



MINERAL NUTRIENTS IN SOME MOSS SPECIES FROM MAHARASHTRA, INDIA

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ABSTRACT

The composition of mineral nutrients was studied in mosses from Maharashtra namely *Barbula unguiculata* Hedw., *Hypnum reflexum* F. E. Tripp., *Steeriophyllum anceps* (Bosch et. Lac.) Broth., *Fissidens crenulatus* Mitt., *Trachypodiopsis blanda* (Mitt.) Fleisch., *Funaria hygrometrica* Hedw., *Macromitrium sulcatum* Brid., *Brachymenium turgidum* Broth., *Bryum coronatum* Schwaegr. and *Hyophila involuta* (Hook.) Jaeg. growing in various habitats like Lonawala and Khandala, Mahabaleshwar, Sinhagad, Kaas Plateau and Aundh (Satara). The study revealed that these eleven nutrients (Ca, Mg, N, K, S, P, Fe, Mn, Cu and Zn) showed differential accumulation from species to species. The level of Ca is usually more than the other macroelements viz. N, P, K, S, and Mg in mosses. It ranges from 10- 26.5 mg/g dry wt. N, P, K and Mg also important macronutrients ranges from 0.41-23.7, 0.8-3.3, 2.5-6.5, 3.3-8.6 mg/g dry wt. The level of S lowest among all those of macronutrients ranges from 1.8 - 5.3 mg/g. The level of Fe (10500-35300 µg/g dry wt.) is the highest and Zn (45-166 µg/g dry wt.) is the lowest among all the microelements in mosses as compared to remaining moss species with few exceptions.

KEYWORD: Accumulation, Mosses, Nutrients, Maharashtra, India.

INTRODUCTION

Mineral nutrients is performs a crucial role in growth and development of mosses. Shacklette (1965) determined the nutrient contents of 29 species of bryophytes and found that the concentrations of Al, Ba, Cr, Cu, Fe, Ga, Ni, Pb, Ag, V and Zn were higher in bryophytes than those in angiosperms. The heavy metal ions the retention efficiency order is $Cu^{2+} > Pb^{2+} > Ni^{2+} > Co^{2+} > Zn^{2+} > Mn^{2+}$ as shown for *Hylocomium splendens* by (Ruhling and Tyler, 1970). Pakarinen and Tolonen (1977) reported major nutrients (N, P, K, Ca, Mg, Na, and Fe) were analysed in 38 *Sphagnum* and water samples taken mainly from bogs and poor fens. The nutrient accumulation in *Sphagnum* mosses observed by (Aulio, 1980, 1982; Wojtun 1993; Tomas and Adamec, 2009) Saxena *et al.* (2005) detected chemical constituents like Copper, Nickel and Iron from corticalous mosses from Mahabaleshwar in Western Ghats. The effect of some heavy metals their toxic effect has been studied in mosses. (Kaur *et al.*, 2010; Saxena and Arfeen, 2010) Lou *et al.* (2013) studied that the content of the heavy metals Pb, Cr, and Cu in the moss *Haplocladium microphyllum*.

MATERIAL AND METHOD

The moss species like *Bryum ghatens* Broth. et Dix., *Hypnum reflexum* F. E. Tripp., *Steeriophyllum ancens* (Bosch et Lac.) Broth., *Fissidens crenulatus* Mitt., *Trachypodiopsis blanda* (Mitt.) Fleisch., *Funaria hygrometrica* Hedw., *Macromitrium sulcatum* Brid., *Brachymenium turgidum* Broth., *Bryum coronatum* Schwaegr. and *Hyophila involuta* (Hook.) Jaeg. collected from various localities such as Lonawala and Khandala, Mahabaleshwar, Sinhagad, Kaas Plateau and Aundh (Satara) during July, 2018 to September, 2018 from moist shady places in rainy season. Before evaluation, material has been cleaned along with water and dried at room temperature for 24 hrs. After that this dried powdered material was used for analysis nutrients.

Bremner (1960) estimated Nitrogen content using Kjeldahl distillation method. Phosphorous determined by Spectrophotometrical method (Chapman and Pratt, 1961). Drosdoff and Nearpass (1948) determined the Magnesium content by Spectrophotometrical method. Sulphur is estimated Spectrophotometrical method by (Tabatabai and Bremener, 1970) and Toth *et al.* (1948) determined Calcium, Potassium and Sodium are by Flame photometrically. The Microelements namely Iron,

Manganese, Zinc, Copper were estimated using Atomic Absorption Spectrophotometer (Perkin-Elmer-3030).

RESULT AND DISCUSSION

Nitrogen content of various mosses is mentioned in Table 1. It is evident from the results that nitrogen content is maximum in *Hyophila involuta* i.e. 23.7 mg/g dry wt. and *Bryum coronatum* (0.41 mg/g dry wt.) have less amount of nitrogen. Rastorfer (1974) has reported that the concentration of nitrogen in different Alaskan Arctic mosses ranges from 9-15 mg/g dry wt. The maximum amount of P was found in *Trachypodiopsis blanda* (3.3 mg/g dry wt.) and minimum amount in *Brachymerium turgidum* (0.8 mg/g dry wt.) as compared to remaining mosses. P content of mosses from Alaskan Arctic region was in the range of 1.8 - 2.3 mg/g dry wt. (Rastorfer, 1974). It is evident from the present results that as compared to this optimum level the level of phosphorus relatively very high in all mosses. The maximum amount of potassium was found in the *Macromitrium sulcatum* (6.5 mg/g) while lowest in *Fissidens crenulatus* (2.5 mg/g) among all mosses. Rastorfer (1974) has reported 5.4 - 8.8 mg/g potassium in the mosses. According to Sawant (2010) concentration of K in the hornwort i.e. *A. subtilis* is (1.7 mg/g) while maximum amount is found in the liverwort *A. wallichiana* (21.3 mg/g). Level of P is more or less similar in *P. intermedium* (15 mg/g) and *C. cavernarum* (10.4 mg/g) while it is the lowest in *T. hypophylla* (5.6 mg/g) among all liverworts. The Maximum amount of Ca is found in *Macromitrium sulcatum* and minimum amount in *Bryum coronatum* as compared to remaining mosses. Rastorfer (1974) has reported 1.5-10.2 mg/g Ca in mosses.

Mg is the also lowest among macronutrients studied. It ranges from 3.3 - 8.6 mg/g dry wt. with the highest concentration in *Funaria hygrometrica* (8.6 mg/g dry wt.), while its concentration is lower in case *Bryum coronatum*. The level of Mg in the mosses studied higher than the optimal levels of Mg given by Mengel and Epstein for higher plants. Rastorfer (1974) has recorded the concentration of Mg in mosses from Arctic region which ranges from 1.3- 4.5 mg/g. The level of sulphur lowest among all those of macronutrients studied. It ranges from 1.8 - 5.8 mg/g. The *Brachymerium turgidum* is the lowest (1.8 mg/g) among all studied mosses while it is maximum in case of *Hyophila involuta* (5.8 mg/g) and there is no much difference in all other cases. It can be said that the level of sulphur less in all mosses. Rastorfer (1974) reported that sulphur content of the mosses from Arctic regions is 0.89-1.045 mg/g. The total sulphur content in the tracheophyte tissues is in the order of 2-5 mg/g in dry matter (Mengel and Kirkby, 1982).

It is clear from the present results (Table 2) that the level of iron is the highest among all the microelements in mosses. Which is also similar in case

of mosses studied (369-1056 ppm) from Arctic regions (Rastorfer, 1974). *Steeriophyllum anceps* has the highest concentration of Fe (35300 µg/g dry wt.) and with the lowest concentration in *Brachymerium turgidum* (10500 µg/g dry wt.). It is also evident from the present study that the level of Fe is higher than that reported by Rastorfer (1974). Levels of Fe higher than 1550 µg/g have been reported in bryophytes (Rao and LeBlance, 1967).

There is diverse range of manganese concentration from 310 to 1020 µg/g dry wt. *Funaria hygrometrica* and *Barbula unguiculata* accumulate more manganese (1020 µg/g dry wt.) and *Bryum coronatum* accumulate minimum (310 µg/g dry wt.). According to Stout (1961) and Epstein (1972), critical level of manganese is 30-50 µg/g dry wt. for tracheophytes.

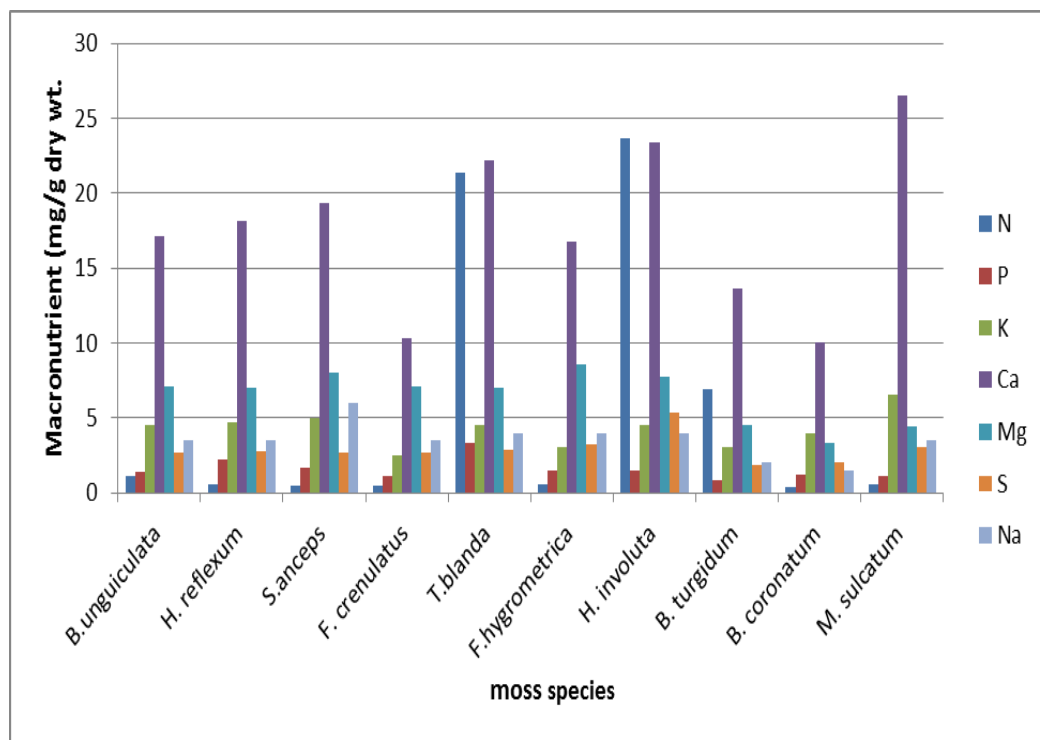
The level of Zinc is the lowest among all the microelements in mosses. It ranges from 45-166 µg/g dry wt. The concentration of Zn for mosses from Arctic region is in the range of 45-66 µg/g (Rastorfer, 1974). The highest concentration level of Zinc in *Hyophila involuta* (166 µg/g dry wt.) while its concentration is lower in case *Bryum coronatum* (45 µg/g dry wt). The result shows that the level of Zn in all mosses is near to the values given by Rao and Leblanc (1967).

The concentration of copper in the mosses was reported to be in the range of 71-541 ppm *Funaria hygrometrica* contains the highest amount of copper (541 µg/g dry wt) from among the remaining mosses and then lower with 71 µg/g dry wt of copper in *Macromitrium sulcatum*. It can be said that the level of copper in all mosses is higher than optimum level of dry plant material. Shacklette (1965) has determined the mineral content of 29 species of bryophytes and found that concentrations of Cu higher in bryophytes as compared to that in angiosperms.

Table 1: Composition of macronutrients (mg/g dry wt.) in moss species.

Sr. No.	Name of Extract Species	N	P	K	Ca	Mg	S
1	<i>Barbula unguiculata</i> Hedw.	1.1	1.4	4.5	17.1	7.1	2.7
2	<i>Hypnum reflexum</i> F. E. Tripp.	0.51	2.2	4.7	18.1	7.0	2.8
3	<i>Steeriophyllum anceps</i> (Bosch et. Lac.) Broth.	0.45	1.7	5.0	19.3	8.0	2.7
4	<i>Fissidens crenulatus</i> Mitt.	0.43	1.1	2.5	10.3	7.1	2.7
5	<i>Trachypodiopsis blanda</i> (Mitt.) Fleisch.	21.4	3.3	4.5	22.2	7.0	2.9
6	<i>Funaria hygrometrica</i> Hedw.	0.58	1.5	3.0	16.8	8.6	3.2
7	<i>Hyophila involuta</i> (Hook) Jaeg.	23.7	1.5	4.5	23.4	7.7	5.3
8	<i>Brachymerium turgidum</i> Broth.	6.9	0.8	3.0	13.6	4.5	1.8
9	<i>Bryum coronatum</i> Schwaegr.	0.41	1.2	4.0	10.0	3.3	2.0
10	<i>Macromitrium sulcatum</i> Brid.	0.58	1.1	6.5	26.5	4.4	3.0

*Values are mean of three replications expressed as mg/g dry wt.

**Fig. 1: Composition of macronutrients (mg/g dry wt.) in moss species.****Table 2: Composition of Micronutrients ($\mu\text{g/g}$ dry wt.) in moss species.**

Sr. No.	Name of Extract Species	Fe	Mn	Zn	Cu
1	<i>Barbula unguiculata</i> Hedw.	30100	1020	142	152
2	<i>Hypnum reflexum</i> F. E. Tripp.	32100	945	102	158
3	<i>Steeriophyllum anceps</i> (Bosch et. Lac.) Broth	35300	950	126	481
4	<i>Fissidens crenulatus</i> Mitt.	32000	785	69	264
5	<i>Trachypodiopsis blanda</i> (Mitt.) Fleisch.	21000	333	80	188
6	<i>Funaria hygrometrica</i> Hedw.	32100	1020	71	541
7	<i>Hyophila involuta</i> (Hook) Jaeg.	29000	770	166	500
8	<i>Brachymerium turgidum</i> Broth.	10500	340	49	120
9	<i>Bryum coronatum</i> Schwaegr.	11700	310	45	216
10	<i>Macromitrium sulcatum</i> Brid.	18200	390	75	71

*Values are mean of three replications expressed as $\mu\text{g/g}$ dry wt.

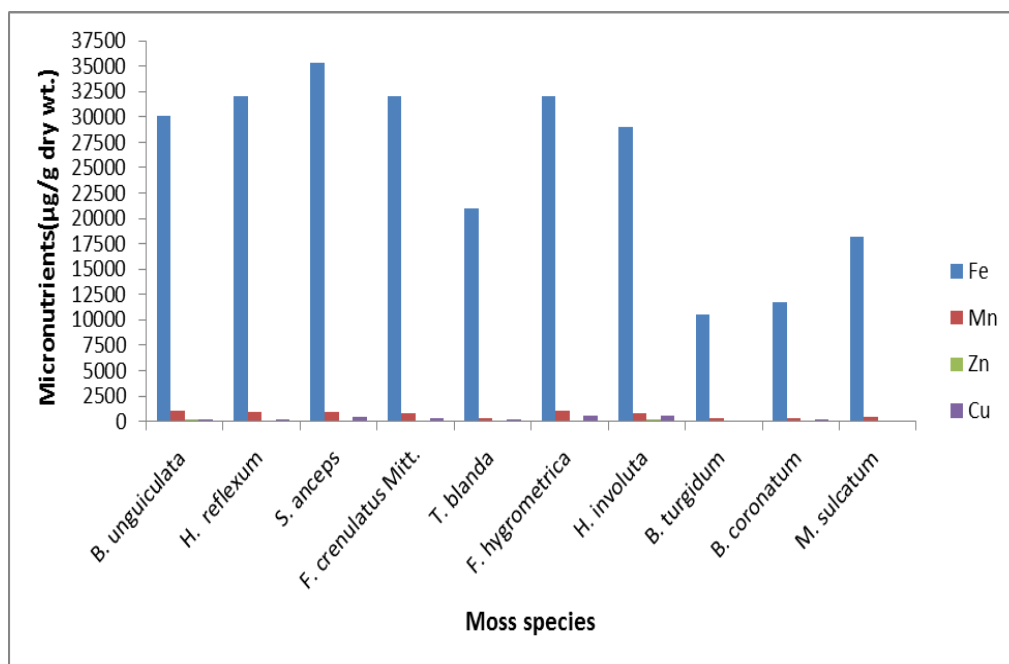


Fig. 2: Composition of Micronutrients (µg/g dry wt.) in moss species

CONCLUSION

The study revealed that these ten nutrients (N, K, P, S, Ca, Mg, Fe, Mn, Cu and Zn) showed differential accumulation from species to species. The nutrient content in *Steeriophyllum anceps* and *Hyophila involuta* was higher as compared to all moss species with few exceptions. The like Ca and Fe concentration was comparatively higher in all moss species. Accumulation of Ca in mosses takes part in regulation of water flow across plant membranes there by helps in stomatal movement to reduce water loss. Iron is an essential nutrient for plants. It accepts and donates electrons, and it plays important roles in the electron transport chains associated with photosynthesis and respiration.

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