J. Ecophysiol. Occup. Hlth. 15(1 & 2), 2015, 1–7

DOI : 10.15512/joeoh/2015/v15i1&2/91176

Heavy Metals Pb, Cu, Co, Ni and Cr Determination Estimation of Biochemical Functions in Mosses in Reference to Chlorophyll along with Elements Zn, Mn and Fe Content in Some Residential Sites using Moss *Octoblepharum albidum Hedw*

Manjul Misra* and Pramod Kumar Tandon[1]

Directorate of Environment U.P., Lucknow (U.P.), India
[1]Department of Botany University of Lucknow, Lucknow (U.P.), India

Abstract: *Some residential area of Lucknow were surveyed and Moss Octoblepharum albidum Hedw samples were collected from some selected residential colonies. Samples were collected from soils and moist brick walls and analysed for determination of heavy metals Pb, Cu, Co, Cr and Ni. Samples collected from Garden and Monument areas were treated as Control. Samples collected from Residential areas showed higher level of heavy metals in comparison to the samples collected from Garden and Monument sites. Higher content of lead, Copper and Cobalt was found in the residential areas as compared to the Garden and monument areas. However variable results were obtained with regard to chlorophyll content and Zn, Mn and Fe content in moss samples collected from different locations of Lucknow.*

Keywords: Heavy Metals, Pollution, Residential areas, Moss, Bio-monitoring.

Introduction

Degradation of environment caused mostly due to manmade activities such as burning of wood, smelting of ores, tanning of leather, primitive methods of sewage disposal. Industrial revolution and urbanization causes irreparable damage to the environment. Diverse range of pollutants such as gases, particulates, agricultural, chemicals, oil spills, other soil wastes on land and atmosphere affecting the environment directly or indirectly. According to the Prof. J.M. Dave, Dean, School of Environmental Sciences at JNU "Heavy vehicles truck and buses mostly of diesel constitute only 8% of the total number but consume 70% of petroleum product and produce 49% of pollutants. Two wheeler and three wheeler vehicles constitute 60% of the number, consume 9% of petroleum products and produce 13% of total pollution. However, scooter and motorcycle emit twice as much hydrocarbons as cars and the same as heavy vehicle. In other words they contribute 29% of all the hydrocarbons eight times more per unit of fuel consumed than heavy vehicle". Air pollution is basically an ecological problem and this problem faced not only by human beings but also by animals as well as plant life. Pollutants like forms of matter, appear in water or soil and eventually in human food and causes adverse affects on health.

Recently the use of mosses in the monitoring of element dispersal pattern around the emission sources have been done by analysis of material either collected directly from the field (Hukabee, 1973; Wallin, 1976; Ellison *et al.,*1976) or keeping in an exposure period after transplanting from uncontaminated habitat, (Goodman and Roberts, 1971; Pilegaard, 1979) or the use of 'moss bags' (Cameron and Nickless, 1977; Little and Martin, 1974; Ratcliffe, 1975). Many authors have been made these surveys around the industrial and urban pollution (Gorham and Tilton, 1978; Groet, 1976; Grodzinska.

*Email: doemanjulmishra@yahoo.com

1978; Rinne and Barday-Estrup, 1980; Solberg and Selmer-Olesen, 1978; Glooschenko and Capobianco, 1978). These kinds of survey work emphasized the high action exchange capacities and high trapping efficiencies of bryophytes. It has been found experimentally that divalent cations have higher affinities for exchange site. Ruhling and Tyler (1970) established the following absorption and retention series Cu, Pb> Ni> Co> Zn, Man for Hylocomium splendens and this has been repeatedly observed by other workers. Although cation binding in bryophytes is dominated by uronic acid acceptors, the nature of other acceptor molecules may also be important because different legend have different affinities for metal atoms. Thus class A metals (eg. N. K. Ca. Mg) have preference for metal binding donor atoms in legend in order O> N> S while class B metals (eg. Ag, Au, Hg) have the reverse order. Divalent metal can have increasingly class B performance in order Mn< Zn< Ni< Fe < Co< Cd< Cu<Pb Nieboer and Richardson (1980). Then it is important that any soluble ion present to a bryophyte cell within laboratory or in field or in soil solution will firstly established an equilibrium with the binding sites on the cell exterior, where and equilibrium has been made then the remaining atoms are available for uptake into the cell.

Materials and Methods

The Lucknow is situated in the upper Gangetic plains of the country at 123 m above sea level. The climate of this region is characterized by hot and humid summers but cold and chilly winters. Summers generally start by the end of March and remains till June. The maximum and minimum temperature goes up to 310°C to 180°C respectively. Manson starts immediately after the summers. Annual mean rainfall is 972 mm. The distribution of rainfall is uneven and about 79% of the rainfall is received during the rainy season i.e. from 15th June to 15th September of total rain fall, about 62% is received only during two months i.e. July and August. October is the time when winter starts. This season is favorable for bryophytes and mosses.

Results and Discussion

Lead concentration

Area A- Garden and Monumental: On the basis of observations moss samples showed Table-1 Pb concentration 52.26 μgg^{-1} collected from Chotal mambara (site no. 1). Moss samples collected from Dr. Bhim Rao Ambedkar Park (site no. 2) did not show Pb concentration. Yeaple (1972) found the minimum Pb concentration 100 mgg^{-1} at road sides and the highest concentration 230 to 425 ugg^{-1} in *A. undulatum.*

Area C– Residential: On the basis of observations in Table-3 it is revealed that samples *Octoblepharum albidum* collected from Green Field School, Rajajipuram (site no. 3) showed Pb concentration 194.0 μgg^{-1} followed by samples collected from C.M. House (site no. 8) 119.90 μgg^{-1}. Rest of the samples collected from different colonies Sector 2, Vikas Nagar (site no. 4), Sector D, Govt. Colony, Aliganj (site no. 5), (site no. 6) ELDECO Colony, Rae Bareli Road (site no. 6) and Paryavaran

Table 1 Showing Pb, Cu, Co, Cr and Ni concentration μgg^{-1} in moss *Octoblepharum albidum* collected from Area-A Garden and Monumental sites.

Site No.	Area A - Garden and Monumental	Pb Mean + SD	Cu Mean + SD	Co Mean + SD	Cr. Mean + SD	Ni Mean + SD
1	Chota Imambara	52.26 + 1.31	50.66 + 2.49	48.33 + 8.73	12.33 + 1.24	1.20 + 0.16
2	Dr. Bhim Rao Ambedkar Park	ND	25.00 + 0.81	35.33 + 4.10		1.86 + 0.50

All the values are mean of three replicate ± standad deviation.

Table 2 Showing Zn, Mn, Fe concentration μgg^{-1} and Chlorophyll content mg/g fr. wt. in moss *Octoblepharum albidum* collected from Area-A Garden and Monumental sites.

Site No.	Area A - Garden and Monumental	Zn Mean + SD	Mn Mean + SD	Fe Mean + SD	Chlorophyll content Mean + SD
1	Chota Imambara	1080.00 + 26.20	362.00 + 49.60	6066.00 + 94.20	2.19 + 0.05
2	Dr. Bhim Rao Ambedkar Park	727.00 + 18.90	340.00 + 14.71	5733.00 + 124.72	2.46 + 0.02

All the values are the mean of three replicates + standard deviation.

Table 3 Showing Pb,Cu, Co, Cr and Ni concentration μgg^{-1} in moss *Octoblepharum albidum* collected from Area C - Residential sites.

Site No.	Area C – Residential	Pb Mean + SD	Cu Mean + SD	Co Mean + SD	Cr. Mean + SD	Ni Mean + SD
3	Green Field School, Rajajipuram	194.00 + 2.16	42.66 + 4.98	121.60 + 13.50	56.00 + 3.74	4.70 + 0.17
4	Sector 2, Vikas Nagar	97.00 + 1.07	30.30 + 6.01	43.40 + 2.49	81.30 + 0.47	6.30 + 0.54
5	Sector D, Govt. Colony, Aliganj	94.20 + 10.06	34.00 + 1.63	37.30 + 5.24	94.60 + 18.26	1.05 + 0.05
6	ELDECO Colony, Rae Bareli Road	54.86 + 6.59	58.66 + 4.71	32.00 + 8.48	84.00 + 2.82	ND
7	Paryavaran Parisar, Gomti Nagar	96.90 + 8.60	36.00 + 5.88	46.00 + 3.09	ND	ND
8	C.M. House	119.90 + 17.87	54.33 + 0.47	37.30 + 1.88	110.60 + 0.94	4.60 + 0.18

All the values are the mean of three replicates ± standard deviation.

Parisar, Gomti Nagar (site no. 7) showed the Pb values 97.00 μgg^{-1},94.20 μgg^{-1}, 54.86 μgg^{-1} and 96.90 μgg^{-1} respectively. Anderson *et al*. (1978) analysed Pb in epiphytic bryophytes

Brachythecium rutabulum (Hedw.) and *Rhytidiadelphus squarrosus* (Hedw.) from 100 stations. He also analysed the regional variations of Pb level in Copenhagen area and described three sub areas with high metal burdens.

Copper concentration

Area A- Garden and Monumental: Samples collected from Chota Imambara (site no. 1) showed comparatively higher concentration 50.66μgg^{-1} and Dr. Bhim Rao Ambedkar Park (site no. 2) 25.00 μgg^{-1}. Balaji and Rao (2000) examined the relationship between body size and bio accumulation of Cu in Moss *Mytilopsis sallei* in Vishakapatnum harbour (India) and found that concentration of Cu decrease with increasing size.

Area C– Residential: Highest concentration has been found in samples collected from (site no. 6) ELDECO Colony 54.86 μgg^{-1} followed by in samples collected from (site no.8), C.M. House 54.33 μgg^{-1}. Samples collected from (site no. 3) Green Field School, Rajajipuram 42.66 μgg^{-1}, (site no. 4) Sector 2, Vikas Nagar 30.30 μgg^{-1}, (site no. 5) Sector D, Govt. Colony,

Aliganj 34.00 μgg^{-1} and (site no. 7) Paryavaran Parisar, Gomti Nagar 36.00 μgg^{-1}. Grodzinska *et al*. (1990) studied the Cu concentration in all Polish National Parks in 1976 and again in 1986. The lowest concentration of Cu were recorded is northern and eastern parks of Poland and higher in southern Parks in two moss species *Hylocomium splendens* and *Pleurozium schreberi*.

Cobalt concentration

Area A- Garden and Monumental: Samples collected from Chota Imambara (site no. 1) and Dr. Bhim Rao Ambedkar Park (site no. 2) showed the concentration of Co 48.33 μgg^{-1} and 35.33 μgg^{-1} respectively. Cymerman *et al*. (2002) found the content of the metal Co in aquatic bryophyte *Platyhyinidum niparioides, Scapariasp* and *Fontinalis antipyretica* sampled from streams in the Erzgeting (ore mountain, eastern Germany) and found the Co concentration 140 mg/kg which is seriously exceeded background values.

Area C– Residential: Cobalt concentration has been found to be highest in samples collected from Green Field School, Rajajipuram (site no. 3) 121.60 μgg^{-1}. Rest of the samples collected from different residential sites Sector 2, Vikas Nagar (site no. 4). Sector D, Govt. Colony, Aliganj (site no. 5), ELDECO Colony, Rae Bareli Road (site no. 6), Paryavaran Parisar, Gomti Nagar (site no. 7) and C.M. House(site no. 8) showed the co concentration between 46.00 μgg^{-1} to 32.00 μgg^{-1}. Reimann *et al*. (2001) examined the moss *Hylocomium splendens* and *Pleurozium schreberi* for Co concentration at catchment area adjacent to 5–10 km of the Ni smelters and refinery at Monchegoresk, Kola peninsula Russia and found the area more enriched in cobalt.

Cromium concentration

Area A- Garden and Monumental: Samples collected from Garden and monument area Chota Imambara (site no. 1) showed Cr concentration 12.33 μgg^{-1} and samples collected from Dr. Bhim Rao Ambedkar Park (site no. 2) did not show any Cr concentration. Lukaszewska *et al*. (2002) studied the Cr Concentration in Nepolonica forest in southern Poland situated in 10 to 20 km of the urban industrial areas and steel works, built in 1950. They reported the Cr concentration in moss *Pleurozium schreberi* was 2.4 mg/kg decreased in time.

Area C– Residential: Samples collected from C.M. House (site no. 8) showed the highest Cr concentration 110.60 μgg^{-1} followed by Sector D, Govt. Colony, Aliganj (site no. 5) 94.60 μgg^{-1}. ELDECO Colony Rae Bareli Road (site no. 6), Sector 2, Vikas Nagar (site no. 4) and Green Field School, Rajajipuram (site no. 3) Sector 2, Vikas Nagar (site no. 4) showed Cr concentration in decreasing order i.e. 84.00 μgg^{-1}, 81.30 μgg^{-1} and 56.00 μgg^{-1} respectively. Carballeira *et al*. (2002) found Cr in the terrestrial mosses *Seleropodium purum* and *Hypnum cupressiforme* collected from 75 sampling sites in Galicia (NW Spain) were determined. He found the result as the dominant lethology in the sampling area and had no influence on the estimated background levels.

Nickel concentration

Area A- Garden and Monumental: Samples collected from Chota Imambara (site no. 1) and Dr. Bhim Rao Ambedkar Park (site no. 2) showed Ni concentrations 1.20 μgg^{-1} and 1.86 μgg^{-1} respectively. Schilling and Lehman (2002) studied the Ni concentration in tissue of moss *Thuidium dilicatulum* in the central blue ridge of Virginia and evaluate the suitability of moss for biomonitoring studies in the southern appalachians.

Area C– Residential: Samples collected from Sector 2, Vikas Nagar (site no. 4) showed highest Ni concentration 6.30 μgg^{-1} followed by Green Field School, Rajajipuram (site no. 3) 4.70 μgg^{-1}, C.M. House (site no. 8) 4.30 μgg^{-1} followed by Sector D, Govt. Colony, Aliganj (site no. 5) 1.05 μgg^{-1}. ELDECO Colony, Rae Bareli

Table 4 Showing Zn, Mn, Fe concentration μgg^{-1} and Chlorophyll content mg/g fr. wt. in moss *Octoblepharum albidum* collected from Area C - Residential sites.

Site No.	Area A - Garden and Monumental	Zn Mean + SD	Mn Mean + SD	Fe Mean + SD	Chlorophyll content Mean + SD
3	Green Field School, Rajajipuram	369.00 + 1.24	184.00 + 0.82	1353.00 + 24.90	0.53 + 0.12
4	Sector 2, Vikas Nagar	277.00 +12.07	245.00 + 8.33	1100.00 + 81.00	0.94 + 0.15
5	Sector D, Govt. Colony, Aliganj	328.00 + 3.26	214.00 + 0.81	2600.00 + 81.60	0.73 + 0.08
6	ELDECO Colony Rae Bareli Road	146.00 + 0.47	214.00 + 0.81	1121.00 + 57.86	0.93 + 0.15
7	Paryavaran Praisar Gomti Nagar	525.00 + 1.24	419.00 + 1.69	5433.00 + 418.90	0.57 + 0.07
8	C.M. House	666.00 + 1.69	112.00 + 1.63	1184.00 + 84.60	0.62 + 0.03

All the values are the mean of three replicates ± standard deviation.

Road (site no. 6) and Paryavaran Parisar, Gomti Nagar (site no. 7) did not show any Ni traces in samples. Fernandz *et al*. (2002) collected 50 species of *Scleropodium purum* from a single study area, and concentrations of Ni were determined in each sample.

Zinc concentration

Area A- Garden and Monumental: Samples collected from Chota Imambara (site no. 1) showed comparatively higher Zn concentrations 1080.00 μgg^{-1} and samples collected from Dr. Bhim Rao Ambedkar Park (site no. 2)showed Zn concentration 727.00 μgg^{-1} which is also towards higher side. Gupta (1995) has made a comparison of accumulation of Zn in *Plagiothecium denticulatum, Bryumargentenum* and *Sphagnum* sp Shillong (Meghalaya) north eastern India, Samples collected from inside Shillong city (urban) and its immediately adjacent outskirts (Suburban) and Sphagnum species collected from a Suburban site only. He found the highest accumulation of Zn in *Sphagnum* sp at vehicle and minor industries, quarry dust was likely to be an important source of Zinc.

Area C– Residential: Zinc concentration has been found higher in samples collected from C.M. House (site no. 8) 666.00 followed by Paryavaran Parisar, Gomti Nagar (site no. 7) 525.00 μgg^{-1}. Green Field School, Rajajipuram (site no. 3), Sector 2, Vikas Nagar (site no. 4), Sector D, Govt. Colony, Aliganj (site no. 5)and ELDECO Colony, Rae Bareli Road (site no. 6) showed the Zn concentration 369.00 μgg^{-1}, 277.00 μgg^{-1}, 328.00 μgg^{-1}, 146.00 μgg^{-1} consequently. Zoltals (1988) sampled peat land within 250 km radius flin flon Manitoba near the smelter. He found the Zn concentration in the surface which is decreasing exponentially away from the source.

Mangenese concentration

Area A- Garden and Monumental: Samples collected from Chota Imambara (site no. 1) and Dr. Bhim Rao Ambedkar Park (site no. 2) Mn concentration also showed towards higher side 362.00 μgg^{-1} and 340.00 μgg^{-1} respectively. Komai (1981) found the Mn concentration in surface soil of parks in the residential and less industrialized Kishiwada City of Japan ranged between 540-188 ppm.

Area C– Residential: Mn concentration has been found highest in samples collected from Paryavaran Parisar, Gomti Nagar (site no. 7) 419.00 μgg^{-1} followed by Sector 2, Vikas Nagar (site no. 4), Sector D, Govt. Colony, Aliganj (site no. 5) and ELDECO Colony, Rae Bareli

Road(site no.6) 245.00 μgg^{-1}, 214.00 μgg^{-1} and 214.00 μgg^{-1} consequently. (site no.3) Green Field School, Rajajipuram samples showed 184.00 μgg^{-1} and (site no.8) C.M. House 112.00 μgg^{-1}. Chung (1993) found 6.4 mg / l Mn concentration in the analysis of ground water on samples of potable water supply in selected locations in the city of Seoul.

Iron concentration

Area A- Garden and Monumental: Fe concentration have been found in samples collected from Chota Imambara (site no. 1) 6066.00 μgg^{-1} and Dr. Bhim Rao Ambedkar Park (site no. 2) 5733.00 μgg^{-1}. Mayer and Garham (1951) analysed the content of 19 moss species from the Lake district of England and they reported that mosses show a stricking tendency to accumulate iron. The highest figure being 400 mg per 100 g dry wt.

Area C– Residential: Fe concentration has been showed highest in samples collected from Paryavaran Parisar, Gomti Nagar (site no. 7) followed by Sector D, Govt. Colony, Aliganj (site no. 5) 26.00μgg^{-1}. Green Field School, Rajajipuram (site no. 3), Sector 2, Vikas Nagar (site no.4), ELDECO Colony, Rae Bareli Road (site no. 6) and C.M. House (site no.8) showed 1353.00 μgg^{-1}, 1100.00 μgg^{-1}, 1121.00μgg^{-1} and 1184.00μgg^{-1} respectively. Lukaszewska *et al.* (2002) found the Fe content in the moss *Pleurozium schreberi* collected from Nepolonice forest situated at 10 to 30 km from the southern Poland.

Chlorophyll concentration

Area A- Garden and Monumental: Chlorophyll concentrations have been found to be 2.19mg/g fr. wt. in samples procured from Chota Imambara (site no. 1) and Dr. Bhim Rao Ambedkar Park (site no. 2) 2.46mg/g fr. wt. Katosh (1983) studied that some bryophytes such as liverwort always form pale to dark green calli, and the chlorophyll content of the cultured cells is generally high for example 13 to 25 mg per germ cell dry weight in *Marchantia polymorpha.*

Area C– Residential: Samples collected from Sector 2, Vikas Nagar (site no. 4) showed Chlorophyll concentration 0.94mg/g fr. wt. followed by ELDECO Colony, Rae Bareli Road (site no. 6) 0.93mg/g fr. wt. Samples procured from Green Field School, Rajajipuram (site no. 3), Sector D, Govt. Colony, Aliganj (site no. 5), Paryavaran Parisar, Gomti Nagar (site no. 7) and C.M. House (site no. 8) showed Fe concentration 0.53mg/g fr. wt., 0.73mg/g fr. wt.,0.57mg/g fr. wt. and 0.62mg/g fr. wt. respectively. Kajta *et al.* (1987) studied that suspensions cells of two species of moss *Barbula unguiculata* and *Sphagnum imbricatum* are also rich in chlorophyll (Ca 12 and 12 mg per gram cell dry weight respectively) and grow actively in light

Acknowledgment

We are grateful to the then, Head, Botany Department, Lucknow University, Lucknow and Director, National Botanical Research Institute, Lucknow, Dr C.S. Bhatt, Member Secretary U.P. Pollution Control Board, Lucknow for providing necessary facility during the study.

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