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Fluoride Levels in Tap and Underground Water Samples from Kinki Area in Japan

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It has been well documented that a high level of fluoride in drinking water has toxic effects, while its optimum level shows beneficial effects on reducing dental caries. The 1962 USPHS Drinking Water Standards recommended that addition of fluoride to drinking water is effective to reduce dental caries (Dangel 1977). Anon (1977) stated that the optimum concentrations in drinking water range from 0.7 to 1.2 mg/l. Horowitz (1972) reported that a fluoride level lower than 1 mg/l in drinking water has a beneficial effect on reducing dental caries without any harm although it causes mottled teeth at a level higher than 2 mg/l. Therefore, many municipal drinking water supplies in the United States maintain a fluoride concentration of 1 mg/l. Kusaka et al.(1974) reported that fluoride concentrations in drinking water mainly depend on the fluoride concentrations in surrounding soil of water source. Therefore, concentrations of fluoride in water samples are affected by the nature of soil. In order to clarify relationship between fluoride concentrations in water samples and the nature of soil, the concentrations of fluoride in tap and underground water obtained from Kinki area in Japan were determined.

MATERIALS AND METHODS

Samples of tap water were taken from 51 stations in Kobe, Osaka, Nishinomiya and Takarazuka cities in Japan from October to December 1989. Samples of underground water were taken from 46 stations in Kobe city from October to December 1989. Rokko natural water was taken from 5 stations in Rokko mountains area. Concentrations of fluoride in water samples were assayed by an alizarin complexone spectrophotometric method.

RESULTS AND DISCUSSION

Table 1 shows the assayed values of the fluoride in

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the tap and underground water samples from the 102 stations. The average values of fluoride ion in underground water and tap water were 0.33 mg/l and 0.09 mg/l, respectively. The former was significantly higher than the latter ($p<0.01$). The 4 samples among 51 of underground water exceeded the water standard of fluoride in Japan (0.8 mg/l), while all of the tap water were under the standard. Kanwar et al.(1968), Paliwal et al.(1969), Somani et al.(1972) and Singh et al.(1975) reported that high concentrations of fluoride were detected in underground water from different localities. Table 2 shows the assayed values of fluoride in the tap water collected from the four cities. The average values in the samples from Takarazuka, Kobe, Osaka and Nishinomiya were 0.37, 0.13, 0.08 and 0.07 mg/l, respectively. The value of Takarazuka was significantly higher than the respective data of Kobe, Osaka and Nishinomiya. These results suggest that the differences may be derived from the nature of surrounding soil. Kasama (1969) reported that Rokko mountains are composed of granite rocks containing high concentrations of fluoride. Therefore, high values of fluoride concentrations in tap water from Takarazuka may be derived from the nature of soil in Rokko mountains. On the other hand, since the tap water in Kobe, Osaka and Nishinomiya is originated from Biwa lake containing low concentration of fluoride, the assayed values were lower than those in Takarazuka. Table 3 shows the assayed values of fluoride in underground water samples obtained from wells of different depths. The average concentration of fluoride in underground

Table 1. Assayed values of pH and fluoride in tap and underground water samples

Sample	n	pH		Fluoride (mg/l)	
		Min.-Max.	M ± SD	Min.-Max.	M ± SD
Tap water	51	6.0-7.5	7.0±0.3	N.D.-0.50	0.09±0.08
Underground water	51	6.0-7.5	6.8±0.4	N.D.-1.53	0.33±0.30[a)]

a) Significantly different from the data of tap water, $p<0.01$.
N.D. : Not detected

water from a depth of more than 30 m was 0.50 mg/l, which was significantly higher than that from a depth of less than 10 m. These results suggest that contents of fluoride in soils increase with increase of depth of ground and these are agreed with NAS's results (NAS 1971). The fluoride level in Rokko natural water obtained from Rokko mountains (0.73 mg/l) was relatively high and it may be due to the nature of soil in Rokko mountains. We conclude that fluoride concentrations in samples of drinking water were significantly affected by the nature of soil in sampling areas. The differences between well water and natural water to the low levels found in tap water may be attributed to the removal of fluoride during the preparation process of drinking water.

Table 2. Assayed values of fluoride in tap water in Takarazuka, Kobe, Osaka and Nishinomiya

Sample	n	Fluoride (mg/l)	
		Min.-Max.	M ± SD
Takarazuka	10	0.19-0.50	0.37 ± 0.10[a)]
Kobe	11	0.06-0.22	0.13 ± 0.05
Osaka	10	0.04-0.13	0.08 ± 0.03
Nishinomiya	4	0.03-0.17	0.07 ± 0.06

a) Significantly different from the data of Kobe, Osaka and Nishinomiya, $p<0.01$.

Table 3. Assayed values of fluoride in underground water taken from wells at a depth of less than 10 m and at a depth of more than 30 m

Sample	n	Fluoride (mg/l)	
		Min.-Max.	M ± SD
Wells at a depth of less than 10m	7	0.06-0.15	0.11 ± 0.03
Wells at a depth of more than 30m	7	0.44-0.67	0.50 ± 0.07[a)]

a) Significantly different from the data of underground water taken from wells at a depth of less than 10m, $p<0.01$.

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