ACTA
STOMATOLOGICA
CROATICA
www.ascro.hr

Acta Stomatol Croat. 2008;42(3):229-234.

IZVORNI ZNANSTVENI RAD
ORIGINAL SCIENTIFIC PAPER

Alessandro Leite Cavalcanti[1], Polyana Sarmento de Oliveira[2], Augusto Pierre de Araújo Evangelista[2], Fernando Fernandes Vieria[3], Ana Flávia Granville-Garcia[1], Christiane Leite Cavalcanti[4]

pH i ukupni topljivi sadržaj koncentriranih i prirodnih razrijeđenih tropskih voćnih sokova

pH and Total Soluble Solid Content in Concentrated and Diluted in Natura Tropical Fruit Juices

[1] Zavod za dječju stomatologiju Stomatološkog fakulteta Državnoga sveučilišta Paraíbe, Campina Grande, PB, Brazil
Department of Paediatric Dentistry, School of Dentistry, State University of Paraíba, Campina Grande, PB, Brazil
[2] Student, Zavod za dječju stomatologiju Stomatološkog fakulteta, Državnoga sveučilišta Paraíbe, Campina Grande, PB, Brazil
Undergraduate student, Department of Pediatric Dentistry, School of Dentistry, State University of Paraíba, Campina Grande, PB, Brazil
[3] Zavod za analitičku kemiju Kemijskoga fakulteta Državnoga sveučilišta Paraíbe, Campina Grande, PB, Brazil
Department of Analytical Chemistry, School of Chemistry, State University of Paraiba, Campina Grande, PB, Brazil
[4] Zavod za prehranu Prehrambenog fakulteta Federalnoga sveučilišta Paraíbe, João Pessoa, PB, Brazil
Department of Nutrition, School of Nutrition, Federal University of Paraíba, João Pessoa, PB, Brazil

Sažetak

Svrha istraživanja: Ovo *in vitro* istraživanje obavljeno je kako bi se procijenio endogeni pH i ukupan topljivi sadržaj (UTS) koncentriranih te *in natura* razrijeđenih tropskih voćnih sokova. **Ispitanici i postupak:** Uzorak se sastojao od devet vrsta (*Ananas sativus* – ananas; *Malpighia glabra* – acerola; *Spondias lutea* – mombinska šljiva; *Anacardium occidentale* – orah cashew; *Citrus sinensis* – naranča; *Mangifera indica* – mango; *Passiflora sp* – gospodinova krunica; *Citrulus vulgaris* – lubenica i *Vitis vinifera* – grožđe). UTS koncentriranih i razrijeđenih sokova bio je izmjeren Abbeovim refraktometrom , a za pH se koristio potenciometar. **Rezultati:** Svi sokovi imali su pH vrijednosti niže od 5,5. Onima od mombinske šljive i lubenice izmjerena je najniža (2,8) i najviša (5,2) vrijednost. Moramo istaknuti da razrjeđivanje nije promijenilo pH. UTS koncentriranih sokova bio je u rasponu od 5,25 posto (acerola) do 16,0 posto (mango). Nakon razrjeđivanja , manji UTS izmjeren je u svim testiranim uzorcima. **Zaključak:** Voćni sokovi u tim istraživanjima imali su manje vrijednosti pH od kritičnih koje rezultiraju demineralizacijom zuba te se zato mogu smatrati potencijalno erozivnima. Iako razrjeđenje nije znatnije promijenilo vrijednosti pH, jako je smanjilo udjel šećera u pićima.

Zaprimljen: 22. svibnja 2008.
Prihvaćen: 13. srpnja 2008.

Adresa za dopisivanje
Prof. dr. Alessandro Leite Cavalcanti
Avenida Manoel Moraes
471/802 – Manaíra
58038-230 João Pessoa, PB, Brazil
dralessandro@ibest.com.br

Ključne riječi
pića; koncentracija hidrogenskih iona; ukupna tvar; karijes; erozija zuba

Uvod

Briga za zdraviju prehranu, povezana sa sve boljom kvalitetom života, povećala je potrošnju voća i prirodnih sokova (1,2). No, kod djece u dobi od 1 do 6 godina ta bi potrošnja trebala biti ograničena na 1812 do 2718 grama na dan. Ipak, više od 10 po-

Introduction

The concern with a healthier diet associated with a better quality of life has produced an increase in the consumption of fruits and natural juices (1,2). Fruit juice intake by children aged 1 to 6 years should be limited to 4 to 6 ounces *per* day. However, over 10

sto američke predškolske djece pije svaki dan oko 355 ml voćnih sokova (3).

Razrijeđeni koncentrati razlikuju se od ostalih bezalkoholnih pića, jer konzument ima nadzor nad onim što unosi u organizam. Budući da se ne zna koliko ljudi čita upute proizvođača, pretpostavlja se da se razrijeđeni voćni sokovi piju i u koncentriranijem i razrjeđenijem obliku (4).

Zagovaratelji javnog zdravstva vjeruju da se loše prehrambene navike u djetinjstvu, posebice ako se prije spavanja pije sok iz bočice, može povezati s razvojem karijesa na mliječnim zubima (5-8). Od nedavno raste zanimanje za utjecaj kiselih pića, kao što su voćni sokovi, na pH dentalnog biofilma. Nekoliko je autora već istaknulo da voćni sokovi smanjuju taj pH (2,9-12).

Vrijednosti pH od 5,5 tradicionalno se smatraju „kritičnima" za otapanje cakline, iako gubitak minerala može početi i kod viših vrijednosti (9). Većina voćnih sokova i pića ima dovoljno nizak pH da može potaknuti eroziju na površini cakline (2,12,13). Voćni sokovi su proizvodi definirani kao tekućine, a dobivaju se gnječenjem ili tiješnjenjem zrelog voća prikladnim tehnološkim postupcima, te imaju karakterističnе boje, arome i okuse (1).

Kad je riječ o endogenom pH, on ovisi o vrsti voća, njegovoj kiselosti, stupnju zrelosti te još nekim čimbenicima (14). Različite vrste sadržavaju različite količine šećera - voće sa sjemenkama 8 do 15 posto, s košticama 6 do 12 posto, grožđe 13 do 20 posto, a neke vrste naranči 3 do13 posto (15).

Brixova ljestvica, ili stupnjevi prema Brixu ($^{\circ}$Bx), numerički odgovara postocima šećera i drugih otopljenih tvari u otopini. Koristi se u prehrambenoj industriji za procjenu količine šećera u voćnim sokovima i drugim pićima (16).

Iako djeca piju mnogo voćnih sokova, istraživanja o tome je premalo. Zato je svrha ove studije bila odrediti *in vitro* endogeni pH i ukupni topljivi sadržaj (UTS) koncentriranih i prirodnih razrijeđenih sokova od tropskoga voća.

Materijal i metode

Za istraživanje se izabralo sljedeće voće: *Ananas sativus* – ananas, *Malpighia glabra* – acerola, *Spondias lutea* – mombinska šljiva, *Anacardium occidentale* – plod cashewa, *Citrus sinensis* – naranča, *Mangifera indica* – mango, *Passiflora sp.* – gospo-

percent of American preschoolers consume at least 12 fluid oz of fruit juices daily (3).

Dilutable concentrates differ from most other soft drinks in that the consumer has control over the composition of what they drink. Because it is not known how many people follow the manufacturer's instructions, it is reasonable to assume that dilutable fruit drinks are consumed in both more concentrated and more dilute forms (4).

Public health advocates widely believe that poor infant feeding practices, particularly feeding juice in a nursing bottle at bedtime, are associated with the development of caries disease in primary teeth (5-8). Recently, there has been an increased interest in determining to what extent acid beverages, such as fruit juices, affect the pH of dental biofilm. Several authors have reported that fruit drinks decrease the dental biofilm pH (2,9-12).

A pH of 5.5 is traditionally considered to be the 'critical pH' for enamel dissolution, although loss of mineral may begin at higher pHs (9). Most fruit juices and beverages have a pH low enough to induce erosion on enamel surface (2,12, 13). Fruit juices are products defined as liquids obtained by expression or extraction of ripe fruits, by means of adequate technological processes, and with characteristic colour, aroma and flavour (1).

Regarding the endogenous pH, this characteristic depends on the type of fruit, its acidity, species, degree of ripening, among other factors (14). The diverse groups of fruits contain varied amounts of sugars: fruits with seeds (8 to 15%), fruits with seed kernel (6 to 12%), grapes (13 to 20%) and several species of orange (3 to 13%) (15).

The Brix scale or degrees Brix (^{o}Bx) is numerically equal to the percent of sugar and other dissolved solids in the solution. This scale is used in the food industry for measuring the approximate amount of sugars in fruit juices and others beverages (16).

In view of the high consumption of fruit juices among children and the lack of international studies addressing this subject, the purpose of this study was to evaluate *in vitro* the endogenous pH and the content of total soluble solids (TSS) in concentrated and diluted *in natura* tropical fruit juices.

Material and Methods

The following tropical fruits were used in this study: *Ananas sativus* - pineapple; *Malpighia glabra* - acerola, *Spondias lutea* - hog plum; *Anacardium occidentale* - cashew fruit; *Citrus sinensis* - orange; *Mangifera indica* - mango; *Passiflora sp.*

dinova krunica, *Citrulus vulgaris* – lubenica i *Vitis vinifera* – grožđe.

Kako smo željeli dobiti koncentrirane sokove, svaki je plod bio pažljivo opran, oguljen (ako je bilo potrebno) i prepolovljen, prerezan ili narezan - već prema potrebi. Jestivi dijelovi koji sadržavaju sok i sjemenke rukom su bili podijeljeni i zatim mljeveni 15 sekundi u sokovniku. Samo je narančin sok bio pripremljen u posebnom uređaju za tiješnjenje toga voća.

Mjerenje pH

Vrijednosti pH svakog soka određivale su se pH-metrom (TEC-2 pH metar; Tecnal, São Paulo, SP, Brazil) postavljenim u tekućinu. Uređaj je najprije bio stupnjevan na 0,1 prema uputi proizvođača. Nakon toga je, uz pomoć puferskih (praškastih) standarda s pH 7 i 4, 50 mL svakog soka stavljen u vrč u kojem je bio pH-metar te je očitana vrijednost.

Stupnjevi prema Brixu (^{o}Bx)

Stupnjevi prema Brixu bili su izmjereni refrakciometrijom pomoću Abbéova refraktometra (PZO-RL1, Varšava, Poljska). Budući da je refraktivni indeks otopine koja sadržava šećer ovisan o temperaturi, refraktometri se kalibriraju na 20°C (16). Oprema je kalibrirana deioniziranom vodom (indeks refrakcije = 1,3330 i 0 $^{\circ}$Bx na temperaturi od 20 $^{\circ}$C), a zatim su obavljena mjerenja na uzorcima (17). Nakon toga su sokovi razrijeđeni vodom u omjeru 1: 2 te su ponovljena mjerenja i pH i $^{\circ}$Bx-a.

Rezultati

Tablica 1. prikazuje distribuciju srednjih vrijednosti pH za koncentrirane i razrijeđene voćne sokove.

- passion fruit; *Citrulus vulgaris* - watermelon and *Vitis vinifera* - grape.

For extraction of the concentrated juices, fresh ripe fruits of each type were carefully washed, peeled (if necessary) and cut into halves, slices or pieces, as appropriate. The edible parts containing juice and seeds were separated manually and blended in a regular blender during 15 seconds, except for the orange juice, which was obtained using an orange-squeezer.

pH Measurement

The pH of each juice was determined using a pH meter (TEC-2 pH meter; Tecnal, Sion Paulo, SP, Brazil) placed directly into each solution. The pH meter accurate to 0.1 was first calibrated according to the manufacturer's instructions, employing buffer standards of pH 7 and pH 4. As much as 50 mL of each beverage was placed in a beaker, the pH meter was immersed into the juice and the reading was recorded.

Degrees Brix (^{o}Bx)

The ^{o}Bx readings were made by refractometry using an Abbé refractometer (PZO-RL1, Warszawa, Poland). As the refractive index of a sugar-containing solution is also temperature-dependent, refractometers are typically calibrated at 20^{o}C (16). The equipment was calibrated with deionised water (refraction index= 1.3330 and 0^{o} Brix at 20^{o}C) and the readings of the samples were performed (17). Thereafter, the juices were diluted at 1:2 ratio and new readings of the pH values and ^{o}Bx were made.

Results

Table 1 displays the distribution of the pH mean values for the concentrated and diluted fruit juices.

Tablica 1. Srednje vrijednosti pH i UTS za koncentrirane i razrijeđene voćne sokove
Table 1 pH mean values and total soluble solids (TSS) for the concentrated and diluted fruit juices.

Voćni sok • Fruit juice	pH		%TSS	
	Koncentrirani voćni sok • Concentrated juice	Razrijeđeni voćni sok • Diluted juice	Koncentrirani voćni sok • Concentrated juice	Razrijeđeni voćni sok • Diluted juice
Ananas • Pineapple	3.9	3.9	15.00	7.75
Acerola	3.5	3.5	5.25	3.25
Mombinska šljiva • Hog plum	2.8	2.8	11.25	6.50
Plod Cashewa • Cashew fruit	4.0	4.1	11.70	7.50
Naranča • Orange	4.1	4.2	9.50	4.00
Mango	3.9	4.0	16.00	9.25
Gospodinova krunica • Passion fruit	3.1	3.1	11.25	6.75
Lubenica • Watermelon	5.2	5.2	7.75	4.00
Grožđe • Grape	3.2	3.2	12.00	6.75

Uspoređujući koncentrirane sokove, najniže vrijednosti imao je sok od mambinske šljive (2,8), a najviše lubenice (5,2). Razrjeđivanje nije znatnije promijenilo vrijednosti pH.

Koncentrirani sok acerole imao je najnižu vrijednost UTS-a (5,25%), a sok manga najvišu (16,0%). UTS-a se kod razrjeđivanja smanjio dosta proporcionalno obavljenom razrjeđivanju.

Rasprava

Djeca su najveći potrošači sokova. Voćni sokovi i voćni bezalkoholni napici pretjerano se piju u dječjoj dobi upravo zbog dobrog okusa. Imaju i prikladno pakiranje koje omogućuje da se drže u bočici ili nose cijeli dan. Budući da se smatra da je sok hranjiv, roditelji obično ne ograničavaju potrošnju. A velik unos soka može pridonijeti razvoju karijesa (3,6-8,17,18).

Mjerenje kiselosti plaka, posebice promjena u vrijednosti pH, predstavlja važnu skupinu testova u procjenjivanju acidogenosti hrane, a time i njihove moguće kariogenosti (13,19). Budući da topljenje cakline postaje kritično kod pH od 5,5, rezultati našeg istraživanja pokazuju da svi voćni sokovi mogu erodirati caklinu zbog razmjerno niskih vrijednosti pH. Stupanj erozije cakline koju potiče voćni sok oko 5 do 8 puta je veći, nego onaj kod voća (mljevenog voćnog soka). Isto je tako jasno da stupanj erozije cakline kod različitih vrsta voća ovisi o kombinaciji čimbenika kao što su pH i količina te vrste organskih kiselina i drugih kemijskih komponenti u samom voću (20).

Općenito, voće i tekućine češće se piju u tropskim zemljama. U Brazilu je i mnogo vrsta čije se vrijednosti pH ne mogu naći u međunarodnoj znanstvenoj literaturi (12). Isto tako, nema opisa analize UTS-a voćnih sokova.

Najčešći uzrok dentalne erozije kod mladih ljudi vjerojatno je konzumacija kiselih pića, kao što su karbonizirana sportska pića i voćni napici. Ta su pića povezana s velikim gubitkom cakline, posebice ako se koriste dok je salivarnost niska, što je slučaj nakon sportskih aktivnosti (2,13,21).

Vrijednosti pH voća odabranog za istraživanje bile su u rasponu od 2,8 (mombinska šljiva) do 5,2 (lubenica). Uzmemo li u obzir samo pH, svako bi voće moglo uzrokovati dentalnu eroziju, jer su njihove vrijednosti bile ispod razine potrebne za demineralizaciju zuba (5,5). To istraživanje je u skladu s onima objavljenima prije (11,12,17,22).

Comparing the concentrated juices, the lowest pH value was recorded for the hog plum juice (2.8) and the highest pH value was recorded for the watermelon juice (5.2). Juice dilution did not produce significant alterations in the pH values.

The concentrated acerola juice presented the lowest TSS content (5.25%), while the concentrated mango juice presented the highest TSS content (16.0%). The decrease of TSS content in the diluted juices was approximately proportional to the performed dilution.

Discussion

Children are the single largest group of juice consumers. Fruit juice and fruit drinks are easily overconsumed by toddlers and young children because they taste good. In addition, they are conveniently packaged or can be placed in a bottle and carried around during the day. Because juice is viewed as nutritious, limits on consumption are not usually set by parents. High intakes of juice can contribute to development of dental caries (3,6-8,17,18).

Measurements of plaque acidity, particularly as changes in pH, form a very important group of tests for assessing the acidogenicity of foods and hence their possible cariogenicity (13,19). As enamel dissolution occurs at a critical pH of around 5.5, the findings of the present study showed that all fruit juices have the potential to erode enamel due to their comparatively low pHs. The degree of enamel erosion initiated by a fruit juice is about 5-8 times higher than that of the fruit (minced fruit juice). It also became clear that the degree of enamel erosion by different fruits depended on a combination of factors, such as the pH, amounts and ratios, as well as the types of organic acids and other chemical components present in the fruits (20).

Overall, fruits and liquids are more consumed in tropical countries. In Brazil, there is a great variety of fruits whose pHs are not available in the international scientific literature (12). Likewise, there are no reports of the analysis of TSS content in fruit juices.

The most common cause of dental erosion in young people is likely to be the consumption of acidic beverages, such as carbonated sport drinks and fruit juices. These beverages have been associated with severe dental enamel loss, particularly if consumed at moments of reduced salivary flow rate, such as immediately after heavy sporting activities (2,13,21).

The pH of the fruits selected for this study ranged from 2.8 (hog plum) to 5.2 (watermelon). Considering the pH alone, any of the tested fruits could cause

Iako je Touyz (22) predložio razrjeđivanje sokova kako bi smanjio učinak kiselina uz caklinu i/ili dentin, u našem eksperimentu dilucija koncentriranih sokova nije promijenila njihov pH, a to je uočeno i u ranijim studijama (12,23). Zapravo, Smith i Shaw (23) su istaknuli da je čak i u otopini od 1,10, pH i dalje bio isti.

Ono što moramo osobito istaknuti u istraživanju jest činjenica da se nakon razrjeđenja smanjuje količina šećera u soku. Iako se pritom ne smanjuje vrijednost pH, manji udjel šećera u razrijeđenim sokovima mogao bi koristiti oralnom zdravlju, budući da su ugljikohidrati vrlo važni u razvoju dentalnog karijesa. Zato, na temelju rezultata ovog istraživanja, možemo preporučiti razrjeđivanje sokova neposredno prije konzumacije.

Stoljećima su se voćni sokovi smatrali izvorom vitamina, a zato što su dobrog okusa, djeca ih vole piti. Iako njihova konzumacija ima prednosti, ima i negativne učinke. Pedijatri bi trebali znati kako podučiti roditelje, skrbnike i djecu da se pravilno koriste sokovima (18). Instrukcije o negativnim posljedicama vrlo su važne i treba ih razmotriti u sklopu prevencije dentalne erozije u djece.

Zaključak

Ovo istraživanje pokazuje da voćni sokovi imaju vrijednosti pH ispod kritičnih, potrebnih za demineralizaciju zuba i mogu pridonijeti razvoju dentalnih erozija. Zato bi razrjeđivanje sokova moglo znatno smanjiti udjel šećera i tako bi izravno utjecalo na oralno zdravlje.

dental erosion because all of them had pH values below the critical value assumed for dental demineralization (5.5). These findings are consistent with those published elsewhere (11,12,17,22).

Although Touyz (22) has suggested the dilution of fruit juices to minimize the effect of the acids present in the juices on the enamel and/or dentine surface, in the present experiment dilution of concentrated juices did not alter their pH, as previously observed by other authors (12,23). In fact, Smith and Shaw (23) have reported that the pH remains acid even with a 1:10 dilution.

An important aspect to be stressed in this study refers to the decrease in the amount of sugars in fruit juices after dilution. Although this decrease in sugar content was not accompanied by an increase of the pH, the lower sugar content of the diluted juices would bring expressive benefits for oral health, as the carbohydrates play a key role in the aetiology of dental caries. Therefore, based on the outcomes of the present study, it would be recommendable that the parents diluted fruit juices before offering these beverages to their children.

Historically, fruit juices have been recommended by paediatricians as a source of vitamins. Because juice tastes good, children readily accept it. Although juice consumption has some benefits, it also has potential detrimental effects. Paediatricians need to be knowledgeable about juice to inform parents and patients on its appropriate uses (18). Instructing parents/caregivers on the negative impacts of an excessive intake of fruit juices by their children is an important aspect to be considered on the prevention of dental erosion lesions.

Conclusion

This study demonstrates that fruit juices present pH values below the critical value assumed for dental demineralization and might therefore contribute to the development of dental erosion. Therefore, the dilution of fruit juices reduces remarkably the sugar content of these beverages, which might bring expressive benefits to the oral health.

Abstract
Objectives: This *in vitro* study evaluated the endogenous pH and the content of total soluble solids (TSS) in concentrated and diluted *in natura* tropical fruit juices. **Material and Methods**: The sample was composed by 9 kinds of tropical fruits (*Ananas sativus* - pineapple; *Malpighia glabra* - acerola, *Spondias lutea* - hog plum; *Anacardium occidentale* - cashew fruit; *Citrus sinensis* - orange; *Mangifera indica* - mango; *Passiflorasp* - passion fruit; *Citrulus vulgaris* - watermelon and *Vitis vinifera* - grape). For concentrated and diluted juices, TSS content was determined by refractometry, using the Abbé refractometer, and the pH was determined by potentiometry. **Results:** All evaluated juices presented pH values lower than 5.5. The hog plum and watermelon juices presented the lowest (2.8) and highest (5.2) pH values, respectively. The dilution of the juices, however, did not produce pH alterations. For the concentrated juices, the TSS content ranged from 5.25% (acerola) to 16.0% (mango). After dilution, a decrease in the TSS content was observed in all tested samples. The fruit juices evaluated in this study presented lower pH values than the critical value assumed for dental demineralization, being therefore, potentially erosive. **Conclusion:** Although the dilution of the fruit juices did not produce expressive alterations in the pH values, it reduced remarkably the sugar content of the beverages.

Received: May 22, 2008
Accepted: July 13, 2008

Address for correspondence
Prof. Dr. Alessandro Leite Cavalcanti
Avenida Manoel Moraes, 471/802
- Manaíra
58038-230 João Pessoa, PB, Brasil
Tel: +55 83 3315-3326
dralessandro@ibest.com.br

Key words
Beverages; Hydrogen-Ion Concentration; Dental Caries; Tooth Erosion

References

1. Tojo Sierra R, Dalmau Serra J, Alonso Franch M, Crespo PS, Esteban MM, Ferri NL et al. Consumo de zumos de frutas y de bebidas refrescantes por niños y adolescentes en España. Implicaciones para la salud de su mal uso y abuso An Pediatr. 2003; 58(6):584-93.
2. Banan LK, Hegde AM. Plaque and salivary pH changes after consumption of fresh fruit juices. J Clin Pediatr Dent. 2005; 30(1):9-13.
3. Dennison BA. Fruit juice consumption by infants and children: a review. J Am Coll Nutr. 1996 ;15(5 Suppl):4S-11S.
4. Hunter ML, Patel R, Loyn T, Morgan MZ, Fairchild R, Rees JS. The effect of dilution on the in vitro erosive potential of a range of dilutable fruit drinks. Int J Paediatr Dent. 2008;18(4):251-5.
5. Dye BA, Shenkin JD, Ogden CL, Marshall TA, Levy SM, Kanellis MJ. The relationship between healthful eating practices and dental caries in children aged 2-5 years in the United States, 1988-1994. J Am Dent Assoc. 2004;135(1):55-66.
6. Kolker JL, Yuan Y, Burt BA, Sandretto AM, Sohn W, Lang SW, et al. Dental caries and dietary patterns in low-income African American children. Pediatr Dent. 2007;29(6):457-64.
7. Lim S, Sohn W, Burt BA, Sandretto AM, Kolker JL, Marshall TA, et al. Cariogenicity of soft drinks, milk and fruit juice in low-income african-american children: a longitudinal study. J Am Dent Assoc. 2008;139(7):959-67.
8. Du M, Luo Y, Zeng X, Alkhatib N, Bedi R. Caries in preschool children and its risk factors in 2 provinces in China. Quintessence Int. 2007;38(2):143-51.
9. Birkhed D. Sugar content, acidity and effect on plaque pH of fruit juices, fruit drinks, carbonated beverages and sport drinks. Caries Res. 1984;18(2):120-7.
10. Grenby TH, Mistry M, Desai T. Potential dental effects of infants' fruit drinks studied in vitro. Br J Nutr. 1990;64(1):273-83.
11. Seow WK, Thong KM. Erosive effects of common beverages on extracted premolar teeth. Aust Dent J. 2005;50(3):173-8.
12. Sobral MA, Luz MA, Gama-Teixeira A, Garone Netto N. Influence of the liquid acid diet on the development of dental erosion. Pesqui Odontol Bras 2000;14(4):406-10.
13. Johansson AK, Lingström P, Birkhed D. Effect of soft drinks on proximal plaque pH at normal and low salivary secretion rates. Acta Odontol Scand. 2007;65(6):352-6.
14. Oncag G, Tuncer AV, Tosun YS. Acidic soft drinks effects on the shear bond strength of orthodontic brackets and a scanning electron microscopy evaluation of the enamel. Angle Orthod. 2005;75(2):247-53.
15. Chaves MC, Gouveia JP, Almeida FA, Leite JC, Silva FL. Physicochemical characterization of the acerola juice. 2004; 4(2):1-10.
16. Ball DW. Concentration scales for sugar solutions. J Chem Educ. 2006;83(10):1489-91.
17. Cavalcanti AL, Oliveira KF, Paiva PS, Rabelo MV, Costa SK, Vieira FF. Determination of total soluble solids content (Brix) and pH in milk drinks and industrialized fruit juices. Pesq Bras Odontoped Clin Integr. 2006;6(1): 57-64.
18. American Academy of Pediatrics, Committee on Nutrition. The use and misuse of fruit juice in pediatrics. Pediatrics. 2001;107(5):1210-13.
19. Edgar WM, Geddes DA. Plaque acidity models for cariogenicity testing: some theoretical and practical observations. J Dent Res. 1986; 65:1498-1502.
20. Grobler SR, Senekal PJ, Kotze TJ. The degree of enamel erosion by five different kinds of fruit. Clin Prev Dent. 1989;11(5):23-8.
21. Khan F, Young WG, Law V, Priest J, Daley TJ. Cupped lesions of early onset dental erosion in young southeast Queensland adults. Aust Dent J. 2001;46(2):100-7.
22. Touyz LZ. The acidity (pH) and buffering capacity of Canadian fruit juice and dental implications. J Can Dent Assoc. 1994;60(5):454-8.
23. Smith AJ, Shaw L. Baby fruit juices and tooth erosion. Br Dent J. 1987;162(2):65-7.