Reduction of Dental Caries and Goiter by Crops Fertilized with Fluorine and Iodine

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Experiments were carried out to determine the increased yield of fluorine and iodine in crops grown in soil heavily fertilized with brown rock phosphate and with various iodine compounds. Diets of these crops were tested on litter-mate rats to determine whether the increased fluorine content prevented dental caries, and whether the increased iodine content prevented goiter. Heavy fertilization of soil with brown rock phosphate resulted in an increased yield of fluorine in fluoriferous plants, and fertilization of the soil with various iodine compounds resulted in increased yields of iodine in the crop. Diets from special crops raised on fluoridated soil had a good effect on calcification of the bones in rats, and dental caries was prevented almost completely. Rats fed diets from iodine-containing crops were spared goiters which occurred in control rats fed diets from water-cultured iodine-free crops.

THIS REPORT concerns reduction of dental caries and goiter in rats by fluorine and iodine in crops after fluoridation and iodination of the soil.

Fluorine Fertilization

Tea plants, the highest in fluorine content among food plants, were dug up in Augusta, Ga., and planted in Lansdale silt loam, but the experiment was terminated after 1 month owing to lack of hardiness of such plants. Because camellias are closely related to tea plants, but more hardy, they also were dug up in Augusta, Ga., and planted in Lansdale silt loam and experiments with them were continued for 10 years. Corn also was selected because it is a more commonly used food.

The corn grain and the camellia leaves were obtained from an unfertilized (0.025 acre) plot of Lansdale silt loam, which was allowed to serve as control for a plot of the same size which was heavily fertilized (12 tons to the acre) with Tennessee brown rock phosphate containing 3.6% fluorine. Additional rock phosphate was placed around the camellia plants to form a surface layer 1 inch thick. The corn roots and yeast for the control experiments were obtained by hydroponic culture.

Analysis of the dried camellia leaves raised on the fertilized plot revealed a large uptake of fluorine (*6*) (Table I).

The diets prepared from these crops consisted of 80 grams of coarse ground corn, 80 grams of ground corn root, 5 grams of dried camellia leaves, 35 grams of dried yeast, and 1 gram of sodium chloride. The diet from fertilized crops contained 66.3 p.p.m. of fluorine, and the diet from unfertilized crops contained 3.1 p.p.m. of fluorine.

Litter-mate rats were used for experiments which were begun at weaning (22 days) and terminated when the animals were 3 months of age. The rats reared on diets from unfertilized crops gained less weight than normal, the incidence of dental caries was high, and there was less than normal calcification of the skeletal bones. Rats raised on diets from crops fertilized with rock phosphate gained more weight than the controls and their bones were normally calcified, as revealed by x-ray examinations (*4*). The incidence of dental caries also was lower, but with fluorosis of the incisors (Table II and Figures 1 and 2).

Table I. Fluorine in Experimental Diets

Dry Food	Wt. % of Diet	Fluorine Content, P.P.M. Unfertilized	Fertilized
Corn grain	40	0.08	0.50
Camellia leaves	2.5	121.0	1370.0
Corn roots	40.0	Hydroponic 0	80.0
Yeast	17.5	Hydroponic 0	0.4
Total	100.0	3.1	66.3

As fluoride was the only variant measured, the influence of other variants on calcification of the bones, better rate of growth, and lower incidence of dental caries is not known.

Iodine Fertilization

In the fertilized portions of each experimental plot of Lansdale silt loam soil, iodine compounds were added: potassium iodide, 1 pound per acre, β-amylose triiodide (Fertidin), 1 pound per acre, and diphenyliodonium chloride, 0.5 pound per acre. The method used was not unlike those of previous investigators (*2, 3, 8, 10, 11, 13*). Sunflowers were planted immediately thereafter.

The control crops for these experi-

Table II. Average Body Weight and Frequency of Caries in Rats on Foods from Unfertilized and Fertilized Crops

	Unfertilized	Fertilized with Rock Phosphate
No. of rats	16	16
Av. wt. at weaning, 22 days, g.	42	41
Av. wt. after 110 days, g.	152	205
No. of rats with caries	13	4
Av. no. of carious molars per rat	4	1

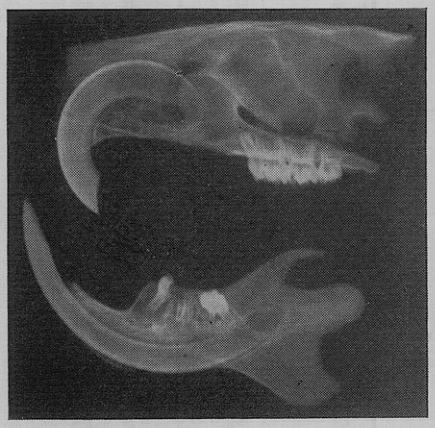

Figure 1. Healthy molars, fluorosed incisors, and well calcified bone in jaws of rat fed diet from crop heavily fertilized with fluorine in rock phosphate

ments were obtained from water-cultured iodine-free sunflower leaves (*7*). The iodine content of the dried sunflower leaves obtained from these water-cultured iodine-free crops was zero, whereas the iodine content of leaves from the potassium iodide plot was 0.19 p.p.m.; of leaves from the Fertidin plot 0.21 p.p.m.; and leaves from the diphenyliodonium plot 0.38 p.p.m., determined by the method of McClendon, Bratton, and Foster (*5*).

The diets prepared from both the halogen-free water-culture crops and the fertilized crops contained 160 grams of ground sunflower seed, 20 grams of powdered sunflower leaves, 20 grams of dried yeast, and 1 gram of sodium chloride. Litter-mate Wistar strain rats at weaning were fed on these diets and halogen-free water. The experiments were begun at weaning and were continued for 57 days. Six litters of four rats each were used and one of each litter was placed on each diet. Most of the rats fed the iodine-free water-culture diet developed goiters, which did not occur in rats fed the iodine-fertilized crops (Table III).

Discussion

The fluorine content of fertilized camellia leaves was not higher than that reported in the literature (*15*). Camellias should be considered fluoriferous, as some workers have found no appreciable increase in fluorine content of forage crops (red clover and Sudan grass) following fertilization with phosphates or calcium fluoride (*9*) except in the roots (*7*). Yet the effect of fertilizers on the nutrient value of foods is receiving and deserves continued interest (*14*). There are so many factors, such as rainfall and aeration of soil, which affect crops that it is difficult to interpret the results of experiments when small amounts of fertilizer have been added. Therefore, larger quantities of fertilizers were used in these experiments.

These experiments on rats using corn roots and camellia leaves were not designed to produce special crops for human consumption.

Morgan and Karpen have indicated that no food contains enough iodine to be detrimental to health (*12*). The Japanese eat kelp (kombu) containing 0.5% of iodine. This seems to ensure them against occurrence of goiter without in any way adversely affecting their health.

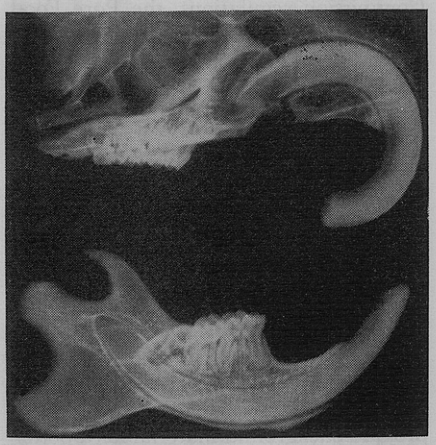

Figure 2. Extensive caries of lower molars with less calcification in bones of jaws in rat litter mate of that in Figure 1

Rat fed diet from crop raised on unfertilized plot of Lansdale silt loam

Summary

Heavy fertilization of Lansdale silt loam with Tennessee brown rock phosphate containing 3.6% fluorine greatly increased the fluorine content of camellia leaves and corn. Diets from these crops reduced the incidence of caries in rats.

Sunflowers fertilized with both organic and inorganic iodine compounds increased their iodine content and, when used as part of the diet, prevented goiter in rats.

Acknowledgment

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Table III. Average Body and Thyroid Weight of Rats on Diets Varying in Iodine Content

	Water-Culture Iodine-Free Crop	Crop from Potassium Iodide Plot	Crop from Fertidin Plot	Crop from Diphenyliodonium Chloride Plot
No. of rats	6	6	6	6
Average wt. at weaning, 22 days, g.	44	45	44	45
Average wt. after 57 days, g.	104	164	177	192
Thyroid, mg./100 g. body weight	19	7	6	5