Effect of Consuming Rebon Shrimp Crackers on Saliva Characteristics in Percobaan Public Elementary School Medan

Gema Nazri Yanti[1]*, Darmayanti Siregar[1], Siska Ella Natassa[1], Ranu Putra Armidin[1]

1. Department of Public Health Dentistry / Preventive, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia.

Abstract

This study aimed to examine the effect of consuming rebon shrimp crackers on the saliva characteristics namely flow rate, pH and viscosity in Percobaan Public Elementary School Medan.

This study was experimental research with pre and post-test control group design consisting of 48 samples, 24 receiving the intervention and 24 as the control group. Unstimulated saliva samples obtained by using the drooling method are then measured for pH and flow rate. The viscosity was assessed using Ostwald viscometer. Paired T-test was used to analyze the effect of rebon shrimp crackers on saliva characteristics, unpaired T-test to analyze differences in rebon shrimp crackers consumption on salivary characteristics, and Pearson correlation to analyze the association between saliva characteristics after treatment.

There was a significant effect on saliva characteristics ($p<0.05$) before and after treatment in the treatment group, but not in the control group ($p>0.05$). After treatment, there was a significant difference in saliva characteristics ($p<0.05$) between the control and treatment groups. A significant correlation was observed between salivary flow rate and viscosity ($p=0.03$), flow rate and pH ($p=0.00$), and pH and viscosity ($p=0.03$) after treatment. Due to their effect on saliva characteristics, rebon shrimp crackers may be used to prevent caries.

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Introduction

In Indonesia, dental caries is the most prevalent chronic disease among school-aged children. According to Indonesia Basic Health Research (RISKESDAS), the total prevalence of caries in North Sumatra, particularly the city of Medan, was 53.6% in children aged 5-9 years and 41.6% in children aged 10-14 years in 2018.[1] This will significantly influence the child's physical and cognitive development as well as their overall well-being. School-aged children are at a greater risk of developing caries, due to their preference for sweet foods. Sweet foods have a high carbohydrate content, are sticky, dissolve easily in the mouth, and are fermented by microorganisms. As a result, acid is produced by these microorganisms, decreasing the salivary pH and initiating tooth demineralization.[2,3]

Saliva in the oral cavity has multiple functions, including aiding in the mastication process, facilitating the remineralization process, and providing protection against demineralization. Saliva is a fluid that is produced by both the major and minor salivary glands in the mouth. Saliva is composed of 99.5% water and 0.5% other substances, which can be either organic or inorganic.[4] Crucial saliva characteristics that contribute to the prevention of dental caries are its pH, flow rate, viscosity, and buffer capacity. The quality and quantity of saliva production play a crucial role in maintaining the equilibrium between demineralization and remineralization processes in cariogenic environment.

One method of preventing caries is by controlling the type of diet consumed. Consuming nutritious food such as rebon shrimp can influence saliva characteristics. The rebon shrimp, also known as kecepe shrimp, is a commonly encountered marine product in Indonesia. Rebon shrimps are affordable, readily available, and provide a protein source that remains relatively unfamiliar. Rebon shrimps are often transformed

Corresponding author:
Dr. Gema Nazri Yanti, drg., M.Kes
Lecturer, Department of Public Health Dentistry / Preventive, Faculty of Dentistry, Universitas Sumatera Utara, Medan, Indonesia.
E-mail: gema.nazri@usu.ac.id

into dehydrated rebon shrimp, with one processing facility located in Bagan Serdang village, Medan. Each 100 grams of dehydrated rebon shrimp contains 59.4 grams of protein and a minimal fat content of 3.6 grams. One additional benefit of dried rebon shrimp is its high content of calcium and phosphorus. The dried rebon shrimp contains 2306 mg of calcium per 100 grams, which is 16 times the calcium level found in 100 grams of cow's milk. Additionally, it has a high phosphorus value of 265 mg.

Rebon shrimp can be transformed into functional food, like crackers, that are appealing to children. Chewing rebon shrimp crackers stimulates the transfer of calcium ions from the crackers to saliva, leading to an increase in calcium ions, salivary pH, and preventing demineralization thus can be used as a dental caries prevention.[6,7]

So far, no studies have investigated the effect of consuming rebon shrimp crackers on saliva characteristics. Nevertheless, numerous research has investigated the effect of rebon shrimp crackers on the increase of calcium ion levels in saliva.

Materials and methods

The study conducted was an experimental study with a pre and post-test control group design. This study's population consisted of 330 children in the Percobaan Public Elementary School. The samples in this study consisted of students enrolled in the Percobaan Public Elementary School. The selection of samples is carried out using a purposive sampling approach, which is based on certain inclusion and exclusion criteria. This study consisted of a total of 48 samples, with 24 samples assigned to the treatment group receiving rebon shrimp crackers and 24 samples in the control group. The inclusion criteria in this study were children between the ages of 8 and 12 who had a decay score of less than 5, and who had parental agreement and were willing to be assessed. Uncooperative children were excluded from the study.

Saliva samples were collected from students at Public Elementary School both before and after consuming rebon shrimp crackers at the Percobaan over 2 days to assess the salivary flow rate, pH and viscosity. Saliva collection is done using the drooling method to collect unstimulated saliva. The pH of the saliva is measured using a pH strip (MQuant, Merck, Germany), and the viscosity of the saliva is measured using an Ostwald viscometer at the Physical Chemistry Laboratory, Faculty of Mathematics and Natural Sciences, USU Medan.

The normality test is conducted using the Shapiro-Wilk test, which indicates that the data follows a normal distribution (p=0.07). Subsequently, the effect of rebon shrimp crackers on salivary flow rate, pH, and viscosity was examined by using the paired T-test. Additionally, an unpaired T-test was used to analyze the differences in consumption of rebon shrimp crackers on the salivary flow rate, pH, and viscosity. A Pearson correlation test was used to analyze the association between salivary flow rate, pH, and viscosity following treatment. This research has passed ethical clearance with reference number 1045/KEPK/USU/2023 from Ethic Committee of Universitas Sumatera Utara, Medan, Indonesia.

Results

The characteristics of the respondents revealed that there were an equal number of male and female students (50%). The predominant age group among the respondents was 9 years old, accounting for 58.33% of the total in comparison with the percentages of ages 8, 10, 11, and 12.

The results showed that there were no statistically significant differences in salivary flow rate (p=0.90), pH (p=1.00), and viscosity (p=0.11) between the control and treatment groups before treatment (Table 1).

Groups	n	Mean Salivary pH ($\bar{x}$ ± SD)	p	Mean Salivary Flow Rate (ml/min) ($\bar{x}$ ± SD)	p	Mean Salivary Viscosity (cP) ($\bar{x}$ ± SD)	p
Control	24	7.50 ± 0.51	1.00	0.76 ± 0.47	0.90	3.91 ± 2.52	0.11
Treatment	24	7.50 ± 0.51		0.80 ± 0.37		2.98 ± 1.24	

Table 1. Differences in Saliva Characteristics Before Treatment.

The results showed that there was a significant effect on salivary flow rate before and after treatment in the treatment group (p=0.06),

while no significant effect was observed in the control group (p=0.00). The results showed a significant effect on salivary pH before and after treatment in the treatment group (p=0.03). However, no significant effect was observed in the control group (p=0.09). The results showed that there was a significant effect on salivary viscosity before and after treatment in the treatment group (p=0.00), whereas no significant effect was observed in the control group (p=0.06) (Table 2).

Variables	Groups	n	Before ($\bar{x}$ ± SD)	After ($\bar{x}$ ± SD)	Mean Difference	*p-value*
Flow Rate	Control	24	0.76 ± 0.47	0.97 ± 0.37	0.21	0.06
	Treatment	24	0.80 ± 0.37	2.06 ± 0.76	1.26	0.00
pH	Control	24	7.50 ± 0.51	7.21 ± 0.66	0.29	0.09
	Treatment	24	7.50 ± 0.51	7.75 ± 0.44	0.25	0.03
Viscosity	Control	24	3.91 ± 2.52	2.77 ± 2.51	1.14	0.06
	Treatment	24	2.98 ± 1.24	1.69 ± 1.25	1.29	0.00

Table 2. Effect of Consuming Rebon Shrimp Crackers on Saliva Characteristics

The results showed that there were significant differences in salivary pH (p=0.00), flow rate (p=0.00), and viscosity (p=0.04) between the control group and the treatment group following treatment (Table 3).

Groups	n	Mean Salivary pH ($\bar{x}$ ± SD)	*p*	Mean Salivary Flow Rate (ml/min) ($\bar{x}$ ± SD)	*p*	Mean Salivary Viscosity (cP) ($\bar{x}$ ± SD)	*p*
Control	24	7.21 ± 0.66	0.00	0.97 ± 0.37	0.00	2.77 ± 2.51	0.04
Treatment	24	7.75 ± 0.44		2.06 ± 0.76		1.69 ± 1.25	

Table 3. Differences in Rebon Shrimp Crackers Consumption on Saliva Characteristics After Treatment.

The results showed that there was a significant relationship between salivary flow rate and pH (p=0.00) with a positive relationship direction (r=0.45). A significant relationship was also found between salivary flow rate and salivary viscosity (p=0.03) with a negative relationship direction (r=-0.32). A significant relationship was found between salivary pH and viscosity (p=0.03) with a negative relationship direction (r=-0.32) (Table 4).

Correlation		Salivary Flow Rate	Salivary pH	Salivary Viscosity
Salivary Flow Rate	*Pearson*	1	0.45	-0.32
	Sig. (2-tailed)		**0.00**	**0.03**
Salivary pH	*Pearson*	0.45	1	-0.32
	Sig. (2-tailed)	**0.00**		**0.03**
Salivary Viscosity	*Pearson*	-0.32	-0.32	1
	Sig. (2-tailed)	**0.03**	**0.03**	

Table 4. Correlation Between Salivary Flow Rate, pH, and Viscosity After Consuming Rebon Shrimp Crackers.

Discussion

Before treatment, the measurement of saliva characteristics, including pH, flow rate, and salivary viscosity, did not reveal any significant differences between the treatment group and the control group. This indicates that the salivary characteristics of the students from Percobaan Public Elementary School were nearly identical before receiving treatment. This is because the study included students who had decay of less than five teeth for both the treatment and control groups. Subsequently, the salivary characteristics were reassessed following a two-day consumption of rebon shrimp crackers by the treatment group, in comparison to the control group who did not consume rebon shrimp crackers. Significant differences in saliva characteristics, including salivary pH, flow rate, and viscosity, were observed between the treatment group and the control group. The treatment group showed an increase in salivary pH and flow rate, as well as a significant decrease in salivary viscosity before and after treatment. In contrast, the control group did not observe any significant changes in salivary flow rate, pH, and viscosity before and after treatment. In addition, the research findings indicate a significant correlation between salivary flow rate, pH, and viscosity following treatment. Consuming rebon shrimp crackers has been found to impact saliva characteristics by increasing salivary flow rate, pH, and decreasing salivary viscosity. Rebon shrimp crackers, which are made without preservatives, flavorings, and colors, are expected to serve as a cost-effective and easily

accessible alternative for reducing dental caries due to their excellent nutritional value.

The findings of this study are consistent with prior research, in which researchers investigated the effects of consuming Brie cheese on increasing salivary pH and discovered that there was a significant increase in pH after consuming Brie cheese. In addition, other researchers have investigated the impact of dairy products on the increase of pH, flow rate, and calcium ions in saliva. Their findings indicate a significant increase in both pH and salivary flow rate following the consumption of dairy products, specifically cheese. This happens due to the presence of mineral-rich food or snacks, particularly those high in calcium. These substances facilitate the transfer of calcium ions from the food to the saliva, resulting in an elevated pH level in the saliva. This increase in pH helps to avoid demineralization, which is a leading cause of dental caries.[8,9]

Hydroxyapatite makes up the mineral components of tooth enamel, dentin, and cementum. Hydroxyapatite maintains a balance of Ca^{2+} and PO_4^{3-} ions in a neutral oral cavity environment. Hydroxyapatite exhibits reactivity towards hydrogen ions when the pH is equal to or lower than 5.5. Hence, a salivary pH of 5.5 is recognized as the critical pH for hydroxyapatite. Hydrogen ions will undergo a chemical reaction with phosphate ions on the surface of the enamel. This process involves the conversion of PO_4^3 into HPO_4^{2-}. The presence of HPO_4^{2-} does not support the equilibrium of hydroxyapatite, thereby leading to the dissolution of hydroxyapatite crystals. The term used to describe this process is demineralization.[10]

The demineralization process can occur otherwise. If the pH returns to neutral and there are sufficient Ca^{2+} and PO_4^{3-}, dissolved hydroxyapatite products are restored to the teeth. The term used to describe this process is remineralization. Maintaining a balance between the demineralization and remineralization processes can prevent the occurrence of caries. Caries arise solely when the demineralization outweighs the remineralization process. Diet is one factor contributing to the process of demineralization. The food or beverage we consume can impact the quality of our saliva, perhaps leading to dental caries. The rate at which tooth enamel dissolves is affected by factors such as pH, duration of exposure to acidic substances, and the presence of calcium ions (Ca^{2+}) and phosphate ions (PO_4^{3-}).[10]

Consuming rebon shrimp crackers helps maintain a neutral saliva pH as a result of the high amounts of phosphate, calcium, and protein present in rebon shrimp. High levels of phosphorus, calcium, and protein increase the saliva buffer capacity. Buffer capacity refers to a mixture of a weak acid and its conjugate base that has the ability to resist variations in pH, hence maintaining the pH level above the critical pH of 5.5 to prevent demineralization. Salivary buffering capacity is an important factor in regulating salivary pH and promoting tooth remineralization. Maintaining the pH of saliva is crucial in keeping the equilibrium between tooth remineralization and demineralization. Saliva has three main buffers system namely bicarbonate (HCO_3^-), phosphate (PO_4^{3-}), and proteins. Phosphate aids in buffering saliva at very low flow rate. The buffer system works by bonding the secondary phosphate ion with hydrogen ions forming H_2PO_4 thus neutralizing salivary pH.[7,13]

Chewing rebon shrimp crackers raises the salivary flow rate, hence increasing the concentration of saliva components, including bicarbonate. Bicarbonate is a buffering agent that is mostly found in saliva due to its ability to readily bind with hydrogen ions, hence decreasing the concentration of free hydrogen ions in saliva. Bicarbonate ions penetrate dental plaque and neutralize acidic byproducts produced during fermentation by bacteria. Increased salivary flow rate promotes self-cleansing, preventing the accumulation of food debris in the oral cavity. Reduced food debris reduces the acid produced by bacteria. By minimizing acidic pH in the oral cavity, the demineralization process on the tooth surface can be avoided, hence preventing dental decay.[14]

The secretion of saliva is affected by both mechanical and chemical stimulation. Mechanical stimulation is initiated by the process of chewing, which is controlled by the parasympathetic nervous system and triggered by the masticatory reflex. This stimulates the secretion of high volumes of saliva. Mechanoreceptors in the oral mucosa detect the presence of food in the oral cavity and transmit this information to the central nervous system. The activation of the masticatory reflex is influenced by the amount of pressure applied during chewing. Consuming

rebon shrimp crackers triggers a chewing process that promotes the transfer of calcium ions from the crackers to saliva, hence preventing demineralization. Chemical stimulation occurs through the perception of tastes such as sour, sweet, salty, and bitter. The central nervous system is activated by this stimulation, which occurs after receiving a stimulus from the Special Visceral Afferent (SVA) on the tongue. The SVA is responsible for sensing taste perception and is supplied by the facial nerve (N.VII), glossopharyngeal nerve (N.IX), and vagus nerve (N.X). The glossopharyngeal nerve controls the parotid salivary glands, whereas the facial nerve controls the submandibular and sublingual glands, both of which play a role in regulating saliva output by the parasympathetic demineralization nervous system. Rebon shrimp crackers that possess a savory and salty flavor, along with a crisp texture that is well favored by the general population can stimulate salivation and cause an increase in saliva production.[16]

An increase in salivary flow rate can lead to a reduction in salivary viscosity due to an increase in saliva secretion, resulting in a larger volume and a lower viscosity of saliva. The reduced viscosity of saliva following the consumption of rebon shrimp crackers suggests that the saliva becomes more diluted, leading to a better self-cleansing effect within the oral cavity, resulting in improved oral hygiene.[17]

The findings showed that there was a significant positive correlation between the salivary flow rate and pH. Furthermore, a significant negative correlation was seen between salivary flow rate and viscosity. A similar result was also observed in the correlation between salivary pH and viscosity, showing a significant negative correlation. The increase in salivary flow rate while chewing rebon shrimp crackers leads to an increase in saliva components, including bicarbonate, which helps regulate salivary pH. The primary role of bicarbonate in saliva is to act as a buffering agent by readily combining with free hydrogen ions. Consequently, the increasing quantity of bicarbonate will result in a rise in pH, ensuring that the saliva remains at a neutral pH level. An increased salivary flow rate is also associated with a decrease in salivary viscosity, meaning that as the salivary flow rate increases, the viscosity of saliva decreases. This occurrence is due to an increase in salivary flow rate leading to a rise in saliva secretion, resulting in a large volume and a reduction in salivary viscosity. A decrease in salivary pH leads to an increase in salivary viscosity. This occurs due to the fact that under acidic conditions, some proteins present in saliva will increase the viscosity of saliva.[18]

Saliva is a bodily fluid that serves a critical function in preserving the structural integrity of the oral cavity and the rest of the body. The salivary flow rate, pH, and viscosity are crucial factors in preserving the structural integrity of both soft and hard tissues within the oral cavity. Consuming rebon shrimp crackers, which have a salty flavor, can enhance the production of saliva. The increased production of saliva leads to reduced viscosity. The effects of reduced viscosity include better self-cleansing, which can help prevent the occurrence of dental caries. Moreover, increased salivary flow rate would increase the concentration of many components in saliva, including calcium, bicarbonate, phosphate, and protein, which collectively contribute to maintaining a neutral pH level in saliva.[17]

Conclusions

The research findings indicate that rebon shrimp crackers have a significant effect on saliva characteristics. They increase the salivary flow rate and pH and reduce salivary viscosity. Therefore, these crackers should be considered as a potential preventive measure against dental caries.

Declaration of Interest

The authors report no conflict of interest.

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