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Determination of Catalase Activity and Estimation of Zn, Mn and Fe in Moss Samples Collected from Heavy Traffic Areas

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Abstract: *Moss Physcomitriumpyriforme and Octoblepharumalbidum samples were collected from some gardens and Monument areas and some Heavy Traffic areas. Samples were collected from soils and moist brick walls and analysed for determination of elements Zn, Mn and Fe. Samples collected from Garden and Monument areas treated as Control. Samples collected from Heavy Traffic areas showed higher level of elements in comparison to the samples collected from Garden and Monument sites. Higher content of Zinc, Manganese and Iron was found in the Heavy Traffic areas as compared to the Garden and monument areas. A parameter, catalase Activity has also been studied by using particular method to determine the effect of pollution on the metabolism of species.*

Keywords: Heavy Metals, Pollution, Heavy Traffic areas, Moss, Biomonitoring.

Introduction

Atmosphere's role in maintenance of the biosphere is in a healthy state. The load of pollutants discharge in the air, chemically dilute, and finally are brought back to earth's surface to be eliminated. The air consists of complex mixture of a number of gases, water vapour and many fine particulate material like Nitrogen (78%), Oxygen (20.95%), Argon (00.93%), Carbon dioxide (00.03%), Neon (00.0015%), Helium (00.00052%), Methane (00.00015%), Krypton (0.001%), Hydrogen (00.00005%), Nitrous oxide (00.00005%), Xenon (00.000009%), and Ozone (00.00007%). There are more than 7,50,000 manmade chemicals present in our environment and to those 1000-2000 new ones are added every year. Massive production of such chemicals directly or indirectly releases thousands of tones of a variety of air pollutants into the atmosphere. Some of the air pollutants released into the atmosphere by man are CO, CO_2 SO_2, some other gases, vapours, odour and dusts of toxic metals like Lead, Arsenic, Asbestos, Nickel, Mercury, Vanadium, Zinc, various hydrocarbons, fluorides etc. Indeed quite a large number of heavy metals are essential to plant and animal (including human life). Few of these include iron, manganese, copper, nickel, zinc, cobalt, chromium and molybdenum. The toxicity of zinc to plants and fresh water algae ranges between 0.004 to 6.0 ppm. Zinc has been established as an essential trace element required for the functioning of several enzymes (Schroeder 1974, Underwood 1977). Concentration beyond limits can be highly toxic causing vomiting, dehydration, stomach pain, nausea, lethargy, dizziness and muscle in coordination (Sandstead 1975).

These investigations in relation to different air pollutants with bryophytes prove their utility as bioindicator in air pollution. Due to some special characters such as habitat diversity, structural simplicity, tot potency and rapid rate of multiplication, bryophytes can be taken for pollution monitoring studies. With this view, study has been carried out on two selected Bryophytes (Mosses) *Octoblepharumalbidum* and *Physcomitrium pyriforme,* in Heavy Traffic areas of

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Lucknow city (Uttar Pradesh), India to observe the effect of environment on these taxa with special reference to element Zn, Mn and Fe accumulation. Folkeson (1979) measured Zn concentration in *Pleuroziumschreberi, Dicranumpolysetum, Hylocomiumsplendens, Hypnumcupressiformie* from 57 sites in coniferous wood land at 1.6 - 7.0 km from a brass foundry in Sweden and found that Zn shows least variation in concentration between species. Zoltals (1988) sampled peat land within 250 km radius flinflon Monitoba near the smelter. He found the Zn concentration in the surface which is decreasing exponentially away from the source.

This paper also deals with the use of mosses as bio-indicator to collect the data of environmental pollution at some heavy traffic areas. Vehicular activity is the main cause of contamination of road side soil. It also depends on traffic density in the area, break oil quality and oil combustion techniques used in vehicles. Many other activities like fabricating works, collection and incineration of garbage, battery refilling, plating, using fertilizers in garden etc. are the main sources of environmental pollution in different heavy traffic areas of the city.

Materials and Methods

Lucknow, the capital city of Uttar Pradesh is situated on the northern Gangetic plain of India, between 26.50° North and 80.50° East at an elevation of 123 meters above sea level. Lucknow city is surrounded by its rural towns and villages. The total area covered by Lucknow is around 3204 square kilometers.

The Gomti River, the chief geographical feature, meanders through the city, dividing it into the Trans-Gomti and Cis-Gomti regions. Lucknow city is located in the seismic zone III. The climate is hot and humid in summers but winters are cold and chilly. Summers start by the end of March and remains till June. Monsoon starts immediately after the summers. Maximum and minimum temperature goes up to 310 C to 180 C respectively. Annual mean rainfall is 972 mm. October is the time when winter starts. This season is favorable for mosses.

Sites have been divided according to the traffic crowded roads and further divided into two groups according to the availability of moss species. Twelve different traffic crowded roads have been surveyed according to the availability of moss *Octoblepharumalbidum* and these sites have been put in to group-A (Table 1) viz Ayurved Hospital, Haiderganj Crossing (site no. 1), DAV College (site no.2), Exone College, Campbell Road (site no. 3), Polytechnic Campus, Kanpur Road (site no. 4), Hindustan Aeronautical Limited (site no. 5), Yojana Bhawan (site no. 6), St. Francis College (site no. 7), Kapoorthala Crossing (site no. 8), I.T. College Crossing (site no. 9), Khurram Nagar Crossing (site no. 10), Krishi Bhawan (site no. 11) and Mill Road, Aishbagh (site no. 12). On the other hand 12 more sites have also been surveyed according to availability of moss *Physcomitriumpyriforme* and put in to group-B (Table 2) vizMedical College (site no. 13), R.B. Inter College (site no. 14), Litracy House, Kanpur Road (site no. 15), Thana Ghazipur, Faizabad Road (site no. 16), Charbagh Railway Station (site no. 17), AMC Road Sadar (site no. 18), Baradari, Kaiserbagh (site no. 19), Gandhi Museum (site no. 20), Doordarshan Kendra (site no. 21), Begum Hazrat Mahal Park Road (site no. 22), Daliganj, Railway Crossing (site no.23), Public Laundry, Nadan Mahal Road (site no.24). In order to collect moss samples of *Octoblepharumalbidum* from pollution free zone gardens and monument places have also been surveyed (Table 3). Moss samples of group-A have been collected from Residency Ruins (site no. 1) and Dr. Bhim Rao Ambedkar Park (site no. 2), and moss samples of groups-B *Physcomitriumpyriforme* (Table 4) samples have been collected from Dilkusha Garden (site no. 3) and Kukrail Reserve Forest Picnic Spot (site no. 4) and all these four samples have been treated as control.

Table 1 Showing Catalase activity (µ moles H_2O_2split / 100 mg fr.Wt and Zn, Mn , Fe concentration µgg^{-1} in moss Octoblepharumalbidum collected from Area-B Heavy traffic sites.

Site No.	**Area-A Heavy traffic sites**	**Zn Mean + SD (conc. in µgg^{-1})**	**Mn Mean +SD (conc. in µgg^{-1})**	**Fe Mean + SD (conc. in µgg^{-1})**	**Catalase activity (µ moles H_2O_2 split / 100 mg fr. wt** Mean + SD
1	Ayurved Hospital, Haiderganj Crossing	195.60 + 18.26	168.00 + 6.70	1900.00 + 216.00	6.50 + 1.00
2	DAV College	200.00 + 8.16	130.00 + 14.14	2000.00 + 163.00	8.00 + 0.50
3	Exone College, Campbell Road	679.00 + 1.41	468.00 + 21.30	3006.00 + 429.00	10.00 + 0.50
4	Polytechnic campus, Kanpur Road	466.00 + 28.50	151.00 + 0.94	6600.00 + 0.00	8.75 + 0.75
5	Hindustan Aeronotical Limited	680.00 + 2.16	202.00 + 1.88	1020.00 + 172.00	6.75 + 0.25
6	YojanaBhawan	147.00 + 0.81	232.00 + 22.60	3000.00 + 163.00	9.00 + 0.50
7	St. Francis College	321.00 + 4.64	207.00 + 2.05	2133.00 + 124.00	11.00 + 0.50
8	Kapoorthala Crossing	526.00 + 0.47	166.60 + 4.64	1666.00 + 94.20	7.75 + 0.25
9	I.T. College Crossing	490.00 + 8.16	203.00 + 38.60	1666.00 + 94.20	8.25 + 0.25
10	Khurram Nagar Crossing	195.00 + 18.35	269.00 + 20.67	1233.00 + 124.00	7.50 + 0.50
11	KrishiBhawan	425.00 + 2.44	240.00 + 28.76	2826.00 + 115.80	8.00 + 1.00
12	Mill Road, Aishbagh	369.00 + 2.05	177.00 + 19.20	1733.00 + 94.20	7.75 + 0.25

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

For the estimation of elements Zn, Mn, Fe and catalase activity in moss material, the samples collected from different sites, were washed twice with de-ionized with water and thereafter were shacked for 15 minutes to remove adhered soil particles from moss material.

For the estimation of Zn, Mn and Fe the moss samples were oven dried for 48 hrs at 85^{0}C. The known weight of dried plant material was well digested in a mixture (10: 1) of concentrated HNO_3 and $HClO_3$ (AOAC 1990). Residues were diluted in 25 ml. distilled water and were filtered through Whatmen Filter Paper No. 11. The concentration of heavy metals in the solution was analysed by using Perkin-Elmer 280 Atomic Absorption Spectrophotometer. Analysis of the samples was carried out in triplicates. Concentrations of Elements were calculated by the formula.

$$\frac{XV}{W}$$

Where: X = reading in ppm on AAS

V = final volume (ml)

W = dry weight of moss in g

Catalase activity was analysed in 3.0 ml reaction mixture containing potassium phosphate buffer

Table 2 Showing Catalase activity (µ moles H_2O_2 split / 100 mg fr. Wt and Zn, Mn , Fe concentration µgg^{-1} in moss Physcomitriumpyriforme collected from Area-B Heavy traffic sites.

Site No	Area-B Heavy traffic sites	Zn Mean + SD (conc. in µgg^{-1})	Mn Mean +SD (conc. in µgg^{-1})	Fe Mean + SD (conc. in µgg^{-1})	Catalase activity (µ moles H_2O_2 split / 100 mg fr. wt Mean + SD
13	Medical College	422.00 + 1.42	137.00 + 1.40	2200.00 + 0.00	6.00 + 1.00
14	R.B. Inter College	316.00 + 1.41	332.00 + 6.18	3466.00 + 94.20	7.25 + 0.25
15	Litracy House, Kanpur Road	665.00 + 4.02	155.00 + 0.81	3816.00 + 23.57	9.00 + 0.50
16	Thana Ghazipur, Faizabad Road	845.00 + 0.47	152.00 + 5.24	1376.00 + 11.77	6.50 + 1.00
17	Charbagh Railway Station	1456.00 + 40.20	221.00 + 6.23	1380.00 + 424.00	6.00 + 0.50
18	AMC Road Sadar	233.00 + 8.49	156.00 + 6.18	1753.00 + 37.71	6.25 + 0.03
19	Baradari, Kaiserbagh	145.00 + 0.81	388.00 + 6.23	3000.00 + 0.00	7.50 + 1.00
20	Gandhi Museum	245.00 + 4.08	428.00 + 1.63	2478.00 + 1.80	9.25 + 1.92
21	Doordarshan Kendra	422.00 + 1.41	383.00 + 6.84	2200.00 + 0.00	8.00 + 0.50
22	Begum HazratMahal Park Road	208.00 + 6.20	454.00 + 10.40	2706.00 + 9.42	8.50 + 0.50
23	Daliganj, Railway Crossing	315.00 + 1.69	336.00 + 1.24	2388.00 + 6.59	9.50 + 0.50
24	Public Laundry, NadanMahal Road	284.00 + 1.63	163.00 + 2.35	2013.00 + 18.80	7.50 + 0.50

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

Table 3. Showing Catalase activity (µ moles **H_2O_2**split / 100 mg fr. Wt and Zn, Mn , Fe concentration µgg^{-1} in moss *Octoblepharumalbidum* collected from Area A – Garden and Monumental.

Site No.	Area A – Garden and Monumental	Zn Mean + SD (conc. in µgg^{-1})	Mn Mean +SD (conc. in µgg^{-1})	Fe Mean + SD (conc. in µgg^{-1})	Catalase activity (µ moles H_2O_2split / 100 mg fr. wt Mean + SD
25	Residency Ruins(oa)	736.00 + 18.80	375.00 + 16.90	11506.00 + 21.90	10.00 + 1.00
26	Dr. BhimRao Ambedkar Parkoa)	727.00 + 18.90	340.00 + 14.71	5733.00 **+ 124.72**	10.50 + 1.25

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

Table 4. Showing Catalase activity (µ moles H_2O_2split / 100 mg fr. Wt and Zn, Mn , Fe concentration µgg^{-1} in moss *Physcomitriumpyriforme* collected from Area A – Garden and Monumental.

Site No.	Area -A Garden and Monumental	Zn Mean + SD (conc. in µgg^{-1})	Mn Mean +SD (conc. in µgg^{-1})	Fe Mean + SD (conc. in µgg^{-1})	Catalase activity (µ moles H_2O_2split / 100 mg fr. wt Mean + SD
27	Dilkusha Garden	476.00 + 4.32	276.00 + 13.69	6666.00 + 189.50	11.25 + 0.25
28	Kukrail Reserve Forest Picnic Spot	1560.00 **+ 16.77**	284.00 + 0.81	8020.00 + 55.62	10.50 + 1.00

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

pH 7.0, 11.0 mM H_2O_2 and moss homogenate following the kinetics at 250°C. Activity was determined Spectrophotometrically by monitoring the decomposition of H_2O_2 at 240 nm by measuring the time required for a decrease of absorbance from 0.45 to 0.40 (Aebi 1983).

The estimation of elements content and catalase activity data were subjected to variance analysis in order to discriminate real average effects from them, which may be due to chance error. The interpretation of the results was done on the basis of analysis of variance (ANOVA) test. The critical difference (CD) at 5 percent P level of probability were worked out to compare the treatments for their significance. Standard error of mean (SEm±) were computed in each case. The standard statistical methods were followed for statistical analysis of the data.

Results and Discussion

Zinc Content

Area A -Garden and Monumental Sites

At Residency Ruins (site no. 25) and at Dr. Bhim Rao Ambedkar Park (site no. 26) moss samples of *Octoblepharumalbidum* showed Zn content 736.00 µgg^{-1} and 727.00 µgg^{-1} respectively. On the other hand at Dilkusha Garden (site no.27) and at Kukrail Reserve Forest Picnic Spot (site no.28) moss samples of *Phy-scomitrium pyriforme* showed Zn content 476.00 µgg^{-1}and 1560.00 µgg^{-1} respectively. Carballeira *et al* (2002) determined the level of Zn in the terrestrial mosses *Scleropodiumpurum* and *Hypnumcupressiforme* collected from 75 sampling sites in Galicia (N.W. Spain).

Area B– Heavy Traffic Sites

In order to evaluate the element contamination in all Heavy Traffic sites two moss species have been taken. Highest Zn contamination was observed in moss *Physcomitriumpyriforme* collected from Charbagh Railway Station (site no. 17) 1456.00 µgg^{-1}. Higher concentrations were also found in samples of *Octoblepharumalbidum* collected from Hindustan Aeronotical Limited (site no. 5) and Exone College, Campbell Road (site no. 3)680.00 µgg^{-1} and 679.00 µgg^{-1} and in the moss *Physcomitriumpyriforme* collected from Thana Ghazipur, Faizabad Road (site no.16) and Literacy House, Kanpur Road (site no. 15) 845.00 µgg^{-1} and 665.00 µgg^{-1} respectively.

Moderate value have been found in moss samples *Octoblepharumalbdum* collected from Polytechnic campus, Kanpur Road (site no. 4), I.T. College Crossing (site no. 9), Krishi Bhawan (site no. 11) 466.00 µgg^{-1}, 490.00 µgg^{-1}, 425.00 µgg^{-1} respectively and followed by the samples of *Physcomitriumpyriforme* collected from Medical College (site no. 2) 422.00 µgg^{-1} and same in samples from Doordarshan Kendra (site no. 21). Moss *Octoblepharumalbidum* procured from DAV College (site no.2), St. Francis College (site no.7) and Mill Road, Aishbagh (site no. 12) showed the range between 200.00 µgg^{-1} -369.00 µgg^{-1}. On other hand in moss *Physcomitriumpyriforme*

collected from R.B. Inter College (site no. 14), Gandhi Museum (site no. 20) Begum Hazrat Mahal Park Road (site no. 22), Daliganj, Railway Crossing (site no.23), and Public Laundry, Nadan Mahal Road (site no. 24), showed the accumulation of Zn between the range 245.00 μgg^{-1} -316.00 μgg^{-1}. Furthermore the lowest concentration in moss *Octoblepharumalbidum* at Ayurved Hospital, Haiderganj Crossing (site no. 1), and at Khurram Nagar Crossing (site no.10) 195.00 μgg^{-1}have been found. Berg et al (1995) studied the data from a survey on atmospheric deposition of Zn in 495 moss samples of *Hylocomiumsplendens* collected in 1990 and analyses that Zn contributes the highest values in the dominant factors. Carballeira *et al* (2002) observed the level of Zn in the terrestrial mosses *Scleropodiumpurum*and *Hypnumcupressiforme* collected from 75 sampling sites in Galicia (N.W. Spain) were determined. It was found that the dominant lethology in sampling area had no influence on the estimated background levels.

Manganese Content

Area A -Garden and Monumental Sites

At Residency Ruins (site no. 25) and at Dr. Bhim Rao Ambedkar Park (site no. 26) moss samples of *Octoblepharumalbidum* showed the Zn content 375.00 μgg^{-1}, and 340.00 μgg^{-1}, respectively. At Dilkusha Garden (site no. 27) and at Kukrail Reserve Forest Picnic Spot (site no. 28) moss samples of *Physcomitriumpyriforme* the Zn content ranged between 276.00 μgg^{-1} to 284.00 μgg^{-1}. 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 B – Heavy Traffic Sites

The highest Mn accumulation has been found in the moss Octoblepharumalbidum collected from the site Exone College, Campbell Road (site no. 3) 468 µgg-1 Followed by in the moss Physcomitriumpyriforme collected from the doordarshankendra (site no. 21) and Daliganj railway crossing (site no. 23) 428.00 µgg-1 and 454.00 µgg-1 respectively. The samples of moss Octoblepharumalbidum collected from Hindustan Aeronotical Limited (site no. 5), Yojna Bhavan (site no. 6), Mill Road, Aishbagh (site no. 12) showed the Mn accumulation range 202-269 µgg-1 and in samples of Physcomitriumpyriforme collected from Charbagh Railway Station (site no. 17), Baradari Kaiserbagh (site no. 19), Begum Hazrat Mahal Park Road (site no. 22), Daliganj, Railway Crossing (site no. 23), ranged between 221-388 µgg-1. Lowest accumulation have been found in Physcomitriumpyriforme at Medical College (site no. 13), 137 µgg-1, Litracy House, Kanpur Road (site no. 15) 155 μgg^{-1}, Thana Ghazipur, Faizabad Road (site no. 16), 152 μgg^{-1}, AMC Road Sadar (site no. 18), 156 μgg^{-1} and at Public Laundry, Nadan Mahal Road (site no. 24), 163 μgg^{-1}. Lowest range of Mn accumulation was found to be in moss *Octoblepharumalbidum at* Ayurved Hospital, Haiderganj Crossing (site no. 1) 168 μgg^{-1}, DAV College (site no. 2) 130 μgg^{-1}, Polytechnic campus, Kanpur Road (site no. 4) 151 μgg^{-1} and Kapoorthala Crossing (site no. 8) 166 μgg^{-1}. Manganese (Mn) is an essential trace element for living being but toxic at higher concentrations. Pyrolusite (MnO_2) is the commonest source of manganese. It is used in ceramics, dry batteries, electrical coils, matches, glasses, dyes, welding rods, fertilizers and iron alloys. Gupta (1995) examined the content of Mn in *Plagiotheciumdenticulatum*, *Bryumargentenum* and *Sphagnum* spp. in Shillong (Meghalaya) north eastern India. Samples were collected from urban and suburban areas of Shillong while Sphagnum sp was collected from suburban sites only and the study showed that Sphagnum sp. accumulated higher amount of Mn and reversed trend was discerned for Mn in *Plagiotheciumdenticulatum*.

Iron Content

Area A -Garden and Monumental Sites

At Residency Ruins (site no. 25) and at Dr. Bhim Rao Ambedkar Park (site no. 26) moss samples of *Octoblepharumalbidum* showed

the Fe content 11506.00 μgg^{-1}, and 5733.00 μgg^{-1} respectively. At Dilkusha Garden (site no. 27) and at Kukrail Reserve Forest Picnic Spot (site no. 28) moss samples of *Physcomitriumpyriforme*the Fe content ranged between 6666.00 μgg^{-1} and 8020.00 μgg^{-1}. Abass (1998) studied the bioaccumulation of Fe in mosses collected from polluted and unpolluted areas of southern parts of Nigeria.

Area B – Heavy Traffic Sites

The highest accumulation of Fe has been demarcated in the samples of *Octoblepharumalbidum* collected from the Polytechnic campus, Kanpur Road (site no. 4) 6600.00 μgg^{-1} and followed by Exone College, Campbell Road (site no. 3) 3006 μgg^{-1}, moss *Physcomitriumpyriforme* showed the highest accumulation range between 3816-3000 μgg^{-1} in the samples collected from Litracy House, Kanpur Road (site no. 15), R.B. Inter College (site no. 14), and Baradari, Kaiserbagh site no. 19). Rest of the samples showed the accumulation range between 1376-2706 μgg^{-1} collected from different sites- Medical College (site no. 13), Thana Ghazipur, Faizabad Road (site no. 16), AMC Road Sadar (site no. 18), Gandhi Museum (site no. 20), Doordarshan Kendra (site no. 21), Begum Hazrat Mahal Park Road (site no. 22), Daliganj, Railway Crossing (site no. 23), Public Laundry and Nadan Mahal Road (site no. 24), Folkeson (1978) studied the Fe content in 5 moss species in 57 sites in coniferous woodland at 1.6-7.0 km from a brass foundry and larger amount of Fe accumulated in *HypnumCupressiforme.*

Catalase Activity

Area A -Garden and Monumental Sites

At Residency Ruins (site no. 25) and at Dr. Bhim Rao Ambedkar Park (site no. 26) moss samples of *Octoblepharumalbidum* showed the Catalase Activity 10.00-10.50 µ moles H_2O_2 split / 100 mg fr. wt. respectively. At Dilkusha Garden (site no. 27) and at Kukrail Reserve Forest Picnic Spot (site no. 28) moss samples of *Physcomitriumpyriforme* the Catalase Activity 11.25 and 10 50 µ moles H_2O_2split / 100 mg fr.Wt. Enzymatic activity in bryophytes have already been reported by various authors. Hebant and Suire (1974) analysed the activity of enzymes- acid phosphatase, cytochrome oxidase, b-fructosidase oxalic acid oxidase, peroxidase and succinate dehydrogenase in moss *Dicranum*.

Area B – Heavy traffic sites

Highest Catalase Activity was found in the moss samples of *Physcomitriumpyriforme* collected from Daliganj, Railway Crossing (site no. 23) 9.50µ moles H_2O_2 split / 100 mg fr. wt. followed by Gandhi Museum (site no. 20) 9.25µ moles H_2O_2split / 100 mg fr. wt. followed by Litracy House, Kanpur Road (site no. 15) 9.00 µ moles H_2O_2 split / 100 mg fr. wt. At Doordarshan Kendra (site no. 21), Begum Hazrat Mahal Park Road (site no. 22) ranged between 8.00- 8.50 µ moles H_2O_2 split / 100 mg fr. wt. samples collected from Medical College (site no. 13) and R.B. Inter College (site no. 14), Thana Ghazipur, Faizabad Road (site no. 16) Charbagh Railway Station (site no. 17), AMC Road Sadar (site no. 18) Catalase Activity ranged between 6.00-7.50 µ moles H_2O_2 split / 100 mg fr. wt.

Samples of moss *Octoblepharumalbidum* collected from St. Francis College (site no. 7) showed the highest Catalase Activity 11.00 µ moles H_2O_2 split / 100 mg fr. wt. followed by Exone College, Campbell Road (site no. 3) 10.00 µ moles H_2O_2 split / 100 mg fr. wt. At DAV College (site no. 2), Polytechnic campus, Kanpur Road (site no.4), Yojana Bhawan (site no. 6), I.T. College Crossing (site no. 9)and Krishi Bhawan (site no. 11) ranged between 8.00-9.00 µ moles H_2O_2 split / 100 mg fr. wt. Samples collected from Ayurved Hospital, Haiderganj Crossing (site no. 1), Hindustan Aeronotical Limited (site no. 5), Kapoorthala Crossing (site no. 8), Khurram Nagar Crossing (site no. 10) and Mill Road, Aishbagh (site no. 12) showed Catalase Activity 6.50, 6.75, 7.75,

7.50 and 7.75 µ moles H_2O_2 split / 100 mg fr. wt. respectively.

Catalase Activity at all these sites might have shown the variation due to pollution affect on habitat of mosses resulted into effect on growth of mosses. At all these sites effect of variable vehicular activities might be the cause of variation in the Catalase Activity. The catalase activity have been observed in Plagiochasma and Riccia. Udar and Chandra (1960) also examined the enzymatic activity in hepatices.

The data indicate that mosses *Octoblepharumalbidum* collected from the site Exone College, Campbell Road are highly contaminated with element Zn and Mn, Hindustan Aeronotical Limited, Kapoorthala Crossing with element Zn. Polytechnic campus, Kanpur Road and Yojana Bhawanare highly contaminated for the element Fe. In case of moss samples of *Physcomitriumpyriforme* collected from the sites Charbagh Railway Station, Thana Ghazipur, Faizabad Road and Doordarshan Kendra are also found to be contaminated for the element Zn. Samples collected from the site R.B. Inter College and Litracy House, Kanpur Road are contaminated for the element Zn, Mn and Fe and Baradari, Kaiserbagh are for Mn and Zn. At Garden and monuments sites Residency Ruins, Reserve Forest Picnic and Dilkusha Garden Fe has been found in high value in both the mosses. Kukrail Reserve Forest Picnic Spot is highly contaminated for Zn. Catalase activity have also been found high in samples collected from Garden and monuments sites.

The present study shows no similar pattern of elements accumulation in both moss samples in Group-A and Group-B at all sites. Different concentrations of elements observed at different sites indicates that the vehicular pollution is not only the cause of heavy metal accumulation in mosses but some other commercial activities being done in these areas also cause the contamination in moss sample. Data also indicates that Zn, Mn and Fe accumulation in both moss samples collected from number of Garden and Monument sites were found to be higher as compared to the elements accumulation found in Heavy Traffic sites. Moss samples taken from the garden soil also showed higher catalase activity and were found to be indirectly proportionate to these areas showed that any type of pollution can cause this decrease in metabolic activities of mosses.

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