STUDY OF SPATIAL VARIATION IN THE ECOPHYSIOLOGY OF AVICENNIA OFFICINALIS L. ALONG THE WETLANDS OF KANNUR DISTRICT, KERALA, INDIA

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Abstract: A comparative analysis carried out to understand the spatial variation in the Ecophysiology of the mangrove *Avicennia officinalis* along the wetlands of Kannur district, Kerala, India. The present study deals with the recording of variation in the antioxidants and stress parameters in the leaves of *Avicennia officinalis* present at different area which differ in their land use i.e. industrialization and urbanization. Habitat ecology is studied by analyzing soil and water samples. Biomarkers like malonaldehyde, chlorophyll, proline and antioxidants like Ascorbic acid and Total Glutathione is used to record the stress levels in the leaves of the plant. The study reveals that the mangroves are highly sensitive to the land use of the area and has a negative impact on the growth and development of mangroves.

Index Terms- Avicennia officinalis, **malonaldehyde, glutathione**

1. INTRODUCTION

Mangroves are salt tolerant angiosperm plants, which are commonly present along the banks of coastal water bodies. They are highly adapted to the saline environment and exhibit a number of unique morphological and eco-physiological adaptations to the coastal environment. The mangrove forests grow by taking nutrients from the tidal waters and in turn provide natural food to the mangrove dwelling fauna. The forest detritus, comprising of fallen leaves and branches from the mangroves, provides nutrients to the coastal environment and support immense variety of sea life in intricate food webs, associated directly through detritus, and indirectly through the planktonic and epiphytic algal food chain.

Mangroves are distributed circum tropically, occurring in 112 countries and territories. Global coverage has been variously estimated at 10 million hectares. In India mangroves forests covers an area of 4,740 sq. km. Mangroves in Kerala are highly fragmented and are estimated to have less than 50sq.km, existing in discrete and isolated patches. Kannur district of Kerala state, exhibits luxuriant mangrove forests which cover almost 80 % of the total mangrove forests of the state [2]. But now mangroves are considered as one of the world's most threatened ecosystems by mankind. The human thrust or pressure, other biotic factors and interactions cause changes in mangrove ecosystems. Due to this, the mangroves are now very dynamic and have become fragile throughout the globe.

The mangroves contain 40 to 70 species belonging to a total of 16 families of Dicotyledons and monocotyledons. According to Kathiresan and Bingham, the major mangrove elements include 34 species of 5 families, whereas the minor mangrove elements include another 20 species belonging to 11 families. The mangrove *Avicennia officinalis* is a dominant mangrove species found along the west coast of Kannur district. *Avicennia officinalis* belongs to family Acanthaceae and is commonly known as white mangrove. This is an evergreen perennial tree; generally attain a height between 15m and 20m; [9]

2. LITERATURE SURVEY

Various botanists studied mangroves in general and different areas of *Avicennia officinalis* L. Literature review indicates studies on morphological and physiological variation with varying environmental factors and geographic patterns within different species of *Avicennia* [6]. Several differences observed in stem and root anatomy probably explains the stunted growth of *Avicennia* in high salinity environment and its vigorous growth at lower salinity [5]. The effect of salinity on chlorophyll content and photosynthetic activity was studied in the seedlings of *Avicennia officinalis L.* under controlled experimental condition [8]. Biochemical study is carried out in *Avicennia marina* to understand the variation of the antioxidants and stress parameters along the Jamnagar coast of Gujarat [1]. Relation between chlorophyll content and secondary metabolites has been found in the seedlings of 14 different mangroves species found in the Bhitarkanika delta region, Orissa [4]. Pollution has an impact on the environment conditions of mangroves, leading to the disturbance in the growth and productivity of the plants. Apart from these, mangroves are also exposed to various biotic stress such as pest, microbial diseases etc. all these stress factors results into the production of reactive oxygen species (ROS) within the cell. Although the mangroves has been adapted to these biotic stresses through the physiological modifications and has developed an efficient antioxidative defense system composed of complex enzymatic and non-enzymatic system [7]. There is increasing

evidence that NaCl salinity is one factor leading to oxidative stress in plants cells. High NaCl concentration seems to impair electron transport in chloroplast and mitochondria, and lead to formation of Reactive Oxygen Species (ROS) [3].
The present study aims to evaluate any damage to *Avicennia officinalis* due to anthropogenic activity with the help of antioxidant enzymes, oxidative stress indicator (Malonaldehyde) and pigments in various areas that differ in their land use.

2.1 Study area
Based on variations in salinity, tidal action, sources of pollution, diversity and distribution of mangroves, five sampling sites were selected.
Station 1 (S-1): Kunhimangalam Kandal Conservation Site, KKCS**:** This is a well conserved site, so the degree of pollution is less. It has relatively more influence of fresh water.
Station 2 (S-2): Valapattanam**:** This station has high anthropogenic activity, as it is close to a fish-landing site. The well-established industries and other developmental activities are a major threat to mangrove diversity in this area.
Station 3 (S-3): Cherukunnu**:** It is a small village; the mangrove diversity is relatively high. The major threat here is non-degradable waste from factories and other domestic wastes directly discharged to the immediate environment.
Station 4 (S-4): Koduvally**:** Fishing is intensively carried out in this region. A portion of the mangrove area was partly destroyed and reclaimed for the construction of a hospital.
Station 5 (S-5): Melur**:** This is a freshwater site predominating with typical freshwater vegetation.

3. MATERIALS AND METHODS
Quadrat of size 10m x 10m were sampled at different location from the above mentioned site randomly. Three plots are taken to study from a single station. Trees with similar girth at breast height (GBH) are selected to elucidate errors related to difference in age of the plants. Further, 3rd leaves from the each branch tip were sampled. Leaves of each tree are separately collected and labeled in separate polythene bags. Water and soil samples were also collected in small bottles from each site.
Standard methods were followed for physiology analysis; Chlorophyll was estimated using Arnon method, Proline determined using Bates method, Total Glutathione content (GSH) as per Rotruck method, Lipid peroxidation (MDA) content determined following Heath and Packer method and Ascorbic acid by using Roe and Kuether method

4. RESULTS AND DISCUSSIONS
Proportions of chlorophyll in leaves are closely related to plant nutrient status. Hence, leaf color, as a function of chlorophyll content, can be used as an index to diagnose nutrient status. Table-1 shows Total chlorophyll in leaves varies from 1.202 to 1.817 mg/g. The total chlorophyll was high in S-2 and low at S-1. There was an increase in total chlorophyll with a further increase in salinity.
Proline, an amino acid, plays a highly beneficial role in plants exposed to various stress conditions. During stress, proline accumulates in plants in large amounts which is either due to enhanced synthesis or reduced degradation. Table-1 shows the proline content varies in plants from 297 to 396 mg/g. High amount of proline is found in S-4 (396mg/g) and low amount is found in S-3 (297mg/g).
Glutathione (GSH; γ-glutamyl-cysteinyl-glycine) is a small intracellular thiol molecule which is considered as a strong non-enzymatic antioxidant. Glutathione also helps to maintain cellular redox balance and performs signaling functions in plants under salt stress. Here total glutathione content range from 17.6 to 41.64 mg oxidized/min/g protein with lower values in S-2 and higher values in S-4 plants. Enhanced GSH level is correlated with enhanced salt tolerance in S-4.


Fig.1. Station 1. Kunhimangalam kandal conservation site


Fig.2. Station 2.Valapattanam Region

Fig.3.Station 3: Cherkunnu

Fig.4. Station 4: Koduvally

Fig.5.Station 5: Melur

Table-1 Variations in the different parameters

Station	Total chlorophyll (mg/g)	Proline (mg/g)	mg GSH oxidized/min/g protein	MDA content in mg/g	Ascorbic acid in mg/100g
S-1	1.202	338.2	36.9	368	1.2
S-2	1.817	320	17.6	198	2
S-3	1.706	297	23.44	121	2.2
S-4	1.344	396	41.64	273.3	1.4
S-5	1.39	342	32.83	371.7	0.8

Increase in MDA and similar decrease in chlorophyll (S-4) is an indication of damage to chloroplast cell due to high oxidative stress. Oxidative stress can be induced by a wide range of environmental factors, including drought. One of the main cellular components susceptible to damage by reactive oxygen species are lipids. MDA ranges from 121 to 371.7 mg/g in the present study (Table-1). MDA are high in S-5 and low S-3.

Ascorbic acid (vitamin C) is an abundant component of plants. It has proposed functions in photosynthesis as an enzyme cofactor and in control of cell growth. The ascorbic acid plays a key role in salt tolerance in many halophytes. The content varies from 0.8 to 2.2 mg/100g. Table-1 shows high amount of ascorbic acid is found in S-3 (2.2mg/100g) and low amount is found in S-5 (0.8mg/100g).

Table-2 Results of water and soil analysis

Sl. No	Parameters	Result				
		S-1	S-2	S-3	S-4	S-5
WATER ANALYSIS						
1	pH	6.67	7.14	6.81	6.89	6.67
2	Total dissolved solids, mg/ l	3040.0	3084.0	3079.0	3042.0	3042.0
3	Total Hardness, mg/ l	4726.0	4848.0	4785.0	4656.0	4756.0

4	Total alkinity, mg/ l	87.63	87.63	87.63	87.63	87.63
5	Chloride, mg/ l	14065.50	14296.0	14287.0	14099.0	14079.0
6	Sulphate, mg/ l	1540.0	1816.0	1810.0	1424.0	1424.0
SOIL ANALYSIS						
Macronutrients						
7	Nitrogen	1.9	0.39	1.1	1.56	0.39
8	Phosphorous(kg/ha)	14.94	29.88	74.7	44.8	7.47
9	Potassium(kg/ha)	309.1	35.32	383.0	330.4	99.05
Micronutrients						
10	Boron(kg/ha)	2	0.5	0	0	0

On the basis of water and soil analysis it is found that higher salinity is found in S-2 followed by S-3 and lower salinity is found in S-1. The increase and decrease in salinity is likely to cause some stresses in plants growing in that region. pH of water ranges from 6.67-7.14. Table-2 shows comparatively hardness of water is high in S-2. Soil analysis results shows that large amount of macronutrients are present in Station 4 and Station 5 is characterized by low macronutrient content.

5. CONCLUSION

From the above analysis it was noted that with increase in salinity total chlorophyll, GSH, MDA and Ascorbic Acid content decreased in *Avicennia*. From the above study it was found that *A. officinalis* at site S-2, S-3 and S-4 have low MDA and GSH content but these sites have high salinity. There is no gradual increase in stress parameters with increase in salinity which suggests that *A. officinalis* has a remarkably high degree of salinity tolerance, and shows an optimal growth and high activity of reactive oxygen species-scavenging antioxidant enzymes at the present range water salinity levels. Since, mangroves present at above station with high anthropogenic activities are under more stress as compared to the other stations. Therefore these stations require special attention for the conservation of mangroves and other associated floras and faunas.

6. FUTURE SCOPE

More investigation on stress physiology of *Avicennia* species is recommended to thrive light on future growth on the mangroves in the district, Kannur. Further, studies to relate the damages through the anatomical features of the leaves are required to understand the level of pollutant uptake. Seasonal variations in physiology can also be studied by considering other factors such as temperature, evaporation, rainfall etc.

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