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Effect of Fluorine on Solubility of Enamel and Dentin.

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The effectiveness of fluorine in preventing dental caries has been demonstrated both in man[1] and animals.[2,3] The finding of a higher fluorine content in caries-resistant teeth[4] indicates that this effect is the result of the incorporation of the fluorine into the teeth. Support for this is found in our unpublished work which shows a reduced acid solubility of fluorine-containing enamel and dentin from incisors of rats fed a high fluorine diet.

The fact that fluorine combines actively with bone,[5] calcium phosphate,[6] and hydroxyapatite[7] suggests that the fluorine may react similarly with the mineral phase of fully formed erupted teeth and give a reduction of solubility like that produced in the calcium phosphates.[6] The following experiments were designed to test this possibility.

Human enamel and dentin powdered to pass a 100 mesh screen were separated and purified by the centrifugal-flotation method.[8] Five hundred milligram samples of enamel were shaken for periods of one hour in 250 cc of solutions containing one part of sodium fluoride in 25, 100, 1000 and 10,000 parts of water, and then thoroughly washed in distilled water. Samples of dentin were similarly treated with 1/1000 sodium fluoride solutions. Solubilities of these and untreated control samples were compared by measuring the respective weight losses of 50 mg samples after one hour in 20 cc of a 0.2 M acetic acid/sodium acetate buffer at pH 4.0.[9]

The results, summarized in Fig. 1, show reduced solubilities in all the treated samples. Of enamel samples washed with 1/25, 1/100, 1/1000 and 1/10,000 sodium fluoride solutions, averages of 13.2,

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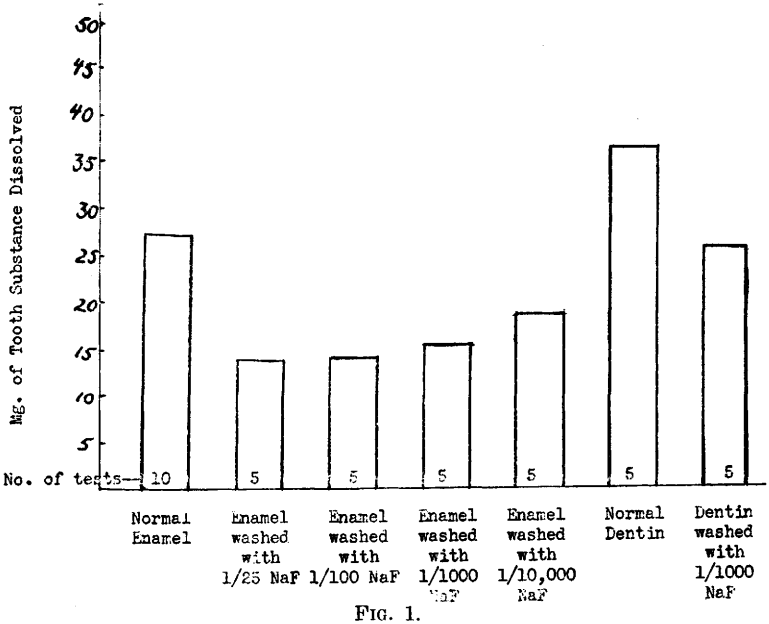

FIG. 1.
Average Solubilities of 50 mg Samples of Dental Hard Tissues.

14.1, 15.6 and 18.5 mg, respectively, dissolved as compared with an average of 27.3 mg for untreated samples. Normal dentin and dentin treated with 1/1000 sodium fluoride lost 36.1 and 26.0 mg, respectively. Confirmatory figures were obtained in 16 tests using decalcification periods of 5 and 30 minutes and 1½, 2 and 2½ hours. Five- to 10-minute applications of the fluoride were almost as effective in reducing the solubility as the one-hour treatments. The diminished solubility of the enamel was not lost after washing in water or saliva for periods up to 70 hours. It was also found that the natural surfaces of whole teeth treated with sodium fluoride were much less affected by acid than those of untreated teeth.

These observations seem to establish that fluorine reacts with tooth substance to produce a less soluble product. This reaction is probably similar to that occurring between fluorine and bone or other calcium phosphates and may consist of change to a fluorapatite, an adsorption of fluorine or a combination of both. The rapidity with which this reaction takes place makes it seem possible that, during the act of drinking, the fluorine from fluorine-containing water could combine to some extent with the teeth. Since such an effect would be most marked on the upper anterior teeth which would have the greatest contact with the water and on which there is a minimal amount of saliva, it is probably significant that Dean[1] found that the resistance to decay produced by fluorine-containing water was

definitely the most marked in these teeth. It is believed that these preliminary findings point to the use of controlled applications of fluorine-containing compounds as a means of preventing dental caries.

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The Fresh-Water Annelid, Tubifex, as a Pharmacological Test Object.

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A study of the regeneration of the fresh-water annelid, Tubifex, necessitated an evaluation of the factors conducing to its survival in the laboratory. Other workers[1, 2] have observed its satisfactory survival in tap-water. Our own experience has shown that it will not survive in the tap-water of New Orleans. The significant differences between the tap-water of New Orleans and the compatible tap-water of other cities appear to be the higher concentration of hydroxyl ion (pH 9-10) and the higher concentration of available chlorine of the water of this city. The chlorine content of New Orleans tap-water is stabilized at a minimum of 0.7 ppm by the addition of ammonium salts.

To investigate the influence of the reaction of the medium on the survival of Tubifex, solutions buffered with phosphate to cover the range from pH 6 to pH 8.4 were prepared. In the original solutions where the concentration of phosphate ion was 0.04 M there was no survival. The criterion of toxicity was death of all animals at the end of the arbitrarily chosen period of 18 hours. To ascertain at what concentrations of phosphate ion survival would result, a graded series of concentrations of phosphate ion for separate concentrations of hydroxyl ion from pH 4.6 to pH 8.4 were prepared. It was observed that Tubifex does survive in aqueous media if the phosphate ion concentration is low enough and also that the toxicity of phosphate ion is increased if the hydroxyl ion is increased. The toxicity seems to be a conjunctive result of phosphate ion with hydroxyl ion rather than an intrinsic toxicity of hydroxyl ion. This interpretation is strengthened by the survival of Tubifex in aqueous media from

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