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Integrated Environmental Risk Assessment Using Biomarkers in Marine Plants of the Gulf of Mannar, India

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Abstract

The purpose of this study was to explore a possible relationship between inorganic metals and oxidative stress in marine plants of south east coast of India. The investigation was carried out during the low tides in Pudumadam, Mandapam, Pamban and Keelakarai coastal areas. The distribution of elements such as phosphorus, nitrogen, lead (Pb), manganese (Mn), iron (Fe), copper (Cu), and zinc (Zn) were determined in the marine plants and its surrounding seawater. An atomic absorption spectrometer, Varian Model SPECTRAA was used to determine the level of heavy metals. The impact of metals on the metabolism of the plants was determined by the level of antioxidant response. Low levels of Mn, Cu were observed in Pudumadam species. The thiobarbutric acid reactive substances formation in the marine plants showed a positive correlation with the trace element selected sites, which indicates the contamination of sewage and industrial pollution in these waters.

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Keywords: Gulf of Mannar; heavy metals; marine plants; oxidative stress

1. Introduction

Marine flora are the extraordinary sustainable resources in the coastal ecosystem which have been used as a source of food, agriculture, medicine etc. The production or growth of the marine plants was affected by natural calamities and anthropogenic activities [1]. Heavy metals and pesticides are the major pollutants in the marine environment due to human activities. The ocean provides a sink for these pollutants. Among which

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heavy metals are non-biodegradable and are strongly phytotoxic (cadmium, lead, mercury etc.,) because of the generation of reactive oxygen species (ROS), which react with macromolecules causing lipid peroxidation, membrane damage, metabolite degradation, inactivation of enzymes, and finally cell death [2]. This study was, therefore, designed to investigate (i) the extent of heavy metals accumulated in seagrass species and (ii) to examine changes in anti-oxidant enzyme activities (SOD, CAT, GSH and GPX) and lipid peroxidation in relation to element accumulation. The ultimate focus of the present study is to examine if aquatic pollutants present in the selected coastal regions are generating biological responses in the seagrass. To accomplish this objective, biomarker responses were measured in seagrass species collected along the coasts of gulf of mannar region.

2. Experimental Method

2.1. Study site

The fresh seagrass of *Halodule uninervis* (Forsskål) Ascherson (HU), *Syringodium isoetifolium* (Ascherson) Dandy (SI) and *Cymodocea serrulata* (R. Brown) Ascherson (CS) were collected from Kellakarai (KKR), Pamban (PBN), Mandapam (MDM) and Pudumadam (PDM) coasts of the Gulf of Mannar region, Tamilnadu, India during April 2013.

2.2. Sample Collection and Preparation

Collected seagrass samples were immediately brought to the University Research laboratory in new plastic bags containing filtered sea water in ice-cold conditions (4°C). Plants were washed thoroughly with tap water to remove epiphytes, sediments and shade dried for metal analysis.

2.3. Determination of Metal concentrations of native seagrass species

Perkin Elmer atomic absorption spectrometer model was used to analyze the concentration (mg/Kg) of heavy metals (Mn, Pb, Zn,Fe, and Cu) in the different seagrass samples. The concentrations of Cu, Zn, Pb, Mn and Fe were determined according to the standard double acid digestion methods analyzed using an atomic absorption spectrometer. Standards were made using certified solutions (Merck, UK) acidified with HNO_3 to the same pH as the samples. Results are expressed as the means ± S.E. of three replicate samples.

2.4. Biochemical analysis

Fresh tissue was homogenized in ice-cold 0.1 M Phosphate buffer at pH 7.8 containing 1 mM EDTA, 1 mM β-mercaptoethanol and 5 ml of 4% polyvinylpyrrolidone/g FW. The homogenate was filtered through a nylon mesh and centrifuged at 20,000 g at 4°C. The supernatant was used for measuring enzyme activity. MDA activity was determined to indicate the level of lipid peroxidation of seagrass species as described by Buege and Aust [3]. The antioxidant enzyme response was measured using Double beam UV spectrometer (Model 2201; Systronics) following the methods *viz*., Catalase [4]; Superoxide dismutase [5]; Gluthathione [6]; Glutathione peroxidase [7] and Ascorbate peroxidase [8]. All Results were expressed as mean ± standard error. Data were analyzed through ANOVA with 95% significance level.

3. Results and Discussion