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Comparative study of antibacterial herbal gels with chlorhexidine gel for gum disorders

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Abstract
This review compares the benefits of antibacterial herbal gels to regular chlorhexidine gel. Many herbal extracts are available as gels to help maintain healthy dental hygiene. Poor oral hygiene is mostly caused by plaque formation and a rise in oral bacteria. Herbal gels like neem, clove oil, Bakul, babul, curry leaves, and others are effective at controlling plaque and reducing gingivitis, making them a safer alternative to chlorhexidine.

Keywords: Antibacterial herbal gel, chlorhexidine gel, dental plaque

Introduction

About 95% of population in India suffering from dental plaque, in that only 50% of population use toothpaste, gels and mouthwashes and just 2% visit dentist [1]. Genetics, systemic factors, and oral hygiene all influence susceptibility to dental and periodontal illnesses. Plaque is the primary cause of gingivitis and periodontitis. Antibacterial substances are frequently found in chemical products to prevent the formation of plaque. Gels, toothpaste, mouthwashes, sprays, irrigators, chewing gum, and varnishes are all options for administering anti-plaque chemicals. Following toothpaste and mouthwash, gels are the most commonly used method for delivering antimicrobial ingredients [2].

The World Health Organisation (WHO) describes "health" as "the state of total physical, mental, and social well-being, instead of simply the absence of illness or infirmity." People with good dental health may maintain their ideal social and functional roles by having a functional and visually suitable dentition. Oral health problems include changes in the form and function of the oro-facial region, such as having trouble speaking or biting food. As a result, a person's social well-being or quality of life suffers, either directly or indirectly.[3]

There is an important connection between oral and general well-being. Individuals with poor dental health face potential risks that include infectious endocarditis, gastrointestinal problems in the elderly, heart disease, stroke, bacterial pneumonia, and premature birth. Periodontitis and other oral infections have been linked to cardiovascular issues. Oral bacteria may cause rheumatic fever and infective endocarditis in patients receiving organ transplants, as well as other systemic issues. Oral infections can trigger cardiovascular disease by a combination of three pathways: direct microorganism-induced atheroma formation in the endothelium, indirect host-mediated actions, or an inherited proclivity for pathogenesis [4]. Figure 1 shows that the effect of periodontitis to cardiovascular diseases.

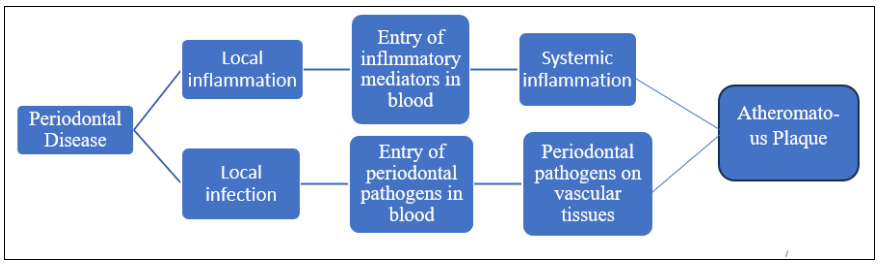

Fig 1: How periodontal diseases causes affect to cardiovascular issues

Dental caries, a progressive illness, is unique to mankind and one of the most prevalent cavities worldwide today. Dental strong acellular tissue gets harmed by acidic waste products produced by bacterial fermentation of dietary carbohydrates, specifically sucrose. It advances cautiously in most people due to an ecological imbalance in an equilibrium between minerals and oral biofilms, which are characterised by microbial activity, leading to changes in plaque pH triggered by infections, the production of acids, and the stabilising action of saliva and the surrounding tooth enamel [5].

Toothache was among the most prevalent explanation for oral pain. Yet, fractured teeth and exposed endodontic may result in endodontic hypersensitivity and dental pain. Untreated dental decay has been acknowledged as the most elementary root cause of toothache influencing everyday activities such as consuming food, studying, concentrating on delicate tasks, and so on. Multiple research studies on the impact of dental and face pain revealed that cavities in the tooth and challenges possess a direct impact on a community's quality of life [6].

Periodontal problems are a chronic inflammatory infection of the periodontal tissue with advanced symptoms such as cartilage destruction and loss of the surrounding bone called the alveolar bone. It is the primary reason of tooth loss and one of the two most serious risks to oral health. There are over 800 species of bacteria prevalent in the oral cavity, and it has been stated that the complicated mix of bacterial infection and host response, affected by behavioural factors such as smoking, may result in gum disease [7].

Gingivitis is a non- destructive scenario that causes inflammation in the Gingiva plaque- induced gingivitis is the most widespread category of gingivitis, as well as the most common type of periodontal disease in aggregate. Gingivitis is reversible by following proper and oral care, yet when not addressed, gingivitis can proceed to periodontitis an illness in which gum inflammation promotes tissue harm and bone resorption around the teeth. Periodontitis may eventually end in tooth loss [8]. Figure 2 indicates that different stages of periodontitis and finally leads to tooth loss.

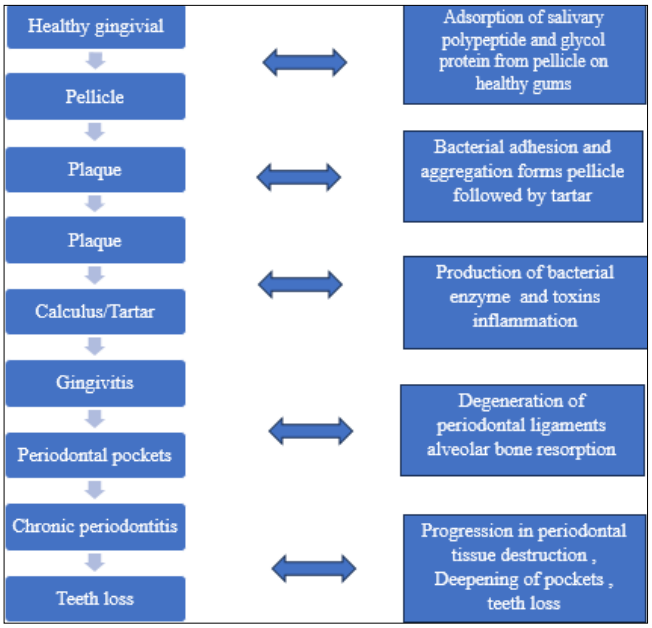

Fig 2: Various phases of periodontal and gingivitis diseases

The bacteria's that cause dental caries of *Streptococcus mutans, Streptococcus salivaris*.

Selective targeting of *S. mutans* in dental biofilms is a viable approach for controlling carries notwithstanding the diseases polymicrobial character s. mutans synthesis insoluble glucans from the sucrose, developing stable biofilm which enables bacteria to flourish on the tooth surface and acts as a diffusion barrier to maintain an acidic atmosphere for carcinogenic bacteria, current dental caries prevention methods advised targeting *S. mutans* especially to avoid the development of carcinogenic biofilms while preserving an optimal oral microbiota. Early investigation concentrated primary on the development of anti-*S. Mutans* vaccines [9].

Gram-negative anaerobic bacteria such as P. *gingivalis*, A. actinomycetemcomitans, and Treponema denticola, among others, have been recognised as essential pathogens responsible for chronic inflammation of PDL tissue. Although these bacteria use proteolytic enzymes to destroy the periodontium, it is now widely accepted that the host's response to these bacteria and their products, which improve the activity and manufacturing of host MMPs, is the main reason of PDL tissue damage [10]. Figure 3 shows factors that causes periodontitis.

Risk factors of periodontitis

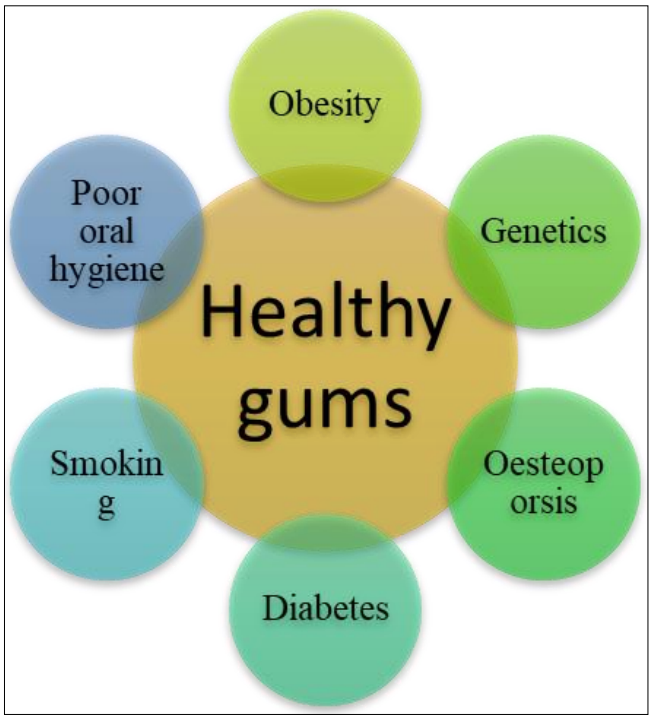

Fig 3: Risk factors that mainly causes periodontitis, a) Obesity b) Genetics c) Osteoporosis d) Diabetes e) Smoking f) Poor oral hygiene.

Gel

Gels frequently originate from a fluid stage thickened with various components like HPMC, carbopol and sodium CMC are usually produced by proficient experts. The term "gel" originates from the "gelatin" indicating "freeze" or "harden". This introduction demonstrates ways you can apply a fluid setup to key regions of strength a texture that is adaptable and maintain fluid features which is acceptable. Gels are semi-unbending structures where the growth of the scattering medium is maintained through a three-layer structure [11].

Chlorhexidine Gel

Chlorhexidine (CHX) has been recognised as the most effective prescription antibiotic for chemically eliminating plaque [12]. It is a chemical synthesis disinfectant with broad-spectrum antiseptic action that's effective against both Gram-positive and Gram-negative bacteria, as well as fungi. Chlorhexidine inhibits the development of dental plaque and addresses gingivitis by causing disruption the bacterial adhesion mechanism, degrading the bacteria's cell wall, and disintegrating cells [13].

Chlorhexidine particles and their different formulations has been researched multiple times, especially within the field of dentistry. Chlorhexidine management for mouth rinsing was immediately accompanied by oral contraindication, notably a possibility of triggering discoloration teeth or cytotoxic impacts subsequent oral surgery. The rewards however, are substantial, and its topical antimicrobial effect has been well demonstrated in *in- vitro* and in human trails.

This is the reason behind it is frequently usage in an array of dentistry areas of expertise [14].

Chlorhexidine gluconate is a gluconate salt, or biguanide molecule, thus that has been utilised for medicinal purposes since the 1950s. It additionally serves as a broad-spectrum antibacterial agent, resulting in disruption within the cellular membrane which helps treat gingivitis as well as periodontitis [15].

Chlorhexidine, a positively charged hydrophilic and lipophilic molecular structure, interacts with phospholipids and lipopolysaccharides on bacterial cell walls by active or passive transport. Its efficacy originates from the interaction of the molecules' positive charge with the negatively charged phosphate groups on microbial cell walls. This alters the pH of the cell and increases the permeability of its wall, allowing chlorhexidine molecules to enter the bacteria [16].

Interestingly, chlorhexidine exhibits distinct consequences at different dosages, without lesser amounts being bacteriostatic and deeper ones that being bactericidal. The exact concentration at which the chemical reaction is bacteriostatic or bactericidal fluctuates per bacterial category [17].

The bis-biguanide chlorhexidine extensively investigated for over twenty years and has since become the most influential chemotherapeutic pharmaceutical against Mutans streptococci. It has against both gram-positive and gram-negative bacteria. It is more successful against Mutans streptococci than *Streptococcus sanguinis* or *lactobacillus*. Studies have dem5nstrated that chlorhexidine has an antibacterial effect against *S. mutans* [18].

Herbal Gel

Herbal medicine is also referred as to as botanical medicine or phytomedicine. Herbal medicine involves the use of any plant's seeds, berries, roots, leaves, bark or flowers for medicinal purposes [19]. Herbal remedies are in great demand in the developing world for fundamental medical needs, not merely because they are inexpensive, but also because they tend to be more culturally acceptable, consistent with the human body, and result in less adverse effects [20].

Many studies have been just been done to confirm the vast diversity of medicinal plants. Herbal gels are popular because of their naturally occurring phytochemicals. That offer antimicrobial and soothing properties. Herbal formulations may be appealing as they are void of alcohol, artificial preservatives, flavours, and colours [21]. Herbal medicine involves using medicinal plants for ailments prevention and treatment, extending from traditional and popular medicines from every corner of globe to use the standardized and titrated herbal extracts [22].

More than 80% of the world's population continues to rely heavily on traditional remedies to treat a wide range of skin conditions. In recent years, there has been a constant revival of interest in the use of medicinal plants in developing countries, owing to reports that herbal medicines are safe and have fewer side effects, particularly when compared to synthetic medications. Topically applied herbal medicines have received a lot of scientific attention due to their benefits. There are several medicinal plants that are commonly used to treat dermatological disorders and dental plaques due to their antibacterial properties [23]. Table 1 shows various antibacterial herbal gels for dental treatment.

Table 1: Various antibacterial gel formulations

Sl no.	Herbal gel	phyto constituents	Zone of inhibition	Treatment	Reference
1	*Aloe vera*	Aloe emodin	19.5mm (*Staphylococcus aureus*) showed action against microorganism in oral cavity.	Gingivitis, Oral mucosal lesions	24
2	*Coriander oil*	Essential oil	25±2.5mm (*S. salivarius*) shows good antibacterial activity	Periodontal diseases and gingivitis	25
3	*Glycyrrhiza glabra*	Saponins Terpenoids Alkaloids Steroids Tannins Flavonoids Amino acids	10.66±0.58mm(*Azadirachta indica)* 9±1mm*(Glycyrrhiza glabra)*	Periodontitis Dental plaque Dental caries	26
4	*Curry leaves (Murraya koeniggi)*	Monoterpenoids Sesquiterpenoids	28mm(*S. aureus)*	Dental caries and skin pathogens	27
5	*Psidium gujava and Cordia Dichotoma Leaves*	Alkaloid Anthraquinones Phenols Flavonoids Triterpene	26±0.8mm(Aspargiliousaureus)	Gum disorders	28
6	*Morus alba*	Alkaloids Phenols Tannins Flavonoids Triterpenoids	*19mm*(*P.gingivalis*)	Periodontitis	29
7	*Ficus benghalensis l and Clove oil*	Carbohydrates Amino acids Proteins Tannins Eugenol	*22.51± 0.1 (S. mutans) 20.42± 0.05(L. acidophilus*)	Dental caries (Tooth decay) and gum disorders	30
8	*Licorice*	*glabridin, glycyrrhizin, licoricidin, licochalcone licorisoflavan*	*(P. gingivalis) 62.5µg/ml*	Periodontal therapy	31

Comparitive Study of Chlorhexidine Gel with Herbal Gel

Recently indicated, individuals who eat excessive amounts of sugar accumulate greater amounts of carcinogenic bacteria in their plaque, particularly mutans streptococci and lactobacilli, and more inclined to acquire dental caries [32]. Even though chlorhexidine has antimicrobial characteristics and is capable of controlling plaque in clinics, it is not suggested for prolonged use due to possible adverse reactions such as taste alteration, supragingival calculus formation and desquamation of the mucous membrane in the mouth. Likewise, it is restricted for use in children and adolescents [33]. Furthermore, it triggers extrinsic staining by attachment to the polyphenolic and tannin families that exists in beverages which include tea and coffee [34]. As an outcome of this consequences, there has been a desire to identify more efficacious natural remedies that are both secure and beneficial for resorting normal health while also being budget appropriate. A various herbal product such as aloe, curcumin, cranberry, Tulsi, curry leaves have a rich

history of medicinal value which enhances oral hygiene as comparative with chlorhexidine gel with lesser side effects. [35] Many comparison investigations of chlorhexidine gel with other herbal extracts, such as curcumin nanogel with chlorhexidine gel for chronic periodontitis, have been undertaken using randomised clinical trials. And concluded that curcumin can be utilised as an antiplaque drug and shown efficiency in reducing periodontitis in comparison to chlorhexidine [36]. The comparison of Boswellia serrta gel to chlorhexidine gel demonstrates that Boswellia serrta has a promising role as an adjuvant to mechanical periodontal therapy due of decreased toxicity and improved patient acceptance [37]. Table 2: shows the comparative study of chlorhexidine gel with various herbal gel for dental treatment which as antibacterial activity along with their therapeutic benefits.

Table 2: Comparison between Chlorhexidine gel vs Herbal antibacterial gels

Comparison		Target	Treatment	Therapeutic outcomes		References
Chlorhexidine	Herbal gel			Chlorhexidie	Herbal gel	
Xanthan based Chlorhexidine gel	*Bakul, Babul, Pomegranate*	Human clinical study age (30-50) years	Chronic periodontitis	There were no substantial reductions in clinical indicators. (Plaque index and gingival index).	All clinical indicators showed considerable reductions. (Plaque index, gingival index).	38
Chlorhexidine gluconate gel	*2% Turmeric gel*	Randomized human clinical trial (age above 18)	Anti-plaque Anti-gingivitis	Cause staining of teeth	Free from adverse effects and inflammation control	39
0.2% Chlorhexidine gel	*2% Curcumin sub gingivally delivered*	Double-blind split mouth randomised control clinical study.	Chronic periodontitis involves scaling and root planning.	Long-term use is not recommended due to tooth staining, taste problems, and increased calculus buildup.	Anti-inflammatory and antibacterial characteristics for treating moderate chronic periodontitis.	40
Chlorhexidine gel	*Morus alba*	Randomized controlled clinical trial (180 patients)	Periodontitis	Did not indicate a statistical difference. (P>0.05) No difference is showed in treating periodontitis	Statistically difference observed P=0.002 No difference is showed in treating periodontitis	41
1% chlorhexidine gel	*3% Ginkgo biloba gel*	Double blinded randomized 40 patients (18-45) years	Gingivitis	Staining of teeth	Shows promising treatment for gingivitis (non-surgical therapy)	42
Chlorhexidine gel	*Neem gel*	A randomization parallel-arm double-blind controlled the experiment (20-30 years)	Dental plaque Gingivitis	Staining of teeth	Neem gel significantly decreased dental plaque, gingival discomfort, and pathogens counts, without any adverse effects.	43

Summary

A number of studies have compared chlorhexidine gel with various herbal gels. Various herbal gels have promising effect in maintaining typical oral hygiene, along with anti-plaque and antibacterial qualities in comparison to chlorhexidine gel. Herbal gels formulated from herbal extracts of leaves, roots, bark, and fruits were found to be more efficient against microorganisms in oral cavities, have more effective post-treatment prophylaxis with no negative side effects from excessive use when compared to chlorhexidine, which can have negative long-term effects such as staining or discolouration of teeth, alteration of taste etc on over usage.

Conclusion

This article seeks to provide an overview of gels and compare them to Chlorhexidine gel in order to raise awareness about the beneficial effects of herbal gels. Despite its limitations, chlorhexidine gel is beneficial for short-term dental therapy. Herbal gel offers a purpose in maintaining oral hygiene. Several initiatives are required to educate individuals about the importance of gel in dental hygiene.

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