FLUORIDE STUDIES IN MALAYSIA

L.C. Foo and Y.H. Chong

Nutrition Division, Institute for Medical Research, Kuala Lumpur, Malaysia.

INTRODUCTION

The relationship between dental caries and fluoride in the drinking water has been extensively studied for more than four decades (Dean, 1933; Green, 1968). In temperate climates, the optimum amount of fluoride in drinking water for prevention of dental caries without causing fluorosis has been recommended at 1 ppm (Leone *et al.*, 1970). On the other hand, in England, fluorosis has occurred in places where the water supply has 1 ppm fluoride or less. This might be attributed to the contribution of some other major fluoride-rich foods such as tea and fish.

In Malaysia, with few exceptions, the content of natural fluoride in drinking water is low, between 0.05 and 0.4 ppm. (ICNND Report, 1964; Chemistry Department, unpublished results ; Foo and Chong, unpublished data.)

The incidence of dental caries in Malaysia is very high (Dental Epidemiological Survey, 1970-1971). Fluoridation of the water supply at 0.7 ppm fluoride, as suggested for the tropics, has been put into practice only in one state, Johore. Results of dental surveys carried out in the towns of Johore Bahru and Kluang in Johore before and after seven years of fluoridation indicated a reduction of 60 and 75 % respectively in the incidence of dental caries (Committee Report, 1971; Awang, 1973). Encouraged by these achievements, the Ministry of Health appointed a Committee to study and report on the possibility of introducing a nationwide fluoridation programme, which the Committee recommended. (Committee Report, 1971). It was proposed that some studies should be conducted to determine the levels of fluoride ingestion, retention and excretion in Malaysia since little information is available on this subject.

This paper is a follow-up of this proposal and its main aims are to assess the fluoride status of residents of Johore Bahru, a fluoridated town, and compare it with that of individuals in Kuala Lumpur, a non-fluoridated, low fluoride area. For this study, the 24-hour urinary fluoride excretion of normal healthy adults living in the two areas have been investigated. Comparative fluoride retention study was also made on the extracted deciduous teeth of children between 6 to 7 years who have been drinking either fluoridated or low fluoride water since birth. In addition, the fluordie content of some important local food items, especially fish foods and tea (McClure, 1944; Ke *et al.*, 1970), which have been reported to contain relatively high concentrations of fluoride, have been determined to assess their contribution towards fluoride ingestion.

MATERIALS AND METHODS

Fluoride in all the materials investigated, namely urines, teeth and foodstuffs, was determined with a Beckman Model 39600 specific-ion electrode and a conventional potassium-chloride electrode in conjunction with a Beckman Model 1019 research pH meter. Where ashing was necessary, this was carried out using platinum crucibles.

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Urine: A total of 201 samples of 24-hour urine pools 120 from Kuala Lumpur and 81 from Johore Bahru, were obtained from the staff of the respective dental departments who had previously been briefed thoroughly on the meaning and importance of a true 24-hour collection. Clean bottles containing 50 ml of 2N HCl as preservative were issued from our laboratory for the above purpose. Appropriate corrections were made in the calculation for the dilution resulting from the addition of HCl. Participants were requested to state in the questionnaire provided the type of beverages consumed during the 24-hour period.

The urine samples were determined directly for fluoride using the select-ion electrode after a 1:1 preliminary dilution with total ionic strength adjustment buffer (Tusl, 1970).

Teeth: Good, non-carious deciduous teeth of children between 6 and 7 years of age were collected with the help of the local dental clinics; 62 were obtained from Johore Bahru and 80 from Kuala Lumpur. Each tooth was washed clean, dried and pounded to a fine powder which was ashed before being analysed for fluoride by the method of Singer and Armstrong (1968) as modified by Ke *et al.*, (1968).

Foodstuffs: Ten popular local fish, two commonly eaten green leafy vegetables and two brands of tea, one local and the other an imported Chinese tea, were analysed for fluoride. The vegetables and fish were bought fresh from the market with the exception of anchovies which had been cooked in brine and sundried before being sold. The items were cleaned and dried before being prepared for analysis. Only the edible portions of the raw fish were analysed but anchovies were estimated whole.

Each item was dried to constant weight and then ground to a fine powder after which it was ashed with magnesium succinate. The fluoride was isolated by the Willard and Winter (1933) distillation technique with modifications as suggested by the Sub-Committee of the Analytical Methods Committee (1943). The concentration of fluoride in the distillate was determined according to the procedure introduced by Ke *et al.*, (1970).

RESULTS

The fluoride concentration and the total amount of fluoride in 24-hour urine samples are shown in Table 1. The results indicated that mean fluoride excretions were higher in the fluoridated area. There was, however, wide individual variation, the values ranging between 0.12 and 1.30 ppm or 0.21 and 1.48 mg fluoride per day in Kuala Lumpur and between 0.27 and 2.0 ppm or 0.30 and 1.95 mg fluoride per day in Johore Bahru. A notable feature was that in both towns, the higher values were excreted by individuals who stated in the questionnaire provided that in addition to water, tea was the sole beverage consumed during the 24-hour period of urine collection.

Table 1

Fluoride concentrations in 24-hour urines.

Locality	No. of samples	F. in drinking water ppm	Mean urine (ml)	Urinary F. ppm ± S.D	Mean Urinary F. mg/24 hr ± S.D
Kuala Lumpur	120	0.14	1063	0.50 ± 0.22	0.52 ± 0.29
Johore Bahru	81	0.71	968	0.90 ± 0.39	0.77 ± 0.44

The fluoride contents of whole deciduous teeth of children between 6 and 7 years of age are presented in Table 2. The results showed a much higher mean fluoride content in the teeth samples from Johore Bahru although individual variation was again

marked; values obtained ranged between 108 and 305 ppm in Kuala Lumpur and between 206 and 725 ppm in Johore Bahru.

Table 2

Fluoride concentrations in deciduous teeth.

Locality	No. of cases	F. in drinking water ppm	Mean F. in teeth ppm ± S.D.
Kuala Lumpur	80	0.14	178.45 ± 60.03
Johore Bahru	62	0.71	416.89 ± 151.96

Table 3

Fluoride contents of foodstuffs.

Food Item	Mean F. concentration ppm dry weight ± S.D.
Fish meat	
Mackerel (Kembong)*	1.90 ± 0.02
Jewfish (Gelama)	3.04 ± 0.20
Trevally (Cencaru)	0.38 ± 0.02
Catfish (Sembilang)	0.94 ± 0.06
Tilapia	4.89 ± 0.20
Sweeper (Sepat)	2.20 ± 0.12
Cobia (Aruan)	2.78 ± 0.10
Pomfret (Bawal Hitam)	0.96 ± 0.04
Anchovy, whole (Bilis)	23.90 ± 0.40
Vegetables	
Mustard leaves (Sawi)	4.10 ± 0.12
Water-convulvolus (Kangkong)	3.74 ± 0.10
Tea leaves	
Local tea, (BOH)**	141.93 ± 1.01
Imported Chinese tea, (LOK POH)	217.36 ± 4.20

* Local name in parenthesis. **Name of brand.

Table 3 summarizes the analytical results obtained from selected foodstuffs; the values given represent the mean of quadruplicate analyses and are expressed as ppm dry weight. The results show that, irrespective of origin, tea leaves had very high fluoride content. The results for fish meat and whole anchovy suggest that the high fluoride found in anchovies may be attributed to their bones.

DISCUSSION

The results obtained on the concentration of fluoride in urine and deciduous teeth from areas with fluoridated and non-fluoridated water supplies indicated that fluoride excretion in the urine and its retention by dental tissues were generally increased with increased concentration of fluoride in the water supplies.

The urinary fluoride excretion of individuals consuming water that contains little or no fluoride ranges from 0.2-0.5 ppm (Harrison, 1949). In comparison the mean fluoride excretion of Malaysians in the low fluoride area studied was 0.5 ppm or 0.52 mg per day and was 0.25 mg lower than that for the fluoridated area studied. Reviews by Hodge *et al.*, (1970) indicate that on the average about half of the fluoride ingested is excreted in the urine in the ensuing 24 hours. This would suggest that the average daily intake of fluoride by adults in our study was about 1 mg in the low fluoride area and about 1.5 mg in the fluoridated area. According to Hodge and Smith (1954), the upper limit for fluoride intake during the first 8 years of life is 2 mg daily above which enamel mottling can be expected in children. In our present investigation, it would appear that, on the average, fluoride intake in the areas studied was less than 2 mg daily.

Tea is a popular beverage with Malaysians. The higher excretion of fluoride by tea drinking individuals reflects the importance of this beverage as a major source of fluoride

in the diet. Our results on the edible portions of the various types of local fish contradict earlier reports by other workers (McClure, 1949) that fish are an important dietary source of fluoride. Almost all of the fluoride found in fish is present in the bones (Ke *et al.*, 1970).

The mean fluoride content of non-carious deciduous teeth from fluoridated areas was about $2\frac{1}{2}$ times that from the non-fluoridated area. No case of enamel mottling has ever been reported, however, in Johore (Awang, 1973; Dental Epidemiological Survey 1970-1971) which has received almost 8 continuous years of fluoridated water. This strongly suggests that fluoridation of the water supplies at a concentration of 0.7 ppm is beneficial to Malaysia as far as dental health is concerned. This concentration is not sufficient to cause ill-effects and any fear that fluoride ingestion might reach toxic levels in future fluoridated areas in Malaysia appears unwarranted.

SUMMARY

Twenty-four-hour urine samples and whole deciduous teeth from fluoridated (0.71 ppm) and non-fluoridated (0.14 ppm) areas together with some selected local food items were analysed for their fluoride content. The mean values for urinary fluoride were 0.90 ppm or 0.77 mg per day for the fluoridated area and 0.50 ppm or 0.52 mg per day for the non-fluoridated area. Assuming that half of all the fluoride ingested is excreted in the urine, this study suggests that the average daily fluoride intakes by adults in the fluoridated and non-fluoridated areas were about 1.5 mg and 1 mg respectively. The mean fluoride content of non-carious deciduous teeth from the fluoridated area was 416.89 ppm compared to 178.45 ppm in the low fluoride area.

Tea can be a major dietary source of fluoride as indicated by its high fluoride content (142-217) and the higher urinary excretion of fluoride by tea-drinkers. Sun-dried whole anchovies *(ikan bilis)* are another rich source, providing 24 ppm on the basis of dry weight. The edible portions of other types of fish as well as the two vegetables analysed do not appear to be important sources of fluoride as indicated by their relatively lower fluoride contents — 0.4 to 4.9 ppm in edible portions of fish and 3.7 to 4.1 ppm in vegetables on a dry weight basis.

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