REVIEW

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A cuppa for caries free teeth ?

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ABSTRACT

Natural products are replacing synthetic chemicals in all arenas of dentistry nowadays. Research regarding beverages especially tea and its components have already gained importance in maintaining oral care. Its role in dental caries is well established. While, Coffee although one of the most favorite beverages consumed worldwide has not been researched widely. Its main components are trigonelline, caffeine and polyphenols. They are known to possess antibacterial, antiadsorption and antiplaque properties. Its polyphenolic content plays a major role in caries inhibition.Coffee is a rich mixture of chemicals, but most of the studies evaluating its oral health benefits are conducted using caffeine. Thus, controversies regarding whether coffee is beneficial or harmful to teeth still exists. Besides, different forms of coffee have shown varied results. Very few studies have been conducted to evaluate the effectiveness of coffee and its components on cariogenic microorganisms. This article highlights the role of coffee and its components against caries pathogenesis with literature review.

Keywords: roasted coffee, green coffee, anticaries, antiadhesive, antibacterial, streptococcus mutans, polyphenols

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This article may be cited as: Kayalvizhi G, Suganya G, Balaji Subramaniyan R. A Cuppa for Caries Free Teeth? Int J Cont Med Res. 2014;1(1) 19-27

Introduction:

Dental disease is regarded as a "Silent epidemic",among which dental cariesremains a serious threat to infants, children and adults[1]. Microflora plays a key role in the initiation and progression of carious lesions, as without bacteria there would be no caries. Cariogenic microorganisms metabolize carbohydrates by adhering to tooth surfaces and glucans are synthesized by glucosyltransferase enzymes. This sucrose metabolism causes further adhesion and aggregation of bacteria leading to acid production and demineralization.[2,3]

Currently, as the focus is shifting towards much safer alternatives, natural products or their components have gained popularity. As their antibacterial role is well established, they have been tried as caries protective agents.[1] Research has shown that natural products containing polyphenols guard the teeth against the growth of cariogenic bacteria especially streptococcus mutans. Coffee is the most popular beverage, rich in polyphenols consumed every day by the people all over the world.[2] A knowledge regarding its oral health benefits could help us deal with the silent epidemic such as dental caries in a more natural way. This review discusses coffee's protective role against caries.

Coffee and its components

The history of coffee dates back to 14th century when it was first cultivated by Arabs. The word "coffee" entered English in 1582 via Dutch koffie, borrowed from Turkishkahve and Arabicqahwa. Later only in 1670, Coffee was grown in Chikmagalur hills in India.[4] Coffee, a dried seed of the fruit is originated from a tree (Coffeagenus, Rubiaceae family), which is processed by fermentation of berries and roasting of seeds. Around eighty different coffee species have been identified. In Brazil, Coffea Arabica and Coffea Canephora are the commonly available commercialized forms.[2] Coffee grain constitutes of water, organic acids, alkaloids, tanic acid, minerals (potassium magnesium), glucides(carbohydrates), lipids, theobromine and several vitamins. Green coffee has caffeine (alkaloid), chlorogenic acids, trigonelline and the pentacyclicditerpene alcohols like cafestol and kahweol, whereas the content of these components are low in roasted coffee.[1,5,6,7]

Role of coffee components in dental caries prevention[1,2]

- Coffee, rich in polyphenols (chlorogenic acids) has a direct

effect on Streptococcus mutans. These chlorogenic acids (caffeoylquinic acids, dicaffeoylquinic acids, feruloylquinic acids) exhibit antibacterial activity by inactivating bacterial toxins. Their content in Coffee Arabica is less when compared to Coffee Canephora.

- Caffeine is a bitter, white crystalline xanthine derivative.Its role in caries is controversial, although its bioactive antioxidant components (Methylxanthine and Chlorogenic acids) possess antibacterial properties they get completely degraded on roasting. Thus, to some extent it exerts antibacterial effect but not antiadhesive effect.[3,6]
- Trigonelline is a water soluble alkaloid biologically derived from enzymatic methylation of nicotinic acid, contributing to coffee's aroma and flavor. Its content in Coffee Canephora is 2/3 of that found in Coffee Arabica. Caries protective effect of roasted coffee remains questionable, as trigonelline degrades to nicotinic acid, niacin, cafestol and kahweol, in turn reducing its antiadhesive effect. Research has proved its antibacterial action against Streptococcus mutans. It is thought that bactericidal effect could be partly due to its tannin content.[1,2]
- Despite the above fact the antioxidant melanoidins (methylpyridinium) which are formed during roasting of trigonelline, add color to the coffee and play an important role in caries inhibition. Catechin, a polyphenolic antioxidant effectively inhibits glucosyltransferaseenzyme.[3,6,7]

Mechanism of anticariogenic action of coffee

Active coffee molecules exert caries protective effect by adsorbing to host tooth surfaces and prevents the tooth receptor from interacting with bacterial adhesions. Further it prevents the reversible and irreversible adherence of Streptococcus mutans to tooth surfaces, thus inhibiting demineralisation.[2,7,8,9,10]

Discussion (Table 1)

Over the last 15 years, various studies have demonstrated the antibacterial

effect of coffee, wherein different concentrations of coffee extracts either inhibited/stunted the growth of certain bacteria. Pure caffeine in coffee has a direct antibacterial effect, while decaffeinated coffee also showed antibacterial effect suggesting the role of other coffee components[21]. Studies evaluating the effect of coffee on dental caries are scarce displaying varied results. They have shown that coffee has antibacterial efficacy against Streptococcus mutans, while green and roasted coffee exhibited high anti

Studies	Type of Coffee	Coffee compounds	Effect on caries
Kashketet al 1985 [11]	Coffee compounds	Caffeic acid and 5-caffeoylquinic, polyphenols, trigonelline, and α-dicarbonil and gelatin-precipitable tannins found in coffee.	Act by inhibiting the formation of glucosyltransferase by cariogenic bacteria and exert antibacterial activity against Streptococcus mutans
Steinberg LM et al 1996 [12]	Coffee with sucrose;sucralose; sucralose plus maltodextrin; sucralose plus dextrose and maltodextrin, and no additional sweetener	Sucralose in coffee	Due to its acidic nature, unsweetened coffee showed modest pH depression. Sucralose with coffee had no statistically significant impact on plaque acidogenesis as it might have reduced the acidogenic potential of coffee. While, other combinations showed only intermediate changes.
Daglia et al 1998[8]	Instant dark roasted coffee	Isolated Compound from coffee	Strong antibacterial activity against Gram positive and Gram negative bacteria, including S. mutans
Daglia et al 2002[9]	Coffee arabica and Coffee canephora extracts in green and roasted coffee	Trigonelline, caffeine and chlorogenic acids	Anti adhesive activity by interfering with S. mutans adsorption to saliva-coated hydroxyapatite beads
Landucci LF et al 2003[13]	Boiled and non-boiled coffee water solutions	Synergistic action of more chemicals occurring in coffee powder.	Significant effect in reducing streptococcus mutans adherence on enamel and dentine
Almeida et al 2006[14]	Coffea arabica extracts with caffeine	Caffeine (0.5 mg/mL to 1.0 mg/mL)	Inhibited S. mutans temporarily (4h), antibacterial activity improved with their synergistic effect. Higher caffeine concentrations could have shown stronger and longer lasting inhibition.
Signoretto et al 2006 [15]	Coffee, barley coffee, tea and wine	Polyphenols	Significant decrease in S mutans, lactobacillus counts and dental plaque
De Oliveira etal 2007[16]	Different coffee solutions	Combination of tanic acid and trigoneline with other coffee compounds	The solutions of Pilão and Mellita coffees, obtained by both simple and boiled methodsreduced significantly the adherence of S. mutans to

			dental surfaces, while Boiled solutions showed better activity
Brandao et al 2007[17]	Water extracts of brazillian coffee powders	Coffee components	Simple and boiled coffee (Pilão, Mellita and Café do Ponto), showed no effect on S. mutans growth, but significantly reduced the adherence of the bacterial cell to glass bead surface
Daglia et al 2007 [18]	Roasted and green coffee	Caffeine with α-dicarbonil compounds	Roasted coffee displayed antibacterial activity in contrast to Green coffee
AnilaLamboodiripad and Kori 2009 [3]	Anticaries effect of Coffee in Indian population (sugar rich diet)	Coffee without additives	Roasted coffee 3 times a day consumed for 35 years, with and without additives found that if it was consumed alone it has beneficial effect but in the presence of additives its effect was totally minimized
Antonio et al 2010[19]	To identify natural antibacterial compounds in coffee (roasting and decaffeination)	Chlorogenicacids, trigonelline and caffeine or other compounds	An inverse correlation was found between bacterial colony-forming units and roasting degree. Plain coffee had no antibacterial effects while Decaffeinated extracts showed lower antibacterial activity against Streptococcus mutans
Antonio et al 2011[20]	Light roasted Coffea canephora extract	Chemical analyses showed a large amount of calcium and phosphorus. Caffeine and phenol exerts antibacterial action	These extracts did not cause rise in biofilm pH , but it prevented mutans growth and inhibited demineralization
Almeida et al 2012[10]	Coffea arabica extracts incorporated with or without natural coffee compounds	Trigonelline, caffeine, caffeic acid and protocatechic acid	Extracts of different samples of Arabica coffee showed antibacterial activity against Streptococcus mutans. The inhibitory effect was not affected by the brewing method (filtered or espresso) or by the different Arabica coffee samples.

adhesive activity. It has been found that Instant coffee had a higher level of inhibitory activity against Streptococcus mutans than ground coffee. Additionally, it is known to reverse the cariogenic effects of other foods, analogous to cheese[1,2,3,8].

Studies have proved that coffee beverage contains both LMW (low molecular weight) compounds and HMW (high molecular weight) melanoidin and non-melanoidin components with a strong ability to interfere with the S. mutans traits relevant for cariogenesis in vitro[22].

In a study, Meckelburg et al found increases in calcium concentration in a medium containing teeth/biofilm exposed to Coffea canephora extract (CCE) they attributed this to its antibacterial effect wherein bacterial lysis and consequent release of calcium occured in the medium. Due to the inhibitory action of light roasted C. canephora aqueous extract against dental biofilm, they considered it as a potential anticariogenic substance[23]. Some additives are known to alter coffee

effect[3,12]. Antonio et al evaluated the ex vivo antimicrobial effect of unsweetened and sweetened (10 % sucrose) brewed light-roasted Coffea canephora on oral biofilms and found that it reduced the microbial count in oral biofilm and suggested that sucrose concentration in coffee brew can influence its antimicrobial property against the referred biofilm[24]. A school dental survey determined the association of dental caries with type and amount of milk additive consumed in 13-15 year old adolescent population. Sugar was found to be most cariogenic additive as compared to tea and coffee. Tea and coffee have found to be anticariogenic.[25]

Although most of the studies highlight the role of coffee and its components in caries prevention. Its harmful effect on teeth could be due to the additives, staining property of coffee and oral cancer risk as shown by very few studies. Nevertheless, coffee controversy can be overcome only with further detailed studies.

Conclusion

Coffee compounds are known to reduce streptococcus mutans growth and its adherence to tooth surface, thus exhibiting antidemineralizing effect on the teeth surface. Based on the evidence from the studies coffee can be considered as an anticaries agent but further in vivo, clinical studies are required to confirm it. Besides, its adverse effects on teeth if any needs to be studied with long term clinical trials.

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