

CHAPTER V

CONCLUSION AND RECOMMENDATION

Nowadays, lead and cadmium has been recognized as a cumulative poison and many works have been done on their distribution and toxicology. Lead and cadmium are widely distributed throughout the environment, resulted from man's activity. The effect of lead and cadmium intoxication may range from simply upsetting to disabling and even fatal. Lead and cadmium which ingested by man is mainly derived from food. The determination of lead and cadmium in various parts of vegetables are valuable for interest.

In this study, the sample solution from a vegetable was obtained after the vegetable had been ashed without an aid of the extraneous chemical in a muffle furnace and then simultaneously analyzed for lead and cadmium by differential pulse anodic stripping voltammetry.

The technique used is simple and it provided high precision (the max deviation was 0.032 mA) and high sensitivity (the detection limit was 1.00 ng/cm³) for determining lead and cadmium in various parts of vegetables.

Table 21 is a conclusion of ranges of lead and cadmium contents in various parts of vegetables which were collected from four different sources : Bang Plad market, Tae Veit market, Sam Yan market and Taling Chan garden. The vegetable analyzed were Chinese kale, flowering white cabbage, celery cabbage, cauliflower, Chinese convolvulus, water convolvulus, water mimosa, coriander, multiplier onion, celery,

Table 21 Ranges of lead and cadmium contents found in vegetable from four different sources

Vegetable	Range of lead content found		Range of cadmium content found	
	µg/g of the dry vegetable sample	µg/g of the fresh vegetable sample	µg/g of the dry vegetable sample	µg/kg of the fresh vegetable sample
Chinese kale				
- leaf	0.86-5.43	0.12-0.80	none-0.15	none-20.49
- stem	0.84-5.52	0.10-0.38	0.10-0.47	5.87-53.25
Flowering white cabbage				
- leaf	2.28-4.43	0.20-0.62	none-0.05	none-6.39
- stem	2.29-4.99	0.13-0.19	none-0.20	none-9.06
Celery cabbage				
- leaf	3.54-11.43	0.21-0.82	none-0.37	none-26.57
- stem	8.78-14.48	0.32-0.68	none-0.19	none-8.95
Cauliflower				
- leaf	0.98-4.09	0.17-0.56	none-0.23	none-26.56
- stem	0.41-2.84	0.03-0.23	none-0.19	none-18.14
- flower	0.79-3.53	0.09-0.37	none-0.10	none-10.70
Chinese convolvulus				
- leaf	3.10-3.60	0.36-0.38	none-0.10	none-8.57
- stem	9.61-18.76	0.55-0.91	none-0.04	none-1.86
Water convolvulus				
- leaf	2.16-2.79	0.36-0.45	none-0.33	none-9.09
- stem	7.69-18.64	0.59-1.43	none-0.12	none-9.28

Table 21 (continued)

Vegetable	Range of lead content found		Range of cadmium content found	
	µg/g of the dry vegetable sample	µg/g of the fresh vegetable sample	µg/g of the dry vegetable sample	µg/kg of the fresh vegetable sample
Water mimosa				
- leaf	0.09-1.34	0.09-0.28	none	none
- stem	0.05-3.96	0.05-0.53	none-0.03	none-4.04
Coriander				
- leaf	0.79-2.36	0.14-0.31	none-0.11	none-11.38
- stem	3.56-6.81	0.34-0.74	0.06-0.16	5.96-21.58
Multiplier onion				
- leaf	1.52-5.67	0.19-0.54	0.06-0.18	7.66-17.36
- stem	0.86-2.66	0.08-0.15	none-0.15	none-8.66
Celery				
- leaf	1.28-2.57	0.02-0.27	none-0.08	none-8.12
- stem	2.88-7.91	0.14-0.37	0.10-0.94	5.17-44.26
Chinese chives				
- leaf	2.15-3.59	0.20-0.31	none-0.08	none-6.85
Cucumber				
- fruit	2.43-3.79	0.09-0.14	none-0.09	none-3.32
Egg plant				
- fruit	0.21-1.93	0.02-0.10	none-0.07	none-5.49
Long bean				
- fruit	0.82-1.94	0.09-0.20	none	none

Chinese chives, cucumber, egg plant and long bean.

By dry ashing method, the amount of lead found ranged from 0.09 to 18.76 $\mu\text{g Pb/g}$ of the vegetable on the dry basis and from 0.02 to 1.43 $\mu\text{g Pb/g}$ of the vegetable on the fresh basis. The maximum values of 18.76 $\mu\text{g Pb/g}$ of the dry vegetable sample and 1.43 $\mu\text{g Pb/g}$ of the fresh vegetable sample were obtained from the stem of Chinese convolvulus and the stem of water convolvulus. The minimum values of 0.09 $\mu\text{g Pb/g}$ of the dry vegetable sample and 0.02 $\mu\text{g Pb/g}$ of the fresh vegetable sample were obtained from the leaf of water mimosa and egg plant.

Furthermore, the amounts of cadmium found ranged from none to 0.94 $\mu\text{g Cd/g}$ of the dry vegetable sample and found none to 53.25 $\mu\text{g Cd/kg}$ of the fresh vegetable sample. The maximum values of 0.94 $\mu\text{g Cd/g}$ of the dry vegetable sample and 53.25 $\mu\text{g Cd/kg}$ of the fresh vegetable sample were obtained from the stem of celery and the stem of Chinese kale. No cadmium was found in long bean.

By this study, it can be seen that lead and cadmium contents were higher in the stem than in the other parts of most of the vegetables analyzed. The decreasing order of lead and cadmium content in various parts of vegetable is stem, leaf and fruit. Thus, uptake of lead and cadmium in the vegetables studied should come from soil and water more than atmosphere. In addition, the uptake of lead and cadmium in various parts of vegetables were different and varied from species to species, from plant part to part and source to source.

Table 22

The average contents of lead and cadmium in all edible parts of the vegetable species

Vegetable sample	average lead content		average cadmium content	
	µg/g of the dry vegetable sample	µg/g of the fresh vegetable sample	µg/g of the dry vegetable sample	µg/g of the fresh vegetable sample
Chinese kale - leaf + stem	3.55±0.04	0.36±0.05	0.14±0.02	14.48±0.19
Flowering white cabbage - leaf + stem	3.23±0.05	0.27±0.03	0.05±0.01	2.99±0.07
Celery cabbage - leaf + stem	8.26±0.08	0.45±0.04	0.11±0.22	5.88±0.09
Cauliflower - leaf + stem + flower	2.08±0.04	0.22±0.03	0.08±0.02	8.92±0.17
Chinese convolvulus - leaf + stem	8.56±0.11	0.53±0.06	0.02±0.01	1.40±0.05
Water convolvulus - leaf + stem	7.03±0.07	0.64±0.06	0.09±0.02	4.32±0.07
Water mimosa - leaf + stem	1.18±0.03	0.21±0.02	0.01±0.01	0.51±0.02
Coriander - leaf + stem	3.36±0.07	0.37±0.04	0.08±0.02	7.63±0.22
Multiplier onion - leaf + stem	2.43±0.04	0.24±0.03	0.09±0.02	8.36±0.16

Table 22 (continued)

Vegetable sample	average lead content		average cadmium content	
	$\mu\text{g/g}$ of the dry vegetable sample	$\mu\text{g/g}$ of the fresh vegetable sample	$\mu\text{g/g}$ of the dry vegetable sample	$\mu\text{g/kg}$ of the fresh vegetable sample
Celery - leaf + stem	3.42 ± 0.07	0.29 ± 0.02	0.18 ± 0.04	9.79 ± 0.14
Chinese chives - leaf	2.93 ± 0.05	0.26 ± 0.03	0.05 ± 0.02	4.16 ± 0.13
Cucumber - fruit	3.09 ± 0.04	0.12 ± 0.03	0.04 ± 0.02	1.25 ± 0.05
Egg plant - fruit	1.02 ± 0.03	0.07 ± 0.01	0.05 ± 0.02	3.28 ± 0.13
Long bean - fruit	1.20 ± 0.03	0.13 ± 0.03	none	none

Lead and cadmium contents in various parts of each vegetable species in this study resulted in some different values within a short range owing to the different environment of the source. The inconsistency of the conversion factors, found in each vegetable species from source to source also emphasized the effect of the environment on a vegetable composition.

The average values of lead and cadmium contents in each vegetable species analyzed are concluded in Table 22. This value can be used to estimate the amounts of lead and cadmium intake by man from vegetables. The maximum values for lead and cadmium contents in the vegetable on the dry basis, were found to be 8.56 $\mu\text{g Pb/g}$ in Chinese convolvulus and 0.18 $\mu\text{g Cd/g}$ in celery, respectively.

For further studies, the determination of these toxic heavy metals should pay more attention to the other foods not only vegetables, which are the main source that man can receive them.