sulphate (SLS), triclosan, and artificial preservatives, and an increasing demand for sustainable and eco-friendly personal care products, herbal toothpastes have emerged as a scientifically credible and commercially viable alternative.*

This comprehensive review article explores the full spectrum of herbal toothpaste research, covering the selection, characterization, and therapeutic mechanisms of key herbal ingredients; the detailed formulation processes for both conventional herbal pastes and the newer herbal tooth tablet (tooth tab) format; rigorous evaluation methodologies including physicochemical, microbiological, and clinical assessments; and the challenges and future perspectives that shape this rapidly evolving field.

The primary herbal actives examined including neem (Azadirachta indicia), clove (Syzygium aromatic), aloe vera (Aloe barbadensis), tulsi (Ocimum sanctum), peppermint (Mentha piperita), tea tree oil (Melaleuca alternifolia), cardamom (Elettaria cardamom), and triphala — have each demonstrated well-documented antimicrobial, anti-inflammatory, antioxidant, and plaque-inhibitory properties through both in vitro and in vivo studies.

The review further addresses the emerging concept of herbal tooth tablets as a zero-waste, preservative-free, and portable alternative to conventional tube-based toothpaste, highlighting their Ayurvedic formulation principles, manufacturing processes, and ecological advantages.

Clinical evidence drawn from randomized controlled trials (RCTs), systematic reviews, and meta-analyses confirms that herbal dentifrices can significantly reduce plaque indices, gingival bleeding scores, and microbial load with minimal adverse effects. However, the review also acknowledges the pressing need for standardization of herbal raw materials, rigorous long-term clinical trials, and robust regulatory frameworks to ensure consistent product quality and patient safety.

Taken together, this review provides a detailed scientific foundation for understanding herbal toothpaste as a legitimate therapeutic tool in preventive dentistry, and charts the trajectory of future innovation in this domain — from personalized oral microbiome-based formulations to nanotechnology-enhanced herbal delivery systems.

Keywords: Oral health

I. INTRODUCTION

Oral health is not just about having a clean mouth and fresh breath — it is deeply connected to our overall health and well-being. [1,2] Diseases of the mouth, including tooth decay, gum infections, and bad breath, are among the most widespread health problems in the world. [3,4] The World Health Organization (WHO) has estimated that oral diseases affect nearly 3.5 billion people globally, making them one of the most significant and underappreciated public health challenges of our time. [5,6] Despite the availability of modern dental products and professional care, oral disease rates remain alarmingly high in both developing and developed nations. [7,8]

India has long been called the 'Botanical Garden of the World,' and for good reason. [9,10] The country is home to more than 45,000 plant species, thousands of which have been used for centuries in traditional healing systems. [11] Long before modern dentistry existed, people across Asia, Africa, the Middle East, and the Americas brushed their

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teeth with herbal twigs, rinsed their mouths with plant-infused water, and applied herbal pastes to soothe sore gums and fight infections. [12,13] These were not merely cultural habits — they were grounded in real medicinal properties that modern science is now confirming through laboratory studies and clinical trials. [14,15]

In recent decades, there has been a major shift in how consumers think about health products. [16,17] People have become increasingly concerned about the potential side effects of synthetic chemicals found in conventional toothpastes — ingredients like sodium lauryl sulphate (SLS), artificial sweeteners, bleaching agents, and fluoride at high concentrations. [18,19,20] Some studies have linked SLS to mouth ulcers and soft tissue irritation; excessive fluoride intake has been associated with dental fluorosis in children; and long-term use of chlorhexidine antiseptic toothpastes has been connected to tooth discoloration and changes in taste perception. [21,22,23] These concerns have driven millions of consumers toward natural, plant-based alternatives, and herbal toothpastes have stepped in to fill this gap. [24,25]

Herbal toothpastes use plant-derived ingredients — extracts, powders, and essential oils — as their primary active components, rather than relying on synthetic chemicals. [26,27] They are designed to clean the teeth, prevent disease, freshen breath, and support gum health, all while being gentler on the body and the environment. [28,29] The global market for herbal dental products have grown rapidly, with brands such as Himalaya, Patanjali, Dabur, Meswak, and others capturing significant market share in Asia, Europe, and North America. [30,31]

This review article brings together findings from more than 120 published studies to provide a thorough, up-to-date, and accessible overview of herbal toothpastes. [32,33]

It covers the science of key herbal ingredients, the most common oral diseases they target, the formulation and quality testing of herbal toothpaste products, comparisons with conventional toothpastes, safety considerations, regulatory frameworks, and the exciting future directions for this field. [34,35] Whether you are a researcher, a pharmacist, a dentist, a student, or simply someone curious about natural oral care, this article aims to give you a clear and complete picture of what herbal toothpastes are and why they matter. [36] Toothpaste, as the primary vehicle for active ingredients in daily oral hygiene, has been central to preventive dentistry since the late nineteenth century. [37,38] Over the decades, the formulation of conventional toothpaste has evolved considerably — from simple chalk and chalk-based pastes to sophisticated multi-component formulations incorporating fluoride for caries prevention, SLS as a surfactant and foaming agent, triclosan as an antimicrobial, and a range of synthetic flavours, colorants, and preservatives. [39,40]Despite the well-established caries-preventive efficacy of fluoride, concerns have emerged around fluorosis when fluoride-containing products are used in excess, particularly among young children. [41] Similarly, SLS has been implicated in the aggravation of recurrent aphthous stomatitis, gingival irritation, and oral mucosa sensitivity in susceptible individuals. [42,43] Triclosan, once a staple antimicrobial in oral care, has been banned or restricted in several countries due to concerns about hormonal disruption and development of antimicrobial resistance. [44,45]

These growing concerns, combined with a culturally-rooted global preference for natural and traditional remedies — particularly in South and Southeast Asia, where Ayurveda oral hygiene practices have been in use for thousands of years — have created fertile ground for the rapid growth of the herbal oral care market. [46,47,48] Traditional medicine systems including Ayurveda, Traditional Chinese Medicine (TCM), and indigenous African and Native American healing traditions have long employed plant-based materials such as neem twigs, clove oil, and peppermint leaves for their oral hygiene properties. [49,50]

Modern pharmaceutical technology has now harnessed these traditional insights, formulating them into standardized, shelf-stable, and clinically tested herbal toothpaste products. [51]

These products are formulated using scientifically characterized phytochemical extracts that provide a range of oral health benefits — from broad-spectrum antimicrobial activity and anti-inflammatory action to antioxidant protection, plaque inhibition, and enamel remineralisation. [52,53]

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II. UNDERSTANDING THE MOUTH AND COMMON ORAL DISEASES

Structure of the Teeth and Oral Cavity

Before we can understand oral diseases, it helps to know a little about the structure of the mouth itself. [54,55] The human mouth contains two sets of teeth over a lifetime: the primary (baby) teeth and the permanent (adult) teeth. [56] A child normally develops 20 primary teeth, while a healthy adult has 32 permanent teeth, including the four wisdom teeth. [57] Each tooth is made up of several distinct layers. The outermost layer, the enamel, is the hardest substance the human body produces. [58] Beneath the enamel lies the dentine, which is softer and contains tiny microscopic channels called dentinal tubules. [59] At the very centre of the tooth is the pulp — a soft tissue containing nerves and blood vessels. When the enamel becomes damaged or the gums pull back and expose the dentine, pain and sensitivity follow. [60,61] Protecting the outer structures of the teeth is therefore the primary goal of any good toothpaste.

The gums, also known as the gingiva, play an equally important role in oral health. [62] They form a protective seal around the base of each tooth, preventing bacteria from reaching the roots and the underlying jawbone. [63] The entire mouth is lined with a moist mucous membrane that is constantly exposed to bacteria, food particles, and other substances. [64] Maintaining a clean, healthy oral environment is essential not just for dental health but for overall systemic health as well, since bacteria from the mouth can enter the bloodstream and affect the heart, lungs, and other organs. [65,66]

Dental Caries (Tooth Decay)

Dental caries — commonly known as tooth decay or cavities — is one of the most prevalent diseases in the world. [67,68] According to the WHO, it affects an estimated 2.3 billion people globally and is particularly widespread among children and young adults. [69,70] Caries is caused by specific bacteria — most notably Streptococcus mutans — that naturally live in the mouth and feed on the sugars and carbohydrates we consume. [71,72] As these bacteria digest sugar, they produce organic acids as a by-product. These acids gradually dissolve the minerals in the tooth enamel in a process called demineralization. [73]

What Makes a Good Toothpaste?

Not all toothpastes are equal, and understanding what makes a truly good toothpaste helps us appreciate why herbal formulations deserve serious attention. [74,75] A good toothpaste should effectively clean the teeth and remove plaque without being so abrasive that it damages the enamel. [76] It should deliver active ingredients to the teeth and gums in a way that prevents disease and promotes healing. [77] It should leave the mouth feeling genuinely fresh, not just temporarily masked with flavouring. [78] It should be free from ingredients that are toxic, irritating, or harmful when swallowed in small amounts — particularly important for children's toothpastes. [79] It should be stable, affordable, and suitable for daily use by people of all ages. [80]Herbal toothpastes are designed to overcome these limitations by using naturally occurring plant compounds that are effective, gentle, and safe. [81] While they may not produce the same dramatic foam as conventional products (because many reduce or eliminate SLS), they clean just as effectively when used correctly and provide additional therapeutic benefits — such as anti-inflammatory action, antioxidant protection, and tissue healing — that conventional toothpastes cannot match. [82]

Key Herbal Ingredients in Toothpaste Formulations

The effectiveness of any herbal toothpaste depends entirely on the plants it uses and the quality of those ingredients. [83] Over centuries of traditional medicine — particularly within Ayurveda, Unani, Traditional Chinese Medicine, and African herbal traditions — certain plants have proven themselves again and again as powerful protectors of oral health. [84] Modern science has now begun to identify and study the specific chemical compounds responsible for these protective effects, validating what traditional healers knew through observation and experience. [85]

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Neem (Azadirachta indica)

Neem is perhaps the most celebrated plant in Ayurveda oral care, and its reputation is richly deserved. For hundreds of years, people across India, Pakistan, Bangladesh, and much of sub-Saharan Africa have chewed neem twigs as a natural toothbrush each morning. The act of chewing releases the active compounds in the twig, which coat the teeth and gums with a natural protective film. Fresh neem twigs have bristle-like ends when chewed, providing both the mechanical cleaning of brushing and the chemical benefits of neem's phytochemicals simultaneously. [86]

Tulsi (Ocimum sanctum — Holy Basil)

Tulsi, or holy basil, holds a uniquely sacred place in Indian culture and is one of the most respected medicinal herbs in Ayurveda. Every part of the Tulsi plant — leaves, stems, seeds, and roots — has been used in traditional medicine for a wide range of conditions, from respiratory infections to skin diseases to oral complaints. In oral care specifically, Tulsi has been valued for its ability to clean the mouth, freshen breath, and protect the gums from infection. [87]The essential oil of Tulsi contains a potent mixture of bioactive compounds, including eugenol, linalool, caracole, methyl eugenol, and rosmarinic acid. These compounds have been shown in multiple studies to have strong antibacterial, antifungal, anti-inflammatory, and antioxidant properties. [88]

Clove (Syzygium aromaticum)

Clove is one of the most pharmacologically well-studied spices in the world, and its role in oral care has a history stretching back thousands of years. The use of cloves to relieve toothache pain is documented in ancient Chinese, Indian, and Egyptian medical records. [89] Clove oil contains eugenol as its primary active compound a substance with documented local anaesthetic properties that is still used by dentists today as a topical pain reliever and as the active ingredient in many cavity-filling materials. [90]

Cinnamon (Cinnamomum zeylanicum)

Cinnamon is one of the oldest and most widely used spices in human history, prized since antiquity for its warm fragrance, distinctive taste, and medicinal properties. In Ayurveda, Chinese, and Egyptian traditions, cinnamon was used to treat a wide range of conditions, including oral infections and gum disease. Modern science has identified cinnamaldehyde the compound responsible for cinnamon's characteristic smell and flavour as the primary source of its antimicrobial power. [91]

Peppermint (Mentha piperita)

Peppermint is one of the most universally recognized and loved flavours in the world, and its role in oral care products goes far beyond simply making toothpaste taste nice. Peppermint essential oil contains menthol as its primary active compound, which provides the characteristic cooling and refreshing sensation associated with good oral hygiene products. Menthol acts on cold receptors in the mouth, creating a lingering perception of freshness that helps motivate regular brushing. [92]

Other Important Herbal Ingredients

In addition to the major ingredients discussed above, several other herbal substances are commonly included in toothpaste formulations, each contributing specific and well-documented oral health benefits. [93]

Babul (Acacia Arabica) also known as gum Arabicis a traditional tooth-cleaning ingredient used across South Asia and Africa. The bark and leaves of the babul tree are rich in tannins, which have strong astringent properties that tighten gum tissue, reduce bleeding, and help prevent bacterial adhesion to tooth surfaces. The tannins in babul form a protective film over the tooth enamel that can help resist acid attack from cariogenic bacteria. [94]

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Formulation and Preparation of Herbal Toothpastes

Key Excipients (Supporting Ingredients)

A toothpaste is not simply a collection of active herbal ingredients — it is a carefully engineered formulation that depends on a range of supporting substances called excipients to function properly. These excipients determine the texture, stability, foaming behaviour, shelf life, taste, and appearance of the finished product, and choosing them wisely is just as important as selecting the right herbal actives. [95]

Calcium carbonate, typically included at 35 to 50 percent of the formulation, serves as the primary abrasive. [96] It gently removes food particles, stains, and soft deposits from the tooth surface without damaging the enamel when used at the correct particle size and concentration. [97] Glycerine, at 20 to 30 percent, acts as a humectant it attracts and holds moisture, preventing the paste from drying out and keeping it smooth and spreadable. [98] Guar gum or carbomer, at around 5 percent, functions as a thickener and binder, giving the paste its characteristic smooth, consistent texture and preventing it from separating during storage. [99,100]

Sodium lauryl sulphate (SLS), typically at 5 to 15 percent, is the foaming agent that creates lather during brushing. [101] However, because of concerns about oral irritation, many herbal toothpaste manufacturers choose to reduce the concentration of SLS or replace it entirely with gentler alternatives like cocamidopropyl betaine or sodium cocoyl glutamate. [102,103] Sodium saccharin at 1 percent provides sweetness without contributing to tooth decay. [104] Titanium dioxide at 5 percent gives the paste its characteristic white colour. [105] Preservatives such as methyl paraben and sodium benzoate, at 2 to 5 percent, extend the shelf life of the product by preventing microbial contamination. [106] Xylitol at 2 percent performs double duty — both sweetening the paste and actively inhibiting cariogenic bacteria. [107]

Methods of Preparation

The preparation of an herbal toothpaste begins with careful collection, quality control, and processing of the plant raw materials. [108] Fresh or dried plant material is first cleaned to remove dirt and contaminants, then dried under carefully controlled temperature conditions to preserve its active compounds. [109] The dried material is ground into a fine, uniform powder using mechanical mills, with particle size controlled to ensure smooth texture in the final product. [110] Plant extracts may also be prepared by soaking the material in solvents such as water or ethanol and then evaporating the solvent to concentrate the active compounds. [111,112]

The actual preparation of the toothpaste paste can be accomplished using two principal methods: the dry gum method and the wet gum method. [113] In the dry gum method, all dry ingredients the herbal powder, calcium carbonate, thickener, and other solids are blended together first in a mixing vessel. [114] The liquid ingredients, including glycerine, water, and essential oils, are then gradually added while mixing continues, until a smooth, uniform, lump-free paste is achieved. [115] In the wet gum method, the thickening gum is first dispersed in the liquid phase to form a gel, and then the dry ingredients are incorporated into this gel base. [116] The wet gum method generally produces a smoother, more homogeneous product and is preferred for formulations that contain high concentrations of insoluble solid particles.

Essential oils such as clove oil, peppermint oil, fennel oil, and cinnamon oil must always be added at the very end of the preparation process, after the bulk of mixing is complete. [117] This is because essential oils are volatile they evaporate easily at elevated temperatures and adding them too early, when the mixing process is still generating heat, would result in significant loss of active compounds and a weaker, less fragrant final product. [118] The essential oils are typically dispersed in a small amount of glycerine or ethanol before being blended into the main paste to ensure even distribution. [119]

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Quality Evaluation and Testing

Once an herbal toothpaste has been prepared, it must undergo a rigorous series of quality tests before it can be used clinically or sold commercially. These tests ensure that the product is safe, effective, stable, and consistently manufactured to the required standard.

Physical examination involves assessing the paste's appearance (colour, uniformity, absence of grit or lumps), smelling its odour profile to ensure the herbal components are present at the right level, and taste testing by trained evaluators to assess flavour balance and palatability. [120] Relative density is measured using a density bottle and compared to a reference to assess the consistency and texture of the paste. [121] The abrasiveness of the paste is tested by pressing a strip of the paste onto a hard surface and examining it for sharp particles that could scratch enamel — this is critical because excessive abrasiveness is one of the most damaging properties a toothpaste can have. [122]

Foaming ability is measured by mixing the paste with a fixed volume of water, shaking it a set number of times, and measuring the volume of foam produced. [123] Good foaming ability — even without high concentrations of SLS — indicates an acceptable sensory cleaning experience. [124] pH determination is performed using a calibrated pH meter. The ideal pH range for a toothpaste is 6.5 to 8.0; below this range, the product becomes acidic enough to damage enamel, while excessively alkaline products irritate the soft tissues. [125] Moisture content testing ensures that the water activity of the formulation is low enough to prevent microbial growth during storage. [126]

Antimicrobial testing is performed using standard microbiological techniques such as the disc diffusion method (Kirby-Bauer test) and minimum inhibitory concentration (MIC) assays against target organisms including Streptococcus mutans, Staphylococcus aureus, Escherichia coli, Candida albicans, and others. [127] Stability testing involves storing the formulation under different temperature and humidity conditions — typically 4°C, 25°C/60% relative humidity, and 40°C/75% relative humidity — over a period of three to six months, and regularly checking for any changes in appearance, pH, spread ability, texture, and antimicrobial activity. [128,129] This ensures that the product remains safe and effective throughout its intended shelf life.

Types of Herbal Oral Care Products

Just as conventional oral care has evolved far beyond a single type of standard toothpaste, the herbal oral care market now offers a diverse and expanding range of products tailored to different needs, preferences, and oral health conditions. This diversity is one of the great strengths of the herbal approach the same rich toolkit of plant ingredients can be combined and proportioned in different ways to create targeted solutions for specific oral health challenges.

Standard herbal paste remains the most common and widely used format, containing a blend of herbal extracts, powders, and essential oils in a base of calcium carbonate and glycerine. [130] Suitable for daily use by adults and children, it provides broad-spectrum oral hygiene maintenance. Herbal whitening toothpaste uses naturally abrasive ingredients like activated charcoal, baking soda, or silica alongside herbal extracts to gently remove surface stains without the harsh bleaching chemicals found in conventional whitening products. [131] These products can lighten stained teeth over time without increasing sensitivity or damaging enamel.

Herbal toothpaste for sensitive teeth is formulated with a lower abrasive content and higher concentrations of soothing, anti-inflammatory herbs like Aloe Vera, chamomile, and marshmallow root. These formulations are appropriate for individuals with exposed dentine, enamel erosion, or after periodontal treatment when the gums are healing and sensitive. Fresh breath herbal toothpaste concentrates higher amounts of peppermint, fennel, cinnamon, and menthol alongside strongly antimicrobial herbs like neem and Tulsi, specifically targeting the bacterial population responsible for halitosis. [132]

Children's herbal toothpaste is made with child-friendly flavours mild fruit or bubble-gum-style mint and uses gentle herbal ingredients that are safe in the small amounts that inevitably get swallowed during a child's brushing routine. Many children's herbal toothpastes are completely fluoride-free or contain only very low fluoride concentrations suitable for young developing teeth. Anti-plaque herbal toothpaste focuses primarily on ingredients with strong

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documented anti-plaque and anti-gingivitis activity neem, Tulsi, guava leaf, and cinnamon to reduce bacterial load and slow the formation of plaque in high-risk individuals. [133]

Chewable herbal toothpaste tablets represent one of the most exciting recent innovations in the oral care space. These are small, solid tablets of compressed herbal ingredients that the user chews before brushing, creating a foamy paste that is then spread around the mouth with a wet toothbrush. Toothpaste tablets are entirely plastic-free, completely travel-friendly, produce no mess, and eliminate the issue of over-dispensing toothpaste. They are particularly popular among eco-conscious consumers and represent a genuine step forward in making herbal oral care more sustainable and accessible worldwide. [134]

How Do Herbal Toothpastes Compare with Conventional Ones?

The question that most people naturally ask about herbal toothpastes is simply this: do they actually work as well as regular toothpastes? The honest answer, based on the weight of available scientific evidence, is yes and in several important respects, they can work better. A growing body of comparative research has directly pitted herbal toothpastes against conventional synthetic products, and the results are consistently encouraging for the herbal side. [135]In terms of safety, herbal toothpastes have a clear advantage. Because they do not contain SLS, synthetic bleaching agents, or fluoride at high concentrations, they are significantly less likely to cause mouth ulcers, oral irritation, tooth sensitivity, or the discoloration associated with chlorhexidine. [136] They are considered safer for children — a population that routinely and accidentally swallows toothpaste while brushing — because the naturally derived plant compounds in properly formulated herbal products do not pose the same risks as synthetic additives in excess amounts. [137] Herbal toothpastes are also generally more affordable and more accessible, particularly in communities where locally grown medicinal plants are readily available. [138]

Safety, Side Effects, and Regulatory Considerations

One of the most compelling arguments in favour of herbal toothpastes is their safety profile. Unlike conventional toothpastes, which rely on synthetic preservatives, artificial sweeteners, petroleum-derived humectants, and high-potency synthetic antimicrobials, herbal toothpastes are based on naturally occurring compounds that human beings have been exposed to, consumed, and used medicinally for thousands of years. [139] This long history of safe traditional use provides a form of evidence that is genuinely meaningful, even if it does not meet the same standards as a modern randomized controlled trial.

That said, being natural does not automatically make a substance safe, and it is important to acknowledge that herbal products are not without risks. Some individuals may have allergic reactions to specific plant compounds for example, people with known allergies to other members of the daisy family (Asteraceae) may react to chamomile. [140] Essential oils in high concentrations can cause irritation of the oral mucosa or, if swallowed in large amounts, systemic toxicity. For this reason, the concentrations of essential oils in toothpaste formulations are carefully controlled. The broad consensus from the literature, however, is that properly formulated herbal toothpastes have an excellent safety record and are genuinely safer than conventional products for the vast majority of users. [141]

Regulatory oversight of herbal toothpastes varies significantly from country to country. In India, one of the world's largest producers and consumers of herbal oral care products, herbal toothpastes must meet the standards established by the Bureau of Indian Standards (BIS). [142] These standards cover safety, efficacy, and quality parameters including pH range, abrasiveness, microbial contamination limits, and heavy metal content. [143] In Europe, herbal toothpastes are regulated primarily as cosmetic products under EU Cosmetics Regulation 1223/2009, which requires safety assessment and proper labelling of all ingredients. [144] In the United States, toothpastes with therapeutic claims such as reducing plaque or preventing gingivitis — are regulated as over-the-counter drugs by the FDA. [145]

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III. FUTURE DIRECTIONS AND OPPORTUNITIES

The field of herbal oral care is at an exciting and pivotal moment. The scientific evidence base has grown substantially, consumer demand continues to rise, and manufacturing technology has improved to the point where high-quality, consistent, and affordable herbal toothpastes can be produced at commercial scale. [146] However, several important challenges and opportunities remain.Perhaps the most pressing need is for larger, better-designed, and longer-term clinical trials. Most of the clinical evidence currently available comes from small studies, often of short duration, and with variable methodology. [147] What the field urgently needs are multi-centre, randomized, double-blind, placebo-controlled trials that follow participants for at least one to two years, measure clinical outcomes rigorously (not just laboratory endpoints), and are conducted to internationally recognized standards (such as those of the CONSORT guidelines for reporting clinical trials). [148] Such trials would provide the high-quality evidence needed to satisfy regulatory requirements for therapeutic claims and to give healthcare professionals the confidence to actively recommend herbal products to their patients. There is also a significant opportunity to develop affordable, standardized herbal toothpaste formulations specifically for populations in low- and middle-income countries that currently have poor access to dental care and commercial oral hygiene products. [149] Many of the most effective herbal ingredients neem, Tulsi, guava, fennel, turmeric — can be locally grown in tropical and subtropical climates at very low cost. [150] Community-level herbal toothpaste production programs could dramatically improve oral health outcomes in underserved populations while simultaneously supporting local agriculture and traditional knowledge. [151]

IV. CONCLUSION

Herbal toothpastes are not a passing trend or a nostalgic return to the past — they represent a scientifically grounded, practically proven, and genuinely important approach to oral hygiene that draws on thousands of years of traditional wisdom and is increasingly validated by modern laboratory and clinical science. The key herbal ingredients reviewed in this article — Neem, Tulsi, Clove, Turmeric, Fennel, Cinnamon, Aloe Vera, Peppermint, Babul, Guava, and many others are rich in pharmacologically active phytochemicals including tannins, flavonoids, terpenoids, alkaloids, and essential oils. These compounds work individually and synergistically to provide genuine antimicrobial, anti-inflammatory, antioxidant, and tissue-healing benefits that are directly relevant to the prevention and management of the world's most prevalent oral diseases.

These toothpastes have been shown to be effective against dental caries, bad breath, gingivitis, periodontitis, and dentine hypersensitivity — the conditions that cause the most suffering and functional impairment in oral health worldwide. They are less abrasive than most conventional products, making them safer for tooth enamel and more appropriate for the large numbers of people who already have sensitivity issues. They are free from synthetic additives that cause side effects in vulnerable populations. They are genuinely safe for children. They are affordable and, in many cases, can be produced using locally available plant materials, making them accessible to communities that conventional commercial dental products do not reach.

The quality testing framework reviewed in this article — pH measurement, abrasiveness assessment, foaming test, stability testing, and antimicrobial evaluation — demonstrates that herbal toothpastes can and should be held to the same rigorous standards as conventional products, and that they consistently meet or exceed those standards when properly formulated. The comparative clinical evidence is consistently supportive of herbal formulations as effective tools in oral disease prevention, with a safety profile that is in many respects superior to that of their synthetic counterparts.

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