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EFFECT OF CARIOGENIC FOOD INTAKE ON SALIVARY pH IN CHILDREN
(PENGARUH KONSUMSI MAKANAN KARIOGENIK TERHADAP pH SALIVA PADA USIA ANAK)

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ABSTRACT

All ages, especially children, favor cariogenic foods. Cariogenic foods are foods that contain fermented carbohydrates, mainly sucrose. Microorganisms are attached to the tooth surface can ferment various types of carbohydrates, becoming acidic and causing a decrease in salivary pH until it reaches a critical point in salivary pH followed by dental caries in the future. Saliva is one of the factors that cause dental caries. This study aimed to determine the effect of cariogenic food intake on changes in children's pH salivary. This research was conducted with a literature study as a reference and analyzed the findings obtained. The sample used was nine pieces of literature consisting of 19 cariogenic foods. This study showed a statistically significant result ($p<0.05$) in a change of salivary pH value before cariogenic food and after cariogenic food intake. Around 42.53% of children experienced a decrease in salivary pH more significant than the average after cariogenic foods intake, and 57.47% of children experienced a reduction in pH salivary. There are 49.74% of children have pH salivary lower than its average

value, which could be lead to demineralization of enamel.
Keywords: cariogenic food; dental caries; pH

ABSTRAK

Semua usia, terutama anak-anak, menyukai makanan kariogenik. Makanan kariogenik adalah makanan yang mengandung karbohidrat hasil fermentasi, terutama sukrosa. Mikroorganisme yang menempel pada permukaan gigi dapat memfermentasikan berbagai jenis karbohidrat, menjadi asam dan menyebabkan penurunan pH saliva hingga mencapai titik kritis pH saliva yang diikuti dengan karies gigi di kemudian hari. Air liur merupakan salah satu faktor penyebab terjadinya karies gigi. Penelitian ini bertujuan untuk mengetahui pengaruh asupan makanan kariogenik terhadap perubahan pH saliva anak. Penelitian ini dilakukan dengan studi kepustakaan sebagai acuan dan menganalisis temuan yang diperoleh. Sampel yang digunakan adalah sembilan buah literatur yang terdiri dari 19 makanan kariogenik. Penelitian ini menunjukkan hasil yang signifikan secara statistik ($p<0,05$) pada perubahan nilai pH saliva sebelum makanan kariogenik dan setelah asupan makanan kariogenik. Sekitar 42,53% anak-anak mengalami penurunan pH saliva yang lebih signifikan dari rata-rata setelah asupan makanan kariogenik, dan 57,47% anak-anak mengalami penurunan pH saliva. Terdapat 49,74% anak yang memiliki pH saliva lebih rendah dari nilai rata-rata, yang dapat menyebabkan demineralisasi email.

Kata kunci: *karies gigi; makanan kariogenik; pH*

INTRODUCTION

Humans as need food intake to fulfill their needs. Various types of food are available in the community, but all ages, especially children, prefer sweet foods. Sweet foods contain sucrose, so it is cariogenic to the teeth. Many cariogenic foods are found sweet, soft, crushed, and attached quickly to the teeth, such as candy, ice cream, biscuits, chocolate, confectionery, and others. This kind of food has a sweet and delicious taste, and the price is relatively low, easy to get, and is sold in various shapes and colors that are varied

and attractive for the children. Sweet foods are easily attached to the tooth surface if they are not cleaned properly and will be metabolized by bacteria to form acids that damage the tooth structure if left for a long time.[1–6]

The foods can affect teeth and mouth health, especially the condition of saliva in the oral cavity. After consuming carbohydrates, the salivary pH decrease in 1-3 minutes until the value is less than five because bacteria and form acids ferment carbohydrates. Meanwhile, cariogenic food will be neutralized by saliva after 60 minutes. If the child often eats cariogenic foods, the oral cavity remains in an acidic atmosphere. It causes a demineralization process because the saliva pH is below the normal salivary (pH value between 6.2-7.6). Microorganisms attached to the tooth surface can metabolize carbohydrates into acids and cause a decrease in salivary pH until it reaches a critical salivary pH. The atmosphere of the oral cavity (pH) in an acidic state will support the growth of acidogenic bacteria in the oral cavity, such as *Streptococcus mutants* and *Lactobacillus*.[6–10]

Based on the modified Keyes Jordan diagram, saliva is one of the primary factors that can influence the occurrence of caries. Caries is the demineralization or dissolution of the organic matrix in the teeth by bacteria that produce acid. The caries process begins with the fermentation of carbohydrates by microorganisms into acid, which causes a decrease in salivary pH to reach a critical pH of less than 5.5 on the enamel surface. The hydroxyapatite ion in the enamel dissolves, and a demineralization process occurs. Caries is the most significant dental and oral health problem in Indonesia. Based on the Basic Health Research (Riskesdas) results in 2018, it was found that the prevalence of caries in Indonesia reached 45.3%. While the majority of caries in children based on the age group 3-4 years is 81.1%, aged 4-9 years is 92.6%, and aged 10-14 years is 73.4%. Along with the high level of cariogenic food consumption in children and the high level of caries in children in Indonesia, where salivary pH is one of the factors for caries occurrence. This study was conducted to know the effect of cariogenic food consumption on changes in salivary pH in children.[11–13]

METHOD

The research was conducted from September 2020 to December 2020 using the required software, journals, and databases, summarize with these sequences.

Research design: The research was descriptive to know the effect of consuming cariogenic foods on the pH value of saliva in children. The research was done by

conducting a literature study on several libraries used as a reference and analyzing the findings obtained.

Research object: Using nine pieces of literature related to the effect of cariogenic food consumption on salivary pH in children with 19 types of cariogenic food.

Method of sampling: A library search was conducted using the google search engine on the internet with the keywords: cariogenic foods, sweet foods, sucrose, saliva, and salivary pH. The database was taken from reputable articles from Google Scholar, PubMed, Researchgate, science direct, WHO, and the Indonesian Ministry of Health.

Research procedure: This research procedure consisted of preparation, implementation, and report generation stages. In the preparatory phase, the researchers search for various kinds of literature according to the theme using Google search engine on the internet with the keywords: cariogenic foods, sweet foods, sucrose, saliva, and salivary pH. The research was carried out by analyzing the literature according to the specified theme. The results are written in a report, and the synthesis was made in the form of a synthesis matrix. It was based on the elements of the same topic and draws conclusions based on the findings in the literature.

Data analysis: The data obtained from the research and synthesis of literature according to the theme were descriptive and statistically checked.

RESULT

The literature study was conducted by analyzing nine pieces of literature. Research undertaken by Asridiana in 2019 used the cariogenic type of chocolate with a sample of 40 children aged 7-12 years. Salivary pH measurement showed that the average salivary pH value before consuming chocolate was 6.04. The average weight of salivary pH after consuming chocolate was 5.73. The difference in the average change in salivary pH before and after consuming chocolate was 0.31.[14]

Jannah et al., in 2016, used a cariogenic food type of 75gr biscuit, which was chewed for 1 minute with a sample of 40 children aged 7-12 years. Salivary pH measurement showed that the average salivary pH value before consuming biscuits was 7.20. The average weight of salivary pH after consuming biscuits was 7.02. The difference in the average change in salivary pH before and after consuming biscuits was 0.18.[15]

Marlindayanti in 2019 used cariogenic food types, purple sweet potato biscuits, and wheat biscuits with a sample

of 2 children aged 10-12 years. The measurement of salivary pH on the consumption of purple sweet potato biscuits showed that the average salivary pH value before consuming purple sweet potato biscuits was 9.30. The average weight of salivary pH after consuming purple sweet potato biscuits was 8.58. The average difference between changes in salivary pH before and after consuming purple sweet potato biscuits was 0.72. The results of the measurement of salivary pH on the consumption of wheat biscuits showed that the average salivary pH value before consuming wheat biscuits was 8.23. The average weight of salivary pH after consuming wheat biscuits was 6.45. The difference in the average change in salivary pH before and after consuming wheat biscuits was 1.78.[16]

Rahmawati et al. (2015) used soft drinks with a sample of 63 children aged 8-9 years. Salivary pH measurement results obtained the average salivary pH value before consuming soft drinks was 5.75. The average value of salivary pH after consuming soft drinks was 4.54. The average difference between changes in salivary pH before and after consuming soft drinks was 1.21.[17]

Soeryani et al. (2020) used cariogenic food types of chocolate and candy with a sample of 30 children aged 12-13 years. The measurement of salivary pH on chocolate consumption showed that the average salivary pH value before consuming chocolate was 7.38. The average value of salivary pH after consuming chocolate was 6.71. The average difference between changes in salivary pH before and after consuming chocolate was 0.67. The measurement of salivary pH on candy consumption showed that the average salivary pH value before consuming candy was 7.38. The average value of salivary pH after consuming sweets is 6.85. The difference in the average change in salivary pH before and after consuming sweets was 0.53.[18]

Sousa et al., in 2020, used a cariogenic food type of 20% sucrose with a sample of 28 children aged 3-5 years. Salivary pH measurement results showed that the average salivary pH value before rinsing with a 20% sucrose solution was 7.67. The average value of salivary pH after gargling with a 20% sucrose solution was 7.54. The difference in the average change in salivary pH before and after rinsing with a 20% sucrose solution was 0.22.[19]

de Sousa et al. in (2020) used cariogenic food types of 20% sucrose, 2% starch, and 20% sucrose plus 2% starter with a sample of 27 children aged 4-5 years. The measurement of salivary pH on gargling with a 20% sucrose solution

obtained the average pH value of saliva before rinsing with a 20% sucrose solution was 7.68. The average value of salivary pH after gargling with 20% sucrose solution was 7.36. The average difference between changes in salivary pH before and after rinsing with a 20% sucrose solution was 0.32. The measurement of salivary pH against gargling with a 2% Starch solution obtained the average value of salivary pH before rinsing with a 2% Starch solution was 7.66. The average value of salivary pH after gargling with 2% Starch solution was 7.53. The average change in salivary pH before and after gargling with a 2% Starch solution was 0.13. The results of the measurement of salivary pH on gargling with a resolution of 20% sucrose plus 2% starter obtained the average value of salivary pH before rinsing with a solution of 20% sucrose plus 2% starter was 7.69. The average value of salivary pH after gargling with a resolution of 20% sucrose plus 2% starter was 7.22. The difference in the average change in salivary pH before and after gargling with a solution of 20% sucrose plus 2% starter was 0.47.[20]

Kumar et al. (2019) used cariogenic foods such as oats biscuits, saltine crackers, sugar biscuits, cream biscuits, and chocolate biscuits with a sample of 50 children aged 10-15 years. The results of salivary pH on the consumption of oats biscuits showed that the average salivary pH value before consuming oats biscuits was 7.48. The average value of salivary pH after consuming oats biscuits was 7.07. The average difference between changes in salivary pH before and after consuming oats biscuits was 0.41. The results of salivary pH on the consumption of salted biscuits showed that the average salivary pH value before consuming salted biscuits was 7.59. The average value of salivary pH after consuming saltine crackers was 7.08. The average change in salivary pH before and after consuming saltine biscuits was 0.51. The results of salivary pH on the consumption of sugar biscuits showed that the average salivary pH value before consuming sugar biscuits was 7.22. The average value of salivary pH after consuming sugar biscuits was 6.32. The average difference between changes in salivary pH before and after consuming sugar biscuits was 0.90. The results of salivary pH on the consumption of cream biscuits showed that the average salivary pH value before consuming cream biscuits was 7.42. The average value of salivary pH after consuming cream biscuits was 6.63. The average difference between changes in salivary pH before and after consuming cream biscuits was 0.79. The results of salivary pH on chocolate biscuit consumption showed that the average

salivary pH value before consuming chocolate biscuits was 7.54. The average value of salivary pH after consuming chocolate biscuits was 6.66. The difference in the average change in salivary pH before and after consuming chocolate biscuits was 0.88.[21]

Janani (2018) used milk chocolate, white chocolate, and dark chocolate cariogenic foods with a sample of 90 children aged 8-12 years. The results of salivary pH on milk chocolate consumption showed that the average salivary pH value before consuming milk chocolate was 6.17. The average value of salivary pH after consuming milk chocolate was 5.28. The average difference between changes in salivary pH before and after consuming milk chocolate was 0.89. The results of salivary pH on the consumption of white chocolate showed that the average salivary pH value before consuming white chocolate was 6.51. The average value of salivary pH after consuming white chocolate was 5.76. The average difference between changes in salivary pH before and after consuming white chocolate was 0.75. The results of salivary pH on dark chocolate consumption showed that the average salivary pH value before consuming dark chocolate was 6.52. The average value of salivary pH after consuming dark chocolate was 6.06. The average difference between changes in salivary pH before and after consuming dark chocolate was 0.46.[21]

Based on the findings in the literature above regarding the consumption of cariogenic foods on changes in salivary pH, the following results were obtained:

Table 1. Changes in salivary pH

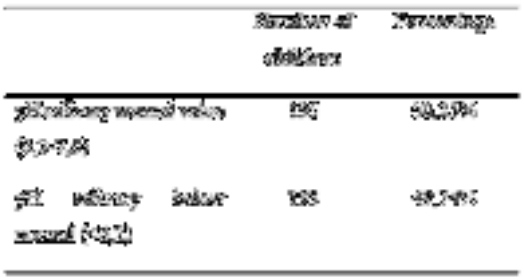
No.	Substance	Age (years)	Number of Samples (children)	pH value before	pH value after
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
				[illegible]	[illegible]
				[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]		[illegible]	[illegible]

[illegible]

Table 2. Percentage of decrease in saliva pH

	Number of children	Percentage
The decrease in salivary pH with more than the average value (>0.46)	[illegible]	[illegible]
The decrease in salivary pH with less than the average value (<0.46)	[illegible]	[illegible]

Table 3. Percentage with normal pH value



DISCUSSION

Based on Table 1, the results of the literature study, the effect of cariogenic food consumption on salivary pH in children that have been carried out show that salivary pH decreased by 0.66 between before and after consuming cariogenic foods based on the calculation of the average change in salivary pH value. The average salivary pH value before consuming cariogenic food was 7.31 and after consuming cariogenic food was 6.65. In Table 1, the result was listed for the t-test and showed a significant effect statistically ($p<0.05$). The total number of children who were respondents in the relevant literature was 388. The percentage of children who experienced changes in salivary pH after consuming cariogenic foods will be explained in Table 2.

The highest salivary pH value before consuming cariogenic food was found by Marlindayanti (2019) with a quasi-experimental research method, a sample of 20 children aged 10-12 years with a value of 9.30, and the type of cariogenic food used was a wheat biscuit. The lowest salivary pH value before consuming cariogenic food was found in a study conducted by Ida Rahmawati et al. (2015) with experimental research methods pretest and posttest group, a sample of 63 children aged 8-9 years with a value of 5.75 and the type of cariogenic food used are soft drinks.[16,17]

The highest pH value of saliva after consuming cariogenic food was found in a study conducted by Marlindayanti (2019) with a quasi-experimental research method, a sample of 20 children aged 10-12 years with a value of 8.58 and the type of cariogenic food used was a wheat biscuit. The lowest salivary pH value after consuming cariogenic foods was found in a study conducted by Rahmawati et al. (2015) with experimental research methods pretest and posttest group, a sample of 63 children aged 8-9 years with a value of 4.54 and the type of cariogenic food used is soft drinks.[16,17]

The highest decrease in salivary pH was found in a study conducted by Marlindayanti (2019) with a quasi-experimental research method and a sample of 20 children aged 10-12 years with a salivary pH value of 8.23 before consuming cariogenic food and 6.45 after consuming cariogenic food. The decrease in salivary pH that occurred in this library was 1.78. The type of cariogenic food used in this

study was a wheat biscuit.[16]

The lowest decrease in salivary pH was found in a study conducted by de Sousa et al. (2020) with experimental research methods with pretest and posttest groups and a sample of 27 children aged 2-5 years with a salivary pH value before consuming cariogenic foods of 7.66 and after consuming cariogenic food by 7.53. The decrease in salivary pH that occurred in this library was 0.13. The type of cariogenic food used in this study was 2% starch.[20]

Based on Table 2, it was found that as many as 165 children, or 42,53% experienced a decrease in salivary pH more than the average after consuming cariogenic foods, and 223 children or 57,47% of children experienced a reduction of salivary pH below the average after consuming cariogenic foods.

Based on the literature study results above, a decrease in salivary pH can occur shortly after exposure to carbohydrates. The decline in salivary pH can be different for each individual, influenced by the individual's oral cavity health. Pachori et al. (2018) a decrease in salivary pH after consuming cariogenic foods can occur because cariogenic foods contain the most suitable carbohydrates for acid production by bacteria in plaque, such as sucrose, glucose, fructose, maltose, and others. Sugars have small molecules that easily diffuse into the plaque and are quickly broken down by bacteria into acids. Carbohydrates in liquid form have less effect than solid carbohydrates. It is because carbohydrates in the form of liquids are lost more quickly from the oral cavity, solid carbohydrates allow them to remain in the oral cavity and are more difficult to clean, especially if the food is quite sticky.[22–24]

Based on Table 3, shows 195 children or 50,25% experienced a decrease in salivary pH but it was still within the normal range of salivary pH after consuming cariogenic foods. Several 193 children or 49,74% experienced a decrease in salivary pH below the normal range of salivary pH after consuming cariogenic foods.

A decrease in salivary pH can cause demineralization when reaches a critical pH below 5.5. In acidic saliva pH conditions, *Streptococcus mutans* grow in the oral cavity and increase their metabolism. After consuming cariogenic food, *Streptococcus mutans* ferment carbohydrates into lactic acid assisted by the GTF enzyme. It synthesizes carbohydrates into glucose as an energy source and forms glucan as a colonization site. Salivary pH takes 60 minutes to be neutralized back to its initial value before consuming cariogenic food. If a person tends to have a high frequency of consumption of cariogenic foods, the salivary pH will continue to be acidic and

reach a critical pH so that demineralization occurs which if not balanced with remineralization can cause caries.[23–26]

The state of salivary pH is influenced by several factors, including the food or drink consumed, the buffering function of saliva, the speed of salivary flow, microorganisms found in the oral cavity, and oral health conditions. Food and drink consumption can cause changes in salivary pH directly. The more bicarbonate ions in the saliva, the better the saliva buffer function. The ability of saliva to buffer can neutralize acids produced by cariogenic microorganisms and function for antibacterial activity. The ability of saliva to buffer acid is very important to keep the pH value above the critical pH. Thereby protecting teeth from demineralization is very important. The type and number of microorganisms in the oral cavity can affect the pH of saliva. Individuals with poor OH microorganisms suffer more microorganisms that affect carbohydrate metabolism to produce acid. The speed of salivary flow affects the quantity of saliva secreted. The more the quantity of saliva, the more bicarbonate ions in the saliva. With age, the salivary secretion decreases because the parenchyma in the glands and replaced by connective tissue and fat tissue.

A person's social and economic status determines attitudes and habits in maintaining oral hygiene and health. In addition to the theoretical factors above, this study also obtained research factors from the literature used. The measurement time and sampling method can affect the results obtained.[23,27–30]

CONCLUSION

Based on the results, we found that there was a significant result statistically ($p<0.05$) changing value between pH salivary before and after consuming cariogenic food. It showed that salivary pH decreased by 0.66 on average, 57.47% of children experienced a decrease in salivary pH exceeding the average. Around 49,74% of children have pH saliva lower than it's normal which could lead to demineralization of enamel. From our viewpoint, each food will have a different effect on salivary pH, depending on the types and ingredients.

CONFLICT OF INTEREST

We hereby declare that there is no conflict of interest in the scientific articles that we wrote.

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