

# Salt fluoridation in Europe and in Latin America – with potential worldwide

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Fluoride is beneficial for the health of teeth. Systemic fluoride (salt, water or milk fluoridation) and, in particular, the use of fluoride-containing toothpastes, result in temporarily higher fluoride concentration in the mouth for at least 15 to 40 minutes. Fluoride acts against the acids formed by the oral bacteria growing on the tooth surface. The use of the above mentioned fluoride approaches are recommended by WHO. Europe and Latin America have successful programs of salt fluoridation. The automatic prevention of dental caries using fluoridated salt commenced in 1955 in Switzerland. Currently, the number of users of such salt is approaching 300 million, almost 200 million in Latin America and 70–80 million in Europe. Further big potential for fluoridated salt exists in Eastern and Southeast Europe, Latin America, China, India and Southeast Asia.

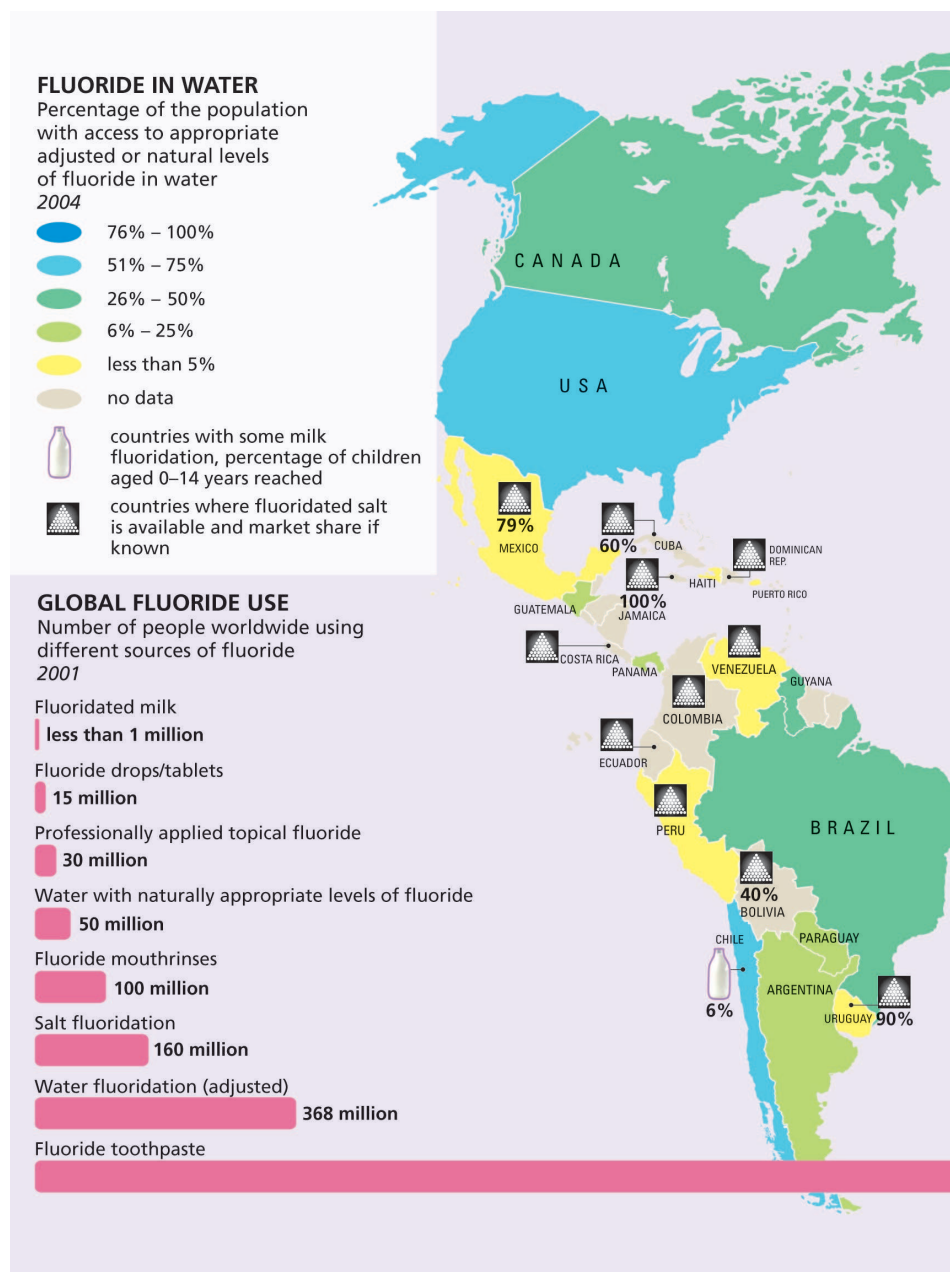


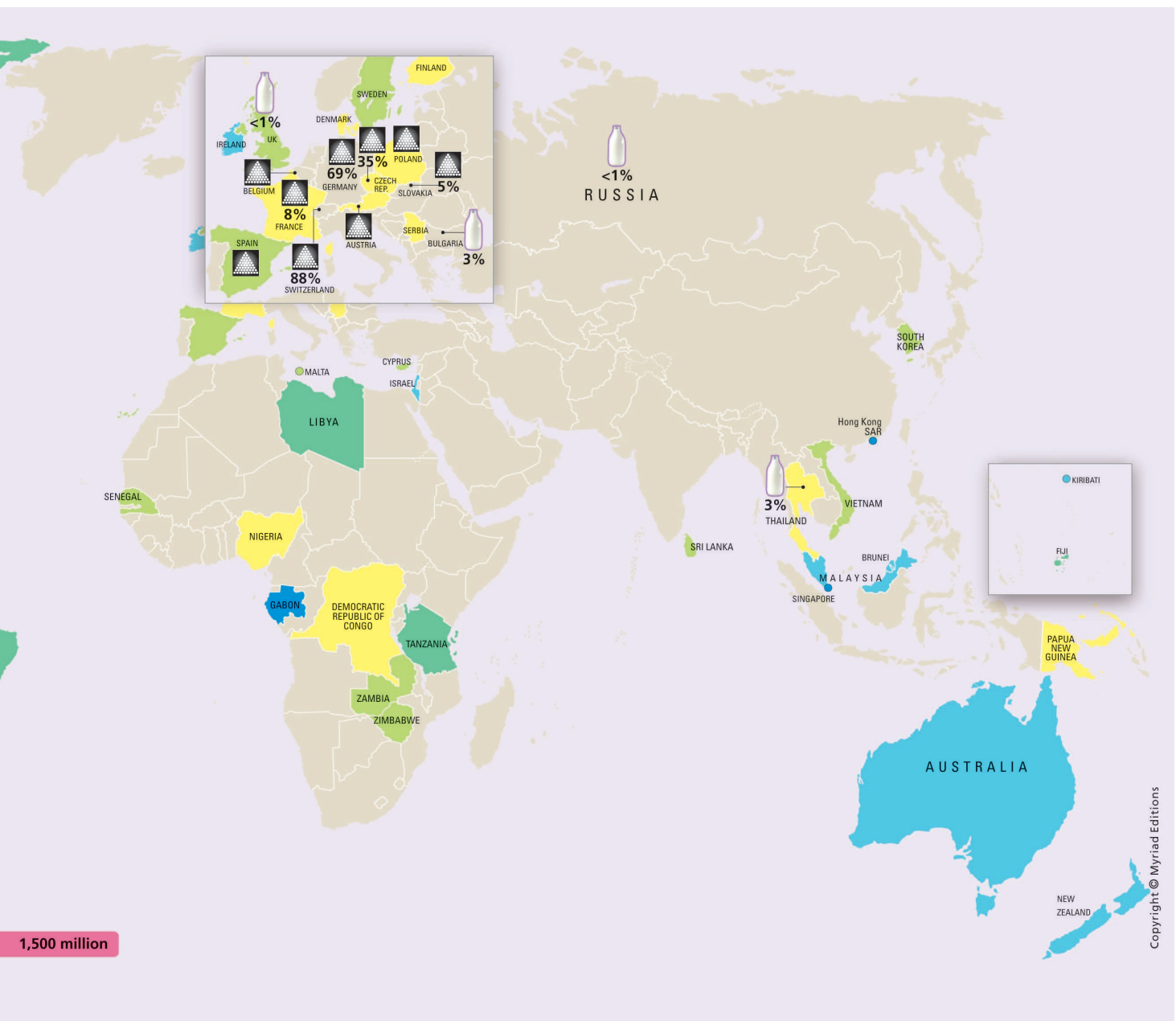
Fig. 1: Map with global fluoride use (Beaglehole et al. 2009).

### Introduction

Oral disease is a significant burden to all countries of the world and is the fourth most expensive disease to treat. Although dental health has improved dramatically across many of the world's populations, principally in economically developed countries, there are still huge problems with dental caries (tooth decay

and cavities) in many sections of society, particularly the underprivileged. Improved general education about oral care and hygiene, research, and practical experience have shown that dental caries can be prevented most effectively through the establishment of fluoride programs (Jones et al. 2005, Marthaler & Petersen 2005).

Fluoride controls caries effectively through various modes of action. It hastens the remineralization of incipient enamel lesions if present in dental plaque and saliva in sufficient amounts and frequency, acting as a healing process for partially demineralized dental hard tissue before cavities become established. Fluoride also interferes with glycolysis



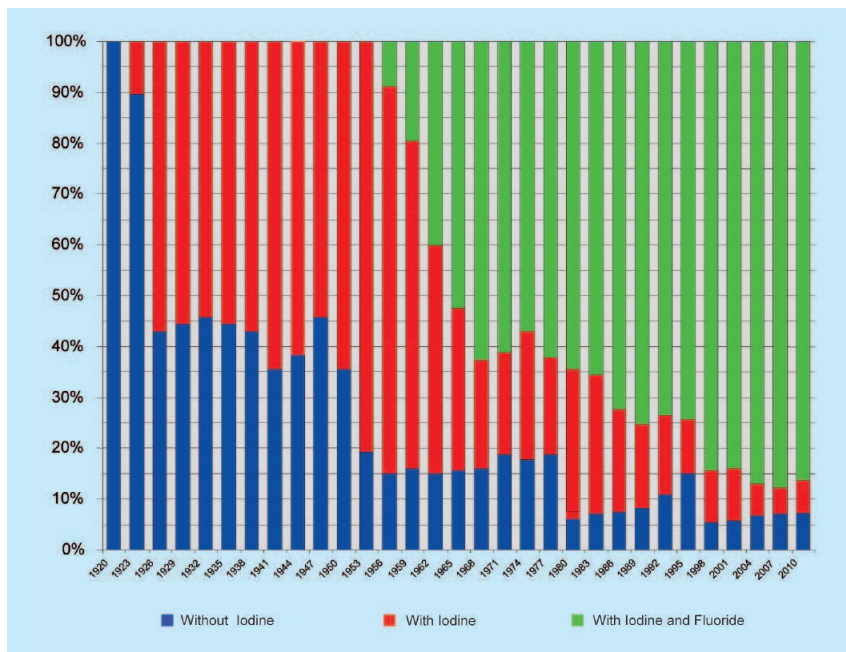


Fig. 2: Market shares in % of unfortified and fortified household salts (card board packages up to 1 kg and shakers) in Switzerland from year 1920 to 2010 (Source: Schweizer Rheinsalinen AG, Schweizerhalle).

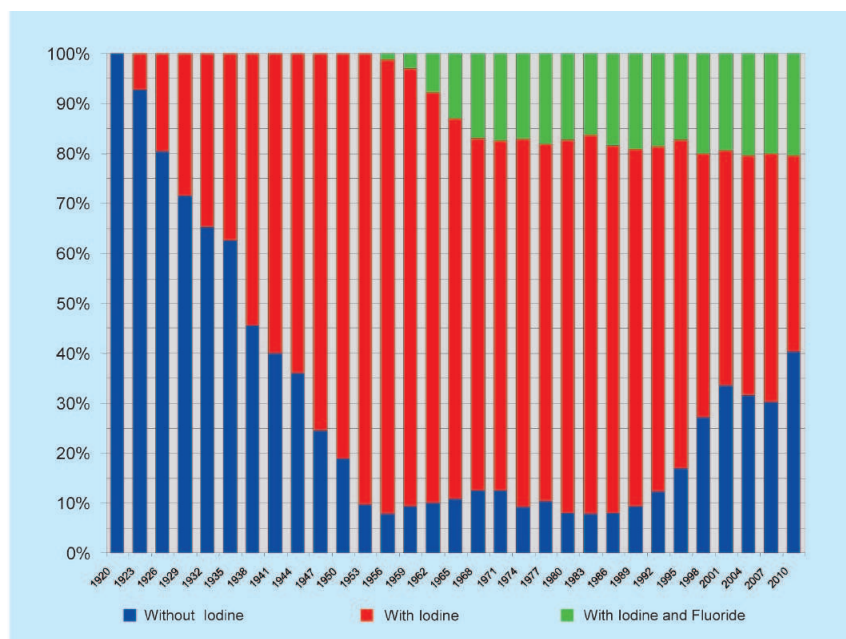


Fig. 3: Shares in % of total sales of unfortified and fortified food grade salts to households and food processing (bakeries etc.) in Switzerland from year 1920 to 2010 (Source: Schweizer Rheinsalinen AG, Schweizerhalle).

or fermentation, the process by which cariogenic bacteria metabolize sugars to produce acid. In higher concentrations, fluoride has a bacteriocidal action.

Figure 1 shows the global fluoride use: Fluoridated milk, fluoride tablets, topical fluoride, water with naturally-appropriate levels of fluoride, fluoridated water, fluo-

ride mouthrinses, fluoridated salt, fluoride toothpaste.

Salt enjoys unique advantages as a vehicle for micronutrient fortification in most parts of the world in terms of universal access, uniformity of consumption and low cost of fortification. Today the micronutrients iodine, fluoride and folic acid, among others are added to salt. Fortified salts which bear health claims are functional salts (Goetzfried 2010), and frequently supermarket packaging refers to UNICEF and WHO recommendations for improved child and oral health. Europe and Latin America are currently the regions of the world with implemented successful programs of salt fluoridation.

### Fluoridated salt in Europe, the beginning

Encouraged by the success of salt iodization, a Swiss gynecologist inferred that addition of fluoride to salt would reduce the prevalence of dental caries in a similar way as the addition of iodine to salt reduces iodine-deficiency diseases. This hypothesis has been shown to be largely correct. After publication of a key paper in 1950 (Wespi 1950), the United Swiss Saltworks (Vereinigte Schweizerische Rheinsalinen, Schweizerhalle, Pratteln) built an apparatus for the addition of sodium fluoride to salt. Finland, in 1952, and the Canton of Zurich in 1955, introduced fluoridated salt (F-salt) with the insufficient concentration of 90 mg F/kg. The Canton of Zurich was the first political unit world-wide to authorize the sale of salt with fluoride. The Fluoride Commission of the Swiss Canton of Vaud, which has a historical monopoly on salt trade, resolved in

1970 that salt for human consumption in the canton should contain 250 mg F/kg. The remaining cantons of Switzerland followed suit in 1983 and the concentration of 250 mg F/kg was adopted throughout Switzerland. The use of F-salt is predominant in the domestic salt (Fig. 2). On a limited scale, it is also available in buckets of 12.5 and 25 kg sacks, used in some cantons and institutions (Marthaler 2005, Fig. 3).

The next to follow in Europe was Spain with legislation in 1983, then France in 1986. The market share of F-salt among all domestic salt in Spain was reported as only 10 % in 2006. In France the market share reached 60 % in 1993 but dwindled to 14 % in 2009. Germany introduced fluoridated salt in 1991. Continued information through professional public relations has resulted in a market share among all domestic salt in that country varying between 65 and 70 % (Fig. 4).

Other European countries with hitherto low levels of use include Austria, the Czech Republic, Spain and Slovakia. Nowadays in eight

European countries national legal regulations exist, or salt producers have obtained individual authorizations, for the production and marketing of fluoridated edible salt: Austria, Czech Republic, France, Germany, Greece, Netherlands, Spain, Switzerland. Fluoridated salt is also available in countries without public programs due to exporting producers and Europe wide distribution of such salt by major discounters. In countries without their own production locations, before importing the fluoridated salt special authorization is obtained or notification made to the responsible national health authority. The notification procedure is based on the principle of mutual recognition. This procedure applies to products for which it can be proven that they comply with the national rules on food fortification of another EU/EEU Member State and for which thorough safety documentation is available (Article 28, 30 European Community Treaty). In Europe major discounters play an important role in distribution of F-salt. Often they sell only one domestic

salt product, if their choice is F-salt, 100 % of the customers consume F-salt (Goetzfried 2006).

### Fluoridated salt in Latin America, a success story

Regarding the development of F-salt in the Americas, a key decision to proceed was taken after the meeting and discussion in Medellin, Colombia in 1977 (First International Symposium on Salt Fluoridation) to review the results of the U.S. National Institutes of Health (NIH) supported Colombia trial and in which representatives of the U.S. Public Health Service and from the University of Zurich and the Chief Chemical Engineer of the Swiss Rhine Saltworks participated (Gillespie & Roviralta 1986). Following the successful trials in Colombia (NaF and CaF<sub>2</sub> fluoridated salt versus water fluoridation and control) (1964–72) the use of fluoridated salt as a community preventive measure for dental caries prevention at country level has increased steadily since 1986. Colombia, Costa Rica, Jamaica, Mexico and Uruguay have more than 20 years of documented community

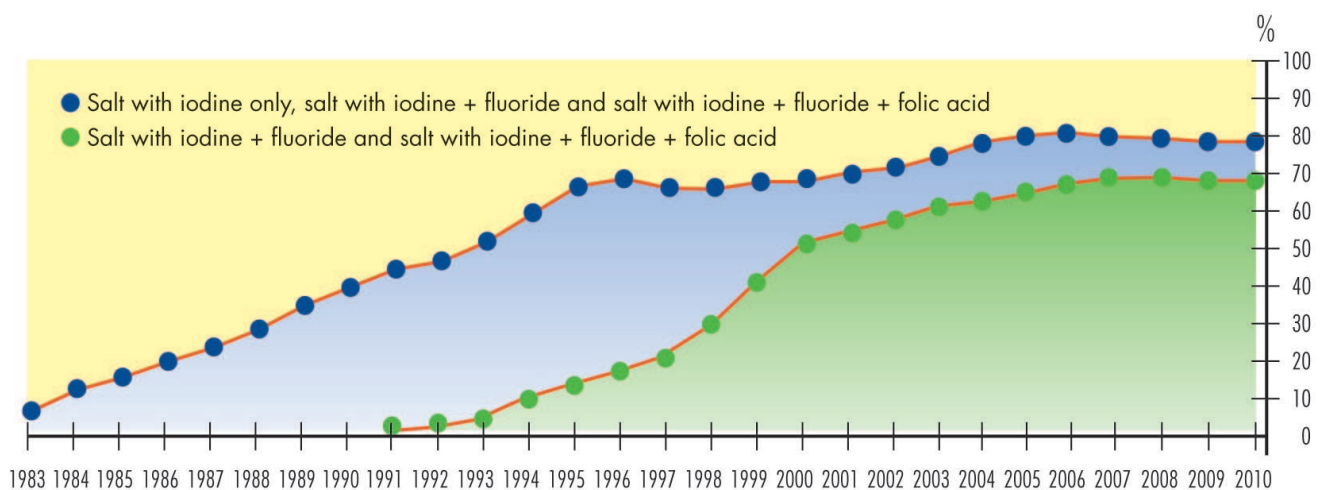


Fig. 4: Market shares in % of iodized and fluoridated salts from the total sales of household salt in Germany from year 1983 to 2010 (Source: DAZ/Informationsstelle für Kariesprophylaxe, Frankfurt).



experience with population coverage up to 98 %. Other countries such as Belize, Bolivia, Cuba, Dominican Republic, Ecuador, Peru, Venezuela have active programs, and an estimated further five countries are in the process of implementing this approach. Fluoridated salt is also available in certain countries that do not have public programs. Mexico, with an estimated population of 112 million, has an estimated 90 million on fluoridated salt and 20 million on fluoridated water (SECRETARIA DE SALUD, MEXICO, 2011). Implementation procedures have been considerably easier and more economical than water fluoridation while achieving an equal or even improved disease prevention accessible to the whole population (Estupinán-Day 2000, Gillespie & Baez 2005). On a worldwide basis, the number of countries involved approximates those with adjusted water fluoride levels.

### Safe product

The European Food Safety Authority (EFSA) has already published an opinion related to the tolerable upper intake level (UL) of fluoride. Their Scientific Panel on Dietetic Products, Nutrition and Allergens derived an UL of 0.12 mg/kg body weight/day. This is equivalent to an UL of 5 mg/day in children aged 9–14 years and 7 mg/day for age 15 years and older, including pregnant and lactating women (EFSA, 2005).

In order to ensure effectiveness in caries prevention, the concentration of fluoride in salt should be specified at 250 mg per kg salt (tolerance  $\pm$  25 %). This maximum amount ensures a high level of protection for consumers and facili-

tates their choice. The amount of fluoridated salt ingested per person per day, from its domestic use, is estimated to be 3 g in France, and 2 g in Germany corresponding to a fluoride intake from F-salt of 0.50–0.75 mg/day (AFSSA, 2003). With a daily consumption of 10 gram F-salt, as it can be assumed for Jamaica, and Latin America, the fluoride intake amounts to 2.5 mg, far below the UL.

Sodium and potassium fluoride are most frequently used for the fluoridation of salt, and both have been approved as an accepted food additive by the EU. Addition of fluoride is carried out either by the wet or the dry process. Qualitatively good F-salt can be produced by using either method (Milner 2000 and 2006, Goetzfried 2006).

In the Colombian trial (1964–1972), calcium fluoride was found to be as effective against caries as sodium fluoride. In the various milk fluoridation trials, the typical procedure was to add sodium fluoride to milk, resulting in concentrations of 2.5 to 5.0 ppm fluoride in the milk. Under these conditions, the once daily intake of fluoridated milk inhibited caries increments in spite of the presence of the calcium concentration in milk being high, at 1000 ppm (Banoczy et al. 2009).

The fluoride content is controlled by the producers as part of the self-monitoring that is stipulated by the law. Three well-established testing methods which have been validated in interlab studies are available to determine the fluoride content in salt. In practice, the potentiometric method has proven to be a simple, accurate and comparably low-priced method and is widely used (Trachsel 2005).

Furthermore, the correct fluoride dosage is supervised by the official food inspections.

Whitford (2005) estimated the potential for acute toxicity in respect of segregation of F-Salt in cardboard boxes, shakers or sacks. Analysis of salt that passes through a 180  $\mu$ m sieve gave elevated fluoride concentrations, while salt that did not pass through a 600  $\mu$ m sieve had concentrations below 100 ppm. The “probably toxic dose” or PTD of fluoride has been set at 5 mg F/kg of body weight. The PTD is “the minimum dose that could cause serious or life-threatening systemic signs and symptoms and that should trigger immediate therapeutic intervention and hospitalization”. In the extreme case of a 1-year-old child with the average body weight of 10 kg, the PTD would be 50 mg which would be contained in 50 g of 1,000-ppm F-salt. It can be concluded, therefore, that the risk of reaching the PTD by ingesting F-salt is virtually non-existent.

### Scientific results, epidemiological and public health studies

The key studies began in 1964 in Colombia and in 1966 in Hungary. A considerable series of scientific publications dealt with all aspects of caries prevention with fluoridated salt. Mejía et al (1976) published the results of the Colombia trial and the publication “Caries Prevention by Domestic Salt Fluoridation” by Karoly Tóth summarized the results obtained in Hungary (Tóth 1984). It is to be noted that the salt used in the Colombia trial was also iodized and no adverse impact was noted, nor has been subsequently where this combination has been used.

	At start of use of F-salt		Last survey		Reduction In %
	Year	DMFT	Year	DMFT	
Jamaica, age 12	1986	6.7	1995	1.1	84
Jamaica, age 15	1986	9.6	1995	3.0	69
Costa Rica, age 12	1987	8.4	1999	2.5	72
Mexico, age 12	1988	4.4	1997	2.5	44
Uruguay, age 11-14	1991	4.1	1999	2.4	42

Tab. I: Caries prevalence at start and after 8-12 years of use of fluoridated salt in several American countries (DMFT = mean number of decayed, missing and filled teeth).

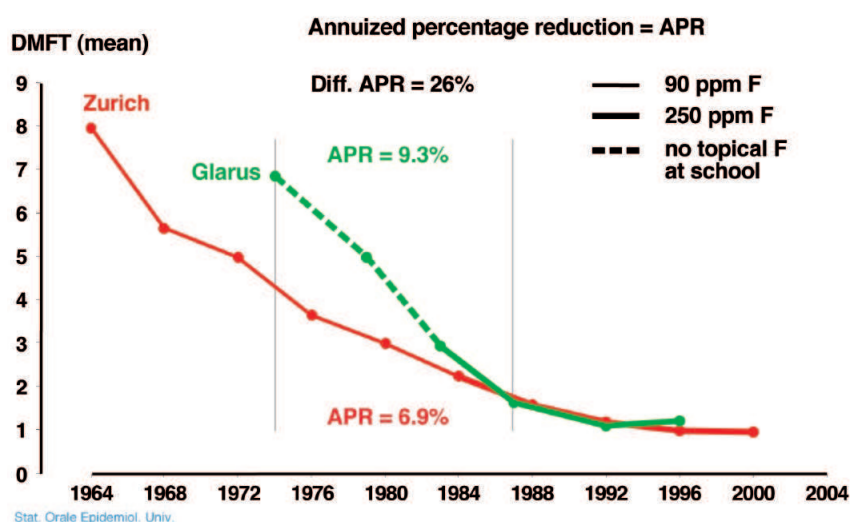


Fig. 5: Changing DMFT of 12-year-olds in Switzerland after introduction of school-based topical fluoride programmes (i.e. toothbrushing with concentrated fluoride preparations) in the 1960s (Zurich) and of fluoridated salt (250 ppm F) in the 1970s (Glarus). Salt fluoridation was introduced in 1983 in the Canton of Zurich and all of Switzerland (Marthaler 2005).

Recent summaries were presented by Estupinán (2005), Gillespie & Baez (2005) and Marthaler & Petersen (2005). The results of these trials were the main basis for the statement, “the results suggest that the effectiveness of fluoridated salt in inhibiting caries is substantial, of the same order as that of fluoridated water when the appropriate concentration and use are achieved” (WHO, 1994).

What can we expect from the current implementation schemes? Jamaica may be the best example.

Virtually all salt destined for human consumption is fluoridated at the only salt refinery on the island. All imported domestic salt for human consumption must contain fluoride. In 2004 it was recognized by the Center for Global Development, Washington DC, as one of the proven successes in public health in the 20th century (Levine 2004). More than half of the salt for direct consumption is fluoridated in Costa Rica, Ecuador, Mexico and Venezuela. The increasingly used dry soups or consommés in Costa

Rica are now required to be made with F-salt, a intelligent measure to counterbalance the advances of food processing. Table I shows the conspicuous decline of caries prevalence in several American countries. The part played by an increasing use of fluoridated toothpastes cannot be identified with certainty. Fluoridated toothpastes had been available for many years in several countries prior to the introduction of F-salt. Irrespective of whether the economic situation has improved to a limited extent or not at all, caries prevalence decreased following introduction of this measure.

The surveys on caries prevalence in the Swiss Cantons of Zurich and Glarus were repeated several times up to the year 2000. The results documented a continued decline of dental caries prevalence (Fig. 5). Statistical data are available to support the hypothesis that fluoridated salt contributed notably to the general decline of caries prevalence in Switzerland.

In Germany, the reasons for the strong decline of caries between 1994 and 2004 are difficult to identify (Tab. II). Fluoride toothpastes have been available for decades. Both the usage of F-salt and of sealant applications (paid by the insurance system) have markedly increased since 1997. Since pit and fissure caries is predominant when the DMFT is below 2.0 or even 1.5, the increasing use of sealants must be expected to have contributed substantially to the decline. The restriction of F-salt to domestic use may result in two contacts per day of salt-borne fluoride with the teeth. The effectiveness of only domestic F-salt in this particular

Year	Mean DMFT	Market share of domestic F-Salt	Children with sealants
1994	2.44	5 %	6 %
1997	1.81	19 %	29 %
2000	1.24	41 %	62 %
2004	0.98	61 %	66 %

Tab. II: Dental caries among 12-year old children and selected preventive measures in Germany (Pieper & Schulte 2004, Schulte et al. 2006).

case may be estimated to be an overall reduction of 12 %, but with impact over a lifetime. Model calculations illustrate the importance of high market shares of F-salt for a substantial effect on the public health scale (Marthaler 2006, Pieper & Schulte 2004, Schulte et al. 2006).

### Factors of note

Whereas the estimated world population is about to reach 8 billion, still less than an estimated 1 billion have achieved community fluoride prevention by either fluoride in drinking water or via fluoridated salt at an increasing rate; less than a million profit from fluoridated milk. There is a need for more extensive and effective caries prevention not only in the very young but also in adults and the aged. Due to severely damaged teeth, extensive treatment is often necessary but is, except for a few affluent countries, rarely affordable. Greatest need is present in developing country populations as well as those in developed countries without access to community fluoride prevention.

Most countries are concerned about costs and coverage in provi-

sion of dental health care on the level of restorative care. The use of fluoridated salt brings notable cost-benefit. The worldwide success of salt iodization (similar process as salt fluoridation) in the last 20 years has illustrated the ability of the salt industry to introduce and implement preventive health measures and to obtain community participation irrespective of economic, social or cultural conditions. Countries which practice iodization of salt with sufficient quality control now have a trained work force which is undoubtedly able to add fluoride also in appropriate concentration to the salt for human consumption.

### No adverse health or social effects

In over 20 years of community experience, no negative health impact attributable to use of fluoridated salt was reported. This was predicted on the basis of the extensive surveys made in water-fluoridated regions, which started already in 1945, 65 years ago. Occasional excessive fluoride intake (in combination with fluoride tablets or ingested toothpaste), have in some instances resulted in

enamel fluorosis, which is the only undesirable cosmetic side effect of fluoridation. Salt fluoridation does not entail rises in the frequency of enamel fluorosis (EFSA, 2005). Fluorosis does not originate from salt fluoridation according to the thorough analysis of the Swiss situation (Steiner et al. 2010). The percentage of cases with slight enamel fluorosis decreased in fact slightly between 1975 and 1996.

Another outstanding positive feature of salt fluoridation is its low cost. It is far cheaper than other community fluoride approaches with the best cost-benefit ratio of any. In technically modern salt production, it is by far the cheapest method for prevention of dental caries. In professional salt production, serving a population of 100,000, the cost per capita / person / year is around US\$ 0.03 to 0.06 or EURO-cent 0.02 to 0.05 (Gillespie & Marthaler 2005, Gillespie 2006).

In addition, salt fluoridation is well accepted by the public. As in salt iodization, the intake of salt was neither increased nor diminished after addition of micronutrients. A WHO Expert Consultation confirmed that there is no conflict between the major public health goals – reducing average population salt intake, and tackling iodine deficiency and dental caries with fortified salts (WHO 2008). Where a sodium fluoride compound is used, the increased sodium is infinitesimal and considered to have no impact relative to hypertension.

### Community fluoridation in combination with fluoride toothpastes

The use of fluoride-containing dentifrices in conjunction with toothbrushing is cited as the most

important reason for the decline of caries prevalence in most highly industrialized countries; an estimated billion people may be regarded as using such dentifrices at 1100–1500 ppm fluoride frequently enough – twice a day – to benefit substantially. Because of small children swallowing much of the toothpaste, many countries limit the fluoride concentration for ages below 6–8, to 250 or 500 ppm fluoride. In less affluent countries, poor regions, and isolated populations, the cost of dentifrices is only affordable for the richest socioeconomic strata. Alternative oral hygiene practices are frequently used that do not involve toothpaste. Their source of fluoride needs to be in the diet.

The direct contact of fluoride with the dental hard tissues – usually referred as “topical fluoride” – has been established to be the main protective mechanism. This topical action is of prime importance because it works at all ages: fluoride applied to teeth of old people protects their teeth partially from caries as it does in young people. Some researchers believe that even in the case of water fluoridation, the caries reduction obtained is achieved 100 % by its topical action. Since the salivary concentrations are very low in fluoride, around 0.1 ppm F, water or food containing 1 ppm of fluoride already leads to fluoride concentrations ten times higher than in saliva, during 10 to 20 minutes. This explains why fluoride added to water, salt and milk has a protective topical effect, in addition to a pre-eruptive effect, in spite of being customarily called “systemic fluoridation”. Fluoridated salt can be expected to

exert an added preventive impact in preventive programs based on use of fluoridated toothpaste. A recent study in 19,885 6- to 15-year old Australians demonstrated that fluoride reaching unerupted teeth in the phase of crown completion had lower caries experience than those exposed only to post-eruptive fluoride, provided by low or optimal fluoride-containing drinking water (Singh K A et al. 2007).

In children of low caries countries, the majority of carious sites are pit and fissures. Since Singh K A et al. did their studies in Australia, currently one of the countries with the lowest caries prevalence, their conclusions are valid for these particular sites, illustrating that community fluoride can provide an additional benefit even in countries in which caries prevalence is already low due to use of topical fluorides.

### Fluoride and the EU Fortified Food Regulation

The Fortified Food and Claims Regulations of the European Union (EU, 2006 ), which are examples for a legal basis of salt fortification with fluorides, supersede the existing national voluntary regulations for the enrichment of foods with minerals and vitamins. With the Fortified Food Regulation the mineral fluoride was approved as a food additive, added as mineral substances sodium and potassium fluoride. The new Regulation has had little impact so far on the market of F-salt in Europe pending the issuance of the following detail regulations:

a) Restriction of the addition of fluoride to salt, water and chewing gum;

- b) Restriction of the addition of fluoride to salt for domestic use, to salt for commercial catering, to salt for bakeries, and to salt for dry soups;
- c) The confirmation of the maximum amount of 250 mg fluoride/kg salt (tolerance +/- 25 %);
- d) Formulation of warning statements (“If using fluoridated edible salt, intake of food supplements containing fluoride and of fluoride tablets should be avoided”, “Fluoridated edible salt should not be used if the drinking water contains more than 0.5 mg fluoride per litre”);
- e) Purity criteria for sodium fluoride and potassium fluoride.

Due to the absence of detail regulations, the German salt producers have needed further special agreements with the Food Authority for the production and marketing of fluoridated salt. Upon the completion of the ongoing legal process in Europe one can expect ideal conditions for further implementation of F-salt in the EU member states.

### Health claims made for fluoridated salt

Health claims which are made for fortified salts in EU Member States have to conform with the Regulation (EC) No 1924/2006 (EU, 2006). This Regulation applies to nutrition and health claims made in commercial communications, whether in the labeling, presentation or advertising of foods to be delivered as such to the final consumer, restaurants, hospitals, schools, canteens and similar mass caterers.

Following a request from the European Commission, the Euro-



pean Food Safety Authority (EFSA Panel on Dietetic Products, Nutrition and Allergies) was asked to provide a scientific opinion on the substantiation of health claims in relation to fluoride and the following claimed effect: maintenance of tooth mineralization. The Panel characterized the fluoride as a well recognized nutrient and as measurable in foods by established methods. The Panel considered that fluoride is sufficiently characterized. The Panel concluded that a cause and effect relationship has been established between the dietary intake of fluoride and maintenance of tooth mineralization. The following wording reflects the scientific evidence: "Fluoride contributes to maintain tooth mineralization" (EFSA, 2009). The final approval of the fluoride health claim by the European Commission is expected for the year 2012.

Reduction of disease risk claims and claims referring to children's development and health for fluoridated salt like "Fluoride helps fight dental caries" may be made where they have been authorized in accordance with the procedure laid down in Regulation (EC) No 1924/2006 (EU, 2006).

### The potential of salt fluoridation on a worldwide scale

Figure 6 shows the status of the global dental caries situation.

In improving oral health and combating dental caries there is tremendous potential for salt fluoridation worldwide due to the proven ability of salt as a vehicle for additives, community role, effectiveness, acceptability, absence of adverse health impact, and minimal cost.

#### WORLDWIDE DENTAL DECAY

Average number of Decayed, Missing and Filled permanent Teeth (DMFT) in 12-year-olds  
latest data available from 1982-2008

- high; more than 3.5
- moderate; 2.6 – 3.5
- low; 1.2 – 2.5
- very low; 0.0 – 1.1
- no data

World average: 2.0

Highest: Croatia 6.7

Lowest: Rwanda, Tanzania, Togo 0.3

#### ANATOMY OF TOOTH DECAY

Proportion of Decayed, Missing and Filled Teeth (DMFT) in children aged 11–14 years by nation grouping 1991–2004

- teeth treated with filling
- teeth missing due to caries
- untreated decayed teeth

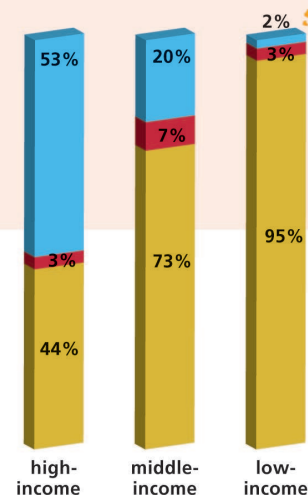
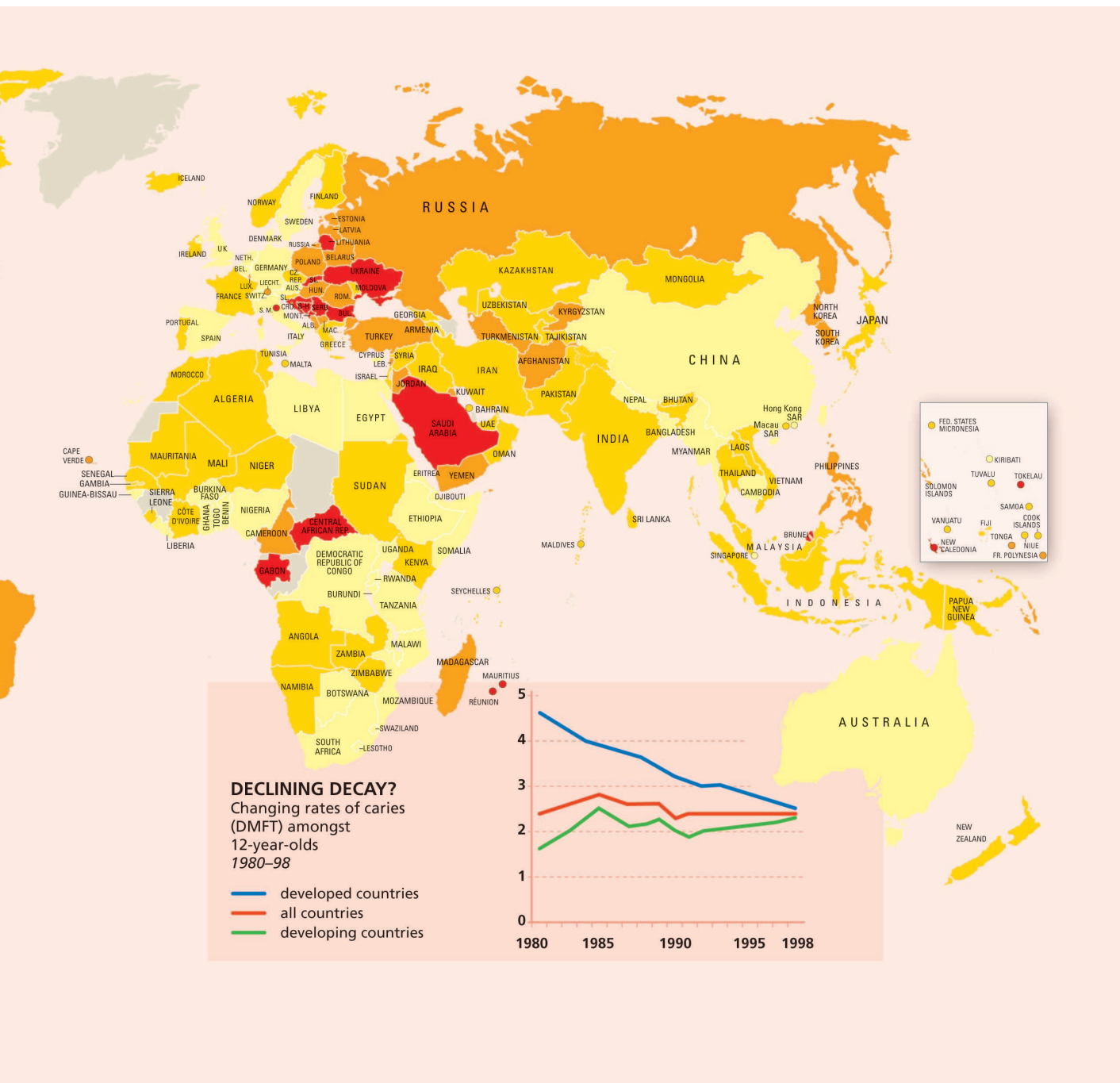


Fig. 6: Worldwide mapping dental caries (Beaglehole et al. 2009)

The world population in 2009 was estimated at 6.8 billion, where the more developed countries contributed 1.2 billion and the less developed 5.6 billion of which Asia contributed 3.8 and Latin America & Caribbean 0.6. This world population is anticipated to expand to almost 8 billion by 2020, of which

an estimated 27 % will be 14 years and under, and 20–25 % will have no access to health systems.

In the rest of the world few small countries fluoridate water and many do not produce, or do not have the capability to produce fluoridated salt – often relying on imports to meet their domestic salt



requirements. This is particularly the case in island groupings in Asia, the Caribbean, and the Pacific. Few countries have a comprehensive dental caries preventive program that prevents early onset of caries and reaches all sectors of the community. The limitations of water fluoridation and toothpaste pro-

grams, while contributing greatly to oral health, are not achieving national population access or coverage, with only an estimated 1 billion currently receiving the benefit they provide, despite more than 60 years of experience.

It is evident that, with increasing health costs, and developing

economies with changes in nutritional patterns and aspirations, greater emphasis has to be given to applying evidence based and community acceptable solutions to expand prevention of this most common disease affecting over 90 % of children in the world. Markets and need exist in both devel-

oping and developed countries, particularly in the young generation. In developed countries, such as USA, Canada, United Kingdom, Australia and Brazil, despite the success of water fluoridation and toothpaste programs, there are significant populations without access to comprehensive community fluoride. For instance it is estimated that in the USA 30 % of the population, in Canada 54 %, and England 90 % do not have access to community fluorides, with many in the poverty level or isolated areas. In several European countries with availability of fluoridated salt, market share is low principally for lack of promotion. A need and space exist to extend prevention through increased market share, and the need to supplement or implement economical preventive programs in Eastern Europe following changes in patterns of delivery and availability of health services.

Poor dental health has been reported in the Chinese National Surveys of Oral Health. With the changing lifestyle and growing consumption of sugars, the incidence of dental caries may well continue to rise, compounded by limited access to professional care. The increasing oral disease burden could become a major public health problem in China, leading to considerable personal and health service costs.

The situation in China is unique with endemic fluorosis due to other non-water sources of fluoride in some areas and a considerable dental caries burden in others. China is in the process of reorienting health services, and this change provides an excellent opportunity to incorporate automatic fluorida-

tion (water, milk or salt) in the overall agenda and national program development (Petersen et al. 2008).

The first experiences with salt fluoridation in China were made in Wuhan city from 1988 to 1991. In the 3-year single blind, randomized controlled trial the effect of salt fluoridation on dental caries in primary teeth, using 200–250 ppm fluoridated salt, was investigated. The fluoride concentration in drinking water in the city is 0.3 ppm and the use of toothpaste containing fluoride was low. In total 414 3–4 year-old kindergarten children were recruited; all children had 3 meals in the kindergarten each day and the average salt consumption was 3–4 g per day. Compared with the control group, about 50 % reduction in caries experience at the end of the trial was observed (Zhang 2006, Petersen et al. 2008).

Taking account of the scientific evidence, as well as several WHO World Health Assembly resolutions, and other technical reports, experts in oral health reaffirmed in 2007 with the Beijing Declaration the need for action to promote oral health by using fluoride (such as water and salt fluoridation, and affordable and effective fluoride toothpaste) in China and Southeast Asia (WHO, FDI, IADR, CSA 2007).

The effective use of fluoride is a WHO priority action area for the improvement of oral health worldwide. The Sixtieth World Health Assembly urged the 193 Member States in May 2007 with its oral health action plan for promotion and integrated disease prevention (WHO-WHA 60:17, 2007): “For those countries without access to optimal levels of fluoride, and which

have not yet established systematic fluoridation programs, to consider the development and implementation of fluoridation programs, giving priority to equitable strategies such as the automatic administration of fluoride, for example, in drinking-water, salt or milk, and to the provision of affordable fluoride toothpaste.”

Salt fluoridation should be linked to iodization schemes (Petersen 2008). The WHO Global Oral Health Programme is currently undertaking further demonstration projects in Africa, Asia and Europe in order to assess the relevance of affordable fluoridated toothpaste, milk fluoridation and salt fluoridation. A recent meta-analysis published in South Africa favoured salt fluoridation for caries prevention compared with no exposure (Yengopal et al. 2010).

### Areas of need worldwide and approaches for action

In order to achieve high market shares of fluoridated salt in countries which have already programs with salt fluoridation, and to start salt fluoridation in countries without access to optimal levels of fluoride, some areas of need and approaches for action are important:

- Need for information – general, technical
- Need to present health benefits and impact of salt to counteract negative impact caused by campaign to reduce overall excessive salt consumption
- Needed production of guidelines and instruction manuals
- Need to improve product monitoring, quality control and reporting

- Establishment of implementation programs similar to approaches used in iodization
- Incorporation of fluoride within international micronutrient programs and projects
- Collaboration in activities related to labeling of food additives
- Creation of a working relationship – salt industry and health
- Creation of demand – social marketing
- Training and development of national capability and capacity
- Provision of information
- Production and distribution
- Monitoring and evaluation

The ability to include fluoride in domestic salt exists within the provisions of the health statutes and regulations in many countries and permit ready initiation without many of the problems and barriers associated with water fluoridation. Internationally, the addition of fluoride to domestic salt has been included in the revised Codex Alimentarius 150, and it is expected that further information will be included in future revisions.

The Pan American Health Organization/WHO published the experience of salt fluoridation in the Americas with guidelines for legislation and implementation (Estupinán-Day 2005).

Optimal conditions for the effectiveness of F-salt may be jeopardized by increasing use of industrial processed food and decreasing preparation of food in the household, as it is in Western Europe. Specific regulatory measures on the use of fluoridated salt intended for food producers should be taken by governments where the main sources of dietary salt are processed foods

and meals consumed outside the households. Accordingly, expanded use of fluoridated salt is indicated: F-salt for bread, for large kitchens (caterer), for consommés.

Politically, it is relatively easy to offer free choice to the consumer to purchase salt with or without fluoride: this does not result in anti-fluoride activities, since it provides freedom of choice, is an accepted vehicle, and a better quality product. From a public health perspective, high market share, or better universal use of fluoridated salt, will always be preferable. Lower socio-economic strata tend to make consistently less use of possibilities of prevention, and the majority reached only under conditions of universal or near-universal usage. However, where free choice is involved, the use of fluoridated salt must be promoted continually to have a community effect.

In May 2000, at the 8th World Salt Symposium ("Salt 2000"), executives of the salt industry met with leaders of governments, NGOs and international organizations to discuss how to better collaborate on eliminating IDD forever. A global coalition of public, private, international, and civic organizations was formed whose goal would be the sustained elimination of iodine deficiency disorders through universal salt iodization. Two years later at a UN General Assembly event (A Smart Start for Children), the "Network for Sustained Elimination of Iodine Deficiency" or the Iodine Network was launched.

Major salt producers have a role to play through their dominance, influence, expertise, and exports in geographic areas – China in Asia, and India in the subcontinent and

the Middle East, for example.

The success of the UNICEF iodization program has greatly expanded the ability and expertise to implement salt iodization in developing countries, such that much of the equipment and staff already are available, thereby facilitating the addition of fluoride and reducing start up costs and investment. Accurate, simple and relatively inexpensive equipment is available for determining fluoride. The use of specific ion electrodes can be used for determining fluoride in multiple applications including fluoride in water, salt, milk and renal excretions. This provides a valuable tool at the processing plant and for epidemiological surveillance and monitoring in community groups.

There is a need for information to be disseminated on the feasibility of salt fluoridation, and greater collaboration developed between salt producers, marketers, cooperatives, health officials, providers, nutritionists, government, and the private sector, to increase the availability of prevention to the ever growing world population in need. The expertise and experience exist and are available.

The ability to permit the use of fluoridated salt exists within the health regulations of many countries, and has enabled this to be initiated and implemented through a variety of approaches. Greater harmonization with the content of legislation and regulations relative to salt iodization needs to be made. The availability of such information should be extended; the Codex and EU legislation and information appropriately modified and updated; and fluoridated



salt recorded in the “generally recognized as safe” (GRAS) category in US FDA regulations, if it would facilitate the availability of the preventive approach to those currently without access.

The initiative and collaboration of the salt industry in the Americas, and a few European countries, has been a major factor in the successful implementation of a disease preventive measure for dental caries and the improvement of oral health of the population in the regions. However, the need exists to improve and expand national capability for monitoring and evaluation, such that consumers and health agencies can note the beneficial impact of their actions.

The creation and subsequent implementation of the Iodine Network was facilitated through collaboration of producers, marketers, health officials, international associations, universities and government agencies, working in conjunction with WHO and international agencies. It has illustrated the feasibility and international effectiveness of salt as a vehicle for disease prevention.

The conditions are right for use of a similar approach and the creation of a similar Fluoride Network by the salt industry involving UNICEF, WHO, and international financing agencies, or the incorporation of fluoride into the salt related programs and micronutrient initiatives of these agencies, and projects such as GAIN (Global Alliance for Improved Nutrition). Such action would present an approach to benefit millions of children and prevent the pain, discomfort, and impact of dental disease rapidly and immediately (Gillespie et al. 2009).

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