Effect of Anionic Ion Exchange Resin Treatment of Milk for Removal of Radioiodine on Its Thiamine Content

A laboratory scale experiment was carried out to determine the influence of an anion exchange procedure for removal of ^{131}I from milk on milk thiamine content. There were no changes observed in the free thiamine, bound thiamine, or total thiamine content of milk treated for ^{131}I removal by anion exchange resin.

Hawk *et al.* (1954) state that thiamine may occur in natural materials as free thiamine, as a protein complex, as a phosphoric acid complex (cocarboxylase), and as a phosphorus–protein complex. In milk, the vitamin is present both as free thiamine and as the vitamin–protein complex. Data on changes in thiamine content of treated milk are necessary to evaluate the nutritional quality of milk.

Several reports have shown that the treatment of milk with ion exchange resins for removing cationic radionuclides or for producing low-sodium milk is accompanied by a decrease in certain vitamins. A report by Aarkrog and Rosenbaum (1962) indicated that three successive resin treatments of milk for the removal of radiostrontium were accompanied by a lack of certain vitamins. A later report from the same laboratory, by Rasmussen (1963) (cited by Isaacks *et al.*, 1967), showed that thiamine, riboflavin, and vitamin B_6 were reduced by 60, 40, and 10 to 20%, respectively. White (1957) reported that the contents of thiamine, nicotinic acid, and vitamin B_{12} in "low-sodium milk" produced by an ion exchange treatment are a little over half of those in ordinary milk.

Isaacks *et al.* (1967) indicate that processing milk to remove radionuclides decreases the thiamine content by 50%. They reported that 86% of the free thiamine and 20% of the bound thiamine were removed from the milk by the resin treatment. All of the above workers employed cationic resins for the treatment of milk. Further work was done at this laboratory to determine the thiamine content of milk treated with an anionic resin for the removal of ^{131}I. The thiamine molecule contains two acid-binding groups; consequently, one would not expect it to exchange with an anionic resin, except possibly as a result of complex phenomena. Our data showed the thiamine content of milk is essentially unaltered by treatment with anion exchange resin.

EXPERIMENTAL

A batch of raw whole milk was stored for 24 hours and divided into two lots. One lot was used for the control and the other for the anion exchange treatment.

The anion exchange treatment of the milk was similar to that described by Murthy *et al.* (1962). The column was filled with Dowex 2-X8, 20–50 mesh anion exchange resin, previously charged with a salt solution containing NaCl, NaH_2PO_4, and sodium citrate.

The milk at normal pH was passed through a $1\frac{1}{4} \times 20$-inch column containing 300 ml. of resin. The flow rate of the milk was 70 ml. per minute.

The first resin bed volume (300 ml.) of milk, which contained considerable water, was discarded. The milk from the column was collected in a series of three fractions: second through the fifth, sixth through the twentieth, and twenty-first through the fortieth bed volumes.

The analytical procedure for thiamine was similar to that used for previous thiamine milk studies in this laboratory reported by Isaacks *et al.* (1967). This procedure utilizes the thiochrome method of Hennessy (1941) with a slight modification in the enzymatic hydrolysis as described by Simpson and Chow (1956). Five milliliters of a solution containing five grams of Taka-Diastase (Parke, Davis, and Company) and five grams of pepsin in 100 ml. of 2.5*M* sodium acetate (pH 4.0 to 4.5) were added to each reaction flask and incubated at 50° C. for three hours instead of using Taka-Diastase alone and incubating for only two hours. The enzymatic hydrolysis was omitted for the determination of free thiamine. Bound thiamine was calculated by subtracting free thiamine from total thiamine.

RESULTS AND DISCUSSION

Table I represents the average of the results of three separate trials. Except for a slight decrease in the free thiamine in the first 5 bed volumes through the column (statistically signif-

Table I. Thiamine Content of Milk Treated for Iodine-131 Removal

	Micrograms per 100 ml. Milk		
	Total thiamine	Bound thiamine	Free thiamine
Control	23.04	11.92	11.12
2nd–5th bed volumes (7.5 minutes)	23.73	13.06	10.67
6th–20th bed volumes (30 minutes)	23.65	12.23	11.42
21st–40th bed volumes (60 minutes)	23.20	11.55	11.64

icant at the 5% level), no changes occurred in the thiamine content of milk treated for ^{131}I removal by Dowex 2-X8 anion exchange resin. Even the free thiamine was shown by statistical analysis of the combined values of all three fractions to be unaffected by the resin treatment. The thiamine content of both the control and resin treated milks was about equally distributed between free and bound forms which is in agreement with earlier work reported from this laboratory by Isaacks *et al.* (1967).

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