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Effect of three-year consumption of erythritol, xylitol and sorbitol candies on various plaque and salivary caries-related variables

Riina Runnel [a,*], Kauko K. Mäkinen [b], Sisko Honkala [c], Jana Olak [a], Pirkko-Liisa Mäkinen [b], Rita Nõmmela [a], Tero Vahlberg [d], Eino Honkala [b,c], Mare Saag [a]

[a] Department of Stomatology, Faculty of Medicine, University of Tartu, Estonia
[b] Institute of Dentistry, University of Turku, Finland
[c] Faculty of Dentistry, Kuwait University, Kuwait
[d] Department of Biostatistics, Faculty of Medicine, University of Turku, Finland

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ABSTRACT

Objective: The objective of the present paper is to report results from oral biologic studies carried out in connection with a caries study.
Methods: Samples of whole-mouth saliva and dental plaque were collected from initially 7- to 8-year-old subjects who participated in a 3-year school-based programme investigating the effect of the consumption of polyol-containing candies on caries rates. The subjects were randomized in three cohorts, consumed erythritol, xylitol, or sorbitol candies. The daily polyol consumption from the candies was approximately 7.5 g.
Results: A significant reduction in dental plaque weight from baseline ($p < 0.05$) occurred in the erythritol group during almost all intervention years while no changes were found in xylitol and sorbitol groups. Usage of polyol candies had no significant or consistent effect on the levels of plaque protein, glucose, glycerol, or calcium, determined yearly in connection with caries examinations. After three years, the plaque of erythritol-receiving subjects contained significantly ($p < 0.05$) lower levels of acetic acid and propionic acid than that of subjects receiving xylitol or sorbitol. Lactic acid levels partly followed the same pattern. The consumption of erythritol was generally associated with significantly ($p < 0.05$) lower counts of salivary and plaque mutans streptococci compared with the other groups. There was no change in salivary *Lactobacillus* levels.
Conclusion: Three-year consumption of erythritol-containing candies by initially 7- to 8-year old children was associated with reduced plaque growth, lower levels of plaque acetic acid and propionic acid, and reduced oral counts of mutans streptococci compared with the consumption of xylitol or sorbitol candies.

* *Corresponding author at*: University of Tartu, Department of Stomatology, Raekoja plats 6, Tartu 51003, Estonia. Tel.: +372 731 9856; fax: +372 731 9856.
E-mail address: riina.runnel@ut.ee (R. Runnel).
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1. Introduction

Ancillary studies carried out as part of clinical trials aimed at investigating caries prevention have provided important information concerning oral physiologic processes and helped outline the mechanism of prevention. Examples of such clinical trial/ancillary study efforts include the Turku and the Belize caries prevention programmes which studied the caries-preventive effects of xylitol and sorbitol.[1,2] A recent clinical study implemented in Tartu, Estonia, offered a further opportunity to investigate the possible caries-preventive effect of a homologous series of dietary sugar alcohols, *viz*. erythritol, xylitol, and sorbitol.[3] In this study, the effect of three-year consumption of erythritol, xylitol, and sorbitol candies was investigated in a child population initially consisting of 485 primary school children from the region around Tartu, southeastern Estonia. The main finding of this study was that the number of dentine caries teeth and surfaces in the mixed dentition were lower in the erythitol group than in the xylitol or sorbitol groups.

The objective of the present paper is to report results from oral biologic studies carried out in connection with the above described caries prevention study in children. The ancillary tests focused on salivary and dental plaque levels of mutans streptococci, on salivary *Lactobacillus* levels, and on chemical analyses of dental plaque. Information was also obtained from plaque gravimetry and salivary flow rates during the study years.

2. Materials and methods

2.1. Study design and general procedures

The Tartu study was set up as a double-blind, randomized, placebo-controlled prospective intervention trial. The study design, study population, and treatment of the subjects have been described in detail elsewhere.[3–5] The overall flow chart of the trial is shown in Fig. 1 with information on the number of subjects. In summary, first- and second-graders (7 and 8 years old; $n = 485$) of the participating Tartu area public school classes were randomly divided into three groups of 156–165 children who consumed either erythritol-, xylitol-, or sorbitol-containing candies on school days over a period of three years. The list of all classes from all participating schools was used as a sample frame. Inside the schools, the 1st grade pupils were allocated into a different group than the 2nd graders to reduce school bias. There were about 200 school days per calendar year. Each child consumed four 0.7 g candies three times per school day, the daily intake of each sugar alcohol amounting to approximately 7.5 g. No side effects were expected with that amount. One piece of candy contained about 90% of erythritol, xylitol, or sorbitol. Otherwise the contents of the candies were similar. Candies were manufactured and provided by Cargill R&D Centre Europe. The teachers distributed and supervised the use of the products before the first lesson in the morning (8 am), immediately after the school lunch (10.30 am), and at the end of the school day (1.30 or 2.15 pm). They were trained by RN before start of the intervention. A group representing the investigating team made three annual site visits to the schools during the intervention to enhance compliance of subjects to the study. Most of the children also confirmed their compliance, when questioned by the researchers during the annual examinations.

The subjects were examined four times during the trial: at baseline in 2008 and in the following years once a year (2009–2011). All examinations, including the plaque and saliva collections in question here, were carried out between January and February. The examinations were conducted at standard dental units of the Department of Stomatology, University of Tartu. The International Caries Detection and Assessment System (ICDAS II) was used in the clinical examinations.[6] At the baseline, subjects were blindly assigned to examiners. The subject-examiner assignment was fixed for the duration of the study. Double-blind clinical examinations of the children in all groups were completed by four trained and calibrated investigators (EH, SH, JO, RR). The number of children studied in all four clinical examinations reduced from 165 to 122 in erythritol group, from 156 to 126 in xylitol and from 164 to 126 in sorbitol groups. All pupils received dental health education on oral hygiene and diet in connection with the annual examinations. Each half year, every child was also given a toothbrush and fluoride toothpaste (Colgate Total® with 0.24% sodium fluoride; and sorbitol as a sweetener). At each examination, children were recommend to brush their teeth more than once a day.

An endpoint control group (an additional comparison group) from the same sample frame was drawn after the above examinations of the pupils in the three intervention groups. This group was examined in May 2011 in a way identical to all the previous examinations, following the completion of the fourth and final examinations of the original three intervention groups. The same number of children ($n = 162$) within the same age groups were thus examined to enable comparisons between the intervention groups and the endpoint comparison group.

The entire study was conducted according to the ethical principles of the Declaration of Helsinki. The study protocol (166/T-7) was approved by the University of Tartu Research Ethics Committee. Approvals of the School Management Authority and school principals were also received. The study was listed to the register of clinical trials (www.clinicaltrials.gov) at initiation as Clinical Trials.gov Identifier NCT01062633. Informed consent was obtained for all study subjects from the parents/caretakers.

2.2. Sample collection and microbiologic methods

Salivary and plaque counts of *Streptococcus mutans* (below collectively called mutans streptococci, SM) and salivary counts of *Lactobacillus* (LB) were determined in connection with all clinical examinations by means of the Orion Diagnostica (Espoo, Finland) Dentocult® SM and the Dentocult® LB Dip Slide procedures, respectively. Prior to each visit for plaque and saliva collection, the subjects were instructed to maintain regular, accustomed dietary habits. They were allowed to eat breakfast in the morning and those children who had examination in the afternoon had a light lunch. They