

# SYSTEMIC FLUORIDES

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## Water Fluoridation

### *Definition*

Fluoridation is “the upward adjustment of the fluoride ion content of a domestic water supply to the optimum physiologic concentration that will provide maximum protection against dental caries and enhance the appearance of the teeth with a minimum possibility of producing objectionable enamel fluorosis”.<sup>1</sup>

### *Optimum levels*

The optimum fluoride level for water in temperate climate is 1 ppm. For warmer and colder climates the amount can be adjusted from approximately 0.7 ppm to 1.2 ppm, adapted in accord with the amount of water consumed. A concentration of 1 part per million (ppm) amount to 1 mg of fluoride per litre (1 mg/litre).<sup>9</sup>

### *Historical juncture*

A great forward stride in the era of preventive dentistry was ushered with the epidemiologic studies of the 1930s sponsored by the United States Public Health Service and directed by Dr TH Dean.

The evidence regarding the safety of water fluoridation was so convincing that the US Public Health Service took the major step in artificially water fluoridating the water supply of Grand Rapids at 1 ppm on 25<sup>th</sup> January 1945. Muskegon town was kept as a control town. The town was to serve as a control town for 15 years. It did not. After 6 years the caries experience in Grand Rapids was half that of Muskegon and it ceased to be a control town.

The other communities that fluoridated their water supplies are as follows.<sup>7</sup>

<i>Date</i>	<i>Fluoridation</i>	<i>Control city</i>
May 1945	Newburgh,	Kingston,

	New York	New York
June 1945	Brantford, Ontario	Sarnin, Ontario
Feb. 1947	Evanston, Illinois	Oak park, Illinois

### ***Equipment and chemicals for fluoridation***

The choice of equipment and of fluorides to be used will depend on

1. Costs and installation
2. Maintenance
3. Surveillance

*The following general characteristics of the system need to be considered:*

- The equipment must be adapted to local conditions and needs of water network.
- Equipment must be efficacious, safe and precise.
- Should have well defined precision limits.

### *Types of equipment*

- a. Saturator system
- b. Dry feeder
- c. Solution feeder
- d. Venturi fluoridator system
- e. Saturation-suspension cone

### *Fluorides used*

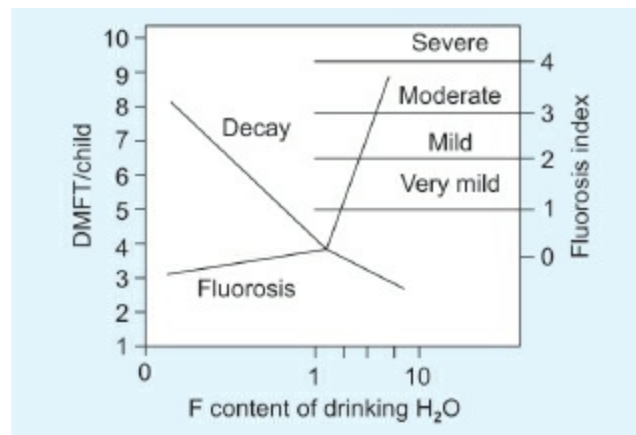
- a. *Sodium fluoride (NaF):*
  1. Used in saturator system to avoid obstruction of gravel bed.
  2. Used in granular form.
  3. Available in 45 kg bags.
  4. Expensive.
- b. *Sodium silico fluoride:*
  1. Available in 45 kg bags.
  2. Cheapest.

c. *Hydrofluorosilicic acid:*

1. Delivered by tanker lorry with a capacity of 19,000 litres.
2. More expensive than sodium silico fluoride on account of transporting liquids.

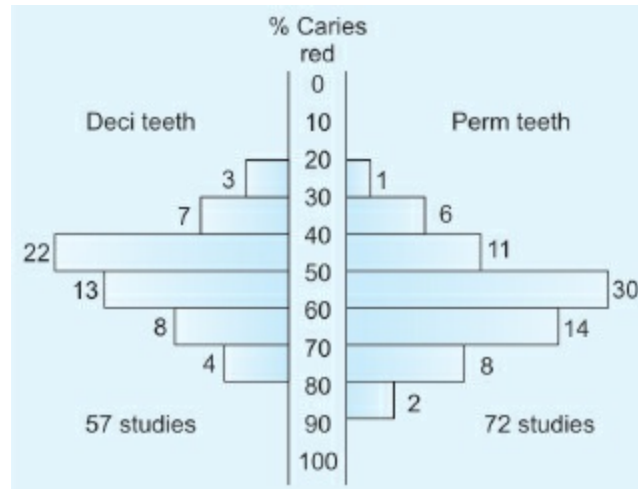
***Benefits of water fluoridation***

1. ***Appearance of teeth:*** Teeth exposed to an optimum or slightly higher level of fluoride frequently are clear, white, shining, opaque and without blemishes (Fig. 21.2).



**Fig. 21.2:** As the fluoride content of water increases beyond 1 ppm, the index of fluorosis accelerates more rapidly than the DMF decreases

2. ***Dental caries reduction in primary and permanent teeth:*** The reduction for caries for primary teeth was between 40 and 50% and the reduction for permanent teeth was between 50 and 60 % (Fig. 21.3).



**Fig. 21.3:** Study reported by Murray JJ and Rugg-Gunn of 94 community fluoridation studies in 20 countries

3. **Root caries:** A report by Stamm and Banting shows that life long consumption of fluoridated water reduces the incidence of root caries by approximately 50%.
4. **Tooth loss:** According to Arnold FA, there is a 75% reduction in the prevalence of extracted first molars in fluoridated areas compared with those that are non-fluoridated.
5. **Malocclusion:** According to Salzman, orthodontic problems are approximately 20% less prevalent among children 6–14 years of age living in a fluoride area compared to those living in areas without the benefits of fluorides. This difference is possibly due to fact that the loss of first permanent molars is minimal in fluoride area.
6. **Interproximal and coronal caries:** There is about 95% less prevalence of interproximal dental caries and a reduction of 60% coronal caries in fluoridated communities compared to those of non-fluoridated.
7. **Economy:** Among other means of fluoride usage—fluoride tablets, school dentifrices, prescription fluorides, water fluoridation is most economical in reducing the cost of public health expenditure.

### **Feasibility**

Water fluoridation procedure is feasible only if

1. There is a municipal water supply reaching a reasonable number of

homes.

2. People drink this water rather than water from individual wells or rainwater tanks.
3. Suitable equipment is present.
4. Supply of fluoride is assured.
5. Workers available in the water treatment plant to maintain the system and keep records.
6. Money should be available for initial installation and running costs.

Fluoridation is feasible but is not implemented for political reasons. In view of the good results achieved in those countries where it has been used extensively for many years, water fluoridation must always be considered as a public health measure. Not only it is safe, but water fluoridation is also by far the most effective and efficient method of bringing the benefits of a continuous low concentration of fluoride to a whole community.

The reasons for rejecting a proven benefit could be

1. Ignorance and confusion on the part of the public about the dental health benefits.
2. Ambivalence of the public towards science and its by-products.
3. Misrepresentation of the scientific and technical information involved.

*School water fluoridation:* It was first initiated as a pilot study in 1954 at St. Thomas Virgin Islands, United States. One of several effective alternatives for prevention of dental caries in children of communities where water fluoridation is not feasible is the fluoridation of the school water supply. It can be used only if the surrounding areas from which the students come have a low fluoride content. Consolidated schools are ideal since all grades are housed in the same building.<sup>7</sup>

The concentration of fluoride in the school water system is 4.5 ppm in contrast to 1 ppm of community water supply. This upward adjustment is to compensate for the reduced water intake since the school day and year is shorter, hence the time spent at school.

The greatest advantage of school water fluoridation is that no effort is required by the recipient. A reduction in DMFT of about 40% was observed in children who drank fluoridated water containing 5 ppm.

### ***Problems***

1. Any effort to fluoridate the school system is subject to possible confrontation by anti-fluoridation groups.
2. The cost of the installation, supplies and maintenance competes with other needs of the school budget.
3. Custodial and back up personnel must be trained and used for continual operation, maintenance and monitoring of the unit.
4. The major concern however is by age 6 all teeth except 3<sup>rd</sup> molars are in an advanced stage of mineralization, thus reducing the pre-eruptive benefits of fluoride.

### ***Salt Fluoridation***

Salt fluoridation appears to be the most effective method to deliver fluoride to a target population where water fluoridation is not possible, and avoiding the firestorm of anti-fluoridationist opposition.<sup>6</sup>

This program was first introduced in Switzerland in 1955, with 5 mg of potassium iodine and 90 mg of sodium fluoride per kg.

### ***Method of preparation***

**Type 1:** Fluoride is added to salt by spraying concentrated solutions of sodium fluoride and potassium fluoride on salt on a conveyor belt.

**Type 2:** Sodium fluoride and calcium fluoride are first mixed with slightly moist salt or mixed with a flow conditioner such as tricalcium phosphate and these premixed granules are added to the dry salt.

### ***Advantages***

1. The possibility of fluorosis is minimal.
2. It is safe.
3. Low cost.
4. Individual monitoring not required.
5. Freely available.
6. Distribution can be easily monitored.

7. Supply can be effectively controlled.
8. Readily accepted—as the addition of fluoride does not alter colour.

### ***Disadvantages***

1. There is no precise control, as the salt intake varies greatly among people.
2. There is now international efforts to reduce sodium intake to help control hypertension.

## ***Milk Fluoridation***

Milk is a reasonable vehicle for fluoride since it is a food used universally by infants, pregnant women and children. Milk is an excellent source of calcium and phosphorous and when fortified with vitamin D, contains all essentials for the development of bones and teeth ([Figs 21.4 and 21.5](#)).



**Fig. 21.4:** Distribution of fluoridated milk



**Fig. 21.5:** Drinking fluoridated milk

Fluoridation of milk was first mentioned by Ziegler in 1956. The rate of absorption of fluoride from milk and water indicates a significant reduction in fluoride absorption from milk during the first hour, but thereafter absorption continues at higher levels for longer periods of time. When milk is fluoridated, most of the fluoride persists in the ionized form for the first 4 hours, thereafter, about one-fifth is bound to calcium and protein.<sup>9</sup>

#### ***Advantage***

- Staple food for children and infants.

#### ***Disadvantages***

- Cost of fluoridated milk would be considerably higher.
- Centralized milk supply should exist.
- Variation in intake and quantity of milk.

### ***Fluoride Tablets***

Fluoride tablets provide systemic effect before mineralization of primary and permanent dentition and a topical effect thereafter.

***Effect on deciduous teeth:*** When fluoride administration in the form of tablets was started before 2 years of age and continued for a minimum of 3–4 years, caries reductions in the range of 50–80% have been reported.<sup>3</sup>



**Effect on permanent teeth:** Majority of the studies showed from no marginal reduction to 20–40% caries reduction. Fluoride must be ingested systemically in order to exert maximum cariostatic effects during the mineralization of the surface of a crown.

**Availability:** Fluoride tablets are commercially available as NaF tablets of 2.2 mg, 1.1 mg and 0.55 mg yielding 1 mg, 0.5 mg and 0.25 mg fluoride respectively (Fig. 21.6).



**Fig. 21.6:** Commercially available fluoride tablets

Sodium fluoride tablets with vitamin combinations are also available. For best topical effect, fluoride tablets should be first chewed and then swallowed.

**Swish and swallow technique:** With the use of tablets, it seemed logical that if a child would chew the tablets, then swish the saliva between the teeth for a minute before swallowing, both a topical and a systemic dosage of fluoride would be achieved. This swish and swallow method is advocated whenever tablets are used.

**Recommended dose:** The daily recommended dose of fluoride for child below 2 years is 0.5 mg, between 2 and 3 years is 0.5–0.7 mg and above 3 years is 1.0–1.5 mg.

Fluoride tablets are commercially available as NaF tablets of 2.2, 1.1 and 0.5 mg respectively yielding 1, 0.5, and 0.25 mg fluoride respectively.

### ***Advantages***

1. Ready for use.
2. Requires a little time to dispense.
3. Some tablets have a flavour that enhances child motivation to participate in the daily ingestion of fluoride tablet.

### ***Fluoride Drops***

Fluoride drops are used to supplement fluoride intake until a child is old enough to swallow fluoride tablets.

Drops are usually administered by use of a plastic dropper bottle, where 10 drops equal 1 mg of fluoride. When 10 drops are placed in a litre of water containing no fluoride, there is a resultant concentration of 1 ppm of fluoride (1 mg/ml).

The use of drops can be expected to produce a caries reduction on the order of 40%. Parents should be cautioned to use the prescribed number of drops and not to assume that just because one drop is effective, two will be better.