Pertanika 15(2), 171-173 (1992)

COMMUNICATION II

Arsenic Contents in Some Malaysian Vegetables

ABSTRAK

Kandungan arsenik dalam empat puluh satu jenis sayur-sayuran yang biasa didapati di Malaysia telah dianalisis dengan menggunakan kaedah pengeluaran hidrida dan spektrometri pancaran atom berjenis plasma berganding secara aruhan. Sampel-sampel tersebut tidak mengandungi paras arsenik yang melebihi 2.00 μ *g* g^{-1}*. Paras yang tertinggi didapati dalam taugeh,* Phaseolus radiatus *(2.00* μ *g* g^{-1}*) dan yang terendah dalam sengkuang,* Pachyrrhizus erosus *(0.20* μ *g* g^{-1}*). Pendidihan menyebabkan kehilangan sebanyak 17 hingga 60% arsenik dalam tanaman-tanaman tersebut.*

ABSTRACT

The arsenic content of forty-one common Malaysian vegetables was analysed by hydride generation-inductively coupled plasma emission spectrometry. None of the samples showed level greater than 2.00 μ *g* g^{-1}*. The highest was found in bean sprouts* (Phaseolus radiatus) *(2.00* μ *g* g^{-1}*) and the lowest in sengkuang* (Pachyrrhizus erosus) *(0.20* μ *g* g^{-1}*). Boiling caused a loss of 17 to 60% arsenic in the plants.*

INTRODUCTION

Although arsenic is generally regarded as a toxic element (Isinishi *et al.* 1986), recent work has shown that it could be an essential trace element. Some studies showed that a trace amount of arsenic is essential to cell metabolism (Uchus *et al.* 1982). Animals have been shown to be adversely affected by dietary arsenic deficiency (Nielson 1980). Even though evidence for the essentiality of arsenic as a trace element in humans is less compelling, the arsenic content of some Malaysian vegetables was investigated as a possible source of dietary arsenic. This paper reports the total arsenic in forty-one vegetables and the effect of boiling on arsenic in some of them.

MATERIALS AND METHODS

Vegetables were purchased on three occasions, giving three different samples of each kind of vegetable, at Seri Kembangan market in 1987. Only the edible portion of the plant was used, to reflect the intake by humans. The plant was washed thoroughly with tap water followed by deionised water. More than 600g of vegetable was used. The moisture content of the plant was determined by drying in an oven at 80°C. One gram of dry powdered vegetable was digested with a mixture of $HNO_3/HC10_4$(4:1). After digestion it was made up with 1.2M HCI and analysed for arsenic using hydride generation-inductively coupled plasma atomic emission spectrometry as described by Lee and Low (1987). Each sample was analysed in duplicate.

In order to establish the accuracy of the analysis, a sample of NBS citrus leaves (No. 1572) was subject to the same treatment.

The effect of boiling on arsenic content was investigated with eight vegetables. They were choy sam (white stem) (*Brassica rapa*), cabbage (*Brassica oleracea* var. *capitata*), wong ngak pak (*Brassica chinensis* var. *pekinensis*). bayam hijau (*Amaranthus paniculatus*), lettuce (*Lactuca sativa*), water convolvulus (*Ipomoea reptans*), bean sprouts (*Phaseolus radiatus*) and Chinese kale (*Brassica alboglabra*). For this experiment, about 600 g of the vegetable was boiled in a glass beaker with 2000 ml of deionised water. At intervals of five minutes approximately 100g of sample was removed and rinsed with deionised water. It was analysed for arsenic as described earlier.

RESULTS AND DISCUSSION

The accuracy of the method for arsenic analysis was established using NBS citrus leaves. The material in duplicate was treated in the same manner as the vegetable samples. Results are shown in Table 1.

TABLE 1
Analysis of arsenic in NBS citrus leaves

	As (μ g g^{-1})
Certified value	3.1±0.3
Observed value	2.97±0.09

The observed value falls within the accepted value, thus establishing the validity of our methodology.

The arsenic content of forty-one vegetables on a dry weight basis is listed in Table 2. Less than 2.00 ug g^{-1} arsenic was found in all vegetables. The highest level was found in bean sprouts (*Phaseolus radiatus*) (2.00 μ g g^{-1}) and the lowest in sengkuang (*Pachyrrhizus erosus*), (0.20 μ g g^{-1}). The high arsenic content in bean sprouts could have originated from the beans or from the water used in the sprouting process.

Although arsenic uptake in general depends on both plant species and element availability, Malaysian vegetables appear to contain relatively low levels of arsenic. They compare favourably with uncontaminated leafy vegetables with a range of 0.01 to 4.00 μ g g^{-1} (Wanchope 1983). Higher levels of arsenic in vegetables have also been reported but they were grown in arsenic-enriched soils. Levels of 3.4 to 10.0 μ g g^{-1} have been reported (Anderson *et al.* 1987; Woolson 1973).

The effect of boiling on arsenic content in selected vegetables is shown in Table 3.

Except for wong ngak pak and cabbage the rest of the vegetables show a decrease in arsenic content upon boiling. In general the amount of arsenic leached is a function of boiling time. Percentage loss after 15 minutes' boiling is from 17 to 60%. Loss of other mineral elements in vegetables upon boiling has also been observed by other workers. Meiners *et al.* (1976) reported 30 to 50% loss for nine mineral elements in raw and cooked legumes.

TABLE 3
Effect of boiling on arsenic content
(μ g g^{-1} dry wt) of some Malaysian vegetables

Vegetables	Boiling time (min)			
	0	5	10	15
Choy sam (white)	1.61	1.22	0.84	0.72
Cabbage	0.36	0.36	0.38	0.34
Wong ngak pak	0.34	0.33	0.38	0.37
Bayam merah	1.19	1.00	0.73	0.73
Lettuce	0.43	0.32	0.25	0.17
Water convolvulus	0.72	0.60	0.60	0.60
Bean sprouts	1.45	1.19	0.96	0.84
Chinese kale	0.18	0.14	0.16	0.10

CONCLUSION

Arsenic content in Malaysian vegetables is generally less than 2.00 ug g^{-1}. This compares favourably with uncontaminated leafy vegetables reported by Wauchope (1983). Boiling is effective in removing a large percentage of the arsenic in the plants.

LOW KUN SHE and
LEE CHNOONG KHENG

Chemistry Department
Universiti Pertanian Malaysia
43400 UPM Serdang, Selangor Darul Ehsan, Malaysia

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(Received 13 December 1990).

TABLE 2
Arsenic and moisture content in some Malaysian vegetables

Scientific name	Common name	arsenic* (μ g g⁻¹ dry wt)	moisture (%)
Allium cepa	Spring onion	0.59±0.55	91.7
Amaranthus gangeticus	Bayam merah	0.60±0.16	91.5
Amaranthus paniculatus	Bayam hijau	0.47±0.25	94.8
Amaranthus spinosus	Mar see yin	0.54±0.14	95.7
Apium graveolens	Celery	0.38±0.02	92.6
Basella rubra	Han choy	0.15	95.0
Benicasa hispida	Wax gourd	0.38±0.27	95.3
Brassica alboglabra	Chinese kale	0.33±0.21	92.2
Brassica chinensis	Chinese cabbage	1.94±0.90	94.1
Brassica chinensis	Pak choy	0.35±0.08	94.3
Brassica chinensis var. *pekinensis*	Wong ngak pak	0.23±0.08	95.8
Brassica juncea	Indian mustard	0.82±0.54	93.0
Brassica oleracea var. *capitata*	Cabbage	0.26±0.04	94.0
Brassica rapa	Choy sam (green stem)	0.97±0.32	92.0
Brassica rapa	Choy sam (white stem)	1.17±0.53	93.3
Capsicum annum	Chilli (red)	0.27±0.04	82.0
Capsicum annum var. *grossum*	Green pepper	0.21±0.09	94.5
Chrysanthemum coronarium	Tong-ho	0.34±0.08	95.7
Cucumis sativus	Cucumber	1.85±0.22	96.4
Cucurbita pepo	Cheat kuar	0.59±0.47	94.3
Hibiscus esculentus	Lady's fingers	0.48±0.16	91.2
Impomoea batatas	Sweet potato leaves	0.99±0.35	91.0
Impomoea reptans	Water convolvulus	1.44±0.27	91.5
Lactuca indica L	Mak choy	0.28±0.10	92.4
Lactuca sativa	Lettuce	0.83	96.2
Luffa acutangula	Angled gourd	0.39±0.08	97.0
Lycium chinensis	Wolfbery leaves	0.29±0.08	91.5
Lycopersicon esculentum	Tomato	0.21±0.12	93.0
Momordica charantia	Bitter gourd	0.29±0.11	95.6
Nasturtium officinale	Water cress	0.29±0.07	96.0
Nelumbo nucifera	Lotus root	0.52±0.10	83.1
Pachyrrhizus erosus	Sengkuang	0.20±0.07	88.1
Phaseolus radiatus	Bean sprouts	2.00±0.65	94.2
Phaseolus vulgaris	French bean	0.36±0.09	92.1
Pisum sativum	Green peas	0.15	86.9
Psophocarpus tetragonolobus	Four-angled bean	0.34±0.07	91.5
Sauropus androgynus	She chai choy	0.77±0.35	82.1
Solanum melongena	Brinjal	0.42±0.13	92.0
Spinacia oleracea	Spinach	0.28±0.05	93.5
Vigna sinensis	String bean	0.48±0.16	90.6

* Mean of three replicates