

The Effect of Isotonic Drinks on The Solubility of Calcium and Phosphate in Tooth Enamel

Sari Dewiyani¹, Larisa Safira²

¹ Lecturer, PhD, Departement of Conservative Dentistry and Endodontics, Faculty of Dentistry Universitas Prof. Dr. Moestopo (Beragama), Indonesia

² Student, Faculty of Dentistry Universitas Prof. Dr. Moestopo (Beragama), Indonesia

ABSTRACT

Introduction: Tooth enamel is a tissue that undergoes a high mineralization process but is susceptible to acidic foods and drinks. Calcium and phosphate are the main components of tooth enamel. Isotonic drinks are soft drinks that people like because they can replace body fluids when dehydrated, but these drinks are high in acid content, which accelerates tooth enamel decay.

Material and methods. Laboratory experimental study (in vitro), a sample of 16 maxillary first premolars were divided into two groups. All teeth are separated by crowns and roots. In group one, the isotonic solution measured calcium levels with a wavelength of 420 nm, and in the second group of isotonic solutions, the phosphate level was measured at a wavelength of 590 nm. Furthermore, the teeth were immersed in 20 ml of isotonic drink for 60 seconds, then the levels of dissolved calcium and phosphate were measured again with a UV-vis spectrophotometer.

Results. There was a significant difference in the increase in the solubility of calcium and phosphate in tooth enamel before and after immersed in isotonic drink $P=0.012$ ($P<0.05$)

Conclusion. Isotonic drink affects the solubility of calcium and phosphate in tooth enamel.

KEYWORDS: Calcium, phosphate, isotonic drink, tooth enamel.

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I. INTRODUCTION

Tooth enamel consist of 95% minerals, 1% organic and 4% water. The mineral composition of enamel in large quantities is Ca, P, CO₂, Na, Mg, Cl, and K, while in small quantities it is F, Zn, Sb, Ba, W, Cu, Mn, Au, Ag, Cr, Co, and Va. The main inorganic substance is hydroxyapatite [Ca₁₀(PO₄)₆(OH)₂] and 90% of its volume is composed of calcium and phosphate components. Calcium and phosphate are the main components of crowns or tooth enamel.^{1,2} Tooth enamel is a tissue that undergoes a very high mineralization process but is susceptible to acid attack, either directly from food or as a result of bacterial metabolism which ferments carbohydrates into acids. The composition of food or drink that contains a lot of acid will accelerate the damage to the tooth enamel surface. Drinks that have an acidic pH include isotonic drinks, which if consumed in daily has the potential to be cariogenic to the teeth.^{3,4}

Isotonic drinks are a type of soft drink that is preferred by the public, because the product can replace body fluids

quickly during strenuous activities that cause dehydration, which can improve electrolyte balance and stimulate the body's metabolism.⁵ The composition of the isotonic drink (Pocari Sweat) consists of 98% water, the other 2% is in the form of sodium chloride ions, potassium phosphate, magnesium citrate and calcium lactate^{6,7} In Indonesia, isotonic drinks are the third most favorite consumed. Sales of isotonic drinks reached 12 billion per liter in 2013. The age group that consumes the most isotonic drinks is teenagers.⁸

The publication Newsmantraa (2022) states that global sales of isotonic drinks have increased from 2015-2020 and provides an analysis of increasingly widespread global market consumption in 2021-2030.⁹

Isotonic drinks have a high acid content below 4.5 resulting in changes in crystal structure and nanomorphology on the tooth enamel surface.³ The problem that occurs is that some people do not know the impact on teeth that can be caused by the habit of consuming these isotonic drinks. The purpose of this study was to provide information and

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broaden knowledge about the impact of consuming isotonic drinks on the dissolving of calcium and phosphate levels in tooth enamel. So that prevention efforts can be made as early as possible against the adverse effects that may be caused by exposure to isotonic drinking acid.

II. MATERIAL AND METHODS

Ethical clearance was performed by Research Ethic Committee Faculty of Dentistry Universitas Prof. Dr. Moestopo (Beragama), laboratory experimental studies (in vitro) were carried out using a tool measure the solubility of calcium and phosphate from the tooth surface, namely Uv-Vis Spectro.¹⁰

This research was conducted at the Engineering and Chemical Research Laboratory, University of Indonesia, Depok. Inclusion criteria: Crown intact and roots fully formed, no caries, no fillings. Exclusion criteria: teeth with

fractures, teeth with structural anomalies such as enamel hypoplasia, teeth with white spot lesions, teeth with calculus, and stains on the crowns of teeth. The sample consisted of 16 first maxillary and Premolars randomly divided into two treatment groups with each group consisting 8 teeth separated by crowns and roots. Before the teeth were immersed in the isotonic drink (Pocari Sweat), the isotonic drink was measured for calcium and phosphate levels using a Uv-Vis Spectrometer. Group one was measured with a wavelength of 420nm to measure the calcium content of 20 ml isotonic drink and group two was measured with a wavelength of 590 nm to measure the phosphate level of isotonic drink before soaking. Then 8 teeth in each group were immersed in 20 ml isotonic drink for 60 seconds. After that, the levels of calcium and phosphate in the isotonic drink were measured again using the Uv-Vis Spectrometer

III. RESULTS

Table 1. The solubility level of calcium and phosphate tooth enamel before and after immersed in isotonic drink (Pocari Sweat) 20 ml for 60 seconds.

	Solubility Level	
	Before Immersed	After Immersed
Ca (Calcium)	0,160	0,178
	0,160	0,178
	0,160	0,186
	0,160	0,177
	0,160	0,172
	0,160	0,178
	0,160	0,171
	0,160	0,176
PO4 (Phosphate)	0,079	0,102
	0,079	0,092
	0,079	0,120
	0,079	0,112
	0,079	0,097
	0,079	0,097
	0,079	0,096
	0,079	0,102

In Table 1 it can be seen that group one with 8 teeth measured calcium levels using Uv-Vis with a wavelength of

420nm and absorbance units, there was an increase in the solubility of phosphate in tooth enamel.

Table 2. Shapiro-Wilk Normality Test

	Shapiro – Wilk		
	Statistics	Df	Sig
Calcium Levels Before Teeth are Immersed	.800	8	.028
Calcium Levels After Teeth are Immersed	.903	8	.307
Phosphate Levels Before Teeth are immersed	.736	8	.006
Phosphate Levels After Teeth are Immersed	.880	8	.189

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Table 2. shows an abnormal distribution of data on tooth enamel calcium levels before immersed with isotonic drinks because the value of $P = 0.028$ ($P < 0.05$).

Normal data distribution on calcium levels in tooth enamel after being soaked in isotonic drinks because the value of $P = 0.307$ ($P > 0.05$). The distribution of data was abnormal on

tooth enamel phosphate levels before being soaked in isotonic drinks because the value of $P = 0.006$ ($P < 0.05$). Normal data distribution on tooth enamel phosphate levels after immersed with isotonic drinks because the value of $P = 0.189$ ($P > 0.05$).

Table 3. Average solubility of calcium and phosphate tooth enamel in isotonic drinks before and after immersed.

	N	Means
Calcium Levels Before Teeth are Immersed	8	.15850
Calcium Levels After Teeth are Immersed	8	.17662
Phosphate Levels Before Teeth are Immersed	8	.07812
Phosphate Levels After Teeth are Immersed	8	.10225

Figure 1.

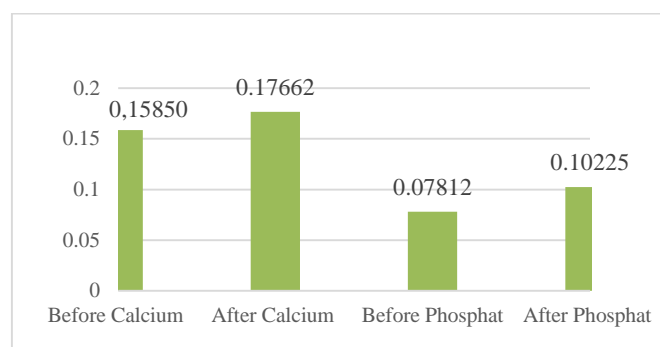


Table 3 and figure 1. Seen the average solubility of calcium and phosphate tooth enamel before and after immersed in isotonic drinks. There was an increase in the average solubility of calcium and phosphate tooth enamel after

immersed for 60 seconds, from the solubility of calcium tooth enamel 0.15850 to 0.17662 with a difference of 0.1812 and from the solubility of tooth enamel phosphate 0.07812 to 1.0225 with a difference 0.2413.

Table 4. Results of analysis of Wilcoxon test Calcium solubility in tooth enamel before and after teeth are immersed in isotonic drinks

	Before Calcium – After Calcium
Z	-2,524 ^a
asyp. Sig.(2-tailed)	012

In table 4. There is a significant difference in the solubility of calcium in tooth enamel in isotonic drinks before and

after immersed because the value of $P = 0.012$ ($P < 0.05$).

Table 5. Results of analysis of Wilcoxon test Phosphate solubility in tooth enamel before and after teeth are immersed in isotonic drinks.

	Before Phosphate – After Phosphate
Z	-2,524 ^a
asyp. Sig.(2-tailed)	012

In table 5. There is a significant difference in the solubility of tooth enamel phosphate in isotonic drinks before and after

teeth are immersed because the value of $P = 0.012$ ($P < 0.05$).

IV. DISCUSSIONS

Enamel is the hardest tissue and forms the outer layer of the tooth.¹¹ Enamel forms the protective covering over the

crown of the tooth. Despite its hard structure, tooth enamel is very brittle due to its high mineral content.¹ Demineralization is the loss of mineralized tooth enamel

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surfaces due to extrinsic and intrinsic factors. Extrinsic factors occur when the tooth surface comes into contact with acidic food or drink.¹² When the tooth surface is exposed to acid, the solubility of calcium and phosphate ions occurs in hydroxyapatite which is at a critical pH of around 5.5.⁵

Isotonic drinks consisting of water, carbohydrates, and electrolytes are solutions that contain the same osmolality as blood, where the normal osmolality is between 280 and 290 mOsm/kg which is useful for controlling water loss and intake, aiming to restore fluid electrolyte and homeostasis.¹³

The research was started by measuring the levels of calcium and phosphate in isotonic drinks using a Uv-Vis Spectrophotometer. After obtaining the levels of calcium and phosphate in the isotonic drink, then 8 samples of dental crowns were placed in the cuvettes, each cuvet containing 20 ml of the isotonic drink for 60 seconds. exposure to tooth enamel with drinks consumed every glass/day.¹⁴

8 teeth in group 1 were measured at a wavelength of 420 nm according to the standard wavelength for examination of calcium levels and 8 teeth at a wavelength of 590 nm for examination of phosphate levels using a Uv-Vis spectrophotometer.

Based on the Wilcoxon test (Table 4) it showed that there was a significant difference in the levels of calcium enamel of the teeth before and after immersed with isotonic drinks because the value of $P = 0.012$ ($P < 0.05$) congestedabel 5the results of the Wilcoxon test showed a significant difference in the levels of tooth enamel phosphate before and after immersed in isotonic drinks because the value of $P = 0.012$ ($P < 0.05$). Table 3 shows the average solubility of calcium and phosphate in tooth enamel before and after immersed in isotonic drinks. There was an increase in the average solubility of calcium and phosphate tooth enamel after immersed for 60 seconds, namely from the solubility of calcium tooth enamel 0.15850 to 0.17662 with a difference of 0.1812 and from the solubility of calcium tooth enamel phosphate 0.07812 to 0.10225 with a difference of 0.2413. The results of this study showed that there were levels of dissolved calcium and phosphate in isotonic drink during 60 second immersion.

The results of this study are in accordance with research by Kazmi (2016) and Ostrowska A (2016) which shows an increase in enamel roughness can occur due to exposure to acidic drinks that have a pH below 5.5, the citric acid component in isotonic drinks causes the demineralization process to occur. Ostrowska (2016) explained that the citric acid component is an organic acid which results in an increase in surface roughness. Citric acid also has the property of a chelating agent as a catalyst in biological reactions^{5,15}. The results of this study are also in accordance with the research of Kaye G (2017) which states that the level of acidity found in sports drinks can cause the solubility of elements in tooth enamel¹⁶ and Cochrane (2012) conducted research on 10 types of isotonic drinks (sports drinks) and stated that sMost of the sports drinks

tested resulted in tooth erosion with substantial surface loss and softening of the enamel surface.¹⁷

V. CONCLUSION

Based on the results of research that has been done, that isotonic drinks affect the solubility of calcium and phosphate in tooth enamel. It is necessary to carry out further research on the morphology or changes that occur in tooth enamel after being immersed in isotonic drinks using a Scanning Electrone Microscope (SEM) and elements dissolved in tooth enamel using the EDAX (Energy Dispersive Spectroscopy) method as well as testing the hardness of tooth enamel.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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