

Salt fluoridation in Europe, comparisons with Latin America

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Many reports on a caries-preventive effect of fluoride when added to salt for human consumption have been published. Under favorable conditions, the cariostatic effectiveness is equivalent to that of water fluoridation which was, and under certain condition still is, the classical method of preventing caries in entire populations. In Switzerland, fluoridation of domestic salt began in 1955 and was extended to the entire country in 1983. France adopted this method of caries prevention in 1986. In 1987 Costa Rica and Jamaica introduced it on a national level. Since then, many Latin American countries have introduced salt fluoridation on a national basis whereas in European countries, while sale of the caries-protective salt has been authorized, policies to cover the entire population have been lacking. This discrepancy is thought to be due to the success, in Europe, of fluoride-containing dentifrices in reducing the levels of dental caries and to lack of consistent public health policies. Addition of fluoride to salt is an important preventive measure but it does not have the potential of eliminating caries whereas salt iodization can in fact eliminate iodine deficiency diseases completely, a results which has been obtained in several countries.

1. INTRODUCTION

In Westernized countries, the prevalence of dental caries was high to very high in the 1950ies and 60ies. More than 14 out of the total of 28 teeth (excluding the third molars) were either decayed (D), missing because of caries (M) or filled (F) per military recruits aged 20. The mean number of DMF-teeth ranged between 18 to 21 in countries like Australia, Denmark, Germany, Norway and Sweden.

The first large scale success in lowering the high levels of tooth decay was obtained by means of fluoridation of drinking water. In the seventies, this measure already covered a total of more than 100 million inhabitants in the USA, Canada, Australia, and several other countries.

At the end of this century, caries prevalence is declining in most highly industrialized countries which are using fluorides in various forms, primarily in dentifrices. Dentifrices conferring topical fluoride to the teeth are now regarded as the most effective means against caries and have been increasingly used in the last 30 years, reaching at least a billion users nowadays. However, the control of caries has by no means ceased to be a problem, and the fluoridation of water, and more recently of salt, continues to be a useful measure for minimizing decay of teeth at all ages.

The reduction of caries prevalence of water fluoridation was established to be around 50 %: the average number of DMF-teeth, in a given population

assumed to have been 14 per adolescent aged 15 years, would be reduced to 7 after 15 years of consumption of fluoridated water instead low fluoride water. Such data have been obtained in studies on all continents.

When fluoridation of salt is implemented in a way to reach all consumers of a region, it confers a reduction of caries prevalence on a community level similar to that of water fluoridation.

2. SURVEY OF COUNTRIES USING SALT FLUORIDATION

Industrial production of fluoridated salt started in Switzerland in 1955 (until 1983 at the insufficient level of 90 ppm, but with 250 ppm thereafter) and the Canton of Zurich was the first region to authorize its sale. Other cantons followed and in 1980, around 60 % of the packaged salt was fluoridated. In 1970, the Canton of Vaud, being the only one with its own salt factory and a cantonal "monopoly" on salt trade, began to fluoridate all salt in packages and sacks to 250 ppm. According to the Swiss Salt Works, which constructed the first technical installation in 1955 (as well as the first iodization apparatus in 1922) and supplies all salt for most of Switzerland, 75 % of the domestic salt sold in Switzerland in 1987-91 contained fluoride. Since 1995, this percentage has remained at 84 %. Thus, the introduction of fluoridated salt has been gradual, as was that of salt iodization which started

in 1922 and eventually led to the elimination of goiter in Switzerland [1].

France introduced fluoridation of domestic salt in late 1986. Until 1991, its market share reached about 45 % in the early 90ies but has remained on this level since then.

In 1987, both Costa Rica and Jamaica introduced salt fluoridation. In these countries, the regular salt destined for human consumption is fluoridated whereas unfluoridated salt is only used in specific circumstances.

Salt fluoridation schemes are also functioning in Uruguay, Mexico and Ecuador. Since 1995, all salt for human consumption in Colombia has been fluoridated to a level of 200 ppm. Beginning in 1993, the Panamerican Health Organization has been promoting salt fluoridation in more than 10 countries, analysing the local conditions of production and distribution of salt and by offering technical assistance, gathering basic data and by assisting in the organization of proper surveillance.

In 1991, fluoridated domestic salt was put on sale in Germany. While in the following years its use was very limited, its market share had reached 30 % among the total sales of domestic salt by the end of 1998.

European countries where fluoridated salt is available but infrequently used include (in alphabetical order) Austria, Belgium, the Czech Republic, Slovakia and Spain. The situation in Belarus and Poland is unclear; at various times, fluoridated salt has been available.

3. COMPARING EUROPEAN AND LATIN AMERICAN PROJECTS

3.1. The public health aspect of salt fluoridation

It may seem encouraging that salt fluoridation, limited to Switzerland until 1986, was already covering more than a hundred millions at the turn of the century, and the population reached will soon approach the one reported for water fluoridation, which in 1994 was stated as 230 millions [2]. On the other hand, it is obvious that only part of the countries make use of the health potential which is possible through salt fluoridation on a national basis.

From the viewpoint of public health, the aim is to cover all individuals susceptible to suffer from tooth decay and therefore the entire population. This has in fact been achieved by water fluoridation in the city states of Hongkong and Singapore. Salt fluoridation has played a similar role in the Swiss Canton of Vaud: all salt destined for human consumption has been fluoridated since 1970, including restaurants, cafeterias, canteens, hospitals and bakeries. Only the salt added to industrial products like bouillon cubes, salted spices etc. was not fluoridated

3.2. Latin America

From the very beginning, Costa Rica and Jamaica conceived salt fluoridation as a public health measure which should benefit the entire population. In *Costa Rica*, there was a minor problem in two communities where the drinking water contained around 1 ppm fluoride, the optimal level under the given climatic conditions. In order to prevent overlapping of fluoridated salt with an already sufficient supply of fluoride through the drinking water, this community is provided with unfluoridated salt. More important in modern times of high mobility is the publicly announced advice (for instance on a large poster on the school building) to use exclusively unfluoridated salt. Such a system is not "watertight", but consequences of overlaps are confined to white stripes/flecks on the teeth of part of the individuals, almost always too mild to be noticed in everyday life. Overlapping of fluoride intake from salt and water (or tablets) has certainly no adverse effects on health, but it is undesirable in principle.

In *Jamaica*, most drinking water is low in fluoride. Moderate levels of 0.3 to 0.5 ppm F are present only in a small region. Accordingly, overlapping fluoridation was no problem. A hearing was held in a small committee on how to market fluoridated salt. There was no dispute about labelling of the fluoride content but discussion arose about recommendations for the use of fluoridated salt, with the idea that unfluoridated salt should be put on sale besides the fluoridated variety. Part of the health ministry officers were contemplating this approach. After some discussion the manager of the refinery (there is only one refinery on the island, which imports crude sea salt from various sources) simply asked: which salt is the better one, the unfluoridated or the fluoridated one? Confronted in this way, everyone's answer was that fluoridated salt is preferable because of its caries-preventive effect. The manager then stated that there is one basic principle, namely "never market an inferior product". He added that for those insisting in purchasing unfluoridated salt, the enterprise will keep unfluoridated salt on stock, but that all usual sales channels will be uniformly provided with fluoridated salt. Thus, the marketing principle was in complete agreement with the public health postulate, and this approach, leading to "universal" salt fluoridation, was immediately adopted. Since then, the benefit has been documented. Within 10 years, the number of decayed teeth per child at age 12 fell from 6 in 1984 to 1.1 in 1995 [3].

A similar situation exists in Colombia. In this relatively large country, almost all drinking water has fluoride levels below 0.3 ppm fluoride. One of the most important studies on the cariostatic effect of fluoridated salt was conducted there in 1964-1972. Subsequently, many attempts were made to introduce the measure nationwide. For many years,

however, the scheme was hampered by technical problems and later by privatization of the salt industry. Eventually, salt fluoridation was firmly implemented in 1995.

3.3. Europe

Essentially, European governments did not go beyond authorization of the sale of fluoridated salt. Little if any advice to use this superior salt was decided upon by the respective ministries whose primary task would seem to promote health. In fact, recommendations to use fluoridated salt were left to private organisations. In France, the "Association for Oral Health" has organized most of the publicity. The market share of the fluoridated salt, however, has remained below 50 %.

In the eighties, German dentists did not believe that fluoridated salt could be authorized before the end of the century. Vociferous antifluoridatists, supported by the "Green" Party, were opposed to public fluoridation, considering this trace element as being hardly admissible even in dentifrices. However, legislation of the European Union enabled German firms to import fluoridated salt from France. Subsequently, German health authorities could not reject the sale (beginning in 1991) and later the production of fluoridated salt (beginning in 1992). In Germany, it was an important salt factory itself which adopted an active role from the very beginning, sponsoring a public relations agency for distribution of flyers and other materials as well as press releases explaining caries prevention, with a modest focus on the importance of fluoridated salt. Since 1992, dental, pediatric and other medical associations, health insurance companies and sick funds have published statements in favor of fluoridated salt or at least of its role in comprehensive caries prevention programs. Extrapolation based on the last 6 years (the percentage has been steadily rising by 4.5 % each year) would indicate that a 50 % market share might be attained by the year 2004.

On the level of the European Union, the use of fluorides was first recommended in a document entitled "Dental Health in Europe: A problem for disadvantaged groups", launched on the eve of the public hearing on the "Future of Health Policy in the European Community" at the European Parliament (Brussels, 27 October 1998). Regarding actions on a national level, it was recommended "that the governments of Member states should: (i) review their oral health promotion strategies ... including the potential impact on tooth decay of water fluoridation, fluoridated salt ...". It is too early to expect responses from this document.

3.4 Reasons for inadequate implementations in Europe

1. *Caries decline in the absence of fluoridation of water or salt.* In Northwestern Europe, dental

caries prevalence started to decline in the 70ies and 80ies. The widespread use of fluoride-containing dentifrices is thought to be the main reason, but other factors also played a role. In view of this favorable development, many experts in preventive dentistry tend to think that "mass prevention methods" like fluoridation of water or salt are no longer necessary. By comparison, caries prevalence is still much higher in Latin America.

2. *Training in Public Health.* It is only in Scandinavia that a "School of Public Health" has been in existence for more than 3 decades. In continental Europe, formal postgraduate training in public health is not widespread even today. On the contrary, many Latin American ministries have physicians in their staff who have completed their training as "Master of Public Health" (MPH), a degree mostly acquired in the USA.

3. *Antifluoridation activities.* Throughout the 60ies and 70ies, water fluoridation was considered to be the first step in any caries prevention project. Since it is very difficult to "escape" fluoridated water, claimed damages of fluoride - all pretended adverse effects have been amply demonstrated to be non-existent -, the antifluoridationists succeeded in creating a considerable opposition against the use of fluorides in caries prevention. Consequently, politicians hesitate to take decisions that might create opposition, which in most cases is supported by the mass media which neglect the viewpoint of public health. While the antifluoride movement is declining gradually, the use of fluoride for the prevention of caries is still widely considered an unnatural concept.

While the above reasons for opposing fluoridation are thought to be generally applicable, reasons in the various countries tend to be more specific. Germany still has no public health policy to warrant sufficient intake of iodine. In Austria, reasons (1) and (3) seem to be important. In Switzerland, the overwhelming success of salt iodization helped to pave the way for the introduction of fluoridation.

The convenience of use and the cariostatic effectiveness of fluoride have been core elements in all caries prevention programs throughout the world. Attempts to lower the frequency of intake of fermentable carbohydrates have not had lasting results despite considerable efforts. On the other hand, dental hygiene is improving in the industrialized countries, and fluoride prevention is again entering the picture by the added benefit of fluoride in dentifrices.

4. COMMENTS

4.1 Fluoridation compared to iodization of salt

Iodization of salt began in Switzerland in 1922 and in the USA in 1924. Since 1941, when New

Zealand started salt iodization, this measure has been introduced in almost all industrial countries and is now making rapid progress in developing countries [1]. This favorable development is based on the overwhelming success in lowering or even eliminating Iodine Deficiency Disorders (IDD), in short most goitres of any degree of severity, documented in many countries who had implemented salt iodization for decades.

Fluoridation, whether using water or salt, cannot be as effective against dental caries. Caries is a multifactorial disease. Accordingly, the prevention of caries requires consideration of several factors as shown in table 1. Whereas the cause of iodine deficiency diseases is in fact eliminated by sufficient intake of iodine, fluoride essentially slows the destruction of teeth, this effect being very strong when fluoride is frequently present in the oral cavity. Remineralization of microscopically demineralized enamel, which is strongly catalysed by fluoride, may lead to the result that most or all teeth can be saved from irreversible demineralisation throughout life. If a few cavities form in the course of a lifetime, the available dental manpower, now mainly trying to restore severely damaged dentitions in adults and old people, can very easily cope with that minor treatment problem.

The role of iodization is thus fundamental for the prevention of goitre and easily understood by politicians. By contrast, the importance of fluoride in controlling dental caries is less obvious; accordingly, it is more difficult to convince politicians to make decisions.

4.2 Production of fluoridated salt

The addition of fluoride to salt must be adapted to the already existing technical conditions of the salt refineries. In continuous production setups, fluoride is added typically by spraying a concentrated potassium fluoride solution on the salt passing underneath on a conveyor belt. When there is batch production, the necessary amount of fluoride, mostly sodium fluoride, is added by mixing the corresponding amount of salt into each batch, e.g. 550 g of NaF in one metric ton to obtain a concentration of 250 ppm. When unfluoridated salt is produced at the same plant, batch production is

much easier to handle. For this reason and because of improved possibilities for tight quality control, some large plants using continuous production procedures for the various steps of refining use batch mixers, as the last step, for adding fluoride.

Production control is essential. During the last 8 years, the author has collected some 40 samples of fluoridated salt on various occasions in several countries dealt with in this paper. In roughly half of the samples, the concentrations, declared as being 200 or 250 ppm fluoride, were below 180 ppm, in several samples even below 100 ppm. Similar deviations were met with in the early days of salt iodization.

4.3 Cost-benefit ratio

The addition of fluoride to salt at concentrations of 200-350 ppm fluoride is technically more difficult than the addition of iodine (whether as iodide or iodate) and the raw material, particularly potassium fluoride, is more expensive than the iodine salts. However, the cost:benefit ratio is still extremely favorable. Fluoridation of salt in Switzerland for instance costs some 0.03 Euros per year whereas avoiding necessity of one filling saves more than 30 Euros. Under most circumstances, more than 100 Euros of treatment cost will be saved by investing 1 Euro in salt fluoridation.

REFERENCES

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Table 1
Comparing the roles of iodine and fluoride in human health

Iodine Deficiency Diseases	Dental Caries, Tooth Decay
Cause(s)	
Insufficient intake of iodine, rarely excessive intake of "goiterogenic" foodstuff.	Microbial plaque on the teeth, which grows incessantly; frequent presence of fermentable carbohydrates in the mouth; acids accumulating in the plaque as fermentation products demineralize the enamel to form cavities.
Prevention	
Increase the supply of iodine to the required range of intake, for which addition of iodide or iodate to salt is the method preferred world-wide.	Plaque removal, which is always partial; low frequency of intake of fermentable carbohydrates, a discipline rarely followed; most effective: frequent presence of fluoride in the mouth, for this trace element catalyses remineralization of initial caries lesions and slows microbial fermentation, resulting in lower concentrations of demineralizing acids.
Health consequences in severe cases	
Brain damage, cretinism, dwarfism, root canal with occasional loss of energy, disfiguring goitre.	Destruction of enamel and dentine, infections of the dissemination of bacteria via the blood and infection of organs such as heart valves, joints and others
Health consequences in less severe or light cases	
Impaired school performance, retarded physical development, loss of energy, visible, but no disfiguring goitre	Progressive destruction affecting most posterior and often anterior teeth. Constant restorative dental treatment at high cost. Partial and eventually total tooth loss in untreated cases.