RESEARCH ARTICLE

Little Color, Little Flavor of Different kinds of Commercially Available Flavored Milk and their Consumption Effect on Salivary pH Value in Children: An *In Vivo* Study

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Abstract

Aim: This study aimed to compare the effect of different flavored kinds of milk on salivary pH value in 6 to 14 years old children.

Materials and methods: The impact of these different kinds of flavored milk on the salivary pH is evaluated between two groups of children, caries-active group ($n = 35$) constituted children who had decayed missing filled tooth (DMFT) ≥ 2, and the caries-free group ($n = 35$) constituted children who had DMFT = 0. Four different flavors of milk are taken for the study, and plain sweetened milk is chosen as the control baseline. The endogenous pH of the salivary samples is measured at baseline and after consumption of the flavored milk immediately and then at 5-, 10-, 15-, and 30-minute intervals. The results are statistically analyzed by using the paired *t*-test and analysis of variance (ANOVA).

Results: It is shown in the present study that caries-active group subjects had a more evident salivary pH fall than the caries-free group subjects which was statistically significant. For caries-active group, subject's salivary pH value took a longer duration to return to baseline pH as compared to caries-free subjects. However, salivary pH value is restored to standard/baseline value after 30 minutes for all the flavored milk taken in both groups; hence, their intake can be regarded safe for the oral environment.

Conclusion: It is concluded from the current study that the consumption of flavored milk can be considered as non-cariogenic for children.

Clinical significance: In the present study, the salivary pH fall in both caries-active and caries-free subjects was found above the critical pH level. Hence, all these flavored milk used in the study did not cause a threat to oral environment health as there was no significant decrease in salivary pH value so their consumption can be regarded as safe for children.

Keywords: Dental caries, Flavored milk, Saliva, Salivary pH.

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Introduction

A microbial disease of the calcified tissues of the teeth, characterized by demineralization of the inorganic portion and destruction of the organic substance of the tooth is called dental caries.[1] In India, about 80% of children and 60% of adults suffer from this disease.[2] The factors including routine dietary habits, amount of saliva generated in the oral cavity, immune status of the body, various oral habits like smoking, oral microorganisms, the periodontal status of the teeth, and genetic makeup of an individual are among the main causes for dental caries.[3] The oral cavity has saliva which maintains the probity of teeth by the use of its buffering action and by controlling the demineralization and promoting remineralization occurring continuously at the enamel surface.[4]

The stable pH of saliva is 6.7–7.4 but as oral bacteria breakdown the carbohydrate, they release organic acids like lactic acid, butyric acid, and aspartic acid which lower's down the pH of saliva. When the salivary pH value in the mouth goes below its critical level (i.e., salivary pH 5.5), these organic acids begin to breakdown the hard enamel on the tooth surface. The more the tooth surface is exposed to a low cariogenic and acidogenic salivary pH, the more faster is the risk for the development of tooth decay.[5] Research studies like that of Vipeholm[6] on the connection between sugars (carbohydrates) and dental caries have concluded that agents such as the physical form of substrate, oral clearance capacity, and frequency of in-between-meal consumption are equally responsible for causing caries.

A child's health and nutrition is based on the same concepts as nutrition for adults. Although children today need different amounts of some specific nutrients, such as vitamins, minerals, carbohydrates, proteins, and fats at different growing stages, a good diet is one that provides adequate nutrition and is necessary for a child's growth and development.[7] For a growing young child, milk is the most important form of nourishment. From birth to adolescence and beyond, for people both rich, affluent, and poor. Today, however, many children do not prefer drinking milk without any additives because of which consumption of these "Flavored Milk" is gaining a continuous alarming interest. Flavored milk contains 8% or more added artificial sugar. Increasing the regular consumption of these sweetened flavored milk in the past two decades raises the question about the dental acidogenicity of these kinds of milk.[8]

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Reasons for the increasing use of these products could be the commercialized brands who claim that the addition of their flavor to milk makes the drink much tastier and healthier. A gray area still exists with not much text regarding the effects of flavored milk on oral health. All these flavored milk can have a harmful effect on oral health that mandates the need for further research in this field. According to World Health Organization, 6–14 years is the index age group for global monitoring as children are in their learning years, health education regarding their dietary food patterns could be easily learned and improved at this age.[9] Therefore, targeting 6- to 14-year-old children seems to be a reasonable choice for the current study.

Aim

To evaluate and compare the variations in salivary pH values after the consumption of different kinds of commercially available flavored milk at various time intervals.

Objectives

To evaluate which flavored milk is potentially more cariogenic in the oral cavity and to analyze the changes in salivary pH values after consumption of these different kinds of flavored sweetened milk in children with and without dental caries.

Materials and Methods

The present study protocol was permitted by the ethical committee of Saraswati Dental College, Lucknow. Clinical examination and visual inspection were done for patients who attended the Out-patient Department (OPD) of Pediatric and Preventive Dentistry at Saraswati Dental College and Hospital and from various schools in Lucknow city, and their DMFT/dmft index was recorded. Based on DMFT/dmft index, a sample of 70 children aged 6–14 years was divided into two experimental groups: Children with dental caries group I ($n = 35$) and children without dental caries group II ($n = 35$). Informed consent was also obtained from the parents/guardians of the children selected for the study. A preliminary survey was carried out to choose the most preferred flavors among children. They were given options of six commercially marketed Amul flavored milk 200 mL with 8 g of sugar (badam, kesar, pista, chocolate, coffee, strawberry, and mango) and were asked to select any four. The majority of students chose chocolate, coffee, mango, and strawberry flavors; thus, these products were used in the following study along with plain sweetened milk which was taken as a control baseline in the study. The quantity of sugar added to plain milk was matched to the commercially available flavored milk, i.e., 8 g of sugar per 100 mL of plain milk.

Caries active children group I (DMFT ≥2) and caries-free group II (DMFT = 0) children were further divided into five subgroups based on the test flavored milk (mango, strawberry, coffee, and chocolate) and plain sweetened milk (control group), thereby involving 14 participants for each experimental group (7 each from group I and group II).

To standardize the quality of salivary samples, all the children involved in the study were instructed not to consume anything orally for 2 hours preceding the appointment. For the collection of unstimulated saliva samples, the children were asked to relax and sit comfortably and then spit the saliva in disposable cups to record the baseline value of salivary pH. After the baseline control score was recorded, beverages were tested on all group children. The children were told to drink the beverages directly from a glass without using a straw to ensure a substantial effect of the intervention in the oral cavity. After intake of different beverages, immediately, salivary pH value was measured using a bench-type pH meter (Hanna instrument) having an accuracy of ±pH 0.1.

Salivary pH value was then measured at intervals of 5, 10, 15, and 30 minutes post-exposure by collecting saliva in sterile disposable containers to avoid any contamination of the sample. The pH-sensitive electrode of the pH meter was dipped in the saliva sample for the reading. The digital reading of the pH meter was allowed to stabilize for a few seconds, and then pH readings were recorded. The electrode was then cleaned with distilled water and placed in a standard solution (normal saline) of pH 7 to ensure continuous stable readings and provided a constant check on the drift.

Results

The average baseline salivary pH value for children with dental caries (group I) was 5.98 while for children without dental caries (group II) was 6.85.

Baseline and at all the follow-up intervals, group I had significantly lower pH as compared to group II for all the flavors as well as for plain sweetened milk (Figs 1 and 2). Maximum pH drop was observed at immediate consumption for all the flavored milk taken in both group I and group II subjects (Figs 1 and 2). However, the salivary pH value did not drop below the critical pH level in both the groups (Figs 1 and 2) and gradually rose toward baseline in 30 minutes of the time interval.

After 5 minutes of consumption of all the beverages, the mean increase in salivary pH value toward baseline was significantly higher in group II subjects as compared to group I subjects ($p < 0.05$) (Table 1).

Evaluation of inter-flavor differences at different time intervals in both groups showed a consistent difference at all time intervals. At all-time intervals (immediate, 5, 10, 15, and 30 minutes) all the flavored milk showed significantly lower pH as compared to plain sweetened milk (Fig. 3). In terms of acidity (lower pH), mango and strawberry flavors showed higher pH drops as compared to coffee

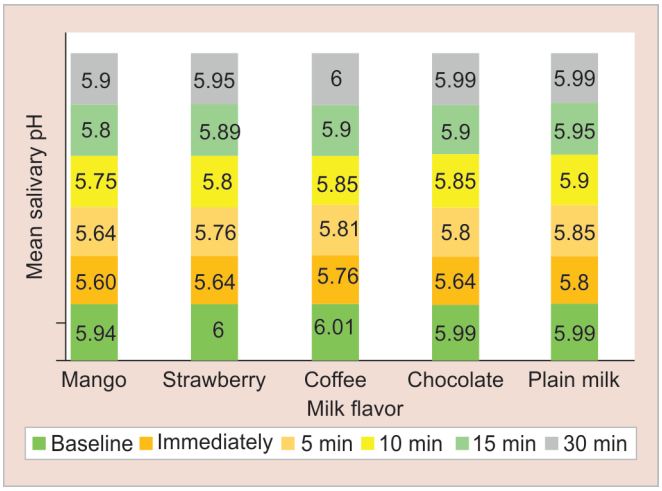

Fig. 1: Mean salivary pH changes in saliva after consumption of different test beverages from baseline through 30 minutes in group I study population

and chocolate flavors which were comparable to plain sweetened milk at all the time intervals.

Discussion

The cariogenic potential of dietary constituents is also dependent upon factors such as organic acids present in various fruit and beverages, which can potentially damage the child's dentition.

Saliva plays an important role in oral health maintenance. It has flushing and neutralizing effects commonly referred to as "salivary clearance" or "oral clearance capacity" (Lagerlof and Oliveby, 1994).[10] Theoretically, saliva can affect the incidence of dental caries in four general ways, firstly by mechanical cleaning of teeth and flushing out the debris which results in less formation and accumulation of dental plaque, secondly by reducing enamel dissolution by means of calcium, phosphate, and fluoride action, thirdly by buffering and neutralizing the organic acids produced by cariogenic organisms or introduced directly through the diet, and finally by anti-bacterial activity.[11,12] It controls the equilibrium stabilization between demineralization and remineralization in a cariogenic environment.

Critical pH is defined as, the pH level above which calcium salts present on tooth surface would not be dissolved from teeth (under mouth conditions) and below which decalcification of tooth would take place.[13,14] Stephen suggested the range for critical pH as 5.0–5.5, whereas Mcintyre (1998)[15] suggested the range for critical pH as 5.2–5.5. However, the usual resting pH of saliva ranges from 6.7–7.4.[16–18]

Milk is an ideal constituent in the balanced diet of children. When compared to plain sweetened milk, various commercially available flavored milk are gaining a lot of popularity among children. The consumption of these flavored milk may lead to a reduction in the salivary pH value, which may further lead to decalcification and demineralization of the tooth as a result of the acid produced, the cariogenic challenge that makes the tooth surface more prone to decalcification and dental caries attack.[19,20]

In the present study, the overall mean resting (baseline) pH of saliva for the healthy caries-free subjects, group II (pH 6.8) was significantly higher than the caries-active subject, group I (pH 5.9). This finding is like the salivary pH observed in earlier research studies by Saigal et al.,[21] and Schatele et al.[22] From the present study, it was also noted that at baseline, caries-active group I had significantly lower baseline pH as compared to caries-free group II, for all the flavors as well as for plain sweetened milk. The probable cause of lower baseline pH in the caries group could be due to the more acidogenic oral environment making it an essential factor in the development of dental caries.[23,24] This correlates with the findings observed by Preethi et al.[24] The result of their study showed that mean resting salivary pH was found to be higher in the caries-free than in the caries-active group.[25]

At all the time intervals after the consumption of different kinds of flavored milk and plain sweetened milk, the pH in caries-active group I was significantly lower than group II (caries-free) which could be due to significant low baseline pH in caries-active group I which causes higher fall at various time intervals irrespective of the flavors taken. This observation was similar to one made by Stephan in 1944[26] and by Vrastsanos and Mandel in 1982[27] who found that in caries-free individuals, oral saliva pH value did not fall below its critical pH level after a glucose rinse. The possible explanation could be that in a caries-active group (DMFT ≥2) the salivary pH fall is increased due to the presence of dental caries, so neutralization of organic acids by saliva is a long procedure making them high caries risk individuals which are in agreement with the previous studies done by Azrak et al.,[28] Rodriquez,[23] and Anisimova et al.[29] which brings to light the fact that recovery back to baseline was quicker in caries-free subjects than caries-active individuals.

The conclusion from the current study shows that the maximum fall in salivary pH value occurred immediately after the consumption of milk irrespective of the flavor taken or the study group (cases or control). This higher drop could be attributed to the relatively lower natural pH of these commercially available flavored milk.

While comparing salivary pH changes at different time intervals, it was observed that a significant pH drop in saliva with respect to the baseline pH value occurred till 10 minutes for mango flavored milk in both cases and control group as well as in the overall study population. Hence, based on the above findings, it was elicited that mango flavored milk causes a maximum fall in salivary pH value while the plain sweetened milk causes a minimum fall in salivary

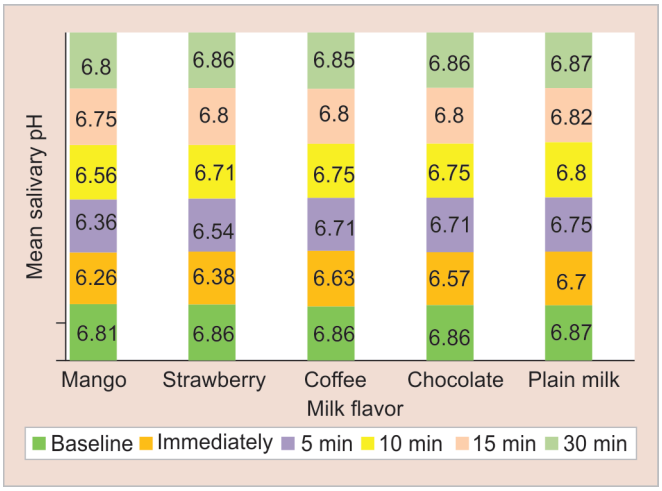

Fig. 2: Mean salivary pH changes in saliva after consumption of different test beverages from baseline through 30 minutes in group II study population

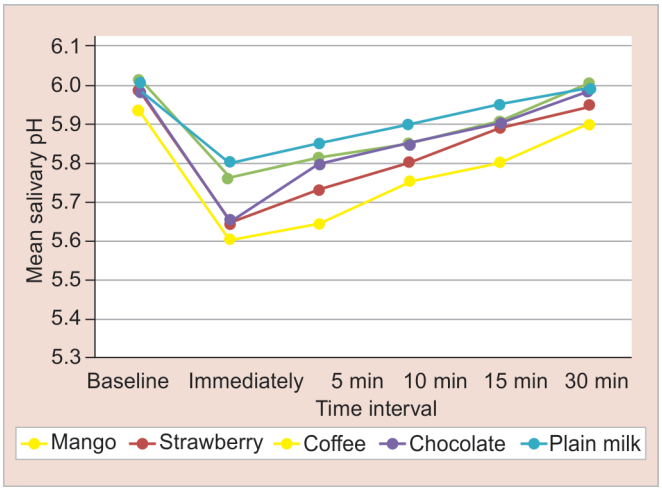

Fig. 3: Mean salivary pH changes in saliva after consumption of different test beverages from baseline through 30 minutes in the overall study population

Table 1: Comparison of pH at baseline and for different milk flavors at different time intervals between cases and controls

S. no.	Milk flavor/time interval	Cases (n = 35)		Controls (n = 35)		Statistical significance	
		Mean	SD	Mean	SD	"t"	"p"
Mango flavor							
1	Baseline	5.94	0.52	6.81	0.23	−9.14	<0.001
2	Immediately	5.38	0.44	6.26	0.35	−9.32	<0.001
3	5 minutes	5.54	0.34	6.36	0.39	−9.44	<0.001
4	10 minutes	5.75	0.36	6.56	0.36	−9.49	<0.001
5	15 minutes	5.80	0.38	6.75	0.33	−9.10	<0.001
6	30 minutes	5.90	0.38	6.80	0.24	−10.11	<0.001
Strawberry flavor							
1	Baseline	6.00	0.52	6.86	0.23	−8.91	<0.001
2	Immediately	5.54	0.37	6.38	0.32	−10.18	<0.001
3	5 minutes	5.73	0.35	6.54	0.27	−11.00	<0.001
4	10 minutes	5.80	0.35	6.71	0.23	−11.43	<0.001
5	15 minutes	5.89	0.37	6.80	0.18	−10.83	<0.001
6	30 minutes	5.95	0.38	6.86	0.14	−10.81	<0.001
Coffee flavor							
1	Baseline	6.01	0.52	6.86	0.23	−8.93	<0.001
2	Immediately	5.76	0.42	6.63	0.29	−10.17	<0.001
3	5 minutes	5.81	0.41	6.71	0.28	−9.58	<0.001
4	10 minutes	5.85	0.42	6.75	0.27	−9.25	<0.001
5	15 minutes	5.90	0.42	6.80	0.19	−8.87	<0.001
6	30 minutes	6.00	0.41	6.85	0.17	−9.09	<0.001
Chocolate flavor							
1	Baseline	5.99	0.52	6.86	0.25	−8.91	<0.001
2	Immediately	5.65	0.44	6.57	0.23	−10.85	<0.001
3	5 minutes	5.80	0.44	6.71	0.19	−10.63	<0.001
4	10 minutes	5.85	0.45	6.75	0.19	−10.06	<0.001
5	15 minutes	5.90	0.44	6.80	0.14	−9.66	<0.001
6	30 minutes	5.99	0.42	6.86	0.14	−8.79	<0.001
Plain sweetened milk							
1	Baseline	5.99	0.53	6.87	0.24	−8.94	<0.001
2	Immediately	5.80	0.44	6.70	0.24	−10.66	<0.001
3	5 minutes	5.85	0.43	6.75	0.22	−10.32	<0.001
4	10 minutes	5.90	0.45	6.80	0.22	−9.04	<0.001
5	15 minutes	5.95	0.43	6.82	0.19	−9.19	<0.001
6	30 minutes	5.99	0.41	6.87	0.17	−9.04	<0.001

pH value which is in agreement with other previous studies done by Khodadadi et al.[14]

The order of acidogenicity could be ranked as follows:

Mango > Strawberry > Chocolate > Coffee > Plain sweetened milk

The end result of the present study also indicates that the addition of these flavors to the milk does not cause any considerable changes in salivary pH value after their consumption. Immediately after their intake, salivary pH value was reduced, but soon after that at various time intervals, it started to rise gradually toward the baseline, and this increase continued till 30 minutes indicating that these flavored milk are non-acidogenic and non-cariogenic for the oral health of children.

However, still more studies are needed with a larger sample size and recording of pH changes for the duration of 30 minutes to 1 hour to test the individual ingredients of these flavored milk available in the market. Oral salivary pH assessment methods alone can only indicate the cariogenic potential of foodstuff and possibly its acidogenic potential.[29] Therefore, further detailed in-depth studies by a combination of salivary pH value model with controls and use of *in situ* intraoral cariogenicity test (ICT) method are recommended to assess the cariogenic and acidogenic potential of all these flavored milk and also the course of changes in plaque pH can also be recorded for better assessment and evaluation.

Conclusion

It is concluded from this study that the consumption of flavored milk can be considered non-cariogenic for children.

Clinical Significance

In the present study, the salivary pH fall in both caries active and caries-free subjects was not significant to an extension of critical pH value. Hence, this flavored milk did not pose a commination as there was no significant fall in salivary pH value so their consumption can be regarded as safe and sound for children.

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References

1. Shafer WG, Hine MK, Levy BM. Textbook of oral pathology. 6th ed., New Delhi: Elsevier; 2009. p. 409.
2. Ministry of Health and Family Welfare, India. National Oral Healthcare Program in India. Available from: http://www.aiims.edu/aiims/events/de. [Last accessed on 2014 Mar 03].
3. Bhure S, Musani I, Survashe P. Effect on salivary pH value after consumption of commercially marketed "Health Drinks." An in vivo study. Univ Res J Dent 2016;6:34–38.
4. Roberson TM. Cariology: the lesion, etiology, prevention and control. In: Roberson TM, Heymann HO, Swift EJ, ed. Art and science of operative dentistry. 5th ed., North Carolina: CV Mosby; 2006. pp. 64–134.
5. Selwitz RH, Ismail AI, Pitts NB. Dental caries. Lancet 2007;369(9555):51–59. DOI: 10.1016/S0140-6736(07)60031-2.
6. Mc Donald RE, Avery DR, Stookey GK, et al. Dental caries in the child and adolescent. In: Mc Donald RE, Avery DR, Dean JR, ed. Dentistry for the child and adolescent. 8th ed., St.Loise, Missouri: Mosby Ink; 2004. pp. 205–214.
7. Pinkham JR, Casamassimo PS, Fields HW. The dynamics of change. In: Pinkham JR, Casamassimo PS, Field HW, Metigue DJ, et al., ed. Pediatric dentistry infancy through adolescence. 4th ed., St. Louise, Missouri: Elsevier Inc; 2005. pp. 199–204.
8. Strokey GK. The effect of saliva on dental caries. J Am Dent Assoc 2008;139(Suppl 5):11S–17SS. DOI: 10.14219/jada.archive.2008.0347.
9. Takahashi N. Microbial ecosystem in the oral cavity: metabolic diversity in an ecological niche and its relationship with oral diseases. International Congress Series, vol. 8. Elsevier; 2005. pp. 103–112.
10. Lagerlog F, Oliveby A. Caries protective factors in saliva. Adv Dent Res 1994;8(2):229–238.
11. Gustafsson BE, Quensel CE, Lanke LS, et al. The Vipeholm dental caries study; the effect of different levels of carbohydrate intake on caries activity in 436 individuals observed for five years. Acta Odontol Scand 1954;11(3-4):232–264. DOI: 10.3109/00016355308993925.
12. Banan LK, Hegde AM. Plaque and salivary pH. changes after consumption of fresh fruit juices. J ClinPediatr Dent 2005;30(1):9–13.
13. Levine RS. Milk, flavoured milk products and caries. Br Dent J 2001;191(1):20. DOI: 10.1038/sj.bdj.4801080.
14. Khodadadi E, Ghasemi N, Pouramir M, et al. Total antioxidant property and pH change of dental plaque and saliva in 6-11-year-old children after consumption of flavoured milk. Caspian J Dent Res 2013;2(2):15–22.
15. Mcintyre IM, Norman TR, Burrows GD. Melatonin rhythm in human plasma saliva. Journal of Pineal Research 1998,4:177–183.
16. Mandel I. Relation of saliva and plaque to caries. J Dent Res 1974;53(2):246–266. DOI: 10.1177/00220345740530021201.
17. Siqueira L, Mustacchi Z, Nicolau J. Electrolyte concentrations in the saliva of children aged 6-10 years with down syndrome. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;98(1):76–79. DOI: 10.1016/j.tripleo.2004.04.007.
18. Stephen RM. Intraoral hydrogen ion concentration associated with dental caries activity. J Dent Res 1944;23(4):257–266. DOI: 10.1177/00220345440230040401.
19. Hans R, Thomas S, Garla B, et al. Effect of various sugary beverages on salivary pH, flow rate, and oral clearance rate amongst adults. Scientifica 2016;2016:5027283. DOI: 10.1155/2016/5027283.
20. Manipal S, John J, Saravanan S, et al. The effect of different beverages on salivary pH in 12-year-old school children in Chennai. J Orofac Res 2013;3(3):166–169.
21. Saigal A, Tewari A. Cariogenicity of milk, apple juice and shikanjvi, a dental plaque study. J American Dent Assoc 1979-80;51-52:373–377.
22. Schatele CF, Jenkins ME. Comparison of methods for monitoring changes in the pH of human dental plaque. J Dent Res 1982;61(10):1117–1125. DOI: 10.1177/00220345820610100201.
23. Rodriquez R. Relationship between oral hygiene, salivary cariogenic microflora, buffer capacity, secretion rate and caries experience in 6 years old and 12 years old in Riga. Stomatologija, Baltic Dent and Maxillofac J 2008;10:76–80.
24. Preethi BP, Maitreyee DS, Dodawad R. Effect of four fruit juices on pH of dental plaque-A four period cross-over study. J ClinDiagnos Res 2010;4:2587–2593.
25. Banan LK, Hedge AM. Plaque and salivary pH changes after consumption of fresh fruit juices. J Clin Ped Dent 2005;30(1):9–13.
26. Stephan RM. Changes in hydrogen ion concentrations on tooth surfaces and in carious lesions. J Am Dent Assoc 1940;27:718–723.
27. Vratsanos SM, Mandel ID. Comparative plaque acidogenesis of caries resistant vs caries susceptible adults. J Dent Res 1982;61(3):465–468.
28. Azrak B, Willershausen B, Meyer N, et al. Course of changes in salivary pH-values after intake of different beverages in young children. Oral Health Prev Dent 2008;6(2):159–164.
29. Anisimova IV, Galiulina MV, Ganzina IV et al. Structural properties of mixed saliva in persons with different levels of tooth resistance to caries. Stomatologiia (Mosk) 2005;84(4):8–10.