

Ingredients used in modern toothpastes

Introduction

The world oral care market is big business that comprises of toothpaste, mouth washes, toothbrushes, mouth fresheners, denture fixatives, plaque indicators, plaque removers, dental floss, toothpowders and other speciality products. In the overall personal product range of toiletries and cosmetics, oral care is a minuscule segment having an average share of say about 10%.

The growth of oral hygiene products is largely due to changing consumer attitudes towards dental care and is directly related to the income and educational levels of the end-user. The state of teeth, gums or the mouth, as a whole, plays a major role in the overall health of an individual and the realisation that tooth loss does not depend on age makes a person buy a premium priced product that offers therapeutic or value-added benefits. Presently, toothpaste represents the largest sector of the oral care market, closely followed by mouthwashes and toothbrushes. In the Indian subcontinent, more so in rural India, toothpowders are still popular.

For consumer acceptance, dental creams should have several physical and chemical attributes. Toothpastes should not be stringy, not show separation of solid and liquid phases and not have varying levels of viscosity on ageing. The dentifrice must be easy to dispense from a tube and yet have excellent ribbon qualities without being runny in character. Toothpowders should be free-flowing with no lump formation and have a good feel. Both contain ingredients that greatly enhance the therapeutic and cosmetic benefits, and have an appealing taste for the consumer to continue buying.

Dental creams and powders are complex mixtures of various ingre-



dients, suitably optimised for maximum therapeutic benefits and consumer delight.

Although many different types of toothpastes are available in the market, majority of them are mixtures of abrasives, humectants, surfactants, thickeners, binders, sweeteners, flavours, and speciality chemicals providing therapeutic benefits or actives. Toothpowder's also contains similar ingredients, but agents like thickeners, binders that maintain homogene-

ity and stability of toothpaste, may not be necessary.

Abrasives

The solid cleansing material of toothpaste that removes plaque, embedded food particles and stains are called as abrasives. Abrasives also function as a polishing agent without adversely affecting tooth enamel or any exposed dentine.

Oral cavity is an open system in the human body, and teeth acquire

Table 1
Some functional ingredients used in toothpastes

| Ingredient | Usage level |
|--------------------------------------|------------------------|
| Abrasives | 10-60% |
| Humectants | 24-60% |
| Water | 0.0-50% |
| Inorganic thickeners | 0.2-12% |
| Organic binders/ gums, etc. | 0.5-03% |
| Surfactants | 0.5-03% |
| Buffers/salts, etc. | 0.5-10% |
| Flavour/sweeteners | 1.0-1.5% |
| Actives (triclosan, fluorides, etc.) | As per specific claims |

a layer of protein material, called as acquired pellicle. Continuous accumulation of pellicle leads to bacterial growth and plaque. Pellicle must be regularly brushed out with an effective toothpaste to prevent teeth from becoming discoloured or stained.

Abrasiveness is usually expressed in the Moh's scale, measuring hardness on a logarithmic scale of 0 to 10. Using the Moh's scale, tooth enamel has a hardness of 4-5, dentine 2-2.5, and the acquired pellicle about 1. A safe and suitable toothpaste abrasive should have an abrasive value in the range of 1 to 2 and the abrasiveness of a dental product must be within reasonable limits to prevent any harm to teeth.

The other important factor to be considered in selecting an effective abrasive is the particle size. A large-sized particle will be ineffective in removing the adhering protein layer due to uneven distribution and will produce a gritty feeling when used. It is preferable to have a particle size in the range of 2-15 μ for maximum efficiency. Likewise, a smooth and regular spherical shaped particle will have little abrading property, whereas an irregularly shaped particle,

harmless to enamel and dentine, may be more effective.

Calcium carbonate, which is available in a variety of grades, is an effective toothpaste abrasive. Its alkaline nature helps in neutralising the acidity generated in the mouth after eating. Dicalcium phosphate dihydrate is also widely used as an abrasive. It has a good colour and a non-obtrusive odour and taste. Aluminium trihydrate and silica are also used as toothpaste abrasives. The advantage of using silica in its pure form is its relative inertness and its compatibility with fluorides and many therapeutic materials. Silica is available in different grades and particle sizes. Popular among them are silica aerogels and precipitated silica. Silica with a refractive index closer to that of the liquid phase of a toothpaste helps in formulating a clear and gel-type product. Silica types that are porous in nature are shear-sensitive and create a self-adjusting particle size distribution in a toothpaste formulation.

Mildly alkaline abrasives such as baking soda (sodium bicarbonate) are also used as a cleansing agent.

Alkaline abrasives thus play a dual

role in dental hygiene. Apart from mechanical removal of the unwanted pellicle, it also neutralises the acidic metabolites present in the mouth cavity. Abrasives being a major component in toothpastes should have low levels of astringency to help formulating a consumer-acceptable flavoured product.

Anti-microbial agents

Tooth decay and dental caries result from the continuous build-up of plaque, a sticky film of bacteria that constantly forms on the mouth together with their decomposition products and food residues. Plaque adheres to teeth and the areas between them and if not removed calcifies to form a cement like substance called tartar. Tartar hardens, staining teeth and making them rough. It also provides a perfect place for bacteria to grow and proliferate. The bacteria present generate acidic metabolites lowering the mouth pH to 5.5, which causes an attack on the dental enamel. Such repeated attack breaks down tooth enamel, exposing the sensitive part of the tooth, leading to rapid onset of dental caries. The formation of tartar also irritates the gums; it becomes red, swollen, or tender, and may bleed on brushing, causing gingivitis, and eventually culminate in periodontal diseases.

Oral diseases cause tooth loss and pain; bad odour causes embarrassment in social circles; loose teeth interfere with speech; and in some cases spread infection to other areas of the mouth and body. Proper brushing helps prevent tartar formation but only a professional dentist can remove built-up tartar by mechanical cleaning either to prevent or to delay the onset of periodontal disease. Dental treatments, apart from being labour-intensive, are also relatively expensive and cause discomfort. To prevent plaque-associated diseases, the plaque formed must be continuously removed. Unfortunately, simple brushing is only partially successful



in this respect. The easier option to help remove plaque is to use toothpaste containing an effective anti-microbial ingredient.

For an antimicrobial to be considered effective in an oral formulation, the following attributes are necessary:

- It should have a broad spectrum activity;
- Good substantivity, i.e. be retained on the surface of the teeth and other parts of the mouth cavity;
- It should have either no taste or acceptable taste;
- Have a very low toxicity and not disturb the oral microbial ecology;
- It should be stable and compatible with other ingredients used; and
- Easy to incorporate in a dentifrice.

It is also very important that active ingredients must be properly blended in a formulation, so that their therapeutic activity is not lost. Cationic ingredients like Chlorhexidine as its gluconate salt, because of its substantivity are effective, but its use is limited due to its incompatibility with many ingredients. It also has a tendency to cause discoloration of teeth and has a long-lasting bitter taste. Cetylpyridinium chloride and plaque reducing enzymes like glucose oxidase and amyloglucosidase have also been used as an active in a toothpaste. Cetylpyridinium chloride has relatively lower substantivity in the oral cavity and therefore frequent use is required to provide any useful activity.

Triclosan (2,4,4'-trichloro-2-hydroxydiphenyl ether) is a non-ionic antibacterial agent now being used by major toothpaste manufacturers, to effectively reduce gingivitis and other periodontal diseases. Triclosan is an effective antibacterial against both gram-positive and gram-negative organisms. Unlike other cationic

agents, it does not induce staining of teeth. It is a very faintly aromatic, off-white powder, stable in normal storage conditions, and easy to incorporate in a toothpaste formulation. Moreover, it does not impair taste sensation. Triclosan is stable to hydrolysis and prevents sodium lauryl sulphate (SLS) induced cytotoxicity to human cells. It also inhibits occurrence of inflammation of the mucous membrane in the mouth (mucositis), which makes it a very suitable antimicrobial agent in a dentifrice. To claim benefits like prevents bleeding gums, gingivitis, plaque, etc. incorporation level of 0.2-0.3% (w/w) of triclosan is necessary.

Use of fluorides

Fluorides are also used in dental creams to prevent caries. Stannous fluoride and sodium fluoride were widely used in toothpaste formulations, but nowadays sodium monofluorophosphate is preferred. Stannous fluoride is said to stain teeth and sodium fluoride is reported to interfere with body enzymes. Sodium monofluorophosphates is popular because of its relatively lower toxicity; superior stability; and compatibility with calcium-based abrasives without causing any adverse reactions. Currently, the maximum level of fluorides permitted in a fluoride dentifrice is 1,000-ppm. Toothpaste specially formulated for children contains much lower fluoride levels.

Toothpastes for sensitive teeth

Teeth become sensitive to temperature variations when the dentine and nerve on the dentine surface stand exposed and pain is experienced when eating an ice cream or drinking hot liquids. Relief may be obtained by use of certain ingredients specially formulated for such purpose. Formaldehyde, strontium chloride, strontium nitrate, potassium nitrate, etc. are used as therapeutic agents that are believed to block the

dental tubes, connecting the pulp nerve endings.

Dentifrice containing Vitamin A palmitate, Vitamin E acetate, Vitamin C, Vitamin B6 are also being developed in various research laboratories to combat various gum diseases to improve overall oral hygiene.

Humectants

Besides water, toothpaste contains humectant to prevent the toothpaste from drying out and increase pleasant mouth feel. Glycerine, propylene glycol, sorbitol, etc. are frequently used as humectant. Usually a mixture of humectants is preferred to give superior function at optimum cost.

Thickeners and binders

Refined bentonites, silica, carboxypolymers, sodium alginate, sodium carboxymethylcellulose, natural gums, etc. are used as thickeners and binders to increase the viscosity of toothpastes and to prevent the separation of liquid and solid phases.

Binders provide body to the toothpaste. The final amount and combination to be used in a formulation depends on ingredient compatibility, costs, benefits desired, local customs and the market segment that has to be catered. In case organic thickeners are used, a suitable preservative such as sodium benzoate becomes necessary to prevent spoilage.

Toothpastes may also contain titanium dioxide as an opacifier.

Sweetening agents

Sweetening agents like sodium saccharate or sodium cyclamate is used to mask the flat, bland or slightly bitter taste of various toothpaste ingredients.

Surfactants

SLS, sometimes in combination with sodium dodecyl benzene sulphonates,

N-lauryl sarcosinate, sodium methyl cocoyl taurate, etc. are used as toothpaste surfactants. The primary function of a toothpaste surfactant is to impart a pleasant smooth feel during use. It also aids the wetting and cleaning action of toothpaste abrasives. Limited usage of surfactants in toothpaste prevents uncontrollable foam levels during usage.

Flavours and fragrances

Complex blends of natural and synthetic compounds, to give a suitable flavour are also used to give fresh breath and pleasant taste. Oils of peppermint, spearmint, clove, cardamom, cinnamon & menthol are used to provide a cooling sensation in the mouth. Sometimes approved food colours are also used to make the product look bright and attractive.

Conclusions

Unlike olden days, modern dental

creams have become far more complex mixtures, providing important cosmetic and therapeutic benefits. They contain ingredients such as fluorides, triclosan, plaque and tartar control agents, etc. All ingredients used require judicious selection to make it compatible with one another in a formulation, without creating adverse reactions.

Much more important is the quality of the ingredients used. Use of inferior quality ingredients does more harm than good. Toxic impurities like certain sultones, dioxins, furans, heavy metals that may be present in inferior quality materials could produce a plethora of responses in humans and their effects may include allergy, acne, carcinogenicity, reproductive and developmental effects, immunotoxicity, enzyme and hormonal disturbances, etc.

Good manufacturing practice is to be followed during manufacture of dentifrice to limit these impurities within acceptable limits. The water used for the manufacture of toothpaste should be of the highest quality, free from contamination. Toothpastes made in unhygienic conditions can also harbour potentially harmful microorganisms and cause the microbial count to rise in excess of the limits laid down by regulatory authorities. This is of paramount importance to the consumers because toothpaste is to be used for oral application and ingestion of microorganisms can even be fatal.



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- MIXTURE OF PARABENS
& THEIR FORMULATIONS

MIXTURE OF PARABENS

- Gujsol-1** : Mixture of Phenoxyethanol, Methyl Paraben, Ethyl Paraben, Propyl Paraben, Butyl Paraben
- Gujsol-2** : Mixture of Phenoxyethanol, Methyl Paraben, Ethyl Paraben, Propyl Paraben, Butyl Paraben, Iso Butyl Paraben
- Gujsol-3** : Mixture of Phenoxyethanol, Methyl Paraben, Ethyl Paraben, Propyl Paraben
- Gujstat** : Mixture of Methyl Paraben, Ethyl Paraben, Propyl Paraben, Iso Propyl Paraben
- Gujsept** : Mixture of Methyl Paraben, Ethyl Paraben, Propyl Paraben
- Gujcombin** : Mixture of Methyl Paraben Sodium, Ethyl Paraben Sodium, Propyl Paraben Sodium & Sodium Benzoate
- Gujsept-2** : Methyl Paraben, Propyl Paraben (4 : 1)

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