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RESEARCH ARTICLE **OPEN ACCESS**

Effect of Sidikalang Coffee on Flow Rate, pH, Total Protein, and the Concentration of Salivary Glucose Levels in Smokers

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Abstract:

Background: Nearly half of the world's population suffers from dental and oral health problems, particularly caries. Drinking coffee can have many beneficial effects on oral health, such as preventing cavities from occurring in active smokers. However, until now, there has been no research examining the effect of Sidikalang coffee on components present in saliva.

Material and Methods: The method used in this research study was pre-experimental, utilizing a two-group pretest-posttest design. The study's population consisted of respondents who were habitual smokers and coffee drinkers between the ages of 20 and 35 years. We selected these respondents through purposive sampling, applying specific inclusion and exclusion criteria. The smoking group consisted of 20 individuals, and we collected their saliva samples both before and 30 minutes after consuming Sidikalang coffee. We measured the salivary flow rate by weighing the collected saliva each time and the salivary pH using a Hanna digital pH meter instrument. We measured total salivary protein using the Pierce TM BCA Protein Assay Kit and salivary glucose concentrations using the GOD-PAP method.

Results: The results showed that drinking Sidikalang coffee increased flow rate (p = 0.001), pH (p = 0.039), total protein (p = 0.044), and salivary glucose concentration (p = 0.144).

Conclusion: Sidikalang coffee consumption had a good effect on increasing flow rate, pH, total protein, and the concentration of glucose levels in saliva.

Keywords: Coffee, Smokers, Salivary flow rate, pH, Total protein, Concentration of glucose levels, Saliva.

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1. INTRODUCTION

Dental and oral health problems are experienced by nearly half of the world's population, including children [1]. In accordance with basic health research data from 2018, 57.6% of Indonesian people experience dental and oral health problems, which are handled by dental clinical workers [2, 3]. One of the most common diseases is dental caries [2, 4].

Untreated caries is one of the most common conditions, affecting 2.5 billion people worldwide. One of the causative factors is saliva [2, 5]. Flow rate, pH, antioxidant defense system, and buffer capacity are among the predisposing

factors that play a role in preventing caries. Saliva can also play a determinant role in the development of periodontal diseases [6].

Saliva is a mixture of various liquids contained in the oral cavity that plays an important role in lubricating the oral mucosa, assisting the phonetic system, and mechanically cleaning oral tissues by removing food particles [7, 8]. Salivary proteins play a crucial role in bacterial attachment and microbial activity, and act as biomarkers for some oral diseases [9].

The process of caries takes a long time and is multifactorial. Saliva with high glucose content increases acid production through bacterial fermentation and demineralization. If this process occurs too frequently, it leads to the change of the salivary environment into an acidic state, subsequently damaging the hydroxyapatite minerals. Not only the levels of calcium, phosphorus, magnesium, and fluorine are very influential in increasing the hardness of the enamel surface, but also bacteria and diet may affect the tooth structure. Bacteria biofilm and dietary carbohydrates influence flow rate, pH, protein, salivary glucose levels, and total protein, by disrupting oral homeostasis [8-11].

The dietary habits, including the type of beverage consumed daily, play an important role in influencing the oral environment. Coffee is one of the most frequently consumed beverages worldwide [12]. If it is consumed in a large amount and very frequently, it reduces the salivary pH due to its caffeine content [13, 14]. The acidic pH stimulates the metabolism of acid production and eventually initiates caries development [15].

Besides drinking coffee, another habit that has an effect on the saliva is smoking [16]. The composition of cigarette has a deleterious effect on the oral cavity [17]. However, the number of smokers continues to rise, particularly in Indonesia, ranking 4th in Southeast Asia [18]. The level of severity caused by smoking in the oral cavity can vary depending on age, gender, lifestyle, type of cigarette, smoking duration, and daily cigarette consumption [19].

Furthermore, drinking coffee and smoking can also cause changes in the glucose levels. Glucose is the basic substance for forming cell wall mannoproteins that increase adhesion and produce acids to lower the pH of the oral cavity. Glucose is easily transported through the body so the level of blood glucose rapidly changes. The increased blood glucose levels enhance the susceptibility to oral disease [20]. Previous findings have found the consumption of caffeinated coffee to cause an acute effect where glucose metabolism increases in the long term [21].

Previous studies have highlighted some changes in the salivary glands and the salivary components in smokers. These alterations include degeneration of vacuoles, vasodilatation, hyperemia, the decreased total protein of saliva, and the distinct salivary magnesium and phosphorus levels between smokers and healthy non-smokers [22]. The offspring of passive smoker parents showed the total salivary protein level to be similar to the ones of non-passive smoker parents and controls [23]. There has been limited study on the effect of coffee on smokers; therefore, this study aimed to investigate the influence of Sidikalang coffee on the flow rate, pH, total protein, and salivary glucose levels in young adult smokers [7].

2. MATERIALS AND METHODS

This study was approved by the health research ethics committee of Universitas Sumatera Utarawith the ethics number 1111/KEPK/USU/2022. The type of research was descriptive analysis involving a cross-sectional approach. The subjects ranged in age from 20 to 35 years, had no history of orthodontic treatment, were not currently undergoing radiation therapy, and were in good physical and mental health. Twenty smokers were included in this study. The saliva was taken between 10 am to 12 pm and collected before and after drinking coffee.

The Sidikalang Robusta coffee was obtained from Sidikalang Regency, North Sumatra, Indonesia. The coffee powder was brewed with hot water at 100°C for 10 minutes to get 150 ml of solution. The subjects were requested to refrain from eating and drinking for one hour before collecting their initial saliva using the draining method. After the initial collection, the subjects were instructed to drink coffee for 2–3 minutes. Then, the subjects were asked to collect their saliva again using the same method after 30 minutes. The flow rate, pH, total protein, and salivary glucose levels were assessed. The data were then analyzed using the SPSS version 25 software, while the dependent t-test was employed for further analysis.

3. RESULTS

The results presented in Table **1** show that the flow rate, pH, and total protein in saliva significantly increased after the consumption of Sidikalang coffee ($p \leq 0.05$). However, the glucose level was found to decrease, but not significantly ($p > 0.05$).

Table 1. Effect of drinking sidikalang coffee on the flow rate, pH, total protein, and saliva glucose concentration in smokers and coffee drinkers group.

Examination	Observation Time	Mean (ml/minute)	SD	*p*-value
Flow rate	Pre	0.55	0.27	0.001*
	Post	0.90	0.48	
pH	Pre	6.67	0.66	0.039*
	Post	6.97	0.46	
Total protein	Pre	1383.20	647.35	0.044*
	Post	2070.15	1048.87	
Saliva glucose concentration	Pre	0.041	1.67	0.114
	Post	-0.036	0.653	

Note: Dependent t-test, *significant at $p<0.05$

Table **2** demonstrates that there was a significant rise in salivary flow rate and a decrease in salivary pH ($p \leq 0.05$) in the group of smokers who did not drink coffee. There was also an increase in total protein and a decrease in salivary glucose concentrations, but not significantly ($p > 0.05$) (Table **2**).

Table 2. Effect of not drinking sidikalang coffee on flow rate, pH, total protein, and saliva glucose concentration in the smokers group.

Examination	Observation Time	Mean (ml/minute)	SD	*p*-value
Flow rate	Pre	0.51	0.28	0.036*
	Post	0.62	0.26	
pH	Pre	7.48	0.71	0.047*
	Post	6.79	0.62	
Total protein	Pre	1369.52	637.85	0.212
	Post	1753.97	705.76	
Saliva glucose concentration	Pre	-0.036	1.162	0.625
	Post	-0.56	1.185	

Note: Dependent t-test, *significant at $p<0.05$.

The results indicated no significant difference in flow rate, pH, total protein, or concentration of salivary glucose levels between smokers and coffee drinkers after drinking Sidikalang coffee ($p>0.05$). However, there were higher differences in flow rate, pH, total protein, and salivary glucose levels in the smoker and coffee drinker group than in the smoker group (Table **3**).

Table 3. Changes in flow rate, pH, total protein, and concentration of glucose levels between the group of smokers and the group of coffee drinkers and smokers.

Group	Mean			
	Flow Rate (mL/minute)	pH	Total Protein (µg/mL)	Saliva Glucose Concentration (mg/mL)
Smokers and coffee drinkers	0.90	6.97	2070.15	-0.83
Smokers	0.62	6.79	1753.97	-0.56
p-value	0.243	0.98	0.549	0.548

Note: Independent t-test.

4. DISCUSSION

The results of this study found that drinking Sidikalang coffee significantly increased salivary pH, flow rate, and total protein, but it had no effect on salivary glucose level. The treatment group included subjects who were smokers and were drinking coffee, while the control group included smokers who were not drinking coffee.

This study showed a significant increase in the salivary flow rate after drinking coffee, with an average rate of 0.55 ml/minute increasing to 0.90 ml/minute ($p<0.05$). However, a study by Hans *et al*. found drinking coffee to significantly reduce the flow rate of saliva [24]. Contrary to the theory that caffeine could lower saliva production, it did not stimulate the salivary flow rate [25]. Likewise, Hildebrandt *et al*. showed that caffeine had no significant effect on the salivary flow rate [26].

The increase in the salivary flow rate in this study could possibly be caused by the salivary pH before drinking coffee, which was 6.67, and afterward increased to 6.97 ($p<0.05$). The results of this study have been found to be in line with the research study by Hans *et al*., which showed that the consumption of coffee increased salivary pH [24]. Simsek *et al*. [27] also supported the results of this study, showing an increase in salivary pH after coffee consumption.

Food and drink provide a strong stimulus for saliva secretion through sensory nerve receptors. The interaction of various taste receptors on the taste buds, followed by the activation of mechanoreceptors in the periodontal ligament and mucosa, generates sensory nerve signals that trigger the central nervous system to secrete saliva. The polyphenol content in coffee, specifically catechins and tannins, stimulates the taste 2 receptor protein (TAS2R) for salivary secretion, thereby increasing the blood flow in the salivary glands and causing them to secrete large amounts of saliva [28, 29].

Increasing the flow rate of saliva prevents tooth decay [28]. Saliva functions as a buffer system, neutralizing acids produced by acidogenic microorganisms through the action of inorganic ions, such as calcium, phosphate, hydroxyl, and fluoride. This capacity helps to defend against the colonization of microorganisms and prevents the demineralization of enamel in the oral cavity [30].

In addition to salivary flow rate and pH, the results of this study showed that drinking Sidikalang coffee also increased total salivary protein, with an average total protein before drinking coffee of 1383.20 µg/ml increasing to 2070.15 µg/ml ($p<0.05$). The results of this study have also been found to be in line with the research findings of Chong *et al*., who found a significant increase in total salivary protein in subjects who had a habit of drinking black tea [31]. This mechanism was attributed to the presence of catechin content found in coffee and tea [9].

A dense network of capillaries supplies the salivary glands. Capillaries have high permeability for small solutes, but they are insufficient for macromolecules, such as proteins [32]. Drinking warm coffee stimulates vasodilation of the blood vessels of the salivary glands, thereby increasing blood flow and causing secretory cells to produce large amounts of saliva as well as protein [33]. An increase in total salivary protein increases the ability of proteins to maintain oral homeostasis [34].

In this study, the average concentration of salivary glucose levels decreased from 0.04 mg/dL to -0.83 mg/dL in the group of smokers and coffee drinkers, but this decrease was not significant ($p > 0.05$). Bhaktha *et al*. conducted a long-term study on healthy individuals who drank coffee five times a day for five years, supporting this research results. The results of this research study stated a decrease in blood glucose levels in the subjects [35].

Caffeine is not the only component in coffee that reduces salivary glucose levels [36]. The level of polyphenols, especially chlorogenic acid, can lower the amount of glucose in saliva. The chlorogenic acid is a strong antioxidant that helps produce GLP-1 (glucagon-like peptide-1). When intestinal L cells secrete GLP-1, it circulates in the systemic circulation and reaches its receptors in the pancreas, inhibiting glucose secretion.

The metabolism of carbohydrates enhances the risk of glucagon formation and results in the inhibition of glucose production in the liver, thus decreasing glucose levels [37].

Lee *et al*. carried out a 2-year study in Korea on pre-diabetic patients and found that chlorogenic acid and strong antioxidants found in coffee can help control blood sugar levels, stop the absorption of glucose in the intestines, and make insulin function better [38]. Chlorogenic acid has been reported to be the second most abundant component in coffee after caffeine [39].

This study showed no significant difference in the flow rate, pH, total protein, and concentration of salivary glucose levels between groups of smokers who drank coffee and those who did not ($p > 0.05$). However, based on the average value, there were higher differences in flow rate, pH, total protein, and salivary glucose levels in the smokers and coffee drinkers group compared to the smokers and non-coffee drinkers group. The catechins contained in coffee and cigarettes not only affect oral health, but they can also inhibit cancer cell proliferation, regulate lipid and glucose metabolism, and stimulate immune function [31, 40].

CONCLUSION

The consumption of Sidikalang coffee increased the flow rate, pH, and total protein of saliva in smokers, but not the salivary glucose levels.

AUTHORS' CONTRIBUTION

It is hereby acknowledged that all authors have accepted responsibility for the manuscript's content and consented to its submission. They have meticulously reviewed all results and unanimously approved the final version of the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the health research ethics committee of Universitas Sumatera Utara, Medan, Indonesia, with the ethics number 1111/KEPK/USU/2022.

HUMAN AND ANIMAL RIGHTS

All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was obtained from all participants of this study.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data and supportive information are available within the article.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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Declared none.

DISCLOSURE

Pengaruh Kopi Sidikalang (Coffea sp.) terhadap Laju Alir, pH, Total Protein, dan Konsentrasi Kadar Glukosa Saliva pada Perokok.

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