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ALUMINIUM IN BLACK TEA

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Aluminium content in made tea as well as in tea liquors prepared by different methods were determined in this study. Made tea contains about 600 ppm Al whereas a cup of brew (one teaspoonful of tea in 1 cup of boiling water) will have only about 4 ppm Al. When water is boiled in a new Al kettle for a long time, more Al is released into the water. The amount of Al varies with grade of tea.

INTRODUCTION

The tea plant, *Camellia sinensis* grows in acidic soils of pH 4.5 to 5.5. Aluminium is one of the major exchangeable cations in acid soils. Tea is known as an aluminium accumulator and it takes up Al throughout its period of growth and stores it in the leaf.

The aluminium content in the flush increases progressively from bud to mature leaf, from 50 to 1500 ppm (Chenery, 1955). In senescent leaves it could reach 16,000 ppm. A large accumulation of Al does not serve any useful purpose. The function of the large amounts of aluminium taken up by tea is still unknown. Eden (1976) argued that aluminium plays some regulatory role in the nutrient economy of tea with respect to toxic ions, such as Mn. Aluminium uptake is high in a soil rich in manganese, but high levels of soil calcium and magnesium lower aluminium and manganese uptake (Matsuda *et al.*, 1979).

Although made tea (black or green tea) contains high levels of aluminium its content in the brew is so small that it is not thought to be harmful to consumers of this beverage.

In the present investigation an attempt has been made to determine the aluminium content in made tea as well as in tea brews prepared by different methods and periods of infusion.

MATERIALS AND METHODS

Total aluminium content in black tea (Broken Orange Pekoe Fannings, BOPF; Broken Orange Pekoe, BOP; Broken Mixed, BM; Dust; Tea bag tea; Chinese green tea) and in the brew prepared by different methods were determined by the procedures given below. The BOPF grade was obtained from a high elevation (St Coombs) and mid elevation (El Teb in the Uva region) factory.

Total aluminium content in black tea

A sample of 0.2 g of black tea was used for dry ashing and aluminium was determined by the standard colorimetric "Aluminon" method (Chenery, 1948).

For purposes of comparison, the aluminium content in the flush as well as in mature leaves was also determined.

Determination of aluminium content in tea brew

The weight of tea and amount of water used for brewing was standardized to 2.5 g in 125 ml water. Tea was infused for varying intervals ranging from 5, 10, 15 and 20 min and the supernatent liquor was filtered from the infused leaf into a pyrex conical flask.

The tea brews were prepared by the following method:

1. Distilled water boiled in pyrex beaker and brewed in pyrex conical flask.
2. Distilled water boiled in pyrex beaker and tea leaves boiled with distilled water in pyrex conical flask.
3. Tap water boiled in a new aluminium kettle and brewed in pyrex conical flask.
4. Tap water boiled in a new Al kettle and tea leaves boiled in new aluminium vessel.

A sample of 5 ml of tea brew was placed in 50 ml pyrex beaker, dried completely on a water bath and ashed in a muffle furnace for 6 h at 450 °C. The content was dissolved in 2 ml of IM HCl and aluminium was determined by the above method.

RESULTS AND DISCUSSION

The total aluminium content in different grades of tea and in tea leaves are given in Tables 1 and 2. The smaller grade teas (BOPF, Fannings, Dust) contains more Al than others while BM consisting of mostly bud and leaf stalk, contains the lowest amount of aluminium. Aluminium content increases progressively from bud to mature leaves. Young leaves contain only about 100 ppm and this increases to between 5000-16,000 ppm in leaves about to fall; certain clones accumulate more Al than others (Chenery, 1955).

TABLE 1 - *Total aluminium content in various grades of tea*

Grades of made tea	Total Al content ($mg\ kg^{-1}$)
BOPF – St. Coombs	644
BOP – St. Coombs	612
Pekoe – St. Coombs	581
Fannings – St. Coombs	625
Dust No. 1 – St. Coombs	612
Dust Ordinary – St. Coombs	694
BM – St. Coombs	494

Grades of made tea	Total Al content (mg kg $^{-1}$)
Ungraded tea – St. Coombs	670
Refuse tea – St. Coombs	511
Tea fluff – St. Coombs	1087
Tea bag tea (Green)	683
Chinese green tea	225
BOPF–El Teb	650

TABLE 2 – *Aluminium content in tea leaves*

	Al content (mg kg $^{-1}$)
Tea flush – St. Coombs	494
Mature leaf – St. Coombs	2400

Tables 3, 4, 5 and 6 show the Al content in tea brew prepared by different methods.

TABLE 3 – *Al content (ppm) in tea brew, prepared by distilled water boiled and brewed in pyrex vessel - Method 1 (means of 3 determinations)*

Source	Brewing time (min)			
	5	10	15	20
Chinese tea (Green tea)	1.6	1.8	2.3	4.9
Indian tea (Black)	3.8	4.1	4.3	No sample available
Tea bag tea (Green tea)	4.9	4.9	6.0	6.0
BOPF – St. Coombs (Sri Lanka Black)	4.3	4.3	6.2	6.5
BOPF – El Teb	7.1	7.1	9.1	9.1
Ungraded tea – St. Coombs	4.4	4.9	5.2	4.5
Refuse tea – St. Coombs	5.0	7.2	7.9	7.1
Tea fluff – St. Coombs	3.1	3.3	3.8	3.9
Mean	4.2	4.7	5.6	6.0

In general, the Al content in cup brew increased with a longer infusion time, but there was only a small increase beyond 10 minutes.

TABLE 4 – *Al content (ppm) in tea brew, prepared by distilled water and tea leaves boiled for varying periods in a pyrex vessel - Method 2 (means of 3 determinations)*

Source	Brewing time (min)			
	5	10	15	20
Chinese tea	1.8	1.9	3.0	3.0
Tea Bag	6.3	7.2	7.5	8.5
BOPF – St. Coombs	5.8	5.9	6.6	6.4
BOPF – El Teb	7.8	7.9	8.5	8.6
Mean	5.3	5.7	6.4	6.6

TABLE 5 – *Al content (ppm) in tea brew, prepared by treated tap water boiled in a new Al kettle and brewed in a pyrex beaker - Method 3 (means of 3 determinations)*

Source	Brewing time (min)			
	5	10	15	20
Chinese tea	5.8	6.3	6.4	6.6
Tea Bag	7.2	8.5	10.4	10.3
BOPF – St. Coombs	9.1	9.7	9.4	7.8
BOPF – El Teb	17.4	18.7	15.9	16.0
Ungraded tea	5.7	5.0	4.4	4.3
Refuse tea	4.5	4.6	4.5	4.9
Tea fluff	3.6	3.9	3.9	4.0
Mean	7.6	8.1	7.8	7.7

TABLE 6 – *Al content (ppm) in tea brew, prepared by treated tap water boiled in a new Al kettle and tea leaves boiled in a new Al vessel - Method 4 (means of 3 determinations)*

Source	Brewing and boiling time (min)			
	5	10	15	20
Chinese tea	7.0	7.6	8.5	9.7
Tea Bag	15.0	15.3	15.6	17.6
BOPF – St. Coombs	12.0	15.3	12.1	17.5
BOPF – El Teb	22.0	19.0	21.2	22.8
Ungraded tea	5.8	6.1	5.4	5.1
Refuse tea	5.5	5.8	6.9	5.9
Tea fluff	3.7	3.6	4.7	4.6
Mean	10.1	10.4	10.6	11.8

In all methods, the amount of Al extracted increased with increasing brewing time. Normally the brewing time is only 5 min. When the tea leaves were boiled with water more Al was extracted in the liquor but this is not the practice in making tea. When water is boiled in an Al kettle or when tea leaves are boiled, the Al content of the brew is increased. Comparison of method 1 with method 3 shows that boiling the water in a new Al kettle alone will increase the Al content of the brew by 4.2 ppm in Chinese tea and by 4.8 in the BOPF grade (St. Coombs).

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