

**DETERMINATION OF Cu, Zn, Fe, Pb AND Cd CONCENTRATION  
IN SELECTED LOCALLY AVAILABLE HERBS IN FRESH AND  
IN ITS PROCESSED FORM**

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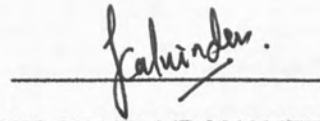
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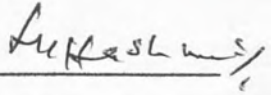
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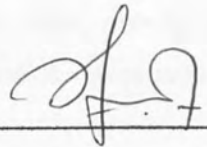
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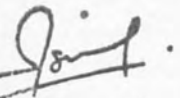
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## ABSTRACT

In this study, comparison of metals concentration such as iron, copper, zinc, lead and cadmium (toxic metals) were carried out in three types of fresh herbs namely Peppermint, Cat's Whiskers and Tongkat Ali. Besides that, research was also done on processed samples of these herbs that are available in market. These samples were BOH Peppermint Tea, Dry Cat's Whiskers and Dry Tongkat Ali. The concentration of tested metals was determined by using Atomic Absorption Spectrophotometry (Flame). The fresh herb shows the highest concentration of iron, ranges  $76.08 \pm 0.03\mu\text{g/g}$  to  $123.8 \pm 0.05\mu\text{g/g}$ . Meanwhile found to be that these herbs shows the lowest concentration of cadmium, between  $0.03 \pm 0.03\mu\text{g/g}$  to  $0.25 \pm 0.05\mu\text{g/g}$ . Peppermint was detected to have highest copper, iron and zinc concentration. In overall processed samples, the highest concentration is shown for iron. The lowest concentration is detected for cadmium. However, Tongkat Ali found to have the highest concentration among samples for toxic metals such as cadmium and lead, range from  $0.17 \pm 0.003\mu\text{g/g}$  to  $0.25 \pm 0.05\mu\text{g/g}$ . For comparison of fresh and processed samples, the highest difference of metal concentration is detected for iron between fresh Peppermint and BOH Peppermint Tea, this range between  $123.80 \pm 0.05\mu\text{g/g}$  and  $1915.0 \pm 25.0\mu\text{g/g}$ . However, for toxic metal (cadmium concentration), the biggest difference is shown between fresh Peppermint and BOH Peppermint Tea, range  $0.10 \pm 0.05\mu\text{g/g}$  to  $0.25 \pm 0.09\mu\text{g/g}$ . A comparison between fresh and processed samples showed significant differences ( $p < 0.05$ ) for all the metal concentration. The heavy metals concentration in fresh herbs and its processed product is still at low and safe level and meets the requirements of Malaysian Food Act 1983 and Food Regulations 1985.



## ABSTRAK

### **PENENTUAN KEPEKATAN Cu, Zn, Fe, Cd DAN Pb DALAM HERBA SEGAR TEMPATAN TERPILIH DAN DALAM HERBA TERSEBUT YANG TELAH DIPROSES**

*Dalam kajian ini, perbandingan kepekatan logam, misalnya ferum, kuprum, zink, plumbum dan cadmium (logam toksik) dijalankan ke atas tiga jenis herba segar iaitu Pudina, Misai Kucing, dan Tongkat Ali. Selain itu, kajian juga dijalankan ke atas sample herba tersebut yang telah diproses dan didapati dari pasaran. Sample tersebut ialah Teh Pudina jenama BOH, Misai Kucing kering dan Tongkat Ali kering. Kepekatan logam yang dianalisa ditentukan dengan menggunakan Atomic Absorption Spectroscopy (flame). Herba segar menunjukkan kepekatan ferum yang tertinggi dalam julat dari  $76.08 \pm 0.03\mu\text{g/g}$  hingga  $123.8 \pm 0.05\mu\text{g/g}$ . Sementara itu, didapati, herba segar menunjukkan kepekatan kadmium terendah di antara  $0.03 \pm 0.03\mu\text{g/g}$  hingga  $0.25 \pm 0.05\mu\text{g/g}$ . Pudina didapati mengandungi kepekatan kuprum, ferum, dan zink yang tertinggi. Secara keseluruhan, untuk sampel yang diproses, kepekatan tertinggi didapati untuk ferum. Kepekatan terendah pula dikesan untuk kadmium. Bagaimana pun, Tongkat Ali didapati mengandungi kepekatan logam toksik yang tertinggi iaitu untuk kadmium dan plumbum dalam julat  $0.17 \pm 0.003\mu\text{g/g}$  hingga  $0.25 \pm 0.05\mu\text{g/g}$ . Untuk perbandingan antara sampel segar dan telah diproses, perbezaan kepekatan logam tertinggi dikesan untuk ferum antara Pudina Segar dan Teh Pudina jenama BOH, dalam julat  $123.80 \pm 0.05\mu\text{g/g}$  hingga  $1915.0 \pm 25.0\mu\text{g/g}$ . Bagaimana pun, untuk logam toksik (kepekatan kadmium) perbezaan tertinggi ditunjukkan antara Pudina segar dan Teh Pudina BOH, di antara julat  $0.10 \pm 0.05\mu\text{g/g}$  dan  $0.25 \pm 0.09\mu\text{g/g}$ . Perbandingan antara sampel segar dan diproses menunjukkan perbezaan nyata ( $p < 0.05$ ) untuk setiap logam yang dikaji. Kepekatan logam berat dalam herba segar dan produknya masih berada pada tahap yang rendah dan selamat dan memenuhi takat yang ditentukan dalam Akta Makanan Malaysia 1983 dan Peraturan Makanan 1985.*



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## LIST OF SYMBOLS

### Symbols

A	Absorption
$\epsilon$	The molar absorptivity for one mol of b is sample
b	The path length of the sample
c	Concentration of sample
C	Sample concentration on graph calibration ( $\mu\text{g/ml}$ )
V	Sample volume in ml unit
m	Weight of sample in gram
$\mu\text{g/g}$	Microgram per gram
mg/L	Miligram per liter
Fe	Lead
Zn	Zinc
Cu	Copper
Cd	Cadmium
Pb	Lead



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# CHAPTER 1

## INTRODUCTION

### 1.1 Herbs

Herbs are defined as the aromatic plants used to impart flavor and odor to foods with, sometimes, the addition of color. The leaves are traded separately from the plant stems and leaf stalks (Peter, 2000). Technically, an herb is a non-woody seed-producing plant that dies at the end of the growing season. However, the term is generally used to refer to any botanical or plant-derived substances. Just because herbs are natural, doesn't mean they are safe for everyone at any dose (Grosvenor *et al.* 2002).

Medicinal herbs such as Tongkat Ali, Cat's Whiskers and peppermint are available locally, especially at wet market. Their roles are recognized since early days among Malaysians. Mixtures of herbs are prescribed by the traditional healers for diseases ranging from common cold to malaria, arthritis, ulcer and etc (Obiajunwa *et al.* 2002). Therefore, these days, become a common practice to use herbs in low doses as food drugs.





Most of the herbs eaten daily have medicinal value, for example is the rhizomes of *Zingiber officinale* and leaves of *Mentha arvensis* L (Obiajunwa *et al.*, 2002). Nowadays, herbals are used as one of the additional ingredients in food to benefit health. It's very common among Malaysians to use these herbs in cooking. Malaysians treat these herbs as vegetables in their daily diets. This is due to its various functions and it's natural.

Now due to the introduction of functional foods, consumers look forward for foods made from healthy and natural ingredients. Therefore food manufacturers grab this opportunity to produce foods and beverages based on herbs or by using herb extracts. This trend is obvious in food market due to the availability of products such as tea, coffee, snack, jelly and many other products are produced using wide variety of herbal extracts. These herbs are not manufactured under strict quality control condition, so there is chance of contamination of various kinds during the process of manufacturing. According to Grosvenor and Smolin (2002), some herbs are sold as part of the raw plant, these maybe toxic by itself.

Besides that, these herbs in fresh or raw form have bitter taste. Sometimes, it's not easy to be consumed due to the taste. For example herbs such as tongkat ali and cat's whiskers which has unpleasant taste. However, with the application of advanced pharmaceutical and food technology, extracts of these herbs are incorporated into food and beverages. In addition, the extracts of herbs are also formulated into capsules or tablets by pharmaceuticals companies to provide better nutritional values to consumers. However, this phenomenon also has its drawbacks due to the fact that manufacturing process is not strictly regulated and it does not provide the same dose (Grosvenor *et al.*, 2002).

Herbal supplement are becoming increasingly popular. Herbal supplements are readily available and are inexpensive. They are taken to cure a variety of ailments such as colds, arthritis, depression and menopausal symptoms as well as to slow aging, improve memory, and enhance well-being. These herbs have been used medicinally since long time ago. According to Grosvenor and Smolin (2002), herbs are used because they are "natural", that is they are not processed and altered from their original plant sources. Therefore, herbs are often view as harmless. Natural however have no guarantee of safety.

Food and Drug Administration (FDA) rules require that all nutrients as well as the percent of the US recommended daily dietary allowance (RDA) of vitamins and minerals should be listed on the container of all food shipped. However, there is little report of limit test for heavy metals or permissible limits for minerals in most herbs and in products produced from herbs extracts (Obiajunwa *et.al.*, 2002). Foods of herbal plant origin may contain various chemical elements in tissues which depending on their amount are termed either macroelements or microelements (trace elements). For some herbs, the risk outweigh the benefits. Serious side effects may occur in long run due to the excessive dosage or unusual combination of herbs.

Moreover, herb plants absorb these metals from the soils and store them either in the roots or leaves. Human or other animals upon consumption of root crops and vegetables are threatened with health problems. Besides, once these metals are present in an environment, they cannot be broken down to non toxic forms as such, remain a potential threat for many years (Essoka *et.al.*, 2006).



Research conducted by Wong (1993) on heavy metals in Chinese Herbal Plants and similarly, Obianjunwa (2002) reported on essential and trace element content of some Nigerian medicinal plants. Research on heavy metals in herbs and medicinal plants from Austria also previously conducted (Chizzola, 2003).

Knowledge of the toxic metals for a wide variety of herbs is presently at an unsatisfactory level. The existing research applies older analytical techniques and changes in environmental condition also contribute to the changes in toxic metals in food.

## **1.2 Importance of heavy metal detection**

The determination of toxic metals in our diets (herbs and herb based products) is now an important part of toxicological studies. This is to assess the adequacy of toxic metals and the safety of human food chain resources.

Toxic metals can interfere enzymatic reactions and disrupt cellular activities. Thus, metals insufficiency or excesses have a significant impact on health. With the enormous amount of toxic compounds used in industry, noxious elements are also widespread and threat to health. A number of extensive research projects are being carried out for the determination of essential and toxic metals in the indigenous wild plants.

The main objective of the present investigation was to determine the concentrations of a number of metals. The present investigation is restricted to the determination of a number of toxic metals. Although the metals are only a small portion

by mass in the body, yet they play important roles in our bodies. Most of the trace metals are toxic at elevated levels and adversely affects the health of human beings.

Most of the research conducted till now is to shows the results on the determination of cadmium, copper, zinc and lead mainly in foods such as beverages, teas, baby foods, seafood but rarely in crops grown on soil such as herbs, spices, vegetables and fruits.

To protect the importance of herbs, the heavy metal content in herbs needs to be emphasized to ensure the safety of consumer who consumes those herbs, perhaps for long term. The heavy metal content that is bind with herbs, if in an excessive amount can cause either side effect that is harmful to human beings. This will also influence the future use of the herbs.

The selected herbs are easily availability at Kota Kinabalu. It's not seasonal and can be obtain at low price and it's affordable, therefore, at one way it's also widely used in foods, medicines and beverages. The suitable environment and soil condition supports the growth of those herbs. Besides that, nowadays, as the value of herbs is rising, the cultivation of herbs also increases. Therefore, 3 types of commonly known and widely used herbs in Malaysia are selected for this research:

- (a) Tongkat Ali
- (b) Cat's Whiskers
- (c) Peppermint



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### 1.3 Objectives

1. To detect the presence of lead, cadmium, copper, iron and zinc in selected fresh herbs and in its processed form.
2. To compare the concentration of metals among selected herbs.
3. To check the level of these metals with the maximum permissible concentration set in the Food Act 1983 and Malaysian Food Regulation 1985.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Metals

Metals are a natural element that is available in the earth. In common metals are released to earth by human activities such as industrialization and development (Hodgson *et.al.*, 2000). In the periodic table, there are 80 elements that are metal. Metals largely belong to the transition group of the periodic table. Metal is element that has atomic weight between 63.546 till 200.570 (Reilly, 2004).

Metals are trace metals with density at least five times that of water. Living organisms, including humans, require trace amounts of some heavy metals, such as copper, iron, and others. Excessive levels of heavy metals can be harmful to living organisms, even when they are necessary for good health (Essoka *et al.*, 2006).

Metals are present in the air, drinking water, food and countless human-made chemicals and products. In the last 50 years human exposure to metals has risen dramatically. Metals such as arsenic, cadmium, lead are toxic for human bio-system even at very low levels of intake and they are usually present in plants because of the increasing industrialization and associated pollution of the biosphere (Reilly, 2004).





In this case metals are taken up from the soil, fertilizers, pesticide treatment and other industrial and anthropogenic operations (Obiajunwa *et.al.*, 2002).

These elements are divided into two classes: Trace elements, stressing their relatively low abundance in soils and also the micronutrients, indicating small quantities needed by organisms (Haygarth *et.al.*, 2002). Metals that are of environmental concern fall into three classes; (1) Metals that are suspected carcinogens (2) Metals that move readily in soil, and (3) Metals that move through in the food chain (Hodgson *et.al.*, 2000).

## 2.2 Metal Toxicity

Metals such as lead, cadmium, zinc, iron and copper can introduce to toxicity, if it's consumed in an excessive amount. However, due to the low concentration of these metals in food, the toxicity occurs after several years. The toxicity is caused due to the ability of these metals to accumulate in the gastrointestinal and released into body (Fairweather-Taif, 1996).

Besides, these metals when introduced into the environment in excessive amounts by human activities constitute a source of great danger to man's health. Naturally, their concentrations in living tissues are very low and for health reasons must be maintained within permissible or tolerable limits to ensure optimum biological performance of living organisms (Essoka *et al.*, 2006).

For a metal to exert its toxicity, it must cross the membrane and enter the cell. If the metal in lipophilic form, it readily penetrates the membrane. When bound to proteins such as cadmium-metallothionein, metal is taken into cell by endocytosis. Whereas, lead



## REFERENCES

- Abdullah, M., Parr, R. M and Iyengar, G. V. 1993. *Trace Element Requirements, Intake and Recommendations*. New York : Wiley-Liss
- Angelova, V. 2005. Study accumulation of heavy metals by plants in field condition. *Geophysical Research Abstracts* . 7.
- Angelova, V. 2006. Heavy Metal Content in Plants from Family Lamiaceae Cultivated in an Industrially Polluted Region. *Journal of Herbs, Spices & Medicinal Plants*. 11(4) :37-46.
- Anon. 2000a. Lamiaceae, <http://wildflower.utexas.edu/plants/result.php?id=MEAR4>. 2 April 2007.
- Anon. 2003. *Eurycoma longifolia* Jack, <http://content.nhiondemand.com/moh/mediaHerb.asp?objID=101048&ctype=herb&mty=1>. 4 May 2007.
- Anon. 2006a. Britannica Concise Encyclopedia-Peppermint. <http://en.wikipedia.org/wiki/Dictionary/Peppermint> . 30 April 2006
- Anon. 2006b. *Mentha arvensis*. [http://en.wikipedia.org/wiki/Mentha\\_arvensis](http://en.wikipedia.org/wiki/Mentha_arvensis). 30 April 2007.
- Anon. 2007a. Flowering Plant. [http://en.wikipedia.org/wiki/Lamiaceae/Flowering\\_plant](http://en.wikipedia.org/wiki/Lamiaceae/Flowering_plant) 30 April 2007.
- Anon. 2007b. *Eurycoma longifolia*. [http://en.wikipedia.org/wiki/Eurycoma\\_longifolia](http://en.wikipedia.org/wiki/Eurycoma_longifolia). 30 April 2007.
- Anon. 2007c. *Orthosiphon stamineus*. [http://en.wikipedia.org/wiki/Orthosiphon\\_stamineus](http://en.wikipedia.org/wiki/Orthosiphon_stamineus) 4 April 2007.
- Bhattacharyya, P., Chakraborty, A., Chakrabarti, K., Tripathy, S and Powell, M.A. 2006. Copper, zinc intake by rice and accumulation in soil amended with municipal solid waste compost. *Environ Geo*. 49: 1064-1070.
- Campbell, C. R. and Plank, C. O. 1998. *Preparation of plant tissues for laboratory analysis*. Boca Raton :CRC.
- Brennand, C. 1994. Home Drying of food <http://extension.usu.edu/files/foodpubs/fn330.pdf>. 2 April 2007



- Chizzola, R., Michitsch, H., Franz, C. 2003. Monitoring of metallic micronutrients and heavy metals in herbs, spices and medicinal plants from Austria. *Eur Food Res Technol.* **216** : 407-411.
- Chizzola, R. & Lukas, B. 2005. Variability of the cadmium content in hypericum species collected in Eastern Austria, Wien, Austria. *Water, Air and Soil Pollution.* **170** : 331-343.
- Clesceri, L.S., Eaton, A.D. & Greeberg, A.E. 1995. *Standard Methods for the Examination of water and wastewater* (19<sup>th</sup> edition). Washington : American Public Health Association.
- Concon, Jose, M. 1998. *Food Toxicology- Principles & Concepts*. New York : Marcel Dekker.
- Dabrowski, W.M. & Sikorski, Z.E. 2005. *Toxins in Food*. New York : CRC Press.
- De Vries, W. & Bakker, D.J. 2002. *Agriculture, Hydrology and water quality*. New York : CABI Publishing.
- Doull, J., Klaassen, C.D and Amdur, M.O. 1980. *Toxicology: The Basic Science of Poisons*. (2<sup>nd</sup> Ed): 28-51, 409-431. New York: Macmillan.
- Dreisbach, R.H. 1980. *Handbook Of Poisoning: Prevention, Diagnosis and Treatment*. Los Altos, California: Lange Medical Publications.
- Dulbecco, R and Nielson, F.H. 1997. *Encyclopedia of Human Biology*. **6** : 707-712.
- Essoka, P. A., Ubogu, A. E. & Uzu, L. 2006. An overview of oil pollution and heavy metal concentration in Warri area, Nigeria. *Management of Environmental Quality. An International Journal*, **17**(2) : 209-215.
- Fairweather-Tait, S. J., and Hurrell, R. F. 1996. Bioavailability of Minerals and Trace Elements. *Nutrition Research Review.* **9** :295-324.
- Ferrante, E. D. 1979 . *Trace Metals : Exposure and Health Effects*. Brussels : Pergamon Press.



- Fergusson & Jack, E. 1990. *The Heavy Elements Chemistry, Environmental Impact & Health Effects*. Oxford : Pergamon Press.
- Freedman, B and Hutchnison T.C.1981. *Sources of Metal and Elemental Contamination of Terrestrial Environment*. London : Applied Science.
- Friberg, L., Nordberg, G. F and Vouk, V. B. 1979. *Handbook on The Toxicology of Metal*. Netherlands : Elsevier/ North-Holland Biochemical Press.
- Grosvenor, M. B. and Smolin, L. A. 2002. *Nutrition-From Science To Life*. United States : Harcourt College Publishers.
- Haygarth, P. M. & Jarvis, S. C. 2002. *Agriculture, Hydrology and Water Quality*. Wallingford : New York CABI Publishing.
- Hock, B & Elstner, E. F. 2005. *Plant Toxicology* (4<sup>th</sup> Ed). New York : Marcel Dekker.
- Hodgson, E & Levi, P. E. 2000. *A Textbook of Modern Toxicology*. (2<sup>nd</sup> edition). Singapore : The McGraw-Hill Companies, Inc.
- Isaac, R. A. & Kerber, J. D.1971. *Instrument Methods For Analysis Soils And Plant Tissue*. In : Walsh, L.M. *Soil Science*. Madison : Amer.
- Kaim., Wolfgang and Brigitte Schwederski. 1994. *Bioinorganic Chemistry: Inorganic Element in Chemistry of Life*. Chichester : John Wiley & Sons.
- Krenkel, P. A., & Novotny, V.1980. *Water Quality Management*. New York : Academic Press.
- Lewis, R. J. 1989. *Food Additives Handbook*. In :Gilbert. *Indirect Food Additives*. Springer.
- Malaysia. 1997. Akta Makanan 1983 and Peraturan- Peraturan Makanan 1985. Kuala Lumpur : MDC
- Malaysia MIT. 2004, Quantitative measurement of the chemical or bioactive constituent of *Eurycoma longifolia* (Tongkat Ali) and development of standardize commercial Tongkat Ali formulations as herbal remedies. [http://minihelix.mit.edu/malaysia/research/np1\\_2.htm](http://minihelix.mit.edu/malaysia/research/np1_2.htm). 4 April 2007.

- MARDI. 2000b. Misai Kucing. <http://www.mardi.my/herba1/misai.html>. 2 May 2007.
- MARDI. 2000c. Tongkat Ali. <http://www.mardi.my/herba1/tongkat.html>. 2 May 2007.
- MARDI. 2000d. Tongkat Ali. <http://www.mardi.my/herba1/tongkat-hitam.html>. 2 May 2007
- Mckee, W. D. 1974. *Environmental Problems in Medicine* : 656-679. USA : East Lawrence Avenue.
- Metcalfe, E. 1987. *Analytical Chemistry By Open Learning. Atomic Absorption and Emission Spectroscopy*. London : Thames Polytechnic.
- Murano, P. S. 2003. *Understanding Food Science and Technology*. Wadsworth : Thompson Learning, Inc.
- Nitisewojo, P. 1995. *Prinsip Analisis Makanan*. Bangi : Penerbit Universiti Kebangsaan Malaysia.
- Nitisewojo, P. 1996. *Instrumentasi Dalam Analisis Makanan*. Bangi : Penerbit Universiti Kebangsaan Malaysia.
- Nielsen, S. S. 2003. *Food Analysis*. (3<sup>rd</sup> Ed). New York : Kluwer Academic/ Plenum Publishers.
- Nriagu, J.O. and Azcue, J.M. 1990. *Arsenic in the Environment*. New York : John Wiley and Sons.
- Obiajunwa, E. I., Adebajo, A. C., Omobuwajo, O. R. 2001. Essential and trace element Contents of Nigerian medicinal plants. *Journal of Radioanalytical and Nuclear Chemistry*. **252** (3) : 473-476.
- O'Haven, T.C. 1976. *Chemical Aspects Of Elemental Analysis*. In : Fordner, J.D. *Trace Analysis Spectroscopic Methods For Elements*. Canada : John Wiley & Sons Publisher.
- Parker, R. 1995. *Aquaculture Science*. New York : Delmer.
- Peter, K. V. 2003. *Handbook of Herbs and Spices-1*. New York : CRC Press.



- Pickford, C. J. 1981. Sources of and Analytical Advances in Trace Inorganic Constituent In food. *Chemical Society Reviews*. **245**
- Reilly, C. 2004. *The Nutritional Trace Metals*. Oxford : Blackwell Publishing Ltd.
- Roussel, A. M., Anderson, R. A. & Favier, A. 2000. *Trace Elements in Man and human*. New York : Kluwer Academic Publishers.
- Sanchez-Castillo, C. P., Dewey, J. S. P., Reid, M. D., Solano, M and Philip, W James, T. 1997. The Mineral and Trace Element Content of Mexican Cereal, Cereal Products, Pulses, and Snacks : Preliminary Data. *Journal of Food Composition and Analysis*. **10** : 312-333
- Schroeder, H. A. 1971. Losses of vitamins and trace minerals resulting from processing and preservation of foods. *American Journal of Clinical Nutrition*. **24** : 562
- Schulte, A & Ruhayat, D. 1998. *Soils of Tropical Forest Ecosystems : Characteristics, Ecology and Management*. Berlin Heidelberg : Springer.
- Sindermann, C. J. 1996. *Ocean Pollution : Effects on Living Resources and Humana*. Boca Raton : CRC Press.
- Singerman, A. 1984. *Exposure to toxic metals : Biological Effects and Their Monitoring*. In : *Hazardous Metals in Human Toxicology*. **4**. Netherlands : Elsevier Science Publishers.
- Skoong, D. A. & Leary, J. 1992. *Principles of Instrumental Analysis (4<sup>th</sup> edition)*. United States : Sanders College Publishing.
- Soepadmo, E & Wong, K. M. 1995. *Tree flora of Sabah and Sarawak.1*. Kuala Lumpur : Ampang Press Sdn.Bhd.
- Soleha Ishak. 1993. *Kimia Makanan, Vol 1*: 493. Kuala Lumpur : Dewan Bahasa Dan Pustaka.
- Stickney, R. S. 2000. *Encyclopedia of aquaculture*. New York : John Wiley.
- Stine, K. E ; Brown, T.M. 1996. *Principles of Toxicology*. London : CRC Press.

- Sullivan, R. J. 1969. *Preliminary Air Pollution Survey of Arsenic and its Compound*. National Air Pollution Control Administration Publication No.APTD 69-26,Raleigh.
- Tabil, L.G., Kashaninejad,M and Crerar,B. 2001. Development and trends in drying of herbs and specialty crops in western china. The Canadian Society for Engineering in Agriculture, Food and Biological Systems. Paper No 05-030 Canada.
- Waheed, A., Jaffar, M., Masud, K. 2003. Comparative study of selected essential and non-Essential metals in various canned and raw foodstuffs consumed in Pakistan. *Nutrition and Food Science*. **33**(6) : 261-267.
- Watson, C. A., 1996. *Official and Standardized Methods of Analysis* (3<sup>rd</sup> Edition). The Royal Society of Chemistry, Cambridge.
- Whitmore, T. C.1983. Tree flora of Malaysia a manual for foresters. **1**. Kepong : Ant Printing Works Sdn. Bhd.
- WHO.1992. *Cadmium.Environmental Health Criteria*.N0134. World Health Organization. Geneva.
- Wilson,T ., Temple & Norman, J. 2004. *Nutrition and Health*. Totowa : Humana Press.
- Wong, M. K., Tan, P & Wee, Y. C. 1993. Heavy Metals in some Chinese Herbal Plants. *Biological Trace Element Research*. **36** : 135-142.
- Yaniv, Z. & Bachrach, U. 2005. *Handbook of Medicinal Plants*. In : *Production and Breeding of Medicinal Plants*. 199-201. United States : Harworth Press.
- Zahara Merican. 1986. Peraturan Makanan 1986 dan Kesannya pada Industri Makanan. *Teknologi Makanan* **5** (1) : 22-30.