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ROLE OF PLANT EXTRACT IN THE INHIBITION OF DENTAL CARIES

DEEPAK SHARMA*, AKANSHA JAIN, SVECHHA AHUJA AND PRANSHU SACHDEVA

Department of Conservative dentistry and Endodontics, Jaipur Dental College, Maharaj Vinayak Global University, Dandh, Amer, Jaipur

ABSTRACT

Oral diseases are major health problems with dental caries and periodontal diseases among the most important but preventable infectious diseases. Oral health influences the general quality of life and poor oral health is linked to chronic conditions and systemic diseases. Oral diseases and the oral microbiota are well defined. There are over 750 species of bacteria that responsible the oral cavities, a number of which are implicated in oral diseases. The expretion of dental caries involves acidogenic and aciduric Gram-positive bacteria (*mutans streptococci, lactobacilli and actinomycetes*) and anaerobic Gram-negative bacteria (*Porphyromonasgingivalis, Actinobacillus, Prevotella and Fusobacterium*) have been linked to periodontal diseases. recent investigations oral disease, increased resistance by bacteria to antibiotics, adverse effects of some antibacterial agents currently used in dentistry and financial considerations in developing countries, in present situation need alternative safe, effective and economic treatment. Some of commercial drugs can unbalance oral flora and have adverse side-effects such as vomiting, diarrhea and tooth staining. Hence, the investigation for alternative phytochemicals isolated from plants used as alternatives medicines. This review covers recent development and investigations in plant extracts, phytochemicals and phytocompounds that control and kill the oral pathogens.

KEYWORD: ***Dentistry, phytochemicals, biofilm, dental caries, natural compounds.***

INTRODUCTION

Today, dental caries are one of the most common diseases in the world. The results of multi-variable modelling support the hypothesis that bacterial infection is important in the aetiology of dental caries. The central role of the *mutans streptococci* in the initiation of caries on smooth surfaces and fissures of crowns of teeth suggests their role in the induction of root-surface caries. The development of dental caries involves acidogenic and aciduric Gram-positive bacteria, primarily the *Mutans Streptococci* (*Streptococcus mutans* and *S. sobrinus*), *Lactobacilli* and *Actinomycetes*, which metabolize sucrose to organic acids (mainly lactic acid) that dissolve the calcium phosphate in teeth, causing decalcification and eventual decay. Dental caries is thus a *supragingival* condition.[1]

Pathogenesis of Dental Caries

Dental caries is a multi-factorial infectious disease, arising from the interplay between oral flora, the teeth and dietary factors. Dietary carbohydrates, mainly mono- and disaccharides, are absorbed into dental plaque and broken down into organic acids by the micro-organisms present in dense concentrations. Due to the minerals present in teeth. The mineral content of teeth is sensitive and produces lactic acid which increases acidic environment. Particularly, a tooth (which is mainly mineral content) is in a regular state of back-and forth demineralization and remineralization between the tooth and surrounding saliva. Demineralization proceeds faster than remineralization When the pH at the surface of the tooth below 5.5 (meaning that there is a net loss of mineral structure on the tooth's surface). The formation of dental plaque plays an important role to increase dental caries and periodontal disease cause by oral streptococci. Dental plaque has been concerned as an important etiologic aspect in dental caries. Bacterial biofilm community is governed by factors such as cell adherence, coaggregation, and growth and survival. Acidic environment support and prolong the cariogenic challenge to teeth, due to plaque bacteria consume carbohydrates on tooth surfaces. Which lead to enamel demineralization and tooth decay. food particles on the surfaces of teeth is major sources of fermentable carbohydrates, thus maintain acid production by plaque bacteria.[22] α-haemolytic *streptococci*, *Streptococcus mutans* and *Streptococcus sobrinus*, are strong cariogenic etiological bacteria, while numerous types of bacteria (markedly *lactobacilli* and *actinomyces*) may also be concerned. Three types of glucosyltransferase (GTFB, GTFC, and GTFD) which polymerize the glucosyl moiety from sucrose and starch carbohydrates into α1, 3- and α1, 6-linked glucans produce by *S. mutans*. Binding to glucans by glucan binding proteins (GbpA, -B, -C and -D) and by the Gtfs facilitates bacterial adherence to tooth surfaces, inter-bacterial adhesion and accumulation of biofilms. GtfBC&D and GbpABC&D, simultaneously with the adhesive extracellular glucans, represent the sucrose-dependent pathway for *S. mutans* to found on tooth surface and are importance in plaque formation and dental caries. The adherent glucan also responsible to the formation of dental plaque, which cause production of acid leads to localised decalcification of the enamel surface. The carbohydrate substrates directly available (as sugar ingested in food or drink) or be derived from dietary starch by the act of bacterial or salivary amylases, or both.

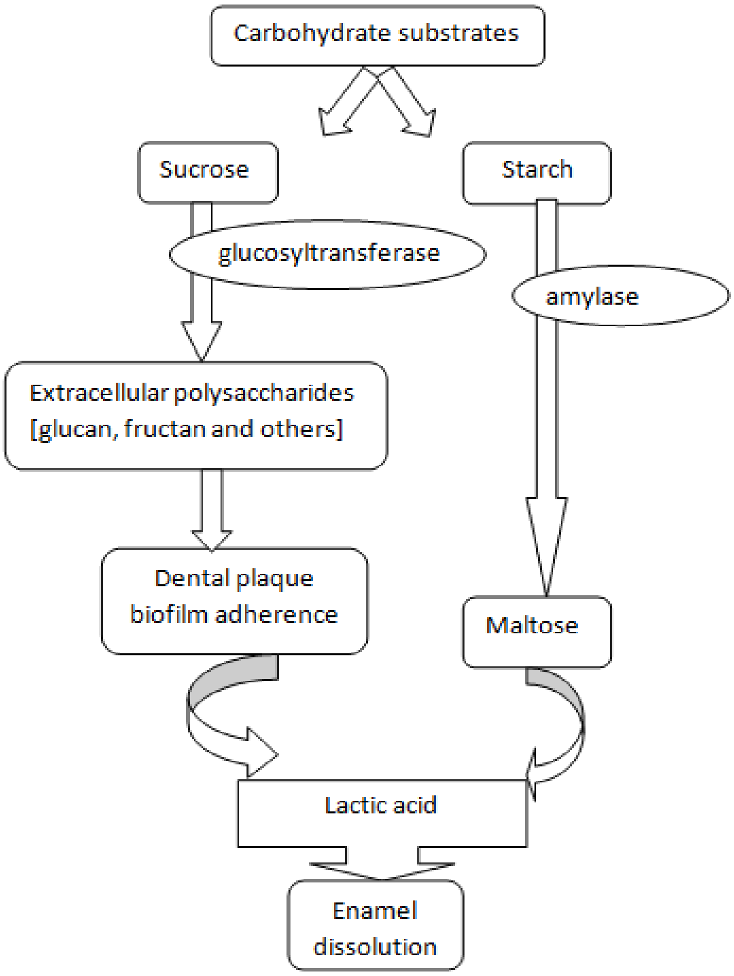

Figure 1
Pathogenesis of dental caries[9]

Different compounds used for the inhibition of dental caries

I - polyphenols

Plants substances polyphenols compound has potential activity in oral disease including tooth decay prevention[3]. Scientific community reported wide range of biological activities, many of which are related to their conventional antioxidant action; however, increasing scientific knowledge has highlighted their potential activity in preventing oral disease and tooth decay. The scientific evidence supporting that: anti-bacterial activity of polyphenols on cariogenic *streptococci*: (1) a direct effect against *S. mutans*; (2) an interaction with microbial membrane proteins inhibiting the adherence of bacterial cells to the tooth surface; and (3) the inhibition of glucosyltransferase and amylase. Currently, polyphenols use a unique bioactive natural products, the general public is aware of and has certainly heard about as a consequence of their presence in plant-derived foods and beverages and their inclusion in the formulations of cosmetic and pharmaceutical items. Occurring in all vegetative organs, as well as in flowers and fruits Polyphenols substance are considered secondary metabolites implicated in the chemical defence of plants against predators and in plant-plant interferences. Some of plants polyphenols are well known, wide variety of molecules that contain at least one aromatic ring with one or more hydroxyl groups in addition to other substituents. polyphenols have antioxidant, anticancer, and anti-inflammatory effects properties on biological system.[4] Many scientific data suggests a variety of possible mechanisms of action by which polyphenols may prevent disease, such as the inhibition of bacterial replication enzymes, the induction of apoptosis in tumour cells, the stimulation of monocytes/macrophages to produce cytokines, and the stimulation of myeloperoxidase-dependent iodination of neutrophils. polyphenols have ability to inactivate bacterial toxins, and there is an increasing interest in this topic because plant polyphenols could represent a source of new anti-infective agents against antibiotic-resistant human pathogens. Tannins are polyphenols that occur widespread in plant-based food.

Classification of Polyphenols

The empirical classification of plant polyphenols as molecules having a "tanning" action led to their being referred to in the early literature as "vegetable tannins". Haslam proposed the first comprehensive definition of the term "polyphenol", attributing it exclusively to water-soluble phenolic compounds having molecular masses of 500 to 3,000–4,000 Da and possessing 12 to 16 phenolic hydroxyl groups and 5 to 7 aromatic rings per 1,000 Da. They encompass several classes of structurally diverse entities that are essentially all biogenerated through either the shikimate/phenylpropanoid or the "polyketide" acetate/malonate secondary metabolic pathways or both.

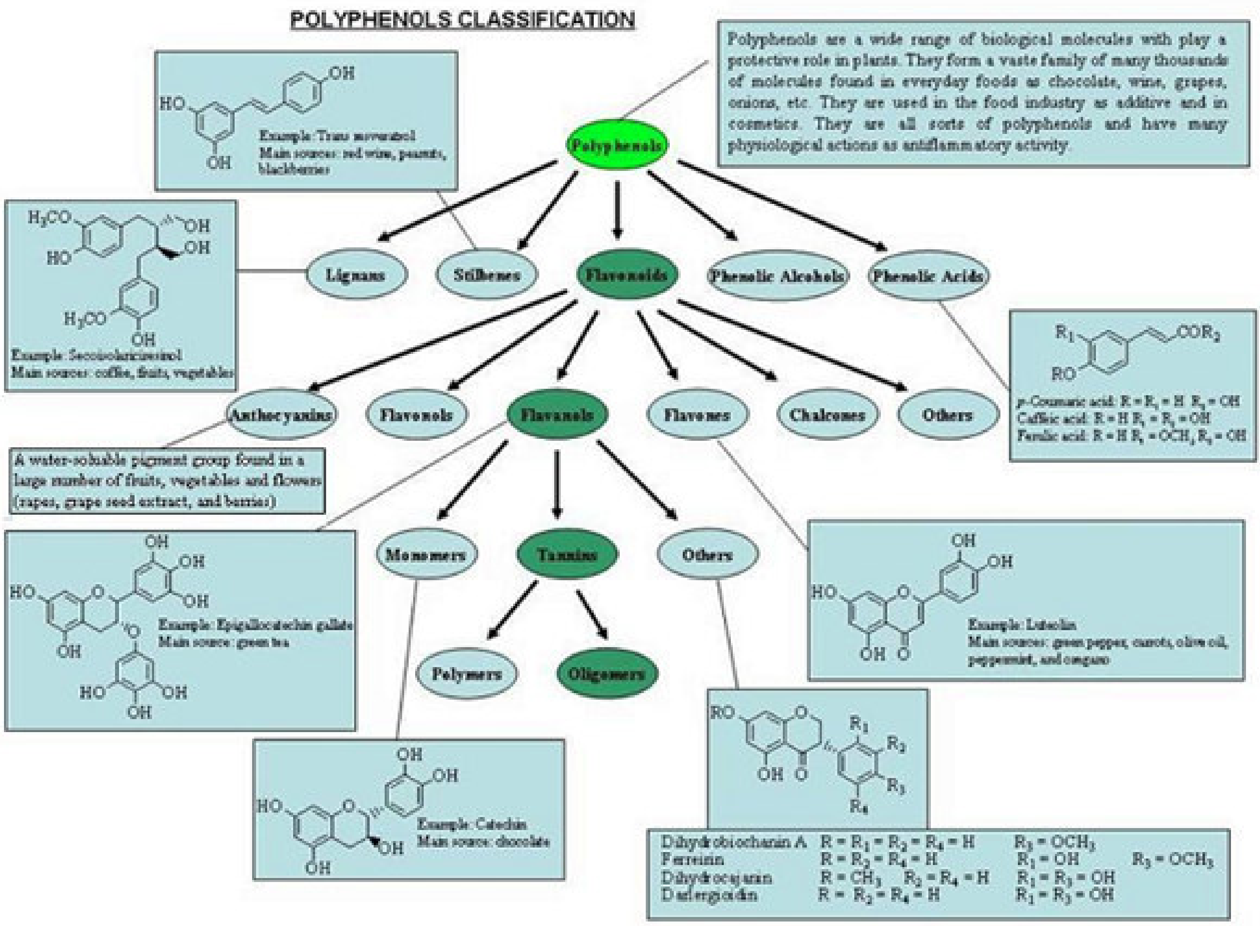

Figure 2
Classification of Polyphenols[4]

1) C6-C3 Phenylpropanoid Compounds
2) C6-C2-C6 PolyhydroxyStilbenes
3) Lignin Derivatives

Categories of Polyphenols

Polyphenols can be classified into several categories: The flavonoids are obtained by the lengthening of the side chain of cinnamic acids by the addition of one or more C2 units, typically resulting in mixed biosynthesis metabolites with important biological properties. In particular, these polyphenolic compounds have 15-carbon skeletons, represented as the C6-C3-C6 system. The flavonoids are 1,3-diaryl propanes, isoflavonoids are 1,2-diarylpropanes, and neoflavonoids are 1,1-diarylpropanes. The term "flavonoid" was first used by Geismann and Hinreiner in 1952 for the classification of those compounds whose structure is correlated to the 2-phenylchroman heterocyclic system (flavan). Their skeleton is made up of two benzene rings with a chain of three carbon atoms of a pyrone system. Thus, the several flavonoidic compound classes differ in the oxidation states of their heterocyclic systems. Single constituent flavonoids of every class are mainly distinguished by the number and the stereochemistry of the hydroxyl groups and/or methoxyls on the two benzene rings and/or the heterocyclic system. Flavonoids are fundamentally important for ecological role as pigment in flowers and fruits. Flavonoids are important for plants' ecological roles in that they are the pigments that give colour to fruits and flowers, thereby attracting pollinators. The coumarins are typical metabolites of higher plants. The benzo-2-pyrone nucleus of the simple coumarins derives from the phenylacrylic skeleton of cinnamic acids via orto-hydroxylation, trans-cisisomerisation of the sidechain double bond, and lactonisation. [5]

Antibacterial Activity of Plant Polyphenols

Phenolic compounds have diverse defensive functions in plants, such as cell wall strengthening and repair (lignin and suberin) and antimicrobial and antifungal activities. Some polyphenols are phytoanticipins, compounds with a defensive role that are not synthesised in response to a pathogen attack but rather are constitutively present in plant cells. Phenolic constituents occur on the surface of plants or in the cytoplasmic fraction of the epidermal cells, where they act as a deterrent to pathogens. In contrast, phenolic phytoalexins are secreted by wounded plants or in response to incompatible pathogens. The induced defence response includes cell death and the formation of a lesion that limits the growth of the pathogen. Cells around the lesion accumulates polyphenols and other antibiotic compounds. Polyphenols as catechin act on different bacterial strains belonging to different species (*Escherichia coli, Bordetellabronchiseptica, Serratiamarcescens, Klebsiellapneumonie, Salmonella choleraesis, Pseudomonas aeruginosa, Staphylococcus aureus,* and *Bacillus subtilis*) by generating hydrogen peroxide and by altering the permeability of the microbial membrane. Microbes stressed by exposure to polyphenols upregulate proteins related to defensive mechanisms, which protect cells while simultaneously downregulating various metabolic and biosynthetic proteins involved, for example, in amino acid and protein synthesis as well as phospholipid, carbon, and energy metabolism. Moreover, polyphenols have been reported to interfere with bacterial quorum sensing, i.e., the production of small signal molecules by bacterial cells of *Escherichia coli*, *Pseudomonas putida* and *Burkholderiacepacia* that trigger the exponential growth of a bacterial population. A large body of evidence indicates that many plants used as folk remedies contain high concentrations of polyphenolic compounds. Plants from a wide range of angiosperm families show antibacterial activity. Plants from more than 20 different families, including Asteraceae, Fabaceae, Poaceae, Lythraceae, Onagraceae, Polygonaceae, Primulaceae, and Verbenaceae showed bactericidal action. Members of the Geraniaceae and Rosaceae families are also rich in polyphenolic compounds with antimicrobial activity, and Cydoniaoblonga Miller, a member of the latter family, was found to be an important source of polyphenols that are active against bacteria growth. Polyphenols with relevant biocidal activity have been isolated from members of other plant families: Taguri et al, isolated castalagin and protodelphinidinflavenoids that are fundamentally important for ecological role as pigments in flowers and fruits, from CastaneacrenataSiebold&Zucc (Fagaceae) and Elaeocarpussylvestris (Lour.) Poir, ellipticus (Elaeocarpaceae), respectively, and found them to be effective against different bacterial strains. In recent years, there has been an increased interest in polyphenolic compounds found in plant foods. This is partly due to the mounting evidence that some of these, the flavonoids, may have beneficial effects on humans. Over 4000 flavonoids have been described (Middleton and Kandaswami, 1994), and they constitute the largest and most diverse family of polyphenols. Tannins constitute a complex group of naturally occurring polymers, and a rigorous chemical definition is difficult. The term was originally used to describe vegetable components that are responsible for converting animal hides into leather in the process of tanning by forming stable complexes with skin collagen. Thus, tannins are considered to be polyphenolic metabolites of plants with a molecular weight larger than 500 and with the ability to precipitate gelatin and other proteins from solution Mehanshoe*et al*., 1987)[6]

Anti-Cariogenic Action of Polyphenols

A variety of compounds capable of controlling dental caries have been extensively surveyed; however, only limited numbers of compounds from natural products are available because of effectiveness, stability, odour, taste, and economic feasibility The effects of polyphenols have been surveyed through both in vitro studies investigating the effect of polyphenols against *mutans streptococci* and *in vivo* studies in animals and humans. The scientific evidence supporting that Droserapeltata (Droseraceae) leaves chloroform extracts showed activity against numerous bacteria of the dental caries with greatest activity against *S. mutans* and *S. sobrinus* (MIC = 31.25 and 15.625 μg mL−1, resp.) *In Vitro* Studies on the activities of phenolic compounds toward cariogenic bacteria can be divided based on the chemical structure of the compound under study. Few studies deal with the anti-streptococcal action of simple polyphenols. Xanthorrhizol (XTZ), isolated from CurcumxanthorrhizaRoxb., has been reported to possess antibacterial activity against several oral pathogens, and it has shown to have rapid bactericidal activity against *S. mutans*. The activity of XTZ in removing *S. mutans* biofilm was dependent on its concentration and exposure time as well as the growth phase of the biofilm. A concentration of 5 μmol L−1 of XTZ completely inhibited biofilmformation by *S. mutans* at the adherent phase of growth, whereas 50 μmol L−1 of XTZ removed 76% of the biofilm at the plateau accumulated phase after a 60-min exposure. Another simple phenol,bakuchiol, isolated from Psoraleacorylifolia L, showed inhibitory activity against *S. mutans*. Yanti et al. reported anti-biofilm activity of macelignan, isolated by nutmeg (MyrisicafragransHoutt.) against oral bacteria including *S. mutans, S. sanguinis and Actinomyces*viscosus. A study demonstrated that macelignan activity at 10 μg/mL for a 30 min exposure time could remove more than half of each single oral biofilm formed by *S. mutans, S. sanguinis* and *A. viscosus* at the plateau accumulated phase (24 h). Ethanol extract of Alcealongipedicellata (Malvaceae) malvidin-3,5-diglucoside (malvin) which is the principal constituent responsible for antibacterial activity. 0.1%malvin could inhibit strongly acid producing ability of *S. mutans* and was about 60% effective in inhibiting bacterial adherence. Kuwanon G, isolated from a methanol extract of root bark of Morusalba L. showed bactericidal action in 1 min. at a concentration of 20 μg/ml against *S. Mutans* and other cariogenic bacteria as *S. sobrinus, S. sanguinis* and *Porphyromonasgingivalis*. The purified compounds (−)-cubebinfrom crude ethanol extract of piper cubeba seeds and its semi-synthetic derivatives were evaluated against oral pathogens. The crude ethanol extract was more active against *S. salivarium* (MIC value of 80 μg/mL) and purified compounds and semi synthetic derivaties displayed MIC values ranging from 0.20 mM for *S. mitis* to 0.32 mM for *S. mutans*. The active flavonoid compound, quercetin-3-O-α-L-arabino-pyranoside (guaijaverin) isolated from Psidiumguajava L. demonstrated high potential antiplaque agent by inhibiting the growth of the *S.mutans*. Magnolol and honokiol isolated from extracts of Magnolia sp. bark have a phenyl-propanoid dimer structure and are active against the cariogenic bacterium *S. mutans* (M.I.C. 6.3 mg/mL). Subsequently, phenolic substances were suggested to be responsible for the observed anti-caries effect of cocoa powder, probably due to their inhibition of the synthesis of water-insoluble glucans. Onion extracts have been reported to act on *Streptococcus mutans* and *Streptococcus sobrinus*as well as *Porphyromonasgingivalis* and *Prevotellaintermedia*, which are considered to be the main causal bacteria of adult periodontitis. Although no active components of the onion extracts were identified, onion is among the richest sources of flavonoids and contributes significantly to the overall dietary intake of flavonoids. Moreover, grape seed extracts inhibit the growth of anaerobic bacteria, such as *Porphyromonasgingivalis* and *Fusobacteriumnucleatum*, associated with periodontal diseases. There are numerous reports of the anti-streptococcal action of flavonoids. Three known isoflavanones, dihydrobiochanin A, ferreirin and darlbergioidin, and one new isoflavanone, 5,2',4'-trihydroxy-7-methoxyisoflavanone dihydrocajanin), which were isolated from Swartziapolyphylla DC heartwood, had potent activity against cariogenic bacteria. A lavandulyl flavone isolated from Sophoraexigua Craig completely inhibited the growth of oral bacteria, including primary cariogenic *mutans streptococci*, other oral *streptococci*, *actinomycetes*, and *lactobacilli*, at concentrations of 1.56 to 6.25 mg/ml. Isoprenyl flavones from Artocarpusheterophyllus showed antibacterial activity against cariogenic bacteria. Sato et al. reported that erycristagallin from Erythrinavariegata showed a high antibacterial activity against *mutans streptococci*, other oral *streptococci, actinomycetes*, and *lactobacilli*. In recent years, polyphenols from some edible plants have attracted attention as potential sources of agents capable of controlling the growth of oral bacteria. Extracts from Perillafrutescens var. Japonica seeds have shown inhibitory activity against oral cariogenic *Streptococci* and periodontopathic Po*rphyromonasgingivalis*. Perilla seed polyphenols were isolated and their activity was tested. The flavonoid luteolin was the phenol that was most active against bacterial growth. Sunphenon is a mixture of flavonols isolated from leaves of Camellia sinensis. The major components of this mixture are (+)-catechin, (+)-gallocathechin, (−)-epicathechin, (−)-epicathechingallate, (−)-epigallocathechin, and (−)-epigallocathechingallate. The addition of Sunphenon to *S.mutans* JC-2 (c) decreased cell viability; multiple applications of Sunphenon caused the death of cells, and the maximum effect was seen with treatment of 60 and 90 minutes.

Inhibition of Adherence

The adherence of bacterial cells to the tooth surface is of great importance to the development of carious lesions, and interference with some of the mechanisms of adherence can prevent the formation of carious lesion. Polyphenols are able to interact with microbial membrane proteins, enzymes, and lipids, thereby altering cell permeability and permitting the loss of protons, ions, and macromolecules. One of the first studies on this topic reported that quercetin, in the range 12.5–50 mg/ml, was effective in preventing adhesive glucan formation by *S. mutans* strains.

Inhibition of Glucosyltransferase and Amylase

The enzymatic activity of glucosyltransferase from *Streptococcus mutans* is inhibited by plant polyphenols. Apple polyphenols extracted from immature fruits markedly reduced the synthesis of water-soluble glucans by glycosyltransferases (GTF) of *S. mutans* and *S. sobrinus* but did not inhibit salivary α-amylase activity. GTF inhibitors from apples are high-molecular-weight polyphenols with a chemical structure similar to catechin-based oligomeric forms and/or gallate-ester compounds Procyanidins from betel nuts (the seed of Areca catechu L.) were the major inhibitors of glucosyltransferase from *S. mutans.*[5,6] Furthermore, HBP also inhibited the action of glucosyltransferase, which was involved in the synthesis of water-insoluble glucan, but did not suppress the growth or acid production of the bacteria. H. lupulus polyphenols significantly reduced the growth of *S. mutans* compared to the control. After an 18-hour incubation, HBP at 0.1% and 0.5% significantly reduced lactic acid production, and HBP at 0.01%, 0.1%, and 0.5% also suppressed water-insoluble glucan production. The polyphenols from bracts of H. lupulus were purified by countercurrent chromatography (CCC). The most potent cavity-prevention activity was found in a very hydrophilic fraction, whose major components were high molecular-weight substances, probably proanthocyanidins, consisting of approximately 22 catechin units in their structures. Grape and pomace phenolic extracts inhibited GTF of *S. mutans* at concentrations of 62.5 µl/ml. These extracts had qualitative and quantitative differences in their phenolic content but similar activity toward *S. mutans* GTF. Extracts of flavonols (FLAV) and proanthocyanidins (PAC) from American cranberry (VacciniummacrocarponAit.), alone or in combination, inhibited the surface adsorbed glucosyltransferase and F-ATPase activities as well as acid production by *S. mutans* cells.[7] Flavonols and proanthocyanidins moderately inhibited the activity of surface-adsorbed GTF and disrupted acid production by *S. mutans* cells without killing them. The combination of three flavonoids, quercetin-3-arabinofuranoside, myricetin, and procyanidin, displayed pronounced biological effects on *S. mutans*, suggesting that the bactericidal activity could be the result of synergistic effects of flavonoids occurring in cranberry extracts.A subsequent study by Yarnanaka-Omada et al. has confirmed that cranberry polyphenols are effective against hydrophobicity, biofilm formation, and bacterial growth of *S. mutans*. Standardised black tea extract (BTE) on caries formation in inbred hamsters that were fed regular and cariogenic diets. The frequent intake of black tea significantly decreased caries formation by 56.6% inhamster on a regular diet and by 63.7% in hamsters on a cariogenic diet.A clinical test to evaluate the effect of a mouthwash containing 0.1% H. lupulus bract polyphenols (HBP) on dental plaque regrowth over three days has shown that the HBP mouthwash was effective in reducing dental plaque regrowth (total plaque reduction of 25.4% compared with the placebo), and it lowered the number of *mutans streptococci*. Moreover, that green tea extracts inhibit human salivary amylase and may reduce the cariogenic potential of starch-containing food such as crackers and cakes because they may reduce the tendency of this kind of food to serve as slow-release sources of fermentable carbohydrate.[5,7]

II- cranberry polyphenols

According to current available data , cranberries and their molecular components are good for human health. Specially high-molecular-weight polyphenols isolated from cranberries have shown potential to dental disease. Cranberry (*Vacciniummacrocarpon*) is one of North America's third original fruits, the other 2 being Concord grape (*Vitus labrusca*; also known as fox grape) and blueberry (*Vacciniumspp*). Cranberries are sold in the fresh produce, dried fruit, juice and encapsulated powders. for the human health Cranberry extracts are particularly rich in polyphenols, including flavonoids.which inhibit the production of organic acids and the formation of biofilms by cariogenic microbes. it also polyphenols compounds may reduce the inflammatory response,as well as the production and activity of proteolytic enzymes contributing to the destruction of the extracellular matrix in periodontal disease.[8] The polyphenols of cranberries interfere with various activities (including formation of biofilm and adhesion)of Porphyromonasgingivalis, the main etiologic agent in chronic periodontitis.The current investigation data holding the promising of cranberry polyphenols to protect and/or treat oral diseases.[9]

Chemical Composition of Cranberry Extracts

Several of the studies conducted to date have used a fraction of cranberries called the non dialyzable material (NDM), which is obtained by dialysis of concentrated cranberry juice. Chemical analysis of the NDM fraction has revealed that it contains about 65% proanthocyanidins,along with a much smaller quantity (0.35%) of anthocyanins. Howell and colleagues determined that oligomericproanthocyanidins isolated from cranberries inhibited *in vitro* adhesion of *E. coli* to uroepithelial cells and thus would be responsible for the preventive effect on urinary tract infections. These oligomericproanthocyanidins are unique in that they have a double linkage between the epicatechin units (A type), whereas the majority of oligomericproanthocyanidins in other fruits have a single linkage.

Cranberries and Dental Caries

In recent years, several researchers have tried to identify edible, non- toxic compounds that could interfere with formation of the cariogenic biofilm. In this regard, it has been demonstrated that certain constituents of cranberries may limit dental caries by inhibiting the production of organic acids by cariogenic bacteria, the formation of biofilms by *S. mutans*and *S. sobrinus*, and the adhesion and coaggregation of a considerable number of other oral species of *Streptococcus*.Cranberry juice and hydroalcoholic crude extracts also prevent bacterial adherence to apatitic surfaces and reduce the formation of biofilms by oral bacteria *in vitro*.[10] Cranberry PAC were extracted from fruit of the cranberry variety ‘Stevens’ harvested at Rutgers University, P.E. Marucci Center, during September/October 2006 and kept frozen at −20°C; the ‘Stevens’ variety is the main cultivar used in the production of commercially available cranberry products [Cunningham et al., 2004; Duarte et al., 2006]. The presence of A-type linkage (which confers rigidity to the molecule) and the DP may be associated with the biological activity of cranberry PAC, including the inhibition of Gtf [Gregoire et al., 2007]. Highly purified A-type PAC fraction reduced the formation of biofilms by *S. mutans* on saliva-coated apatitic surface, which correlated well with a reduction in the amounts of insoluble polysaccharides in the extracellular matrix. The insoluble exopolysaccharides (mostly insoluble glucans rich in 3-linked glucose) are essential for the adherence, coherence and accumulation of microorganisms on the tooth surface, and provide bulk and structural integrity to the biofilms’ matrix [PaesLeme et al., 2006; Xiao and Koo, 2009]. The influences of the PAC fraction on the acidogenicity of *S. mutans* biofilms may be associated with the presence of procyanidin A_2 (despite some inhibitory effects caused by oligomers). Recently, we have shown that procyanidin A_2, a low-molecular-weight PAC dimer, disrupted both the acid production and acid tolerance of *S. mutans* cells as determined by glycolytic pH drop experiments, and partially inhibited the activity of membrane-associated F-ATPases [Gregoire et al., 2007]. Yamanaka and colleagues assessed the effect of cranberry juice on the ability of several oral species of *Streptococcus* to adhere to hydroxyapatite pellets that had been pretreated with saliva. When the bacteria were exposed to cranberry juice, their adhesion to the pellets decreased significantly. Furthermore, the hydrophobicity of the cells declined with increasing concentration of cranberry juice. In the same study, the authors found that the NDM fraction of cranberry juice inhibited 80% to 95%of biofilm formation among the streptococci studied (*S.sobrinus, S. mutans, Streptococcus criceti, Streptococcus sanguinis, Streptococcus oralis and Streptococcus mitis*). Other groups subsequently confirmed the ability of cranberry extracts to prevent the formation of biofilms by cariogenic streptococci. It has also been reported that the polyphenols in cranberries led to the desorption of *S. sobrinus* from an artificial dental biofilm. These observations suggest that cranberry polyphenols can inhibit the colonization of dental surfaces by oral streptococci and thereby slow the development of cariogenic dental plaque. In a clinical study, Weiss and colleagues investigated the effect on oral health of a mouthwash supplemented with the NDM fraction of cranberries. After 6 weeks of daily use of the mouthwash, total microflora, notably *S. mutans*, was significantly reduced. In support of these *in vivo* results, *in vitro* studies showed that the NDM fraction inhibited the adhesion of *S. sobrinus* to a hydroxyapatite surface pretreated with saliva. The polysaccharides glucan and fructan play a primary role in the adhesion of bacteria to dental surface sand in the maturation of the biofilm. Various groups have demonstrated that the cranberry's ability to inhibit the adhesion of *S. mutans*to the dental biofilm depends on inactivation of glucosyltransferase and fructosyltransferase. extracellularenzymes produced by *S. Mutans* that catalyze the formation of glucan and fructan, respectively. The proteins binding the glucans on the surface of *S. mutans* also contribute to the formation of the biofilm. Koo and colleagues,using hydroxyl apatite surfaces pretreated with glucans, found that cranberry juice significantly blocked the adhesion of *S. mutans* to glucan binding sites.The biological actions were attributed to the combined inhibitory effects of PAC on the activity of surface-adsorbed GtfB and GtfC, and on bacterial glycolysis.[11] Cranberry extracts containing a mixture of either flavonols or proanthocyanidins (PACs) inhibited the glucan synthesis by surface adsorbed GTFs B and C, and the acidogenicity of *S. mutans* within biofilms (Duarte et al. 2006). Flavonoid extracts from cranberry contain complex mixtures of low and high-molecular-weight polyphenols (Foo et al. 2000; Cunningham et al. 2004; Vvedenskaya and Vorsa 2004; He and Liu 2006).[12]

III - cratoxylum formosum

The gum of Cratoxylumformosum, commonly known as mempat, is a natural agent that has been used extensively for caries prevention by the people belonging to hill tribe in Thailand. The objective of this study was to investigate the antimicrobial activity of Cratoxylumformosum gum on *Streptococcus mutans* (*S. mutans*) *in vitro*. The gum extracted from stem bark of Cratoxylumformosum was investigated for antimicrobial activity against different strains of *S. mutans*, including *S. mutans* KPSK2 and 2 clinical isolates. Inhibition of growth was primarily tested by agar diffusion method. A two-fold broth dilution method was then used to determine the minimum inhibitory concentration (MIC) of the extract. The extract of Cratoxylumformosum was effective against *S. mutans* with the inhibition zones ranging from 9.5 to 11.5 mm and MIC values between 48 µg/ml and 97 µg/ml. The gum of Cratoxylumformosum has high antimicrobial activity against *S. mutans* and may become a promising herbal varnish against caries. ratoxylum is a small group belonging to the Guttiferae family, distributed in several Southeast Asian countries (Iinuma et al, 1996).Species of this genus have been used for their diuretic, gastric and tonic effects, as well as for diarrhea, flatulence, food poisoning and internal bleeding (Grosvenor et al, 1995). C formosum is widely distributed in northeastern Thailand. The gum has been used extensively by the people belonging to hill tribe of Thailand for painting on tooth surfaces as varnish to prevent dental caries. It is a Thai medicinal plant used in folk-medicine as an agent to prevent oral diseases, especially dental caries. People belonging to Hill tribe use black gum from the burned stem bark to stain their teeth by smearing it on the buccal and occlusal surfaces.The antimicrobial activity of an agent may be indicative of the presence of metabolic toxins or antimicrobial substances.It has been reported that xanthones and anthraquinonesare the main components of C. Formosum(Chantrapromma et al, 2006). Xanthones have antimicrobial activity against both gram-positive and gram-negative bacteria, such as *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Streptococcus faecalis* and *Samonellatyphi* while anthraquinones have little activity. Tayanin and Bratthall (2006) found little inhibitory effect of C.formosum on the growth of salivary *Mutans streptococci* (*MS*). In their study, plastic strips of the Strip Mutans Test kit were partly covered with the extract and stimulated saliva from persons with high MS levels was added. After incubation, a few colonies were observed. It should be noted that the strip method used in their study is not the standard method to investigate antimicrobial activity. Natural products have recently been studied as an alternative to synthetic chemical substances for prevention of dental caries Blackgum from the burned bark of C. formosum is considered a promising source. Further studies are needed to clarify the bioactive compound in this plant extract.[13]

IV – plant stimulant beverages

Coffee

Polyphenols occurring in cocoa, coffee and tea can have a role in the prevention of cariogenic processes, due to their antibacterial action. Cocoa polyphenol pentamers significantly reduce biofilm formation and acid production by *Streptococcus mutans* and *S. sanguinis*. In the same way, trigonelline, caffeine and chlorogenic acid occurring in green and roasted coffee interfere with adsorption of *S. mutans* to saliva-coated hydroxyapatite beads. Studies carried out on green, oolong and black tea indicate that tea polyphenols exert an anti-caries effect via an antimicrobial mode-of-action, and galloyl esters of (−)-epicatechin, (−)-epigallocatechin and(−)-gallocatechin show increasing antibacterial activities. The anti-cariogenic effects againstα-haemolytic *streptococci* showed by polyphenols from cocoa, coffee, and tea suggest further studies to a possible application of these beverages in the prevention of pathogenesis of dental caries. Although folk medicinal uses have been reported for chocolate (Theobroma cacao L.),coffee (Coffeaarabica L., C. canephora Pierre) and tea (Camelliasinensis (L.) O. Kuntze), their universal diffusion is due to the stimulant action on nervous system of caffeine, an alkaloid occurring in coffee and tea, and, to extent, also in cocoa.T. cacao L. is a member of Bromeliaceae native to forests of Central and South America. Two subspecies are cultivated: calabacillo (T. cacao L. subsp. Sphaerocarpum (A. Chev.)Cuatrec.), from South American rainforests, and criollo (T. cacao L. subsp. cacao) from Mexico. The two subspecies are interfertiles. The use of cacao seeds to prepare drink was diffused among Aztecs, and Spanish introduced this use in Europe, during the XVII century. Today, the seeds of T. cacao is used to prepare both cocoa powder and chocolate tablets.[15]

Tea

It is prepared from fresh tea leaves that are pan-fried or steamed and dried to inactivate enzymes. Black tea is prepared by crushing withered tea leaves and allowing enzyme mediated oxidation, commonly referred to as fermentation. During the fermentation process, the constituents of the leaves are converted to numerous secondary products that contribute to the characteristic color and flavor of black tea. Finally, oolong tea is a partially fermented product, manufactured in China and Taiwan, and highly valued in Asia. An in vitro study demonstrated that the tea polyphenol (TP) has no effect on de/remineralisation of enamel blocks, but it exerts an anti-caries effect via an anti-microbial mode-of-action. Smullen et al. have shown that extracts from unfermented cocoa, green tea, and red grape seeds, all with a high polyphenol content, are effective against *S. mutans* and reduce its adherence to glass. Cacao, coffee and tea are potential beverages and their flavonoids having anti-cariogenic property in oral pathology. Tea polyphenols can inhibit the preliminary adherence of *Streptococcus mutans* and *Actinomyces viscosus* to S-HA effectively. TP may prevent enamel from caries by decreasing the adherence of main cariogenic bacterium to salivary acquired pellicle.[15] The effect of tea polyphenol (TP) on mineralization behaviour of enamel in two sterile *in vitro* systems was also investigated. The data from this *in vitro* study suggest that TP has no effect on de/remineralization of enamel blocks and there is no synergetic action of TP and fluoride in a sterile system. This finding supports the proposition that teapolyphenols exert an anti-caries effect via an anti-microbialmode-of-action. Extracts obtained from different teas affect caries development, as their polyphenol components reduce the production of acidic compounds and the ability of streptococci to synthesize adherent water-insoluble glucan from sucrose with the cooperative action of glucosyltransferase Polyphenol compound (designated Sunphenon) from leaf of C. sinensis has been partially purified by extraction of the boiling water with ethyl acetate. The effect of Sunphenononcariogenic *S. mutans* groups (serotype c and g) were studied in both *in vitro* and *in vivo*. 1) Addition of Sunphenon to *S. mutans*JC-2 (c) causes a decrease in cell viability. The activity of Sunphenon showed that multiple application are required for killing cells and the maximum effect was seen between 60and 90 min treatment. However, treatment of *S. mutans* with Sunphenon did not induce complete cell death after 90 minincubation. 2) When *S. mutans* JC-2 (c) was pretreated with Sunphenon, the cellular attachment on saliva-treated hydroxyapatite surface was significantly reduced. 3) When salivatreatedhydroxyapatite surface was pretreated with Sunphenon, the cellular attachment of *S. mutans* JC-2 was also markedly inhibited.4) Sunphenon had no inhibitory effect on lactic acid production by *S. mutans* 5)Sunphenon showed a strong inhibitory effect against water-insolubleglu can synthesis by glucosyltransferase from *S. mutans* JC-2(c) or *S. sobrinus* 6715 (g).6) Specific pathogen-free rats infected with *S. mutans* JC-2 (c) and fed a cariogenic diet containing 0.5% Sunphenon developed significantly fewer carious lesions than controls infected with *S. mutans* and fed the same diet without Sunphenon. Furthermore, feeding of the drinking water containing 0.1% Sunphenon reduced caries incidence in *S. mutans* infected animals. Sakanaka and co-workers (1990) noted that tannins derived from Japanese green tea were potent inhibitors of glucan synthesis and produced significant reductions in bacterial adherence to hydroxyapatite.[26] The inhibitory effects of oolong tea extract (OTE) on the caries-inducing properties of *mutans streptococci* were examined *in vitro*. OTE reduced the rate of acid production by *mutans streptococci* accompanied with the retardation of growth rate of *mutans streptococci*, while the action by chromatographically isolated oolong tea polyphenol (OTF6) was weak. On the other hand, both oolong tea products decreased cell surface hydrophobicity of almost all the oral *streptococci* examined in the study, and also induced cellular aggregation of *S. mutans*, *S. oralis, S. sanguinis or S. gordonii*. Furthermore, the oolong tea products inhibit the adherence of *mutans streptococci* to saliva-coated hydroxyapatite. These results suggest that OTF6 may inhibit bacterial adherence to the tooth surfaces by reducing the hydrophobicity of *mutans streptococci*, and OTE may inhibit caries-inducing activity of *mutans streptococci* by reducing the rate of acid production. A study on black tea has determined the effects of a standardized black tea extract (BTE) on caries formation in inbred hamsters on a regular and a cariogenic diet. It was concluded that a frequent intake of black tea can significantly decrease caries formation, even in the presence of sugars in the diet.[16] Studies on the development of anti-plaque agents for prevention of dental caries have investigated effects of some of tea preparations and their individual components on the glucan synthesis catalyzed by glucosyltransferase (GTF) from *S. mutans*. Extracts of green tea and polyphenol mixtures showed appreciable inhibition in the synthesis of insoluble glucan. Among the components isolated from tea infusions, the aflavin and its mono- and digallates had potent in hibitory activities at concentrations of 1–10 mM against GTF. (+)-Catechin, (−)-epicatechin and their enantiomers had moderate inhibitory activities at these concentrations, while galloyl esters of (−)-epicatechin, (−)-epigallocatechin and(−)-gallocatechin had increased inhibitory activities. Different bacteria were separated from saliva and teeth of cariogenic patients and identified by a variety of morphological and biochemical tests. Extracts of green tea strongly inhibited *Escherichia coli*, *S. salivarius* and *S. Mutans*. Experiments also demonstrate the inhibition of salivary amylase activity by extracts of a commercial tea. This effect on salivary amylase may contribute significantly to reduce the cariogenicity of starch-containing foods.[14]

Cocoa

The cocoa has protective effect on dental caries has been consideration, but according to available datain relation to the anti-cariogenic effects of elements of chocolate are contradictory. current research supported that a high sucrose diet was equally cariogenic in the presence or absence of cocoa bean ash, although integration of Cocoa powder or chocolate into hamster diets was published to inhibit caries and one more study has shown that the cariogenic potential indices (CPI) of chocolate with high cocoa levels was less than 40% that of sucrose (10% w/v) and also lower than chocolates including low cocoa levels. More recently it has been found that cocoa products contain inhibitors of the enzyme dextransucrase, responsible for the formation of the plaque extracellular polysaccharides from sucrose. Subsequently, it was suggested the possibility that phenolic substances could be responsible of the observed anti caries effect of cocoa powder. Moreover it was showed that a water soluble extract of cocoa powder significantly reduced caries scores in rats infected with *S. sobrinus*. As reported by the scientific community, the observed effect could be due to the inhibitory action of the cocoa water extract on the synthesis of water-insoluble glucans. Some of other research authenticate that cocoa polyphenols inhibit the growth of *S. sanguine* , but not that of *mutans streptococci*. The pre-treatment of artificial saliva-coated wells with cocoa polyphenol pentamer (the most active component from MIC studies) significantly reduced biofilm formation and acid production by *S. Mutans* and *S. sanguine*. So, although MIC/MBC studies showed that the cocoa polyphenol pentamerrefractory the growth-inhibitory or lethal effects on *S. mutans*, acid production from sucrose was significantly inhibited. Recently some of research investigation reported that the ground husk of cocoa beans, a product of cocoa manufacture, were used top repare a mouth-rinse for kids. The normal use of the mouth-rinse has given a 20.9 reduction of *mutans streptococci*co units, and was even more efficient in controlling plaque scores.

Coffee

Roasted coffee possesses antibacterial activity against Grampositive and Gram negative bacteria, including *S. mutans*. Moreover *C. arabica* and *C. canephora* extracts interfere with *S. mutans* adsorption to saliva-coated hydroxyapatitebeads. Green coffee and roasted coffee showed comparable antiadsorption properties. The components which exhibited the highest anti-adhesive activity were trigonelline, caffeine and chlorogenic acid. These findings have been partially confirmed by another study conducted on Brazilian coffee powders Water extracts prepared with these products showed no effect on *S. mutans* growth, but significantly reduced the adherence of the bacterial cell to glass bead surface. In a following paper the same authors have evaluated the effect of boiled and non-boiled coffee water solutions on the adherence of dental enamel and dentine. Both the solutions of commercial coffee had significant effect, reducing the adherence of *S. mutans* to dental surface. The author hypothesis is that this effect could be due to the synergistic action of more chemicals occurring in coffee powder.

V a- mangostin

Guttiferae group comprises a large family of medicinal plants many of which are also known for their edible fruits. For example, Garciniamangostana L. is cultivated for food in southeast Asian nations, including Thailand, Sri Lanka, Philippines, and Vietnam (Ee et al. 2006). The pericarp of G. mangostana has been used to treat a variety of infectious diseases in these countries. Experimental studies have demonstrated that the pericarp of G. mangostana is a good source of xanthone substances that have antioxidant, antitumor, antiallergic, anti-inflammatory, antibacterial, and antiviral activities. (Gopalakrishnan et al. 1997; Ee et al.2006, 2008; Jung et al. 2006). Antimicrobial activities of xanthones against oral bacteria have not been investigated in any detail previously. Ethanolic extracts from the peels of G. mangostana showed promise. In addition, Obolskiy et al. (2009) have written an extensive review of the pharmacological properties and medical uses of components of G. mangostana, including those of a-mangostin.

Extraction and isolation of a-mangostin

Ethanolic extracts of G. mangostana were prepared for the initial step of a-mangostin isolation. A total of 1000g of dried powder of G. mangostana peels was extracted with ethanol at room temperature, followed by evaporation of solvent to give a dark brown gummy residue (105 g). This residue was taken up in water, followed by extraction within-hexane to produce the most bioactive fractions. Then-hexane fraction was then evaporated and dried under reduced pressure. Further separation was performed using silica gel column chromatography (Merck Kieselgel 60, 70-230 mesh) by eluting with n-hexane – ethyl acetate – methanol (6:3:0.1, by volume) and 10 ml volumes of eluant were collected in test tubes. The aliquots of each fraction were subjected to thin-layer chromatography (60 F254,1 mm plate, Merck) in a solvent system containing toluene –ethyl acetate – acetone – formic acid (5:3:1:1, by volume).Partially purified a-mangostin (4 g) was recovered from the active fractions and then further separated by silica gel column chromatography (Merck Kieselgel 60, 70-230 mesh) and eluting with n-hexane – chloroform – ethyl acetate –methanol (4:1:0.5:0.3, by volume), yielding a single compounda-mangostin as yellow crystals (105 mg). The purityof a-mangostin was examined by high-pressure liquid chromatography connected with mass spectrometry (LCMSD-Trap-SL Mass spectra, Agilent 1100, Palo Alto, California).[17] A-mangostin is a potent inhibitor of glycolysis, with a IC50 in the micromoles per liter range. Moreover, its capacity for reducing acid production from glycolysis was enhanced at acid pH values. Cell-membrane functions were especially sensitive to a-mangostin, and IC50s were in the range of 20–30 mmol/L–1 at pH 7.0. Biofilm cells had greater resistance to a-mangostin than cells in suspensions, but the IC50s for biofilms at pH 7.0 were still about 60 mmol/L–1. These concentrations are close to the lethal concentrations of the agent, and lethality may result from irreversible in hibition of glycolysis.[18]

VI – Novel propolis

Propolis, a non-toxic resinous hive product collectedby Apismellifera bees from various plant sources, has been recognised to have several properties that may confer health benefits to humans, includingprevention of oral diseases. However, the chemical composition and the pharmacological activity of propolis are highly variable depending on its geographic originits ethanolic extract showed potent inhibitory activities against *mutans streptococci* and glucosyltransferase (GTF) activity. In addition, Duarte et al. showed that the non-polar hexane fraction of propolis type 6 was the most active extract against *mutans streptococci in-vitro*. Thus far, diterpenic acids and phenolic compounds, such as flavonoid aglycones and (hydroxyl) cinnamic acid derivatives, have been widely cited as the main biologically active compounds in propolis.

Cariostatic effects

(1) Reduction of acid production by both *S. mutans* UA159 and *S. sobrinus* 6715biofilms, and (2) inhibition of the proton-translocating F-ATPase activities. By inhibiting the activity of F-ATPase, propolis type 6 could disrupt the DpH across the cell membrane affecting the acid tolerance of *mutans streptococci*. In addition, the disruption of the intracellular pH would also inhibit the pH-sensitive glycolitic enzymes, thereby reducing the ability of the micro-organisms to produce acids. In summary, fatty acids such as oleic, palmitic, linoleic and stearic acids are the putative active compounds in propolis type 6 and its non-polar bioactive hexane fraction. It is likely that these compounds are influencing some of the critical virulence factors associated with the pathogenesis of dental caries, including acid production, F ATPase and GTF activities.[19]Brazilian propolis is known for its complex and variable chemical composition; so far, 12 chemically distinct types of propolis have been identified (Koo et al., 1999; Park et al., 2000, 2002). Furthermore, it has been found that specific types of Brazilian propolis (type-3 and -12) exhibit anti-caries/anti-plaque properties *in vitro* and *in vivo* (Koo et al., 1999, 2000).[20]

VII- Terminalia chebula

Tannic acid represents the major constituent of the ripe fruit of *T. chebula* and is present in a concentration of 20–40% (Chopra and Handa, 1958). Studies canrried out at our laboratory indicate that the amount of tannic acid in the aqueous extract of *T. chebula* is 13% (Ramamurti, 1979). Some studies have reported that tannic acid is bacteria static or bactericidal to some Gram (+) ve and Gram (-) ve pathogens (Kau, 1980). At concentrations of 10%, the extract has an immediate effect on the salivary bacteria, and this effect was retained for 3 h. For an agent to work successfully in the oral cavity, it should have an immediate effect that is sustained over time. The prolonged release of the tannic acid is essential as high antibacterial activity per sec is not sufficient to obtain inhibition of plaque formation. Extract of *T. chebula* may be an effective agent in the treatment of carious teeth, owing to it sability to inhibit the growth and accumulation of *S. mutans* on the surface of the tooth. This would prevent the accumulation of acids on the surface of the tooth, and thus the further demineralization and the breakdown of the tooth enamel.[21]

VIII- Punica granatum linn (pomegranate)

The antimicrobial activity of *Punicagranatum Linn* has been widely investigated. The findings of several studies, suggest that the phytotherapeutic use of this plant might be a viable option in controlling different microbial species. The largest components of the *Punicagranatum L.* fruit extract are tannin and polyphenolics. The gel presented an inhibitory activity on the adherence of different bacterial strains and one yeast commonly found in the oral cavity. There is the possibility that the gel might be used in the control of bacteria and yeasts responsible for oral infections such as caries, periodontal disease and stomatitis.[22]

IX- Cyperus rotundus

Cyperusrotundus L. (C. rotundus) is sedge belonging to the family Cyperaceae., the tuber of C. Rotundusis used against spasms, bowel, stomach disorders, candidiasis, malarial fever, and inflammatory diseases in Indian, Chinese, Japanese, and Korean medicines(Weenenet al., 1990; Jagtap et al., 2004; Duarte et al., 2005). It has also been used to treat toothache, dental caries, and periodontal disease (Huh, 1984). At concentrations higher than 0.5 mg/ml, the extract substantially reduces the adherence of *S. Mutans*. The extract of C. rotundus can inhibit the synthesis of water-insoluble glucan by crude GTFase. Suppressed the synthesis of water-insoluble glucan in a dose dependent manner.[23]

X- Rheum Undulatum l

RheiRhizoma is one of the important herbal drugs widely used as a purgative and anti-inflammatory agent in East Asia (Yang et al., 2004). Moreover, it has been traditionally used as a controlling agent for dental diseases in Korea (Hur, 1994). It is a dried root and derived from the outer corky layer of the genus Rheum. Rheum undulatum, R. palmatum,

R. tanguticum, R. coreanum, and their hybrids have been generally used in Korea, Japan, and China (Lee et al, 2003). Dichloromethane fraction (DF) from R. undulatum root inhibits S viability of oral pathogenic bacteria. Moreover, DF significantly inhibited *in vitro* dental plaque formation and acid production by *S. Mutans* and *S. sobrinus* at the concentrations lower than MIC. These results indicate that DF might be useful for the control of dental plaque formation and subsequent dental caries development.[24]

XI- Eucalyptus oil

There are numerous constituents within crude EO that may contribute to its overall antimicrobial efficacy including 1,8-cineole, camphene, α-pinene, globulol and limonene, though these vary with season and between species of eucalyptus. The major component of crude EO is 1,8-cineole (eucalyptol), which ranges in percentage composition from 44.3% to 84.4%[1] and is known to possess antimicrobial properties, as well as being a penetration enhancer for topical delivery to the skin. Bacterial biofilms are well reported to exhibit increased resistance to antimicrobial agents compared with their planktonic counterparts, due in part to the physical barrier they create. This makes biofilms particularly important in clinical settings as their removal presents many difficulties, while their presence often creates serious complications with regard to patient management. EO results in damaged structural stability of the cell, leading in turn to increased permeability.[25]

XII-Neem

The isolation of bioactive compounds from *Azadirachtaindica*, commonly known as the Neem plant, has led to an expanding number of scientific reports on its other interesting biological properties and uses (Ruskin, 1992).There has been a growing interest in the economic development of its components for new medicinal products. The widespread use of the Neem "chewing stick" as an oral hygiene device in certain Asian and African countries has raised the question that it may possess some anti-plaque properties. Dentists in areas where it is in use have noted its effectiveness in preventing certain plaque-related dental diseases (Elvin-Lewis, 1980). Some of the observed anti-plaque activity can be attributed to the fibrous nature of these sticks, which could offer a mechanical advantage toward plaque removal; however, the possibility that portions of the Neem plant might also contain chemotherapeutic antiplaque agents should not be overlooked. The Neem stick extracts exhibited broad bacterial aggregating activity among the oral streptococci. The presence of gallotannins during the early stages of plaque formation could effectively reduce the number of bacteria available for binding to the tooth surface by increasing their physical removal from the oral cavity through aggregate formation.[26]

CONCLUSION

The studies carried out in recent decades have confirmed the antibacterial role of polyphenols: they may reduce bacterial growth rate and adherence to tooth surface, and also can perform inhibitory effects on the enzymatic activity of glucosyltransferase and amylase. Moreover, polyphenols largely occur in flowering plants and could be used at a reasonable cost in the preparation of specificremedies. Flavonoids seem to be particularly promising anticariogenic molecules, but research on the relationships between chemical structure and anti-microbial activity of these compounds, as well as their synergistic/antagonistic effects, is still required. The polyphenols of cranberries, specifically the proanthocyanidins in the NDM fraction isolated from cranberry juice, appear to have potential for preventing and/or treating dental caries and periodontal disease. However, results obtained *in vitro* are difficult to transpose to the *in vivo* situation, since the oral environment could interfere with the biological properties of these molecules Cranberry polyphenols cause Reduction in production of extracellular polysaccharides. Inhibition of biofilm formation and adhesion of periodontopathogenic bacteria. Inhibition of acid production by cariogenic bacteria, Inhibition of proteolytic activities of bacterial and tissular origin, Inhibition of function of proteins that bind to glucans, Inhibition of cytokine production byimmune and mucosal cells. Reduction in formation of dental biofilm, Inhibition of production of matrixmetalloproteinases by immune and mucosal cells.

CONFLICT OF INTEREST

Conflict of interest declared none

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