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Effect of black coffee and black tea consumption on pH, flow rate, and viscosity of saliva

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Abstract
Introduction: Saliva is a mixture of various fluids found in the oral cavity. Saliva is an essential factor that plays a role in preventing dental caries and tooth demineralization. This study aims to determine the effect before and after consuming black coffee and black tea.
Methods: The type of research used is descriptive quantitative. The research method is quasi-experimental with a cross-sectional approach, where data collection on the affected and affected variables is carried out almost simultaneously. The design uses a pre-test and post-test design. This research was conducted on May 20, 2021, with 40 female respondents. The instruments used were pH check sheets, plastic pots, and pH strips.
Results: Before the black coffee intervention, salivary pH showed a very alkaline condition with a value of 7.2, and then decreased to 6.8 after the black coffee intervention. Before the intervention of black tea, the salivary pH was 6.9, and after the intervention, the salivary pH increased to 7.2. The salivary flow rate before the intervention of black coffee was 1.82, and after consumption, it decreased to 0.60. Meanwhile, the salivary flow rate before the intervention of black tea was 0.85, and it increased after the intervention of black tea to 1.90. Before the intervention of black coffee, salivary viscosity was 4.03 and increased to 5.75 after the intervention of black coffee. At the same time, the salivary viscosity value before the intervention of black tea was 4.30 to 3.03 after the intervention of black tea. The results showed an influence between black coffee and black tea consumption on pH, salivary flow rate, and viscosity.
Conclusion: Black coffee and black tea are proven to reduce pH and flow rate and increase salivary viscosity, while black tea can increase pH and flow rate and decrease salivary viscosity.

Keywords: Saliva pH, Flow rate, viscosity, Black Tea, Black Coffee

1. Introduction
Dental and oral health efforts in Indonesia have not been able to be appropriately implemented, comprehensively, and continuously. Therefore, it is necessary to plan an oral and dental health program as a reference for developing dental and oral health to avoid dental caries [1]. Caries are an infectious disease that affects almost 95% of the world's population [2]. The national prevalence of dental and mouth problems is 25.9%. The prevalence of caries and periodontal disease reaches 60% in Indonesian society [3].
Dental caries is a disease of the hard tissue of the teeth caused by the activity of a microorganism characterized by the demineralization of the hard tissue of the teeth [4]. Various factors, including the bacteria Streptococcus mutants and lactobacilli, cause the formation of dental caries. Streptococcus mutants and lactobacilli bacteria convert glucose and carbohydrates in food into acids through fermentation process [5].
Saliva is a mixture of various fluids in the oral cavity [6]. Saliva functions as a cleansing fluid in the mouth; for this reason, it is needed in sufficient quantities [7]. A lack of saliva will create a high amount of plaque in the mouth [8]. The acidity level of saliva also influences the emergence of cavities or caries [9]. Low salivary pH levels will facilitate the occurrence of dental caries [10]. A low decrease in salivary flow will significantly increase caries activity, and a higher salivary viscosity will reduce the flow rate of saliva, which causes the accumulation of food debris, which can eventually lead to the development of caries [11].

The pH of saliva is the degree of acidity. The normal pH state is 7; if it is less than the normal pH, it is called an acidic state, and more is called an alkaline state [12]. Salivary flow rate is an indicator of saliva that influences the formation of carious lesions and oral disease. In contrast, salivary viscosity is a way to express how long the resistance of salivary flow is and a measure that expresses the thickness of saliva. The degree of acidity in the saliva is an essential factor that plays a role in preventing dental caries and tooth demineralization [13]. The salivary glands can be stimulated mechanically, for example, by chewing hard food or chewing gum, and chemically by taste stimuli such as sour, sweet, salty, bitter, and spicy [14]. This chemical stimulation is usually obtained from consuming coffee and tea because coffee and tea have a bitter taste which can stimulate changes in salivary secretion [15].

Coffee and tea are trendy drinks often consumed by people, especially in Indonesia [16]. Coffee has an anti-bacterial effect, so it is effective as an anti-plaque and prevents a decrease in salivary pH [17]. In their research, Imran *et al*. (2017) stated that the caffeine contained in coffee only has anti-bacterial properties but does not have non-stick properties, so bacteria in the oral cavity, such as Streptococcus mutants, will form plaque on the teeth and be followed by a decrease in tooth decay—salivary pH, as well as tea [18].

Tea is one of the most popular beverages consumed by the public [19]. Tea has been known for a long time as a drink with a thousand benefits (Majidah *et al*., 2022). In Indonesia, this is the first time anyone knows about this drink. Tea is known to have many health benefits [20]. Drinking tea can relax the body during daily activities [21].

Tea has properties against salivary pH which can prevent cavities because tea contains an active substance, namely fluoride, which can protect teeth from plaque, helps prevent the growth of caries on teeth, and strengthens teeth [22]. Several types of tea are sold in the market, including black tea. *Black tea* is the tea leaf that has undergone the most prolonged fermentation process, so the color is very dark, and the aroma is strongest [23]. Black tea contains polyphenols which can help prevent dental caries [24].

A preliminary study on homemakers RT.03, RW.07, Pamulang Barat, Tangerang Selatan stated that most of the mothers in the RT often consume black tea in the morning and, during particular weather, consume black coffee. Almost the majority of mothers tend to have moderate tooth decay status. From the preliminary study results, researchers are interested in knowing the effect of black coffee and black tea consumption on pH, salivary flow rate, and viscosity in mothers RT.03, RW.07, Pamulang West, South Tangerang.

This study aimed to determine the effect of black coffee and black tea consumption on pH, salivary flow rate, and viscosity in women from RT.03, RW.07, Pamulang Barat, Tangerang Selatan.

Methods

The Quasi Experiment study used a pre-post without control group design which was carried out in RT.03, RW.07, West Pamulang, South Tangerang, Indonesia which involved 40 mothers who were divided into two groups; 20 mothers were the group that received the black coffee intervention and the other 20 mothers received the black tea intervention. The sample of this study was randomly selected and met the inclusion criteria as mothers who were not currently ill during the study.

The dependent variable of this study was to measure the pH, flow rate, and viscosity of saliva before the study (before consumption of black coffee and black tea), and a final observation was made to measure the state of pH, flow rate, and salivary viscosity after treatment (after consumption of black coffee and tea).

No economic incentives were offered or provided for participation in this study. In this study, because the subject was still a minor, the researchers had asked for and obtained parental consent so their child could participate. The study was performed under the ethical considerations of the Helsinki Declaration.

The research data are presented in a quantitative descriptive manner, describing the study results using percentages in tabular form accompanied by table narratives.

Results

The research results are presented in the table 1:

Table 1: Frequency distribution of salivary pH before and after consumption of black coffee and black tea

Salivary pH criteria	Black Coffee		Black Tea	
	Pre test	Post test	Pre test	Post test
Acid	6 (30%)	11 (55%)	8 (40%)	4 (20%)
Neutral	4 (20%)	2 (10%)	7 (35%)	4 (20%)
Alkaline	10 (50%)	7 (35%)	5 (25%)	12 (60%)

Table 1 shows a difference in salivary pH before and after the consumption of black coffee. The salivary pH before consumption of black coffee was mainly alkaline, 50% (10 people), and the lowest condition was neutral, namely 20% (4 people). In the treatment after consuming black coffee, the situation changed, namely salivary pH; the acid criteria were 55% (11 people), and the alkaline criteria decreased to 35% (7 people). For the lowest, the neutral criteria were 10% (2 people).

Furthermore, there is a difference in salivary pH before and after consuming black tea. The salivary pH before consumption of black tea was mainly acidic, namely 40% (8 people), and the lowest condition was alkaline, 25% (5 people). Whereas in the treatment after consumption of black tea, the situation changed, namely salivary pH, the alkaline criteria became 60% (12 people), the acid criteria decreased to 20% (4 people), and the neutral criteria were the same as the acidic criteria, namely 20% (4 people).

Table 2: Frequency Distribution of Saliva Flow Rate before and After Consumption of Black Coffee

Salivary pH criteria	Black Coffee		Black Tea	
	Pre test	Post test	Pre test	Post test
Low	6 (30%)	9 (45%)	6 (30%)	4 (20%)
Normal	5 (25%)	5 (25%)	8 (40%)	6 (30%)
High	9 (45%)	6 (30%)	6 (30%)	10 (50%)

Table 2 shows a change in salivary flow rate before and after treatment. Before the treatment of black coffee consumption, the salivary flow rate of most of the respondents was in the high category of 35% (9 people), while after being given the treatment, the consumption of black coffee was mostly in the low salivary flow rate of 45% (9 people).

It can further be explained that there were changes in the salivary flow rate before and after treatment. Before the treatment, the salivary flow rate of the respondents was mostly average, as much as 40% (8 people). After being given, the treatment, most respondents with a high category salivary flow rate was 50% (10 people).

Table 3: Frequency Distribution of Saliva Viscosity before and After Consumption of Black Coffee and Black Tea

Salivary pH criteria	Black Coffee		Black Tea	
	Pre test	Post test	Pre test	Post test
Low	6 (30%)	5 (25%)	6 (30%)	10 (50%)
Normal	6 (30%)	5 (25%)	5 (25%)	4 (20%)
High	8 (40%)	10 (50%)	9 (45%)	6 (30%)

Table 3 shows an increase in salivary viscosity consistency before and after the consumption of black coffee. Most of the salivary viscosity before consuming black coffee was in the high category; 40% (8 people) increased to 50% (10 people) with the high salivary viscosity category after consuming black coffee.

It can be further explained that there is a change in the consistency of salivary viscosity before and after the consumption of black coffee. Most of the salivary viscosity conditions before the consumption of black coffee were in the high category, namely 45% (9 people). After consuming black coffee, most of the respondents in the low salivary viscosity category were 50% (10 people).

Table 4: Difference in average pH value, flow rate and saliva viscosity before and after consumption of black coffee

Difference value (pre-post)	Black Coffee	Black Tea
pH	0.4	-0.3
Flow rate	1.22	-1.05
Viscosity	-1.72	1.27

Table 4 shows that the difference in salivary pH after consumption of black coffee tends to decrease by a difference of 0.4, while in black tea, it increases by a difference of -0.3. The value of salivary flow rate before and after consumption of black coffee decreased with a difference of 1.22, while after consumption of black tea tended to increase with a difference of -1.05. Salivary viscosity values tended to increase after the consumption of black coffee, with a difference of 1.72, and decreased after the consumption of black tea, with a difference of 1.27.

Discussion

The results showed that most of the salivary pH before consumption of black coffee tended to be alkaline criteria, which was equal to 50%; after being given the treatment of black coffee consumption, the highest pH was obtained with acidic criteria of 55%, and the lowest pH with neutral criteria of 10%. Based on these results, the consumption of black coffee can potentially reduce salivary pH because coffee contains high carbohydrates, namely sucrose and monoxide [25]. Streptococcus mutans bacteria can lower salivary pH by fermenting carbohydrates into acids in the mouth [26]. Following Kusmana's opinion (2021) states that carbohydrates will be fermented by mouth bacteria and form acids that can lower the salivary pH. This situation is a critical pH state that can cause tooth decay, such as dental caries. Based on the explanation above, there is a tendency for the effect of black coffee consumption on salivary pH. It can be seen from the results that after the consumption of black coffee, the salivary pH tends to fall to the acidic criteria [6, 13].

Based on the analysis in Table 2, it is known that there was a change in the salivary flow rate before and after treatment. Before the treatment of black coffee consumption, the salivary flow rate of most of the respondents was in the high category of 35% (9 people), whereas after being given the treatment, the consumption of black coffee was mostly in the low salivary flow rate of 45% (9 people); thus it can be interpreted that the rate of salivary flow before and after consumption of black coffee in respondents tends to be low, this can increase the potential for dental caries.

Based on the analysis in table 3, it is known that there is an increase in the consistency of salivary viscosity before and after the consumption of black coffee. Most of the salivary viscosity before consuming black coffee was in the high category; 40% (8 people) increased to 50% (10 people) with the high salivary viscosity category after consuming black coffee. High viscosity (thick saliva) can cause a low salivary flow rate, leading to the accumulation of food debris, which can eventually cause caries. In contrast, low viscosity (watery saliva) will increase the salivary flow rate to obtain an excellent self-cleaning effect. It can reduce the occurrence of dental caries; thus, it can be concluded that salivary viscosity increases in black coffee consumers.

In the treatment of black tea consumption, the study's results follow Table 1, where most of the salivary pH conditions before consumption of black tea tended to have acidic criteria of 40%. After being treated with black tea consumption, the highest alkaline criterion was 60%, while the neutral and sour criteria were 20%. Based on these results, black tea can potentially increase salivary pH because black tea usually tastes bitterer when consumed. This bitter taste can suppress changes in salivary pH [27]. Following the opinion of Sutedjo in Subekti (2014), which states that changes in salivary pH are influenced by chemical stimuli, namely by stimulating bitter taste, this stimulus can affect the speed of salivary secretion so that the volume of saliva increases and affects the salivary pH to increase. The speed of secretion can be stimulated by chemical stimulation in the form of sour, sweet, salty, bitter, and spicy tastes [28]. Based on the explanation above, there is a tendency for the influence of black tea consumption on salivary pH. It can be seen from the results that after the consumption of black tea, the salivary pH tends to increase to an alkaline criterion.

Table 2 shows the salivary flow rate change before and after treatment. Prior to the treatment, the salivary flow rate of the respondents was mostly normal, as much as 40% (8 people); after being given treatment, most of the respondents with a high category salivary flow rate of 50% (10 people), thus it can be interpreted that the salivary flow rate before and after consumption of black tea in respondents tends to be high. From table 3, it can be seen that there is a change in the consistency of salivary viscosity before and after the consumption of black coffee. Most of the salivary viscosity before consumption of black coffee was in the high category, namely 45% (9 people); after consumption of black coffee, most of the respondents with low salivary viscosity category were 50% (10 people), so it can be concluded that the consistency of black tea consumption Saliva viscosity tends to be low.

The difference in salivary changes between the two treatments could be caused by a carbohydrate-rich diet and stimulation of the speed of salivary secretion, which can directly affect changes in the degree of acidity (pH) in the mouth [29]. The degree of salivary acid (pH) is influenced by several changing factors, including diet, day and night rhythms, secretion speed stimulation, and stimulation duration [30, 31]. The acidity level of saliva also influences the occurrence of cavities or dental caries [32]. The more acidic, the easier caries to occur [33]. The caffeine content in black coffee has anti-bacterial abilities, so it will protect against bacteria that can cause tooth decay [34]. In line with Manis (2016), his research states that black tea

also inhibits plaque growth on the teeth, so it effectively prevents tooth decay (dental caries).

Conclusion

Before the consumption of black coffee, the pH was very alkaline, with a value of 7.2, and then decreased to 6.8 after the consumption of black coffee. Before the consumption of black tea, the salivary pH was 6.9, and then after consumption, the salivary pH increased to 7.2. The salivary flow rate before the consumption of black coffee was 1.82, and after the consumption fell to 0.60. Meanwhile, the salivary flow rate before the consumption of black tea was 0.85, and it increased after the consumption of black tea to 1.90. Before the consumption of black coffee, salivary viscosity was 4.03 and increased to 5.75 after the consumption of black coffee. Meanwhile, the salivary viscosity value before black tea consumption was 4.30 to 3.03 after black tea consumption. The results showed an effect of the consumption of black coffee and black tea on salivary pH, flow rate, and viscosity.

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