DETERMINATION OF NUTRIENTS AND HEAVY METALS IN ENVIRONMENTAL SAMPLES USING INDUCTIVELY COUPLED PLASMA MASS SPECTROMETER (ICP-MS)

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Interest in eco-friendly and sustainable agricultural practices using biological approach have increased rapidly with considerable success. However, extensive use of chemical fertilisers has led to environmental problems such as soil degradation, water pollution and emission of greenhouse gases. Environmental pollution has increased rapidly in the recent years, especially soil and groundwater contamination. Hence, it is vital to determine the concentration of contaminant rapidly and precisely, in particular those toxic heavy metals. A reliable analytical method is also needed for quantification of macro, micro and trace elements from the oil palm agro-environment that can determine the level of toxicity and its effect on the environment. Inductively Coupled Plasma Mass Spectrometer (ICP-MS) is a fast, precise and sensitive multi-element analytical technique for the determination of trace elements for analysing samples in aqueous solution. ICP-MS is characterised by high selectivity, sensitivity and detection limits. It can read up to 60 elements in less than 3 min with detection limit up to parts per trillion (ppt), thus suitable for rapid analysis of elements in environmental samples, particularly in the oil palm plantations and palm oil mills.

OBJECTIVE

To analyse the macro, micro and trace elements in environmental samples, particularly soil, leaf samples and effluents.

METHODOLOGY

Preparation of Samples for Analysis

Soil or leaf samples are acid digested using microwave oven following the US EPA test method 3050B (Arsenic, 1996). The digested samples need to be filtered using filter paper and diluted with MilliQ water prior to analysis. The amount of sample required is 0.5 g for soil and 0.3 g for leaves.

Instrumentation

Determination of elements in aqueous samples was carried out by ICP-MS (*Figure 1*). The principle behind ICP MS is the generation of positively charged ions using high temperature argon plasma (Robert, 2001). The procedure includes five basic steps; generating an aerosol of the sample, ionising sample in the ICP source, extracting ions in the sampling interface, separating ions by mass and detecting ions for calculating the concentrations. The concentration of elements in the samples is expressed in parts per million (ppm). The nutrients content are calculated with reference to a set of calibration solutions prepared.
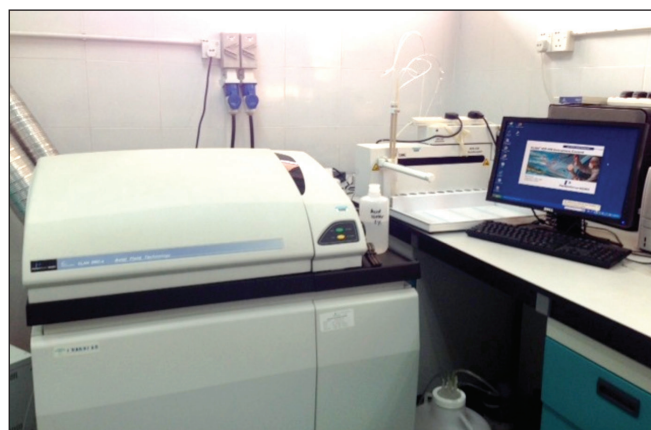

Figure 1. Inductively Coupled Plasma Mass Spectrometer (ICP-MS).

General Analytical Conditions

All data were generated under normal operating conditions on an ICP-MS using an autosampler. The instrumental operating conditions are shown in *Table 1*.

RESULTS

The results showed that the concentration of Ni, Zn, and Pb content was lower as compared to the concentration in soil under oil palm (*Table 2*). The

TABLE 1. INSTRUMENT OPERATING PARAMETERS

Parameters	Current value
Nebuliser gas flow (NEB)	0.82 litre min^{-1}
Auxillary gas flow	1.2 litres min^{-1}
Plasma gas flow	16 litres min^{-1}
RF power	1050 W

TABLE 2. DETERMINATION OF TRACE ELEMENTS IN MINERAL SOIL BEFORE DEGRADATION AT MPOB KERATONG USING ICP-MS

Elements	Cr	Ni	Cu	Zn	Pb	Cd
Before degradation	4.4± 0.9	0.6± 0.1	1.5± 0.3	5.7± 1.1	0.2± 0.01	0.15± 0.03
Optimum level	4 - 54**	1 - 36**	1.0 - 6.0**	10 - 40**	2 - 33**	0.02 - 0.38**

Note: Data shown are means of four replicates with standard error and expressed in ppm. Data has been submitted as an article in the *Journal of Oil Palm Research*. ** Elements optimum level in soil under OP (Bernhard *et al.*, 2004).

concentration of Cr, Cu and Cd were in the normal range. From these results, ICP-MS is capable to determine the elements of interest in one analysis, thus saving the analysis time as compared to the manual individual tests.

BENEFIT

A fast, precise and reliable method for detection and quantification of macro, micro and trace elements in environmental samples.

COST

The cost for this analysis is RM 300 per sample per element, including sample preparation and analysis. Additional RM 50 per element is charged to the sample for multi-element analysis. The cost is subjected to change without prior notice.

REFERENCES

ARSENIC, A M (1996). EPA SW 846 Method 3050B: acid digestion of sediments, sludges and soils. SW 846 Online, www.epa.gov/wastes/hazard/test-methods/sw846/online/3_series.htm

BERNHARD, A Z; ISHAK, C F; MCLAUGHLIN, M J and COZENS, G (2004). Heavy metals in soils and crops in Southeast Asia. 1. Peninsular Malaysia. *Environmental Geochemistry and Health, 26*: 343-357.

ROBERT, T (2001). A beginner's guide to ICP-MS: Part I. *Spectroscopy, 16(4)*: 38-42.

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