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Effects of Black Tea on Salivary pH and Flow Rate

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Abstract

Saliva is the mouth's main defense against tooth decay, keeping the mouth's tissues healthy and offering protection from microbial invasion that can lead to disease. The present study was undertaken with the aim of assessing the effect of black tea on salivary pH and flow rate amongst 255 healthy adults between the ages of 25 and 30. Saliva samples were collected before and after consumption of black tea for 3 minutes. The changes in the unstimulated and stimulated saliva were monitored by measuring the flow rate with a measuring cup that was weighed in a precision balance while the salivary pH was measured with a digital pH meter. A paired t-test was used to analyze results. Both salivary flow rate and pH level results were statistically significant ($p \leq 0.05$) with a p-value of ($p = 0.013$) for flow rate and a value of ($p = 0.0004$) for pH level after consumption of black tea. Study shows that black tea significantly increases the pH level and flow rate of saliva.

Keywords: ***Saliva; Black tea; Salivary flow; Salivary pH; Saliva stimulation; Camellia sinensis.***

Introduction

Nowadays, people consume different beverages without knowing the beneficial or harmful effects of these drinks on their dental and overall body health. These beverages include soda, coffee and tea. After water, tea is the second most widely consumed beverage globally.[1] Black tea is made from the leaves of a plant called Camellia sinensis. The leaves of this plant are exposed to moist, oxygen-rich air to be oxidized. The process of oxidation turns the green leaves into a brownish-black color. Tea manufacturers can control the amount of oxidation. Black tea is a fully oxidized tea.

Iranians have one of the highest per capita rates of tea consumption in the world. Although only 1% of the world population, Iranians account for over 5% of the world's total tea consumption.[2]

Regular intake of tea has been lauded for improving antioxidant status, contributing to lowering the risk of coronary heart disease, stroke, and certain types of cancer. In this past decade, there has been significant interest in evaluating the health benefits of tea, particularly its polyphenolic components.[3] However, little is known of the acid content of tea and its influence on salivary pH and salivary flow rate during and after consumption.

Saliva is the mouth's main defense against tooth decay, keeping the mouth's soft and hard tissues healthy, washing away food and debris and neutralizing acids produced by bacteria. Saliva offers protection from microbial invasion that leads to disease.[4] It is produced by salivary glands that are found in the underlying tissues of the mouth. Clusters of cells called acini form the basic secretory units of the salivary glands. Human saliva contains water, mucus, enzymes and electrolytes.[5] The body's major salivary glands are parotid glands, submandibular glands and sublingual glands. These glands differ in the type of secretion they produce. Saliva production is controlled by the autonomic nervous system, which acts largely unconsciously. Saliva secretion is controlled by two types of nerves sympathetic and parasympathetic nerves. Parasympathetic nerves evoke ample flow of saliva. Sympathetic nerves evoke either little flow or no flow at all.[6] Dry mouth, the result of salivary glands not working properly, impacts a person's oral hygiene negatively. When the pH level of the mouth goes below the critical pH value of 5.5, lactic, butyric and aspartic acids break down the teeth's enamel.[7] Thus, adequate saliva is essential in maintaining healthy teeth.

With salivary flow and pH playing a significant role in the prevention of dental caries, the study was a quest to understand how black tea can impact salivary properties and oral hygiene. The researcher did this by evaluating the effects of black tea on salivary pH and flow rate.

Materials and Methods

Two hundred fifty-five healthy subjects, both male and female between the ages of 25 and 30 and with no history of salivary gland disease, took part in the study. Subjects were selected randomly from students of Centro Escolar University Manila campus and were examined at the Centennial Research Laboratory for 5 months starting November 2016. Informed patient consent was obtained before sialometry. Centro Escolar University's Research and

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Evaluation Office approved the research project within which the work was undertaken. It conforms to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh 2000).

Sialometry was used to examine the subjects' saliva, resting (unstimulated) saliva flow rate (RSF) and whole stimulated saliva flow rate (SSF) was measured. Unstimulated whole saliva was collected in the morning, 2 to 3 hours after breakfast, in a ventilated and well-illuminated laboratory room using the "spit" method. (8) Before saliva collection, subjects were requested to rest for 5 minutes, with their eyes open, without stimulating salivation, and then they comfortably sat, with their arms resting on their knees, and their heads lowered and facing slightly forward, between their arms. The participants rinsed their mouth with water before collection. They were instructed to swallow all the saliva present in the mouth and to allow new saliva to accumulate. For the next three minutes, the accumulated saliva was collected in a sterile graduated receptacle from Mercury Drug (Quezon City, 1110 Metro Manila, Philippines). Then subjects were given black tea. Ahmad Earl Grey black tea leaves from Tehran, Iran were used in the study. All subjects were asked to drink the same tea. The tea was prepared in a ceramic teapot with the measurement of one teaspoon of tea leaves per cup of water. The tea leaves steeped in boiling distilled water for 7 minutes, following instructions on the tea packaging. The tea was allowed to cool for 3 minutes before being given to each subject. After the subjects drank black tea, stimulated saliva was collected in the same way as unstimulated saliva. The receptacles containing saliva were then weighed in an Asuki High Precision Balance digital weighing scale. The collected saliva samples were immediately subjected to measurement of the pH using a Denver Instrument digital pH meter.

Using statistical treatment indicated by Prem S. Mann, the weight of saliva was then divided by the time of duration of the collection (3 minutes) and the flow rate was calculated in g/min, which is equivalent to mL/min, since over 99% of the saliva is composed of water. The amount of saliva in mL, divided by the time of duration of the collection was recorded as the mean salivary flow rate. The measurement of salivary flow before and after drinking the black tea was recorded. The study did not check on other effects of black tea on the oral cavity.

Comparative analysis of data was done using Microsoft Excel spreadsheet. Statistical mean for RSF and SSF and pH were computed to get the average of the salivary flow rate and salivary pH of samples. Standard deviation was calculated to measure the dispersion, which depends upon the distance from the mean. Paired T-Test was used for measuring statistical difference in the salivary pH and salivary flow rate before and after drinking black tea and to get the p-value to determine the statistical significant difference, with significance set at $p<0.05$.

Table 1: Comparison of Salivary Flow Rate before and After Drinking Black Tea

	Mean $\overline{X}$	*P* value	Verbal interpretation
Before drinking	0.53 ml/min	*0.013*	Significant
After drinking	0.56 ml/min		p<0.05

Table 2: Comparison of Salivary pH Level Before and After Drinking Black Tea

	Mean $\overline{X}$	*P* value	Verbal interpretation
Before drinking	6.04	0.0004	Significant
After drinking	6.13		*p*<0.05

Results

The mean salivary flow rate before and after consumption of black tea are shown in Table 1. Average unstimulated salivary flow rate was 0.53 ml/min while stimulated whole salivary flow rate after consumption of black tea was 0.56 ml/min. Computed P-value was ($p = 0.013$) revealing that flow rate difference is statistically significant ($p < 0.05$) before and after drinking black tea. The result of the study regarding pH level of subjects' saliva is shown in Table 2. The mean salivary pH before consumption of black tea was 6.04. After drinking the black tea, the pH level of saliva increased to 6.13.

Comparison of salivary pH level before and after drinking black tea ($p = 0.0004$) reveals that statistically there is a significant difference in the subjects' saliva pH level before and after consuming black tea.

Discussion

Tea is more than a beverage in many countries. It is commonly consumed at social events. Much has been said about the benefits of drinking tea. Previous studies have determined the positive effects of tea on the prevention of acid production in the mouth, how it is a natural source of fluoride and how its tannins can stop bacterial growth.[9,10,11] The present study is in agreement with the findings of these other studies because of the increase in the subjects' salivation and pH level. According to results obtained from this study, drinking black tea increased both salivary flow rate and pH level. The average daily flow of whole saliva

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varies between 1 and 1.5 L. Anything above 0.1 mL/min is accepted as normal flow of unstimulated saliva. The minimum volume for the accepted norm of stimulated saliva is 0.2 mL/min.[12] In this study, the subjects' salivary flow rate increased from 0.53 to 0.56 ml/min after consuming a cup of black tea. Eating and drinking is a strong stimulus for saliva secretion.[13] Some sensory receptors are activated in response to drink or food intake. Mechanoreceptors, gustatory receptors, nociceptors, and olfactory receptors, and the different kinds of taste (sweet, sour, bitter, salty), evoke salivary secretion that is called gustatory salivary reflex. Among all 4 modes of taste, sour creates the strongest stimulus followed by salty. The taste buds, which reside in the tongue's papillae, have microvilli that relay messages to the brain about the taste of food and drinks. Commercially available black tea generally has a bitter taste. In this study, all the subjects drank bitter black tea. Bitterness is processed at the dorsum of the tongue. The Taste 2 Receptors (TAS2R) proteins function as bitter taste receptors.[14] When the subjects drank black tea, the tea activated the taste receptors and that stimulated salivation. Another factor to take into consideration is the blood flow of salivary glands. Salivary glands are supplied with a dense capillary network.[15] The capillaries have a high permeability to small solutes but not enough for macromolecules like proteins. Parasympathetic induced vasodilatation may generate a 20-fold increase in gland blood flow, which ensures the secretory cells produce large volumes of saliva over a long period of time.[16] Drinking warm tea enhanced the vasodilation of the subject's salivary glands. Therefore, salivary flow increased significantly with ($p = 0.013$). Saliva acts as buffer and cleans the acids produced by acidogenic microorganisms.[17] The carbonic acid-bicarbonate system is the most important buffer in stimulated saliva, while in unstimulated saliva, it serves as the phosphate buffer system.[18]

The level of the subjects' saliva pH rose from a mean average of 6.04 to 6.13. All subjects experienced significant ($p = 0.0004$) increase in salivary pH level after drinking black tea. Increase of salivation of subjects caused the increase in their pH level as saliva acts as a buffer for the oral cavity. The results of the present study suggest that drinking black tea could be beneficial to those suffering from dry mouth. Further studies are required for analyzing the reaction of tea and whole saliva and the speed of these reactions. The present study only checked the effects of black tea on salivary flow rate and pH level and did not check on other effects of black tea on the oral cavity.

Conclusion

According to the results obtained from the study, drinking black tea can increase both salivary flow rate and pH level. Aside from other health benefits of tea, consuming black tea in moderation can help individuals protect their mouths from problems associated with dry mouth. People who are experiencing dry mouth can try drinking black tea to help stimulate salivation but further studies with participation of individuals suffering from dry mouth is required to confirm the beneficiary effects of black tea on dry mouth.

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