ROLE OF DIFFERENT INGREDIENTS OF TOOTH PASTES AND MOUTHWASHES IN ORAL HEALTH

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Many different kind of ingredients are incorporated in toothpastes and mouthwashes to keep the oral health in a perfect condition. We have different kinds of toothpastes and mouthwashes available in the market like anti-cavity, extra-whitening and toothpaste for sensitive teeth, toothpastes with stripes, clear and even liver flavored toothpaste for dogs. Modern type of toothpaste contains abrasives which help to scour off bacterial films and fluorides to harden the teeth against caries and have thickeners that stay on the toothbrush. The role of detergents is to remove the fatty films, and water softeners to make the detergents work better. The sweeteners play the role as a non-nutritive which may help stop the attraction of bacteria. Different kind of ingredients incorporate such as detergents and phosphates to prevent the awful taste. A variety of mouthwashes are available in the market according to the different oral conditions like antibacterial mouthwash, whiting mouthwash, fluoride mouthwash and bad breath mouthwash which have a strong enough flavor to hide the bad tastes of decaying bits of previous meals. Both mouthwashes and toothpastes contain active and inactive ingredients which have their own importance and will be recommended according to their different oral conditions.

KEY WORDS: Toothpastes, Mouthwashes, Fluoride, Abrasive, Potassium nitrate, Chlorhexidine

INTRODUCTION

Toothpaste is a paste or gel dentifrice used with a toothbrush as an accessory to clean ,maintain the oral health and improve the esthetics.[1] A dentifrice is a paste, liquid or powder used to help maintain good oral health: it serves as an abrasive that aids in removing the dental plaque and food from the teeth and their associated structure.[2] It is an important part of the daily life to maintain oral hygiene and the most important factor of the cleaning is achieved by the mechanical action of the toothbrush and not by the toothpaste.[3,4] Most of the pastes contain the same basic functional ingredients, all of which have a specific role to play within the formulation. These include: solid cleansing abrasive materials, humectants for solubilisation of other ingredients and to prevent the formulation from drying out and thickening agent to define the rheological properties of the formulation. The use of surfactant to generate foam and impart desirable sensorial properties during use, active agents such as fluoride to provide health benefits, flavour, sweetener, opacifying agents, colours, buffering agents and preservative to maintain formulation stability.[5]

Toothpaste has a history that stretches back nearly 4000 years.[6] Different materials were used like green lead and incense to clean stains from teeth until mid-nineteenth century. In middle ages, fine sand and pumice were the primary ingredients in the tooth-cleaning formulas used by Arabs.[7] In 1950, Dr. Washington Wentworth Sheffield, a dental surgeon and chemist, invented the first toothpaste.[8] The regular formulation of modern

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toothpastes contains abrasive agents, detergents, humectants, thickening, flavoring, coloring and antimicrobial agents.[9] Tooth pastes are oriented towards a certain goal in oral health that is cleaning and provide the antimicrobial action which is responsible to prevent plaque accumulation and reduce caries and hypersensitivity.[10] The role of antimicrobial agents is to prevent the formation of new plaque, selectively inhibiting those particular bacteria that are associated with disease and inhibiting the expression of virulence determinant.[11]

Mouthwash is defined as a non sterile aqueous solution used mostly for its deodorant, refreshing or antiseptic effect and also these rinses are designed to reduce oral bacteria, remove food particles, temporarily reduce bad breath and provide a pleasant taste.[12] The first known reference to mouth rinsing is found in Chinese medicine, around 2700 BC.[13] Different products were used for mouth rinsing over the centuries. In the 1500s, wine or beer were used, in the late 19th century, the use of essential oils was introduced among the dental care habits.[14].Listerine, a mouthwash composed of a mixture of essentials oils,was created in 1987 by Dr Joseph Lawrence and pharmacist Jordan Wheat Lambert from StLoius ,Missouri.[15] In which essential oils included thymol, eucalyptol, menthol and methyl salicylate; which was a novel formulations initially intended as a surgical antiseptic.[16] Finally in the mid-1970−80's it was established as a mouthrinse for prevention of plaque and gingivitis. Remarkably, in spite of its long controversial past, Listerine has survived and has now found a bonafide place as an antiseptic mouthrinse for use in oral health care.[17] Refreshening bad breath has been the traditional use of mouth rinsing. Besides this cosmetic purpose, therapeutic mouth rinsing is now commercially, available containing ingredients like: chlrohexidiene, fluoride and quaternary ammonium compounds.[18]

Mouthwashes differ from toothpastes in a way that they do not contain abrasives.[19] Mostly the mouth washes contain 6% to 26.9% alcohol and they are called acohol containing mouth washes [20]. The purpose of alcohol in mouthwashes is to act as a vehicle to dissolve other ingredients and as an antiseptic agent [21] but the presence of alcohol in mouthrinses is contraindicated for patients with mucositis, patients with sensitive tissues associated with head and neck radiation therapy, immunocompromised patients, patients sensitive to alcohol and patients with composite restorations.[22, 23] Investigators have also shown that ethanol, used as a solvent in most alcohol-containing mouthrinses can contribute to surface softening and increased wear of dental resins and composite materials.[24] There was a reported higher risk of oral cancer in persons who on a daily basis, use mouthrinses that contained greater than 25% alcohol.[25] The concept of alcohol-free or water based mouthrinses or is relatively new.[26] Preliminary studies have found that mouthrinses containing less than 10 % or no ethanol did not induce significant oral pain, whereas, mouthrinses containing more than 10% ethanol caused pain.[27]

Different Ingredients of Toothpastes and Mouthwashes

Mouth washes and tooth pastes contain both active and inactive ingredients. Active ingredients are those that offer a therapeutic benefit like sodium flouride act as anti caries.[28] while inactive ingredients are non therapeutic and also contribute to the physicochemical properties of the dentifrice like its feel, consistency, sweetness, flavour, pH, texture, abrasiveness and appearance.[29]

Fluorides

Today almost all toothpastes contain fluoride in one form or the other like: sodium fluoride, sodium monoflourophosphate and stannous fluoride.[30] Most fluoridated toothpastes contain around 1000-1100 ppm fluoride.[31] Toothpastes contain 1.0 to 1.5 mg fluoride per gram and based on estimates of an average ingestion of 0.5 g toothpaste per use for 2 to 5 year old children, could result in the intake of 0.50 to 0.75 mg fluoride per use.[32] Fluoride-containing mouthwash could contribute 0.2 to 0.4 mg fluoride per use.[33]

Fluoride exerts its caries protective properties in several ways. The primary cariostatic effect of fluoride is topical which inhibits demineralization and enhances remineralization of early carious lesions.[34] There is also biochemical incorporation of fluoride ions directly into the chemical structure of tooth which results in substitution of hydroxyl ions with the fluoride ions leading to the formation of fluoroapatite.[35] This leads to reduction in acid solubility and buffering action of fluoride released from enamel crystals during the acid formation stage in the caries process. This new enamel structure is more resistant to bacterial acid dissolution.[36] In addition, the fluoride inhibits bacterial acid production by interfering with enzyme activity in the bacterium and inhibiting bacterial production of adhesive polysaccharides.[37] It seems that a consistent low concentration of fluoride in saliva and plaque has a greater effect on inhibiting enamel demineralization than does a high concentration of fluoride incorporated into enamel during early tooth development.[38] Over the last 10 years it

has been noted that an increasing number of infants and very young children have tended to ingest toothpaste and this is likely to be contributing to the increasing level of enamel fluorosis. This could be due to parents brushing their babies' teeth with toothpaste at too young an age (before 18 months to 2 years when baby molars appear in the mouth) or when children have not learned how to adequately rinse out their mouths and they, in turn, ingest too much toothpaste.[39] Symptoms of acute oral fluoride intoxication in humans include severe nausea, vomiting, hypersalivation, abdominal pain, and diarrhea.[40] In severe or fatal cases, these symptoms are followed by convulsions, cardiac arrhythmias, and coma.[41-43] Acute toxic doses range from 1 to 5 mg/kg,[44] doses exceeding 15 to 30 mg/kg may be fatal.[42] Acute oral LD50 values for fluoride compounds in laboratory animals range from 20 to 100 mg/kg.[44] A probable toxic dose of 5 mg fluoride per kilogram can be reached in a 10 kg, 1-year-old child after ingestion of approximately 1-mg fluoride tablets, 50 g of 1000 ppm-fluoridated toothpaste, or 50 ml of 0.2% sodium fluoride rinse or 0.4% stannous fluoride rinse or gel.[42] Ingestion of approximately twice these amounts can cause toxicity in a 5 year old child.[42] Mild gastrointestinal symptoms of acute intoxication may occur at doses as low as 1 mg fluoride per kilogram or about one fifth of the probable toxic dose.[43] Fluoride rinses are not recommended for use in children under 6 years old, since young children usually have inadequate control of their swallowing reflexes.[43.44]

Chlorhexidine

Chlorhexidine is considered to be the gold standard for oral antiseptics.[45,46] It maintains oral health through its ability to suppress overgrowth of Gram-positive and Gram-negative bacteria, as well as yeasts.[47] This is beneficial as it reduces dental plaque, which leads to a reduction in dental caries, as well as preventing gingivitis and periodontitis .[48] Chlorhexidine is a cationic biguanide that kills bacteria by membrane damage followed by intracellular coagulation. [49] The use of lower doses of chlorhexidine inhibits oral bacteria, including those implicated in halitosis.[50] The halitosis, if arises from the oral cavity is known as oral malodor,[51] this condition is able to be attributed to microbial purification occurring in oral cavity due to volatile sulphur compound which predominately comprises of dihydrogen sulphide and methyl mercaptan.[52] This microbial metabolism occurs on tongue in the saliva or in dental plaque.[53] It has the potential to cause anaphylactic reactions,[54,55] including different adverse effect like altered the taste sensation, drying and superficial desquamation or burning of the oral mucosa[56], discolouration of the teeth and tongue and possibly an increase in calculus formation.[57] In addition, some cases of ototoxicity, deafness, conjunctivitis and colitis have also been reported [58] According to some reporters organisms may develop resistance against long-term effects of 0.2%chlorhexidine (up to two years) after continuous use.[59, 60]

Benzydamine hydrochloride

Benzydamine hydrochloride mouthwash is a nonsteroidal drug with analgesic, anti inflammatory and antimicrobial properties. Its mechanism of action is not entirely known, but the drug may affect the formation of thromboxanes and alter the rate of prostaglandin production, thereby inhibiting platelet aggregation and stabilizing cell membranes.[61] 0.15%Benzydamine hydrochloride mouthwash (Difflam, Riker Laboratories, Loughborough, England), possesses topical anaesthetic properties that makes it useful for obtaining pain relief in the management of chemotherapy-induced pharyngitis, radiation-induced oral mucositis, and recurrent aphthous stomatitis.[62,63,]

Cetlypyridinium chloride (CPC)

Cetlypyridinium is a cationic agent and is therefore capable of absorbing negatively charged bacterial cell membrane phosphates possibly disrupting the cell wall and increasing permeability. Many years ago, CPC was shown to be bactericidal to Gram positive bacteria but relatively ineffective against some Gram negative bacteria.[64] Several studies have shown that CPC-containing mouthwashes inhibit plaque formation (reduction in plaque weight but no effect on clinical plaque score) [65-67] although its efficacy is variable due to limited substantivity.[68] Cetlypyridinium chloride has an insignificant toxic effect when used at a concentration of 0.05% w/v, although minor side-effects such as a mild burning sensation of the tongue has been reported".[69]

Xylitol

According to the studies by Ma¨kinen and Scheinen,[70,71] xylitol has been widely used as a caries-inhibiting sweetener and it was officially approved by the authorities in Japan (1997). Recommended as a safe food additive and incorporated in different products like chewing gum and tablets as a sugar substitute.[72] The use of xylitol-containing dentifrice resulted in significantly lower caries incidence compared with the use of non-xylitol-containing dentifrice.[73]

Triclosan

Triclosan (2,4,4'-trichloro-2'-hydroxydiphenylether) is a non-ionic, lipid soluble, broad spectrum antimicrobial agent that has been used for the last 25 years in soaps, cosmetics and deodorants. A more recent application is its use as a dentifrice and mouth-rinse to inhibit bacterial colonization.[74] Its antimicrobial activity is less than that of chlorhexidine but is compatible with the other ingredients in toothpaste and has an acceptable taste.[75] Adding the copolymer has improved and extended triclosan's clinical antimicrobial activity. The antibacterial activity of triclosan/copolymer toothpaste is at work in controlling gingivitis but the antiinflammatory properties provide an additional benefit against inflammatory periodontal disease. Triclosan has been shown to limit the ability of human gingival fibroblasts to produce several inflammatory cytokines and mediators of inflammation.[76]

Zinc Citrate Trihydrate (ZCT)

Zinc citrate trihydrate has a long history of use in oral care products. ZCT is responsible to prevent the calculus formation by inhibiting crystal growth and also inhibits the growth of bacteria. Several studies have clinically proven that it helps prevent plaque formation and gingivitis.[77]

Potassium Nitrates

Potassium nitrate is used in tooth paste and mouth washes to alleviate dentinal hypersensitivity.[78,79] Toothpastes with ingredients that include stannous fluoride, strontium chloride hexahydrate, aluminum ferric oxalates, potassium ferric oxalates and fluorides are designed to reduce flow in the dentinal tubules by occluding or sclerosing the tubules, desensitizing toothpaste is considered the simplest and most cost-effective as compared to the other products because of the potassium compounds.[80,81] Potassium ions are thought to block the action potential generated in intradental nerves agents.[82]

Pyrophosphate

Tetrasodium pyrophosphate, disodium dihydrogen pyrophosphate, and sodium tripolyphosphate are all tartar control ingredients.[83] Studies have shown that these not only serve to disrupt or retard the formation of calcium phosphate crystals, but also inhibit some bacterial growth. The pyrophosphate ion inhibitors are identifiable and have been proven to be safe and effective. They are capable of maintaining the integrity of the enamel while preventing crystallization of plaque minerals.[83]

Abrasives

Abrasive is a substance that is used for abrading grinding or polishing.[84] Abrasives are the insoluble components added to toothpaste in order to aid the physical removal of stains, plaque and food debris.[85] Abrasives used in toothpaste date back over 2000 years where preparations used bones and ground shells.[86] In order to optimize the removal and control of extrinsic stains specific abrasives and chemical agents can be added to the toothpastes and these improved stain removal or these are termed as whitening toothpastes.[87] A wide variety of abrasive systems of various particle size are thus present in commercially available toothpastes today including: precipitated silica, alumina, dicalcium phosphate, dihydrate, insoluble metaphosphate, calcium carbonate and other whitening agents.[88] Different abrasive and chemical ingredients of whitening tooth pastes are shown in table 1.[89]

TOOTH WHITENING AGENT	
ABRASIVES	Hydrated silica, Calcium carbonate,Dicalcium phosphate dehydrate, Calcium pyrophosphate, Alumina, Perlite, Sodium bicarbonate,
CHEMICALS	Hydrogen peroxide, Calcium peroxide, Sodium citrate, Sodium pyrophosphate, Sodium tripolyphosphate, Sodium hexametaphosphate, Papain
OPTICAL	Blue covarine

Table-I: Abrasive and chemical ingredients of whitening tooth pastes

Different formulations contain different abrasive agents, some being more abrasive than others. Relative Dentine abrasivity (RDA) is a numeric scale, which indicates the degree of abrasivity and is useful for comparison between different pastes. A higher RDA value indicates a greater abrasive formula.[90] When choosing a toothpaste, the dental professional needs to understand how the hardness of the abrasive can have a direct effect on the tooth surfaces. Abrasive particles have been evaluated based upon their hardness relative to dentin. Moh's hardness number of some common abrasives used in toothpastes is presented in Table 2.[91]

Compound (Formula)	Moh's Hardness
Dentin	2.0- 2.5
Baking soda	2.5
Dicalcium phosphate dehydrate	2.5
Calcium carbonate	3.0
Anhydrous dicalcium phosphate	3.5
Hydrated silica dioxide	2.5-5.0
Calcium pyrophosphate	5.0
Alumina	9.25

Table-2: Moh's hardness number of dentifrice abrasives.

Some of the abrasives contain the carbonate group which have an alkaline pH and can act as a natural buffer in the oral cavity while other abrasives have a neutral pH. Sodium bicarbonate (baking soda), unlike other calcium carbonates, is naturally occurring in the body and have a beneficial role in neutralizing pH changes in acid forming plaque after exposure to sucrose [92] and caries inhibition due to its alkaline pH.[93] The abrasives in toothpastes, hydrated silica, alumina and calcium pyrophosphate are considered to be inactive.

This compares to other abrasives that have some chemical activity in promoting dental health beyond the removal of plaque and stain. Other abrasive combinations are more effective as compared to the individual one. When dicalcium phosphate dehydrate, (dical) combined with sodium fluoride (NaF) in a toothpaste, it was significantly superior to the silica dentifrice with NaF in preventing caries.[94] In fact, dical provides the calcium necessary for remineralization.[95] Similarly restorative material like glass-ionomer cement contains 15.7% calcium fluoride which may be responsible for the reactivity of fluoride.[96] This release of fluoride from glass-ionomer cement may depend on proportion during mixing of powder liquid ratio, therefore, practitioners need to be aware of the affect of any changes in powder liquid ratio on their physical and biological properties.[97]

Sodium Lauryl Sulfate (SLS)

Sodium lauryl sulfate an anionic detergent, also exhibits antimicrobial activity and is widely used as a synthetic cleansing agent in cosmetics and dentifrices. However, SLS may cause adverse effects including skin dermatitis,[98] inflammation and desquamation of the oral mucosa.[99] SLS can interact strongly with the skin and may swell and disrupt stratum corneum which affect the lipid and protein structures.[100]

Inactive Ingredients

Inactive ingredients include all the remaining ingredients in the toothpaste which are not active and their role is to provide structure, texture, "mouth feel", cleansing activity, colour(s), and flavour(s), as well as preservatives.[29] Inactive ingredients and their functions are presented in Table 3.[101]

Inactive Ingredients and their Functions[84]		
Binders	Alginates, Cellulose derivative	Provide body, Prevent separation
Humectants	Glycerin, Sorbitol	Retain moisture, Prevent dehydration Give sweetness
Surfactants / Detergents	Sodium lauryl sulfate	Cause foaming, Reduce surface tension, Loosen & suspend plaque
Buffering agents	Sodium hydroxide	Control the pH
Sweeteners		Sweeten the dentifrice
Flavorings	Essential oils, Menthol, peppermint, wintergreen, Cinnamon.	Provide flavor
Dyes	Vegetable dyes	Improves appearance
Opacifier	Titanium dioxide	Give opacity
Preservatives	Alcohols, Benzoates	Preserve the dentifrice
Water		Form a paste with the ingredients

Table-3: Different inactive ingredients and their functions

CONCLUSION

The importance of ingredients present in mouthwashes and toothpastes is according to different oral conditions. Mouthwashes have the same composition as toothpastes, although they do not contain abrasives but may use alcohol (6%-26.9%) as a preservative and a semi-active ingredient. Both mouthwashes and toothpastes contain active and inactive ingredients which have their own importance. An active ingredient for example Sodium fluoride, Sodium Monofluorophosphate may act as anti caries whereas anti plaque and anti calculus components

like Triclosan/copolymer, cholrohexidiene, Tetrasodium pyrophosphate, Sodium hexametaphosphate, chlorine dioxide may be responsible for preventing halitosis and promote tissue regeneration. Inactive ingredients may help provide the texture, "mouth feel", cleansing activity, colour(s), and flavour(s), as well as preservatives.[22.]

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