

The Adjunctive Use of Selected Over the Counter (OTC) Mouthwashes in Maintaining Oral Health: An Overview

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Abstract

The importance of maintaining good oral health cannot be underestimated in maintaining overall health and self-esteem. The use of oral care products including mouthwashes as part of a self-performed oral hygiene regime to control dental plaque is well documented in the dental literature. These products are available over the counter in pharmacies and supermarkets etc., and often sold as cosmetic products highlighting on their packaging (labelling) various claims such as “protects gums, reduces inflammation, kills plaque bacteria” This information may help the consumer in determining which product would be suitable for treating their problem. The purpose of this review is to evaluate the effectiveness of the active ingredients in selected mouthwash products and substantiate the claims made by the manufacturers from the published literature.

Introduction

Oral diseases are considered a major public health problem and affect approximately 3.5 million people

worldwide (World Health Organization (WHO) report). Both dental decay (dental caries) and periodontal disease(s) (gum health) are therefore conditions of major health and economic concerns, not only to susceptible individuals, but also in the time and expertise required to professionally treat these conditions (The Economist

Group 2024). Periodontal diseases are not a single disease entity but include several inflammatory conditions under this umbrella term. For simplicity, the terms ‘gingivitis’ and ‘periodontitis’ will be used when appropriate in this review. The former term implies that the condition is confined to the gingival tissue and there is no underlying destruction of the periodontal ligament and alveolar bone whereas the term ‘periodontitis’ indicates that there is destruction of both the periodontal ligament and underlying alveolar bone depending on the degree of severity (see Delivering better oral health 2021). Routine checkups (dental examinations) at a Dentist are important in the diagnosis and treatment of both dental caries and gum health and this may involve screening as part of an evaluation of the oral condition (hard and soft tissue valuation including pocket depth measurements and radiographic examination). Following a clinical diagnosis of any problems, a treatment plan will be outlined to resolve any diagnosed dental problem which may include restoration of tooth tissue or a program of periodontal treatment depending on the severity of the problem (e.g., professional mechanical plaque removal (PMPR) (by the dentist or a dental hygienist), Good oral hygiene by the individual is, however a key component in the prevention of gingivitis and preventing the progression to periodontitis, this involves self-performed procedures (such as toothbrushing, flossing etc.,) at home to remove

dental plaque (dental biofilm) and maintain a healthy oral microbiome.

According to Vranic et al., (2004) mouthwashes are defined as non-sterile aqueous solutions used for their deodorant, refreshing and antiseptic effects, which in turn can prevent, alleviate, and treat various oral conditions such as dental caries, halitosis, gingivitis, periodontitis, mucositis etc., (Radzki et al., 2022). Mouthwashes can be either cosmetic or therapeutic in nature and are available over the counter or by prescription depending on the formulation (ADA 2021). It should be noted, however, that mouthwashes have an adjunctive use in treating gingivitis and periodontitis, e.g., they have limited penetrating effects (< 2mm below the gingival margin) and as such cannot be used as a substitute for the primary mechanical methods of cleaning and therefore should only been in conjunction with other methods or when toothbrushing cannot be used (e.g., following periodontal surgery) (Macfarlane et al., 2010, McGrath et. 2023). The key ingredient of a typical mouthwash comprises as a mixture of water and glycerine, supplemented with a sweetener, surfactant, preservative, colourant, and flavouring agents as well as sodium fluoride (anticaries) and essential oils (antimicrobial) (Radzki et al., 2022) (Table 1).

Ingredient	Action
Solvent	Alcohol is the most common solvent used in mouthwashes, and it acts as both a solvent and taste enhancer (Vranic et al., 2004). The most frequently used solvents include ethanol, glycerine, and propylene glycol. Ethanol is present in 10.8% of all mouthwashes, glycerine is present in 74.7% of all mouthwashes and propylene glycol is present in 42.7% of mouthwashes (Radzki et al., 2022). Alcohol free mouthwashes also exist and do not contain ethanol however many of the ingredients are the same as ethanol-containing mouthwashes. These usually consist of water, humectant, surfactant, flavouring agents, sweeteners, colour,

	preservatives and active ingredients (Yano et al., 2023).
Surfactants	Surfactants (such as Sodium Lauryl Sulphate [SLS]): reduce the surface tension within the oral cavity, facilitating better contact between the mouthwash and the teeth. This enables them to penetrate and dissolve plaque, making the process of cleaning teeth easier. Surfactants can also disperse the flavours in mouthwash enhancing both taste and smell (Vranic et al., 2004). Surfactants are present in 92.5% of mouthwashes (Radzki et al., 2022).
Flavouring agents	Flavouring agents eliminate the unpleasant odour and taste of other ingredients present within the mouthwash while also giving a cold and refreshing taste. Mouthwashes commonly include combinations of water-insoluble essential oils such as spearmint, peppermint, eucalyptus, and menthol (Vranic et al., 2004). 99.2% of all mouthwashes contain flavouring agents (Radzki et al., 2022).
Preservatives	Preservatives such as sodium benzoate, methylparaben and ethylparaben inhibit the growth of microorganisms in mouthwashes (Vranic et al., 2004). These are present in 82.2% of all mouthwashes (Radzki et al., 2022).
Sweeteners	Sweeteners are present in 96.7% of all mouthwashes (Radzki et al., 2022) and are used to enhance the flavour and taste of mouthwashes, providing a sweeter taste. The most used sweeteners include sodium saccharin, sorbitol, and glycerol. Often, xylitol is also used as it is claimed to provide anti-caries activity (Vranic et al., 2004).
Colouring agents	66% of all mouthwashes contain colouring substances to provide a more attractive appearance (Vranic et al., 2004, Radzki et al., 2022,).

Table 1: Examples of key ingredients of a mouthwash (Acknowledgment Vranic et al., 2004 and Radzki et al., 2022)

An alternative classification of therapeutic mouthwashes may be based on the specific therapeutic compounds as shown in Table 2

Compound	Agent
Enzymes	Protease, Lipase, Nuclease, Dextranase, Mutanase, Glucoseoxidase, Amyloglucosidase
Bisbiguanides	<p>Chlorhexidine (CHX) is a cationic bisbiguanide with broad antibacterial activity. It can bind to oral tissue and alter the integrity of the bacterial cell membrane, thereby damaging the cytoplasm. CHX can bind and remain in the oral cavity (substantivity). Chlorhexidine is bacteriostatic at low concentrations and bactericidal at higher concentrations.</p> <p>Available by prescription in a 0.12% solution in the United States and at higher concentrations (e.g., 0.2% in Europe and Canada).</p> <p>Considered to be the Gold Standard.</p>
Quaternary Ammonium Compounds	<p>Quaternary ammonium compounds are a group of cationic agents that bind to oral tissues. Their mechanism of action is to rupture the cell wall and alter the cytoplasm. The initial attachment to oral tissue is very strong, but they are released rapidly and therefore have not shown the same efficacy as chlorhexidine. In addition to emulsifying and detergent properties quaternary ammonium compounds have bactericidal activity against gram – positive and at higher concentration, against some gram – negative bacteria.</p> <p>The most used agent in dentistry is cetylpyridinium chloride (CPC), usually utilized at 0.05%.</p>
Phenolic compounds	<p>Phenols disrupt cell walls and inhibit bacterial enzymes and is available as a brand and generic product with a combination of thymol, eucalyptol, menthol, and methylsalicylate. Long-term studies (3-6 months) have reported significant reduction in the levels of biofilm and gingivitis.</p> <p>Examples: Thymol, 4-Hexylresorcinol, 2-Phenylphenol Eucalyptol, Listerine</p>
Fluorides	<p>Fluoride compounds have both antibacterial and cariostatic effects and are used to reduce the prevalence of caries and in remineralization of the early carious lesion (Zero et. al. (2006)</p> <p>. Fluorides function by creating fluorohydroxyapatite crystals which exhibit higher resistance to organic acids in comparison to hydroxyapatite crystals found within tooth enamel (Vranic et al. 2004).</p> <p>Adding stannous fluoride has been shown to have many benefits including the reduction of dental calculus build-up, dental plaque, and gingivitis (Rajendiran et al., 2021).</p> <p>Examples: Sodium fluoride, Sodium monofluorophosphate Stannous fluoride, Amine fluoride</p>
Metal ions	<p>Examples are Copper, Zinc, Tin (Stannous). Zinc is present in mouthwashes such as zinc chloride. Zinc ions have antibacterial properties and can also be used an antiplaque</p>

	<p>agent. The antibacterial properties arise from its actions on the cytoplasm and glycolytic enzymes together with the inhibition of glycolysis. Zinc ions may also reduce calculus formation through crystal growth modification or inhibition (Radzki et al., 2022).</p> <p>Stannous ions have numerous benefits including the reduction of dental calculus build-up, dental erosion dental plaque, and gingivitis (Rajendiran et al., 2021) (see also Fluorides as an anti-caries agent).</p>
Oxygenating agents	<p>The efficacy of peroxide is limited with the antimicrobial effect based on the release of oxygen and the impact on anaerobic organisms and is usually combined with other agents in commercial dentifrices and mouthwashes.</p> <p>Sodium perborate is an oxidising agent, which kills micro-organisms that survive without oxygen (anaerobes). These types of micro-organisms can be present in the plaque that builds up on teeth and causes gum disease.</p> <p>(Fresh Look at Mouthwashes—What Is Inside and What Is It For?)</p> <p>Sodium bicarbonate in solution can disrupt biofilms without an antimicrobial effect, hypothetically by disrupting the exopolysaccharide matrix structure of dental plaque (Radzki et al. 2022). Sodium Bicarbonate mouthwashes are also effective in increasing salivary pH above the threshold level required for the prevention of enamel demineralization and enhancing remineralization (Chandel et al. 2017).</p> <p>Examples are peroxides, bicarbonates</p>
Other Antiseptics	<p>Examples are Iodine, Povidone iodine, Chloramine-T Sodium hypochlorite, Hexetidine, Triclosan</p>

Table 2: Examples of plaque control agents (Modified from Balagopal, Arjunkumar 2013)

According to Rathore and Gillam [2024] most manufacturers, make claims under the Cosmetic regulations rather than making a direct clinical claim such as ‘prevents gingivitis’ etc., which would require clinical evidence from well-conducted randomised clinical trials (RCT) to claim clinical efficacy [CPTA Guide 2024]. The aim of this short review is, therefore, to evaluate the effectiveness of selected over the counter (OTC) mouthwashes (packaging claims) and compare these claims with evidence from the available published literature (including evidence from systematic, reviews, meta-analysis, Cochrane reviews and clinical studies).

Methodology

A study was conducted by one of the authors (DA) to

identify a range of home or consumer (over the counter) mouthwash products for the treatment of gum health in a local supermarket store in the UK. Information relating to the ingredients of the various selected mouthwashes together with the claims made on the containers (packaging/labelling) which subsequently included data from the internet (manufacturers’ websites). A comparison was made on the various claims made by the manufacturers on their products with the available evidence from peer reviewed journals and information was subsequently collated into table (Table 3).

Results

From the initial observations of the various products available in UK Supermarkets and supplementary data

from the manufacturers’ websites, a table was constructed outlining the claims and active ingredients in selected mouthwashes (Table 3).

Over the counter toothpastes claims and observations

Packaging (labelling) of most mouthwashes often have multiple claims about the advantages of the active agents such as preventing bleeding, promoting gum health, and

fighting plaque. Packaging may also state that a particular product is ‘scientifically proven/clinically tested’. A search of online manufacturing websites identified mouthwashes that claimed to help with ‘gingivitis’ etc., Table 3 below details the acquired information to assess the claims on each product with the active agents identified in each mouthwash together with the literature supporting these claims.

Mouthwash	Claims	Active Ingredients	Evidence
Corsodyl Act Gum Health Mouthwash Soft Mint	“Actively targets plaque bacteria”. “Creates a protective shield” (Tesco.com, 2023)	Sodium lauryl sulphate, Zinc Chloride, Sodium fluoride (Tesco.com, 2023)	Contains SLS and zinc chloride which both have antibacterial properties. The sodium fluoride provides both antibacterial and cariostatic effects. (Vranic et al., 2004, Rajendiran et al., 2021, Radzki et al., 2022)
Corsodyl Original Alcohol-Free Intensive Treatment Mouthwash	“Kills the main cause of gum problems in 30 seconds”. “For the treatment of gum problems bleeding gums, irritated gums and mouth ulcers” “Intensive care to help stop bleeding gums, swollen and inflamed gums”	Chlorhexidine Digluconate 0.2% w/v (Corsodyl, 2023)	Contains chlorhexidine which has bacteriostatic and bactericidal effects (Rajendiran et al., 2021).
Listerine Advanced Defence Gum Treatment Mouthwash	“Creates an invisible protective shield that helps prevent plaque germs from attaching to the gums, allowing gums to repair and restore themselves to a natural, healthier state” (Listerine, 2023)	Ethyl Lauroyl Arginate HCl (LAE) 0.147%w/w (Listerine, 2023)	Ethyl Lauroyl Arginate is a cationic surfactant that is used as an antimicrobial agent/preservative (Gunsolley et al., 2006, Araujo et al. 2015, Gallob et al., 2015).
Colgate Peroxyl Medicated Mouthwash	“Rapid release of oxygen helps remove debris and has an antibacterial effect on anaerobic bacteria. This mouthwash facilitates healing and alleviates discomfort caused by	100ml of solution contains 1.5g of Hydrogen peroxide (as 35% Hydrogen Peroxide solution) (Colgate, 2023)	Hydrogen peroxide has antimicrobial activity because it is active against bacteria, yeasts, fungi, viruses, and spores

	<p>minor mouth and gum irritations.</p> <p>(Colgate, 2023)</p>		(Rashed, 2016).
Clinisept+ Mouthwash	<p>“Cleanses, deodorizes and protects against the harmful bacteria that cause gum disease and tooth decay.”</p> <p>(Victoriahealth.com, 2023)</p>	Sodium Hypochlorite (Victoriahealth.com, 2023)	Sodium hypochlorite has strong antimicrobial properties (De Nardo et al., 2012, Hussain et al., 2021).
Listerine Total Care Teeth and Gum Mouthwash	<p>“Reduces plaque below the gumline”.</p> <p>“Contains fluoride to help strengthen enamel”.</p> <p>“Contains zinc fluoride to help prevent tartar”. “Helps kill plaque causing germs to keep gums healthy.”</p> <p>(Listerine, 2023)</p>	Zinc chloride and sodium fluoride (Listerine, 2023)	Zinc chloride has antibacterial properties (Radzki et al., 2022). The sodium fluoride provides both antibacterial and cariostatic effects (Rajendiran et al., 2021).
Listerine Multi Protect Gum Mouthwash	<p>“12-hour germ protection”</p> <p>“Gum protection”</p> <p>“Reduces plaque”</p> <p>(Listerine, 2023)</p>	Sodium lauryl sulfate, Sodium fluoride, Zinc chloride (Listerine, 2023)	Contains SLS and zinc chloride which both have antibacterial properties. Sodium fluoride provides both antibacterial and cariostatic effects (Vranic et al., 2004, Rajendiran et al., 2021, Radzki et al., 2022).
Oral B Gum & Enamel Care Fresh Mint Mouthwash	<p>“Protects gums, strengthens enamel and helps to prevent caries”</p> <p>(Oral B UK, 2023)</p>	Sodium Fluoride (Oral B UK, 2023)	The sodium fluoride provides both anti-bacterial and cariostatic effects (Rajendiran et al., 2021). (Fejerskov et al. 1981)
Dentyl Dual Action CPC	<p>Shake to activate this two-phase mouthwash for 12 hours of lasting fresh breath.</p> <p>Physically lifts plaque and removes bacteria with results you can see instantly in the sink.</p> <p>Clinically proven 61% plaque reduction after only 28 days of use*</p> <p>Contains Fluoride and CPC antimicrobial agent, Cetylpyridinium Chloride, for healthy teeth and gums.</p> <p>Alcohol free, does not sting</p>	Fluoride and CPC antimicrobial agent, Cetylpyridinium Chloride, Essential oils Aqua, isopropyl myristate, mentha arvensis extract, sorbitol, sodium saccharin, eugenol, eugenia caryophyllus leaf oil, limonene, cetylpyridinium chloride, sodium fluoride, tricolsan, 2-bromo-2-nitropropane-1, 3-Diol, sodium phosphate, CI 17200, CI 42090, CI 61565, linalool, citric acid. Contains sodium fluoride	(Stookey et al. 2005)

	or dry the mouth, for adults and kids 6 years+ to use twice daily	0.05% (225 ppm F)	
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Table 3 Evidence of effectiveness of selected active agents in over-the-counter mouthwashes

Discussion

The packaging on many over-the-counter mouthwashes has a range of different claims such as “protects gums, reduces inflammation, kills plaque bacteria” and after analyzing the active ingredients present in the formulation many of these assertions appear to be supported by evidence. It is important to conduct further investigations on these active ingredients through clinical studies to further evaluate their impact on both gingivitis and periodontitis as well as to determine whether there is any evidence of antimicrobial resistance and/or any adverse effects. For example, sodium lauryl sulphate has been reported to cause mucosal desquamation, irritation or inflammation of oral mucosa or the dorsal part of the tongue, ulcerations, and toxic reactions (Kasi et al. 2022). Chlorhexidine has also been reported to cause hypersensitivity reactions following dental procedures (Pemberton et al. 2012) although such reactions are rare, but dentists should be aware of the possibility when using the product. More commonly chlorhexidine may cause mouth ulcers, disturbed taste, staining, desquamation of the tongue (Drugs.com 2023).

The use of oral care products including mouthwashes as part of a self-performed oral hygiene regime to control dental plaque is well documented in the dental literature and as such the role of mouthwashes should be adjunctive in nature (Serran et al. 2015, McGrath et al. 2023). Both toothpastes and mouthwashes contain anti-plaque and anti-microbial agents to manage plaque biofilms and to prevent and treat both gingivitis and periodontitis. As indicated in this overview, common active ingredients include chlorhexidine (Rajendiran et al., 2021), sodium lauryl sulphate (SLS) (Vranic et al., 2004), fluoride

compounds (sodium fluoride, stannous fluoride, stannous chloride) (Rajendiran et al., 2021), cetylpyridinium chloride, and zinc chloride (Stookey et al. 2005, Rajendiran et al., 2021, Radzki et al., 2022) may be added to reduce bad breath (oral malodour). Both chlorhexidine and essential oils can be used to help control plaque and gingivitis (Gunsolley et al., 2006, Araujo et al. 2015, Blom et al., 2012, Gallob et al., 2015, Van der Weijden et al, 2015, Rashed, 2016, James et al. 2017, Brookes et al. 2020, Spuldaro et al. 2020). The analysis of the various claims on packaging of these products appears to be substantiated from the published literature (depending on whether the claims are cosmetic or therapeutic in nature). There is documented evidence of efficacy from 3- and 6-month clinical studies as well as evidence from meta-analysis and Cochrane reviews on chlorhexidine and essential oils (James et al. 2017, Richards 2017).

It should be noted however, that some of the formulations of these products have changed over time and some of the quoted studies are somewhat dated. More recently there has been concern expressed on the effect of mouthwashes on the oral microbiome and whether mouthwashes such as chlorhexidine may upset the normal flora (dysbiosis) and enable more dominant species to appear (Brookes et al, 2023). A recent study by do Amaral et al. (2023) however reported that both CHX and CPC mouthwashes promoted changes in the oral microbial structure with accompanying reductions in community diversity favouring the resolution of dysbiosis. It is clear from the do Amaral et al. (2023) study that further long-term clinical studies (e.g., 3- and 6-months) are required to fully understand the extent to which antimicrobial mouthwashes modulate the oral microbiome.

Conclusion

In general, the claims made by the manufacturers of over-the-counter mouthwashes are supported by evidence from the published literature, however additional clinical studies on the current formulations are still required to assess the extent of their impact on gum health. It is also necessary for consumers to remember that using these mouthwashes alone will not treat their gum health problems. Patients need to focus on good oral hygiene using effective toothbrushing techniques and interdental aids to ensure their gums are kept healthy.

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