DENTINO
JURNAL KEDOKTERAN GIGI
Vol VII. No 2. September 2022

THE CHANGES IN SALIVARY PH BY CHEWING BLACK TEA (*Camellia sinensis*) CANDY CONTAINING THE SORBITOL

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ABSTRACT
Background: *Tea contains beneficial chemical compounds, one of which is polyphenols. The polyphenols in black tea can inhibit the growth of bacteria and prevent oral infections. Black tea extract has been proven to increase salivary pH, but children do not like it because of its bitter taste. Therefore, innovation is needed by incorporating black tea extract into candy containing sorbitol.* ***Objective:*** *To determine the effectiveness of chewing black tea candy containing sorbitol on salivary pH compared to non-black tea candy in children aged 7-8.* ***Methods****: This research is an experimental field study using a single-blind randomized controlled trial with a pretest-posttest control group design. The research subjects were of 42 children aged 7-8 years divided into two groups, the treatment group, and the placebo group, using a simple random sampling technique. A sampling of saliva was carried out before and after chewing hard candy. Monitoring was carried out for approximately 23 days, and pH was measured three times. Measurement of pH using a digital pH meter®.* ***Results****: After conducting the research, it can be seen that there is a significant difference between chewing hard candy made from black tea and sorbitol on the changes in salivary pH (p-value = 0.0001).* ***Conclusion:*** *Chewing hard candy made from black tea and sorbitol is likely to help increase salivary pH, and it could be a solution to prevent dental caries in the future.*

Keywords : *Black tea; Dental caries; Hard candy; Salivary pH ; Sorbitol.*

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INTRODUCTION

Dental caries is the most common disease suffered by children, regardless of age, gender, race, and socioeconomic status. In children, dental caries is the most common chronic disease. It was stated by the Centers for Disease Control and Prevention (CDC, 2013) that dental caries mainly occur in children aged 6-11 years (25%) and adolescents aged 12-19 years (59%).[1] Based on Primary Health Research conducted by the Ministry of Health in 2018, as many as 93% of early childhood aged between 5-6 years experienced dental caries.[2]

One of the efforts made by the government in overcoming dental caries in school-age children is through the School Dental Health Unit (hereinafter referred to as UKGS). Interventional activities of UKGS can be in the form of shared toothbrushes, dental surface protection, dental fillings, tooth extractions, application of fluoride, or gargling with fluoride-containing solutions, which can be carried out at schools, at the public health center, or in the practice of individual dentists or family dentists. However, implementing the School Dental Health Unit (UKGS) cannot entirely reduce the dental caries rate because many health workers are still less active in implementing UKGS.[3]

Tea is an herbal product that can increase salivary pH and has an antibacterial effect. Most of the polyphenolic compounds contained in the tea are catechins. The catechins in tea inhibit the activity of glycosyltransferase enzymes by inhibiting the attachment of bacteria to the pellicle. It can also inhibit the process of plaque formation.[4] In research conducted by Peiman Shalah (2017), it is said that consuming black tea can increase salivary pH. The study conducted on 255 research subjects whose saliva pH was checked before and after consuming black tea proved that the salivary pH level of the research subjects increased from an average of 6.04 to 6.13.[5]

In previous research children did not like using black tea extract. Therefore, innovation was made using black tea as a candy containing sorbitol. Sugar substitute in the form of sugar alcohol is one agent that has been proven to have anti-cariogenic properties like sorbitol. Like other polyols, sorbitol is non-cariogenic because it

is not metabolized by oral bacteria that break down sugars to release acids that cause cavities. It has alcohol higher than sugar, and it is relatively more resistant to fermentation and acid formation caused by microorganisms found in the oral cavity.[6] For this reason, sorbitol is used for sweetening and serving non-cariogenic foods and soft drinks. Rafeek R study (2018) said polyol group sugar includes sorbitol can increase the salivary flow and pH, and also it has an inhibitory effect on streptococcal bacteria.[7]

Therefore, this study aims to determine the effectiveness of chewing candy made from black tea and sorbitol in changing salivary pH. It also compares among the pH of unstimulated saliva at baseline to see the effect of changes in saliva during 2 weeks of treatment, 7 days, and 23 days with the pH of stimulated saliva to see the difference of changes in saliva during 3 weeks of treatment.

METHODS

This research is an experimental field study using a single-blind, randomized clinical trial with a pretest-posttest control group design. The selection of the research site was carried out using the purposive sampling technique. The research sample was taken using a simple random sampling method to obtain a sample of 42 people, of which 20 children were in the treatment group, and 22 were in the placebo group. The research samples were divided into two groups, and then the salivary pH was checked before stimulation. Then the samples were directed to chew candy made from black tea and sorbitol, while the other group was required to chew the placebo candy for 7 days to 23 days of the study. After the stimulation, the salivary pH was examined in both groups of the study sample, and the DMF-T index score was examined in both groups.

This study was conducted at SDN 19 Cempaka Putih Barat, Central Jakarta and SDN 03 Pagi Pasar Minggu, South Jakarta. The inclusion criteria in this study were students aged 7-8 years who had no history of systemic disease and were not currently under orthodontic treatment. The exclusion criteria in this study were students who were not cooperative in the sampling process, parents who disagreed that their children were involved in the study, and those with a history of systemic disease.

The production of hard candy requires sorbitol, black tea solution, isomalt, and food colouring and flavouring. First, 10 grams of sorbitol and black tea solution were heated over low heat until dissolved. Meanwhile, placebo hard candy did not use black tea solution, but only flavourings and food colouring. After dissolving, 40 grams of isomalt is added to the dough, then stirred again until the solution reaches a temperature of 150 degrees, all ingredients are well mixed, and air bubbles disappear.[8]

Permission to conduct research has been obtained from the Ethics Committee of YARSI University, and parents of students whose children are willing to become research subjects have filled out informed consent given them before the research is conducted.

The research involves the following steps: First visit, the action taken was scaling. Furthermore, on the second visit, subjects were asked to chew hard candy made from black tea in the treatment group and placebo candy in the control group for 2-3 minutes, the pH was checked before and after chewing hard candy in both groups to get the first saliva measurement (Salivary pH 1). The saliva sample was collected in the tube. Subjects were asked to chew hard candy with a dose of one candy every day at school for 3 weeks and pH measurements were carried out before and after chewing hard candy on the seventh (Salivary pH 2) and 23rd day (salivary pH 3). After finishing chewing, subjects were instructed not to eat or drink for one hour after chewing the candy. The saliva samples that had been collected were stored in a cooler, which was then taken to the Herbal Laboratory of Universitas YARSI to measure the salivary pH. Measurement of pH was carried out using a pH meter (Docu pH-Meter Sartorius). Salivary samples were collected at begging before treatment, on the 7th day, and on the 23rd day. Data processing was done using the SPSS program, with the Shapiro-Wilk normality test, the independent t-test, and the Two-Way Anova test.

RESULT

Result of this study: table 1 shows the independent t-test, which explains that in the first, second, and third week of examination, there was a significant difference ($P<0.05$) between the difference in salivary pH (the result of salivary pH after chewing candy reduced by salivary pH before chewing) in the black tea candy group and the placebo candy group. A tendency is to increase salivary pH in the black tea candy group. In contrast, the placebo candy group decreased, indicating a negative difference. The dependent t-test on salivary pH examination before and after being treated every week also showed a significant difference in the black tea candy group (P-value = 0.0001). However, there was no significant difference in the placebo candy group, namely the P-value=0.567 ($P>0.05$), between the salivary pH before and after chewing the candy.

The test results of the Two-Way ANOVA (table 2) showed that there was a significant difference in salivary pH in the three measurement times, both in the pre-and post-examination in the black tea candy group and placebo candy group, namely the p-value = 0.0001 and in the pre-examination group in chewing placebo hard candy with p-value=0.002 ($p<0.05$).

Table 1. Test Results of Independent and dependent t-Test on Black Tea and placebo group

Variable	Candy Group		*P-value*
	Black Tea	Control	
	Mean±SD	Mean±SD	
Salivary pH 1			
Before	6.47±0.20	6.63±0.21	
After	6.64±0.24	6.59±0.23	
Δ pH	0.17±0.29	-0.03±0.29	
0.004			
P-value	**0.0001**	**0.567**	
Salivary pH 2			
Before	6.52±0.11	6.57±0.21	
After	6.78±0.17	6.52±0.19	
Δ pH	0.26±0.14	-0.05±0.16	
0.0001			
***P*-value**	**0.0001**	**0.123**	
Salivary pH 3			
Before	6.62±0.27	6.79±0.17	
After	6.97±0.24	6.75±0.20	
	Δ pH	0.35±0.33	
-0.03±0.31	**0.0001**		
***P*-value**	**0.0001**	**0.583**	

Salivary pH 1 are the salivary pH measured on the first day intervention. Salivary pH 2 are the salivary pH measured on 7th day and Salivary pH 3 measured on 23rd day

Table 2. Test Results of Two-Way ANOVA

Variable	Candy Group			
	Black Tea		Control	
	Mean± SD	p-value	Mean±SD	p-value
pH check before treatment				
Week 1	6.47±0.20	0.0001	6.63±0.21	0.002
Week 2	6.52±0.11		6.58±0.21	
Week 3	6.63±0.27		6.79±0.17	
pH check after treatment				
Week 1	6.64±0.25	0.0001	6.60±0.23	0.0001
Week 2	6.78±0.17		6.52±0.19	
Week 3	6.89±0.24		6.75±0.20	

DISCUSSION

This study was conducted on elementary school students in grade 1, where the number of samples in each school was 30. Students at SDN 03 Pasar Minggu are a placebo candy group. Parents did not approve of three children as research subjects, and three other children were not cooperative when the research activities were carried out. Therefore, the research subjects in the placebo candy group became 24 children. Students at SDN 19 Cempaka Putih are a black tea candy group. When starting the study, five children were not approved by their parents to be research subjects, three children were not cooperative, and two had systemic diseases and were not allowed by their parents to participate in the study, so they were included in the exclusion criteria. A salivary pH examination using a digital pH meter was carried out in the Herbal Laboratory of Universitas YARSI.

The results showed a significant difference ($p<0.05$) in the examination of salivary pH before chewing black tea hard candy or placebo in the first and third week, with an average pH of 6.47 for the black tea and 6.47 for the placebo group. 6.63. It is in line with the theory that the normal range of salivary pH is 6.2-7.6.[9] However, the second week of statistical tests showed insignificant results ($p>0.05$) on salivary pH before chewing black tea or placebo candy. It may be due to uncontrolled variables that can affect the value of salivary pH. One of them is that before the saliva sample was taken, the subject consumed food or drink that could affect the pH of his saliva. Meanwhile, in the examination of salivary pH after chewing black tea candy or placebo candy, both in the first, second, or third week there was a significant difference ($p<0.05$).

The tea itself has the main content of polyphenols consisting of tannins and flavonoids. The flavonoids in tea are catechins. These catechins can increase pH and inhibit bacterial growth.[10] In addition, tannins as a subclass of polyphenols cause a bitter taste in tea, stimulating the central nervous system to increase salivary flow. The impact also increases salivary pH.[12] Based on research conducted by M.A Adil (2017), it was said that after consuming green tea and chamomile tea, there was a reduction in the number of Streptococcus mutans in the oral cavity. Streptococcus mutans can lower salivary pH by fermenting carbohydrates into acid in the mouth. Therefore, consuming green tea is effective in reducing the number of Streptococcus mutans and can increase salivary pH.[12]

Following the statistical tests that have been carried out, it was found that there was a significant difference in salivary pH before and after chewing black tea candy in the first, second, and third week. Hawadalla et al. (2011) showed significant differences in the number of Streptococcus mutans and salivary pH after

gargling with 2% green tea extract for five minutes. It is said that the catechins contained in green tea can prevent the decrease in salivary pH after eating and can also maintain salivary pH in a normal state. Black tea has the same content as green tea that it contains catechins, although in smaller amounts. While in the group chewing placebo candy, there was no significant difference between before and after chewing candy. It may be due to the absence of an active substance in the placebo candy that can affect changes in salivary pH.[10]

Based on research that has been done, there is an increase in salivary pH after chewing black tea candy after 23 days, where the average salivary pH at baseline was 6.47. After chewing black tea candy for 23 days, the average increased to 7.07. It is in line with research by Prihastari, L, et al. (2019), where there was an increase in salivary pH after gargling with black tea, which may be influenced by mechanical stimulation from the act of gargling and the presence of a stimulus in the form of paraffin wax.[13] Research conducted by Miller, Hammilton (2001) (in Kamalaksharappa) also stated that gargling with Green tea containing catechins for a particular time can prevent acid production and maintain pH in the normal range (7.2-7.4).[14] This study is also in line with Kamalaksharappa's (2018) research that there is an increase in the average pH of saliva after gargling with green tea for one month, where the catechins contained in green tea show a significant effect on salivary pH and dental plaque.

The group chewing placebo candy also showed a significant difference after chewing ($p<0.05$). It can occur because of the movement of chewing candy. Chewing can increase salivary flow through a combination of gustatory and mechanical stimulation. Mechanical stimulation from chewing black tea candy containing sorbitol will stimulate the salivary glands to secrete more saliva. Stimulation of chewing increases the secretion and volume of saliva, which can affect salivary pH and enzyme function. These changes are also expected to affect the intraoral environment. Thus, the stimulation of chewing considerably affects the various chemical components of saliva.[15]

The ability to increase salivary pH in black tea can provide a breakthrough for the prevention of dental caries. Black tea is also known to inhibit the growth of bacteria that cause dental caries. In a Ramadan AM study (2019), it was shown that black tea has a tendency (though not statistically significant) to reduce the number of S. mutans and, to a lesser extent, can also reduce the number of Lactobacillus.[16] According to Shagana, J. A (2017) proved that black tea extract had the highest antimicrobial activity compared to green and white tea extracts. It may be because both black and green tea leaves have antibacterial properties that can cause a decrease in the number of bacteria.[17] Further research on the effectiveness of black tea candy against bacteria needs to be done.

Research conducted by Dan-Ying Tao (2013) showed that there was still an increase in the average DMF-T in children who chewed gum containing tea polyphenols after a 24-month study. However, when compared with the other chewing candy groups, the polyphenol group had a minor increase (p-value=0.003).[18] The accumulation of plaque on the tooth surface that persists for two to three weeks can cause white spots. The journey of a white spot turning into a cavity takes time, which varies depending on age. For children aged one and a half years, it takes around six months, while at the age of 15, it takes two years, and at the age of 21-24 years, it takes almost three years. However, it, of course, depends on each individual.[19]

This research is quite complex because they have to keep an eye on the subject to keep chewing candy daily to avoid missing a day. In addition, researchers were also constrained in the manufacture of candy, resulting in the start of the research being delayed. The time required for this research is quite long, but due to the cutoff of the end-of-year holidays for elementary school students, this research cannot be carried out as initially planned. Difficulties also occur during saliva sampling, where children are not conducive to having saliva samples taken twice in one day. It can be concluded that there is a significant difference in the effectiveness of black tea candy with sorbitol content on salivary pH with a p-value = 0.000 ($p <0.05$). The ability to increase salivary pH can help black tea candy as an alternative dental caries prevention innovation in the future with more research samples and a more extended time. The author declares that there is no conflict in this research and thanks YARSI University for the financial support for the implementation of this research.

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