TED ANKARA COLLEGE FOUNDATION HIGH SCHOOL

Investigating the erosive effect of energy drink on human dental enamel surface morphology of permanent teeth by measuring the surface roughness with profilometer

---

Biology Extended Essay

Supervisor: Bahar CİHANOĞLU

Name of student: Zeynep ÖZALP

Candidate Number: D1129-048

Word Count: 3558

ABSTRACT

Dental erosion, which is a loss of dental hard tissue, is a big problem in today's world. One of the main reasons of this problem is the acidic and carbonated beverages among which I have chosen the energy drinks. This experiment is focused on the erosive effect of energy drinks on dental enamel surface morphology of human permanent third molar teeth with the research question: "How is the dental enamel surface morphology of human permanent third molar teeth effected by increasing exposure time interval of permanent teeth in energy drink while the temperature, pressure, type of energy drink is kept constant, by measuring the surface roughness with contact profilometer?" Would increasing exposure time redound the dental erosion? For this experiment 7 freshly extracted caries free human permanent third molar teeth were used. Samples were placed in a plastic container with 100 mL of energy drink and stored at 36,5°C. The surface roughness of 7 teeth were measured by contact profilometer at the end of the 1st day, 1st week, 1st month, 3rd month and 6th month. The test solution was changed daily. The data were statistically analyzed by Wilcoxon Signed-Rank Test.

The results showed that there was a clear rise in surface roughness on dental enamel of permanent third molar teeth as the exposure time interval of permanent teeth in energy drink is increased. There was a significant difference between the surface roughness values from the beginning until the end of 6th month. The results of this experiment supported my hypothesis, in which; there would be a significant dental enamel loss caused by energy drink, was stated.

Word count : 268

Table of Contents

INTRODUCTION

I have always been interested in biology, however, never selected a topic that could be investigated seriously. My mother is a dentist that lead me to get interested in oral health. I saw one of her patients who had a dental erosion problem. It was an attractive subject for me to search and I attributed my study on that province.

I carried out researches on the substances and factors that cause dental erosion. Dental erosion is defined as loss of dental hard tissue by a chemical process that does not involve bacteria[1]. Etiological factors in dental erosion include acidic and carbonated beverages, vomiting and gastro esophageal reflux and frequent swimming in heavily chlorinated water[2]. Chemical factors that influence the erosive potential of erosive agents such as acidic drinks and foodstuffs include pH, mineral content, tooth surface clearance and calcium- chelation properties[3,4]. Biological factors such as saliva, tooth structure and positioning in relation to soft tissues and tongue are related to the pathogenesis of dental erosion. Behavioral factors include eating and drinking habits and decrease in salivary flow caused by exercise, excessive oral hygiene and an unhealthy life style related to conditions such as chronic alcoholism [5]. I chose the pH factor and associated it with the energy drinks because they have a pH ranging from 3.1 to 3.4 and this pH value is suitable for dental erosion.[6]

I searched the energy drinks which are widespread in Turkey. Based on my researches I decided to study with "Burn".

I decided time intervals as independent variable because the consumption frequencies are more important. In a later research, I decided to work on the impacted human permanent third molar teeth because they have not been interphased with the oral environment before the study.

---

[1] Pindborg, J.J. (1970): Pathology of Dental Hard Tissues, Copenhagen: Munksgaard, pp. 312-321
[2] Peres KG, Armênio MF, Peres MA, Traebert J, De Lacerda JT. Dental erosion in 12-year-old schoolchildren: a cross-sectional study in Southern Brazil. Int J Paediatr Dent 2005 ;15: 249-55.
[3] Bartlett DW, Bureau GP, Anggiansah A. Evaluation of the pH of a new carbonated soft drink beverage: an in vivo investigation. J Prosthodont 2003;12: 21-5.
[4] Meurman JH, Härkönen M, Näveri H, et.al . Experimental sports drinks with minimal dental erosion effect. Scand J Dent Res 1990; 98: 120-8.
[5] Lussi A, Jaeggi T. Erosion—diagnosis and risk factors. Clin Oral Investig 2008;12 : 5-13.
[6] Owens BM, Kitchens M. The Erosive Potential of Soft Drinks on Enamel Surface Substrate: An In Vitro Scanning Electron Microscopy Investigation. *J Contemp Dent Pract* 2007; 8 : 11-20

This experiment will focus on the research question:

"How is the dental enamel surface morphology of human permanent third molar teeth effected by increasing exposure time interval of teeth in energy drink while the temperature, pressure, type of energy drink is kept constant, by measuring the surface roughness with contact profilometer?"

The importance of this research topic is to demonstrate the erosive effect of energy drinks on dental enamel surface morphology of teeth. Especially, in recent years it is observed that one of the top oral health problem is dental erosion. Searching the effects of consumption frequencies of energy drinks -a nutrient that could affect the dental erosion - on dental enamel surface morphology of human teeth could represent a model for importance of oral health.

HYPOTHESIS

Teeth are essential for mastication, phonation and aesthetic. Early loss of tooth is important for oral health. Besides, dental caries, dental erosion is a major factor which leads to tooth loss. One of the most considerable etiological factor of dental erosion is acidic and carbonated beverages among which I have chosen the energy drinks. However, besides the consumption of energy drinks, the consumption frequency is more important. As a result it can be hypothesized that " Different exposure time intervals of teeth in energy drink will affect the dental enamel surface morphology of teeth". My hypothesis implies a few possible outcomes; energy drink can either increase the dental erosion or makes no significant change on the dental enamel. My prediction is that; energy drink would show its erosive effect and increase the surface roughness by increasing the dental erosion and loss of dental enamel when it is consumed with high frequencies.

METHOD DEVELOPMENT AND PLANNING

In order to perform the experiment in the most suitable way, there was a need to an appropriate method. There are lots of variables that could affect the results of the experiment, so; all variables should be kept constant except the independent variable which in this case is the exposure time intervals of human permanent third molar teeth in energy drink. The dependent variable in this case is the surface roughness of the dental enamel measured by contact profilometer, which is going to be changed according to the independent variable. In order to avoid undesired impacts of the other variables, the following variables have to be kept constant in order to observe the effect of exposure time intervals of teeth in energy drink: Room temperature, pressure, freshly extracted impacted human permanent third molar teeth, source, volume and temperature of distilled water, size of acrylic resin, type and volume of energy drink.

In order to design an appropriate method, I examined the scientific articles about dental erosion and I searched the experiments about my topic. Before I started my experiment I conferred to my mother, who is a dentist, about the selection of teeth. Considering her advices, I decided to collect impacted human permanent third molar teeth and the characteristics such as age and sex were not considered. The reason to extract the impacted teeth was, they have not been interphased with the oral environment before the study, so the enamel surface of the teeth were not affected by the bacterial attack, saliva or any food and drink.

7 samples of teeth were collected from Ankara University Faculty of Dentistry, Department of Oral Maxillofacial Surgery. Immediately after the extraction, the teeth were stored in distilled water at room temperature so as not to dry until they were used for the experiment. Then, the teeth were cleaned from the organic debris with Pumice in order to maintain a clear surface.
The first problem I came across was to determine the type of test solutions. An earlier study reports that, sports and energy drinks have the greatest erosive effects on enamel, also suggested this finding could be related to the higher concentrations of refined carbohydrates (sucrose and glucose) found in these drinks [7] . I decided to use energy drinks in my

[7] Owens BM, Kitchens M. The Erosive Potential of Soft Drinks on Enamel Surface Substrate: An In Vitro Scanning Electron Microscopy Investigation. J Contemp Dent Pract 2007; 8 : 11-20

experiment. The reason that lead me to concentrate on this type of drink was its' being acidic and having higher concentrations of carbohydrates, as well as the high consumption rate of them in Turkey. Considering all these facts, my choice was to employ "Burn".

After the cleaning process of the teeth, the crowns were separated from the roots using a Diamond Bur with the aim to study only the dental enamel. The samples were embedded in Acrylic Resin for ease of handling during the experiment. This process was done by mixing the powder and the liquid acrylic together and then pouring them into a mould and the teeth were embedded.

The enamel surface of the samples were ground with Abrasive Paper (500-2000 grid) in order to maintain a flat surface. Then I labeled the samples with a pen from 1 to 7.

The purpose of my study is to investigate the erosive effect of energy drink on dental enamel, so I decided to measure it by contact profilometer to evaluate the surface roughness. The profilometer is obtained from the Gazi University Faculty of Dentistry. For the base line value, the first sample is taken and three values are measured digitally from the same point on dental enamel. I measured three values from the same point and obtain the mean value, in order to be as accurate as possible. This process is repeated for the other 6 samples, too.

As the pH is one of the major factor in dental erosion, the pH of the energy drink was measured by a pH electrode upon opening the can. The composition and the pH of the energy drink is given in Table 1.

Beverage	Manufacturer	Composition	pH (0-14)
Burn	The Coca –Cola Co.Atlanta , GA,USA	water, acidity regulator (citric asit, natrium sitrat), antioxidants (ascorbic asid), arginine, aromas (theobromine), B vitamines, caffeine, carbonated water, food coloring (E 163, E150d), ginseng, glucuronolacton, guarana, maltodextrin, preservative(E202), sugar, taurine[8].	2.6

Table 1: Table showing the composition and pH of 'Burn'.

[8] http://en.wikipedia.org/wiki/Burn_(energy_drink)

The samples were placed in a plastic container with 100 mL of energy drink and stored at 36.5°C. To get rid of the problem of maintaining the temperature constant, the plastic container with samples were stored in etuve. The solution was changed daily at 19:00 p.m.

As my independent variable is the exposure time intervals of the teeth, the samples were measured by profilometer at the end of the 1st day, 1st week, 1st month, 3rd month and 6th month. The data were statistically analyzed by Wilcoxon Signed-Rank Test.

MATERIALS

7 human permanent third molar teeth
Diamond Bur
Distilled water
Pumice
Acrylic Resin
Mould
Glass
Abrasive paper
pH electrode
Plastic container (200 mL)
Etuve
Energy drink (Burn) (100 mL)
Pen
Paper
Gloves
Mask
Contact Profilometer (Surftest 402 mitutoyo, Tokyo)

METHOD

A. Preparation of the samples

1. 7 samples of teeth were cleaned from the organic debris with Pumice by brushing.
2. The crowns of the teeth were seperated from the roots using a Diamond Bur.
3. The powder and the liquid acrylic were mixed in a glass and then poured into the mould.
4. The samples were embedded in Acrylic Resin.
5. The enamel surface of the samples were ground with Abrasive Paper.
6. The samples were labelled with a pen from 1 to 7.
7. The pH of the energy drink was measured by pH electrode and recorded.

B. Surface roughness measurement for the base line

1. For the base line values the 7 samples' enamel surfaces were measured digitally by profilometer.
2. The profilometer was contacted to the enamel surface and measurements were obtained.
3. For each sample 3 measurements were done.
4. The data was recorded and the mean values were obtained.

C. pH analysis and immersion of the samples

1. pH of the energy drink was measured and recorded by a pH electrode upon opening the can.
2. By using a measuring cylinder, 100 mL energy drink was poured into a plastic container.
3. The samples were placed into the container.
4. The apparatus were put in to etuve and stored at 36.5°C.
5. The solution was changed daily at 19:00 p.m.

D. Surface roughness measurements

1. The samples were measured by profilometer at the end of the 1^{st} day, 1^{st} week, 1^{st} month, 3^{rd} month and 6^{th} month.
2. The data were statistically analyzed by Wilcoxon Signed-Rank Test.

RESULTS

Table 2: Raw data table showing the roughness of the surface of the teeth samples measured with the contact profilometer. R(a) value is the unit of the profilometer which identifies the roughness.

Sample	Trial	Initial Surface Roughness (R(a)) (±0.01)	Surface Roughness Measured On The 1st Day (R(a)) (±0.01)	Surface Roughness Measured On The 1st Week (R(a)) (±0.01)	Surface Roughness Measured On The 1st Month (R(a)) (±0.01)	Surface Roughness Measured On The 3rd Month (R(a)) (±0.01)	Surface Roughness Measured On The 6th Month (R(a)) (±0.01)
1	1	0.72	0.72	0.73	0.75	0.80	0.88
	2	0.72	0.72	0.73	0.75	0.79	0.88
	3	0.71	0.71	0.72	0.74	0.79	0.87
2	1	0.72	0.72	0.73	0.75	0.80	0.88
	2	0.71	0.71	0.72	0.74	0.79	0.87
	3	0.71	0.71	0.72	0.74	0.79	0.87
3	1	0.71	0.71	0.73	0.75	0.81	0.89
	2	0.70	0.70	0.72	0.74	0.80	0.88
	3	0.71	0.71	0.72	0.74	0.79	0.88
4	1	0.72	0.72	0.73	0.76	0.82	0.90
	2	0.72	0.72	0.73	0.75	0.80	0.88
	3	0.72	0.72	0.74	0.77	0.84	0.91
5	1	0.72	0.72	0.74	0.76	0.82	0.90
	2	0.73	0.73	0.74	0.76	0.82	0.90
	3	0.73	0.73	0.74	0.77	0.84	0.92
6	1	0.70	0.70	0.71	0.73	0.78	0.86
	2	0.71	0.71	0.72	0.74	0.79	0.87
	3	0.71	0.71	0.72	0.74	0.79	0.88
7	1	0.72	0.72	0.73	0.75	0.80	0.87
	2	0.71	0.71	0.72	0.75	0.81	0.89
	3	0.73	0.73	0.74	0.76	0.82	0.90

Table 3: Mean values of surface roughness (in R(a)) of teeth samples. R(a) value is the unit of the profilometer which identifies the roughness.

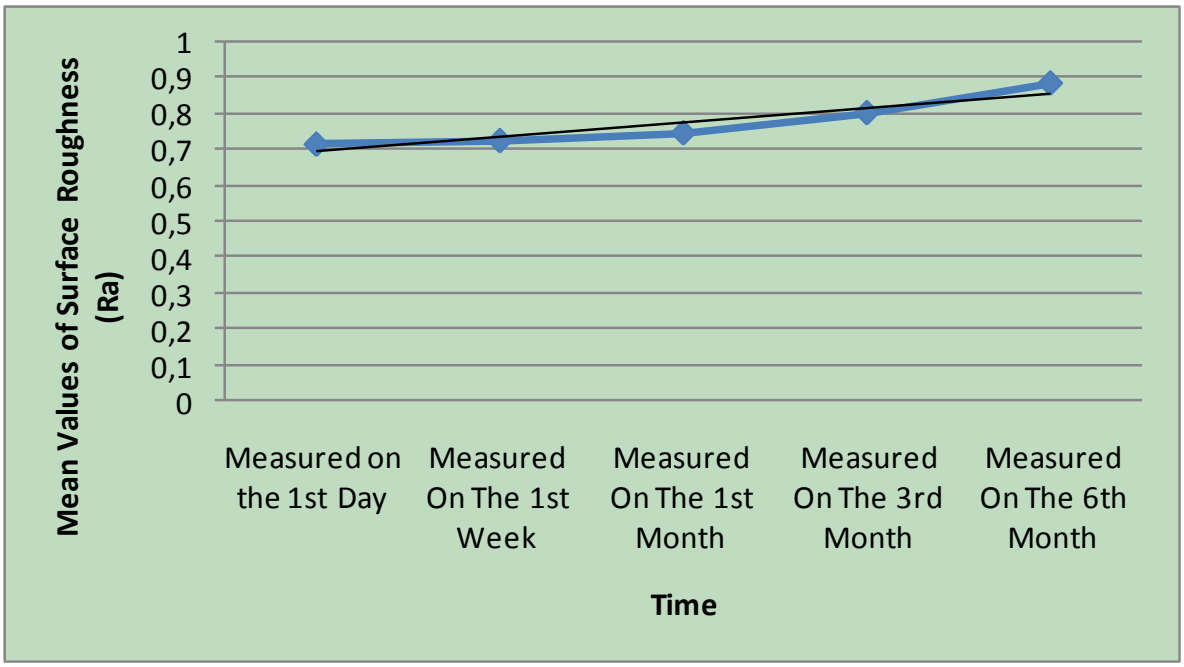
Sample	Initial Surface Roughness (R(a)) (±0.01)	Surface Roughness Measured On The 1st Day (R(a)) (±0.01)	Surface Roughness Measured On The 1st Week (R(a)) (±0.01)	Surface Roughness Measured On The 1st Month (R(a)) (±0.01)	Surface Roughness Measured On The 3rd Month (R(a)) (±0.01)	Surface Roughness Measured On The 6th Month (R(a)) (±0.01)
1	0.72	0.72	0.73	0.75	0.79	0.88
2	0.71	0.71	0.72	0.74	0.79	0.87
3	0.71	0.71	0.72	0.74	0.80	0.88
4	0.72	0.72	0.73	0.76	0.82	0.90
5	0.73	0.73	0.74	0.76	0.83	0.91
6	0.71	0.71	0.72	0.74	0.79	0.87
7	0.72	0.72	0.73	0.75	0.81	0.89

DATA ANALYSIS

Table 4: Processed data table showing the mean values of surface roughness of the tooth due to the increasing exposure time interval of teeth in energy drink, standard error, standard deviation and confidence interval of groups calculated by using Microsoft Excel 2007 Programme.

Samples/Surface Roughness	Initial	Measured on the 1st Day	Measured On The 1st Week	Measured On The 1st Month	Measured On The 3rd Month	Measured On The 6th Month
1	0,72	0,72	0,73	0,75	0,79	0,88
2	0,71	0,71	0,72	0,74	0,79	0,87
3	0,71	0,71	0,72	0,74	0,8	0,88
4	0,72	0,72	0,73	0,76	0,82	0,9
5	0,73	0,73	0,74	0,76	0,83	0,91
6	0,71	0,71	0,72	0,74	0,79	0,87
7	0,72	0,72	0,73	0,75	0,81	0,89
Mean	0,717142857	0,717142857	0,727142857	0,748571429	0,804285714	0,885714286
Standard Deviation	0,007559289	0,007559289	0,007559289	0,008997354	0,016183472	0,015118579
Standard Error	0,002857143	0,002857143	0,002857143	0,00340068	0,006116777	0,005714286
T	2,446911846	2,446911846	2,446911846	2,446911846	2,446911846	2,446911846
Confidence Level (95,0%)	0,006991177	0,006991177	0,006991177	0,008321165	0,014967215	0,013982353

Graph 1 : Line graph showing the average surface roughness of the teeth due to the increasing exposure time interval of teeth in energy drink(Burn).



H_0 : There is <u>not</u> a significant difference between the means of surface roughness of human permanent third molar teeth the due to the increasing exposure time interval of teeth in energy drink.

H_1 : There is a significant difference between the means of surface roughness of human permanent third molar teeth the due to the increasing exposure time interval of teeth in energy drink.

In order to decide whether the alternative hypothesis or the null hypothesis is supported, a test is made. The results are shown in the table below.

Table 4: The results of the Wilcoxon Signed-Rank Test made with the Microsoft 2007 Excel Programme.

	n	Mean	Median	Minimum	Maximum	z	p
Initial Surface Roughness (R(a))	7	0,717	0,72	0,71	0,73		
Surface Roughness Measured On The 1st Day (R(a))	7	0,717	0,72	0,71	0,73		
						0	1
Initial Surface Roughness (R(a))	7	0,717	0,72	0,71	0,73		
Surface Roughness Measured On The 1st Week (R(a))	7	0,727	0,73	0,72	0,74		
						-2,65	0,008
Initial Surface Roughness (R(a))	7	0,717	0,72	0,71	0,73		
Surface Roughness Measured On The 1st Month (R(a))	7	0,749	0,75	0,74	0,76		
						-2,53	0,011
Initial Surface Roughness (R(a))	7	0,717	0,72	0,71	0,73		
Surface Roughness Measured On The 3rd Month (R(a))	7	0,804	0,8	0,79	0,83		
						-2,38	0,017
Initial Surface Roughness (R(a))	7	0,717	0,72	0,71	0,73		
Surface Roughness Measured On The 6th Month (R(a))	7	0,886	0,88	0,87	0,91	-2,39	0,017

The Wilcoxon Signed-Rank Test results revealed that p values are smaller than alpha value (0.05). The difference between the surface roughness of the teeth with different expose time intervals of teeth in energy drink is too big to be explained by chance only. This shows that there is a statistically significant mean difference. Hence, H_0 is rejected and H_1 is accepted.

CONCLUSION AND EVALUATION

The aim of this experiment was to decide whether there is a significant difference between the means of surface roughness of teeth due to the increasing exposure time interval of teeth in energy drink. It was hypothesized that different exposure time intervals of teeth in energy drink will affect the dental enamel surface morphology of teeth.

In this experiment 7 samples of impacted human permanent third molar teeth taken from Ankara University Faculty of Dentistry, Department of Oral Maxillofacial Surgery were firstly cleaned from the organic debris and then the crowns were separated from the roots and the samples were embedded in acrylic resin. The enamel surface of the samples were ground and labeled from 1 to 7. For the base line values the 7 samples' enamel surfaces were measured digitally by profilometer. The samples were placed into the container which contains 100 mL of energy drink. In order to determine the changing surface roughness with the changing exposure time, the samples' surface were measured by profilometer at the end of the 1st day, 1st week, 1st month, 3rd month and 6th month.

It was seen that the greatest surface roughness was observed in 6th month when compared with the measurements of other time intervals. The average surface roughness of teeth were found as 0.71714, 0.71714, 0.72714, 0.74857, 0.80428 and 0.88571 for groups initial, 1st day, 1st week, 1st month, 3rd month and 6th month respectively. As it is observed in Graph 1, there is a notable incline in the surface roughness of the teeth as the exposure time in energy drink increase. To decide whether there is a statistical difference between these mean values Wilcoxon Signed-Rank Test is applied. The null hypothesis formed for the test stated there is not a significant difference between the means of surface roughness of teeth due to the increasing exposure time interval of teeth in energy drink.

In the test, there are two values; the first one is 'z' and the second one is 'p'. The statisticians used to deal 'z' value in order to compare the statistics however, this value is not used in the results of the experiments. The 'p' value is used in evaluation of the results. Look at the table 4, the 'p' values found are smaller values than alpha value (0.05). 'p' value being smaller than 0.05 indicates that there is a statistically significant mean difference amongst the groups. As a result the null hypothesis is rejected and the alternative hypothesis, stating there is a significant difference between the means of surface roughness of teeth due to the increasing

exposure time interval of teeth in energy drink is accepted. With the result of the statistical test, main hypothesis stating different exposure time intervals of teeth in energy drink will affect the dental enamel surface morphology of teeth is supported.

The standard deviation values for the groups initial, 1st day, 1st week, 1st month, 3rd month and 6th month are 0.007559289, 0.007559289, 0.007559289, 0.008997354, 0.016183472, 0.015118579 respectively. Since the standard deviation indicates the reliability of the distribution of the data within the group, when they are compared it can be said that the data are consistent.

Graph 1, shows the average surface roughness of the teeth due to the increasing exposure time interval of teeth in energy drink. Since the independent variable shows a continuous trend, a line graph was found appropriate for the data.

The dental erosion is affected from several factors like; etiological, chemical, biological and behavioral. To set up a reliable experiment the effect of these factors need to be minimized. Because of these reasons, it was decided to use human permanent third molar teeth and the characteristics such as age and sex were not considered. However, some genetic factors such as the mineral content of the teeth can affect the dental erosion.

Even though it is not possible to get rid of the differences that took place due to the mineral content of the teeth, it is possible to minimize the effects of these differences. The collected 7 samples were examined with 3 times repeated measurements reducing the effect of random variation and the errors caused by the faulty measurement of profilometer. In order to have a more reliable data, the average values are taken.

Although the factors mentioned above were tried to be kept constant during the experiment, there were systematic errors made in conducting the experiment which lead to inaccurate results.

The main systematic error arose from the grinding process of the teeth. The enamel surfaces of the samples were ground with Abrasive Paper (500-2000 grid) manually in order to maintain a flat surface. However, the pressure applied for the grinding process is important because both high and low pressures affect the surface roughness of the teeth. During this

process, the force applied was tried to kept constant however, in order to obtain more reliable results the experiment can be repeated by using an automatically controlled abrasion tool.

Secondly, there are some random errors caused by unpredictable changes. It is impossible to prevent differences caused by the content of the teeth. In this experiment, 7 samples were collected and each measurement was repeated 3 times reducing the effect of random variation. However, in order to obtain more reliable data the number of samples can be increased.

The brands of the energy drink can affect the erosion on dental enamel and the surface roughness of the teeth due to their pH and ingredient. Since one brand of energy drink was used in the experiment it cannot be said that it reflects all the properties of all energy drinks. Therefore, this experiment can be repeated with different brands of energy drinks in order to make the statements general about the erosive effect of energy drinks.

In evaluating the results of this in vitro study, it should be noted that the energy drinks will likely exhibit different behavior in vivo, particularly when consumed together with foodstuffs. Importantly, within the oral environment, the enamel surface is covered by a protective pellicle in addition to the protection offered by the flushing, buffering and remineralizing effects of saliva.[9,10] In order to overcome this limitation, a special contrivance which provides in vivo medium can be used.

The main factor that led me to do my extended essay on this topic is to observe whether energy drinks have an erosive effect on dental enamel or not. In the experiment the aim was to observe the surface roughness of the teeth, however many factors affected the results. It can be indicated that the comprehension of this study is beyond my limits and should be evaluated at academic level.

Consequently, my research question; "How is the dental enamel surface morphology of human permanent third molar teeth effected by increasing exposure time interval of teeth in energy drink while the temperature, pressure, type of energy drink is tried to be constant and

[9] Nekrashevych Y, Stösser L. Protective influence of experimentally formed salivary pellicle on enamel erosion. An in vitro study. Caries Res 2003; 37: 225-31
[10] Woltgens JH, Vingerling P, de Blieck-Hogervorst JM, Bervoets DJ. Enamel erosion and saliva. Clin Prev Dent 1985; 7: 8-10

by measuring the surface roughness with contact profilometer?" is answered in favor which means there is a statistical difference between the means of surface roughness of teeth due to the increasing exposure time interval of teeth in energy drink. As the exposure time of teeth in energy drink increases, the dental erosion and the surface roughness increases.

As a conclusion, following could be mentioned; with the decrease in prevalence of dental caries in many developed countries, increasing attention has been paid to the problem of dental erosion, which has been recognized as an important cause of tooth tissue loss in children, adolescents and adults.[11,12,13,14] There are many beverages that cause dental erosion and dental enamel loss besides energy drinks. The potentially erosive effects of beverages on dental hard tissues should be kept in mind by pediatricians, dental practitioners, dieticians and pediatric dentists.

[11] Al-Dlaigan YH, Shaw L, Smith AJ. Dental erosion in a group of British 14-year old school children. Part III: Influence of oral hygiene practices. Br Dent J 2002;192: 526-30

[12] Ganss C, Klimek J, Giese K. Dental erosion in children and adolescents-across sectional and longitudinal investigation using study models. Community Dent Oral Epidemiol 2001;29: 264-71

[13] Lussi A, Schaffner M, Hotz P, Suter P. Dental erosion in a population of Swiss adults. Community Dent Oral Epidemiol 1991;19: 286-90

[14] Nunn JH, Gordon PH, Morris AJ, Pine CM, Walker A. Dental erosion—changing prevalence? A review of British national childrens' surveys. Int J Paediatr Dent 2003;13: 98–105

APPENDICES

i.Appendix 1

Below is information about Contact Profilometer (Surftest 402 mitutoyo, Tokyo).

Contact Profilometer (Surftest 402 mitutoyo, Tokyo)

Profilometer is a measuring instrument used to measure a surface's profile, in order to quantify its roughness.[15]

This type of measurement gives the arithmetical average of the absolute summations of all roughness on a surface (gradient and depth) at a certain measurement distance. In general surface roughness is defined as arithmetical average roughness (Ra).

Profilometer can be a contact or non-contact type. The type we used is a contact type, which means; it should have a direct contact with the enamel surface to get the measurements.

[15] http://en.wikipedia.org/wiki/Profilometer

ii.Appendix 2

Below are the photographs of the experimental process.

Figure 1: 7 samples of human permanent third molar teeth.

Figure 2: The crowns of the teeth were seperated from the roots using a Diamond Bur.

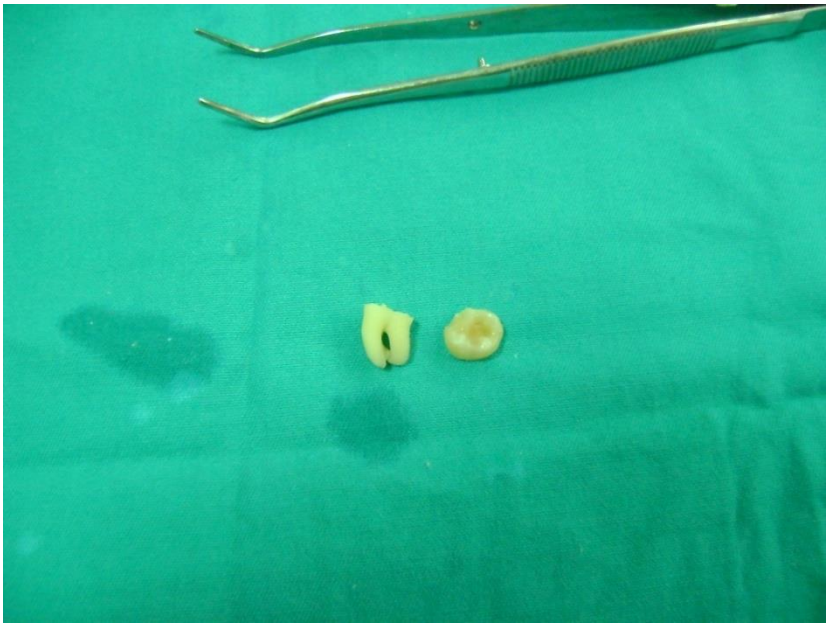


Figure 3: The samples were embedded in Acrylic Resin.

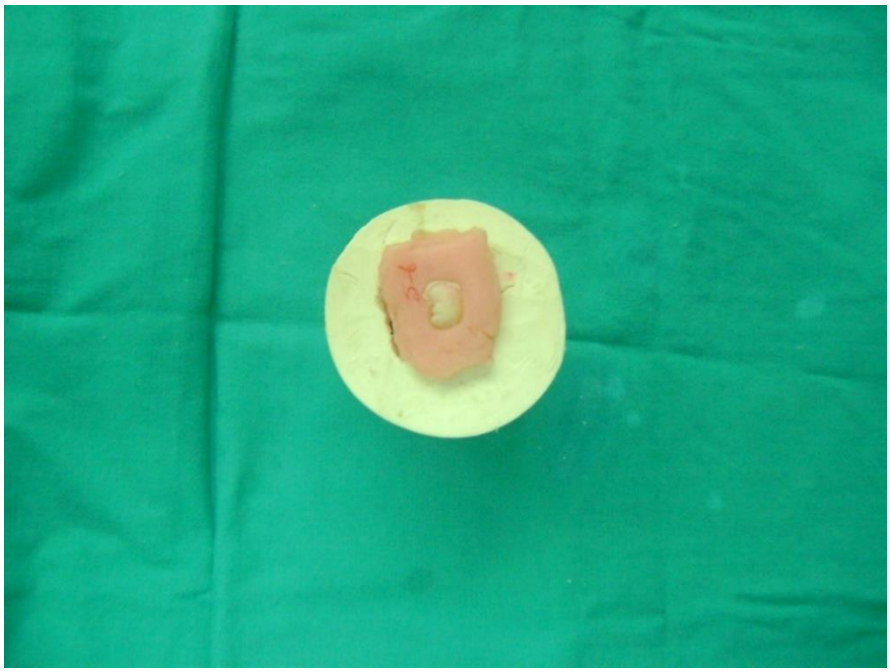


Figure 4: The samples are placed in a container which contains 100 mL of energy drink (Burn).

BIBLIOGRAPHY

1- Pindborg, J.J. (1970): Pathology of Dental Hard Tissues, Copenhagen: Munksgaard, pp. 312-321

2- Peres KG, Armênio MF, Peres MA, Traebert J, De Lacerda JT. Dental erosion in 12-year-old schoolchildren: a cross-sectional study in Southern Brazil. Int J Paediatr Dent 2005 ;15: 249-55

3- Bartlett DW, Bureau GP, Anggiansah A. Evaluation of the pH of a new carbonated soft drink beverage: an in vivo investigation. J Prosthodont 2003;12: 21-5

4- Meurman JH, Härkönen M, Näveri H, et.al . Experimental sports drinks with minimal dental erosion effect. Scand J Dent Res 1990; 98: 120-8

5- Lussi A, Jaeggi T. Erosion—diagnosis and risk factors. Clin Oral Investig 2008;12 : 5-13

6- Owens BM, Kitchens M. The Erosive Potential of Soft Drinks on Enamel Surface Substrate: An In Vitro Scanning Electron Microscopy Investigation. J Contemp Dent Pract 2007; 8 : 11-20

7- http://en.wikipedia.org/wiki/Burn_(energy_drink)

8- Nekrashevych Y, Stösser L. Protective influence of experimentally formed salivary pellicle on enamel erosion. An in vitro study. Caries Res 2003; 37: 225-31

9- Woltgens JH, Vingerling P, de Blieck-Hogervorst JM, Bervoets DJ. Enamel erosion and saliva. Clin Prev Dent 1985; 7: 8-10

10- Al-Dlaigan YH, Shaw L, Smith AJ. Dental erosion in a group of British 14-year old school children. Part III: Influence of oral hygiene practices. Br Dent J 2002;192: 526-30

11- Ganss C, Klimek J, Giese K. Dental erosion in children and adolescents-across sectional and longitudinal investigation using study models. Community Dent Oral Epidemiol 2001;29: 264-71

12- Lussi A, Schaffner M, Hotz P, Suter P. Dental erosion in a population of Swiss adults. Community Dent Oral Epidemiol 1991;19: 286-90

13- Nunn JH, Gordon PH, Morris AJ, Pine CM, Walker A. Dental erosion—changing prevalence? A review of British national childrens' surveys. Int J Paediatr Dent 2003;13: 98–105

14- http://en.wikipedia.org/wiki/Profilometer