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FLUORIDE CONCENTRATIONS OF WATER SOURCES IN TIBET

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SUMMARY: Fluoride concentrations of 60 samples randomly selected from surface and underground water sources in major population regions of north-central, central, southern, and southern border regions of Tibet were determined with a fluoride-ion selective electrode. The concentrations ranged from 0.02 to 0.18 mg F/L with the highest levels in river and well waters. The results indicate that most drinking water sources in Tibet are low in fluoride and are therefore not responsible for the widespread occurrence of dental fluorosis that appears to be caused by early childhood intake of fluoride from high-fluoride "brick tea".

Keywords: Brick tea, Fluorosis from tea, Tibet water sources, Water fluoride.

INTRODUCTION

As a mountainous region with generally ample precipitation and runoff, Tibet has abundant supplies of surface waters. The plateau lake areas are among the highest and largest in the world, and there are plentiful water supplies in widely dispersed marshlands. Important sources of drinking water are from rivers, wells, and marshes. Because of the importance of water-borne fluoride effects in the human body, especially on the teeth and bones, and because of the widespread occurrence of dental fluorosis in Tibet without knowledge of F levels in the drinking water, we undertook a survey to determine the fluoride content of the principal domestic water sources.

MATERIALS AND METHODS

Areas included for study were randomly selected from six counties and two cities in northcentral, central, southern, and southern border regions of Tibet (see map).[1] Fluoride determinations were made with a fluoride-ion selective electrode and potentiometer (ORION 868 type, USA).[2] The calibration curve was plotted against standard NaF fluoride solutions containing 0.1, 0.5, 1.0, 5.0, and 10.0 mg F/L, and a total ionic strength adjustment buffer was used. The mV readings were linear against the logarithm of mg/L F concentration, $E = 197.4 - 50.2 \log F$ (mg/L), $r = -0.9948$. The 50 mL water samples were collected in September 1998 with water sample tubes (BOMEX, Beijing Glass Factory).

RESULTS

The location and description of the regions studied are presented in Table 1. These regions typify the important economic and geographical features of Tibet.

Table 2 shows that the fluoride concentrations in the six water sources sampled in Naqu County ranged from 0.03 to 0.18 mg/L. The mean value of the 18 samples was 0.09 mg/L.

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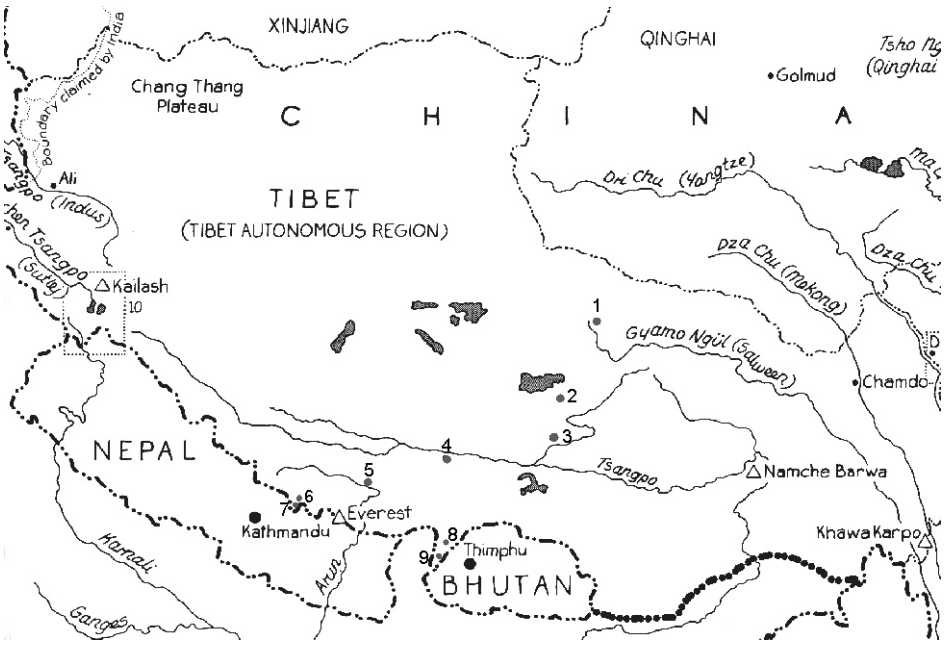
Map of Tibet showing locations of study areas



1 Naqu	4 Shigatse	7 Zhangmu
2 Damzhung	5 Dingri	8 Pari
3 Lhasa	6 Nyelam	9 Yadong

Table 3 lists the water fluoride concentrations of samples taken in three areas in Damzhung and Qushui counties under the jurisdiction of Lhasa City. These concentrations ranged from 0.02 to 0.15 mg F/L, averaging 0.07 mg/L.

Table 4 gives the fluoride concentrations in surface and underground water sources in the Shigatse and southern border areas, which ranged from 0.02 to 0.15 mg F/L with an average level of less than 0.1 mg/L.

An overall summary of fluoride concentrations in the 60 samples in the different types of water sources is given in Table 5, which shows that none exceeded 0.18 mg F/L with an average level less than 0.1 mg/L.

Table 1. Basic geological and economic character of water-sample areas

Region Location	Geological type and economic structure	Altitude (m)	Annual precipitation (mm)	Soil type
Northcentral region	North Tibet plateau, pastoral area	4500	406	Mountain meadow
Naqu county				
Xiangmu countryside				
Sangxiong countryside				
Gulu countryside				
Central region				
Lhasa city	River valley flood plain, City	3650	200-510	Hill brush grassland
Damzhung county	Gangdisi-Nianqing-Tanggulla mt., pastoral area	4200	481	Mountain meadow
Qushui county	River valley flood plain, agricultural area	3650	200-510	Hill brush grassland
Southern and southern border regions				
Shigatse City	City, plain	3800	420	Hill brush grassland
Dingri County	Himalayas mt. area, semi-nomadic	4300	319	Hill brush grassland
Nyelam county				
Zhangmu town	Himalayas mt. valley, forest area	2000	618	Forest
Yadong county				
Xiasima town	Mountain valley, forest area	2800	873	Forest
Pali town	Himalayas mt. area, semi-nomadic	4300	410	Hill brush grassland
Duina countryside	Himalayas mt. area, semi-nomadic	4300	410	Hill brush grassland

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Table 2. Fluoride concentration in water sources in Naqu County region of Northcentral Tibet

Area	No. of samples	Range mg F/L	Mean ± SD mg F/L
River water in Naqu county	3	0.03 - 0.07	0.05 ± 0.008
Tap water in Naqu town	3	0.14 - 0.14	0.14 ± 0.03
Well water in Naqu town primary school	3	0.16 - 0.18	0.17 ± 0.05
Well water, Xiangmu countryside primary school	3	0.08 - 0.12	0.10 ± 0.04
Marsh water in Sangxiong countryside	3	0.05 - 0.07	0.06 ± 0.009
Marsh water in Gulu countryside	3	0.04 - 0.08	0.06 ± 0.008

Table 3. Fluoride concentration in water sources in Damzhung County and Lhasa City region of Central Tibet

Area	No. of samples	Range mg F/L	Mean ± SD mg F/L
Yaluzangbu river in Qushui county	3	0.04 - 0.06	0.05 ± 0.007
Lhasa river	5	0.12 - 0.15	0.13 ± 0.08
Dangqu river in Damzhung county	4	0.04 - 0.08	0.06 ± 0.005
Tap water in Lhasa city	4	0.02 - 0.05	0.04 ± 0.05

Table 4. Fluoride concentration in water sources in Shigatse and Nyelam County Regions of Southern Tibet

Area	No. of samples	Range mg F/L	Mean ± SD mg F/L
Niancu river	3	0.03 - 0.05	0.04 ± 0.009
Well water in Shigatse city	4	0.03 - 0.04	0.03 ± 0.007
Tap water in Shigatse city	3	0.08 - 0.12	0.10 ± 0.06
Pengqu river in Dingri rural areas	3	0.04 - 0.05	0.04 ± 0.07
Well water in Dingri rural areas	4	0.04 - 0.06	0.05 ± 0.009
Boqu river in Zhangmu town of Nyelam	3	0.03 - 0.03	0.03 ± 0.009
Yadong river in Xiasima town of Yadong	3	0.02 - 0.03	0.02 ± 0.008
Tap water in Pali town of Yadong	3	0.06 - 0.08	0.07 ± 0.005
Well water in primary school of Duina countryside, Yadong	3	0.07 - 0.08	0.07 ± 0.007

Table 5. Fluoride concentration in different water sources in Tibet

Type	No. of samples	Range mg F/L	Mean ± SD mg F/L
River water	24	0.02 - 0.15	0.05 ± 0.01
Well water	17	0.03 - 0.18	0.08 ± 0.03
Tap water	13	0.02 - 0.14	0.09 ± 0.04
Marsh water	6	0.04 - 0.08	0.06 ± 0.02

DISCUSSION

Dental fluorosis caused by fluoride in drinking water is a common sight in many parts of the world.[3-5] In Tibet, however, water sources for domestic use come mainly from rivers, wells, and springs, which, in this study, were all found to have less than 0.2 mg F/L. Therefore, drinking water type dental fluorosis would not be expected from any of these waters. Although not often used as sources for drinking water, the 279 known hot springs in Tibet are reported to have 1.0 to 212 mg F/L, and the effects are readily seen. For example, in the village of Kacheng in Xietongmen County, where such water is used for drinking, the prevalence of dental fluorosis is 67.49%.[6]

Nevertheless, we found that dental fluorosis was fairly common in our study areas, even though the drinking water is quite low in fluoride. The explanation probably lies in the fact that people in Tibet, including young children, have a long-standing tradition of drinking high-fluoride brick tea made from old stems and leaves of tea bushes. A "brick tea" type fluorosis that results is prevalent among many minority populations in China, and it therefore probably accounts for most of the high prevalence of dental fluorosis we observed among children in our low-fluoride study areas.[7-9]

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