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Short communication

Tealeaves may release or absorb fluoride, depending on the fluoride content of water

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Abstract

As the tea plant (*Camellia sinensis*) is known to accumulate fluoride from the soil, the tealeaves may contain high concentrations of fluoride, which is easily released during infusion. In this study, we have tested the possible effect of original fluoride concentration in the water on the fluoride release from tea. Moreover, we wanted to test the possible capacity of tealeaves (commercially available tea) to absorb fluoride from high-fluoride water.

In low-fluoride water, fluoride is easily released from tealeaves. Depending upon the fluoride content of the water, dried tealeaves are able also to absorb fluoride. Thus, if a cup of tea is made from high-fluoride water, the fluoride concentration of the infusion may actually be lower than the original fluoride concentration of the water.

Keywords: Fluoride; Tealeaves; High-fluoride water

The tea plant (*Camellia sinensis*) is known to accumulate fluoride from soil. Consequently, the tealeaves may contain high fluoride concentrations (Xie et al., 2001). As the fluoride is easily released during infusion (WHO, 1994), tea is considered a major source of fluoride among tea drinkers.

We have previously studied various fluoride sources in the Ethiopian Rift Valley (Malde et al., 1997). As the fluoride content of the local drinking water is, in general, high (Malde et al., 2003; Reimann et al., 2003), water is definitely the main etiological factor in the development of endemic dental fluorosis in East Africa. However, children's consumption of tea may also be considered among relevant risk factors.

In the present laboratory-study, we have tested the effect of the fluoride content of water on the fluoride release from tea and, implicit, the possibility of tealeaves *absorbing* fluoride from high-fluoride water.

From eight different brands of tea, samples of 1 and 5 g were weighed (Mettler AG 204 Delta Range) into plastic cups and transferred to polypropylene beakers (250 ml). Distilled water (<0.01 mg F^-/l) as well as NaF solutions containing 20 mg F^-/l was prepared. Water samples (1 dl) were heated to 100 °C and then added to the tea samples. The brew was left at room temperature, unstirred. Aliquots of 10 ml were taken from the beakers and transferred into 30 ml plastic tubes (Sarstedt) after 1, 5, 10 and 20 min, and after 24 h. The samples were analysed at room temperature. TISAB III (Orion Research) was added to each sample (1:10) before analyses were made by the use of a fluoride ion-selective electrode (Orion 9609) according to standard procedures (Orion Research Incorporated, 1991). The fluoride electrode was calibrated using fluoride standards of 1 and 10 mg/l, made from a stock solution of NaF (i.e. 100 mg F^-/l) (Orion Research).

Table 1
Fluorine content (mg F/kg wet weight) of different types of tea

Tea	A	B	C	D	E	F	G	H
mg F^-/kg	100	160	230	240	300	570	600	630

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Table 2
Fluoride leaching (mg F/l) from different brands of tea after infusion of 1 g tea in 100 ml distilled water (0.005 mg F/l) for various time periods

Infusion time	Tea sample							
	A	B	C	D	E	F	G	H
1 min	n.m.	0.5	0.8	0.5	2.2	2.2	2.9	2.3
5 min	n.m.	1.0	1.0	0.6	2.4	2.4	n.m.	2.5
10 min	n.m.	1.1	0.9	0.8	2.5	2.9	n.m.	2.9
20 min	n.m.	1.4	1.1	0.8	2.6	3.1	3.9	3.1
24 h	1.7	2.4	1.9	1.9	3.7	4.7	n.m.	5.6

n.m., not measured.

The fluoride content of tealeaves was analysed with the fluoride ion-selective electrode after fusion with alkali as ashing aid, according to a method previously described by Malde et al. (2001). A Certified Reference Material (Fluoride in Vegetation, SRM-2695, National Institute of Standards and Technology) was analysed together with the samples.

The fluoride content of the tealeaves ranged from 100 to 630 mg/kg wet weight (Table 1). The observed variation in fluoride concentration in different brands of tea is in harmony with previous findings (Han et al., 1995; Fung et al., 1999).

As shown by Tables 2–5, relatively more fluoride was released from the 1-g samples than from the 5-g samples, irrespectively of water fluoride concentration. When a sample of 5 g tealeaves was added to 1 dl high-fluoride water (Table 5), three of the infusions had, after only 1-min exposure, a *lower* fluoride concentration than the original water (average mean reduction 0.8 ± 0.7 mg F^-/l). After 20 min infusion, the fluoride binding effect of tealeaves was observed in two more teas. After 24-h infusion, the mean fluoride concentration in six out of eight samples was *lower* (mean reduction 2.1 ± 0.9 mg F^-/l) than what was initially seen in the high-fluoride waters (Table 5). Only one of the teas (Tea H, 630 mg F^-/kg) had an *increased* fluoride concentration after 24-h infusion. Another high-fluoride tea (Tea G, 600 mg F^-/kg) reduced the fluoride concentration by 1.5 mg/l, already after 1-min infusion, and, after 20 min, the fluoride content was still below the original value (Table 5).

It is interesting to note that, in 1 dl distilled water, a five-fold increase in the amount of tealeaves (1 g vs. 5 g), resulted only in a two-fold increase in the fluoride concentration of the infusion, even after 24 h (Tables 2 and 3). Thus, the 5-g samples released relatively less fluoride than the 1-g samples. As expected, however, the total fluoride binding capacity was greater in the bigger samples (Tables 4 and 5). The absorbing capacity of the teas seems to be independent of the fluoride concentration of the tealeaves. Thus, both the high-fluoride teas F and G reduced the fluoride concentration of the infusion below the initial water fluoride concentration. This may indicate that factors other than the fluoride content of the tealeaves are of importance for fluoride release and absorption. When 1 g of tealeaves is added to 1 dl water, the fluoride release has been reported to range from 40% to 90%, depending upon the brand of tea (Wei et al., 1989; Fung et al., 1999). Our experiments also indicated that the fluoride content of water influences the fluoride release from tealeaves. In fact, tealeaves may absorb F from high-F water, thus resulting in tea with *lower* fluoride concentration than in the water used for infusion.

Table 3
Fluoride leaching (mg F/l) from different brands of tea after infusion of 5 g tea in 100 ml distilled water (0.005 mg F/l) for various time periods

Infusion time	Tea sample							
	A	B	C	D	E	F	G	H
1 min	n.m.	2.4	2.5	1.8	6.8	7.1	7.5	9.3
5 min	n.m.	4.3	2.7	3.2	7.2	7.4	n.m.	9.9
10 min	n.m.	4.7	2.9	3.5	7.4	7.7	n.m.	9.9
20 min	n.m.	4.8	2.8	3.6	7.4	7.8	8.3	10.1
24 h	4.3	6.2	4.1	4.6	7.6	8.3	n.m.	10.8

n.m., not measured.

Table 4
Relative change of fluoride concentration (ΔF^-) in infusion (1 g tea sample infused in 100 ml water with 20 mg F^-/l)

Infusion time	Tea sample							
	A	B	C	D	E	F	G	H
1 min	n.m.	0.9	−0.1	1.9	1.9	1.1	−0.3	2.3
5 min	n.m.	1.6	0.1	1.4	2.3	1.5	n.m.	3.0
10 min	n.m.	1.5	0.2	1.4	2.2	1.4	n.m.	3.0
20 min	n.m.	1.7	0.7	1.6	2.2	1.7	0.6	3.2
24 h	2.4	3.3	2.7	2.8	3.5	3.4	1.3	4.8

n.m., not measured.

Table 5
Relative change in fluoride concentration (ΔF^-) in infusion (5 g tea sample infused in 100 ml water with 20 mg F^-/l)

Infusion time	Tea sample							
	A	B	C	D	E	F	G	H
1 min	n.m.	2.1	−0.7	1.4	−0.2	0.1	−1.5	3.8
5 min	n.m.	1.0	−0.8	0.7	−0.8	1.9	n.m.	3.8
10 min	n.m.	−0.6	−0.8	0.2	−1.6	2.0	n.m.	4.0
20 min	n.m.	−0.6	−0.4	−1.3	−1.4	2.0	−1.3	4.1
24 h	−2.6	−3.6	−2.0	−1.8	−1.5	−0.9	n.m.	4.0

n.m., not measured.

In practical life drinking water with a fluoride content of 20 mg/l is rarely used for consumption. Water sources with 14 mg F^-/l are, however, in daily use in the Ethiopian Rift Valley (Malde et al., 2003).

Further studies are therefore needed to assess the effect of tea consumption in areas with low-fluoride water as well as in high-fluoride areas.

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