FLUORIDES

Added to public water supplies, they cut down on tooth decay in children. But here's a way they might do twice as good a job.

by JACK E. McKEE

THE PRACTICE OF adding fluorides to municipal water supplies, as a prophylactic measure to minimize dental caries, has gained wide acceptance in recent years. Moreover, it is being urged upon many reluctant waterworks authorities by an aroused public. By mid-1951 fluoride was being added to 82 supplies serving a total population of 1,700,000 and approval had been granted for fluoridation of 95 other supplies, to serve nearly 6,000,000 persons. Today, almost every waterworks superintendent in the country is faced with the problem of whether to fluoridate or to try to resist the landslide toward this practice.

The enthusiam for fluoridation of public water supplies is not without reason or merit. Already there are scores of papers in the waterworks and public-health literature that attest to the fact that the presence of natural fluorides up to 1.0 to 1.5 parts per million or the addition of artificial fluorides to water supplies so as to produce concentrations of 0.8 to 1.2 ppm, is associated with 50 to 60 percent reductions in the prevalence of dental caries. Furthermore, it appears to be well established that the presence of 1.0 ppm of fluoride ion in water is not detrimental to the teeth and bone structure of children or adults; nor does it produce unfavorable reactions or effects in industrial process waters used for soft drinks, brewing, food processing, metal plating, chemical industries, etc. Only in the manufacture of ice has fluoride been troublesome, and this effect can be overcome by proper control of the process. Thus, the evidence in favor of fluoridation of public water supplies seems to be so positive and so overwhelming that many people cannot understand why it should not be put into effect immediately at all municipal waterworks.

There are other sides to the question, however, and like the arguments in favor of fluoridation, those in opposition have a certain logic. Natural resistance arises from the waterworks superintendent whose supply originates in numerous wells or surface sources, each of which must be equipped with proportional-feeding fluoridating devices. It has been estimated that the cost of equipment for each source of supply will vary from $1,000 to $15,000, with the higher figures predominating for most municipal sources.

For example, consider the water supply of San Bernardino, California, which originates in 17 separate well fields and surface streams, all of which are pumped directly into the distribution grid with reservoirs floating on the system throughout the city. The initial cost of fluoridating equipment and appurtenances for this city would be at least $200,000, not to mention the problems of servicing and maintaining the equipment.

Such a cost, to be sure, is a small fraction of the total waterworks value and can be readily amortized. On a national basis, the total operating and amortized investment cost of fluoridation has been estimated at from 5 to 15 cents per capita per year, but for San Bernardino the annual cost of amortization alone (at 3 percent interest for 20 years) would be $13,500, or about 20 cents per capita. To this must be added the cost of extra servicing and maintenance as well as chemicals. It is understandable, then, that the complexity and magnitude of such multiple installations cause the public officials to think twice before committing the city to fluoridation.

Perhaps more serious than the cost of fluoridation is the limited supply of fluorides. As more and more cities climb on the bandwagon, the present capacity for production is being approached rapidly by the demand. If several of the large cities should institute the practice, the existing supplies would probably have to be rationed, unless measures are taken to increase production.

An argument against fluoridation of public water supplies arises from the fact that only a small proportion of the water is consumed by children to whom fluoridation will be advantageous. Thus, if a city uses 150 gallons per day per capita, only about 0.3 gpd will be consumed by the average person, or about 0.2 percent of the supply. Assuming that 20 percent of the population consists of children in the ages during which fluoride affects teeth, only about 0.04 percent (four ten-thousandths) of the added fluoride will be serving a useful purpose. Most of the remainder will be flushed or drained into the sewer, or used for garden watering or car washing.

The third and perhaps most vociferous objection comes from Christian Scientists and other religious groups who balk at "mass medication." The same type of opposition arose several decades ago when proposals were made to add iodine to water supplies in order to counteract tendencies toward goiter. Fortunately, this argument abated with the introduction of iodized salt, the use of which is optional. While many public-health-minded citizens may be exasperated by such opposition of minority religious groups, few of them wish to violate the concepts of religious freedom or to incur the ill will of fellow citizens.

Another reason for urging caution in the hasty adoption of water fluoridation arises from the uncertainties and irregularities of water consumption by children. In his thorough study of food and water requirements of children from one to 12 years old, F. J. McClure states: "Drinking of water is a variable factor, especially among children, whose drinking habits are greatly influenced by muscular activity as well as by atmospheric temperature and humidity. It is likewise true of children's diets especially that the requirement of water is met largely by preformed water in the food or by liquid food, particularly milk. The water deficit made up by drinking water may be a relatively small fraction of the total daily amount of water ingested."

Variation in water consumption

That water consumption varies widely from child to child, and for the same child from day to day and season to season, is evident to all parents. Very few observers of children's habits cite specific data to show the magnitude or the variation of the quantities of water consumed. It is this extreme variation in water consumption that may account, in part, for dental fluorosis in some children while others in the same community have numerous cases of caries.

Granted, then, that the objection to fluoridation of public water supplies have some merit, is there any way that the aforementioned advantages of fluoridation can be achieved without the disadvantages? To answer this question it is necessary to investigate other vehicles, especially pills, tooth-paste, chewing gum, salt, solid foods, and milk.

The first four of these can be ruled out quickly for obvious reasons. Fluoridated pills or tooth-paste, already on the market, reach a very small segment of the population, even when highly advertised. Chewing gum is neither an aesthetic way nor a reliable means to promote prophylaxis. Fluoridated salt would provide fluorides for adults—to whom it would be of no advantage—but very few children like salt on their foods, nor could careful control over the dosage be exercised. The selection narrows, therefore, to food and milk.

The fluoride contents of meats, fish, hen's eggs, cow's milk, citrus fruits, non-citrus fruits, tea, cereals and cereal products, vegetables and tubers, miscellaneous substances and wine have been tabulated by F. J. McClure. With the exception of seafoods and tea, the majority of foods found in the average diet contain from 0.2 to 0.3 ppm or less of fluoride in the food as consumed. Consequently the average diet, exclusive of drinking water, appears to provide 0.2 to 0.3 mg of fluoride daily. Tea was found to contain as high as 398.8 ppm of fluoride in the dry tea, with average values of about 100 ppm, 75 percent or more of which is extracted by boiling water. At 100 ppm, one tea ball alone would provide approximately 0.2 mg of fluoride. Unfortunately, in this respect, children under 8 years of age seldom drink tea. Nor is seafood generally a favorite of the younger set.

Attempts have been made to increase the fluoride content of vegetables, fruits, and grains by adding calcium fluoride to the soil or water in which the plants are grown. The results demonstrate, however, that the fluoride content of the soil or water has little or no influence on the fluoride content of leaves, fruit, or roots. Hence, the possibility of increasing the fluoride content of solid foods, other than by the addition of fluoridated salt, appears to be remote. The search narrows further, then, to liquid foods that are acceptable to and preferred by children; or, in other words, to milk.

The fluoride content of cow's milk, with no unusual fluoride in the cow's ration or drinking water, varies from 0.07 to 0.55 ppm, with a median value of 0.10 to 0.20 ppm, according to McClure. Furthermore, the addition of fluoride to the cow's ration or drinking water has no appreciable influence on the fluoride content of the cow's milk, the added fluoride probably being excreted in feces, urine, and perspiration as it is for humans.

Inasmuch as the natural fluoride content of milk is too low to provide an adequate dietary supplement in the volume normally consumed by children, serious consideration should be given to artificial fluoridation of bottled milk. Such consideration involves questions of assimilation of milk-borne fluoride, quantities and variations of daily consumption, effects of fluoridation on the palatability and nutritive value of milk, universal application, cost, and reception by the public.

Fluorides must be assimilated

To be effective in reducing dental caries, it is apparent that fluorides must be assimilated and carried in the blood stream. Mere contact of the weakly fluoridated liquid with exposed enamel of fully formed teeth seems to have little, if any, prophylactic value—although the topical application of a 2 percent solution of sodium fluoride has been effective in reducing dental caries in 7 to 17-year-old children by 40 percent. For these reasons it is desirable that optimum fluoride intake of water or milk be maintained during the ages from 1 to 10, and that the fluoride be in a form that can be assimilated.

It appears that natural fluorides in food and milk, or artificial fluorides added thereto, are largely available for assimilation. In fact, McClure showed that when no control was exercised over eating and drinking habits, there were no indications of a difference in total assimilation by young rats of water-borne versus food-borne fluorides.

In other tests, McClure, Mitchell, Hamilton, and Kinser, of the U. S. Public Health Service, added 3.50 to 6.00 mg of fluoride per day in the form of sodium fluoride, calcium fluoride, mineral cryolite and bone meal to the food or water of five young men, and measured the fluoride eliminated via feces, urine, and perspiration. The results showed that about 13 to 55 percent of the ingested fluoride remained in the feces and hence was not assimilated. Maximum assimilation (80 to 90 percent) occurred from sodium fluoride in food and water, and from calcium fluoride in water, while less fluoride was assimilated from cryolite and bone meal. Of the assimilated fluoride, about 50 to 80 percent appeared in the urine and 20 to 50 percent in the perspiration, depending upon muscular activity, temperature, and humidity. The total daily intake, even at these high rates of ingestion, appeared to have been eliminated practically 100 percent.

The foregoing tests lead to the assumption that sodium fluoride or calcium fluoride added to milk would be available for assimilation as readily as the fluorides added to drinking water, and that in concentrations of 1.0 to 1.5 ppm almost all assimilated fluorides would be eliminated from the body rather than accumulate in bones or tissues. It has been demonstrated, moreover, that food-borne and water-borne fluorides both have inhibitory effects upon dental caries in rats and both cause mottled enamel when concentrations exceed 1.5 ppm of fluoride. Although sodium fluoride or sodium silicofluoride may form insoluble calcium fluoride with the naturally high calcium content of milk, there appears to be no reason to believe that such fluoride would not be readily assimilable or that it would produce effects different from those of fluorides added to water.

Milk consumption

Milk consumption by children is subject to far less variation, by age, sex, season, or climate, than is water consumption. It is estimated that the average child consumes about 1.5 pints of milk per day. Most children from 2 to 8 years of age drink a glass of milk at each meal and possibly a mid-afternoon or mid-morning glass. Moreover, milk consumption by children does not change much with season, temperature, or humidity, for children tend to vary their water consumption instead. The more-uniform consumption of fluoridated milk than of water should tend to reduce the variations in total fluoride intake from child to child and from season to season and thereby should minimize the probability of dental fluorosis in one child while another in the same community has a deficient fluoride intake.

There are some children, to be sure, who do not drink milk, but they are relatively few in number.* Deliveries of bottled milk in most metropolitan areas cover wider territories than do the municipal water supplies; in fact, many rural areas throughout the nation are well served with bottled milk. In Los Angeles County there are reported to be over 500 municipal and private water companies supplying domestic consumers, with hundreds more in contiguous areas; yet the Los Angeles telephone directories list less than 70 major milk distributors. To reach a high proportion of children through the few dairies would be infinitely more certain than to try to do it through the numerous water supplies. Similar examples can be cited for almost all metropolitan areas.

Detrimental effects?

Any detrimental effects of fluorides upon the palatability and nutritive value of milk remain to be demonstrated. Inquiries of local dairy research staffs and biochemists at local universities have failed to uncover any arguments or proof to show that the addition of 0.8 to 1.0 ppm of sodium fluoride would alter the taste, nutritive value, or enzymes of milk. (I have been adding 0.5 ppm of fluoride in the form of sodium fluoride to the milk used by my family, including three children, and have yet to notice any change in the palatability of the milk, or to receive any complaints from the children.) This is a matter, however, that deserves more thorough consideration and research.

The cost of chemicals for the fluoridation of milk, up to 1.0 ppm, is infinitesimal ($0.000,005 per quart) and the dairies should be willing to absorb the cost as part of routine operations. If it becomes necessary, however, to increase the cost of milk by 1 cent per quart in order to cover added costs of handling, labelling, distributing, and advertising, most parents of small children should be willing to pay the difference, considering the ultimate savings in dental bills.

Finally we come to the question of acceptance of fluoridated milk by the general public. It is sometimes surprising how rapidly the public will accept a new idea and clamor for its adoption in local communities, especially following a few newspaper editorials or advertisements or an article in a national magazine. That the public should oppose the concept of fluoridated milk, especially when its purchase is optional, seems inconceivable. Dairies could advertise the availability of fluoridated milk for families with small children, pointing out that regular milk is still sold for adults or for those who object to fluoridation. This optional feature should appeal to religious groups who now oppose water fluoridation.

This presentation of the possible case for milk rather than water as the optimum vehicle for fluoridation is intended not as a firm endorsement thereof but rather as a stimulant to further thinking and research into the matter. The many arguments in favor of milk as a fluoride carrier are so enticing that some action should be taken by research agencies either to confirm or to discredit them on the basis of sound fundamental data. The author urges such research and welcomes any logical criticism or reasons in opposition to the ideas propounded in this article.

*One of the exceptions was the present writer, who was allergic to milk when young: yet he has had relatively few dental caries. Perhaps his good fortune in this respect is attributable to the fact that he was weaned on tea, which has a high fluoride content.