The effect of cheving on the ph of dental plaques after carbohydrate consumption

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Eighteen volunteers were given a mouth rinse with a 50 per cent sucrose solution and the pH of superficial dental plaque was measured electrometrically after 2, 5, 10, 20 and 30 minutes either when the person was continuously chewing paraffin or without paraffin chewing. The paraffin was chewed on one side of the mouth and the samples for measurement of the pH were taken from the other side of the mouth. In one series of experiments paraffin was chewed but the mouth was not rinsed with the sugar solution. The results revealed that the pH-decrease caused by the sugar rinse was diminished significantly by chewing. Chewing paraffin raised the pH by about 0.4, compared with the initial pH-values recorded after 10 minutes. This pH-increase lasted throughout the experimental period of 30 minutes. The difference was statistically significant.

Key-words: Dental plaque; hydrogen-ion concentration; chewing; sucrose

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It has been shown that dental plaque pH is influenced by chewing (*Mühlemann* 1969; *Hassell*, 1971). If the substance being chewed does not contain sugar the pH of interdental plaques will often rise. But if the substance does contain sugar, the pH will fall, but less if the substance is chewed than if it is swallowed without chewing. These effects, which are of considerable practical interest, are believed to depend on an increased salivary secretion, an increased buffer capacity of the saliva and an accelerated elimination of sugar from the oral cavity during chewing.

The aim of the present investigation was to quantitate the influence of chewing on the pH-changes occurring in superficial dental plaques at different intervals after rinsing of the mouth with a 50 per cent sucrose solution.

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MATERIAL AND METHODS

The method has been described in some detail previously (*Frostell*, 1970). Eighteen volunteers, aged 15 to 50 years, participated in the trial. They had all at least 20 natural teeth, moderate to marked predisposition to dental plaque formation and moderate to high caries frequency.

Solutions (50 per cent w/v) of analytically pure grades of sucrose were prepared. In the chewing experiments the persons were given paraffin (melting point 46°C) pieces which weighed ca 1.5 grams.

The persons were instructed not to clean their teeth for two days before the experiment and not to eat or drink anything, except tap water, on the morning of the examination. The experiments were always carried out in the forenoon. On arrival at the laboratory the patient rinsed his mouth with tap water to remove loose debris before the 30-second rinse with the sucrose solution. With a blunt scale small amounts of dental plaque material were removed from at least twenty different areas on and between the teeth in one half of the mouth. The material was pooled in a drop (0.05 ml) of distilled water in a one drop glass electrode belonging to a Beckman Expandomatic pH-meter, and the pH in the material was determined. The experiments were carried out at room temperature (22°C). Samples for pH determination were also taken in the same way 2, 5, 10, 20 and 30 minutes after the beginning of the mouth rinse. In the chewing experiments the paraffin chewing was started immediately after the end of the sucrose rinse and continued till the end of the experimental period (30 minutes). The subjects always chewed on one side of the mouth. Samples for pH-determinations were taken from the other side of the mouth. In one series of chewing experiments the sucrose rinse was omitted.

The error of the single observation of the pH, as judged from a large number of measurements at pH 6.00 and pH 5.00, was calculated as ± 0.05 and ± 0.09, respectively, when the pH-meter was calibrated against a standard buffer pH 6.00. Before and during each experiment the meter was checked against buffers, pH 6.00 and pH 5.00.

The results were evaluated statistically in the way described previously (*Frostell*, 1970). The calculations were made with the use of the pH-values or the differences between the pH-values instead of the corresponding hydrogen-ion concentrations. The reason for this was that the pH-values were found to be distributed more closely to the normal curve than the actual concentration values, and could thus be used in a paired t-test. For the same reason the mean pH-values are given (geometric mean of hydrogen-ion concentrations) because they are considered to be more representative than the means of the actual mean hydrogen-ion concentration values.

As stated previously (*Frostell*, 1970), a statistical investigation revealed that the differences between the pH-values seemed to be more representative (more evenly distributed) than the pH-values themselves. These differences were therefore used for the determination of pH-changes. For the statistical calculations an Olivetti Programma computer was used.

RESULTS

As found previously, a 30-second rinse with a 50 per cent sucrose solution was followed by a typical increase in hydrogen-ion concentration of the dental plaques with its maximum after 10 minutes in the present experiments. In experiments with chewing the pH-decreases (Table I., Fig. 1) in the plaques were less pronounced and of shorter duration than in experiments without chewing. The differences were highly significant at 10, 20 and 30 minutes, but not significant at 2 minutes or 5 minutes. Chewing of paraffin without a sucrose rinse caused a mean pH-increase in the plaques by about 0.40 throughout the experimental period of 30 minutes.

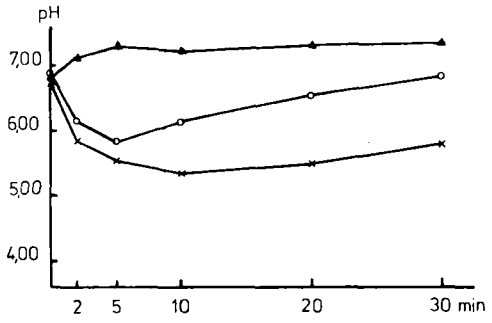

Fig. 1. Mean pH changes in the dental plaques in 18 persons.
×———× after a 30-second sucrose rinse without chewing.
▲———▲ after a 30-second sucrose rinse followed by paraffin chewing during the entire experimental period.
o———o during paraffin chewing during the entire experimental period (no rinse).

DISCUSSION

The experimental method permits measurements in superficial plaques only. Therefore, the results cannot be regarded as representative of interdental plaques in which the pH-decrease after sugar consumption is larger than in superficial plaques and in which the effect of chewing may be expected to be less pronounced than in superficial plaques.

Since the statistical methods seem to have given rise to some discussion, especially the use of pH-differences for calculating means and for statistical operations, they will be commented on in some detail. Since the pH-values are logarithms the differences between pH-values are logarithms, too. The corresponding actual figures are, thus, factors telling how many times the acid concentration is increased in the interval between the initial consumption and the sampling time. For example, if the initial pH is 7.0 and the pH at the time the sample is taken is 6.5, the pH-difference 0.5 means

Table I. *Statistical evaluation of the differences in results between experiments with and without chewing of paraffin*

	Initial pH	2		5		10		20		30 min.	
	Mean pH	Mean pH	Mean pH decrease	Mean pH	Mean pH decrease	Mean pH	Mean pH decrease	Mean pH	Mean pH decrease	Mean pH	Mean pH decrease
Sucrose rinse	6.79	5.87	0.92	5.55	1.24	5.35	1.44	5.46	1.33	5.69	1.10
Sucrose rinse + paraffin chewing	6.96	6.16	0.80	5.87	1.09	0.13	0.83	6.57	0.39	6.82	0.14
Difference	0.1705		0.1160		0.1438		0.6144		0.9383		0.9194
t-value	1.6145		1.1157		1.2259		4.5646		7.4115		6.7011
Level of significance	—		—		—		XXX		XXX		XXX
Paraffin chewing without sucrose rinse	6.87	7.11	—0.24	7.24	—0.38	7.24	—0.38	7.27	—0.41	7.26	—0.39

that the H-ion concentration in the plaques has increased 3.16 times. In the same way if the initial pH is 6.0 and the pH, at the time the sample is taken, is 5.5 the difference will also be 0.5 and the acid concentration will have increased 3.16 times in this experiment, too.

Thus, the statistical operations are carried out with these factors, which are found to fit a gaussian curve better than the actual changes in hydrogen-ion concentration. It is readily understood that this holds true if it is recalled, that the hydrogen-ion concentration is 100 times higher at pH 5.00 than at pH 7.00, and therefore that one incorrect measurement of the pH (or an extreme value) may outweigh 10 or more correct readings. The influence of such extreme results are accordingly reduced by the statistical method used.

The results of the present investigation confirm previous findings by *Mühlemann* (1969) and *Hassel* (1971) on the effect of chewing on dental plaque pH. If it is true that the pH-decrease in the dental plaques is an indication of the cariogenicity of the food investigated, the results show that the cariogenicity of a foodstuff depends to a varying extent with the way it is consumed. Foods requiring intense chewing may be expected to be less cariogenic than a food of the same chemical composition, which does not require chewing. This fact indicates that every type of foodstuff constitutes a problem of its own in this respect, and there will probably always be great need for methods for assessing the effect of different foodstuffs on the pH of dental plaques. The chewing experiments without sucrose rinse demonstrate the pH-increasing effect of chewing.

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