TOTAL FLUORIDE INTAKE AND FLUORIDE CONTENT OF COMMON FOODS: A REVIEW

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SUMMARY: In current publications and textbooks most data regarding the fluoride content of common foods as well as tables showing the average daily intake of fluoride in various countries, are based upon work carried out up to thirty-seven years ago. Such work does not allow for the effect of fluoridated drinking water on fluoride levels of processed and cooked foods. Moreover, the accuracy of data due to early testing methods may be questioned. Work done internationally may raise questions regarding identification of foods and relevance to urban type diets. In one table, for example, the fluoride content of cereal is given as < .10 - 20 ppm fluoride based on a range of data compiled from eight sources namely, four from U.S.S.R., three from Germany, and one from Japan. One must question what is meant by "cereal" in this listing and how to relate it to processed products. Data in tables published in the 1970's, citing average fluoride ingestion, were found to be based upon a small sampling. Some figures presented were found to include misquoted data. It must therefore be concluded that data on fluoride content of foods should be updated.

In the monograph "Fluorides" published in 1971 by the National Research Council, National Academy of Sciences, a table on the fluoride content in food is accompanied by the following statement: "Little fluoride is consumed in the diet,...The daily dietary (including drinking water) fluoride consumption in several countries has been...found to be at least 0.2 mg, and in only three...greater than 1 mg" (1). The data from the NRC/NAS table, are presented in Table 1. Since they are also recorded in three other major books (2-4) on fluoride, they constitute the basis for the concept that little fluoride is ingested in foods and

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Presented at the Sixth Annual Conference of I.S.F.R., Williamsburg, 11/7-9/74.

beverages.

Because of the importance of this question in assessing the health effects of fluoride, it was of interest to investigate the basis for the figures shown in this table, particularly in the light of the great increase in the number of fluoridated communities and of improved methods of fluoride analysis during recent years.

An attempt to ascertain the origin of the data in Table 1 revealed that the 1971 figures were adapted from a similar table utilized by Hodge and Smith (4) in 1970 who in turn adapted their table from work presented by Cholak in 1959 (5). Therefore most of the data in table 1 originated in 1959.

TABLE 1

Daily Dietary Fluoride [a]

Country	Fluoride ingested in Food and Water, mg	Fluoride in Drinking Water, ppm
Canada	0.18 - 0.3	0.1
England	0.3 - 0.5	trace
Japan	0.47 - 2.66[b]	0.01 - 0.08[c]
Newfoundland	2.74[d]	trace
Norway	0.22 - 0.31	0.01 - 0.07
Soviet Union	0.6 - 1.2	0.2 - 0.3
Sweden	0.9	-
Switzerland	0.5[e]	-
United States	0.2 - 0.3[e]	-
	0.34 - 0.80	0.1

[a] Adapted from Hodge and Smith. (4)
[b] Including 0.07 - 0.86 mg from green tea.
[c] Milligrams of fluoride ingested.
[d] Including 1 mg from tea.
[e] Exclusive of that in drinking water.

Table 2 presents the 1959 data of Cholak which included fluoride values in food consumed in the U.S.A. These data were derived from work done by Heyroth et al. in 1951-1954 (6), by Armstrong and Knowlton in 1942 (7) and by McClure in 1949 (8). It is of interest to note when these data were obtained in view of the fact that they appear in 1971.

TABLE 2

Quantities of Fluoride in the Food Consumed Daily by Adults
(According to Cholak, 1959)

Location	ppm in drinking water	Fluoride in Food (mg)	
United States of America			
Cincinnati, Ohio	0.1	0.34 - 0.80	Exclusive of fluoride in drinking water
Galesburg, Ill.	2.0	0.94 - 1.16	
Ennis, Texas	5.0 - 6.0	1.32 - 1.35	
Lake Preston, S. Dak.	6.0	0.99 - 2.19	
Bartlett, Texas	8.0	2.33 - 3.13	
O'Donnell, Texas	18.0	1.41 - 1.49	
(Average general diet)		0.2+ - 0.3+	
Norway		0.22 - 3.1	Inclusive of low-level fluoride in drinking water
U.S.S.R.		0.6 - 1.2	
Canada		0.18 - 0.3	
Switzerland		0.5	
England		0.6 - 1.8	

For this table, the following original sources are cited for fluoride in food in countries other than the U.S.A.:

Norway	-	Danielsen et al., Chem. Abstr. 1957 (9)
U.S.S.R.	-	Gabovich 1951 (10)
Canada	-	Ham and Smith, 1950 (11)
Switzerland	-	Von Fellenberg, 1948 (12)
England	-	Longwell, 1957 (13)

When Hodge and Smith in 1970 utilized fluoride values in food from the 1959 Cholak table, they added values for Sweden, Newfoundland, and Japan but failed to update the figures for England. It is of interest to explore the source of these English figures.

Cholak had recorded a daily intake of 0.6 to 1.8 mg in 1959, a figure which was changed by Hodge and Smith to 0.3 - 0.5 mg in their 1970 paper, although the source for the data of both Cholak and Hodge and Smith was the same article, namely that by Longwell in 1957. The figure, 0.6-1.8 mg fluoride, recorded by Cholak represents the probable intake in non-fluoridated areas, whereas Longwell presents probable values for fluoridated areas as 1.2 - 3.2 mg fluoride daily. Cholak had chosen the lower of Longwell's two values. Hodge and Smith's figure, obtained from the work of Longwell, excluded beverages. With

beverages included, according to Longwell's work the figure would be 1.7 mg. The above analysis indicates the biased choice of data which constitute the basis for the conclusion that "diets are usually low in fluoride and remarkably uniform world wide" (14).

In the Hodge et al. 1970 table the data cited for Newfoundland were obtained from a 1960 publication by Elliot and Smith (15). These authors in turn utilized a 1945 survey (16) of Newfoundland dietary intake and compiled fluoride food values using McClure's 1949 figures. The last mentioned are actually a compilation of data on the fluoride content of food analyzed prior to 1949 (8).

Of further interest to Canadians is the entry in table 2 for Canada, namely 0.18 - 0.3 mg, as the daily fluoride intake from food. The data were obtained from work done in 1949 and reported in 1950 by Ham and Smith (11) at the University of Toronto and consisted of assays of four typical restaurant meals in Toronto, exclusive of tea. This work was carried out thirteen years prior to the fluoridation of Toronto's water supply. The meals consisted of: Breakfast - juice, cream of wheat, toast, jam; Lunch - fruit salad, rolls, butter, dessert; Dinner - #1 tomato juice, halibut, potatoes, spinach, bread, butter, dessert, #2 tomato juice, beef, potatoes, mixed vegetables, bread, butter, dessert. The food values recorded by Ham and Smith represent pre-fluoridation background levels. However their figures should not be considered typical of Canadian intake levels of fluoride in the 1970's.

In view of these facts, one cannot but question the reliability of older data in tables utilized in 1970 and later to indicate that little fluoride is consumed in the diet.

Prior to the research by Marier and Rose in 1966 (17) and by Kramer et al. in 1974 (18) little attention had been paid to the elevated fluoride levels in food and beverages due to food processing. Marier and Rose (17) reported on the fluoride content of several foods and beverages processed with fluoridated water. Although the Marier and Rose data were available in the literature, the 1970 WHO report on Fluorides and Human Health relied upon the 1949 figures by McClure (8) instead of the more recent data. An interesting case in point is the figure given for the fluoride content of beer in the WHO table, namely 0.20 ppm, a value derived from a paper by P. Clifford in 1945 (19), as recorded in McClure's 1949 table. For beer processed with fluoridated water Marier and Rose (17) obtained .68 ppm fluoride. Yet the WHO report in 1970 presented the lower 1945 data by McClure.

The extent of the use of fluoridated water in processing commercial food and beverages in Canada has recently been reported by

Farkas and Parsons (20). In this study it was shown that, of the fifteen plants in the Montreal-Quebec area manufacturing carbonated beverages, eleven were located in areas where the water supply is fluoridated and, of eight plants manufacturing soups in Canada, five were located in fluoridated areas. Thus many food products are processed in fluoridated areas. Other work by Farkas et al (21) has shown that beverages made from concentrates, diluted with fluoridated water and sold as a liquid product, have surprisingly high fluoride levels. For instance, orange juice contained .9 ppm fluoride and an infant formula .9 ppm fluoride.

Also of interest to note is the origin of the data given for fluoride content of foods and beverages in fluoride food tables. Use of wide ranges of fluoride values in calculating a potential daily fluoride intake is difficult. The majority of the citations in table 3 were compiled from Chemical Abstracts and are of international origin. The use of international data for North American dietaries may be questioned. A case in point is the entry for cereals: cereal plus cereal products .10 to 20 ppm, .18 to 2.8 ppm.

TABLE 3

Comparison of Fluoride Levels in Fresh Foods as Reported by Cholak (5) and Hodge et al. (4)

Food, ppm	Cholak, 1959	Hodge, et al., 1970
Meats	0.01 - 7.7	0.14 - 2
Fish	0.10 - 24	1.0
Sardines	--	8 - 40
Shrimp	--	50*
Fish meal	--	186
Citrus fruits	0.04 - 0.36	0.07 - 0.17
Non-citrus fruits	0.02 - 1.32	0.03 - 0.84
Cereals and cereal products	0.10 - 20	0.18 - 2.8
Vegetables and tubers	1.10 - 3.0	0.02 - 0.9

*Shrimp meat, 0.4 ppm; shrimp shell, 18-48 ppm

The following references for this item are cited: 1956 Norwegian (22); 1955, 1961, 1962, 1963 U.S.S.R. (23-26); 1964 Japanese (27); 1963, 1965 German (28, 29). In other words, the data cited were compiled from work done on grains, flours and meals. In one U.S.S.R.

study, the analysis of wheat, oats, and barley was made in a known endemic fluorosis area (23). One cannot but question the relevance of these outdated data to North American dietaries of 1970. The great import of the outdated fluoride values in food is brought to the fore by the fact that many recent texts rely on McClure's data obtained prior to 1948. Food tables which appear in Heinz Handbook of Nutrition (30); WHO, Fluorides and Human Health (2) and McClure's, Fluoridation, The Search and the Victory (3) cite these early values. Other food tables, presented in major works such as Fluorides (1) and Advanced Chemical Series, Dietary Chemical vs. Dental Caries (4) are adapted mainly from Cholak's 1959 data much of which was also cited from earlier publications. It is obvious from the analysis presented here that current data on fluoride content of foods and beverages are needed in order to estimate the average daily dietary intake of fluoride in 1975.

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THE SAFE MAXIMUM DAILY INTAKE OF DIETARY FLUORIDES

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SUMMARY: A survey questionnaire which was sent to authorities in the fields of dentistry, nutrition and medicine in order to establish a criterion for safe daily maximum intake of fluoride yielded no consensus. Many respondents to the questionnaire expressed their answers in relative terms considering fluoride intake in parts per million of fluoride ingested. For any discussion of this subject it is desirable to employ absolute terms i.e. milligrams of fluoride ingested. If a criterion of mg/kg body weight is used as a basis for recommending daily fluoride intake levels, it is essential to know the level of fluoride in current diets, and in foods and beverages. Little data is available in this regard.

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Presented at the Sixth Annual Conference of I.S.F.R., Williamsburg, 11/7-9/74.