Element and Heavy Metal Concentrations of Some Fern Spiecies at Phu-Soi-Dao National Park, Thailand

Supaporn Pongthornpruek [a]*, Savent Pampasit [b], Nimit Sriprang [c], Kongsakdi Promtep [d], Pensiri Nabheerong [d]

[a] Biological Science, Graduate School, [b] Department of Natural Resource Management and Environment, Faculty of Agriculture Natural Resources Management and Environment, [c] Department of Chemistry, Faculty of Sceince, [d] Department of Biology, Faculty of Science, Naresuan University, Phitsanulok, Thailand 65000

Introduction

Ferns are naturally abundant in the forests of Thailand. Some of the fern species have a good possibility for use in phytoremediation process. The objectives of this study were to determine the accumulation of heavy metals in various fern species and to study the ecological effects of this heavy metals absorption. The study was conducted at Phu-Soi-Dao National Park Phitsanulok Province, Thailand. Its approximate geographical coordinates are17° 41'-18° 04' North latitude and 100° 56'-101° 09' East longitudes, levation 600-1633 m above sea level (Fig.1).

Fig. 1 Topographic map of the area showing the location of Phu-Soi-Dao National Park, Thailand

Materials and Methods

The soil and fern samples (193 plots and 330 samples) were taken in December 2005. Line transect method along the pathway and applied square plot of 1 x 1 m^2 were used for sampling. Soil properties, pH, Organic matter (OM), Cation Exchange Capacity (CEC), of the samples were measured. Heavy metals were extracted by DTPA 0.005 M. Plant samples were prepared for analysis using the wet digestion method. The metal concentrations in the samples were reported on a dried mass basis

Results and Discussion

Total 330 samples were collected from terrestrial fern over 5 cm in hight. Sampling ferns were identified as 19 species, 11 genera and 11 families. The overall mean of the concentration of the concerned elements and of each compartment were calculated. The results of the chemical analysis for the overall means showed that Ca > Fe > P >Mg > N > K > Na > Mn > Zn > Ni > Pb > Cu > Cr > Co > Cd. The element Ca showed the highest mean concentration in stem and leaves. Fe showed the highest mean concentration in root. The element concentrations in the leaves decreased in the following sequence : Ca > P > Mg > K > Fe > N > Na > Mn > Zn > Pb > Ni > Cu > Cr > Co > Cd.

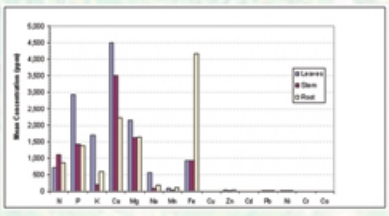

Fig. 2 The mean concentration of the element in root stem and leaves of fern

The soil properties as pH, OM, CEC, all played a role for the observed element concentrations in the leaves. Analytical results are summarized in Table 1. All soils were acidic range from 4.84 – 6.20. Organic matter range from 0.89 – 10.70 %. Cation Exchange Capacity were range from 4.31 – 11.91 me/100g.

Table 1 Soil Properties in each fern species.

Family	Species	pH	OM (%)	CEC me/100g
DENNSTAEDTIACEAE	*Pteridium aquilinum*	5.15±0.47	7.15±4.85	9.89±2.51
BLECHNACEAE	*Blechnum orientale* L.	6.20±0.28	10.70±1.19	11.91±1.36
MARATTIACEAE	*Angiopteris evecta*	5.80±0.38	8.57±5.05	10.55±1.60
PTERIDACEAE	*Pteris vittata* Linn.	5.67±0.40	2.85±1.05	7.51±3.29
	Pteris ensiformis Burm.f.	4.84±0.00	3.27±0.00	5.43±0.00
	Pteris biaurita L.	6.00±0.00	1.00±0.00	4.87±0.00
SCHIZAEACEAE	*Lygodium* sp.	5.46±0.43	2.45±1.08	8.32±0.83
DRYOPTERIDACEAE	*Tectaria hapotrocaulis* Holtt.	5.83±0.37	3.54±2.91	7.79±2.64
	Tectaria impressa	5.94±0.60	2.42±1.02	10.61±0.92
	Tectaria angulata	6.01±0.00	2.72±0.00	7.42±0.00
	Tectaria polymorpha	5.97±0.74	1.92±0.03	4.31±1.26
THELYPTERIDACEAE	*Thelypteris roulae*	6.14±0.23	2.59±1.01	5.80±2.83
	Thelypteris terminans	5.39±0.50	6.36±4.46	9.34±1.53
	Thelypteris interrupta	5.46±0.44	5.85±4.32	9.44±1.51
LINDSAEACEAE	*Lindsaea ensifolia* Sw.	4.84±0.00	3.27±0.00	5.43±0.00
POLYPODIACEAE	*Colysis pothifolia*	6.02±0.03	8.65±5.15	9.30±3.69
PARKERIACEAE	*Adiantum caudatum* L.	5.92±0.53	0.89±0.67	6.91±3.63
	Adiantum philippense L.	5.41±0.68	2.37±1.51	8.77±2.46
ATHYRIACEAE	*Diplazium esculentum*	6.00±0.00	1.00±0.00	4.87±0.00

Leaves are the physiologically active organs of a plant converting the inorganic matters into organic compounds. Some ferns had a high potential for absorbing heavy metals from the soil. Among 19 terrestrial fern species, five species had high concentration of heavy metal in leaves. Adiantum caudatum L. accumulated more Fe and Co than other species, while high Cu and Pb concentration were found in Adiantum philippense L. Zn, Mn and Cd were largely collected in Pteris ensiformis Burm.f., Lindsaea ensifolia Sw. and Lygodium sp., respectively. Different factors influenced the heavy metal accumulation in the plants. Heavy metal uptake was decreased when soil CEC was increased and accelerated organic matter in soil. The uptake rate of all these elements was promoted by low pH values that might be an explanation for their different accumulation.

Conclusions and Outlook

Five terrestrial species had high concentration of heavy metal in leaves. The result from this study showed the potential of using ferns in bioremediation to reduce the concentration of heavy metal from the environment.

Adiantum Philippense L.

Adiatum caudatum L.

Contact :
Supaporn PongThornpruek, Naresuan University, Phitsanulok, Thailand 65000
E-mail : pongthornpruek@hotmail.com