CHILDREN'S TOOTHPASTE EFFECT CONTAINED *FLUORIDE* AND *XYLITOL* ON MICRO HARDNESS OF PRIMARY TEETH ENAMEL *IN VITRO* *(PENGARUH PASTA GIGI ANAK YANG MENGANDUNG FLUORIDE DAN XYLITOL TERHADAP KEKERASAN MIKRO ENAMEL GIGI ANAK SECARA IN VITRO)*

Henri Hartman[1]*, Badi Soerachman[2], Imanda Asysyifa Salma[1]

[1] Department of Pediatric Dentistry, Universitas Jenderal Achmad Yani
[2]Department of Conservative Dentistry, Universitas Jenderal Achmad Yani

*Corresponding author
henri.hartman@lecture.unjani.ac.id

JHDS.unjani.ac.id/jite
Doi: 10.54052/jhds.

Article History
Received:22/05/2022
Accepted: 29/05/2022

ABSTRACT

Children's toothpaste has a variegated of ingredients. Each ingredient has different benefits, one of which is to increase the hardness of tooth enamel. Several factors could affect the hardness of tooth enamel, such as fluoride and Xylitol. This study aimed to determine the effect of children's toothpaste containing fluoride and Xylitol on the micro-hardness of children's tooth enamel. The research method used a laboratory experiment measuring the micro hardness of primary tooth enamel before and after treatment using the Vickers Hardness Tester. The samples were treated on primary incisors and divided into two groups, first as the experiment group and another one as the control group. The treatment was carried out using two types of children's

toothpaste containing fluoride and Xylitol. After the final measurement, the data were analyzed using the Independent T-test ($p < 0.05$), which was previously tested for normality and homogeneity with Shapiro Wilk ($p < 0.05$) and Levene's test ($p < 0.05$). The results showed that the sample group that was treated with toothpaste containing fluoride and Xylitol experienced an increase in the microhardness of the enamel differences. The results of data analysis with the Independent T-Test showed $p = 0,02$ ($p<0,05$) in the fluoride group, indicating that there was a significant increase, and the results in the xylitol group $p = 0,003$ ($p<0,05$). These results suggest that toothpaste containing fluoride and Xylitol can affect the microhardness of children's tooth enamel. The research concluded that children's toothpaste containing fluoride and Xylitol could be a tool to prevent dental caries because it can increase the micro hardness of tooth enamel.

Keywords: fluoride; toothpaste; Vicker hardness; Xylitol

ABSTRAK

Pasta gigi anak memiliki kandungan yang bermacam-macam dan setiap kandungan memiliki manfaat yang berbeda, salah satunya adalah meningkatkan kekerasan enamel gigi. Faktor utama yang mempengaruhi kekerasan enamel gigi salah satunya adalah fluoride dan xylitol. Tujuan penelitian ini adalah untuk mengetahui pengaruh pasta gigi anak yang mengandung fluoride dan xylitol terhadap kekerasan mikro enamel gigi anak. Metode penelitian ini merupakan eksperimental laboratorik dengan melakukan pengukuran kekerasan mikro enamel gigi sulung sebelum dan sesudah pemberian perlakuan menggunakan alat Vickers Hardness Tester. Perlakuan pada sampel dilakukan pada gigi insisif sulung yang dibagi dalam 2 kelompok perlakuan dan satu kelompok kontrol, lalu perlakuan dilakukan menggunakan dua jenis pasta gigi anak yang mengandung fluoride dan pasta gigi yang mengandung xylitol. Setelah pengukuran akhir, data dianalisis menggunakan Independent T-test (p<0,05) yang sebelumnya

dilakukan uji normalitas dan uji homogenitas terlebih dahulu dengan Saphiro Wilk (p<0,05) dan Levene's test (p<0,05). Hasil penelitian menunjukkan bahwa kelompok sampel yang diberi perlakuan dengan pasta gigi mengandung flouride dan xylitol mengalami peningkatan kekerasan mikro enamel dengan selisih yang bervariatif. Hasil analisis data dengan Independent T-Test didapatkan p = 0,02 (p<0,05) pada kelompok fluoride menunjukkan bahwa terdapat peningkatan yang signifikan dan didapatkan hasil pada kelompok xylitol p = 0,003 (p<0,05) menunjukkan bahwa terdapat peningkatan yang signifikan. Hasil tersebut menunjukkan bahwa pasta gigi anak yang mengandung fluoride dan xylitol dapat memengaruhi kekerasan mikro enamel gigi anak. Disimpulkan bahwa pasta gigi anak yang mengandung fluoride dan xylitol dapat menjadi salah satu alat bantu untuk mencegah karies gigi karena dapat meningkatkan kekerasan mikro enamel gigi

Kata kunci: fluorida; *pasta gigi;* vicker hardness; *Xylitol*

INTRODUCTION

Awareness of dental and oral health is essential. With the increasing incidence of caries in preschool children with an average of above 90%, several primary preventions can be carried out in the form of procedures before the onset of symptoms of a disease to reduce or decrease the incidence of caries. Brushing teeth is part of primer prevention measures for dental and oral health, especially caries.[1,2] Toothbrushes can effectively be used to prevent caries if it is done correctly with appropriate toothpaste. The ideal toothpaste is a toothpaste that is effective in removing bacterial plaque and *stains* and increases the level of hardness on the surface of teeth and restorations with minimum abrasion.[3,4]

There are many types of children's toothpaste on the market with different benefits, one of which is increasing the hardness of tooth enamel. Fluoride and Xylitol are the main factors affecting tooth enamel hardness and surface roughness.[4] *Fluoride* is an element that functions in the mineralization process. It is effective in preventing or stopping the decay of newly formed teeth. The state of the enamel significantly affects the *fluoride* adsorption process. If the enamel has a sufficiently high

level of porousness, it will facilitate the diffusion and absorption of fluorine. Toothpaste containing *fluoride* has an effective agent capable of preventing caries.[4,5,13] *Xylitol* is a sugar variation in the form of sugar alcohol. This substance intensively functions as a prophylactic and preventive agent in dentistry. Toothpaste containing *Xylitol* can increase the pH of saliva to prevent dental caries without eroding its surface, both in primary and permanent teeth.[4,6,10]

Primary or children's teeth have a thinner layer of enamel than permanent teeth. They are more susceptible to demineralization of enamel than permanent teeth. Dental enamel consists of a *rod sheath* and *enamel rod*, where the *enamel rod is* formed from hydroxyapatite crystals which are the main structure of enamel. *Rod seat* is the outermost part of the enamel prism, a primarily organic fibrous substance.[7,8,9–11] Enamel cannot regenerate or repair itself when tissue damage occurs. Enamel can carry out the remineralization process. The thinner primary tooth enamel condition and children's habit like eating sweet foods and drinks require preventive measures such as toothpaste that protect against the outermost layer of the teeth (known as the enamel.[7–12])

Maintaining dental and oral health from an early age; many children's toothpaste have different contents and benefits.[10] The authors were interested in researching the effect of children's toothpaste containing *fluoride* and *Xylitol* on the microhardness of children's tooth enamel *in vitro.* Generally, Indonesian people are familiar with toothpaste containing *fluoride*. *Fluoride* in toothpaste is more often promoted in advertisements as an ingredient that can prevent caries. In contrast to *Xylitol*, people are still unfamiliar with *Xylitol* because the mass media rarely inform the public that *Xylitol* is also a toothpaste ingredient that can prevent dental caries.

METHOD

The research was conducted from December 2020 to January 2021 using the required software, journals, and databases.

Research design

This study used an experimental method with analytical laboratory research, including a *pre-post test-controlled group design* to determine the effect of children's toothpaste containing *fluoride* and *Xylitol* on the microhardness of children's tooth enamel *in vitro*.

Research object

The materials used in this study were primary incisors, two types of children's toothpaste with an active ingredient of 0.22% sodium *fluoride* and toothpaste with an active

ingredient of 40% xylitol solution *formaldehyde*, 1L of artificial saliva with a pH of 7. The tools used in this research are *Vickers Hardness (VHN) Tester*, an electric toothbrush, label. The research object used was the maxillary and mandibular primary incisors obtained from private dental practices, public medical health centres, and hospitals in Cianjur city.

Method of sampling

This research used consecutive sampling by selecting samples that meet the research criteria for a certain period until several samples were met. According to the Software Sample Size Determination in Health Studies from WHO, the sample calculation comes from a formula. It was found that a minimum sample size of 3 maxillary and mandibular primary incisors was obtained after extraction. In this study, we used 15 samples of teeth to be divided into three groups (two treatment groups and one control group), each group consisting of 5 teeth.

Research procedure

The research preparation was carried out by randomly dividing the sample into three groups of samples. Each group consisted of 5 teeth. Furthermore, according to the research by Maden *et al*. in 2017, micro enamel hardness can be measured using the Vickers method.[4] The study procedure is that the sample is first cleaned with running water and then immersed in a 10% formaldehyde solution for *approximately* one week. This process acts as a disinfectant and antiseptic. Samples immersed in formaldehyde were stored in artificial saliva before measurement and treatment to prevent teeth from becoming dehydrated. The following procedure is to perform a hardness test with three indents on each sample's surface of the tooth enamel using the *Vickers Hardness Tester* (without special treatment such as surface scraping). The results obtained were the initial hardness values before being treated and recorded. After giving treatment to each sample group, each sample in the group was brushed with children's toothpaste with an active ingredient of 0.22% sodium *fluoride,* and group II was brushed using a toothbrush given a child's toothpaste containing 40 % *xylitol* as much as 1 gram. It was carried out on each sample side using the horizontal brushing method. Brushing was done twice daily with a brush duration of five seconds each time brushing. The sample brushed with toothpaste was left for 60 seconds, rinsed with running water, and then immersed in an artificial saliva solution until the next brushing. The treatments were consecutive for 28 days, with a brushing duration was 280 seconds in each sample. After 28 days of brushing, the enamel microhardness measurement was again

carried out in each sample group as the initial measurement. The data obtained was analyzed.

Data analysis:

The analysis carried out in this study used the SPSS application to see the effect of the independent variable and the dependent variable. In this study, data analysis was preceded by a normality test using the Shapiro Wilk test and a data homogeneity test using the Levene test. The research used an *independent t-test* to determine changes in each group's microhardness of tooth enamel before and after treatment.

RESULT

Effect of Children's Toothpaste Containing *Fluoride* on Micro Hardness of Primary Teeth Enamel

The hardness of children's teeth treated with children's toothpaste containing 0.22% *sodium fluoride was* measured using a *Vickers hardness tester* by applying pressure by an indenter in the form of a ball on the tooth surface automatically using software that is already integrated into the tool.

Table 1 The results of tooth hardness in the group of children's toothpaste containing fluoride (in VHN)

	Tooth 1	**Tooth 2**	**Tooth 3**	**Tooth 4**	**Tooth 5**
Before	311.22	295.89	302.93	292.55	293.90
After	396.26	412.64	416.98	402.32	400.24
Difference	85.040	116.75	114.05	109.77	106.34
Average			106.39		

Data in Table 1 shows that the results of measuring the hardness level of children's enamel teeth before and after being treated using paste teeth containing 0.22% sodium *fluoride* increased by various numbers. The lowest difference is 85.040 VHN, the highest contrast is 116.75 VHN, and the average increase in the hardness value is 106.39 VHN.

Table 2 Hardness results of the control group (in VHN)

	Tooth 1	**Tooth 2**	**Tooth 3**	**Tooth 4**	**Tooth 5**
Before	339.36	344.16	306.05	292.31	304.50
After	394.36	394.27	382.82	384.85	400.29
Difference	55.00	50.11	76.77	92.54	95.79
Average			74.04		

Data in Table 2 shows that the results of measuring the hardness level of children's enamel teeth in the control group have increased significantly. The lowest difference is 50.11 VHN, the highest contrast is 95.79 VHN, and the average increase in hardness value is 74.04 VHN.

The measurement of the tooth enamel microhardness of children in the *fluoride* group and the control group resulted in an increase in the hardness value of the teeth with varying weights. The result emerged because each sample had a different thickness and level of enamel hardness.

The measurement of the microhardness value of the primary tooth enamel treated with toothpaste containing *fluoride* and the control group were tested for normality and homogeneity using the *Shapiro Wilk test,* and *Levene's test* is listed in.

Table 3 Normality and homogeneity test of *fluoride* group

	Normality Test		**Homogeneity Test**	
	P-Value	**Interpretation**	**P-Value**	**Interpretation**
Before	0.38	Normal	0.59	Homogeneous
After	0.21	Normal		

Table 3 showed that the data on micro enamel hardness values in primary teeth were normally distributed (p>0.05) for the *fluoride*. Furthermore, the homogeneity test with the results of p> 0.05 indicates that there is a similarity of variance between groups or means thait is homogeneous.

Table 4 Normality and homogeneity test of the control group

	Normality Test		**Homogeneity Test**	
	P-Value	**Interpretation**	**P-Value**	**Interpretation**
Before	0.25	Normal		
After	0.47	Normal	0.004	Not Homogeneous

Table 4 shows that the data on the micro enamel hardness values in the primary teeth are normally distributed (p>0.05) for the control group. Furthermore, the homogeneity test with p <0.05 indicates no similarity in variance between groups or means that it is not homogeneous.

After testing for normality and homogeneity using *the Shapiro Wilk test* and Levene's *test*, the Independent T-Test was carried out as follows.

Table 5. The results of the independent t-test value of enamel microhardness with fluoride

	n	**Mean±SD**	**T (*t-test*)**	**P-Value**
Before	5	312.3 (27)	-6.62	0.03
After	5	407.2(17.3)		

Based on Table 5 shows the probability value (*p-value*) in the study of the enamel microhardness test before and after being treated with *fluoride* was 0.03 (<0.05). As a result, is a significant difference in the micro hardness of the child's tooth enamel before and after treatment.

Effect of Children's Toothpaste Containing *Xylitol* Micro Hardness on Primary Teeth Enamel

The hardness of children's teeth treated with children's toothpaste containing *Xylitol was* measured using a *Vickers hardness tester* by applying pressure by an indenter in the form of a ball on the tooth surface. It was calculated automatically using software already integrated into the tool.

Table 6 Results of tooth hardness in the children's toothpaste group containing *Xylitol* (in VHN)

	Tooth 1	**Tooth 2**	**Tooth 3**	**Tooth 4**	**Tooth 5**
Before	354.42	286.68	290.61	315.79	314.15
After	425.98	389.00	388.90	419.07	412.93
Difference	71.56	102.32	98.29	103.28	98.78
Average			94.85		

Data in Table 6 shows that various numbers have increased the hardness level of children's teeth enamel before and after being given treatment using toothpaste containing Xylitol. The lowest difference is 71.56 VHN, the highest difference is 103.28 VHN, and the average increase in the hardness value is 94.85 VHN.

Table 7 Hardness results of the control group (in VHN)

	Tooth 1	**Tooth 2**	**Tooth 3**	**Tooth 4**	**Tooth 5**
Before	339.36	344.16	306.05	292.31	304.50
After	394.36	394.27	382.82	384.85	400.29
Difference	55.00	50.11	76.77	92.54	95.79
Average			74.04		

Data in Table 7 shows that the results of measuring the violence on children's teeth in the control group have increased with differences. The lowest difference is 50.11 VHN, the highest contrast is 95.79 VHN, and the average increase in hardness value is 74.04 VHN.

The microhardness value measurement of the primary tooth enamel (treated with toothpaste containing fluoride and Xylitol) were tested for normality and homogeneity first using the Shapiro Wilk test and Levene's test.

Table 8 Normality and homogeneity test of *xylitol* group

	Normality Test		**Homogeneity Test**	
	P-Value	**Interpretation**	**P-Value**	**Interpretation**
Before	0.31	Normal	0.62	Homogeneous
After	0.52	Normal		

Table 8 shows that the data on micro enamel hardness values in primary teeth are normally distributed (p>0.05) for the *Xylitol*. Furthermore, the homogeneity test with the results of p> 0.05. The result indicates a similarity of variance between groups or means that it is homogeneous.

Table 9 Normality and homogeneity test of the control group

	Normality Test		**Homogeneity Test**	
	P-Value	**Interpretation**	**P-Value**	**Interpretation**
Before	0.25	Normal	0.004	Not Homogeneous
After	0.47	Normal		

Table 9 shows that the data on the micro enamel hardness values in the primary teeth are normally distributed (p>0.05) for the control group. Furthermore, the homogeneity test with p <0.05 indicates no similarity in variance between groups or means that it is not homogeneous.

After testing for normality and homogeneity using *the Shapiro Wilk test* and *Levene's test, the Independent T-Test was carried out* as follows.

Table 10 *Independent t-test* enamel micro hardness with *xylitol* group

Group	n	Mean±SD	T (*t-test*)	P-Value
Before	5	299.3(7.8)	-20.338	0.002
After	5	405.7(8.7)		

Based on Table 10. shows the probability value (*p-value*) in the study of the enamel microhardness test before and after being treated with children's toothpaste containing *Xylitol* was 0.002 (<0.05). These results show a significant difference in the micro hardness of the child's tooth enamel before and after being given treatment.

DISCUSSION

Research on the effect of children's toothpaste containing *fluoride* and *Xylitol* on the micro enamel hardness of children's teeth has resulted in an increase in the value of tooth hardness with varying values, because each sample has a different thickness and level of enamel hardness. The samples were divided into three groups, each consisting of 5 samples of primary incisors. Samples were immersed in *formaldehyde* for approximately one week, acting as a disinfectant and antiseptic. The purpose of immersing the sample with *formaldehyde* is to maintain the stability of the essential elements in the sample so that they are not dissolved or distorted before the treatment procedure is carried out.

The treatment group was brushed for 5 seconds, each brushing for 28 days with a total brushing duration of 280 seconds because the ideal brushing time is about 2-5 minutes. The whole brushing in sample groups I and II was equivalent to 4-5 brushing teeth.

This research was conducted by measuring the microhardness of tooth enamel using a *Vickers Hardness Tester* before and after treatment. Measurements were carried out without special treatment, such as surface scraping beforehand, and measurements were made at three indentation points which were not confirmed in the same position due to the small surface area of the primary incisors.

The hardness value was obtained from the labial surface of the primary incisors, but the indentation point during measurement was not in the same position.[13–15]

The sample group treated with *fluoride* experienced a significant increase in the hardness value. *Fluoride* in children's toothpaste forms tooth enamel, which strengthens the tooth structure so that the teeth can withstand erosion caused by acid. Histologically, enamel consists of 96% inorganic material and 4% organic fibrous tissue and water. The inorganic substance is mostly million of crystals of hydroxyapatite with the chemical formula Ca10(PO4)6(OH)2, which includes carbon (0.4%), sodium (0.6%), magnesium (1.2%), chloride (0.2%), and *fluoride* (0.01%). Enamel contains high mineral content, which causes the characteristics of the enamel to be very hard and able to withstand mechanical forces.[16,17]

Fluoride does not have an anti-bacterial effect systemically, thus capable of forming fluorapatite crystals. And changing the hydroxyapatite structure in enamel to fluorapatite. This structural change is more useful in the enamel formation process.[16–18] The chemical reactions that occur are as follows:

$$Ca_{10}(PO_4)_6(OH)_2 + 2F \rightarrow Ca_{10}(PO_4)_6F_2 + 2OH$$

The fluorapatite formed from this reaction changes the enamel hardness value, which is greater than the group. Xylitol. Enamel with a fluorapatite structure is stronger against acid. And can inhibit demineralization and increase remineralization of enamel.[19–21]

Based on the results of the data analysis shown in Table 5., the increase in the value of the *fluoride* had a significant or significant result. Based on the research of Wiryani *et al.* (2016), it was explained that there was a significant effect on the hardness of the enamel treated with *fluoride* with an application time of 30 minutes.[22,23]

The sample group treated with Xylitol toothpaste experienced a slight increase in the hardness value with varying values. In dentistry, *Xylitol* has been widely used in various products such as toothpaste, chewing gum, and lozenges. *Xylitol* offers anti-caries benefits in toothpaste, and several studies have shown that toothpaste containing *Xylitol* can reduce the growth of cariogenic bacteria, so it is highly recommended for use by people with high caries risk.[16]

Based on the results of the data analysis shown in table 10. the increase in the value of the *Xylitol* had significant or significant results. Yanagisawa *et al.* (2003) explained that the role of pentitol in *Xylitol* affects remineralization by observing the growth of crystals in tooth enamel.[24] *Xylitol* with a concentration of 20% helps the enamel

remineralization process, especially in the middle layer of enamel. *Xylitol* is chemically capable of forming certain types of complexes, such as the Ca-*Xylitol* in the oral cavity. Based on research by Mäkinen and Söderling *et al.* (1983), *Xylitol* significantly inhibits the spontaneous deposition of calcium so that it has the potential to affect biochemical remineralization and can prevent caries.[25]

This study has limitations in the small size of the sample impact of the pandemic covid-19 situation. We suggest improving the sample size and treatment approach to make better results in the future.

CONCLUSION

From the study results, there is an effect of children's toothpaste containing *fluoride* on the microhardness of the child's tooth enamel. And there is an effect of the children's toothpaste containing *Xylitol* on the microhardness of the tooth enamel.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this study.

ACKNOWLEDGEMENT

Our gratitude to the Faculty of Dentistry Universitas Jenderal Achmad Yani and several parties who helped with this research.

REFERENCES

1. Simaremare RT, Simaremare AB. Motivasi Anak Dalam Pemeliharaan Kesehatan Gigi Terhadap Status Kesehatan Gigi Pada Siswa/I Kelas iii-a SD Swasta Cerdas Bangsa 2014;9(2):162–5.
2. Hidayati S, Utami NK, Amperawati M. Indeks def-t pada anak taman kanak-kanak sekota banjarbaru kalimantan selatan. 2014;5(2):1–7.
3. Octarina, Meilita R. Pengaruh pasta gigi dengan kandungan nano kalsium dan nano kitosan terhadap kekerasan permukaan email. Pros Semin Nas Pakar. 2019;0(0):1-2.2-1.2.6.
4. Maden EA, Altun C, Polat GG, Basak F. The *in vitro* evaluation of the effect of xyliwhite, probiotic, and the conventional toothpastes on the enamel roughness and microhardness. 2018;(1):51–8.
5. Dzulfia L, Damiyanti M, Herda E. Pengaruh Susu Sapi dan Protein Whey Terhadap Kekerasan Email Gigi Setelah Demineralisasi. J Mater Kedokt Gigi. 2016;5(2):28.
6. Najoan SB, Kepel BJ, Wicaksono Da. Perubahan ph saliva siswa ma darul istiqamah manado sesudah menyikat gigi dengan pasta gigi mengandung *xylitol*. E-Gigi. 2014;2(2).
7. Phosphate CPC, Whitney-test M, T-IS. Casein phosphopeptide-amorphous

calcium phosphate. 2019;3(2):257–62.
8. Nuruwael JM. Pengaruh pasta gigi pemutih terhadap kekerasan dan kekasaran mikroenamel gigi manusia. Makassar: Fakultas Kedokteran Gigi Universitas Hassanudin. 2016.
9. Noviasari AN, Christiono S, Hadianto E. Perbedaan Kekerasan Permukaan Enamel Gigi Desidui Terhadap Pola Konsumsi Ikan Laut Studi Pada Anak Usia 5 – 7 Tahun Di Desa Teluk Awur Dan Desa Jlegong Kabupaten Jepara. Odonto Dent J. 2018;5(1):76–9.
10. Combe EC. Notes on dental materials, 6th ed. New York: Churchill Livingstone Inc; 1992. p. 282-8.
11. Ritter AV, Boushell LW, Walter R. Sturdevant's Art and Science of Operative Dentistry. 7th ed. St. Louis, Missouri 63043: Elseiver; 2018. p.1-9.
12. Beek, Yuwono GCV, Andrianto L, Petrus. Morfologi gigi : penuntun bergambar. 2nd ed. Jakarta: EGC; 1989. hal. 2-5.
13. Panjaitan, M. Ilmu pencegahan Karies Gigi. Edisi 1. Medan: USU Press; 1997
14. McDonald RE, Avery DR, Dean JA. Dentistry for the Child and Adolescent. 8th ed. Drive St. Louis, Missouri: Mosby Elsevier; 2004. p. 54.
15. Nelson S. Wheeler's Dental Anatomy, Physiology, and Occlusion. 11th ed. St. Louis, Missouri: Elseiver; 2019.
16. Nwankam C, Ejim CJ, Unachukwu MN. The Effects of selected toothpaste on the microbial flora of the mouth of GOU Student. International Journal of Current Microbiology and Applied Science 2014; 3(9): 785-6.
17. Hartami E, Irmawati, Herawati. Perbedaan Kadar Kalsium dan Fosfor Gigi Sulung pada Anak dengan DEF-T Rendah dan Tinggi. E-Prodenta J Dent. 2019;3(2):232–9.
18. Anastasia D. Perbedaan Kekerasan Permukaan Enamel Gigi Setelah Perendaman Dalam Berbagai Minuman Berenergi. J Ilm dan Teknol Kedokt Gigi. 2019;15(2):47
19. Harahap, A. Analisa Kandungan Fluorida (F), Tingkat Pengetahuan dan Tindakan Orang Tua Anak Usia 4-5 Tahun Tentang Pasta Gigi yang Dipakai di Taman Kanak-kanak Kecamatan Medan Area Tahun 2015. Medan: Fakultas Kesehatan Masyarakat Universitas Sumatera Utara. 2015.
20. Liwang B, Irmawati I, Budipramana E. Kekerasan mikro enamel gigi permanen muda setelah aplikasi bahan pemutih gigi dan pasta remineralisasi (Enamel micro hardness of young permanent tooth after bleaching and remineralization paste application). Dent J (Majalah Kedokteran Gigi). 2014;47(4):206
21. Angriani S. Uji Kekerasan Permukaan

Email Gigi Geligi Anak yang Berdomisili di Daerah Endemik Fluorosis dan Daerah non Endemik Fluorosis. 2014;15–25. Available from: http://repository.unhas.ac.id/handle/123456789/11600

22. Kidd, E. A. M. dan Bechal, S. J. Dasar-dasar Karies, Penyebab, dan Penanggulangannya. Alih bahasa oleh Narlan Sumawinata dan Safrida Faruk. Jakarta: EGC; 1992.
23. Gigi JK, Pada T, Kelas S, Awayan S, Kelas S. Dentin Perbandingan Indeks Karies Dmf-T Berdasarkan Jumlah Kandungan Fluor Air Gunung Di Kabupaten Balangan Dengan. 2018;II(1):45–50.
24. Yanagisawa T, Miake Y, Saeki Y, Takahashi M. Remineralization Effects of Xylitol on Demineralized Enamel. Journal of Electron Microscopy 2003. Vol 52. p. 471-476.
25. Makkinen KK. History safety and dental properties of *Xylitol*. http://www.naturallysweet.com.au/uploads/50072/ufiles/download_info/History_Safety_and_Dental_Properties_of_*Xylitol*.pdf. (Accessed 10 July 2020).