Occupational syrup-tasting and dental health

Inkeri Rytömaa, Varpu Järvinen and Olli P. Heinonen
Department of Cariology and Department of Public Health, University of Helsinki, Helsinki, Finland

Rytömaa I, Järvinen V, Heinonen OP. Occupational syrup-tasting and dental health. Acta Odontol Scand 1994;52:20–24. Oslo. ISSN 0001–6357.

In the sugar industry the quality of a syrup is judged by taste. The aim of this study was to investigate whether tasting affected the taster's teeth. Seven technicians who had tasted syrups for at least 2 years and 21 age-matched controls working in the same factory were investigated. Dental, medical, and dietary histories were obtained, and salivary and intra-oral examinations were undertaken. The tasters had similar DMFS indices to but more decayed surfaces than the controls (3.4 versus 1.0; $p < 0.05$), especially on proximal surfaces (2.0 versus 0.7; $p < 0.05$). The tasters had also higher visible plaque index and gingival bleeding index than the controls (23% versus 11% and 23% versus 10%; $p < 0.05$). We conclude that frequent exposure to syrup may increase caries activity, despite the various preventive measures commonly adopted. It is concluded that those selected for tasting should be carefully examined for general health and oral status and that preventive dental measures be emphasized.
□ *Caries; gingiva; sugar; teeth*

Inkeri Rytömaa, Department of Cariology, University of Helsinki, Mannerheimintie 172, SF-00300 Helsinki, Finland

In the sugar industry, syrups are tasted in the course of quality control. A technician commonly tastes a 65–77% sugar solution 5–15 times per working day.

Fermentable carbohydrates play a major role in the pathogenesis of dental caries, and repeated rinsing of the mouth with a sugar solution particularly increases caries activity, especially if oral hygiene is poor (1). Salivary flow rate influences the rate at which sugar is eliminated from the mouth (2, 3). Careful cleaning of tooth surfaces by dental health personnel every second week also prevents caries and reduces the incidence of gingivitis (4, 5). There is a causal relationship between the caries decrease in the 1970s and 1980s and the topical use of fluorides (6).

The aim of the present study was to investigate whether syrup-tasting results in untoward changes in the saliva, tooth plaque, and dental health of the technicians concerned. We are not aware of any previous study in which the effect of occupational sugar tasting on dental health has been investigated.

Materials and methods

The study was based on comparison of syrup tasters and their controls. It was conducted in a sugar factory in the spring of 1991. The exposed subjects (tasters) were seven technicians who had tasted 65–77% syrup solutions 5–15 times per working day for at least 2 years. Syrup solution contains 60% sucrose and 40% glucose-fructose mixture. For each taster three age-matched non-exposed subjects (controls) were selected from workers in the same factory. None of the controls had ever tasted syrups. All subjects and controls were women from 24 to 60 years old (Table 4).

In the clinical examination dental caries was recorded on the basis of WHO criteria (7). For carious surfaces one cavitation grade (DS) and one precavitation grade (DS ini) were recorded. Bite-wing radiographs were taken and assessed at 1.5× magnification. Criteria applied were DS = radiolucency visible in dentin and DS ini = radiolucency visible in enamel. Dental plaque and gingivitis were recorded with the visible plaque index (VPI) and gingival bleeding index (GBI) of Ainamo & Bay (8). Color photographs were taken. The assessor did not know whether the subjects were tasters or controls. To investigate intra-examiner reliability, 10 subjects were examined twice, 3 weeks apart. The kappa value for caries

recordings was 0.94 (9). The subjects were asked to allow us to contact the dentist who had treated them. From the dentist's records information was obtained about the caries lesions (DS) treated during the 2 years. From these treated lesions and decayed surfaces observed in the clinical examination the 2-year caries increments were counted.

Unstimulated and stimulated (by paraffin chewing) saliva were collected for 5 min. Buffering capacities were measured using the Dentobuff method (Dentobuff strip, Orion Diagnostica, Espoo, Finland). The numbers of salivary lactobacilli, *Streptococcus mutans*, and *Candida albicans* were assessed with Dentocult-LB, Dentocult-SM strip mutans, and Oricult-N kits, respectively (Orion Diagnostica).

Medical and dietary histories were taken. Emphasis was given to recording diseases and medicines that could have affected salivary flow rate. Questions were asked about sensitivity of the teeth to hot, cold, and sweet stimuli. Sensitivity was considered to be present if the stimuli caused pain. Dietary information was collected by means of a 24-h recall interview. 'Eating occasions', daily meals, and snacks were counted. An eating occasion was defined as ingestion of food or beverage items more than 20 min apart. A food-frequency questionnaire was used to evaluate consumption of products with added sugar. Syrup tasters were asked what they ate or drank after syrup-tasting. Oral hygiene habits and use of topical fluorides were evaluated. Each interview and clinical examination lasted for about 1.5 h.

The statistical significances of differences between tasters and controls were assessed by paired *t* test and chi-squared test for matched data (10).

The Ethical Committee at the Institute of Dentistry approved the study.

Results

Tasters and controls had, on average, the same numbers of teeth and fairly similar DMFS values. The syrup tasters had on average 2.4 more decayed surfaces than the controls ($p < 0.05$). On the approximal surfaces the difference between the means was 1.3 surfaces ($p < 0.05$).

Table 1. Numbers of teeth and caries indices (mean ± SD) among tasters and matched controls at the examination and during the preceding 2 years

	Tasters ($n = 7$)	Controls ($n = 21$)
No. of teeth	27.0 ± 1.2	27.2 ± 1.3
DMFS	33.7 ± 18.5	39.2 ± 21.2
DS	3.4 ± 3.0	1.0 ± 1.5*
DS proximal	2.0 ± 1.5	0.7 ± 1.0*
DS occlusal	0.4 ± 0.8	0.0
DS bucc-ling surf.	1.0 ± 1.2	0.3 ± 0.6
DS ini	3.8 ± 2.7	2.6 ± 2.2
DS per 2 years	5.1 ± 4.2	2.4 ± 2.0
DS proximal per 2 years	3.3 ± 1.5	1.7 ± 1.6

* $p < 0.05$.

The caries increment over the preceding 2 years averaged 5.1 decayed surfaces among the tasters and 2.4 decayed surfaces among the controls ($p < 0.08$) (Table 1).

VPI and GBI values were higher among the tasters than among the controls (Table 2). The daily toothbrushing frequency was 1.4 ± 0.5 (mean ± SD) among the tasters and 2.1 ± 0.5 among the controls ($p < 0.01$). The tasters used fluoridated toothpaste 1.4 ± 0.5 and the controls 2.0 ± 0.8 times daily ($p < 0.05$). Three tasters and nine controls used toothpicks. Three tasters and 11 controls used dental floss. Only one taster and three controls used fluoride mouthwash.

Excluding syrup tasting, the tasters ate daily (meals and snacks) 5.7 ± 0.9 times on weekday and 3.6 ± 0.8 times on weekends; among the controls the corresponding frequencies were 5.6 ± 0.7 and 4.0 ± 0.6. The

Table 2. Visible plaque index (VPI, %) and gingival bleeding index (GBI, %) for all surfaces and for lingual surfaces in tasters and matched controls (mean ± SD)

	Tasters ($n = 7$)	Controls ($n = 21$)
VPI (%)	23 ± 21	10 ± 10*
VPI (%) (lingual)	28 ± 28	9 ± 12*
GBI (%)	23 ± 16	10 ± 13*
GBI (%) (lingual)	27 ± 20	10 ± 13**

** $p < 0.01$; * $p < 0.05$.

Table 3. Stimulated and unstimulated flow rates (mean ± SD) and numbers of individuals with low buffering capacities and high bacterial counts in saliva in tasters and matched controls

Saliva	Tasters ($n = 7$)	Controls ($n = 21$)
Stimulated flow rate (ml/min)	1.9 ± 0.7	1.9 ± 0.6
Unstimulated flow rate (ml/min)	0.3 ± 0.1	0.4 ± 0.3
Buffer capacity pH < 5.5	3/7	9/21
Lactobacillus count > 10^5 CFU/ml*	3/7	6/21
Streptococcus mutans count > 10^6 CFU/ml	6/7	10/21
Candida growth	4/7	8/21

* CFU = colony-forming units.

tasters consumed sugary products 3.9 ± 2.4 times and the controls 3.1 ± 2.0 times daily. None of these differences were statistically significant.

Average values for saliva measurements were similar in the two groups. Six of the seven tasters but only half of the controls had high *S. mutans* counts ($p < 0.01$) (Table 3).

Tasters' teeth were more sensitive than controls' teeth to exogenous factors. Four of the seven tasters had teeth sensitive to cold, five to sweetness. Among the controls, the corresponding figures were 3 and 1 (of 21). The differences between tasters and controls were statistically significant ($p < 0.05$ and 0.01).

Table 4 gives information about each taster. Two of them (T2 and T5) had been totally free from caries during the preceding 2 years. Taster 7 had a low salivary flow rate and a poor salivary buffering capacity. Taster 4 had a very high DMFS index. Five tasters rinsed their mouths with water after syrup-tasting. Taster 3 drank sweet beverages and taster 4 did not ingest anything after tasting. General health among tasters and controls was good, except that taster 4 had a gastrointestinal disease and taster 7 had cardiovascular and respiratory conditions.

Discussion

The results of the present study show that syrup-tasting can be an occupational oral health hazard. All indices reflecting the actual quantity of caries observed in the examination and treated during the 2 previous years were higher among the tasters than among the controls. The tasters had higher VPI and GBI indices and higher *S. mutans* counts than the controls. Frequent

Table 4. Characteristics of tasters

Taster	Age, years	DS per 2 years	DMFS	GBI† %	Buffer capacity	Daily frequency of sucrose intake	Daily frequency of toothbrushing
T1*	24	7	25	20	Medium	6.4	1
T2*	30	0	12	43	Good	1.1	2
T3**	31	4	29	5	Good	6.7	2
T4**	34	11	60	7	Medium	4.1	1
T5*	37	0	16	12	Good	1.4	1
T6**	40	5	39	40	Good	5.5	1
T7**	60	9	55	35	Poor	2.0	2

* Tasted 2 preceding years.
** Tasted 5 preceding years.
† GBI = gingival bleeding index.

tooth sensitivity to external factors in the tasters possibly also indicates higher caries activity in them than in controls.

If these differences are to be explained in terms of syrup-tasting, it is necessary to exclude other causes of caries. Special emphasis was therefore placed on evaluation of such factors.

Average frequencies of eating and consumption of sugar, excluding syrup tasting, were similar in tasters and controls. The major difference between the two groups in relation to exposure to sugar was therefore that the tasters had tasted 65–77% syrup solutions 5–15 times per working day.

Exposure to syrup solution can cause a decrease in the plaque pH of the tasters lasting 2.5 to 7.5 h, thus providing conditions favoring dissolution of tooth surfaces (11). The pH decrease in dental plaque, particularly in undisturbed approximal plaque, is great and of long duration after consumption of solutions with high sugar concentrations, especially in individuals with reduced salivary flow rate (12–14). Frequent consumption of sugar increases tight attachment of cariogenic microorganisms to tooth surfaces and enhances formation of insoluble polysaccharides in plaque (15). The presence of such plaque leads to dental decay and gingivitis (16).

Toothbrushing frequency was higher among controls than among tasters, but in both groups brushing frequency was more than once a day. It has been suggested that one effective cleaning daily is sufficient to ensure gingival health. Cleaning habits were sufficient to maintain relatively good oral hygiene among the controls but apparently not among the tasters. The more frequent use of fluoridated toothpaste among controls than tasters may possibly have had some effect on caries activity. It is known that the addition of fluoride to a sucrose rinse significantly inhibits acid production in dental plaque (17).

Because syrup-tasting is not a common type of work, the sample size is small, but this material was nevertheless sufficient to reveal a statistically significant difference in caries activity between the tasters and the controls. Tasters and age-matched controls were from the same social class and had similar living conditions. The number of teeth and the life-time cumulative caries experience (DMFS index) did not differ between the tasters and the controls. This means that the tasters and the controls were comparable except with regard to exposure to the syrup. Tasting of sugar products in other fields of food industry could also be risk for oral health, although this has not been reported in the literature, possibly because every factory has only a few tasters.

The results shown in Table 4 demonstrate that despite their frequent exposure to syrup solution, not all tasters had caries. Tasters 2 and 5, who had tasted for 2 years, had not had new caries lesions over the 2 years before the study. In both these tasters, 'normal' consumption of sugar was infrequent. They also consistently rinsed their mouths with water after tasting a syrup solution at work. These subjects were apparently suitable for tasting, although taster 2 needed advice about oral hygiene because of high visible plaque and gingival bleeding indices. Taster 7 had high caries activity. Because of a general disease, this taster took medication that reduced her salivary flow rate and buffer capacity. Taster 4 had always had severe caries. Her DMFS index was 60. She did not rinse her mouth after tasting. She used fluoridated toothpaste only once a day, in the morning. She also had a gastrointestinal disease. These two cases show that when selecting tasters, it is important to consider general and dental health and the salivary flow rate to protect the taster against deleterious effects of the syrup.

In our opinion, those selected for tasting should be carefully examined with regard to their general health and oral status, and preventive dental measures (good oral hygiene, daily use of topical fluoride, and avoidance of sugar consumption) should be emphasized. An individual with a low salivary flow rate and a high caries experience does not appear suitable for tasting. If a taster gets a disease or starts medication that reduces the flow rate of saliva, he/she should discontinue tasting. Before tasting, teeth should be as clean as possible. After tasting, the mouth should be rinsed with a water and

fluoride solution. Tasters might also benefit from use of xylitol-containing chewing gum. We believe that with these preventive measures syrup-tasting does not pose a great occupational hazard to dental health.

Acknowledgements.—We are most grateful to Mr. Kari Hänninen, M.Sc., for his contribution to the data analysis. This investigation was supported by Sucros Ltd., Finland.

References

1. von der Fehr FR, Loë H, Theilade E. Experimental caries in man. Caries Res 1970;4:131–48.
2. Dawes C. A mathematical model of salivary clearance of sugar from the oral cavity. Caries Res 1983; 17:321–34.
3. Sreebny LM, Chatterjee R, Kleinberg I. Clearance of glucose and sucrose from the saliva of human subjects. Arch Oral Biol 1985;30:269–74.
4. Axelsson P, Lindhe J. The effect of a preventive programme on dental plaque, gingivitis and caries in schoolchildren: results after one and two years. J Clin Periodontol 1974;1:126–38.
5. Axelsson P, Lindhe J. Effect of fluoride on gingivitis and dental caries in a preventive program based on plaque control. Community Dent Oral Epidemiol 1976;3:156–60.
6. Fejerskov O, Thylstrup A, Larsen MJ. Rationale use of fluoride in caries prevention. A concept based on possible cariostatic mechanisms. Acta Odontol Scand 1981;39:241–9.
7. Oral health surveys. Basic methods. 3rd ed. Geneva: World Health Organization, 1987.
8. Ainamo J, Bay I. Problems and proposals for recording gingivitis and plaque. Int Dent J 1975; 25:89–93.
9. Fleiss JL. Statistical methods for rates and proportions. New York: John Wiley and Sons, 1973: 143–7.
10. Breslow NE, Day NE. Statistical methods in cancer research. Vol. I. The analysis of case-control studies. Lyon: International Agency for Research on Cancer, 1980. IARC scientific publications No. 32.
11. Lindfors B, Lagerlöf F. Effect of sucrose concentration in saliva after a sucrose rinse on the hydronium ion concentration in dental plaque. Caries Res 1988;22:7–10.
12. Frostell G. Dental plaque pH in relation to intake of carbohydrate products. Acta Odontol Scand 1969;27:3–29.
13. Hase JC, Birkhed D. Salivary glucose clearance, dry mouth and pH changes in dental plaque in man. Arch Oral Biol 1988;33:875–80.
14. Firestone AR, Mühlemann HR. In vivo pH of plaque-covered and plaque-free interdental surfaces in humans following a sucrose rinse. Clin Prev Dent 1985;7:24–6.
15. Rölla G, Scheie AA, Ciardi JE. Role of sucrose in plaque formation. Scand J Dent Res 1985;93:105–11.
16. Loesche WJ. Chemotherapy of dental plaque infections. Oral Sci Rev 1976;9:65–107.
17. Oliveby A, Weetman DA, Geddes DAM, Lagerlöf F. The effect of salivary clearance of sucrose and fluoride on human dental plaque acidogenicity. Arch Oral Biol 1990;35:907–11.

Received for publication 22 February 1993
Accepted 11 May 1993