International Journal of Oral Health Dentistry 2023;9(2):78–85

Content available at: https://www.ipinnovative.com/open-access-journals

International Journal of Oral Health Dentistry

Journal homepage: www.ijohd.org

Review Article

Mouth-rinses for children – A narrative review

Aarcha S Kumar[1], Mallayya C Hiremath[1,*], S K Srinath[1], Raja Jayadev Nayak[1]

[1] *Dept. of Pediatric and Preventive Dentistry, Government Dental College and Research Institute, Bangalore, Karnataka, India*

ARTICLE INFO

Article history:
Received 17-05-2023
Accepted 06-06-2023
Available online 26-06-2023

Keywords:
Children
Herbal
Mouth-rinse
Mouthwash
Plaque control

ABSTRACT

Mouth rinses are topical agents that can be used after adequate mechanical plaque control measures to help one keep the oral cavity clean. Children have less manual dexterity and motivation for adequate brushing or flossing. Hence, mouth rinses can act as an adjunct to mechanical plaque removal methods and help in preventing dental caries, halitosis, mucositis, and gingival/periodontal diseases in children.
Mouth rinses can provide effective biofilm control that can do wonders for oral health. From antibiotics to probiotics, various compositions of mouthwashes have been introduced from time immemorial to the 21st century. This review is an overview of the literature search on mouth rinses from 1942 to 2022. The purpose of this review was to compile the history and various types of mouth rinses that can be used in children, many of these are commercially available and some are under clinical trial.

This is an Open Access (OA) journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprint@ipinnovative.com

1. Introduction

The development of oral care preparations has been geared towards the combination of anti-plaque substances that plays a crucial part in maintaining oral health because modern dentistry emphasizes the necessity of dental plaque control to maintain good oral health. To prevent and control dental caries and periodontal disorders, it is crucial to use both mechanical and chemical plaque control approaches. The efficiency of brushing is affected by a number of significant factors, particularly in children, including dexterity, cognitive development, and motivation.[1,2]

Additionally, in addition to mechanical plaque reduction, less accessible portions of the oral cavity such as the subgingival and interproximal areas require adjuncts like chemotherapeutic medicines for plaque control. Furthermore, the literature highlights the connection between the quantity of Streptococcus mutans in saliva and the number of colonized surfaces, suggesting a role for these mutans in the development of pit and fissure caries in the primary, mixed, and permanent dentition. As a result, it seems rational to use chemical plaque control methods in addition to mechanical ones to lessen the likelihood of dental caries.[3]

Chlorhexidine is the "gold standard" among chemotherapeutic agents, but a number of side effects, such as bitter taste, brown discoloration, and oral mucosal erosion, etc., necessitate the need to find an alternative agent with similar efficacy yet fewer side effects, shifting the focus to biogenic agents.[4] A sizable number of herbal mouthwashes have shown encouraging results in the reduction of salivary mutans count and plaque and gingivitis management.[5,6]

The effects of mouthwash use in the general population have been thoroughly reviewed and meta-analyzed in dental literature;[4] however, there is a dearth of information regarding mouthwash use in the pediatric population, making it unlikely that patients and dental healthcare professionals will receive comprehensive advice based on the best available evidence. In order to examine

* *Corresponding author*.
E-mail address: drmallayyahiremath@gmail.com (M. C. Hiremath).

https://doi.org/10.18231/j.ijohd.2023.015
2395-4914/© 2023 Innovative Publication, All rights reserved.

the overall effects of mouthwashes on plaque, gingivitis, cariogenic microflora, and oral hygiene status in the pediatric population, this discussion will cover the literature that is currently available.[7,8]

2. Discussion

2.1. Historically speaking

People had understood the need for oral cleanliness for a very long time before we had any concept of plaque and its connection to mouth diseases. According to Chinese medicine, mouth washing was initially mentioned as a recommended practice around 2700 B.C. for the treatment of gum disorders. The printed reference was to rinse with a child's pee. According to descriptions in many nations over the years, cleaning the mouth with urine became commonplace.[9] The ancient Egyptians and Romans also popularised the use of mouthwashes as a supplement to other oral hygiene practices. From 40 to 90 A.D. While Hippocrates is known to have prescribed mouth washing with a mixture of alum, salt, and vinegar in the ancient period, D. Pedanius Dioscorides, a Greek physician, recommended a mixture of olive juice, pomegranate seeds, wine, and gum myrrh for the treatment of halitosis.[10]

Willoughby D. Miller, a dentist with microbiology training, was the first to advocate using an antibacterial mouthwash with phenolic chemicals to treat gingival irritation in the 1880s. He evaluated a large variety of antiseptics, at different dilutions, for their ability to stop the growth or kill oral germs as a skilled bacteriologist working under Robert Koch. He calculated the shortest amount of time needed to kill the organism by knowing the maximum time of contact between the antiseptic and the bacteria in the mouth cavity. Additionally, he distinguished between a bacteriostatic and a bactericidal effect and established that using an antibacterial mouthwash after brushing the teeth had both eliminated oral debris and decreased the bacterial burden.

The American Dental Association (ADA) endorses that mouthwashes be effective at changing microbiology by eradicating pathogens selectively without having any adverse effects on the healthy commensals in our mouths.[9] According to evidence, using anti-plaque and anti-gingivitis mouthwashes twice a day for a prolonged period of time, specifically 0.12% CHX gluconate and essential oils with methyl salicylate that are approved by the ADA's Council on Dental Therapeutics.[11,12]

2.2. Chlorhexidine mouthwash

Due to its broad anti-microbial spectrum, chlorhexidine (CHX) gluconate is a widely used mouthwash and is regarded as the "gold standard". CHX interferes with bacterial cell osmosis and weakens the bacterial cell wall. Furthermore, the bacterial uptake of CHX is quick, which makes it easier for the cell wall to tear and ultimately the cytoplasmic membrane to rupture, leading to cell death. Its use as a therapeutic drug is constrained, nonetheless, by a variety of local adverse effects that Lindhe et al. reported. The precipitation of salivary proteins and organic salts causes a number of adverse effects, including tooth discoloration, changed taste perception, mucosal irritation, parotid edema, and a greater degree of supra-gingival calculus formation.[18]

The recommended daily dose of chlorhexidine in mouthwashes is 20 mg, which is equivalent to 15 ml of mouthwash containing 0.12% chlorhexidine or 10 ml of mouthwash containing 0.2% chlorhexidine (20 mg). Although 30-second rinse times are suggested as being effective and pleasant, 60-second rinse intervals are also indicated.[19] Chlorhexidine di-gluconate (0.2%) inactivated more than 99.9% of the SARS-CoV-2 virus in just 30 seconds of limited contact. Compared to povidone-iodine administered for 30 and 60 seconds, this had superior efficacy. In terms of the proportion of the virus they were able to inactivate, both mouth washes performed similarly, albeit chlorhexidine showed a better relative shift in Ct values.[20]

The ability of CHX to adsorb (adhere to) anionic substrates like hydroxy apatite, pellicle, salivary glycoproteins, and mucosa is what gives it its remarkable antiplaque potency. Using radioactively labeled CHX, Bonesvoll et al.[21] found that when a person washed with 10 ml of a 0.2% CHX solution for 1 minute, about 30% of the medication was still present. In the following 8 to 12 hours, the bound CHX was released, and throughout the following 24 hours, very low amounts of CHX could be detected in saliva. The medication's retention sites allow for a gradual release of the antibiotic, which prolongs the bactericidal effect.[22]

It is well recognized that antibiotic use is linked to the emergence of microbial resistance. Subgingival plaque has established resistance to long-term medication therapy, according to observations made on patients who received systemic tetracycline for a prolonged period of time by Korman S[23] and others.[24] With regard to CHX, this has not been proven, and Gjermo proposed that although human bacteria did not acquire resistance after CHX therapy, the strains were less sensitive to the medication. A tiny amount of the industrial chemical para-chloroaniline (PCA) has been discovered in CHX products. It develops as a breakdown product when CHX is exposed to high temperatures or has a long shelf life. Researchers have found that Hibiclens, which contains 4% CHX, creates between 19 and 51 mg of PCA per liter.[25] This is only half the level that the FDA has specified as allowed. This can be avoided by keeping CHX solutions in dark, chilled bottles. Both the FDA and the United Kingdom have established a limit of 100 mg/liter for PCA as acceptable.[26] Williams et

Table 1: Classification ofchemical plaque control agents [13,14]

Based on generations.	Considering the agents' chemical makeup.	Depending on the chemistry	Mandel's classification
• First-generation agents are efficient in-vitro but ineffective in vivo due to a lack of substantivity. • Second-generation agents that are substantive and successful in vivo. Agents of the third generation prevent microbial colonization.	• Chlorhexidine and alexidine are bis-biguanides. • Octenidine hydrochloride, a bispyridine. • Iodine, iodophors, and fluorides are halogens. • Heavy metal salts, including tin, copper, zinc, mercury, and silver. • Sanguinaria extract, a type of herbal extract. • Oxidising substances like peroxides and perborate. • Phenolic substances, such as Listerine, phenol, thymol, triclosan, 2-phenyl phenol, and hexylresorcinol Hexetidine is a pyrimidine. • Quaternary ammonium compounds, such as domiphen bromide, benzethonium chloride, and cetylpyridinium chloride.	Anionic, Cationic, Non-ionic, and other combinations	• Enzymes like mucinase, Amyloglucosidase, mutanase, glucose oxidase, dextranase, pancreatin, zendium, and proteinase-amylase are antiplaque in nature. Plaque-modifying substances are Urea peroxide and ascoxal.

Table 2: Chemotherapeutic agents - mechanism of action [15–17]

Class of inhibitor	Example	Mechanism of action
Bis-biguanide	Chlorhexidine	Hinders the transfer of sugar, the formation of acids, the absorption of amino acids, the synthesis of polysaccharides, and the activity of proteases in bacteria.
Enzymes	Amylo-glucosidase-glucose oxidase, dextranase, and mutanase.	Reduce the production of plaque biofilm matrix by bacterial polysaccharide breakdown and bacterial glycolysis by activating the salivary peroxidase system.
Essential oil	Menthol, thymol, eucalyptol, and methyl salicylate are all extracts.	Lipopolysaccharide synthesis is inhibited while bacterial growth is decreased.
Metal	Zinc, copper, and tin ions	Salts impede the formation of acids, sugars, and proteases.
Quaternary ammonium compounds	Cetyl pyridinium chloride (CPC)	Bacterial enzymes are inhibited by their damaged cell membranes.
Phenols	Triclosan	Impede the formation of acids, sugars, and proteases.
Natural molecules	Plant extracts	Inhibition of acid production and polysaccharide synthesis.
Surfactants	Delmopinol and (SLS) Sodium lauryl sulfate	damage to bacterial cell membranes and inhibition of enzymes.

al. [25,27] found PCA as mildly genotoxic, although Thompson et al. [28] using the same test reported it to be negative. There haven't been any reports of an increase in cancer incidence in Europe after 20 years of oral CHX use.

2.3. Bis-biguanides, Alexidine-based mouthwash

Alexidine, a bis-biguanide chemically linked to chlorhexidine, has demonstrated promise in reducing plaque and gingivitis in both animal research and brief clinical trials. Over the course of a six-month study, two groups used a placebo and twice-daily washings with 0.035% alexidine. Plaque levels in the alexidine group significantly dropped over the course of the study. At 30 and 90 days, gingivitis was less severe, but not at 180 days, and tooth discoloration was still visible. Additionally, there were some cases of taste disturbance. In later research, plaque significantly decreased during a 60-day period, but gingivitis did not. There have been no additional studies reported since alexidine did not appear to have any advantages over chlorhexidine. [14]

2.4. Bis-pyridines-based mouthwash

In the 1980s, octenidine dihydrochloride (OCT), a novel antibacterial cationic surfactant molecule, was created at

the Sterling-Winthrop Research Institute in Rensselaer, New York. By attaching to negatively charged microbial surfaces and clinging tenaciously to lipid components, it breaks the cell membrane of fungus, bacteria, and yeast. There is a lack of information about secondary pharmacodynamics, drug interactions, metabolism, and microbiological resistance.

It is not believed that Octenidine dihydrochloride (OCT) accumulates in the body because it is flushed out with feces. It is more effective in-vitro against numerous bacterial and fungal species, giving it a wide range of activity than chlorhexidine (CHX), polyvinylpyrrolidone-iodine (PVP-I), poly-hexamethylene biguanide (PHMB), and triclosan. Its efficacy is pH-dependent. There was a statistically significant reduction in oral microbial growth after its treatment in all ten studies that looked at it (P= 0.05 to 0.001).[29] There were eight studies that examined OCT and CHX for their effects on oral microbial development, and seven of them found it to be more effective than CHX.[29]

Tooth stain was a commonly associated complaint with OCT use. The other side effects, which varied in frequency across the trials included, included poor mucosal tolerance, altered taste, tongue dorsum discoloration, bitter aftertaste, minor tongue tingling, and altered flavor.

2.5. Halogens-iodine, iodophor-based mouthwash

Iodine has long been utilized topically in medicine due to its well-known antiseptic and antibacterial qualities. Iodine's bactericidal impact is controlled by its chemical makeup. A povidone-iodine preparation (polyvinylpyrrolidone) that offers 10% of the iodine as free iodine and a 2% aqueous I2-KI in 53% glycerol solution have both been recommended for use in clinical settings. The latter formulation has largely been investigated as an anti-microbial and has been shown to minimize buccal lesions in experimental animals by more than 70%.[9]

Because it possesses oxidizing capabilities, hydrogen peroxide has some minor antiseptic qualities. It has mostly been utilised as a wound-cleansing agent despite being relatively unstable. The molecule is quickly broken down into H2O and O2 by the catalase enzyme, which is found in bacteria and tissue fluids. A unique rinse made up of 5% povidone-iodine (PVP-I2) and 1.5% hydrogen peroxide has been created using a combination of the aforementioned ingredients. Despite the fact that this mouthwash is relatively new and has not undergone the rigorous testing of those described earlier, initial in-vitro and in-vivo data suggest that it is capable.[30]

2.6. Fluoride mouth rinses

Bibby[31] and Cheyne[32] autonomously reported in 1942 that topical application of fluorides to teeth is useful in reducing caries. Sodium fluoride and stannous fluoride are the two compounds most extensively studied. Shannon[33] performed widespread laboratory studies on a stannous fluoride at the USAF School of Aerospace Medicine. Swerdloff and Shannon[34] demonstrated the practicability of using the stannous fluoride mouth rinse as a part of a school preventive dentistry camp. Although they worked with a small group of children, they were able to detect an apparent benefit and could establish the safety of the technique.

Through a clinical trial, the anti-caries benefit of sodium fluoride mouthwash was assessed. Two examiners independently observed caries reductions of 33% and 43% in DMFS scores for the group using the stannous fluoride mouth rinse.[35] According to the findings of a separate research project carried out in South Africa, the application of sodium fluoride at a concentration of 0.2% over the course of a period of six years led to a reduction in the number of cases of dental caries.[36] The use of mouthwash containing 0.2% sodium fluoride on a weekly basis led to a 52.2% reduction in the average DMFT score in a research project that included 750 children from the United States.[37]

2.7. Heavy metal salt-based mouthwash

Heavy metal salts have a long history of use as powerful antibacterial agents. When 0.5% zinc citrate or zinc chloride is added to mouthwash, it has an effect by attaching to the surface of oral bacteria, affecting adhesion, changing metabolic processes, and slowing the growth of the bacteria. Recent research has demonstrated zinc's contribution to decreasing plaque development. Up to this point, there have only been brief investigations on zinc salts in mouthwash.

Zinc salts do not cause staining. They have anti-calculus effects at the right concentrations, but the level that can be utilized is constrained by taste. The sanguinaria products also include 0.2% zinc chloride. Numerous investigations also revealed that plaque and gingivitis might be reduced by 0.035% copper sulfate concentration. Compared to chlorhexidine, it leaves some stains but not as many. Compared to zinc, copper has a higher affinity for binding to plaque and seems to be far more effective at reducing acid formation. Additional research on copper would be necessary. Stannous fluoride is a far more potent antiplaque agent than sodium fluoride, according to a number of short-term trials highlighting the significance of the tin ion itself.[9]

2.8. Herbal extract-based mouthwashes

2.8.1. Sanguinarine-based mouthwash

It is an alkaloid extract from the Sanguinaria canadensis bloodroot plant. Fagaronine, a structurally similar molecule identified in Nigerian chewing sticks with potential benefits for oral hygiene, is an interesting observation. In a cross-over investigation of experimental gingivitis lasting 14 days, either 0.03% sanguinaria extract (corresponding to 0.01% sanguinarine) or a placebo was rinsed twice daily by 14 dental students. The active rinse reduced plaque

levels by almost 40% and gingivitis scores by 20%.[9,14] The present recipe includes 0.03 percent mixed extract (which is equivalent to 0.01 percent pure sanguinarine) and 0.2 percent zinc chloride to boost the anti-plaque effect. In the US, toothpaste and mouthwash containing sanguinaria are sold under the brand name Yiadent. The mouthwash has an alcohol content of 11.5% and a pH of 4.5. The dentifrice has a pH of 5.2.[14]

Epidemiological data links exposure to sanguinarine to leucoplakia development. Histological analysis by Eversole et al. revealed that borderline dysplasia was present in 55% of sanguinaria-associated leucoplakias, mild dysplasia in 42.5% of cases, and moderate dysplasia in 2.5% of cases. Since no lesions exhibited significant dysplasia or cases of cancer developing within a leukoplakia connected with sanguinaria, the safety of using sanguinaria products in children remains uncertain.[38]

2.8.2. *Galla chinensis-based mouthwash*

Galla chinensis is created when the Rhus chinensis Mill leaves are parasitized by the Chinese sumac aphid Baker (Melaphis chinensis Bell). The extracts of Galla chinensis (GCE) have been shown in various investigations to be beneficial in re-establishing the "Demin- Remin" balance. GCE has the ability to alter the balance between de- and remineralization, but it can also suppress dental biofilms. As a mouthwash and a component of dentifrice, Galla Chiensis is a potential new ingredient.[39]

2.8.3. *Propolis-based mouthwash*

Due to its antibacterial effectiveness against a wide range of harmful microorganisms, propolis has attracted attention recently. Flavonoids, organic acids, phenols, many enzymes, vitamins, and minerals make up the majority of propolis' chemical makeup. In-vitro testing has demonstrated the anti-cariogenic and antibiofilm properties of Tunisian propolis ethanol extract. Propolis' active ingredients inhibited glucosyltransferase activity and bacterial growth. Propolis' cytotoxicity was confirmed using gingival fibroblast cells. The outcomes showed that it is possible to create solutions that are both highly bactericidal and noncytotoxic.[39]

2.8.4. *Magnolia bark-based mouthwash*

For the past 2000 years, magnolia bark has been extensively employed in medicine. Magnolol and honokiol, the two active components of magnolia bark extract, have been shown to reduce dental caries in animal testing in the laboratory and inhibit the growth of a number of various bacteria, including Porphyromonas gingivalis, Aggregatibacter actinomycetemcomitans, Capnocytophaga, and Veillonella in-vitro. Chewing gum with xylitol has officially included magnolia bark extract. In a randomized controlled experiment, chewing gum with magnolia bark extract for 30 days had positive benefits on plaque acidogenicity, salivary mutans counts, and bleeding upon probing.[39]

2.8.5. *Tea-based mouthwash*

Green and black tea leaves can be utilized as acceptable, slow-release sources of catechins and theaflavins to prevent dental caries, according to a study by Lee et al. Salivary and plaque mutans count can be significantly inhibited by using a sugar-free green tea solution as an oral rinse. Chewing gum with Camellia extract was the source of fluoride employed by Suyama et al. According to in-situ studies, tooth enamel was formed with a higher level of remineralization and acid resistance. Oolong tea leaves contain polymeric polyphenols, which have been demonstrated to have a high anti-glucosyltransferase action in oolong tea extract. Oolong tea extract has also been demonstrated to lessen human dental plaque build-up. Oolong tea polyphenols prevent bacterial adhesion to tooth surfaces by lowering the hydrophobicity of Mutans streptococci's cell surfaces. Additionally, it slows down the creation of acid and lessens tooth cavities.[39]

2.8.6. *Grapes-based mouthwash*

Effective anti-infective agents have traditionally included grapes (Vitis vinifera) and grape seed extracts (GSE). The GtfB and GtfC enzymatic activity of mutans can be greatly reduced by the phenolic fractions of a small number of grape types, including V. vinifera and Vitis interspecific hybrid varieties. Dental cavities are believed to be inhibited most effectively by the proanthocyanidins found in GSE. The activities of surface-adsorbed glucosyltransferase and F-ATPase as well as Streptococci acid generation may be inhibited by proanthocyanidins.

It has also been observed that GSE has the capacity to prevent demineralization and encourage remineralization in artificial root carious lesions. Fluoride and GSE showed antioxidant and antiplaque action. According to the findings, the combination of 10.2 mg/ml of fluorine and 2,000 g/ml of GSE had a stronger antibiofilm effect than each component evaluated alone. Timothy et al. discovered that phenolic extracts from wine and grapes might eradicate several Streptococcus strains linked to tooth caries.[39]

2.8.7. *Coffee-based mouthwash*

Coffee is another widely used beverage that has been linked to the prevention of certain disorders, including dental caries. The polyphenols also contributed to the antimicrobial properties. One benefit of coffee is that it is typically ingested in a concentrated form, ranging from 6 to 10%, which is higher than the effective concentration previously reported (1-2%).[39] A recent study has demonstrated the antibacterial action of Coffea Canephora extract against S. mutans, and how it prevents

dental enamel from demineralizing. C. Additionally, canephora induced bacterial lysis, which led to the release of calcium into the medium.[39]

2.8.8. Cacao based mouthwashes

Some of the polyphenols found in cacao beans have anti-glucosyltransferase action. Previous research suggested that cacao mass extract has some anti-cariogenic properties, but they are not sufficiently potent to significantly reduce sucrose's cariogenic activity. The extract may develop into a novel anti-insect chemical as a moderate chemoprophylactic agent, according to an animal study.[39]

2.8.9. Hesperidin-based mouthwashes

It was discovered that the citrus flavonoid hesperidin protects bovine dentine collagen from being broken down by proteolytic agents.

Hesperidin's method of action may be related to its interactions with noncollagenous proteins and/or collagen, which stabilize the collagen matrix and trigger remineralization.

Hesperidin has been shown to have a good potential for promoting remineralization and lowering the susceptibility of dentin lesions to acid-dependent demineralization.[39]

2.9. Phenolic compounds – Triclosan-based mouthwashes

Triclosan TCL is an aromatic chlorinated non-ionic chemical triclosan. It has ether and phenol functional groups. It is used in consumer goods like soaps and detergents because of its antibacterial and antifungal qualities. Triclosan is a non-ionic germicide that is a bis-phenol with a broad spectrum of antibacterial activity and low toxicity. Two strategies have been developed to increase the clinical effectiveness of oral triclosan products: (1) combine it with zinc citrate to benefit from its potential antiplaque and anti-calculus properties, and (2) incorporate triclosan in a copolymer of polyvinyl methyl ether and maleic acid. At low doses, it alters the bacteria's cytoplasmic membrane's permeability, resulting in cell efflux and variations in cellular oxygen levels; at higher concentrations, it also induces protein coagulation and denaturation. Mouthwashes contain 0.3% triclosan by weight.

In the USA, triclosan was outlawed in 2016 by the Food and Drug Administration. On September 6, 2017, it was pulled from the marketplace. The possibility has been raised that triclosan might harm the thyroid and heart by upsetting the body's endocrine equilibrium.[40]

2.10. Listerine pyrimidines – Hexetidine-based mouthwash

The cationic chemical hexetidine (C21H45N3) belongs to the class of pyrimidine derivatives. It has a broad spectrum of antibacterial activity and is effective against both Candida albicans and Gram-positive bacteria. Hexetidine had previously been used to treat cervicitis and vaginitis. Additionally, it has been suggested as a supplement for halitosis, gingivitis, and aphthous ulcers. It has a strong affinity for plaque and oral mucosa proteins. Hexetidine can eliminate up to 98% of saliva-borne pathogens immediately after rinsing, but its effectiveness is limited since bacterial counts rebound to their baseline levels after 70 to 90 minutes. There have been reports of negative effects, such as desquamation of the oral mucosa epithelium.[40]

2.11. Quaternary ammonium compounds

2.11.1. Cetyl-pyridinium chloride-based mouthwash

C21H38CIN, also known as cetyl-pyridinium chloride (CPC), is a cationic quaternary chemical. The bacterial cell membrane is damaged as a result of its capacity to bind to negatively charged dental plaque and lower the surface tension of the bacterial cell membrane. Additionally, CPC greatly lessens microbial adherence to tooth surfaces. With the exception of fluoride compounds, CPC is the component of mouthwashes that is used the most commonly. The characteristics of cetyl-pyridinium chloride are similar to those of chlorhexidine, however, CPC lasts much less time in the mouth. In comparison to chlorhexidine, its content in the oral cavity falls substantially more quickly within 12 hours. CPC needs to be applied twice as regularly to be as effective as chlorhexidine. Useful solutions of cetyl-pyridinium chloride are 0.05% and 0.07%. In toothpaste, CPC is not present. CPC side effects include tooth discoloration, desquamation of the oral mucosal epithelium, and irritation and ulceration of the oral mucosa. Additionally, patients have reported experiencing burning in their tongues and oral mucosa.[41]

2.11.2. Enzyme-based mouthwash

With crude mutanase, Kelstrup et al. conducted two clinical investigations. Only a minor effect was shown in one research. In the second study, the enzyme added to chewing gum significantly reduced plaque and gingivitis. When using crude enzyme preparations, some local adverse effects were noticed, such as the discomfort of the tongue, localized ulceration, and taste abnormalities. A novel method is developed to use enzymes to create an antibacterial product that could affect plaque and gingivitis as well as caries.

A recent example is the use of the enzymes amyloglucosidase as well as glucose oxidase. The theory behind this combination is that amyloglucosidase, which converts residual starch into glucose, and glucose

oxidase, which hydrolyzes glucose into gluconic acid and hydrogen peroxide, gradually produce hydrogen peroxide in the mouth. Hypothiocyanite is created when the naturally occurring enzyme salivary peroxidase interacts with the thiocyanate ions in the mouth cavity to form peroxide. This ion is a strong oxidizing agent and can convert the thiol groups in the bacterial enzymes that create acid. Before we can utilize this method with assurance, we need to conduct additional in-depth research.[9]

2.12. Plaque modifying agents

A few products have combined a number of ingredients to deliver antibacterial and plaque-disrupting properties. Ascoxal (also known as Ascutal-T) was created as a "mucolytic" substance based on the presence of ascorbic acid, percarbonate, and copper sulphate. Numerous studies that have been published have shown that gingivitis has not progressed while plaque scores significantly decreased (over the course of a four-week period). Another mixture that has been investigated for its antiplaque and anti-gingivitis properties is urea peroxide, 11% in anhydrous glycerine gel. The capacity of urea to denaturize proteins with its antibacterial and debridement properties is combined in this more stable form of hydrogen peroxide. Two clinical studies found a temporary decline in plaque scores but not gingivitis. It makes perfect sense to combine several agents, but the ideal mix hasn't yet been discovered.[9,14]

2.13. Probiotic mouth-rinses

Probiotics are living microbes that decrease the level of bad bacteria that is detrimental to one's oral health. They have a huge market in the pharma sector. They have already been used in the treatment of many diseases like GIT infections, UTI, Lactose intolerance, and even cancer chemotherapy, Currently, research is going on in the field of dentistry as well. Examples are lactobacillus species and Bifidobacterium species. Bifidobacterium was most effective in the reduction of S. mutans counts. S. Salivarius can be used in the reduction of halitosis. They have emerged as an alternative to biotherapeutics and can be a huge boon in the field of dentistry.[42]

The FDA published guidelines in 2016 that describes how manufacturers can satisfy the manufacturing requirements for early clinical studies for probiotics. As of right now, no probiotic has received FDA approval as a "live biotherapeutic product". However, there are FDA-regulated foods, including nutritional supplements, that contain probiotics that are legally offered, even though it is illegal for these goods to advertise that they can treat, prevent, or alleviate any disease.[43]

3. Conclusion

1. A biofilm known as dental plaque develops naturally on the exposed tooth surfaces and in other parts of the oral cavity. For oral disorders including dental caries and periodontal diseases, it is the main etiological factor.
2. The key to preventing dental caries and periodontitis has been maintaining adequate control of plaque build-up on teeth. The primary method of controlling plaque is mechanical, and chemical plaque management treatments serve as helpful adjuvants.
3. Dentifrices and mouthwashes contain antimicrobial and antiplaque ingredients that work in a variety of routes to diminish or eliminate dental biofilms and stop bacterial growth.
4. Mouthwashes are effective adjuncts to mechanical plaque control methods in children and help in improving oral health. However, some of these mouthwashes have minor adverse effects such as transient taste disturbance and staining of teeth.

4. Source of Funding

None.

5. Conflict of Interest

None.

References

1. Vander Weiden G, Hioe KP. A systematic review of the effectiveness of self-performed mechanical plaque removal in adults with gingivitis using a manual toothbrush. *J Clin Perio*. 2005;32(6):214–28.
2. Lakade LS, Shah P, Shirol D. Comparison of antimicrobial efficacy of chlorhexidine and combination mouth rinse in reducing the mutans streptococcus count in plaque. *J Indian Soc Pedod Prev Dent*. 2014;32(2):91–6.
3. Osso D, Kanani N. Antiseptic mouth rinses an update on comparative effectiveness, risks, and recommendations. *J Dent Hyg*. 2013;87(1):10–8.
4. Cai H, Chen J, Perera NKP, Liang X. Effects of herbal mouthwashes on plaque and inflammation control for patients with gingivitis: a systematic review and meta-analysis of randomized controlled trials. *Evid Based Complement Alternat Med*. 2020;p. 2829854. doi:10.1155/2020/2829854.
5. Nayak SS, Kumar BR, Ankola AV. The efficacy of Terminalia chebula rinse on Streptococcus mutans count in saliva and its effect on salivary pH. *Oral Health Prev Dent*. 2010;8(1):55–8.
6. Rodrigues IC, De Oliveira D, De Menezes P. Effect of Lippia sidoides in mouth rinses on de novo plaque formation: a double-blind clinical study in humans. *Indian J Dent Res*. 2013;24(5):533–6.
7. Salzer S, Slot DE, Van Der Weijden FA. Efficacy of inter-dental mechanical plaque control in managing gingivitis-a meta-review. *J Clin Periodontol*. 2015;42(Suppl 16):92–105.
8. Van Der Weijden F, Slot DE. Efficacy of homecare regimens for mechanical plaque removal in managing gingivitis: a meta-review. *J Clin Periodontol*. 2015;42(16):77–91.
9. Mandel ID. Chemotherapeutic agents for controlling plaque and gingivitis. *J Clin Periodontol*. 1988;15(8):488–98. doi:10.1111/j.1600-051x.1988.tb01020.x.
10. Kukreja BJ, Dodwad V. Herbal mouthwashes: A gift of nature. *Int J Pharm Biol Sci*. 2012;3(2):46–52.
11. Kocak MM, Ozcan S, Kocak S, Topuz O, Erten H. Comparison of the efficacy of three different mouth rinse solutions in decreasing the level

of Streptococcus mutans in saliva. *Eur J Dent*. 2009;3(1):57–61.
12. Balagopal S, Arjunkumar R. Chlorhexidine: The gold standard antiplaque agent. *J Pharm Sci Res*. 2013;5(12):270–4.
13. Newbrun E. Chemical and mechanical removal of plaque. *Compend Contin Educ Dent*. 1985;(6):110–6.
14. Mandel ID. Antimicrobial mouth rinses: overview and update. *J Am Dent Assoc*. 1994;125(2):2–10.
15. Marsh PD. Controlling the oral biofilm with antimicrobials. *J Dent*. 2010;38(1):11–5.
16. Marsh PD. Are dental diseases examples of ecological catastrophes? *Microbiology*. 2003;149(2):279–94.
17. Sugano N. Biological plaque control: novel therapeutic approach to periodontal disease. *J Oral Sci*. 2012;54(1):1–5.
18. Niklaus P, Lindhe L, Lindhe J. Textbook of Clinical Periodontology and Implant Dentistry. Blackwell Publications; 2008. p. 748–54.
19. James P, Worthington HV, Parnell C, Harding M, Lamont T, Cheung A. Chlorhexidine mouthrinse as an adjunctive treatment for gingival health. *Cochrane Database Syst Rev*. 2017;3(3):CD008676. doi:10.1002/14651858.CD008676.
20. Jain A, Grover V, Singh C, Sharma A, Das DK, Singh P, et al. Chlorhexidine: An effective anticovid mouth rinse. *J Indian Soc Periodontol*. 2021;25(1):86–8.
21. Bonesvoll P, Lokken P, Rolla G. Influence of concentration, time, temperature and pH on the retention of Chlorhexidine in the human oral cavity after mouth rinses. *Arch Oral Biol*. 1974;19(11):1025–9. doi:10.1016/0003-9969(74)90089-2.
22. Bonesvoll P, Lokken P, Rolla G, Paus P. Retention of Chlorhexidine in the human oral cavity after mouth rinses. *Arch Oral Biol*. 1974;19(3):209–12. doi:10.1016/0003-9969(74)90263-5.
23. Kormán S, Karl E. The effect of long-term low dose tetracycline therapy on the subgingival microflora in refractory adult Periodontitis. *J Periodontol*. 1982;53(10):604–10. doi:10.1902/jop.1982.53.10.604.
24. Osterberg SK, Williams B, Jorgensen J. Long-term effects of tetracycline on the subgingival microflora. *J Clin Periodontol*. 1979;6(3):133–40.
25. Vratsanos SM, Kesner L. Nontechnical summary paper: rapid liquid Chromatographie assay of chloroaniline isomers. In: Presented at the 174th National Meeting of the American Chemical Society. Chicago; 1977. p. 111.
26. Ciarlone AE, Gangarosa L, Fong BC. Detection of p-chloroaniline in chlorhexidine solutions using thin-layer chromatography. *J Dent Res*. 1976;55(5):918. doi:10.1177/00220345760550054201.
27. Williams G, Laspia MF, Dunkel VC. Reliability of the hepatocyte primary culture/DNA repair test in testing coded carcinogens and noncarcinogens. *Mutat Res*. 1982;97(5):359–70. doi:10.1016/0165-1161(82)90003-6.
28. Thompson CZ, Hill L, Epps J, Probst G. The induction of bacterial mutation and hepatocyte unscheduled DNA synthesis by monosubstituted anilines. *Environ Mutagen*. 1983;5(6):803–11.
29. Grover V, Mahendra J, Gopalakrishnan D, Jain A. Effect of octenidine mouthwash on plaque, gingivitis, and oral microbial growth: A systematic review. *Clin Exp Dent Res*. 2021;7(4):450–64.
30. Walker CB. Microbiological effects of mouth rinses containing antimicrobials. *J Clin Periodontol*. 1988;15(8):499–505. doi:10.1111/j.1600-051x.1988.tb01021.x.
31. Bibby BG. Preliminary report on the use of sodium fluoride applications in caries prophylaxis. *J Dent Res*. 1942;21:341.
32. Cheyne VD, Rice TB. Effects of topically applied fluorine on human dental caries, including a method for its application. *J Dent Res*. 1942;21:320.
33. Shannon IL. Laboratory studies in the development of stannous fluoride mouthwash. *J S Calif State Dent Assoc*. 1964;32:167.
34. Swerdloff G, Shannon IL. A feasibility study of the use of a stannous fluoride mouthwash in a school preventive dentistry program. *Tech Rep SAM-TR*. 1967;p. 52–67.
35. Radike AW, Gish CW, Peterson JK, King JD, Segreto V, Vincent A. Clinical Evaluation of Stannous Fluoride as an Anticaries Mouthrinse. *J Amn Dent Assoc*. 1973;86(2):404–8.
36. Mcdonald RE, Avery DR, George KS. Dental caries in the child and adolescent. In: McDonald R, Avery D, Dean J, editors. Dentistry for the Child and Adolescent. St. Louis: Mosby; 2004. p. 205–32.
37. Koch G, Modeer T, Poulsen S, Rasmussen P. Pedodontics: A Clinical Approach. Copenhagen: Munksgaard; 1997.
38. Croaker A, King GJ, Pyne JH, Anoopkumar-Dukie S, Simanek V, Liu L, et al. Carcinogenic potential of sanguinarine, a phytochemical used in “therapeutic” black salve and mouthwash. *Mutat Res Rev Mutat Res*. 2017;774:46–56.
39. Cheng L, Li J, He L, Zhou X. Natural products and caries prevention. *Caries Res*. 2015;49(1):38–45.
40. & Szymańska J, Olejnik E. Active ingredients of mouthwashes. *Acta Poloniae Pharm*. 2021;77(6):825–32.
41. Jafer M, Patil S, Hosmani J, Bhandi SH, Chalisserry EP, Anil S, et al. Chemical Plaque Control Strategies in the Prevention of Biofilm-associated Oral Diseases. *J Contemp Dent Pract*. 2016;17(4):337–43.
42. Mishra S, Rath S, Mohanty N. Probiotics - A complete oral health care package. *J Integr Med*. 2020;18(6):462–9.
43. Early Clinical Trials with Live Biotherapeutic Products: Chemistry, Manufacturing, and Control Information guidance for Industry [Internet]. Fda.gov; 2016. [cited 2023 May 15]. Available from: https://www.fda.gov/media/82945/download.

Author biography

Aarcha S Kumar, PG Student

Mallayya C Hiremath, Associate Professor

S K Srinath, Professor and HOD

Raja Jayadev Nayak, PG Student

Cite this article: Kumar AS, Hiremath MC, Srinath SK, Nayak RJ. Mouth-rinses for children – A narrative review. *Int J Oral Health Dent* 2023;9(2):78-85.