
Research Article

Anti-Cariogenic Effects of Raw Robusta Coffee Bean Compared To Instant Robusta Coffee Powder through Dental Biofilm Inhibition

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Abstract: Coffee beans contain active ingredients including tannin and trigonelin which have a higher percentage than instant coffee. Tannin and trigonelin have the ability to prevent dental caries by inhibiting the formation of dental biofilms. The aim of this study is to compare the activities of anti-cariogenic between raw Robusta coffee beans and instant Robusta coffee powder solution. This study was a quasi-experimental using purposive sampling. The number of research samples was 20 female subjects aged of 20-30 years. Plaque was assessed using the plaque index personal hygiene performance (PHP) from Podshadley and Haley. The results showed a difference in plaque index after gargling the solution of raw Robusta coffee beans and instant Robusta coffee powder solution with a difference in the average plaque index of 0.6990 and 1.1828. The study concludes that raw Robusta coffee beans have greater ability to inhibit dental caries by preventing dental biofilm formation compared to instant Robusta coffee powder.

Keywords: anti-cariogenic, raw Robusta coffee beans, instant Robusta coffee powder, dental biofilm

Introduction

Dental caries is a diseases consequence to oral microflora activity, diet, dentition and oral environment. The disease is a very common occur among young population with high percentage of 60-90% [1]. Dental caries has a multifactorial etiology that act as major role in determination of the changes its prevalence. They could be included of dietary habits, particularly sugar consumption, oral hygiene, pathogen microorganism of oral and biofilm as well as oral immune status [2]. The bacteria are a crucial factor in initiating the progression of the disease, it would not be carious lesion without bacteria [3]. *Streptococcus mutans* is a major microbial agent among oral pathogen microorganism which causes dental caries due to its ability to metabolize carbohydrate into acid although there are many more microorganism may act at the same way [4]. These bacteria have the ability to form glucans by synthesizing water insoluble of sucrose whereby this product can act as a mediator of adherence to teeth surfaces which will further contribute to dental biofilm formation that is very vital for the development of dental caries [2] [5]. The other bacteria that may be found on biofilm and playing the major role in the progression of dental caries are *Streptococcus sobrinus*, *Lactobacilli* and *Actinomyces*. Therefore, the existence of dental biofilm will lead to enamel demineralization resulting in dental caries due to acid accumulation [2].

Talking about dental biofilm, it can be defined as a various species of bacteria collection attached to the polymer matrix produced by bacteria and their host that can transform from normal to pathological conditions associated with caries and

periodontal tissue disease [6], [7]. Its bacteria are always actively metabolizing biochemically so that it will cause a fluctuating pH which in turn this pH change can lead to sustained demineralization and remineralization of dental hard tissue that will be the beginning of the formation of a carious lesion[6], [8]. Therefore, it is very important to prevent the formation of pathological dental biofilm. Dental biofilms will develop faster under optimal temperature, particular nutrient supply in the oral cavity and the hard non-shedding surface. *Streptococci* are suggested as prominent bacteria during the initial stages of dental biofilm formation but other bacteria also have the role as the earliest colonizer of dental biofilm formation such as *Actinomyces* genera which can even reach up to 27% of pioneering bacteria. Some *Actinomyces* species are normal oral microflora that can be found in supra-gingival plaques and several studies confirm that the species of *A. naeslundii* is a significant member of the initial colonizers of the tooth surface. *A. naeslundii* is species of *Actinomyces* that has tight conjunction with other bacteria in the initial multilayer dental biofilm formed in vivo for up to 48 hours and definitively indicates that *A. naeslundii* specifically occupies the inner part of the initial multilayer biofilm. However, its pH-modulating properties relevant to the process of dental caries still need to be explored [9]. The etiology of dental caries has long been recognized to be related to bacterial accumulations in plaque composition and dental caries yet remain a widespread public disease that highlight an urgent need to find new effective strategies. If some remedies will not initiate, there could be a serious negative impact upon the future oral health (and systemic health) of the global

community, with a major increase in the cost of dental services [10], [11].

Prevention of biofilm accumulation on tooth surfaces is obviously the very important strategy in declining dental caries that has been proposed by several researchers ranging from restrictions on sugar consumption or sugar substitutes to the use of certain antibacterial vaccines or the use of antiplaque mouthwash and toothpaste. Recently, researchers have been studying to concentrate more on natural products as antiplaque alternatives to reduce microorganisms involved in the dental caries process as an effort to diminish its prevalence and severity. One natural product that has antibacterial effects is plant extracts containing phenolic compounds such as coffee which have been investigated by several researchers and proven to prevent oral diseases, especially those related to biofilm on the tooth surface [12]. Thus, this study is purposed to investigate the effect of raw Robusta coffee bean compared to instant Robusta coffee powder in inhibition dental biofilm as an effort to decrease dental caries.

Method

The research was carried out by method of quasi experimental using purposive sampling with a double blind system. The study population was patients who came to get periodontal treatment. The samples were 20 patients who had criteria for women aged of 20-30, good general health, had never taken antibiotics for the past 6 months, did not use dentures and orthodontic devices, did not smoke and consume alcohol. Subjects were asked to fulfill informed consent. The independent variable was a solution of 8% raw Robusta coffee beans and an instant Robusta coffee powder solution with a concentration of 8% which is processed by boiling them which will be used as a mouth rinse [13]. The dependent variable was plaque while the controlled variable was the frequency of gargling that is 3 times a day by moving the cheeks, lips and tongue for 1 minute. The making of raw Robusta coffee bean solution was done by boiling 144 grams of coffee beans that have been blended in 1800 ml of distilled water for 15 minutes to get a coffee solution with a concentration of 8% which subsequently filtered by using filter paper. This procedure was repeated for having raw Robusta coffee powder solution. Research subjects were divided into 2 groups, each consisting of 10 subjects and on the first day they got a scaling so that they had zero of plaque index. The first group was asked to rinse with a solution of raw Robusta coffee beans and the second group was asked to rinse with a solution of an instant Robusta coffee powder, this process was done in a double blind system. Research subjects were asked to rinse 3 times a day, after breakfast, after lunch and before bed and not allowed to brush their teeth during the investigation. Plaque accumulation on the surface of the teeth is examined according to Podshadley and Haley which aims to assess dental hygiene after tooth brushing instruction.

The examination of teeth surface was conducted by using Green and Vermilion dividing the tooth surface into 5 areas, namely 3 areas divided longitudinally and 1/3 the middle is

divided into 3 areas horizontally. The examination was carried out systematically on the buccal surface of upper first molar teeth, labial surface of the first right upper incisor, buccal surface of the upper left first molar, lingual surface of the lower left first molar, labial surface of the lower left first incisor and lingual surface of the first molar lower right. Plaque assessment methods are as follows [14]:

score 1: there is a plaque on one sub-section of the tooth surface

score 2: there are plaques on two sub-surfaces of the tooth

score 3: there are plaques on three sub-surfaces of the tooth

score 4: there are plaques on four sub-surfaces of the tooth

score 5: there is plaque on the entire surface of the tooth

Plaque index is determined by the following formula:

PI = the total number of plaque scores for all tooth surfaces examined / number of teeth examined.

The criteria for assessing the level of oral hygiene based on personal hygiene performance (PHP) plaque index are:

0 = very good

0.1 - 1.7 = good

1,8 - 3,4 = moderate

3.5 - 5.0 = bad

The collected data was analyzed by using the effectiveness test per treatment with t-dependent test while the comparison of effectiveness between treatments was carried out by t-independent test.

Result

Research data is presented in the tables below. Table 1 shows the plaque index data before and after rinsing using raw Robusta coffee bean solution while table 2 shows the plaque index data before and after gargling using instant Robusta coffee solution.

Table 1. Plaque index data before and after rinsing with a solution of raw Robusta coffee bean

No	Plaque index		difference
	before	after	
1	0	0.33	0.33
2	0	0.5	0.5
3	0	1	1
4	0	0.83	0.83
5	0	1	1
6	0	0.5	0.5
7	0	0.5	0.5
8	0	0.83	0.83
9	0	0.5	0.5
10	0	1	1
Mean		0.69	0.69

Table 2. Plaque index data before and after rinsing with a solution of Robusta coffee powder

No	Plaque Index		difference
	before	after	

1	0	1	1
2	0	1	1
3	0	1.33	1.33
4	0	1	1
5	0	1.5	1.5
6	0	1.17	1.17
7	0	1.17	1.17
8	0	1.17	1.17
9	0	1.17	1.17
10	0	1.33	1.33
Mean		1.18	1.18

Table 3 below exhibits the data analyzed by t-dependent test showing that rinsing with raw Robusta coffee bean solution had given the result of plaque index mean before rinsing is 0 and after rinsing is 0,69. The difference between both is very significant is that 0,69. The mean of plaque index before rinsing coffee powder solution is 0 and after rinsing is 1,18 resulting significant difference between both is that 1,18. Statistical analysis resulted in a t-value for each solution of Robusta raw coffee beans = -8.55 and a solution of instant Robusta coffee = -22.66. Each Robusta coffee solution has df of 9 and their t-table with $\alpha = 0.05$ is ± 2.26 .

Table 3. The average of plaque index before and after rinsing withdraw Robusta coffee bean and Robusta coffee powder solution

No	solution	N	The average of plaque index	
			before	after
1	Robusta raw coffee bean	10	0	0.69
2	Robusta coffee powder	10	0	1.18

Table 4. The average value of the difference in plaque index for each treatment

No	Larutan	N	The difference of plaque index average	
1	Robusta raw coffee bean	10	0	0.69
2	Robusta coffee powder	10	0	1.18
p-value			0,00	

Discussion

The chemical composition of coffee is characterized by its contents of caffeine, chlorogenic acids, trigonelline and the diterpenes cafestol and kahweol. Chlorogenic acids is a major

content of phenolic compounds property by coffee is known to be the largest contributor to the antioxidant activity. On the other hand, trigonelline is an alkaloid that is biologically derived from enzymatic methylation of nicotinic acid which has bioactivity potential as an antibacterial compound against *Streptococcus mutans* which is a cariogenic bacterium. Both of these contents of coffee, either chlorogenic acid or trigonelline have antibacterial activity against *Streptococcus mutans* as a bacteria initiating dental biofilm formation which will lead to dental caries. Thus, this statement can conclude that the virulence of dental biofilms attached to the tooth surface is the main factor causing dental caries, although dental caries is actually a multifactorial infectious disease as an interaction between oral microflora, the teeth and dietary habit. Coffee activity as an anti-cariogenic is not only through preventing the formation of dental biofilms but also through the interaction of its mineral content with organic matrices which will prevent the decomposition of the organic matrix during the attack of acids produced by microorganisms. Besides, the interaction between polyphenol and organic matrices of enamel seems to inhibit the demineralization process meanwhile coffee is very rich of polyphenol. Thus, it can be concluded that coffee has the ability to prevent dental caries directly through decreasing of the speed of mineral ions loss consequently enamel demineralization is inhibited, and indirectly through prevention dental biofilm formation [15].

The results of this study showed differences in plaque index, literally showing dental biofilm existence, before and after gargling with a solution of raw Robusta coffee beans and gargling with instant Robusta coffee powder solution. Biofilm formation in the group rinsing with raw Robusta coffee beans was lower than the group that rinsed with instant Robusta coffee powder. This happens because the percentage of trigonellin substances in the solution of raw Robusta coffee beans is higher in content, which is 0.6-1.75% compared to instant Robusta coffee powder solution which has a trigonellin percentage of only 0.3-0.6% [16]. The trigonellin is a substance that can prevent the attachment of *streptococcus mutans* to the surface of the tooth so that biofilm formation will decrease [17].

The chemical composition of coffee beans will undergo a series of transformations during the roasting process which will cause pyrolysis, caramelization, degradation reactions so that the coffee content of thermolabile such as chlorogenic acid, trigonellin and diterpene becomes decreased. Martin et al. have proven that roasted coffee beans and instant coffee have less tannin content compared to raw coffee beans. This happens because the roasting process will change the composition of the chemical properties of coffee due to the relatively high processing. Tannins in coffee have the ability to inhibit the activity of the glucotransferase enzyme is that an enzyme that can increase carbohydrate metabolism, especially sucrose, into extracellular polysaccharides known as glucans. If the activity of the glucotransferase enzyme is inhibited, the synthesis of glucan will be inhibited as well, so that the attachment of microorganisms to the tooth surface as the

initial process of microorganism colonization on dental biofilm formation will not occur. Therefore, it could be said that tannin in coffee has a role in inhibiting biofilm [18]. In vitro study conducted by Oliveira et al. has given the result that boiled sugarless Arabica coffee to gain 8% of the percentage exhibits that the combination of the content of tannin and trigonelin can synergistically inhibit the attachment of *Streptococcus mutans* to enamel and dentin of teeth [19]. Therefore, raw coffee bean have a larger activity against microorganism colonization on dental biofilm compared to that roasted coffee.

Conclusion

The research concludes that raw Robusta coffee beans have greater ability to inhibit dental caries by preventing dental biofilm formation compared to instant Robusta coffee powder.

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