

Acidity Rate and Fluoride Content of Consumed Beverages in Kerman/Iran

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Abstract

Background: High consumption of nonalcoholic beverages is one of the causes of dental erosion. Annual consumption of beverages in Iran is 48 LPCY (Lit per capita per year) that is equal to 144 bottles per capita in year and is relatively a high rate. Taking this into consideration, the present study was planned to determine the pH and fluoride content of beverages consumed in Kerman, south east of Iran.

Methods: In a descriptive cross-sectional study during 2006-2007, samples of any type of beverages in Kerman were taken once every 4 months and each sample was examined for its acidity and fluoride content in ambient and refrigerator temperatures. A total of 744 experiments were conducted on 62 brands of beverages with different colors to determine the acidity and on 31 brands of beverages to determine their fluoride content. Acidity was determined by pH-meter in the ambient temperature and refrigerator temperature (+4° C). Fluoride content was determined using specific electrode method. Data analysis was done by SPSS software package.

Results: Mean acidity of the consumed beverages in Kerman was 2.55 and 2.78 mg/L in the ambient temperature and refrigerator temperature, respectively. Mean fluoride concentration in the temperature of the ambient and refrigerator were 1.13 and 1.27 mg/L respectively. Therefore beverages consumption in Kerman had a higher acidity than national standard.

Conclusion: Since some of the consumed beverages in Kerman are distributed and consumed in other parts of Iran as well, necessary precautions for controlling dental erosion especially in Kerman residents should be taken.

Keywords: Dental erosion, Acidity, Fluoride, Beverages

Introduction

High consumption of nonalcoholic beverages is one of the main causes of dental erosion. Sugar and acid content of nonalcoholic beverages, sweetened beverages and sports drinks can provide a good environment for dental erosion (1, 2). Dental erosion and caries both are the results of demineralization. Non reversible destruction of enamel and crown by chemical agents and in the absence of bacterial agents is called dental erosion (3-5). Steffen in a study performed in 1996 concluded that oral bacteria in the presence of acidic nonalcoholic beverages in-

crease dental erosion (6). Acidic nonalcoholic beverages such as Coca Cola and 7 up have a negative effect on enamel (7, 8). Oral pH in normal situation [6.2-7] has no destructive effect on teeth and dental erosion starts in pH < 5.5 (1). Cookies, fruits, carbonated fruit juices with high concentration of citric acid, phosphoric acid and other dietary acids decrease oral pH to less than 5.5 (3, 9-13). Some factors other than pH such as acid type, titratable acid, buffered capacity and temperature affect dental erosion capacity caused by acidic liquids (14). High consumption of nonalcoholic beverages has some other

health problems such as osteoporosis, kidney stones, weight gain and obesity. These beverages facilitate the risk of two types of diabetes in adolescents and adults (1). Bone fracture is 5 times more in girls who consume carbonated beverages compared to girls who do not consume these kinds of beverages (1, 15, 16). Long term consumption of liquids with high fluoride concentration leads to dental fluorosis. Fluoride in very high concentrations can cause osteofluorosis. Fluoride and antioxidants prevent dental erosion (17, 18). Fluoride in addition to increasing dental resistance to acid has antimicrobial effect and causes remineralization of primary caries (19). According to a study performed during 2004, American population paid a total of 66 billion American dollars for carbonated beverages. One fifth of the 1-2 yr old American children were consuming nonalcoholic beverages and approximately half of the 6-11 yr old American children were consuming soda (1). Annual consumption rate of non-alcoholic beverages in Iran is 48 LPCY (Lit per capita per year) that is equal to 144 bottles (on the average there is 330 ml in each bottles) per year (19).

Considering high rate of nonalcoholic beverages consumption in Iran and its effects on dental erosion, the present study was performed with the aim of determining pH and fluoride content of consumed beverages in Kerman.

Materials and Methods

In this descriptive cross-sectional study, during 2006-2007, once every 4 months, one sample of each type of non-alcoholic beverages in Kerman was taken. Samples were being taken to the Research Laboratory at School of Public Health, Kerman University of Medical Sciences, and studied for their acidity and fluoride content once in the ambient temperature and once in the refrigerator temperature (+4 °C). Totally, 744 experiments were performed on 62 brands of beverages with different colors for determina-

tion of acidity and on 31 brands of beverages for determination of fluoride content. Beverages were purchased from supermarkets, wholesalers and beverage factories. Acidity was determined by digital pH meter (HANNA) and based on standard method in two conditions of ambient temperature and refrigerator temperature (+4 °C) (20- 22). Fluoride content was determined based on ISIRI NO: 2351 by fluoride-selective electrode (QSE 333, EDT instruments Ltd) method. This method was preferred to colorimetric method because of the disturbing effect of presence of Fe^{+3} , Al^{+3} , SI^{+4} leading to the formation of a color complex with fluoride. Moreover, color content of beverages, itself, is another reason for avoiding colorimetric method. In order to prevent the interference resulting from the presence of sulfate or phosphate in selective electrode method a buffer solution with pH= 5-5.5 was used (23). These methods are based on standard methods mentioned in the textbook of "standard methods for examination of water and wastewater" (22). Data analysis was done by SPSS software package.

Results

Mean acidity of consumed beverages in Kerman was 2.56 ± 0.42 with the range of 2.03-4.55 with standard deviation of 0.42 in 22.5 °C and 2.2-4.59 with standard deviation of 0.43 in 2.78 °C (Table 1). Fig.1 and 2 shows the obtained mean acidity in this study and the approved standards in Iran.

As it is shown in Table 1 mean fluoride content of the consumed beverages was 1.14 ± 0.55 with the range of 0.65-2.7mg/L with standard deviation of 0.55 in the condition of ambient temperature and 1.27 ± 0.52 with the range of 0.7-2.7 with standard deviation of 0.52 in the refrigerator temperature. Considering the standard range of 3.2-3.8 for the acidity rate of nonalcoholic beverages in Iran, 3.17% of the consumed beverages in Kerman in the duration of this study had high acidity, 4.76% had standard acidity and the rest had low acidity.

Table 1: Max, Min, SD and average of pH and Fluoride at environment and refrigerator temperature

Statistical Parameter	Fluoride Concentration at 22.5°C (mgr/lit)	Parameter	
		Fluoride Concentration at 2.8 °C (mgr/lit)	
Max	2.7	2.7	4.55
Min	0.65	0.7	2.03
Average	1.14	1.27	2.56
SD	0.55	0.52	0.42

Table 2: Amount of pH at different beverage and Comparison with Standard

Kind of beverage	pH at 22.5°C	pH at 2.8°C	Maximum Limit of standard	Minimum Limit of standard
Kerman zamzam(colorless)	2.8	3.1	3.8	3.2
Esfahan Cofi Cola(colorless)	3.1	3.4	3.8	3.2
Esfahana Arso Cola(colorless)	2.5	2.9	3.8	3.2
Esfahana Arso Deniz(colorless)	2.8	3.1	3.8	3.2
Tehran Fanta Noshab(yellow)	2.8	3.1	3.8	3.2
Tehran Coca Cola(black)	2.5	2.9	3.8	3.2
Tehran Iranda (Colorless)	3.8	4.1	3.8	3.2
Tehran Iranda (yellow)	3.1	3.4	3.8	3.2
Tehran Zamzam Cola (black)	2.5	2.9	3.8	3.2
Yazd tagarg(black)	2.7	3.0	3.8	3.2
Yazd tagarg(yellow)	3.4	3.8	3.8	3.2
Saman Parsi Cola (black)	2.5	2.8	3.8	3.2
Saman Parsi Cola(yellow)	2.9	3.2	3.8	3.2
Kermanshah TokaFana (yellow)	2.9	3.1	3.8	3.2
Kermanshah TokaFana (black)	2.6	2.8	3.8	3.2
Eshtehard Kavare Cola (black)	2.6	2.9	3.8	3.2
Eshtehard Kavare Cola (yellow)	2.9	3.1	3.8	3.2
Khoramshahr Arso (yellow)	2.7	3.0	3.8	3.2
Tabriz Colak Cola(black)	2.4	2.8	3.8	3.2
Tabriz Colak Fanta (yellow)	2.9	3.2	3.8	3.2
Saveh Vetos(yellow)	4.6	4.6	3.8	3.2
Saveh Vetos(black)	2.2	2.3	3.8	3.2
Vash Ab Zahedan (yellow)	2.6	2.8	3.8	3.2
Vash Ab Zahedan (black)	2.1	2.3	3.8	3.2
Mashhad Zamzam (yellow)	2.6	2.7	3.8	3.2
Mashhad Zamzam black)	2.0	2.2	3.8	3.2
Ghochan Shadab (yellow)	2.5	2.8	3.8	3.2
Ghochan Shadab (black)	2.3	2.5	3.8	3.2
Noshahr Afra (yellow)	2.5	2.6	3.8	3.2
Noshahr Afra (yellow)	2.3	2.5	3.8	3.2
Esfahan Cofi Cola(colorless)	2.6	2.8	3.8	3.2
Esfahan Cofi Cola(yellow)	2.3	2.4	3.8	3.2
Tehran Golnush Cola(yellow)	2.7	2.7	3.8	3.2
Tehran Golnush Cola(black)	2.2	2.3	3.8	3.2
Mashhad Fanta (yellow)	2.4	2.5	3.8	3.2
Mashhad Cofi Cola (black)	2.2	2.4	3.8	3.2
Chenaran Alis (yellow)	2.7	3.0	3.8	3.2
Chenaran Alis (black)	2.4	2.6	3.8	3.2
Kashan Rabi Cola(yellow)	2.4	2.5	3.8	3.2
Kashan Rabi Cola(black)	2.3	2.5	3.8	3.2
Tehran Eram (black)	2.3	2.7	3.8	3.2

Table 2: Continued...

Tehran Eram (yellow)	2.2	2.4	3.8	3.2
Tehran Eram (colorless)	2.6	2.7	3.8	3.2
Tehran Parsi Cola (black)	2.3	2.4	3.8	3.2
Rasht Ashi Mash (yellow)	2.7	2.8	3.8	3.2
Rasht Ashi Mash (black)	2.3	2.5	3.8	3.2
Gachsaran Iranda (yellow)	2.2	2.6	3.8	3.2
Gachsaran Iranda (black)	2.1	2.4	3.8	3.2
Tehran Nushab Cola (yellow)	2.2	2.3	3.8	3.2
Tehran Nushab Cola (black)	2.3	2.4	3.8	3.2
Mashhad Pepsi(black)	2.8	2.9	3.8	3.2
Mashhad Miranda(yellow)	2.8	3.0	3.8	3.2
Khorasan Alis (colorless)	2.8	3.0	3.8	3.2
Kerman Asi (yellow)	2.3	2.4	3.8	3.2
Tabriz Bamshad (yellow)	2.2	2.5	3.8	3.2
Tabriz Bamshad (black)	2.5	2.9	3.8	3.2
Kerman Kohestan	2.1	2.7	3.8	3.2
Tehran Zamzam (Yellow)	2.5	2.9	3.8	3.2
Tehran Zamzam (black)	2.4	2.7	3.8	3.2
Kerman ZamZam(yellow)	2.2	2.5	3.8	3.2
Kerman ZamZam(black)	2.1	2.4	3.8	3.2
MAX	4.55	4.59	-	-
MIN	2.03	2.2	-	-
MEAN	2.56	2.79	-	-
STD	0.42	0.43	-	-

Table 3: Fluoride Concentrations at different beverage (mgr/lit)

Kind of beverage	Fluoride Concentration at 22.5 °C (mgr/lit)	Fluoride Concentration at 2.8 °C (mgr/lit)
Noshahr Afra (yellow)	0.86	0.95
Esfahan Cofi Cola(colorless)	0.89	1.02
Esfahan Cofi Cola(yellow)	0.9	1.03
Tehran Golnush Cola(yellow)	0.89	1.02
Tehran Golnush Cola(black)	0.9	1.03
Mashhad Fanta (yellow)	0.89	1.02
Mashhad Cofi Cola (black)	0.87	1.01
Chenaran Alis (yellow)	0.83	0.94
Chenaran Alis (black)	0.89	0.95
Kashan Rabi Cola(yellow)	0.89	0.96
Kashan Rabi Cola(black)	0.87	1.01
Tehran Eram (black)	0.89	1
Tehran Eram (yellow)	0.8	0.97
Tehran Eram (colorless)	0.97	1.2
Tehran Parsi Cola (black)	0.91	1.13
Rasht Ashi Mash (yellow)	0.95	1.2
Rasht Ashi Mash (black)	0.98	1.1
Gachsaran Iranda (yellow)	0.79	0.87
Gachsaran Iranda (black)	0.83	0.93
Tehran Nushab Cola (yellow)	0.98	1.1
Tehran Nushab Cola (black)	0.94	1.03
Mashhad Pepsi(black)	0.9	1.1
Mashhad Miranda(yellow)	0.69	0.83
Khorasan Alis (colorless)	0.68	0.89
Kerman Asi (yellow)	0.65	0.88
Tabriz Bamshad (yellow)	0.7	0.84

Table 3: Continued...

Tabriz Bamshad (black)	0.73	0.89
Kerman Kohestan	0.65	0.9
Tehran Zamzam (Yellow)	0.69	0.83
Tehran Zamzam (black)	0.7	0.85
Kerman ZamZam(yellow)	0.83	0.99
Kerman ZamZam(black)	0.85	1.02
MAX	2.7	2.7
MIN	0.65	0.7
MEAN	1.14	1.27
STD	0.55	0.52

Discussion

According to the findings, mean acidity of 92% of the consumed beverages during the time of the present study had been lower than the standard range (3.2-3.8). As it is shown in Table 2, among all types of the studied beverages, the acidity rate of Saveh yellow Venous brand (4.6) and Tehran colorless Iranda brand (4.1) was higher than standard rate and only the acidity rate of Isfahan colorless coffee cola brand (3.38), Tehran yellow Iranda brand (3.44) and Yazd yellow Tagarg brand (3.75) had been in the standard range. The acidity rate of all other studied beverages had been lower than the permitted rate. Low acidity of non alcoholic beverages is due to their CO₂, citric acid and phosphoric acid contents. These substances are responsible for dental erosion (6, 24, 25) and citric acid is more erosive than phosphoric acid (26). According to the study of Gedalia Coca Colas comparing to 7 ups are more erosive due to their phosphoric acid content (3, 27). Carbonated beverages are also more erosive comparing to noncarbonated beverages (28, 29). In a study performed in 2005 in Mashhad/ Iran a significant relationship was found between dental hardness reduction and consumption of carbonated beverages (30, 31). Gedalia et al in their study in 1991 showed that enamel softening occurs one hour after drinking coca cola and oral pH of less than 5.5 causes dental erosion (27, 32, 33). According to a study in Shiraz (2005), Pepsi Cola has had the highest and Zam Zam Cola

has had the lowest erosive effects on enamel and in whole, imported beverages had more erosive effect comparing to the beverages produced in Iran (34). Hughes et al believe that dental erosion is a health problem in children and its main cause is acidic compounds in the diet and nonalcoholic beverages are one of the important etiologic factors in this regard (35).

Considering low pH of consumed beverages in Kerman, dental erosion in this region and also in other cities that the same beverages are distributed is probable. Therefore, attention to this issue and necessary precaution in this regard is highly recommended.

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