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Effects of Xylitol on the Absorption of ^{203}Pb in Mice and Cockerels

H. M. Mykkänen[1] and S. J. Salminen[2]

[1]Department of Nutrition and [2]Department of Food Chemistry and Technology, University of Helsinki, 00710 Helsinki, Finland

Xylitol is a sweet five carbon sugar alcohol which has been recommended as a sugar substitute for special dietary uses (Mäkinen 1978). Earlier studies have indicated that xylitol may increase the absorption and urinary excretion of dietary oxalate (Salminen et al. 1983). It has also been indicated that xylitol increases the absorption of calcium (Rosenthaler 1971). It may be that xylitol and other alditols have such stability constants that they may increase the solubility of 2-valued cations (Kieboom et al. 1975). Intestinal absorption of lead, a divalent contaminant in the diet, is in many respects similar to that of calcium (Mykkänen and Wasserman 1981, 1982). The purpose of this study was to evaluate the effects of xylitol on the intestinal absorption of lead using two different approaches: the *in situ* ligated intestinal loop technique in cockerels and gastric gavage in mice.

MATERIALS AND METHODS

The absorption of lead (^{203}Pb) was determined in 3-week old white Leghorn cockerels (Turun Muna Oy, Paimio, Finland) using the *in vivo* ligated duodenal loop procedure (Wasserman and Taylor 1973). The chicks were gradually adapted to either 20 % xylitol or 20 % saccharose in drinking water (Table 1). The animals were fasted overnight and a dose containing 0.5 µCi ^{203}Pb, 0.01 mM lead acetate, 1 mM sodium acetate, 150 mM NaCl, and 0 or 100 mM xylitol, pH 6.5, was injected into the ligated duodenal loop of the anesthetized animal. Absorption was allowed to proceed for 60 min, after which the animal was killed and the loop was recovered. The luminal contents, intestinal tissue and carcass were counted for ^{203}Pb. The following parameters of absorption were determined: 1) "unabsorbed" which is the amount of ^{203}Pb (% dose) in the luminal contents, 2) "intestinal retention" which is the amount of ^{203}Pb (% dose) in the intestinal tissue, and 3) "transfer to body" which is the amount of ^{203}Pb (% dose) in the carcass without the intestinal loop.

The absorption and intestinal transit of ^{203}Pb was determined in male NMRI mice by oral dosing (via gastric gavage) of 3 µCi ^{203}Pb in 1 ml of solution containing 0.03 mM lead acetate, 3 mM sodium

acetate, 150 mM NaCl, and 0 or 20 mg of xylitol, pH 6.5. Mice were fed either a powdered rodent diet (Mjölform, Astra Ltd., Sweden) or adapted to 20 % dietary xylitol as described in Table 1. After dosing the animals were kept for 24 hours in individual metabolic cages and urine and feces were collected separately. At the end of the absorption period the animals were killed and the gastrointestinal tract was removed. The gastrointestinal tract, carcass without the GI-tract, and feces were counted for ^{203}Pb.

Table 1. Procedures for adapting white Leghorn cockerels and NMRI mice to 20 % xylitol.

Time	Cockerels's diet	Time	Mouse diet
1st day	Tap water	1st week	Powdered diet[1]
2nd day	5 % xylitol[2] in tap water	2nd week	5 % xylitol[2] in the powdered diet
4th day	10 % xylitol in tap water	3nd week	10 % xylitol in the powdered diet
6th day	15 % xylitol in tap water	4th week	15 % xylitol in the powdered diet
8th day	20 % xylitol in tap water	5th week	20 % xylitol in the powdered diet
10th day	12 hour fasting and dosing with ^{203}Pb	6th week	12 hour fasting and dosing with ^{203}Pb

[1] Mjölform, Astra Ltd., Sweden
[2] Xylitol; pyrogen free parenteral grade, Xyrofin Ltd., Switzerland

The ^{203}Pb content of the samples was determined using a well-type gamma counter (1280 Ultrogamma II, LKB-Wallac Ltd., Turku, Finland). The radioactivity in the carcass was determined using a whole body counter. Counts were expressed as percentage of the initial dose. Carrier-free ^{203}Pb (as acetate) was obtained from New England Nuclear (Boston, MA).

RESULTS AND DISCUSSION

Adaptation to high doses of xylitol in drinking water did not appear to affect the intestinal absorption of the radiolabeled lead in the chicks (Table 2). Similarly, 100 mM xylitol in the intraluminal dose did not influence the transport of ^{203}Pb from the intestine (Table 2). A slight reduction in the intestinal retention of the label was observed in the animals injected with xylitol, but the difference did not reach statistical significance due to the large variability in the individual values.

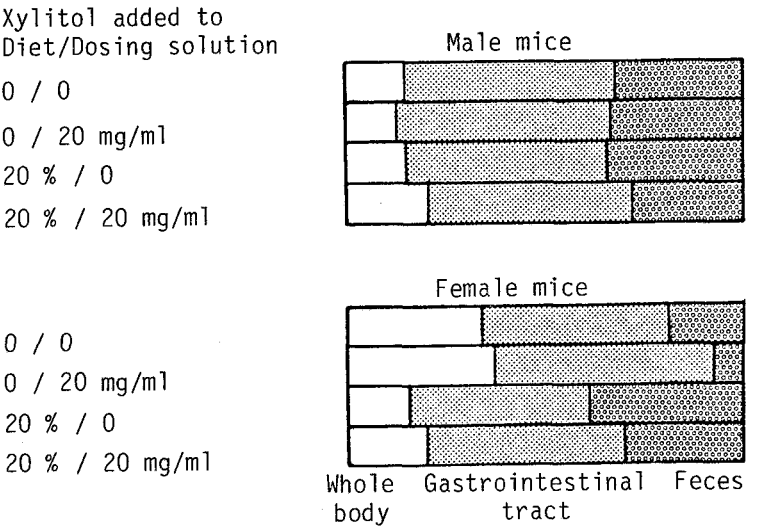

Figure 1. Effect of xylitol on the intestinal absorption and transit of ^{203}Pb in xylitol-adapted and control NMRI mice.

Table 2. Effect of xylitol on the duodenal absorption of ^{203}Pb in chicks gradually adapted to either 20 % saccharose or 20 % xylitol in drinking water[1].

Xylitol in the dosing solution (mM)	Unabsorbed	Intestinal retention ^{203}Pb (% dose)	Transfer to body
	Saccharose, 20 %		
0	48.7 ± 2.3	39.0 ± 5.2	4.2 ± 1.0
100	58.8 ± 2.6	32.2 ± 2.7	3.4 ± 0.6
	Xylitol, 20 %		
0	52.4 ± 7.8	38.2 ± 5.4	3.2 ± 0.9
100	55.3 ± 9.6	30.5 ± 6.5	7.1 ± 2.7

Each value is the mean ± SEM of 4-5 chicks.
[1]The intraluminal dose contained 0.5 μCi ^{203}Pb, 0.01 mM Pb-acetate, 1 mM Na-acetate, 150 mM NaCl, and 0 or 100 mM xylitol, pH 6.5. The absorption period was 60 min.

In female mice xylitol adaptation resulted in increased excretion of ^{203}Pb in the feces (Fig. 1), suggesting that the intestinal transit time of lead was decreased. However, no difference was observed in the ^{203}Pb transport between the adapted and non-adapted male mice. Furthermore, dosing of ^{203}Pb with 20 mg/l xylitol did not result in any consistent alteration of the absorption in either female or male mice (Fig. 1).

The data in chicks indicate no interaction between xylitol and lead absorption. In contrast to this, the results in female mice show that xylitol may decrease the intestinal absorption of lead by increasing the intestinal transit of lead. Data in mice are, however, somewhat contradictory, since the effect was seen only in female mice and there was no direct interaction between xylitol and lead in the intestinal lumen. These discrepancies need to be studied further. It has been shown that high concentrations of lactose facilitate lead absorption in rats only for a short period after weaning (Bushnell and De Luca 1981, 1983). It may be of nutritional and public health importance to investigate in more detail the conditions in which xylitol can be used to lessen the risks of undue lead exposure.

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