Cadmium in Jamaican Bush Teas

LA Hoo Fung[1], VR Rattray[1, 2], GC Lalor[1]

ABSTRACT

Samples of Jamaican plants used as bush teas were collected from households in high soil-cadmium (Cd) areas of central Jamaica and analysed by graphite furnace atomic absorption spectrophotometry for total cadmium and for cadmium extractable with a hot water brew as prepared for human consumption to determine their contribution to dietary cadmium exposure. The concentrations ranged from < 0.03 to 6.85 µg/g for total Cd, between 1 and 15% of which was extracted with a hot water brew. One cup (200 ml) of the teas examined was found to contain < 0.04–1.18 µg of Cd and would contribute 0.1 – 0.3 µg of Cd to a person's dietary intake. This is significantly below the provisional tolerable weekly intake (PTWI) of 7 µg Cd/kg body weight established by the World Health Organization (WHO). While this suggests that bush tea consumption does not contribute significantly to the PTWI, some of the teas examined exceed the WHO recommendation of less than 0.3 mg/kg Cd for medicinal plants.

Keywords: Bush tea, cadmium, Jamaica

El Cadmio en las Tisanas Jamaicanas

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RESUMEN

Muestras de plantas jamaicanas utilizadas en las tisanas o tés herbales, fueron recogidas de los hogares en zonas de Jamaica central, donde el suelo presenta un alto contenido de cadmio (Cd). Las muestras fueron analizadas mediante espectrofotometría de absorción atómica con horno de grafito para investigar el contenido total de cadmio así como el cadmio extraíble con una infusión de agua caliente, al preparar infusiones para el consumo humano, y determinar su contribución a la exposición al cadmio dietético. Las concentraciones fluctuaron de < 0.03 a 6.85 µg/g para el Cd total, extrayéndose entre el 1 y el 15% de este con una infusión de agua caliente. Una taza (200 ml) de las tisanas examinadas contenía < 0,04 – 1.18 µg de Cd, lo cual contribuiría 0.1 – 0.3 µg de Cd al consumo dietético de una persona. Esta cantidad se halla significativamente por debajo de la "Ingesta semanal tolerable provisional" (PTWI por sus siglas en inglés) establecidas en 7 µg Cd/kg peso corporal por la Organización Mundial de la Salud (OMS). Si bien esto sugiere que el consumo de tisanas no contribuye significativamente al PTWI, algunas de las infusiones examinadas exceden la recomendación de la OMS de menos de 0.3 mg/kg Cd para las plantas medicinales.

Palabras claves: Tisanas, cadmio, Jamaica

West Indian Med J 2014; 63 (1): 26

INTRODUCTION

The leaves of many bushes serve as "teas", both for foods and as herbal medicines (1), particularly in poorer communities in developing countries (2). "Bush teas" were an early research focus of the then University College of the West Indies (3–5), resulting in the identification of a new disease known as veno-occlusive disease and produced warnings on the potential toxic effects of bush teas (6). But despite warnings to the public and the availability of modern medicines (7), bush teas remain quite widely used and some teas may be introduced as early as in the first six months of life (8). The early work did not address trace elements which have become of interest because of naturally elevated levels of heavy metals in some Jamaican soils (9) and foods (10).

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DOI: 10.7727/wimj.2012.322

One such element, cadmium (Cd), is of global concern as a possible contributor to numerous diseases such as osteoporosis and renal disease (11) which occur commonly in Jamaica. The soil cadmium levels found in geochemical studies of Jamaica (9) are elevated relative to the world mean values, which the mean for central Jamaica also exceeds (12). The focus of this study was to quantify the contribution to dietary cadmium exposure from bush tea consumption in high cadmium areas in central Jamaica (Figure). About 50% of respondents reported regular consumption of more than one type of bush tea (13), which commonly includes cerasee (*Momordica charantia*), fever grass (*Cymbopogon citratus*), lime (*Citrus aurantifolia*) leaf, ginger (*Zingiber officinale*), white peppermint (*Mentha x piperita officinalis*), black peppermint (*Mentha x piperita vulgaris*) and soursop (*Annona muricata*) leaf. Total cadmium and extractable cadmium with hot water (brew) were assessed.

METHOD

Sample treatment: Samples of bush tea leaves were collected from households in an area of central Jamaica with highly variable soil cadmium concentrations (Figure) of 1–289 mg/kg.

Figure: Study area in central Jamaica.

The number and type of samples collected were dependent on what the householders had available at the time of sampling. The samples were washed clean of any visible dirt or debris with distilled deionized water, patted dry with paper towels, then oven dried to constant weight at 80 ˚C and stored in airtight plastic containers. Boiling water extraction was done to mimic actual tea preparation using 0.5 g of the dried, unground sample accurately weighed into a plastic centrifuge tube and adding 40 ml of boiling distilled deionized water. The tube was capped and the suspension allowed to steep for approximately five minutes, after which it was inverted several times to mix, centrifuged and the supernatant decanted into a clean tube.

Total cadmium concentrations: 15 ml of concentrated trace metal grade nitric acid and 5 ml concentrated trace metal grade hydrochloric acid were added to the residue from the boiling water extraction and digested for two hours at 120 ˚C on an electrically heated graphite block. After cooling, the digest was made up to 30 ml using distilled deionized water. All acids used were trace metal grade.

Analysis: Cadmium concentrations were determined by graphite furnace atomic absorption spectrophotometry (GF-AAS) using a PerkinElmer 5100 PC Spectrophotometer (10). A standard reference material, NIST 1570a (Trace Elements in Spinach Leaves), was also included with every 10 samples as a check on the accuracy of the determination of the total cadmium content.

RESULTS

The cadmium recovery from the reference material was better than 90% for all determinations. Per cent relative standard deviation (%RSD) of analytical replicates of the samples and reference material was less than 15.

The Table summarizes the results for the total concentrations of cadmium in the various bush teas examined, the mean percentage of total Cd extracted by boiling water, and the amount of cadmium which would be present in a serving of the tea (normalized to 200 ml).

Mean total cadmium concentration was 1.62 µg/g for cerasee (n = 8), 0.91 µg/g for fever grass (n = 9), < 0.03 µg/g for ginger (n = 2), 0.72 µg/g for lime leaf (n = 1), 0.83 µg/g for mint (n =1), 0.28 µg/g for black mint (n = 2) and 1.40 µg/g for soursop leaf (n = 5). One to fifteen per cent of total cadmium was extracted in the hot water brew, with the lowest being a sample of soursop leaf and the highest a sample of fever grass. There was also significant variation within a sample type.

It was found that a 200 ml serving of tea would contain < 0.04 – 0.325 µg of cadmium, which at the maximum would contribute 0.1–0.3 µg Cd to dietary intake. The World Health

Table: Cadmium (Cd) in bush teas

Local common name	n	Extracted solution concentration (µg/L)	µg Cd in 200 ml (*ie* 1 cup) tea	Extractable Cd (µg/g tea)	Total Cd (µg/g) DW tea	% Cd extracted
Cerasee	8	< 0.2 – 6.13 (1.26)	< 0.04 – 1.18 (0.24)	< 0.016 – 0.47 (0.10)	0.13 – 6.85 (1.62)	3–13 (7)
Fever grass	9	0.29 – 1.94 (1.30)	0.06 – 0.39 (0.26)	0.023 – 0.154 (0.10)	0.385 – 1.37 (0.91)	6–15 (11)
Ginger	2	< 0.2 – < 0.2 (< 0.2)	< 0.4 – < 0.4 (< 0.4)	< 0.015 – < 0.016 (< 0.016)	< 0.03 – < 0.03 (< 0.03)	
Lime leaf	1	0.26	0.05	0.021	0.72	3
Mint	1	0.64	0.13	0.048	0.83	6
Mint (black)	2	< 0.2 – < 0.2 (< 0.2)	< 0.4 – < 0.4 (< 0.4)	< 0.014 – < 0.015 (< 0.015)	0.21– 0.34 (0.28)	
Soursop leaf	5	< 0.2 – 1.62 (0.57)	< 0.04 – 0.325 (0.12)	< 0.016 – 0.126 (0.04)	0.11– 3.95 (1.40)	1–11.5 (5)

Numbers in parentheses are mean values

Organization (WHO) recommends a provisional tolerable weekly intake (PTWI) of 7 µg Cd/kg body weight (14). However, because of the long half-life of cadmium in the body, a provisional tolerable monthly intake (PTMI) of 25 µg/kg body weight was established (15). For dietary exposure, it is generally assumed that body weight for females = 65 kg and for males = 70 kg.

DISCUSSION

The small number of samples of ginger, lime leaf, mint and black mint were due to availability, as these samples were what the participating householders had on hand at the time of sampling. Nonetheless, the data give an idea of the cadmium uptake of those sample types. It is recognized that this is a limitation of the study. Additionally, because of the dependence on availability from participating householders, some sample types may have been excluded from the study and it was not possible to obtain larger numbers of existing sample types. Nonetheless, a useful baseline has been established for future reference.

The cadmium content for a particular species largely reflects the cadmium content of the soils on which the bushes were grown, and two samples (one cerasee, the other soursop) stand out. Both were grown in the Mile Gully region, which is known to be rich in cadmium (9), but even these levels would hardly contribute significantly to human Cd exposure and, moreover, the total uptake by the plants does not indicate the potential removal of cadmium from these soils by phytoremediation. While the soil Cd levels in the study area do vary to some extent, they are mostly elevated, and would almost certainly fall above the world mean of 0.5 mg/kg (9).

Studies have been done in other countries to examine the cadmium content of locally produced or consumed herbal teas. Herbal teas in India (16) were found to contain 0.1–0.26 µg/g Cd; most of the teas contained more than one ingredient. An examination of medicinal plants in Ethiopia (17) found concentrations of 0.38–1.83 µg/g, while a study in Thailand (18) found concentrations of 0.002 – 4.772 µg/g. The study done in Thailand also found 14.18 – 24.03% of Cd was extracted in a brew, and estimated dietary intake from herbal teas to be 0.000 – 0.0069 mg Cd/day. The total Cd values are mostly comparable to what was found in this study, although the per cent extraction in the Thailand study is somewhat higher. It is of note that the WHO has established a limit of 0.3 mg/kg for medicinal plant materials (19) and some of the samples examined exceed this limit. While the contribution to PTWI from bush tea consumption does not appear to be significant, it is worth noting that consumption should be moderate in light of the recommended upper limit for medicinal plants.

CONCLUSIONS

While there is some variation in the cadmium content of bush teas examined, on average, a cup of tea contributes 0.1–0.3 micrograms of Cd to a person's intake, well below the PTWI of seven micrograms of ca dmium per kilogram body weight recommended by the WHO (14), therefore these bush teas are not a significant exposure source for cadmium in Jamaica. It is worth noting, however, than many of these teas may exceed the WHO recommendation of 0.3 mg/kg Cd for medicinal plants, and so consumption should be monitored.

ACKNOWLEDGEMENTS

The authors thank the International Development Research Centre (IDRC) for funding this research.

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