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EFFECT PH ON DEMINERALIZATION DENTAL EROSION

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Effect pH on Demineralization Dental Erosion

Rosihan Adhani, Widodo, Bayu Indra Sukmana, Eko Suhartono

***Abstract*—South Kalimantan is a province of Indonesia. It is located in Kalimantan, the Indonesian territory of Borneo. About three quarters of the province is flat and less than 100 m above sea level, while about 8,000 km² are swampland. It makes the water conditions in south Kalimantan is swamp water. However, due to the amount of the swamp water, the water is used as a source of public drinking water. These conditions resulted in many residents have abnormalities in the teeth. These can make a demineralization of the tooth resulted the dental erosion. The relation between water condition in south kalimantan and demineralization of tooth that can caused the dental erotion were never been investigated, thus our study aimed to evaluate the potential effect of water in South Kalimantan on demineralization of dental which can caused a dental erosion by measuring their correlation. From our resluted, we found that there are a correlation between mineral cocentration of the tooth and day in different pH, and a correlation between minerals in different pH. The results of this study concluded that chronic exposure to acid water can caused demineralization of the tooth and resulted a dental erotion.**

***Index Terms*—Acid Water, Dental Demineralization, Dental Erotion, tooth.**

I. INTRODUCTION

The area of Province of South Kalimantan is 37,530.52 km². It spreads between 1140 19' 13" and 1160 33'28" East Latitude and 1210 49" - 410 14" South Longitudinal. Administratively the government is divided into 13 Regencies and 2 Cities, namely Regency of Tanah Laut, Regency of Kotabaru, Regency of Banjar, Regency of Tapin, Regency of Hulu Sungai Selatan, Regency of Hulu Sungai Tengah, Regency of Hulu Sungai North, Regency of Tabalong, Regency of Tanah Bumbu, and Regency of Balangan as well as 2 Cities, namely Municipality of Banjarmasin and Municipality of Banjarbaru. The widest regency is Regency of Kotabaru (14,489.69 kitf) and the least is Municipality of Banjarbaru (367.12 kitf). The most rainfall occurs between 2000 and 3000 mm yearly and the temperature is 25.60°C - 26.90°C [1].

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Province of South Kalimantan has good territorial water both river and swamp [2]. It makes the water conditions in south Kalimantan is swamp water. Swamp water is surface water which is widely available in swamps areas and lowlands, especially in Sumatra and Kalimantan, which has the following characteristics are the intensity of high color (brownish red), low pH, high content of organic matter, turbidity and low content of suspended particle and low cation content [3].

Characteristics of swamp water as mentioned above showed that the swamp water is less favorable to be used as water drink for people. However, due to the amount of the swamp water, the water is used as a source of public drinking water. Conditions were less beneficial in terms of health are as follows low pH acidity levels can cause tooth decay and pain stomach. These conditions impact on health, especially the health of tooth [2].

Low pH levels can cause tooth decay. The acidic conditions can cause demineralization of the tooth. Dental Enamel consists of densely packed mineral crystal mainly hydroxyapatite (HA) and it can become demineralized due to exposure to plaque acids. Besides HA, dental enamel consists another minerals such as Ca, Na, Cl, Zn and P. Tooth enamel can undergo a process called demineralisation if the pH of the mouth falls to lower than normal levels. The combination of mouth bacteria and sugars from some foods, snacks, soft drinks and sweets can generate lactic acid. The acidic conditions over time cause the enamel to slowly dissolve, creating tooth cavities. This process also known as dental erosion [4].

Dental erosion, otherwise known as erosive tooth wear, is the loss of dental hard tissue through either chemical etching and dissolution by acids of non bacterial origin or chelation. Evidence based on case reports, clinical trials, epidemiological, cohort, animal, in vitro and in vivo studies have described acids that could cause dental erosion as originating from gastric, dietary or environmental sources [6].

Dental erosion may have a multifactorial etiology, attributable to intrinsic and extrinsic causes. The intrinsic causes are associated with gastric acids, and may present intra-orally following vomiting, regurgitation, gastro-oesophageal reflux or rumination. The extrinsic factors involved in erosion include environmental factors, dietary factors, medications and lifestyle. Associations between diet and dental erosion have received considerable attention, especially in relation to acidic foods and drinks, and clinical studies have identified some particular foods and drinks as etiological factors in erosion [7].

In the study by Lussi and Schaffner, the group with high progression had the following significant differences compared with the group with small progression: intake of

dietary acids, the buffering capacity of stimulated saliva, and the bristle stiffness of the tooth brush. The dietary habits of the high-progression group changed very little between the first and second examinations despite discussions with patients about the dangers of erosive food stuffs. Overall, the high-progression group had four or more acid intakes per day. An intake frequency of the same magnitude has been associated with an increased risk for erosion in children [8]. In other studies in children and adults who consumed acidic foods and drinks is known associated with the presence and progression of dental erotion [9].

The relation between days of exposure, water pH and demineralization of dental that can caused the dental erosion were never been investigated, therefore a study should be performed. Thus our study aimed to evaluate the potential effect of water in South Kalimantan on demineralization of dental that can caused dental erotion by measuring their correlation.

II. MATERIAL AND METHODS

The present study was a experimental study design to examine the impact of water pH to demineralization of the tooth. Tooth put in water with a pH of 4 and 7 for 4 days. Observation were made every day and each day the levels of Ca, Zn, and PO4 was examined.

A. Chemical Materials

NH4OH, HCl (1:4), 0.5 M HCl, 10% oxalic acid, NH4-oxalate, H2SO4,, 0.1 N KMnO4, ammonium molybdate, SnCl2.2H2O, ammonia buffer pH 10, EBT and EDTA 0.01 M.

B. Preparation of Dental Sample

Tooth samples were incubated at pH = 4 and pH = 7 is cleaned and crushed to 40 mesh size. After that, 1 gram sample was diluted to 200 mL with aquadest (sample solution). This material will be used to analyze the levels of Ca, PO4, and Zn.

C. Calcium Determination

Sample solution was added NH4OH, HCl (1:4), 0.5 M HCl, and 10 mL of 10% oxalic acid. The solution was heated to boiling and while stirring add 15 mL of NH4-oxalate. Then filtered and washed with hot water until free of chloride. After that, add 10 mL of H2SO4 and heated to boiling and then cooled. Titrate with 0.1 N KMnO4.

D. Phosphate Determination

A total of 50 mL of sample solution was added 2 mL of ammonium molybdate and 5 drops of SnCl2.2H2O. Subsequently, the solution was put in a cuvette and measuring the spectophotometric with X = 590 nm.

E. Zinc Determination

A total of 25 mL of sample solution was added 15 mL of aquadest, 10 ml of ammonia buffer pH 10 and EBT. Titration with EDTA 0.01 M.

F. Data Analysis

For analyzing of the data, Excell software 2010 was used and was examined by linear regression.

III. RESULTS

Demineralization of the tooth in pH 4 and pH 7 showed in figure 1, 2 and 3.

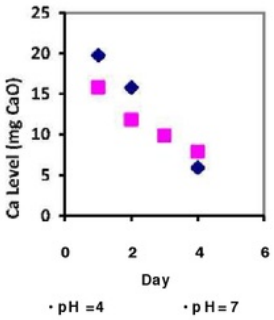

Fig. 1. Calcium Tooth Level in pH 4 and pH 7

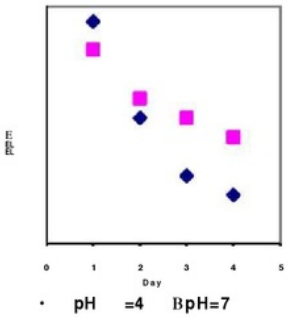

Fig. 2. Zinc Tooth Level in pH 4 and pH 7

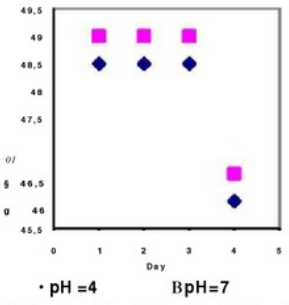

Fig. 3. Phosphate Tooth Level in pH 4 and pH 7

The correlation between mineral cocentration of the teeth and day in different pH was evaluated (Table I).

TABLE I : CORRELATION BETWEEN MINERALS CONCENTRATION AND DAY IN DIFFRENT PH

pH	Minerals	Day 1	2	3	4	Slope	r
	Ca (mg CaO)	15,8 1	11,85	9,88	7,9	- 2,57	-0,983
7	Zn (ppm)	1,31	0,98	0,85	0,72	- 0,19	-0,969
	PO4 (mg/ml)	49	49	49	46,5	- 0,74	-0,775
	Ca (mg CaO)	19,7 6	15,81	9,88	5,93	-4,74	-0,997
4	Zn (ppm)	1,5	0,85	0,46	0,33	-0,8	-0,958
	PO4 (mg/ml)	48,5	48,5	48,5	46	-0,75	-0,775

The result showed that the time effect on the mineral concentration. The increasing number of days of exposure can decrease the mineral concentration. From table I, also showed that the decrease of pH will accelerate the rate of decreasing mineral concentration. The dereasing of mineral occurs at pH 4 is faster than pH 7.

Table II showed the correlation between minerals in different pH.

TABLE II : CORRELATION BETWEEN MINERALS IN DIFFRENT PH

pH	Minerals	Ca	PO4	Zn
7	Ca	1	0,683	0,998
	Zn	0,998	0,647	1
	PO4	0,683	1	0,647
4	Ca	1	0,995	0,75
	Zn	0,75	0,955	1
	PO4	0,995	1	0,995

The data in table II shows that there is a positive correlation between all minerals. It indicates that the calcium release will be followed by the release of other minerals such as zinc and phosphate. The data in table II also shows that the releasing of mineral occurs at pH 4 is larger than pH 7, where the correlation values at pH 4 at is larger than pH 7 except on the correlation between Ca with Zn.

IV. DISCUSSION

The enamel of the teeth is made of minerals. Tooth enamel is the hardest and most highly mineralised substance in the body. It is 96% mineral, with water and protein content for the other is 4%. This high mineral content gives it strength and hardness, but also brittleness. The minerals found in human teeth that give them their hardness and strength belong a mineral family known as biological apatites. The biological apatites are forms of calcium hydroxyapatite (HA), which has the formula Ca10(PO4)6(OH)2 [10].

Besides the HA, enamel of the teeth contain different mineral sucha as Na, Cl, Mn, K, Mg, Zn, Cu and Fe. Lakooma EL (1977) studies in dentin and enamel of primary and permanen teeth collected in six different localities in finland. Na, Cl, Al, Mn, Ca, and P were determined by neutron activation analysis, K, Mg, Zn, Cu, and Fe by the atomic absorption method, and F with the fluoride specific electrode. Most elements were present in higher concentrations in the enamel than in the dentin: Mg, however, was higher in the dentin. Compared with the permanent teeth, the primary teeth contained more K and Mn in enamel and K and Mg in dentin, but less Na and Zn in enamel [11].

Because the enamel of teeth is made of minerals, it has been referred to as "the living stone" in mouth. Stones, as we know, are difficult to damage, but it is possible. Over time, they can wear due to elements they are exposed to. Well, just the same, the teeth can wear due to the things that eat or expose to the teeth to. In fact, other than extreme trauma to the teeth, one of the most common ways to damage the teeth is through the process of demineralization [12,13].

Demineralization occurs when the enamel of teeth is exposed to sugar, starch, and acid for long periods. The bacteria that forms around teeth due to improper oral hygiene after eating something that is sugary, starchy, or acidic can breech the thin layer of enamel that protects your teeth. Once this breech has occurred, calcium, phosphate ions, and other important minerals begin being leeched out of the teeth and spots of demineralization appear [14].

Demineralization of the enamel is damaged hydroxy apatite tooth enamel which is the main component of enamel due to chemical processes. The condition occurs when the pH of the solution surrounding the enamel surface is lower than 5.5, (generally ranging from 2.3 to 3.6 pH) and the concentration of the acid that does not dissociate higher on the surface enamel, rather than in the enamel [15].

Demineralization of enamel occurs through a diffusion process, ie the process of moving molecules or ions dissolved in water to or from the enamel to saliva because there are differences in the concentration of acidic water on the surface of the tooth enamel. Acidity water which has a high concentration, and a low initial pH will diffuse into the enamel, through the crystal lattice and prismatic enamel tubules containing water and organic matrix proteins.when the acid diffuse through plaque and into the porous of subsurface enamel, it dissociating to produce hydrogen ions as they travel. The hydrogen ions readily dissolve the mineral, freeing calcium and phospate into solution, which can diffuse out of the tooth [16].

Besides HA, acid conditions can demineralyzed other minerals that contruct tooth such as zinc (Zn). Essential trace minerals such as zinc is used for the maintenance of healthy tooth. These minerals are involved in the formation of the tooth framework structure contributing to the organic component of the dental matrix. The hard mass characteristic of healthy tooth is formed by inorganic minerals such as calcium and phosphorous. The structural framework around which the inorganic minerals deposits is termed the organic matrix is comprised of proteins that require zinc, as essential co-factors for enzymes involved in their synthesis [17].

Zinc accumulates in the surface structures of teeth and occurs in low concentrations in subsurface material, thus exhibiting a distributive pattern similar to that of fluoride and lead. Concentrations of zinc in surface enamel of teeth from different areas range from 430 to 2100 p.p.m. In terms of molar concentrations the concentrations are frequently of the same order as those of fluoride. In enamel the major deposition of zinc takes place before tooth eruption. In

contrast to fluoride, posteruptive deposition of zinc appears to be irregular. Zinc is readily acquired by synthetic hydroxyapatite, competing with calcium for positions on the surface of the apatite crystal. Zinc pretreatment of hydroxyapatite produces a resistance to acid dissolution similar in magnitude to that produced by equivalent molar concentrations of fluoride [17].

Demineralization caused by the acidic conditions known to cause dental erosion. Erosion begins as superficial demineralization of the enamel, which can cause dissolution of the subsurface layers and eventual loss of tooth structure. Any acid with a pH below the critical pH of dental enamel can dissolve the hydroxyapatite crystals in enamel [18].

Dental erosion is a common condition, and its prevalence seems to be trending higher in recent decades. It is difficult to accurately assess the prevalence of dental erosion from published literature, for there is not a universally accepted standard for clinical evaluation of this condition. Dental erosion is almost always complicated by other forms of tooth wear. The reported prevalence of dental erosion varies greatly in the literature, which can be partially explained by age, country and different evaluation standards. The median prevalence of dental erosion is 34.1 percent of children (interquartile range 27.4) and 31.8 percent of adults (interquartile range 18.7). In studies that reported prevalence of dental erosion in different age groups, there is a clear trend of increasing prevalence with age in children and adults. Dental erosion has been considered a common condition limited to developed countries [19].

Dental erosion starts from the release of calcium ions, and if this continues, it will cause the loss of some of the enamel prisms, if it continues to happen porosity. Porosity will cause the tooth enamel surface hardness will be reduced. The decrease in surface hardness of tooth enamel by heavy immersion in acid solution according to previous studies, saying that if there is a decrease of one unit of pH, will cause calcium release rate of 19.5 times, this means that the smaller the pH or the more acidic media, it is increasingly high reaction rate of calcium release from the tooth enamel. Obtained enamel hardness test becomes soft, and can be lost due to brushed, after contact with the acid, especially lemon juice [20].

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