

Air Quality Analytics and Monitoring: A study employing Transplanted Porina Lichen in Mumbai City

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Abstract

Present work aims to investigate bioaccumulation of heavy metals of anthropogenic origin employing lichens as active bioindicators in different locations of Mumbai. Lichens act as reliable bioindicators of terrestrial air quality due to lack of significant cuticle or epidermis combined with their extraordinary capability to grow in a large geographical area. *Porina Internigrans* (Nyl.) Mull. Arg. was collected from different locations of Bhimashankar for 3 consecutive years, identified at National Botanical Research Institute and transplanted at 30 locations of Mumbai for three months. Dried and powdered lichen samples, standard and control were digested and heavy metals were analyzed. Metals such as Al, Ba, Cd, Cr, Fe, Hg, Mn, Ni, Pb, Cu and Zn were analyzed and the correlation between exposure time and concentrations were statistically tested and enrichment factor (EF) and exposed-to-control (EC) ratio were calculated showing a spatial distribution in the concentration of heavy metals. Differences in concentrations of elements were accounted for by EC ratio, which allowed interpretation of changes in element concentrations.

In this study, some high levels of metals were observed which are attributed to discrete pollution events that occurred a short time before sampling and confirming the ability of lichen transplants for active monitoring.

Keywords: Anthropogenic, Enrichment factor, Bioaccumulation, Exposed-to-Control ratio.

Introduction

The present work has aimed to investigate bioaccumulation of heavy metals of anthropogenic origin using lichens as bioindicators in different locations of Mumbai city and secondly to confirm the ability of the transplanted lichens as potential bioindicators for biomonitoring of heavy metals of anthropogenic origin. Mumbai, most densely populated city of India, is overburdened with thousands of industry and millions of vehicles running every day on the roads across the length and breadth of the city. Despite these facts, to date, no serious attempt has been made to measure the atmospheric heavy metal deposition employing bioindicator.

Many definitions of heavy metals have been proposed based on their density, atomic number, atomic mass, toxicity etc.

But the most common one is metals having density more than 5g cm^{-3} . Study of heavy metals is very important as many are toxic due to their stability and non-biodegradability. Hence, they make entry into the food chain. Anthropogenic activities can alter the balance of heavy metals in the environment and hence can alter biochemical and geochemical cycles. Major sources of heavy metals in urban areas are anthropogenic e.g. industrial effluents, solid waste disposal, metal reprocessing etc.

Lichens as bioindicators: The word lichen has a Greek origin which denotes the superficial growth on the bark of trees, rock as well as soil. Lichen species are collectively called as “Stone flower” in English, “Patthar ka Phool” in Hindi, “Dagad Phool” in Marathi etc. Lichens are composite organisms comprised of a mycobiont (fungus) and one or more photobiont (algae) living together in symbiotic association in which the algal partner produces essential nutrients and fungal partner provides mechanical strength. Development and establishment of lichen on a substratum are achieved by fruiting bodies (apothecia) produced by the fungal partner, which must germinate and find an algal partner before they can form a new thallus or may produce minute fragments (isidia or soredia) containing both partners, which can disperse quickly and colonize available habitat.

Biomonitoring employing Lichens: Biomonitoring can be defined as “A continuous observation of a geographical region with the help of a suitable bio-species that reflect changes over space and time”. The use of plant biomonitoring has proved to be a complementary method of investigation for pollutant analysis, as they constitute real biological integrators capable of providing a basis for assessment of environmental quality and/or contamination.¹⁻⁴ Over the past few years, research has been focused on the measurement of chemical compounds of plants as indicators of a particular environment state which provides a basis for determining the long-term impact of even low levels of pollution. Since these physiological changes appear before morphological and anatomical symptoms, they provide an early warning signal of modifications in environmental quality.

Lichens are perennial plants with a very slow growth rate which is mainly attributed to the growth of the mycobiont. There is no supply of nutrients from the central part of the growing part and the food produced by the photobiont at the growth site is used by the mycobiont. The pattern of growth, in general, is centrifugal, apical and marginal. In crustose