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Open Access Heavy metal content in moss samples from Jebel Marra, Darfur, Sudan

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Abstract
A survey of heavy metal contents in 9 moss species: *Barbula ehrenbergii* (Lor.) Fleisch, *Pleurochaete squarossa* (Brid.) Lindb., *Tortella humilis* (Hedw.) Jenn, *Pholonotis longiseta (MMichx) E. Britton, Philonotis tenuis* (Hedw.) Brid, *Funaria hygrometrica* Hedw, *Bryum pseudotriquetrum* (Brid.) Shwaegr, *Thuidium furfurosum* (Broth.) Broth and *Polytrichum juniperinum* Hedw. Collected from three sites in Jabel Marra region, Darfur, Sudan was carried out . Concentrations of the elements sodium, potassium, zinc, calcium, copper, manganese and iron in the mosses gave an indication of the soil content in the selected sites and significant differences in heavy metal concentrations were recorded for different sites.

Keywords: Moss, Heavy metals, bioindicator, Atomic absorption

Introduction

Mosses are small green plants that reproduce by means of spores (or vegetatively) instead of seeds. Although often small and inconspicuous, mosses successfully exploited many environments, perhaps partly because they are rarely in direct competition with higher plants. (Anderson, 1980). Mosses have been shown to be capable of surviving complete desiccation and temperatures as extreme as 110°C which is a remarkable adaptation to remain alive for long periods without water, and then resume photosynthesis within seconds after being moistened by rain or dew. They are resistant to many substances which are highly toxic for other plants species (Cenci et al., 2003;
Fernandez, et al., 2006; Dragovič and Mihailovič, 2009). Since they provide information on the environment or the quality of environmental changes, then they considered bioindicators (Poikolainen, 2004. Mosses as bioindicator are popular not only due Mosses cannot prevent ions penetrating into their tissues, but also because they have high counter-gradient mechanisms by which they accumulate significant concentrations of metals in their bodies (Shakya et al., 2008). After this successful discovery. many mosses have been used as biomonitors of atmospheric heavy metals in different European and Asian countries (Steinnes et al. 1992; Raman et al., 2000 and Akin and Onder, 2010). Such moss surveys can uncover regional differences and temporal trends of airborne pollution, enabling in certain cases the possibilities to establish comparison between contamination levels in geographically different areas (Alvarez, et *al*., 2006).
Jebbel Marra is sparsely populated and far from being an industrialized area. The present study presents data on the concentrations Na, K, Ca, Cu, Fe, Mn and Zn in 9 mosses collected from three sites on Jebel Marra. The present elemental study establishes a base-line data for future comparison of a pristine environment to be compared with data from heavily polluted sites in European and Asian countries.

Materials and Methods

a) Sampling procedure:

The study was carried out (July- August 2000) at three different sites, Nyrtete on the western lower slope at an altitude of approximately 1000 m.a.s,l., Golol on the southwest slope at an average altitude of approximately 1500 m.a.s.l. and Togi on the south west slope at an average altitude of approximately 2600 meter above sea level (m.a.s.l.). Three different moss species were collected for the analysis from each site.

b) Sample Preparation:

Samples were partially cleaned in the field and placed in paper bags, dried and stored at room temperature until finally cleaned in the labrotary prior to analysis. One gram of dried plant tissue was weighed and placed in a porcelain crucible and then placed in a cool muff1e furnace and ashed at 500°C for overnight. The ash was cooled and dissolved in 5 ml of 20% hydrochloric acid. The solution was filtered through an acid- washed filter paper into 50 ml volumetric flask and diluted to the volume with deionized water (Perkin Elmer, 1994).

c) Measurement:

The quantitative estimation of Sodium, potassium, zinc, calcium, cobalt, copper, manganese and iron concentrations were determined using atomic absorption spectrophotometer A.A.S. 3110 following the manual (Perkin Elmer, 1994). Metal concentrations in the analyzed mosses were expressed as (mg/kg) on a dry weight basis.

d) Statistical analysis:

Cluster analysis was done according to Sokal and Sneath (1963) using the statistical package SPSS.

Results and Discussion

The following are the results of the elemental analysis of the studied mosses with special reference to their localities:

1. Sodium content:

The results of this analysis show that, the studied mosses are approximately similar in their sodium content. The recorded data show the content range (12.0 -18.5 mg/Kg) where 12.0 mg/Kg were recorded for *Polytricum juniperinum* collected from Togi and 18.5 mg/Kg recorded for *Philonotis tenuis* collected from Golol.

2. Potassium content:

The potassium content of the studied mosses reflects a relatively homogenous entity: *Barbula ehrenbergii, Pleurochaete squarossa* and *Tortella humilis* which are grouped as Nyrtete collection. However, minimum and maximum contents (17.0 and 57.25 mg/Kg) were recorded for two different species from one collection group, that is Togi

3. Zinc content

The studied mosses are extremely variable in their zinc contents. The results show maximum zinc content of about 30.175 mg/Kg. recorded for *Tortella humilis* collected from Nyrtete, Also, within the same collection group there are clear variations between different species

4. Cobalt content:

The results of the cobalt content show the range between 0.0 recorded for the Togi collection group and 0.050 mg/Kg which is recorded for *Philonotis longiseta* collected from Golol. However, variation within the species from the same collection group is very small.

5. Copper content:

The results of copper content show the range between 0.064 mg/Kg as minimum record and 0.109 mg/Kg as maximum records for the two species: *Funaria hygrometrica* collected from Togi and *Tortella humilis* collected from Nyrtete respectively.

6. Manganese content:

Manganese content of the studied mosses shows the range between 0.637 mg/Kg recorded for *Tortella humilis* and 2.17 mg/Kg recorded for *Bryum psedoriquetrom* which are different species from Nyrtete and Togi respectively. Also, it is observed that the three different species: *Bryum pseudotriquetrom*, *Thuidium furfitrosum* and *Polytricum jlmiperimml* which are grouped as Togi collection group show the maximum records

7. Iron content

The iron content of the studied mosses shows minimum content of a about 18.52 mg/Kg recorded for *Tortella humilis* collected from Nyrtete and maximum content of about 46.57 mg/Kg recorded for *Thuidium furfurosum* collected from Togi.

Generally, the studied mosses are extremely variable in their iron content even those collected from the same locality.

Compared to results obtained from polluted areas, our results show very low concentrations of elements for example Raman et al.(2000) studied the amount of elements released into the atmosphere from observation of a coal fired brick kiln in Islamabad in Pakistan. He recorded 2.9 -12.76 mg/Kg, 76.5- 192.8 mg/Kg and 86.6-430 mg/kg for copper, manganese and zinc respectively. Akinand Onder (2010) also recorded high element concentrations in moss samples from east and south Marmara region in Turkey. Their results showed 1.8-14.7, 0.46- 9.1, 3.9-195.29, 6.0 -293.5 mg/Kg for Calcium, cobalt, copper and zinc respectively. In another study for polluted area in Norway Stennes et al (1994) recorded high concentrations of iron, cobalt, copper and zinc. The elements concentrations ranges are 530-1025, 0.23-0.44, 3.8- 7.5, 25- 57 mg /kg. Descriptive data of the obtained results for Jebel Marra compared to those obtained for polluted areas are also displayed in Table 1.

Table 1 Elements contents of mosses (mg/kg) from Jebel Marra, Sudan compared to polluted sites from other countries

		Zinc	**Cobalt**	**Copper**	**Manganese**	**Iron**
Sudan, Jebel Marra Sites:	**Nyrtete**	6.75-30.175	0.016-0.018	0.072-0,109	0.637-1.643	18.52-35.6
	Golol	5.8-12.85	0.004-0.05	0.064- 0.088	1.44-1.80	28.2-39.77
	Togi	5.57-28.72	0.00-0.00	0.069-0.089	1.80-2.171	25.05-46.57
Polluted sites in other countries	**Norway**	25.0-57.0	0.23-0.44	3.8-7.5		530-1025
	Pakistan	86.6-430		2.9-12.76	76.5-192	
	Turkey	24-57	0.46-9.1	3.9-195.29		

Conclusion

Heavy metal concentrations in the mosses recorded in this study were very low compared to concentrations recorded in mosses collected from different polluted areas. This can be attributed to the fact that the only source of heavy metals in the present study was the soil. Therefore mosses may be taken as good indicators of soil conditions. However variations of heavy metal contents among different species collected from each site were evident.

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