

Ecophysiological studies of *Excoecaria Agallocha* L. along the Wetlands of Kannur, Kerala, India

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Abbreviations

LDL- Latex cell length, VD- Vessel diameter, MDA- Malondialdehyde, Chl- chlorophyll, GSH- Total glutathione, AA- Ascorbic acid, N-nitrogen, P- phosphorous, K- potassium

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ABSTRACT

Spatial variation in the ecophysiology of selected plant *Excoecaria agallocha*, is conducted in randomly selected sites of Kannur district. The present study deals with the variations in characters like leaf area, stomatal index, latex cell length and vessel diameter of *E. agallocha* collected from different ecological conditions. With the help of biomarkers like chlorophyll, MDA, proline and antioxidants like AA and total glutathione stress levels has been recorded in the leaves of the plant under study. Habitat ecology studied by analyzing the water and soils from the selected sites. The leaf area and stomatal index under selected sites shows variation. The xylem of plants exposed to high salinity showed vessels with smaller diameter than those in the xylem of plants grown under less stressful conditions. The total chlorophyll values in the leaves varied from 0.712 to 2.149 mg/g fresh weight. Total glutathione content in the present study ranged from 7.460 to 8.060 mg/g. MDA level variation indicating the presence of oxidative stress condition and damage of internal tissue. The study is significant in the conservation point of view as it provide the data of stress faced by the selected mangrove species, *Excoecaria agallocha*.

1. Introduction

One of the most threatened ecosystems in the world by mankind are the mangroves. 'Mangrove' has been variously defined in literature. The Oxford dictionary mentioned the words 'mangrove' and 'mangrove' since 1613, indicating tropical trees or shrubs found in coastal swamps with tangled roots that grow above the ground, whereas the Americans, the Spanish and the Portuguese used the term 'Mangle' and 'Mangue' indicating trees and shrubs of the genus *Rhizophora* (Mephram & Mephram, 1985). Later, the term 'mangrove' was referred to the individual plant or tidal forest or both, as 'Mangrove plants' and 'mangrove ecosystem' (Mandal & Naskar, 2008). Mangroves are possibly evolved just after the first angiosperms, around 114 million years ago (Duke *et al*, 1998). There are two categories of mangroves, true mangroves & mangrove associates (Wang *et al.*, 2014). The species which are adapted to mangrove environment and do not extend into other coastal environment and also found within mangroves are called mangrove associates (Ragavan *et al.*, 2016).

Mangroves are found between the latitudes of 32 degree N and 38 degree S of the globe and also in the mouths of estuaries and in intertidal areas. Ragavan *et al.*, (2016)) shows that Indian mangroves consist of 46 true mangroves species belonging to 14 families and 22 genera, which includes 42 species and 4 natural hybrids. Mangroves are highly localized in Kerala, but the species diversity and their associates are comparatively rich. Mangroves are a diverse group of tree species that grow in saline, tidal wetlands on tropical and subtropical coastlines. Mangroves tolerate a wide range of soil salinity while salinity has long been recognized as an important factor that limits mangrove growth and productivity (Mandal &

Naskar, 2008, Odum *et al.*, 1982 Hutching *et al.*, 1987). Mangroves are nonetheless highly adapted to salt concentrations in soils that exceed concentrations tolerated by most other plant species (Ball, 1998).

The present study is carried out in a true mangrove species *Excoecaria agallocha*. L belongs to the family Euphorbiaceae. It is a glabrous tree or shrub with acrid milky juice. The *Excoecaria* ('Kannampotti') are usually seen in the saline muddy area with less water content while compared to other true mangroves like *Avicennia* and *Rhizophora*.

2. Material and Methods

The present study was carried out in the following four randomly selected mangrove occurring sites in Kannur district of Kerala, India.

Station 1- Kunjimangalam (S1) – This is a well conserved site in which the degree of pollution is relatively less. It has more influence of fresh water.

Station 2- Muttill (S2) - This is a freshwater site predominating with typical freshwater vegetation.

Station 3 – Vayalapraka (S3) – The major threat to mangroves in this area is tourism and the Vayalapraka ayal floating park.

Station 4- Thavam (S4) – Here 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.

Three quadrats (10m×10m) were randomly selected from each station by using nails and thread. The areas of study were frequently visited from August 2017 to March 2018. Fresh leaves were collected in triplicates from three plants of each quadrat. Individual plants with similar girth at breast height (GBH) were selected to elucidate errors related to difference in age of the plants. Further, third leaf from each branch tip was sampled from all the quadrats. Water and soil from each station were collected for analyzing habitat ecology.

Chlorophyll content (Arnon, 1949), Ascorbic acid by Roe and Kuether method (Roscoe et al., 1954), Proline (Bates et al., 1973), Total Glutathione content (GSH) (Rotruck et al., 1973) and Lipid peroxidation (MDA) content (Heath and Packer, 1968) were analysed physiologically by using standard methods.

3. Results and Discussion

Plant physiologists require leaf area measurements for studying primary production in plants and it may vary with light interception, evapo transpiration, photosynthetic efficiency, fertilizers and irrigation responses and plant growth. The leaf area under selected sites (table 1) shows that plants with highest leaf area are in S4 and least in S3. Stomata are known to play a pivotal role in productivity of plants. Table 1 also illustrates the variations in stomatal index of stations under study. The ascending order of stomatal index is as follows; S2>S4>S3>S1. It implies that least stomatal index is that of S1.

T.S. of leaf shows variation in the length of latex cell seen on either side of the wing. LCL is comparatively high in S1 and least in S4. The xylem of plants exposed to high salinity often contains vessels with smaller diameter than those in the xylem of plants grown under less stressful conditions. Vessel diameter in stem T. S. is comparatively high in S1 and less in S4. Vessel length is comparatively high in S1.

Table 1- Morphological and anatomical features of *Excoecaria agallocha*.L in different sites under study.

SITES	MORPHOLOGICAL ANALYSIS	ANATOMICAL ANALYSIS		
	Leaf Area (Cm ²)	Stomatal Index	LCL (10X) (micro meter)	VD (45X) (micro meter)
S1	20.134	11.758	252.283	36.071
S2	21.258	13.539	147.565	24.232
S3	17.846	13.002	133.281	25.411
S4	28.344	13.381	124.102	22.386

The total chlorophyll values (table 2) in the leaves varied from 0.712 to 2.149 mg/g fresh weight. It is found that the chlorophyll contents were reduced significantly as a result of increase in salinity. Light and temperature fluctuations like factors may induce salinity of water and may inhibit chlorophyll synthesis. The total chlorophyll value were high in S-2 and low at S-4.

Proline, an osmolyte is also regarded as a powerful antioxidant. During stress, proline accumulates in plants in large amounts which is either due to enhanced synthesis or reduced degradation (Verbruggen & Hermans, 2008). In the present study high proline content can be observed in S-2 and low in S1. Stabilization of the plasma membrane by glutathione helps to reduce passive Na⁺ influx, which enhances plant salt tolerance. Total glutathione content in the present study ranged

from 7.460 to 8.060 mg/g with higher value in S-4 and lower in S-2 (table -2).

Increase in MDA and similar decrease in chlorophyll is an indication of damage by chloroplast cell due to high oxidative stress (Amita & Deepa, 2016). In the present study high MDA levels were reported from S1 and low at S2 indicating the presence of oxidative stress condition and damaged internal tissue. Oxidative stress can be induced by a wide range of environmental factors; including drought. MDA is a reliable indicator of membrane injury caused by ROS. It may result in the breakdown of chlorophyll. So S1 contains less amount of chlorophyll. Ascorbic acid plays a key role in the salt tolerance in many halophytes. AA in the present study reported high at S-3 (3 mg/100g tissue) and S-2 (0.6).

Table 2 –Some physiological characters of *Excoecaria agallocha*.L in different stations under study.

SITE	CHLOROPHYLL (mg/g)			PROLINE (μmol/g tissue)	GSH (mg/g)	MDA (mg/g)	AA(mg/100g tissue)
	Chl a	Chl b	Total chl				
S1	0.712	0.531	1.243	10.043	7.461	153.65	1.3
S2	1.388	0.671	2.149	84.848	7.070	94.69	0.6
S3	1.074	0.478	1.552	49.696	7.996	109.76	3
S4	0.424	0.291	0.715	33.246	8.060	103.44	1

The pH is a measure of the concentration of the hydrogen ions. For acidic solution, the lower the pH the conductivity will be greater due to higher the total dissolved solids (TDS). TDS represents the total concentration of dissolved substance like

calcium, phosphate, nitrates, sodium, potassium and chloride. This trend can be seen in the S4>S3>S1>S2 according to the ascending order of pH. The low or absence of phosphate indicates no problems of eutrophication.

The degradation of organic matter deposited through time is also part of mangrove soils. Soil analysis indicates that soil characteristics are major factor limiting growth and distribution of plants in mangroves. Species composition and distribution of mangroves are also related to soil characteristics. The pH is

more basic in S3 soil followed by S4, S1 & S2. The amount of total nitrogen is shown a slight variation between stations. It is high in S3 and less in S2 & S4. High amount of potassium and phosphorous has been reported in S1 and S2 respectively (table- 3).

Table 3 – Water and soil analysis of the different stations under study

STATIONS	WATER ANALYSIS			SOIL ANALYSIS			
	pH	TDS	Turbidity	pH	N (%)	P (kg/ha)	K(kg/ha)
S1	6.67	3040	16.20	6.40	1.9	14.94	309.1
S2	6.16	3006	1.02	6.55	1.1	119.5	67.6
S3	6.71	3062	1.05	5.66	2.92	7.47	89.5
S4	6.81	3089	1.50	6.01	1.1	74.7	383

4. Conclusion

From the above observations it is clear that the mangrove at S1 & S3 are under more stressed conditions as compared to other sites. The stress indicator MDA showed higher values at station S1 and low levels of chlorophyll indicating damage to the cell membrane. The mangroves present at the S1 are facing shrimp farming as major threat and S3 is facing tourism, developmental activities, clearing and felling, invasive species like Acacia etc were the threats identified. The various physiological parameters like proline, ascorbic acid etc were

helpful in assessing the stress conditions of the mangrove *Excoecaria agallocha* from different sites. The data were helpful in planning conservation strategies and also in plotting threatened habitats.

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