



Dissolution of Calcium Ion from Human Enamel Treated With Zamzam Water in Comparison with Sodium Fluoride

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Abstract

Zamzam water has scientifically been proven to contain high concentration of calcium, magnesium, fluoride and many other minerals. This study aimed to test the ability of zamzam water to increase the resistance of enamel surface against acid dissolution compared to sodium fluoride. Teeth sample of 15 maxillary first premolars were randomly divided into 3 groups, study group treated with zamzam water, control positive treated with sodium fluoride and control negative treated with deionized water. The treatment lasted for two minutes once daily for 20 days interval. Then the concentration of the dissolved calcium ion in the etching solution of 2N HCl was measured by flame atomic absorption spectrometer. The amount of the released calcium ion from zamzam water treated group was lesser than that released from sodium fluoride treated group. However the difference was statistically not significant. A highly significant more calcium was dissolved from the water control group compared with the mentioned agents $P < 0.01$. Zamzam water effectively increase tooth resistance against acid dissolution, therefore it is useful to harden enamel surface against dental caries challenge.

Key words: Zamzam water, Calcium dissolution, acid etching.

Introduction

Minerals from foods or water can affect the erupted tooth via contact, or they can be absorbed in the intestinal tract and later secreted in the saliva. Some of these minerals are considered as cariostatic elements like fluoride, phosphorus and calcium, while others show caries promoting action like magnesium, selenium and cadmium⁽¹⁾. Water sufficient in quantity and quality to meet basic human needs is a prerequisite for both better health and sustainable development⁽²⁾. Water from zamzam spring is considered to be especially holy in the Islamic world. Islamic history tells that this spring

was opened for Hagar and her son Isma'il when they were dying of thirst in the desert. It lies within the precincts of the holy mosque at Makkah city. The well is forty-two meters deep and its water is slightly salty^(3,4,5). The sacred well of zamzam remains extremely popular with Muslim pilgrims, who drinks its water after taking their journey to Mecca and its also bottled and shipped to devout Muslims throughout the world⁽⁶⁾. A sign of its virtue is that Allah's Messenger said that "The best water on the face of the earth is the water of

zamzam. It satisfies in place of food and it is a cure from illness" (7).

Analysis of anions and cations revealed that zamzam water contains high level of calcium, fluoride, sodium, chloride, sulphate, nitrate, magnesium and potassium. With exception of fluoride all the mentioned minerals were found higher in concentrations in zamzam water compared to other drinking water included natural mineral water, bottled drinking water and tap water (6,8). Only traces of chromium, manganese and titanium have been found in zamzam water, the four toxic elements, arsenic, cadmium, lead and selenium have been found below the danger level for human consumption. The optimum limits for the elements are actually controlled by environmental conditions. Its pH value of 7.4 shows that the zamzam water is slightly alkaline, also it is medium hard water (9). It is naturally pure and sterile that has no germ in it (10), the chemical and biological characteristics of zamzam water determine its usefulness for drinking purpose (9). It provides effective germicidal action (6) and also it can affect the prevalence of dental caries (11). Zamzam water constituents as calcium, fluoride and other minerals may react with the outer enamel surface changing the resistance against caries challenge. However the purpose of the present study was to test the effect of zamzam water in increasing the enamel resistance against acid dissolution.

Materials and Methods

Teeth sample consisted of 15 randomly selected human maxillary first premolars extracted from 10-13 year old patients for orthodontic purpose. The extracted teeth were cleaned using conventional hand piece and rubber cup with non fluoridated pumice and deionized water and then

stored in 0.1% thymol solution at 4 C° until use to minimize brittleness of enamel and microbial growth (12).

Teeth were divided randomly into three equal groups and then immersed individually for two minutes once daily over 20 days in 30ml of their assigned test agents which included, zamzam water and sodium fluoride 0.05gm/100ml, which is the approved concentrations of daily home-used sodium fluoride mouth rinse (13), deionized water group was used as control negative. After each immersion the specimens were water washed in deionized water for 5 minutes, then stored in humid condition of deionized water to which 0.1% thymol was added until the next immersion. After the 20-day treatment period, a circular area 3mm in diameter were selected on each enamel specimen by applying prepared annular adhesive discs, avoiding macroscopic cracks and hypoplastic areas. The rest of the specimen was covered with sticky wax, leaving only the circular enamel window exposed for subsequent etching. The windows were etched for 15 seconds in separate polyethylene tubes each containing five ml of 2N HCl. The concentration of dissolved calcium ion was measured by flame atomic absorption spectrometer (12,14).

Statistical parameters, mean and standard deviation were calculated. Analysis of variance (ANOVA) and least significant difference (LSD) tests were used to evaluate the significance of difference between different variables. The confidence limit was accepted at 95%.

Result

The mean values of the dissolved calcium concentration were shown in Table (1). The maximum amounts was registered for deionized water group

followed by sodium fluoride treated group, while the least dissolved calcium concentration in acidic solution was recorded for zamzam water. Table (2) illustrated by ANOVA test that the difference in the calcium concentration was statistically highly significant between different groups. LSD test showed that there was statistically not significant difference between zamzam water group and sodium fluoride group, but only between the mentioned agents and deionized water the difference was highly significant.

Discussion

Water from holy zamzam well is consumed by many Muslims in the world. It is scientifically proved that it contains high level of minerals like calcium, fluoride magnesium and sodium. The quality of zamzam water from chemical point of view with regard to its effect on health indicates that it is suitable for drinking purpose^(6,8,9), for these reasons zamzam water was selected in the present study to test its ability to increase the resistance of enamel surface against acid dissolution.

The cariostatic efficacy of fluoride has been convincingly demonstrated and the recent decline in caries prevalence is primarily attributed to the increase use of various fluoride agents. The history of fluoridation is more than 70 years old. Sodium fluoride was the first topically applied fluoride compound, it is stable when kept in plastic container, its taste is well accepted by patients, the solution is not irritating to the gingiva, does not cause discoloration of tooth structure⁽¹⁵⁾ and its effectiveness to harden dental enamel was documented by many studies^(16,17), therefore it was used in this experiment as control positive. Calcium is one of the enamel major

elements that comprise about 33.6% - 39.4% of hydroxyapatite crystals which give enamel its hardness^(15,18), so calcium was chosen to test its dissolution upon exposure to acid attack.

After treatment of enamel samples with zamzam water and sodium fluoride 0.05%, an acid etching revealed that the released calcium ion concentration was higher for deionized water than the selected agents and the difference was statistically highly significant. This may be an indication of incorporation of ions that decrease porosity and increase enamel microhardness against demineralization by acid. When sodium fluoride solution is applied on the tooth surface as topical agent, it reacts with the enamel to form calcium fluoride or fluoridated hydroxyapatite crystals and these will increase the concentration of fluoride on enamel surface which in turn makes the tooth surface more resistant to acid attack⁽¹⁵⁾. Zamzam water was also effective to harden enamel and decrease dissolution of calcium ion from its surface and this was reflected by highly significant difference in the amount of dissolved calcium between zamzam water group and control negative group which was treated by deionized water. Zamzam water contains many minerals like calcium, fluoride sodium and potassium^(6,8), which can react with hydroxyapatite crystals and increase its resistance against acid challenge, but the mechanism of chemical reaction is not well known. However the presence of fluoride in zamzam water may be primarily responsible for the chemical reaction between zamzam water and hydroxyapatite crystals. Zamzam water contains multiple cariostatic elements⁽⁸⁾ and these elements may be responsible for the less concentration of calcium ion dissolved from zamzam

water treated group and more released calcium from sodium fluoride treated group, however the difference was statistically not significant. The time of treatment by selected solutions in this study was two minutes for 20 days, so increase the treatment time may increase the enamel hardness against acid, but this need to be confirmed by further studies.

It can be concluded from this experiment that zamzam water is effective to reduce enamel solubility and by that increase its resistance against caries attack, but these findings need more investigations by further studies before application of zamzam water in dentistry as caries preventive aid.

Reference

- 1- Harris No. Primary preventive dentistry .4th ed Appleton and Lange. Stamford, Connecticut , 1995 .
- 2- Guerquin F. world water actions: making water flow for all. Earth scan, 2003: 113.
- 3- Chatel V. water sheikhs and dam builders: stories of people and water in the middle east. Transaction publisher 2007:27.
- 4- Hughes T. A dictionary of Islam: Being acyclpaedia of the doctrines, Rites Asian Educational services 1996:701.
- 5- Schimmel A. Deciphering the signs of God: a phenomenolical approach to Islam. SUNY Press, 1994:6.
- 6- Altman N. Sacred water: the spiritual source of life. Hidden spring, 2002: 167.
- 7- Mubarakupri S. History of Makkah.Darussalam, 2002:75.
- 8- Saad B, Pok F, Sujar A, Saleh M. Analysis of anions and cations in drinking water samples by capillary ion analysis. Food chemistry. 61, Jan. 1998: 249-254.
- 9- Naem A, Alsanussi M, Almohandis A. Multielemental and hydrochemical study of holy zamzam water. J New England water works Association 1983; 97(2): 158-169.
- 10- Analytical report of zamzam water during the Ramadan and hajj seasons 1425 H. Cited from the institute of custodian of the Two Holy Mosque for Al Hajj Research Centre in Om Al Qura University (personal communication) 2005.
- 11- Al-Zuhair N, Khoungaian R. A comparative study between the chemical composition of potable water and zamzam water and its effect on tooth structure in Saudi Arabia. Saudi Dental Journal 2006; 18:843-855.
- 12- Barbakow F, Sener B, Snr Lab tech, Lutz F. Dissolution of phosphorus from human enamel pretreated in vitro using SnF₂ stabilized with amine fluoride 297. Clin prev Dent. 1987; 9(5): 3-6.
- 13- Featherstone JD. Prevention and reversal of dental caries, role of low level fluoride. Community Dental Epidemiol. 1999, 27: 31-40.
- 14- Al-Baldawy SH. Effect of ultrasonic cinnamon extract on the microhardness and microscopic features of artificial root caries compared to fluoridated agent. Master thesis. College of Dentistry, University of Baghdad, 2009.
- 15- Peter S. Essentials of preventive and community dentistry 2nd .Arya publishing house .Darya Ganj . New Delhi, 2004:249 .
- 16- AL-Ann: M. Effect of selected metal salts on the microhardness and microscopic features of initial carious lesion of permanent teeth .A master thesis, college of Dentistry, university of Baghdad, 2005.
- 17- Shaker N. Effect of water extract of cinnamon on the microhardness and microscopic features of initial caries like lesion of permanent teeth compared to fluoridated agent. A master thesis, College of Dentistry, university of Baghdad, 2008.
- 18- Thylstrup A, Fejerskov O. Textbook f Cariology, 1st ed . Munkgaard, Copenhagen, 1986:189.

Table 1. Concentration of calcium ion (mean and standard deviation) dissolved in HCl from enamel treated with selected agents.

Agent	No.	Mean(mg/dl)	± SD
Zamzam water	5	7.9	1.67
Sodium fluoride	5	9.8	1.92
Deionized water	5	17.3	1.48

Table 2. ANOVA test among difference solutions

	Sum of Squares	df	Mean square	F-value	P-value
Between groups	247.03	2	123.52	42.59	0.000*
Within groups	34.80	12	2.9		
Total	281.83	14			

* highly significant

Table 3. Least significant difference (LSD) between each two agents

Agent (1)	Agent (2)	Mean difference	P
Zamzam water	Sodium fluoride	1.9	N.S.
	Deionized water	9.4	0.00*
Sodium fluoride	Zamzam water	1.9	N.S.
	Deionized water	7.5	0.00*
Deionized water	Zamzam water	9.4	0.00*
	Sodium fluoride	7.5	0.00*

* highly significant