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Heavy Metal Hyperaccumulator Fern *Angiopteris evecta* in Myanmar

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Introduction

Angiopteris evecta Hoffm., (the Giant Fern) is

- ancient species with reputedly the largest fronds of any fern on earth
- the only species of the genus *Angiopteris* found in Australia
- a decoction of the rhizome is used to stop bleeding during a miscarriage; the pounded stem is used to treat cough, and the young fronds are used as a poultice for swellings
- one of the compounds isolated from this plant, Angiopteroside Monohydrate showed low cytotoxic activity against cancer cell lines and inhibit HIV-1 reverse transcriptase [1,3,4]
- In Myanmar, medicinally used for traumatic wounds, fracture of limb bones, varicose veins, dog bite, snake bite, malaria, abscess, acne, eye disease, heat exhaustion and menstrual irregularities. It was also taken with honey for longevity [2]

Objective

To determine the accumulation of heavy metals of *Angiopteris evecta* fern and to study the ecological effects on heavy metals absorption

Materials and Methods

Plant Collection and its soil :

The plant was collected from Western Bago Yoma on 2nd May 2015 and soil sample (0-15 cm, approx, 100g) was taken by using line transects method along the pathway.

Chemicals:

Quality Control Standards, 21 Elements Pure (Pure XVI), N9300281

Analytical Instruments:

Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) optima 8000, Perkin Elmer

Analysis of Calibration:

Aliquots of ICP multi element standard solution (100 mg/L) were used in the preparation of calibration solutions. Working standard solutions were prepared by dilution of the stock standard solutions to desired concentration in 1% HNO_3. The ranges of the calibration curves (4 points) were selected to match the expected concentrations for all the elements of the sample studied by ICP-OES. The correlation coefficient obtained for all cases were 0.9999.

Plant authenticity:

The species was identified and confirmed by its specific botanical name by a competent taxonomist from the Department of Botany, West Yangon University, Yangon.

Botanical name: *Angiopteris evecta,* Family name: Marattiaceae

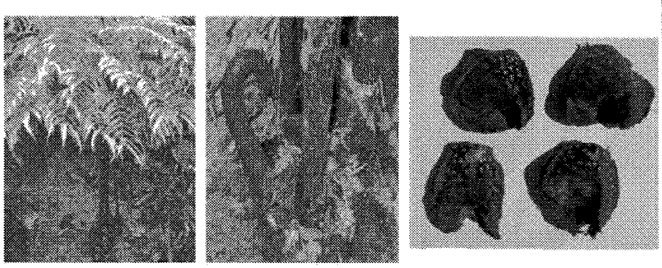


Photo: The whole plant of *Angiopteris evecta* and its rhizome

Sample preparation of rhizome:

The rhizome materials were washed thoroughly with tap water and then with double de-ionized water, after that cut and dried in shade at room temperature. These dried samples were crushed, powdered and homogenized, using a mortar and pestle, and were kept in polyethylene sampling bags for analysis.

Digestion of rhizome sample:

Specified weight (2.5 g) of rhizome crushed powder was placed into crucible for heating in an oven at 110 °C for 2 hours to remove moisture. Charring was placed in furnace at 550 °C and the ashed for about 4 hr until a white or grey ash residue was obtained. 5 ml of 6M HNO_3 was added to the ash sample to dissolve and digest the content and then filtered by Whatman (no.42) filter papers, transferred to 50 ml volumetric flasks and were diluted with de-ionized water [5].

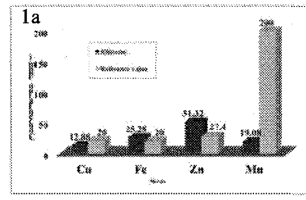
Sample preparation of soil:

The soil was air dried for a week and then it was sieved (2-mm mesh) to remove stone and plant material. The soil sample was dried in an oven at 110°C for 2 hr until brittle and crisp.

Digestion of soil sample:

A portion (1g) of dried, soil sample was placed separately in 50 ml beakers and then digested with 12 cm^3 of a mixture of HNO_3-HCl (in the ratio of 1:3 v/v) to near dryness in an oven at 110°C for 3 hr and cooled. 20 ml of 2% HNO_3 was added into this beaker on a hot plate to boil for 10 mins and cooled. Then filtered into a 100 ml volumetric flask using Whatman (no. 42) filter paper and the volumes made up to the marks with double de-ionized water [6].

Results



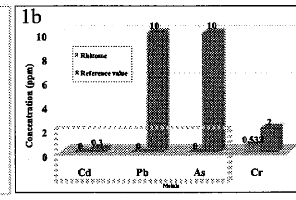


Figure: (1 a & 1b) Heavy metal concentrations in rhizome of *Angiopteris evecta*

No.	Metals	Soil (ppm)	Reference value of soil (ppm)
1	Cd	0	3*
2	Pb	0	600***
3	As	0	10**
4	Cr	57.3 ± 0.0095	100**
5	Cu	7.014 ± 0.0034	140*
6	Fe	294.4 ± 0.1611	50000**
7	Zn	32.13 ± 0.0041	300*
8	Mn	696.2 ± 0.082	2000*

* Australian and New Zealand Guidelines [7]
** FAO/WHO, 2001[8]
*** Nwajeiet al, 2007 (Nigeria)[9]

Table: (1) Level of heavy/toxic metals (ppm) in soil sample of *Angiopteris evecta*

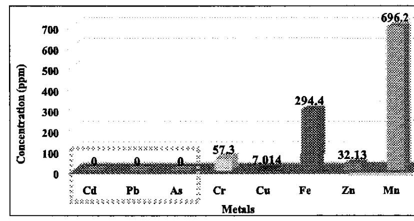


Figure: (2) Heavy metal concentrations in soil sample of *Angiopteris evecta*

Discussion

In rhizome sample,

- The toxic metals Cd, Pb and As concentration were not detected.
- Cr detected (0.532 ppm) but lower than the permissible limit. (Cr= 2 ppm)
- The contents of Fe and Zn concentration were found to be higher than permissible limit (Fe= 20 ppm, Zn= 27.4 ppm)

In soil sample,

- The toxic metals Cd, Pb and As concentration were not found.
- Cr detected (57.3 ppm) but lower than the permissible limit. (Cr= 100 ppm)
- The contents of Cu, Fe and Zn concentration were detected to be lower than permissible limit (Cu= 140 ppm, Fe= 50000 ppm, Zn= 300ppm)
- Cd and Pb causes both acute and chronic poisoning, adverse effect on kidney, liver, vascular and immune system [12].
- Exposure to As causes acute and chronic adverse health effects. The most significant consequence of chronic exposure to arsenic is the occurrence of cancers in various organs especially in the skin and lungs [13, 14].
- Chronic exposure to Cr may result in liver, kidney and lung damage [12].
- Fumes of Cu may cause metal fumes fever with flu like symptoms, hair and skin discoloration [15].
- Fe is necessary for the formation of haemoglobin and also plays an important role in oxygen and electron transport in human body systems [12]. Excess of 'Fe' can cause haemosiderosis [12].
- Zn is present in blood and about 85% of it combines with protein for transport after absorption and its turnover is rapid in pancreas. Deficiency of 'Zn' causes diabetic hyposomia, hypogensia or coma [15].
- Deficiency of Mn in human causes myocardial infarction and other cardiovascular diseases, also disorder of bony cartilaginous growth in infants and children and may lead to immuno deficiency disorder and rheumatic arthritis in adults [10].

Conclusion

- There have been no own soil and plant quality standard in Myanmar yet. Therefore, Myanmar still has to establish soil and plant quality standards, the data generated in this study may also be useful as a basis for formulation of standard guideline.
- The selected medicinal rhizome from Western Bago Yoma which are within permissible limit and it is generally safe for use.
- This plant was hyperaccumulator even their soil contain the lower elemental level.
- The result from this study can play an important role in bioremediation process to mitigate concentration of heavy metals from the environment. It was observed that the ferns had higher potential for heavy metals accumulation than in soil.
- As a conclusion, heavy metal distribution data in soil and plant sample is very useful for becoming main references or guidelines in order to monitoring and avoid environmental pollution become worst in terms of quality of soil and safe level for medicinal plant to be consumed.

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