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Milk and Its Products: Effect on Salivary pH

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ABSTRACT

BACKGROUND: Dairy products are perceived to be important for one's overall and dental health. Dairy products have been identified as having anticariogenic activity due to the high content of calcium and phosphorous ions and casein phosphopeptides.
AIM: To determine the pH levels of human saliva after consuming different dairy products.
DESIGN: sixty students were divided into 2 groups (30 with caries and 30 caries free) aged 5-9 years, visited to department of paedodontics and preventive dentistry, who agreed to refrain from oral hygiene procedures for 24 hours were selected for this study. Both groups were further randomly sub-divided into 3 groups (milk, curd and paneer group). After determining baseline salivary pH using a digital pH meter, the subjects were asked to eat the test foods (milk 50ml, curd 50g and paneer 50 g) and salivary pH was measured at time intervals of 1, 5, 15 and 30 minutes.
RESULTS AND CONCLUSION: The results were statistically measured by using ANOVA test for intergroup and intragroup comparison. Significant decrease in pH was observed at various time intervals and more decrease was observed in caries active group.

KEYWORDS: Salivary pH, Milk, Curd, Paneer

INTRODUCTION

Dental caries is a major dental public health problem and is the most prevalent oral disease among lower age group across the world. It is estimated that around 95% of the world's population is affected by dental caries.[1] In India, 23% of 12 year olds suffer from this condition.[2] The role of nature of saliva as an etiological factor behind dental caries cannot be denied. The mechanism of salivary role has been the aim of study by countless investigators, either for direct reasons or because of suspected causal relationship with tooth decay. The properties and functions of saliva, as well as role of saliva in oral health have been discussed extensively in textbooks and numerous publications.[3]

"Good oral health comes from good food" – this concept has given to a tremendous increase in the consumption of milk and milk derivatives. Commonly available drinks/beverages are known to lead to a significant dip in the salivary pH due to the presence of sugars and organic acids. In the literature pertaining to dental health, this drop point is reported to be the critical pH of salivary fluid, the value of which is 5.5 (Stephan, Englander et al and Schmidt-Nielson, 1946). A further fall in pH disturbs the calcium and phosphate regulatory balance at which dental caries becomes inevitable.[4]

The nature of milk and related products has been thoroughly argued. They are known to have a low cariogenic potential, but their Cariostatic behavior has also been reported (Johansson, 2002).[5] Research data till date has demonstrated that milk and related products such as yogurt, curd and cheese are beneficial to the health of hard dental tissues.[6] The caries stabilizing effect of milk and derived products is probably due to the buffering capacity generated from the high content of Calcium and Phosphate ions and the presence of casein phosphopeptides.[7]

One of the objective of dental research has been to identify the factors in food that can protect teeth against caries. Two major advantages of protective agents found in milk and milk products are that a) It would be perceived as a natural product and b) Milk is recommended on account of its nutritional properties, chiefly as a source of calcium and protein and accordingly its use does not raise any toxicological problems.[6]

Drop in the salivary pH after any dietary intake is a determining parameter for oral health. With all this on mind, the following study was proposed to be conducted to ascertain the disparity in pH of whole saliva, following the intake of milk and milk derivatives.

The aim of the present study was to determine the pH levels of human saliva after consuming different dairy products.

MATERIALS AND METHOD

The approval was obtained from Ethical Committee, Swami Devi Dyal Hospital and Dental College, Barwala, Panchukula, Haryana. The study was carried

out among 60 voluntary subjects (30 with caries and 30 caries free) with the age group 5-9 years and were screened using following inclusion criteria:

Inclusion Criteria:
i) Child should be 5-9 years of age.
ii) Without any relevant past medical history.
iii) Without any history of antibiotic medication therapy two months prior to the study.
iv) Children with optimum cooperation for the smooth functioning of investigation.

The study subjects were classified as caries free (CF) and caries group (CG). From each group the study subjects were randomly divided into 3 subgroups of milk (n=10), curd (n=10) and paneer (n=10). Details of the study procedure were explained to the subjects and they were asked to abstain from eating and drinking (except plain water) until after that day's dental visit and informed consent was also obtained from each participant.

The digital pH meter (Max Electronics, India. Model Me 962-P & Me 963P) accurate to 0.1 was first be calibrated according to the manufacturer's instructions, employing buffer standards of pH 7 and pH 4. The intrinsic pH of dairy products was measured by the calibrated digital pH electrode. 50 ml milk, 50g curd and 50g paneer crushed in grinder (all at room temperature) were placed in a beaker and stirred until a stable reading was obtained. An electrode was placed directly into each solution. Between readings, the electrode was rinsed in distilled water to ensure that no cross contamination occurred. Estimation of endogenous pH of dairy products was done prior to saliva collection.

The salivary pH was assessed before and after consumption of dairy products (without added sugar). A baseline pH was measured for all the groups. The subjects were asked to chew one gram of paraffin wax for 3 minutes and saliva samples were collected in glass beakers. The pH of saliva was recorded as the baseline score by using a standard digital pH meter.

After the baseline estimation of salivary pH the subjects were allowed to chew and swish the different dairy products (milk- 50ml, curd- 50g and paneer- 50g) for 3 minutes followed by swishing their mouth with plain water and the saliva samples of each subject was collected in separate sterile beakers after 1 min, 5 min, 15 min and 30 min. The collected saliva samples were immediately subjected for estimation of pH changes using a digital pH meter. The recordings of the pH were tabulated and statistical analysis was done.

RESULTS

Table 1 summarizes data recorded for the three groups analyzed at baseline, 1 minute, 5 minute, 15 minute and 30 minutes. The results showed a statistically significant difference in mean salivary pH between baseline, 1 minute, 5 minute, 15 minutes and 30 minutes. However, there was a statistically non-significant difference in mean salivary pH between baseline and 30 minutes following consumption of dairy products.

Figure 1 illustrates that the mean salivary pH in the paneer group rose rapidly after 5 minutes and decreased slightly after 15 and 30 minutes; however the saliva pH at 30 minute was nearly at baseline. Among those who took milk saliva pH slightly decreased after 5 minutes and increased again after 15 and 30 minutes. Among the subjects who consumed curd, saliva pH dropped rapidly after 5 minutes and rose after 15 and 30 minutes. ANOVA one way analysis results showed the saliva pH at 1 minute, 5 minute and 15 minutes are highly significant but it is non-significant at baseline and 30 minutes.

Table 2 compares caries active and caries free subjects at different time intervals after dairy product consumption. Statistically significant differences were seen between caries-active and caries-free subjects for all the groups at each time interval, all are highly significant except for curd group which is significant at 5 minutes.

DISCUSSION

Milk derived products have low caries causing potential and signify anticaries activity, although there is a need to conduct additional studies.[8] The anti-caries activity of milk and its products was directly attributable to the chemical effects of casein phosphopeptides, calcium and phosphate ions.[6] One strategy for evaluating the cariogenic ability of food involves estimating the notability of saliva pH behaviour following ingestion.

The data compiled in this study revealed the protective nature of dairy products against dental caries. This finding is in line with other write ups unveiling a

causal relationship between dairy products consumption and reduction of dental caries.[9-11]

Numerous mechanisms by which dairy products can lead to a reduction in enamel demineralization have been advocated. Levine proposed three of these mechanisms. Firstly, milk proteins may get adsorbed onto the surface layer of enamel and may hamper enamel demineralization; secondly, milk fat could adsorb onto the surface layer of enamel and play its safeguarding role; thirdly, enzymes present in the milk enzyme may have a functional role in hindering the proliferation and multiplication of acidogenic plaque bacteria.[12]

Calcium, phosphorus and CPPs are the ingredients in milk derivatives which may exert a shielding effect on the tooth surface. Calcium and phosphorus ions are released from milk products and their concentrations gets increased in the dental plaque, causing inhibition of demineralization and favouring remineralization by common-ion effect.[11]

The present study uncovered that milk and cheese ingestion led to an escalation in salivary pH, but cheese showed a greater elevation in saliva pH till 5 minutes, then approached near baseline at 30 minutes whereas the maximum decrease in salivary pH of milk and yogurt was seen 5 minutes. After 30 minutes, the salivary pH of the subjects in the milk group was similar to that of the baseline pH, while in yogurt group, it was slightly lower.

After consuming milk products, subjects in cheese group showed highest rise in mean salivary pH. A similar study was performed by Banan LK, Hedge AM[13] in 2005 on plaque and salivary pH changes after consumption of fresh fruit juices and reported that frozen juices lead to a greater dip in Ph of plaque and saliva when compared to refrigerated fruit juices. The effect of cheese in raising plaque pH has been observed by several investigators (Rugg-Gunn et al. 1975; Silva et al. 1986).[14-15] The acidic constituents of cheese (lactic and sorbic acid) may have contributed directly to the subsequent reduction of plaque pH and also may have depleted the saliva's buffering power.[8] Minah et al.[16] in 1986 reported that factors such as salivary pH rise may favor the competitiveness of less harmless oral bacteria and discourage aciduric bacterial strains such as streptococci and lactobacilli. It can be conjectured that as the pH rises, less cariogenic bacteria may metabolize the available substrates, producing weaker acids which will help maintain an elevated pH.

Thus, in summary cheese has two mechanisms of protection against enamel demineralization: 1. By releasing calcium and phosphorus and therefore increasing their concentrations in the dental plaque which inhibits demineralization and favours remineralization by a common ion effect.[2] By stimulating salivary flow and consequently, buffering the dental plaque and exerting a sugar-clearing effect. However milk group also showed a rise in mean saliva pH levels, but slightly less than cheese group. The decrease in salivary pH within 5 minutes after consuming milk was similar to a 1985 study by Rugg-Gunn et al.[17], in which a sucrose solution caused a substantial drop in plaque pH, while milk depressed plaque pH only slightly. In 2002, Johansson[5] observed increased acid production due to bacterial enzymes involved in lactose transport and catabolism. The pH increased slightly after 20 min due to the peptides and amino acids produced by the hydrolysis of casein, which upon further catabolism, can raise the plaque pH and prevent demineralization. This process of alkaline production may counteract the acid production from lactose fermentation.[5]

The curd consumption in this study led to a rapid drop in the salivary pH, the decrease drive it near critical pH of 5.5 at 5 minutes similar to results of a 2007 study by Sonmez and Arasi.[18] The initial fall in plaque pH was due to acidic nature of the yogurt (4.0-4.5 pH). The increase in pH after 15 and 30 minutes may be due to the buffering capacity of stimulated saliva, and the reduced lactose content of the yogurt due to fermentation. The increase in pH may also be due to the fact that the natural CPP content present in yogurt is higher than that of milk due to proteolytic activity of microorganism contained in yogurt and the peptides and amino acids produced by hydrolysis of casein. Both of these have a potential to produce a pH rise in plaque upon further catabolism and prevent demineralization.[5,18]

The curd group also showed a rise in mean saliva pH but slightly less than for cheese group. The results of our study are similar to those of Ferranzzano et al.[7] in 2008. It has been hypothesized that bacteria present in yogurt may have a positive influence on the ecology of dental plaque, re-establishing the microbial hemostasis broken down by the bacterial metabolism. Recent studies reported that yogurt and probiotic containing milk and cheese consumption has been positively related with a decrease in streptococcus mutans in dental plaque and/or saliva (Nikawa et al., 2004; Caglar et al., 2005).[19-20] This hypothesis could

represent a favorable outcome in terms of prevention of dental caries.

CONCLUSION

Among the 3 dairy products consumed, paneer showed the most appreciable salivary pH 5 minutes after consumption followed by milk and curd, then reached baseline at 30 min. This suggests that cheese has the top most anti-cariogenic property among these dairy products. Curd in this study lessened the salivary pH to critical pH of 5.5 at 5 min, below that enamel demineralization and dissolution are anticipated, but it increased and reached baseline at 30 min. These findings reaffirm that paneer and milk are non-cariogenic and to some extent Cariostatic. Milk and milk derived products can be used as surrogate for high-carb desserts and snacks, which may reduce the incidence and prevalence of dental caries.

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LEGENDS

Group	Baseline	1 minute	5 minute	15 minute	30 minutes
Paneer	6.50 ± 0.38	6.76 ± 0.40	6.86 ± 0.45	6.75 ± 0.44	6.63 ± 0.42
Milk	6.61 ± 0.46	6.60 ± 0.34	6.38 ± 0.41	6.54 ± 0.35	6.64 ± 0.46
Curd	6.63 ± 0.42	6.17 ± 0.39	5.55 ± 0.14	6.12 ± 0.39	6.54 ± 0.44
ANOVA	0.084	10.95	57.82	11.58	0.27
P	0.632[c]	0.000[a]	0.000[a]	0.000[a]	0.765[c]

Table 1. Mean plaque pH of subjects (+ SD) of different groups at different time intervals.
(p< 0.05, a: Highly significant; b: Significant; c: Non-significant)

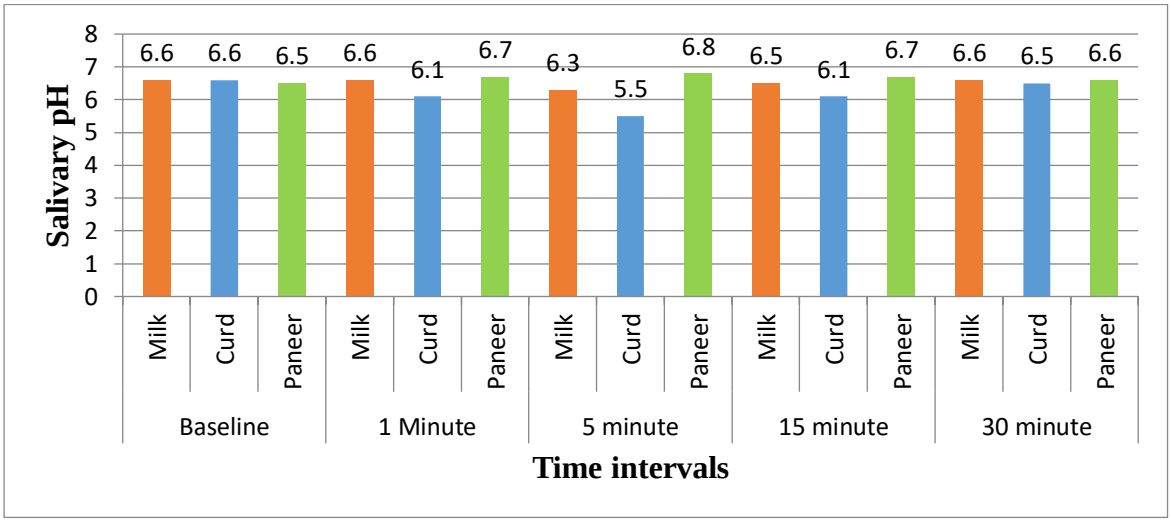

Figure 1. Mean salivary pH in the three groups at different time intervals

	Baseline		1 minute		5 minute		15 minute		30 minute	
Group	Caries	Caries free	Caries	Caries free	Caries	Caries free	Caries	Caries free	Caries	Caries free
Milk	7.03 ±0.14[a]	6.14 ± 0.06	6.90 ±0.15[a]	6.26 ±0.05	6.74 ±0.14[a]	5.97 ±0.09	6.84 ±0.18[a]	6.21 ±0.04	7.06 ±0.14[a]	6.17 ±0.04
Curd	7.01 ±0.06[a]	6.20 ±0.13	6.52 ±0.08[a]	5.78 ±0.14	5.64 ±0.10[b]	5.45 ±0.12	6.47 ±0.07[a]	5.72 ±0.13	6.94 ±0.06[a]	6.09 ±0.11
Paneer	6.80 ±0.31[a]	6.21 ±0.11	7.07 ±0.30[a]	6.45 ±0.18	7.22 ±0.32[a]	6.50 ±0.19	7.12 ±0.30[a]	6.39 ±0.17	6.97 ±0.31[a]	6.30 ±0.15

Table 2. Mean Saliva pH of subjects (+ SD) at different time intervals among paneer, milk and curd groups. (p< 0.05, a: Highly significant; b: Significant; c: Non-significant)