

The Effect of Gargling with Lemon Water (*Citrus limon L*) on Debris Index and Saliva pH in Students of SDN 12 Banda Aceh City, Indonesia

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ABSTRACT Control of debris or plaque is an effort to prevent plaque buildup. These efforts can be made mechanically or chemically. Getting rid of dental plaque and neutralizing the pH of saliva from the tooth surface is done by brushing your teeth and gargling. Herbal mouthwash that can be used is lemon juice, a bright yellow fruit known to have an acidic taste. This study aims to determine the effect of rinsing lemon water (*Citrus Limon L*) on the debris index and salivary pH in fifth-grade students of SDN 12 Banda Aceh City. This type of research is quasi-experimental. The subjects in this study were all Class V students of SDN 12 in Banda Aceh City, totaling 60 children, then divided into two groups, the intervention group consisted of 30 children given intervention (gargling with lemon juice), and the control group consisted of 30 children who were not given intervention (gargling with water). Analysis of data results (quantitative) in this study using; using the non-parametric (Wilcoxon) and Mann Whitney. The results of the study show. There was no difference in the mean value of acidity of saliva (salivary pH), and index debris means statistically significant values ($p > 0.05$) in the control group (rinsing with water before and after the intervention. There was a mean difference in the value of acidity of water saliva (salivary pH), and index debris means were statistically significant ($p < 0.05$) in the treatment group (rinsing with lemon juice) before and after the intervention. There was no significant difference between the treatment and control groups in pH Saliva and index debris before intervention (pre-test). It was shown p statistically > 0.05 . There was a significant difference in the Saliva pH and index debris after the treatment (post-test) between the treatment and control groups. $p < 0.05$, which means that gargling with lemon juice containing 10% citric acid can cause changes in the pH of the saliva and the debris index. San lemon can be used as an alternative mouthwash to overcome dental and oral health problems.

KEYWORDS: Lemon Water Gargle, Debris Index, Saliva pH

INTRODUCTION

Caries are a disease caused by the interaction between bacteria, plaque, diet, and teeth. There is no doubt that there will be no caries without plaque, so knowing the cause is essential to understanding how to prevent it. Prevention of caries accompanied by improvement of dental health has become the main goal in dental nursing since it is known that dental plaque is a factor that dominates the cause of tooth loss due to caries and periodontal disease.¹

The accumulation of dental plaque can be influenced by debris on the tooth surface. Debris is

food residue left on the surface of the teeth between the teeth and the gums. Plaque is a soft deposit that forms a biofilm layer and adheres tightly to the surface of the teeth and gums.² Plaque provides nutrients for bacteria to grow, collects bacteria on its sticky feeling, and provides an acidic atmosphere that will contact the tooth surface. The enamel dissolves and causes tooth decay. Caries. The condition of the oral cavity with a high debris index allows the formation of high plaque. It is because debris, which is food residue that is not cleaned, can adhere to the plaque on the tooth surface, increasing

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the risk of caries.³

One effort to control plaque can be done mechanically or chemically. Prevention of chemical plaque is by using mouthwash. Several chemical substances in mouthwash have antiseptic or antibacterial properties that inhibit plaque formation and prevent gingivitis.⁴ Antibacterial compounds are needed to help eliminate inflammation by inhibiting bacterial growth and reducing the concentration of bacteria in dental plaque.⁵

Apart from the accumulation of dental debris and plaque, the acidity of the oral cavity can also affect the occurrence of dental caries. Tooth enamel constantly undergoes dynamic cyclical changes between demineralization and remineralization. Tooth demineralization occurs when the concentration of acid in the oral environment has a pH below 5.5, which causes the dissolution of inorganic minerals in tooth enamel. Demineralization will stop if the pH returns to normal and there is a high concentration of calcium ions or phosphate ions in the saliva so that the remineralization process can occur. The demineralization process needs to be balanced with remineralization.⁶

If the caries problem is left unchecked and its tendency to increase in the future is not prevented, the consequences will be detrimental. The impact of caries on children is tremendous, including pain. This impaired chewing function inhibits the consumption of food or nutrition, anemia, and comfort disturbances in the form of lack of sleep decreases the child's quality of life and affects learning achievement.⁷ Dental problems are not included in the list of deadly diseases. This condition makes some people try to prevent and even treat dental and oral diseases.⁸

The National Basic Health Research (Riskesdas) results in 2013 show that 25.9% of the Indonesian population has dental and oral problems. It was recorded that 62.9% of the people in Aceh province experienced caries. In general, Acehnese brush their teeth every morning and evening with 90.7%. The proportion of people who brush their teeth every day after breakfast is only 12.6%, and before going to bed, only 20.7%.⁹ Based on a report from the Public Health Office of Banda Aceh City in 2014, dental and oral disease (caries) was ranked 14th out of the 20 most prominent conditions with 4779 visits. According to the dental and oral examination results for the 6-14 year age group in Banda Aceh City during the UKGS activity, 34% of children suffered from caries.¹⁰ The state of dental and oral health in the Banda Aceh City area shows that the status of dental and oral

health is still concerning.

Based on the high caries prevalence rate in Indonesia, it is necessary to prevent the formation of dental plaque and decrease the pH of saliva, which is one of the causes of caries. Getting rid of dental plaque and neutralizing the pH of saliva from the surface of the teeth is not only done by brushing your teeth but can also be done by gargling. Herbal mouthwash that can be used is lemon juice, a bright yellow fruit known to have a sour taste. In a study conducted by N. Murali, lemon fruit extract contains essential oils and eryocitrine (flavonoid). Flavonoids are known to be bactericidal. The citric acid contained in lemon juice has antibacterial properties. According to research by Dharmago J, et al., lemon juice can inhibit the viability of the growth of *Streptococcus sanguis* bacteria.¹¹ In addition, a study by Batubara, NA, also stated that lemon water has antibacterial properties because it has been shown to reduce *Staphylococcus aureus* colonies.¹²

The degree of acidity of saliva is measured in a unit called the pH scale can be carried out with saliva (saliva). The pH ranges from 0-14 with an inverse ratio where the lower the pH value, the higher the acid in the solution. On the other hand, increasing the pH value means a high base in the solution. At pH 7 there is no acidity or alkalinity of the solution and is called neutral. Pure water has a pH of 7. Saliva usually is slightly acidic, having a pH of 6.5. Meanwhile, pH 5.7 is considered a critical pH point for tooth decay.⁶

A common misconception is that if the food tastes sour on the tongue, then the food has an acid-forming effect on the body. It is not always true. Mostly, foods that taste sour are alkaline-forming in the body. An example is lemons. Indeed, lemons taste sour on the tongue. Still, lemons are alkaline-forming because the residues (minerals) left behind after digestion help remove hydrogen ions, resulting in an alkaline effect on the body. It takes the body's pH slightly above 7.0 (slightly alkaline) to get optimal health conditions. And when we can maintain the body's pH at optimal levels, metabolism, enzymes, the immune system, and repair will work effectively. Maintaining the pH at the number above means that our body has adequate minerals to balance the acidic conditions in the body.¹⁴

In the initial survey conducted on ten children of class V at SDN 12 Banda Aceh City, the researchers found that 85% of children had poor debris index criteria, ranging from 1.9-3.0. The average salivary pH was below normal, namely 5.8-5.9. This research will be conducted in class V because the average age of children is between 10-12 years. In general, children are more cooperative so

that data collection is more straightforward and accurate. The results are expected to be more optimal. To conduct dental and oral health research. In this age group, children are easy to teach and like to be around people who pay attention. In general, dental health behavior at this age is more cooperative than the younger age group, and this is also considered to be independent in maintaining dental and oral health.

Based on the above background, the authors are interested in knowing the effect of gargling lemon water on the debris index and salivary pH in fifth-grade students of SDN 12 Banda Aceh City. In

this study, lemon juice was used because lemons are known as a source of vitamin C. The citric acid contained in lemon juice has antibacterial power. Complex carbohydrates in non-starch polysaccharides (commonly known as dietary fiber) are good for health. In addition, lemon is also widely known, the price is relatively low and is consumed by the people of Indonesia, and its preparation is also relatively easy. This study aims to determine the effect of gargling lemon (*Citrus Limon L*) water on the debris index and salivary pH of fifth-grade students at SDN 12 Banda Aceh.

MATERIALS AND METHODS

The subjects in this study were all students of Class V SDN 12 Banda Aceh City totaling 60 children, then divided into two groups, the intervention group consisted of 30 children given the intervention (gargling with lemon juice), and the control group consisted of 30 children who were not given the intervention (gargle with water). The sampling technique in this study is the total population. The intervention variable in this study was gargling with lemon juice. The independent variables (influence) were the Debris index and salivary pH before the intervention, while the dependent variable (influenced) was Debris index and salivary pH after the intervention. The measuring instruments used are debris index and pH strip.

The lemon water used in this study was prepared by selecting lemons with the same diameter. Then make 10% lemon juice made by cutting lemons and squeezing the liquid and then filtering it to get 100 ml of lemon juice and then diluting it with water until the volume of the solution reaches 1000 ml. In the treatment group,

students rinsed their mouths with 10% lemon juice as much as 40 ml given orally and then left in the oral cavity for 30 seconds and then discarded. While in the control group, students were not given the intervention of gargling with lemon juice but only gargling with water.

Analysis of the results of quantitative data in this study used non-parametric statistical tests consisting of the Wilcoxon test and the Mann Whitney test. The Wilcoxon test was used to determine the difference in changes in the debris index before and after the intervention (gargling with lemon juice) and the difference in salivary pH before and after the intervention (gargling with lemon juice) from pre-test to post-test on each Group. The Mann-Whitney test was used to determine the difference in students' debris index and salivary pH changes between the intervention group and the control group pre-test and post-test. Data analysis used the Statistics Program for Social Science (SPSS), with hypothesis testing based on the significance level of $p < 0.05$.

RESULTS

The research results were conducted on fifth-grade SDN 12 Banda Aceh City, Indonesia, from July to August 2018. Table 1. shows that in the treatment group (gargling with lemon juice), the

Debris index before intervention with a mean value of 2.7 and after intervention with a mean value of 1.05.

Debris Index and Saliva pH in the Treatment Group (gargle with Lemon Juice)

The debris index decreased by 1.65 degrees of salivary acidity (pH Saliva) before the intervention with a mean value of 4.6 with a mean value of 6.8. At the salivary pH there was an increase of 2.2.

There was a statistically significant difference in the value of the acidity (pH) of saliva and debris index ($p < 0.05$). There was a statistically significant increase in salivary pH ($p < 0.05$).

Table 1. The mean difference and standard deviation of the Debris Index and salivary pH in the treatment group

Variable	Median (min-max)	Mean $\pm$ SD	p
Debris Indeks	3,0 (2,0-3,0)		
Pretest	0,6 (0,6-1,9)	2,7 $\pm$ 0,32	0,000*
Posttes		1,05 $\pm$ 0,51	
pH Saliva			
Pretest	5,7 (0,0-6,5)	4,6 $\pm$ 2,1	0,000*
Posttes	6,8 (6,8-7,2)	6,8 $\pm$ 0,08	

Wilcoxon *: $p < 0.05$ (significant)

Debris Index and Saliva pH in the Control Group (gargle with water).

Table 2. shows that in the control group (pH Saliva) before the intervention with a mean value of 5.73 with a mean value of 5.75. At the intervention with a mean value of 2.8 and after intervention with a mean value of 2.7. The debris index decreased by 0.1 degrees of salivary acidity the acidity (pH) of saliva and debris index ($p > 0.05$).

Table 2. The mean difference and standard deviation of the Debris Index and salivary pH in the control group

Variable	Median (min-max)	Mean $\pm$ SD	p
Debris Indeks			
Pretest	2,8(2,0-3,0)	3.0 $\pm$ 0,31	0,716
Posttes	2,7(2,0-3,0)	2,95 $\pm$ 0,32	
pH Saliva			
Pretest	5,8(5,2-6,5)	5,73 $\pm$ 0,35	0,109
Posttes	5,8(5,2-6,5)	5,75 $\pm$ 0,33	

* $p > 0.05$ (not significant)

Debris Index

Table 3 shows no significant difference in the Debris Index before the intervention (pre-test) between the treatment and control groups. It is shown statistically $p > 0.05$. There is a significant difference in Debris Index after treatment (post-test) between the treatment and control groups. It is statistically demonstrated $p < 0.05$.

Table 3. The mean and standard deviation of the Debris Index between the treatment group and the control group

Debris Index	Group	Mean $\pm$ SD	p	
Pre-test	treatment	2,7 $\pm$ 0,32	0,492	not Significant
	Control	2,8 $\pm$ 0,31		
Post-test	treatment	1,05 $\pm$ 0,51	<0,001*	Significant
	control	2,7 $\pm$ 0,32		

Mann Whitney*: $p < 0.05$ (significant)

Degree of Acidity of Saliva (pH Saliva)

Table 4 shows no significant difference in Saliva pH before the intervention (pre-test) between the treatment and control groups. It is shown statistically $p > 0.05$. There was a significant

difference in salivary pH after treatment (post-test) between the treatment and control groups. It is statistically demonstrated $p < 0.05$.

Table 4. The mean and standard deviation of Saliva pH between the treatment group and the control group

Salivary pH	Group	Mean $\pm$ SD	p	
Pre-test	Treatment	4,6 $\pm$ 5,7	0,08	Not Significant
	Control	5,73 $\pm$ 0,35		
Post-test	Treatment	6,8 $\pm$ 0,86	<0,001*	Significant
	Control	5,75 $\pm$ 0,33		

DISCUSSION

Degree of Acidity of Saliva (pH Saliva)

The analysis results between groups (Mann Whitney) showed no significant difference in salivary pH before the intervention (pre-test) between the treatment group and the control group. It is statistically demonstrated $p > 0.05$. There was a significant difference in salivary pH after treatment (post-test) between the treatment and control groups. It is shown $p < 0.05$ statistically. That is, gargling with lemon juice containing 10% citric acid can cause changes in salivary pH.

Based on the results of the analysis by conducting a paired sample t-test for students of SDN 12 Banda Aceh City. Showed that in the control group (gargling with water), the degree of acidity of saliva (saliva pH) before intervention with a mean value of 5.73 and after intervention with a mean value of 5.75. At the salivary pH, there was an increase of 0.02. There was no statistically significant difference in the mean value of the acidity (pH) of saliva ($p > 0.05$) (Table 2). In the treatment group (gargling with lemon juice), the degree of acidity of saliva (saliva pH) before intervention with a mean value of 4.6 and after intervention with a mean value of 6.8. At the salivary pH, there was an increase of 2.2. There was a statistically significant difference in the value of the degree of acidity (pH) of saliva ($p < 0.05$). There was a statistically significant increase in salivary pH ($p < 0.05$). The results of measuring the pH value of saliva in each subject show an increase in the average value of salivary pH after gargling with lemon juice at a concentration of 10% after gargling with lemon juice. It is probably because the pH value of the subject's saliva before rinsing with lemon juice was not much different from the pH of the subject's saliva after gargling with lemon juice with a concentration of

10%. The average salivary pH value increased significantly.

The increase in the acidity of saliva in research subjects can also be influenced by the presence of white water used in this study. According to WHO, water or drinking water has a degree of acidity close to neutral, 6.5-8.5. The pH of the water also affects the salivary pH of the research subjects to increase the salivary pH of the issues given the intervention. Research Merne ME, et al. stated that the alkaline state of drinking water could have a local effect on the oral cavity, including the pH of the saliva of rats.³¹ In addition, research by Razvan et al. also stated that there was an effect of the mineral composition of drinking water on the design of dentin so that drinking water is also a means that can be used to prevent dental caries.³²

The degree of acidity (pH) of saliva varies significantly from one individual to another. A diet containing carbohydrates will cause a decrease in salivary pH which can accelerate the demineralization of tooth enamel. Ten minutes after eating carbohydrates, the acid will be produced through glycolysis, and the pH can decrease to below the critical pH. Several factors can influence salivary pH. Some will increase immediately after waking up (resting state) but quickly decrease. In addition, it will also increase a quarter of an hour after eating (mechanical stimulation), but usually within 30-60 minutes down again. Then the salivary pH will also increase towards night but will decrease again.²¹

According to Prasko (2011), the pH of saliva changes from normal to acidic twenty minutes after sugar enters the plaque. A decrease in pH will cause an increase in the release of calcium from tooth enamel. The hardness of the enamel will be soft due

to the acidity of the drink (pH), which is less than seven or is acidic.²² Changes in salivary pH are influenced by the type of food consumed, stimulation of salivary secretion, salivary flow rate, time, oral microorganisms, and salivary buffering capacity. Salivary pH decreases due to acid production from bacteria after carbohydrate consumption.^{23,24}

Citrus limon, commonly known as lemon, belongs to the family Rutaceae. Lemon is rich in nutritional supplements that contain carbohydrates, fats, proteins, vitamins such as thiamine, riboflavin, niacin, pantothenic acid, folate, choline, and rich sources of vitamin C.²⁵ Lemons also contain elements such as calcium, magnesium, potassium, zinc and several phytochemical compounds such as tannins and flavonoids.^{26,27}

On the other hand, the salivary pH will increase when the acid is washed and neutralized using the ions that make up the mineral content of the tooth (calcium, phosphate, and hydroxyl ions). The degree of acidity of saliva also increases when the good plaque bacteria acid metabolism produces alkalis such as ammonia from nitrogen compounds found in food and saliva; calcium, phosphate ions begin to repair damaged mineral crystals from enamel.²⁴

The flavonoid content in citrus has broad biological activities, including antibacterial, antifungal, antidiabetic, anticancer, and antiviral activity. Flavonoids can function as direct antioxidants and scavenge free radicals and have the capacity to modulate enzyme activity and inhibit cell proliferation. In plants, flavonoids play a role in attacking pathogenic microorganisms, such as bacteria, fungi, and viruses.²⁸

Giuseppe et al. (2007) reported the presence of limonoids in citrus species, which were thought to fight clinically isolated bacteria. Limonoids obtained from lemons showed good antibacterial and antifungal activity.²⁹ Based on research conducted by Tomotaka et al., the substance that can be antibacterial in lemons is citric acid, the leading organic acid in lemon juice. In addition, according to Zu et al., the content of essential oils (monoterpenes and sesquiterpenes) such as limonene has an antibacterial activity where lemons also contain essential oils in the form of limonene. According to Nagata et al., citrus plants contain flavonoid components which, according to Cushnie, et al. have antibacterial activity.³⁰

Debris Index

The analysis results between groups showed no significant difference in the Debris Index before the intervention (pre-test) between the treatment group and the control group. It is shown statistically

$p > 0.05$. There is a significant difference in Debris Index after treatment (post-test) between the treatment and control groups. This is statistically demonstrated $p < 0.05$. After gargling with lemon juice containing 10% citric acid, it can cause changes in the debris index.

Based on the results of the analysis by conducting a Wilcoxon test for the students of SDN 12 Banda Aceh City. Showed that in the control group (gargling with water), the Debris index before intervention with a mean value of 2.8 and after intervention with a mean value of 2.7. The Debris Index decreased by 0.1. There was no statistically significant difference in the mean value of the debris index ($p > 0.05$) (Table 2). In the treatment group (gargling with lemon juice), the Debris index before intervention with a mean value of 2.7 and after intervention with a mean value of 1.05. The Debris Index decreased by 1.65. There was a statistically significant difference in the mean value of the debris index ($p < 0.05$). There was a statistically significant increase in the decrease in the debris index ($p < 0.05$). The reduction in the debris index score occurred because lemon contains essential oils that have antibacterial power in the presence of limonene compounds. Limonene will act as an antibacterial agent by expanding cell membranes, increasing membrane tension, and penetrating bacterial cell membranes to inhibit bacterial respiration enzymes, essential elements of the cell's energy system. Limonene will hinder the growth of *Porphyromonas gingivalis* bacteria so that the production of Methyl Mercaptan produced by these bacteria will decrease.² Research conducted by Dhanavade et al. explained that lemons contain essential oils and flavonoids with solid antimicrobial activity compared to limes.²⁸

These results indicate that lemons have a higher vitamin C content than limes and as a source of vitamins A, B1, B2, phosphorus, calcium, pectin, essential oil 70% limonene, felandren, coumarins bioflavonoids, geranyl acetate, citric acid, linalyl acetate, calcium, and fiber.³⁰ The antibacterial effect is due to lemon juice's citric acid and phenol derivatives. Flavonoids are compounds that are found in many types of medicinal plants. Plants synthesize flavonoids in response to microbial infection, so they are effective in vitro against microorganisms. These compounds are antimicrobial because they form complex compounds with extracellular proteins, change the physical and chemical properties of the cytoplasm, and denature bacterial cell walls employing hydrogen bonds. This activity will interfere with selective permeability, active transport function, and

control of protein composition, causing death in bacteria.²⁷

The flavonoids in citrus fruits have a broad spectrum of biological activities, including antibacterial, antifungal, antidiabetic, anticancer, and antiviral activities. Flavonoids can function as direct antioxidants and free radical scavengers. In plants, flavonoids play a role in resisting invading pathogens, including bacteria, fungi, and viruses.¹⁴

Lemons have long been known to have benefits and contain nutritious essential oils. The essential oil contained in lemons has seven times

higher content when compared to limes. This is in line with several studies examining the effectiveness of lemons against bacterial growth and oral thrush. Research conducted by Waidulla et al., Kadhim et al., Okeke et al. stated that lemons effectively inhibited the growth of *Staphylococcus aureus* bacteria.²⁹ Jumar et al.'s research also explained that lemon extract effectively inhibited the growth of *Streptococcus pyogenes* bacteria.³⁰

CONCLUSION

From the results of this study, it can be concluded that 10% lemon (*Citrus Limon* L) juice can increase the pH of saliva and reduce the debris index in fifth-grade students of SDN 12 Banda Aceh City. However, it is still necessary to do further research on giving lemon extract solutions with different concentrations.

In addition, from the results of this study, that lemon juice can be used as an alternative ingredient for mouthwash in overcoming dental and oral health problems, so further research needs to be carried out to produce products from lemon, for example, in the form of mouthwash that is feasible to be marketed.

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