

# Effect of a buffering sugar-free lozenge on intraoral pH and electrochemical action

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Nilner K, Vassilakos N, Birkhed D. Effect of a buffering sugar-free lozenge on intraoral pH and electrochemical action. *Acta Odontol Scand* 1991;49:267-272. Oslo. ISSN 0001-6357.

Two double-blind crossover studies were performed to test a sugar-free lozenge containing bicarbonate and phosphate buffers (Profylin®). The studies were performed in groups of 20 and 13 individuals. In Study I active buffering or placebo lozenge (not buffered) was given, and the pH of plaque and saliva was measured after 2, 5, 10, 20, and 30 min. In study II the lozenges were given 10 min after a sucrose rinse, and both the pH and the potential and polarization of amalgam restorations that made contact in the oral cavity were measured. In study I both lozenges increased the pH of plaque and saliva, but the values after sucking on the active lozenge were significantly higher than after placebo. In study II a pH recovery of plaque and saliva after the sucrose rinse was recorded for both types of lozenge, but it was most pronounced for the active, buffering lozenge. A statistically significant difference was, however, found only 5 min after sucking on the lozenge. No influence on the current magnitude was observed. The results thus indicate that the buffering sugar-free lozenge raises the pH of plaque and saliva and accelerates the pH recovery after a sucrose rinse but seems to have no influence on the galvanic current magnitude of amalgam restorations in contact. □ *Buffering effect; clinical study; dental plaque; electrochemistry; impaired salivation; saliva*

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Various metal alloys are used for restorations in dental treatment. It has been claimed that ions released from the metallic fillings might cause local and remote symptoms (1-4). Certain symptoms in the oral cavity, described as oral galvanism, could possibly be caused by the galvanic current flowing between two metallic restorations when they make contact in the oral cavity (5). Furthermore, lesions in the oral tissue, such as oral lichen planus, are assumed to be caused by sensitivity to ions released from amalgam restorations (6, 7).

The inhibitory effect of saliva and its buffer systems on the corrosion process in the oral cavity has been shown *in vitro* (8, 9), as has the effect of the pH of the electrolyte on the galvanic current generation in an electrochemical coupling between amalgam and gold (10). It was recently found in an *in vivo* study, however, that soft drink rinsing and sweet consumption did not lead to significantly higher current magnitude when amalgam restorations made contact in the oral cavity (11).

Impaired salivation is a common side effect of various drugs and radiotherapy in the head and neck region and can be a symptom in some systemic diseases, such as Sjögren's syndrome. The effect of a low salivary secretion rate on the corrosion processes in the oral cavity has been speculated on by some authors (9, 12). The aim of this study was therefore to investigate the effect of a saliva-stimulating, sugar-free lozenge, Profylin®, containing various buffering substances, on the pH of plaque and saliva and on the magnitude of the current that may be created between amalgam restorations when they make contact in the oral cavity.

## Materials and methods

### *Experimental design*

Two separate studies were carried out, here called study I and study II. They were both double-blind with a crossover design. A commercially available lozenge, Profylin

(Prophyllactor, Stockholm, Sweden) (Table 1), and a placebo, which did not contain any buffering substances but otherwise had the same ingredients as the active product, were tested. The active lozenge was, according to the manufacturer, composed to act in the oral fluid as a supersaturated solution of calcium and phosphates.

In both studies the subjects, who had at least 15 natural teeth, were asked to refrain from all oral hygiene procedures for 2 days before the experiment. At least 1 week passed between administration of the two types of lozenge. The participants were asked not to consume anything for at least 2 h before the measurements. Half of the subjects in both study I and study II had a low salivary secretion rate— $<0.7$  ml/min for paraffin-stimulated whole saliva.

### Study I

Twenty subjects participated. They were asked to suck on one of the lozenges, and the pH of dental plaque (13) and unstimulated whole saliva was measured before (time zero) and 2, 5, 10, 20, and 30 min after the lozenge was given. The experiment was repeated after 1 week, using the other type of lozenge.

### Study II

Thirteen subjects participated. They were examined before the study for metallic contacts between amalgam restorations. Poten-

tial and polarization measurements were then performed in accordance with a previously described method (5). The current magnitudes were calculated, and the two pairs of amalgam restorations with the highest current between them on contact were selected for each of the subjects. All these restorations were placed more than 6 months before the experiment. This method, applied for estimation of the current, has been shown to present values comparable to the directly measured currents or to other methods for assessment of intraoral electrochemical activity (14).

The subjects were asked to rinse their mouths for 1 min with 10 ml of a 50% sucrose solution. Ten minutes later they started to suck on the lozenge. The pH of the dental plaque and unstimulated whole saliva and the potential/polarization of the amalgam fillings were measured before (time zero) and 5, 10, 12, 15, 20, 25, 30, and 40 min after the start of the rinsing. The experiment was repeated after 1 week with the other type of lozenge. A third experiment was carried out with the sucrose rinse only—that is, without using any lozenge.

### Statistics

Comparisons of  $\Delta$ pH values (versus time zero) of plaque and saliva and of current for the two types of lozenge were carried out with Student's *t* test for paired observations.  $P < 0.05$  was considered statistically significant. Since no differences were found between the subjects with normal and low salivary secretion rates, the data for all individuals in study I and study II were pooled.

Table 1. Ingredients (mg) of the Prophylin® lozenge

Ingredient	mg
Xylitol	285
Sorbitol	275
Disodium hydrogen phosphate	21.3
Sodium hydrogen phosphate	20.6
Sodium bicarbonate	19.2
Magnesium stearate	9.0
Sodium polyphosphate	7.7
Mint aroma	6.0
CMC	5.0
Calcium chloride	1.1
Zinc chloride	0.1
Total	650.0

## Results

### Study I

The  $\Delta$ pH values in plaque and saliva are presented in Fig. 1. In plaque, Prophylin resulted in an increase, and the  $\Delta$ pH was statistically significantly higher than for the placebo at all times (2, 5, and 10 min,  $p < 0.001$ ; 20 and 30 min,  $p < 0.05$ ). The placebo lozenge increased the pH only

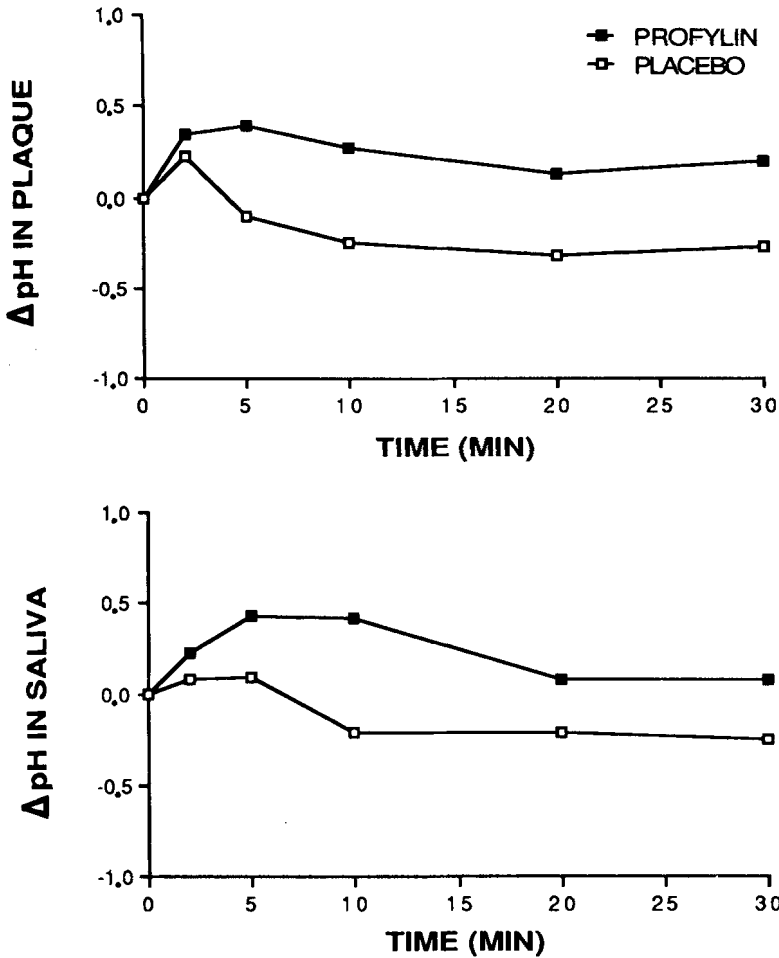


Fig. 1. Changes of pH ( $\Delta$ pH) in dental plaque and saliva after Profylin® or placebo lozenge intake. Mean values of 20 subjects.

slightly at 2 min and caused a decrease at all other time points. Profylin also resulted in a statistically significant increase of pH in saliva at 5 and 10 min ( $p < 0.01$ ), whereas the placebo caused a slight increase at the 2- and 5-min registrations and a decrease at 10, 20, and 30 min.

*Study II*

The  $\Delta$ pH values in plaque and saliva are presented in Fig. 2. As expected, the sucrose rinse gave a pH drop. Both lozenges resulted in a recovery of pH in both plaque and saliva compared with the sucrose rinse only. The increase of pH in plaque was significantly

greater for Profylin than for placebo at 30 min ( $p < 0.05$ ). The pH recovery was somewhat more pronounced in saliva than in plaque, although the result as a whole was similar. Profylin gave significantly higher values than placebo at 20 min ( $p < 0.05$ ). The magnitude of the current is illustrated in Fig. 3. No statistically significant differences were observed between the values obtained either within or between the three different experiments.

**Discussion**

The aim of this study was to investigate the influence of a commercially available sugar-

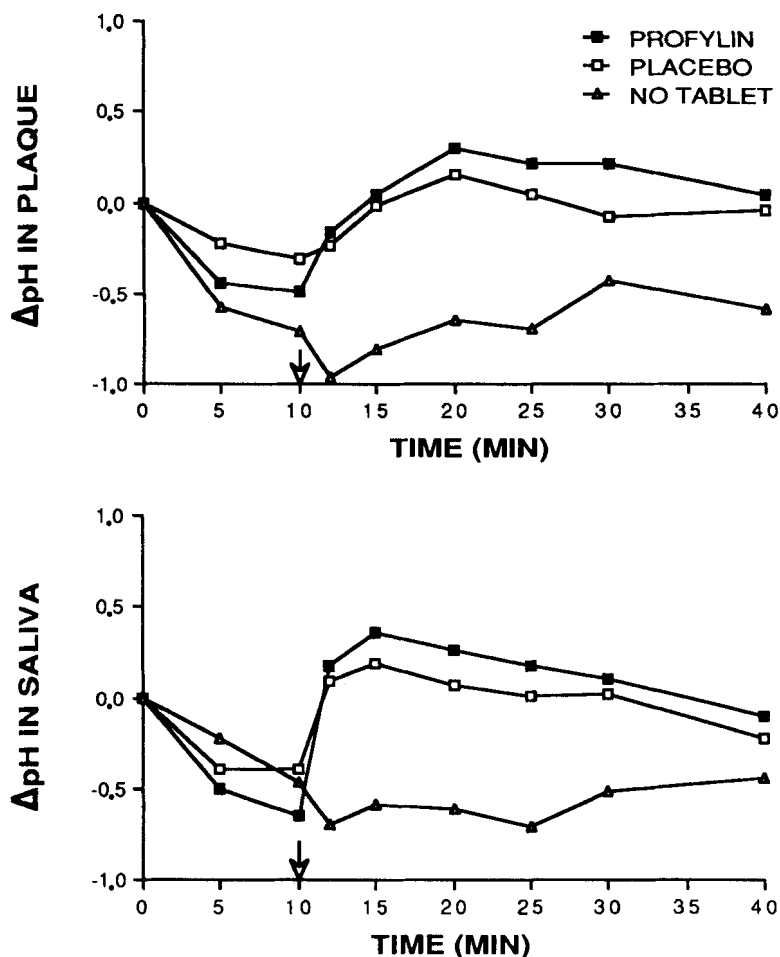


Fig. 2. Changes of pH ( $\Delta$ pH) in dental plaque and saliva after a 10-min sucrose rinse followed by Profylin® or placebo lozenge intake. Mean values of 13 subjects. The arrow indicates the start of sucking.

free lozenge, containing both bicarbonate and phosphate buffer systems, on the pH of plaque and saliva and on the magnitude of the galvanic current created when amalgam restorations make contact in the oral cavity. The dissolution time of the lozenge in the mouth varied for the different subjects from 4.0 to 6.5 min (mean value, 5 min). The three buffering salts used in Profylin—that is, disodium hydrogen phosphate, sodium hydrogen phosphate, and sodium bicarbonate—are probably quickly released from the tablet to saliva during sucking. However, the salivary clearance was not measured in the

present study. Further studies are therefore required to ascertain the optimal concentrations of the buffering substances in the product and their release in the oral cavity.

The results in both parts of the study indicate that Profylin enhances the intraoral pH. A small increase was also observed for the placebo tablet, which could be attributed to a stimulation of the salivary flow. It is well known that the major buffering component in human saliva is bicarbonate, which also increases in concentration when the saliva is stimulated (15). This is the probable explanation for the elevation in pH of plaque and

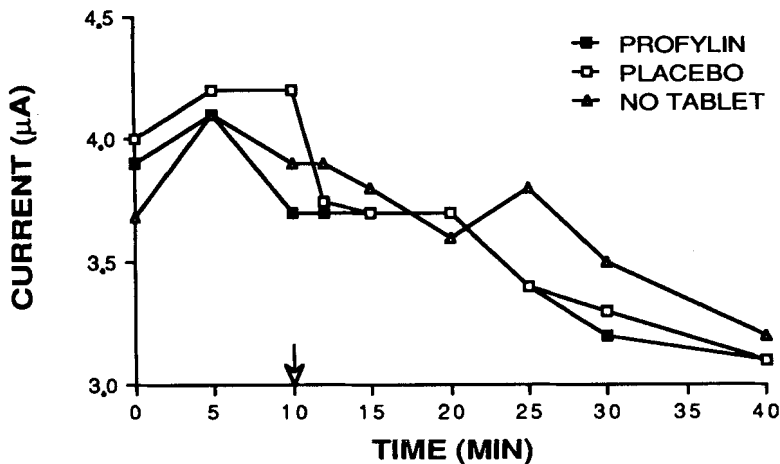


Fig. 3. Current magnitude values obtained from amalgam fillings after a 10-min sucrose rinse followed by Profylin® or placebo lozenge intake. Mean values of 13 subjects. The arrow indicates the start of sucking.

saliva after sucking on the placebo lozenge. The additional effect of Profylin is believed to be caused by its content of bicarbonate and phosphate buffers. These conclusions are in agreement with the results of Igarashi et al. (16), who found that addition of sodium bicarbonate to a sugar-free chewing gum markedly enhanced its capacity to cause and maintain an elevation of interproximal plaque pH previously lowered by exposure to fermentable carbohydrates. It has also been shown, both *in vivo* and *in vitro*, that the addition of a bicarbonate-phosphate mixture to sucrose elevates the pH of saliva and dental plaque (17–19).

No difference in the current magnitude after Profylin and placebo intake was observed. It showed a tendency to increase after the sucrose rinse but recovered to values that at the last measurement were lower than at base line. These results are in line with another study, in which pH changes after a soft drink rinse or sweet consumption did not affect the galvanic current created between amalgam restorations in contact (11). A possible explanation for this finding could be that all of the potential and polarization measurements were performed on restorations placed at least 6 months before the experiment. Electrochemically, such restorations might be considered quite stable, with mixed surface potentials resulting from

the equilibrium between corrosion and passivation. In contrast, newly placed amalgam restorations exhibit an increasing corrosion rate due to selective dissolution of the most electronegative elements (20). This initial corrosion is independent of the pH of the saliva and forms metal complexes on the surface of the restoration, subsequently retarding the corrosion processes (21). These products seem, however, to be sensitive to low pH, which increases their solubility. This sequence of events is observed in *in vitro* studies, which have shown increasing corrosion rates in experimental solutions with low pH values (22). Further, in another *in vitro* study high pH of the electrolyte in a gold-amalgam galvanic coupling resulted in a reduced attack on the amalgam (10). As the above-mentioned studies indicate, salivary buffer systems and their pH-regulating effect are of importance for the corrosion rate of dental amalgams, especially when newly placed.

To conclude, this study shows that sucking on a sugar-free lozenge, containing bicarbonate and phosphate buffers, increases the pH of plaque and saliva and accelerates the recovery of pH in the oral cavity after a sucrose rinse. However, no effect was found on current generated when amalgam restorations more than 6 months old make contact.

*Acknowledgement.*—We should like to thank Mrs Elisabeth Thornqvist for excellent technical assistance.

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Received for publication 3 July 1990