

**LOSS OF CALCIUM FROM ENAMEL SURFACE AFTER EXPOSURE
TO SOFT DRINK (IN VITRO)**

THESIS

Submitted to complete one of the requirements Achieve

a Bachelor's degree in Dentistry



ARRANGED BY:

MUHAMMAD SAHID MUNAWIR

J011201134

DEPARTMENT OF ORAL BIOLOGY

FACULTY OF DENTISTRY

HASANUDDIN UNIVERSITY

MAKASSAR

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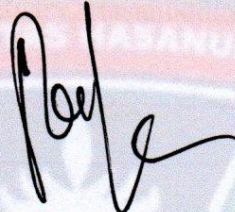
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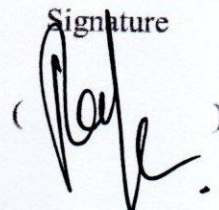
THESIS APPROVAL SUPERVISOR PAGE

The undersigned:

Name of Supervisor:

1. Rafikah Hasyim, drg.,M.Biomed

Signature

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MOTTO

“Embrace the Journey, Ignite the Spirit”

PREFACE

Praise and gratitude the author prays to the presence of Allah SWT for all His grace, taufik and guidance so that the thesis entitled "Loss of Calcium From Enamel Surface After Exposure to Soft Drink (IN VITRO)" can be completed well and on time. Don't forget to give prayers and greetings. The author expresses gratitude to the great lord, the Prophet Muhammad SAW, who has brought us from the realm of darkness to the realm of bright light.

The author realizes that in the process of writing this thesis he experienced many difficulties which sometimes made the author want to give up, but thanks to the help, prayers and support both materially and morally as well as the best plans that have been prepared by Allah SWT, the Giver of convenience and ability, so that the difficulties can be overcome. This experience can be resolved well and wisely. During the process of preparing this thesis, of course, there was guidance, support and assistance from various parties. On this occasion, the author would like to express many thanks to the parties who have helped complete this thesis, namely:

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3. **Prof. Dr. Asmawati, drg.,M.Kes., PBO** and **Prof. Dr. Irene Edith**

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4. All Lecturers, Academic Staff, Administrative Staff, FKG UNHAS Library Staff, Residence of oral disease, who have helped the author during the lecture process and the preparation of this thesis.
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Madika as a my best friend

9. and partner who accompanies the writer all this time, who always listens to complaints, calms, helps and encourages the writer all this time.
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11. All other parties who the author cannot mention one by one who have contributed and helped the author, thank you for the support, understanding and encouragement given to the author so far.
12. Finally, the author realizes that there are still many shortcomings in the preparation of this thesis. For this reason, the author apologizes and understands if there are any mistakes, mistakes or shortcomings in writing this thesis, whether consciously or unconsciously.

Loss of Calcium From Enamel Surface After Exposure to Soft Drink (IN VITRO)

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ABSTRACT

Background: Tooth enamel is the strongest tissue in the human body that forms the outer surface of the teeth. At the beginning of tooth formation, the enamel composition contains more organic matter, in addition to inorganic and water. In inorganic tissues, enamel integrity is more influenced by pH and the presence of minerals in saliva. Critical pH is the pH at which the solution is only half saturated with minerals such as enamel is saturated with saliva at a pH of 5.5-6.5. At this pH, the ionic product (I_p) of minerals is said to equal the product solubility (K_{sp}), It has been shown that, the surface solubility of enamel and its critical pH are not constant, but there are changes in the solubility of minerals in the enamel with different pH cycles. In individuals with a low ratio of calcium and phosphate in saliva, the critical pH is about 6.5 and in individuals with a high ratio, the pH is around 5.5. In situations where the pH of the solution is lower than the critical pH ($I_p < K_{sp}$), whereas when the pH is above the critical pH ($I_p > K_{sp}$)

Objective: To compare calcium levels before and after consuming soft drinks and also to find out whether there is a relationship between the length of time teeth are exposed to drinks and the demineralization process. **Methods:** The type of research used in this research is Analytical Experimental Time Series Design. The reason for using this type of research is because apart from being given a lot of treatment, there are a series of observations made on the same variables sequentially from time to time and act as control subjects. **Results:** The calcium solubility in tooth samples when soaked in soft drinks for 15, 30, and 60 minutes. it shows that tooth enamel calcium dissolves when soaked by using soft drink.

Keyword: Soft drinks, teeth calcium dissolution

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CHAPTER I

INTRODUCTION

1.1 Background

Tooth enamel is the strongest tissue in the human body that forms the outer surface of the teeth. At the beginning of tooth formation, the enamel composition contains more organic matter, in addition to inorganic and water. As the enamel matures, there are changes in the enamel where it contains more inorganic material. The most important minerals are calcium and phosphate in the form of hydroxyapatite (HA) crystals. Mature enamel contains approximately 96% minerals, 3% water and less than 1% is organic matrix. Although enamel is the hardest tissue, it is permeable to fluids and bacterial products.¹

In inorganic tissues, enamel integrity is more influenced by pH and the presence of minerals in saliva. Critical pH is the pH at which the solution is only half saturated with minerals such as enamel is saturated with saliva at a pH of 5.5-6.5. At this pH, the ionic product (Ip) of minerals is said to equal the product solubility (Ksp).² Ksp here means an equilibrium solution containing an ionic mixture.³

It has been shown that, the surface solubility of enamel and its critical pH are not constant, but there are changes in the solubility of minerals in the enamel with different pH cycles. In individuals with a

low ratio of calcium and phosphate in saliva, the critical pH is about 6.5 and in individuals with a high ratio, the pH is around 5.5. In situations where the pH of the solution is lower than the critical pH ($I_p < K_{sp}$), whereas when the pH is above the critical pH ($I_p > K_{sp}$). The longer and more often the teeth are exposed to acidic solutions, the faster the demineralization of the enamel surface will result.²

In today's life, driven by the need for a practical and fast-paced lifestyle, the new beverage industry is growing and offering more types, flavors and packaging. A variety of soft drinks (including carbonated, fruit-flavored drinks, juices, teas, milk) available in both carbonated and non-carbonated forms are useful in meeting the needs of daily beverage consumption.

In countries like Indonesia, the existence of soft drinks is one of the preferred types of drinks, and they have been around for a long time and have spread on the market. The percentage of people's demand for soft drinks tends to increase along with changes in dietary patterns. The Soft Drink Industry Association (ASRIM) noted, Soft drink production capacity utilities improved to 70 percent to 75 percent in the last quarter of 2021. The improvement in soft drink production utilities this year is predicted to grow 9.3 percent to 7 billion liters. Last year, production tended to stagnate at 6.4 billion liters, unchanged from the 2020 position. Meanwhile, the production figure before the Covid-19 pandemic or in 2019 was recorded at 8 billion liters. This increase is causing concern in global health, including dental health.

Based on the data above, the authors are interested in conducting research related to the current human lifestyle has changed. The habit of consuming food and soft drinks increases both in terms of frequency and amount. especially in teenage children because they are considered to follow the latest lifestyle. In fact, nowadays you can also see parents who are busy with activities outside the home providing unhealthy food and soft drinks that can cause damage to teeth. This made me interested in making a topic about “Loss Of Calcium From Enamel Surface After Exposure to Soft Drink (IN VITRO)”.

1.1 Formulation of Research Problems

Based on description above, the problem can be formulated as follows:

1. Is there a difference in calcium levels before and after consuming soft drinks?
2. Is there a relationship between the length of time the teeth are exposed to sweet drinks and the demineralization process?

1.2 Research Purposes

Some of the objectives of this research are as follows:

1. To compare calcium levels before and after consuming soft drinks
2. To find out whether Is there a relationship between the length of time the teeth are exposed to Soft Drink and the demineralization process

1.3 Benefits of Research

The benefits of this research are as follows:

1. To support the development of science and technology in the field

of Oral Biology, specifically regarding the pH of drinks on the release of calcium from the tooth enamel surface.

2. Providing knowledge to the public about the dangers of soft drinks which damage the tooth enamel surface.
3. Can be used as a source of data and information to conduct further research in the future

1.4 Research Hypothesis

1. There are differences in pH among the soft drinks studied.
2. There is a relationship between the time teeth are exposed to drinks and the deposition of calcium on the enamel surface.

CHAPTER II

LITERATURE REVIEW

2.1. Enamel

2.1.1 Definition of Enamel

Enamel is the hard, outer layer of the teeth that protects the inner layers of the teeth from damage and decay. It is the hardest and most highly mineralized substance in the human body, and it is composed of a hard, mineralized substance called hydroxyapatite. The enamel of the teeth is responsible for providing protection and support to the teeth. It helps to prevent tooth decay and cavities by protecting the inner layers of the teeth from the acid produced by bacteria in the mouth. It also helps to maintain the shape and structure of the teeth, and it plays a key role in the proper function of the teeth.⁴

Calcium is a very vital mineral and is needed by the body in larger quantities than other minerals. Approximately 99% of calcium is found in hard tissues, namely in bones and teeth, while 1% of calcium is found in blood and soft tissues. In addition to its main function in building and maintaining bones and teeth, calcium also plays an important role in the body's enzyme activity.⁵

The enamel of the teeth is formed during tooth development, and it is the first layer of the tooth to form. It is formed from specialized cells called ameloblasts, which secrete the matrix that forms the enamel. Once

the enamel has been formed, it is fully mature and cannot be regenerated. The enamel of the teeth is vulnerable to damage and wear, and it can be eroded or worn away by acidic foods and Soft Drink, poor oral hygiene, and certain medical conditions. To protect the enamel of the teeth, it is important to maintain good oral hygiene practices, such as brushing and flossing regularly and using fluoride toothpaste, and to limit the consumption of acidic foods and beverages.

Enamel is a calcified substance (calcification that covers the entire crown of the tooth and protects the dentin). In newly formed enamel, it contains approximately 96-98% apatite and the rest are proteins, lipids and water. Pores form between the crystals in the enamel, making up about 12% water by volume. In this phase/stage that has been protracted for many years, the dynamics of demineralization and remineralization occur.⁶

The thickness of the enamel varies in different parts of the corona, with thickness being highest at the cusps and incisals, and thinnest in the cervical region. The natural color of enamel is white or bluish-white and this is shown in the incisal region and cusp tips of teeth which are devoid of dentin. As the enamel wears away, the dentin becomes prominent and the enamel becomes darker in color.⁷

The level of mineralization also affects the color of the enamel. It is shown by a more opaque color in hypomineralized areas than in normally mineralized areas where the color is usually translucent. The components of mature enamel are 85% inorganic, 12% water and the remainder is 3% protein and lipids. The inorganic matrix component is calcium phosphate in

the form of hydroxyapatite crystals, while the organic matrix component is composed of non-collagen proteins called amelogenin and enamelin.⁶

Tooth minerals are substituted by various ions such as sodium, zinc, strontium and carbonate which make them more reactive than native hydroxyapatite. Excessive fluoride may enter into the crystal structure, depending on the local fluoride concentration on the tooth surface. Over time, the enamel surface becomes fully mineralized if the local pH of the environment is neutral or alkaline.⁶

Almost all of the enamel protein matrix is lost with the maturation of the enamel. The exchange of calcium, phosphate and fluoride ions in and out of the enamel is continuous, depending on local concentrations and pH. This is important in dental maintenance procedures. At a pH below 5.5, minerals can be lost from the surface and central enamel. Meanwhile, at a pH above 5.5, loss of enamel is recovered from calcium and phosphate in the saliva.⁶

2.2. Calcium

2.2.1 Definition of Calcium

Calcium plays a very important role in keeping teeth healthy. Calcium protects teeth indirectly by strengthening the jawbone, strengthening the attachment of teeth and bones, preventing gaps where bacteria can invade the teeth, promoting infection, preventing inflammation and bleeding. Adequate calcium consumption is necessary for the growth of good tooth structure. It is one of the main

minerals found in the enamel of the teeth, along with phosphate and fluoride. The enamel is the hard, outer layer of tooth structure that covers the crown of the tooth and is responsible for protecting the tooth and helping to keep it strong and healthy.⁸

Calcium is essential for the proper development and maintenance of the teeth and bones, and it plays a key role in the process of tooth remineralization. Remineralization is the process by which minerals, such as calcium and phosphate, are replaced in the enamel of the teeth. It occurs naturally in the mouth and helps to repair and strengthen the enamel.⁹

The tooth does not form and calcify merely as an entity in itself but rather as a part of the body. The tooth is therefore subject, with of course some modification, to the same physical and chemical laws as the bones. The calcium which is present in one's daily food is absorbed through the intestinal tract, whence it is carried into the blood stream. Calcium is present in the food in both organic and inorganic forms. It is probable that the organic must be converted to the inorganic form in the alimentary tract prior to being absorbed. Absorption of calcium occurs mainly in the upper regions of the small intestine.⁹

2.2.2 The Role and Function Of Calcium

Calcium is an important mineral for humans, 99 percent of calcium in the human body is found in bones. And as much as 1 percent of calcium is found in body fluids such as blood serum, in body cells, in extracellular and intracellular fluids.¹²

1) The role of calcium in body fluids:¹³

- Muscle contraction and relaxation
- Transmission of nerve impulses
- Blood clotting
- Regulates hormone secretion

As a co factor (factor support) in some enzymes

2) The role of calcium for the human body:¹³

- As a reinforcement of bone structure
- As a calcium bank, if calcium in the blood decreases, the body will take reserves from the bones with the help of several hormones.

3) The function of calcium for the body:¹³

- Formation of bones and teeth With good calcium intake, bones and teeth become strong and grow normally. Calcium intake is very important for pregnant and lactating women, so that their children have healthy teeth and bones. For children's bones that lack calcium and vitamin D will become less strong, even the shape of the legs can become X or O.
- Regulates blood clotting
- Muscle contraction and muscle relaxation When calcium is low, the muscles cannot relax, causing spasms. Control of calcium in the blood by vitamin D, parathyroid hormone/PTH and the hormone calcitonin

4) The benefits of calcium for the body include:¹³

- Formation and Maintenance of Bones and Teeth. Children need calcium for the growth of their bones and teeth. Lack of calcium can cause the child's bone growth to be imperfect and suffer from rickets. Adults need calcium to constantly rejuvenate their bone and teeth system. The minerals in our bones and teeth are replaced 100% every seven years.
- Prevent Osteoporosis. If you don't get enough calcium from food, your body will take it from the "calcium banks" in the joints of your hands, feet and other long bones. Lack of calcium consumption for a long time will cause the body to take it directly from solid bones. This results in porous bones and break easily (osteoporosis). If a woman aged 20 years consumes 400 mg less calcium every day than needed, at the age of 55 her bones are porous by 1/3.
- Storage of Glycogen. Calcium plays a role in the process of storing glycogen. If there is no calcium, the body will feel hungry constantly because it cannot store glycogen.
- Improve the function of the muscles, brain and nervous system. Muscles, brain and nervous system need calcium to function optimally. Calcium deficiency can cause muscle spasms and impaired function of the brain and nervous system

5) Calcium On Teeth¹²

The main function of calcium is actually to support the formation of bones and teeth to stay strong. Even from the amount of calcium in the body, about 99% is stored in the bones and teeth. In the teeth themselves, this mineral is needed to form tissues in the teeth such as enamel (enamel), dentin, and also tooth cementum. If you don't get enough intake, then the formation of the network will also be disrupted.

Calcium deficiency can cause tooth decay. Calcium is an essential mineral needed to maintain healthy teeth and bones. If a person does not get enough calcium then their bones and teeth can become weak and prone to decay.

Some of the concrete impacts of calcium deficiency on teeth include:

- Porous teeth
- Teeth break easily
- Periodontitis (Inflammation of the tissue that supports the teeth)
- Dental caries (most common of tooth decay)

2.3.Demineralization

2.3.1 Definition of Demineralization

Demineralization is the process of removing minerals from a substance. In the context of oral health, demineralization refers to the loss of minerals, such as calcium and phosphate, from the enamel of the teeth. Enamel is the hard, outer layer of the tooth structure that covers

the crown of the tooth. It is made up of minerals and is the hardest tissue in the human body. It is also the most visible part of the tooth, as it is the white, shiny surface that can be seen in the mouth.⁹

Demineralization can occur when the mouth is exposed to acidic substances, such as sugary foods and drinks, or when there is a reduction in the amount of saliva in the mouth. Saliva helps to neutralize acid and maintain the balance of minerals in the mouth, so a decrease in salivary production can lead to demineralization. When the pH of the mouth becomes too low, the enamel can start to dissolve, leading to the loss of minerals from the teeth.¹⁰

Demineralization is a natural process that occurs in the mouth, and it can be exacerbated by poor oral hygiene and a diet high in sugar and acid. When demineralization occurs, the enamel becomes weaker and more prone to tooth decay. Tooth decay is a common dental problem that occurs when bacteria in the mouth produce acids that attack the enamel of the teeth. As the enamel becomes weakened and damaged by acid, it can start to break down and form holes or cavities.¹⁰

To prevent demineralization and tooth decay, it is important to maintain good oral hygiene by brushing and flossing regularly and visiting the dentist for regular checkups and cleanings. It is also important to limit the intake of sugary and acidic foods and drinks, as they can contribute to demineralization. Drinking water and using fluoride-containing toothpaste can also help prevent demineralization and promote healthy teeth.¹¹

2.3.2 Etiology of Demineralization

The etiology of demineralization refers to the causes or origins of the loss of minerals from the enamel of the teeth. In the context of oral health, demineralization is a natural process that can occur when the mouth is exposed to acidic substances or when there is a reduction in the amount of saliva in the mouth.¹⁰

One of the main causes of demineralization is the consumption of sugary and acidic foods and drinks. When the mouth is exposed to these types of substances, the pH of the mouth becomes too low, which can lead to the dissolution of the enamel. The bacteria that live in the mouth also produce acid as a by-product of their metabolism, and this acid can attack the enamel of the teeth, leading to demineralization.⁹

Another cause of demineralization is a reduction in the amount of saliva in the mouth. Saliva helps to neutralize acid and maintain the balance of minerals in the mouth, so a decrease in salivary production can lead to demineralization. This can occur due to certain medications, certain medical conditions, or as a result of aging.

Poor oral hygiene is also a contributing factor to demineralization. When bacteria are allowed to accumulate on the teeth, they produce acids that attack the enamel, leading to demineralization. Regular brushing and flossing can help remove plaque and prevent demineralization.¹¹

Other factors that can contribute to demineralization include dry mouth, tooth grinding, and the use of tobacco products. Overall, the

etiology of demineralization is complex and can involve a combination of factors. To prevent demineralization, it is important to maintain good oral hygiene, limit the intake of sugary and acidic foods and drinks, and maintain adequate saliva production in the mouth.¹⁰