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Estimation of protein and reducing sugar in some mangroves at Mirya creek of Ratnagiri, Maharashtra.

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ABSTRACT

Mangroves are salt-tolerant halophytic plants that thrive in intertidal regions of tropical and subtropical coastlines. Important ecological services provided by these special ecosystems include biodiversity support, coastline stabilization, and disaster mitigation from cyclones and tsunamis. Additionally, mangroves are abundant in bioactive substances that have both nutritional and therapeutic value. A biochemical examination was carried out in the present investigation to assess the amount of soluble protein and reducing sugars in some of the selected mangrove species from Mirya Creek in Ratnagiri, Maharashtra: Sonneratia alba, Avicennia marina, Rhizophora mucronata, and Acanthus ilicifolius. Protein estimate was done using the Lowry method (1951), and reducing sugar estimation was done using the DNSA method (Miller, 1959).

The results showed that the biochemical components varied significantly between species. *Acanthus ilicifolius* had the lowest sugar levels (0.05 mg/g) and the greatest protein (0.88 mg/g), while *Rhizophora mucronata* had the highest protein (0.92 mg/g) and reduced sugar (0.43 mg/g). These variations point to species-specific saline stress adaptation strategies. The rise in soluble proteins in salinized environments may be associated with nitrogen storage, osmotic adjustment, and stress response. Higher decreasing sugar levels, on the other hand, might promote turgor maintenance and osmotic control. Different physiological responses to salinity are indicated by the different protein–sugar profiles of *R. mucronata* and *A. ilicifolius*. These results demonstrate the potential of employing such biochemical markers for evaluating salt tolerance and are consistent with other reports (e.g., Parida *et al*., 2004).

INTRODUCTION

Mangroves are a type of halophytes that thrive in the intertidal saline marshes of tropical and subtropical coastlines. These are plants that can withstand harsh environmental conditions and are found in estuaries. The existence of "pneumatophores," or breathing roots, is their unique adaption. They are also economically and ecologically important species. Coastal populations have benefited greatly from mangroves' products, which are used for fuels, building, fishing, agriculture, and cattle feed, among other uses. Mangroves are also crucial for sustainability [1]. They are also utilized for fuel, food, medicine, and lumber. Mangroves can slow shoreline erosion and are crucial in defending coastal regions against natural disasters including tidal bores, tropical cyclones, and tsunamis [2].

Mangroves have been utilized as medicines for many years since they are a rich source of new bioactive metabolites [3]. The metabolites isolated from the mangroves are very significant from a human health. Proteins, carbohydrates, and amino acids are the products of primary metabolism they are essential for life's growth, while alkaloids, flavonoids, steroids, and terpenoids products of secondary metabolism and they have ecological, toxicological, and pharmaceutical significance [4].

Carbohydrates are fundamental assimilatory products in plants, essential for energy supply and structural functions. Among them, reducing sugars defined as carbohydrates containing a free aldehyde or ketone group are chemically reactive and capable of acting as reducing agents. These sugars are not only central to energy metabolism but also participate in osmoregulation, especially under environmental stress conditions such as salinity. Salinity stress reduces a plant's ability to absorb water, thereby impacting its overall growth and metabolism [5-6]. However, plants exhibit adaptive mechanisms to mitigate this stress, such as the absorption of mineral ions and the biosynthesis of soluble organic compounds like sugars. These compounds help restore the water potential gradient, enabling the re-establishment of cell turgor pressure [7-8]. Experimental studies further support this response. For instance, Kotmire (1983) reported higher concentrations of total sugars and starch in the leaves of *Thespesia populnea* from saline environments compared to non-saline conditions. Similarly, Chandrashekar and Sandhyarani (1994) found an increased amount of soluble sugars in Alysicarpus vaginalis, a wild leguminous species, when growing in saline habitats versus non-saline counterparts. These findings underline the role of soluble sugars as Osmo protectants that help mangroves and other halophytes withstand saline conditions.

Proteins, particularly soluble proteins, form another vital component in plant metabolic regulation. They include enzyme proteins, which catalyze essential biochemical reactions. These proteins are continuously synthesized and degraded in response to the cellular metabolic needs. In stress conditions, such as high salinity, soluble proteins contribute to stress signaling, detoxification, and maintaining osmotic balance. In recent years, plant-based proteins have attracted considerable interest, not only for their ecological sustainability but also due to their nutritional benefits. These proteins are rich in dietary fiber, vitamins, minerals, and phytochemicals, making them significant from both ecological and health perspectives. Although it remains difficult to isolate the specific health effects of plant proteins from those of plant foods in general, intervention studies involving isolated plant proteins such as soy and pea have shown potential in improving health biomarkers related to cardiovascular diseases.

In mangrove ecosystems, the accumulation of reducing sugars and proteins under environmental stress reflects an adaptive metabolic shift aimed at protecting the cellular machinery and ensuring survival in saline and dynamic estuarine habitats. These compounds are not only essential for plant resilience but also hold promise for bioprospecting in nutraceutical and pharmaceutical industries.

The district of Ratnagiri, situated along the Konkan coast of Maharashtra, exhibits a diverse ecological profile due to its unique physiographic features and coastal geography. Mangrove forests in this region, though smaller in scale compared to eastern coastal belts, play a critical ecological role. [11-14]. The present study was undertaken to evaluate the total protein and reducing sugar content in selected mangrove species located at Mirya Creek, a prominent estuarine ecosystem situated in Ratnagiri district, Maharashtra. This creek is well known for its diverse mangrove flora and serves a vital ecological function in maintaining local biodiversity, supporting nursery habitats, and facilitating nutrient cycling. In the present investigation, representative mangrove species were systematically collected and subjected to biochemical analysis to assess their nutritional composition, with a particular focus on quantifying total protein and reducing sugar levels. These biochemical parameters are important indicators of the metabolic activity of mangrove plants and provide insight into their adaptive strategies in saline and fluctuating environmental conditions.

Materials and Methods:

Study Area:

Mirya Creek is an estuarine region in the Ratnagiri district, located along the Konkan coast of Maharashtra. The site is characterized by brackish water and dense mangrove cover.

Sample Collection:

Healthy and mature leaves of selected mangrove species were collected from Mirya Creek in 2023. Immediately after collection, the samples were transported to the laboratory and stored at 4 °C until further analysis.

Estimation of Soluble Protein: Soluble proteins were estimated following the method described by Lowry *et al.* (1951). The procedure involved:

- Preparation of the extract using phosphate buffer
- Reaction with Reagent C (a mixture of sodium carbonate, copper sulfate, and sodium-potassium tartrate)
- Addition of Folin-Ciocalteu reagent
- Incubation in dark for 30 minutes
- Measurement of absorbance at 660 nm using a spectrophotometer
- Bovine Serum Albumin (BSA) was used for preparing the standard curve.

Estimation of Reducing Sugar: Reducing sugars were estimated using the DNSA method (Miller, 1959):

- Sample extract was reacted with DNSA reagent
- Mixture was heated in a boiling water bath for 5–10 minutes
- After cooling, the absorbance was measured at 540 nm
- A glucose standard curve was used for quantification

Results and Discussion:

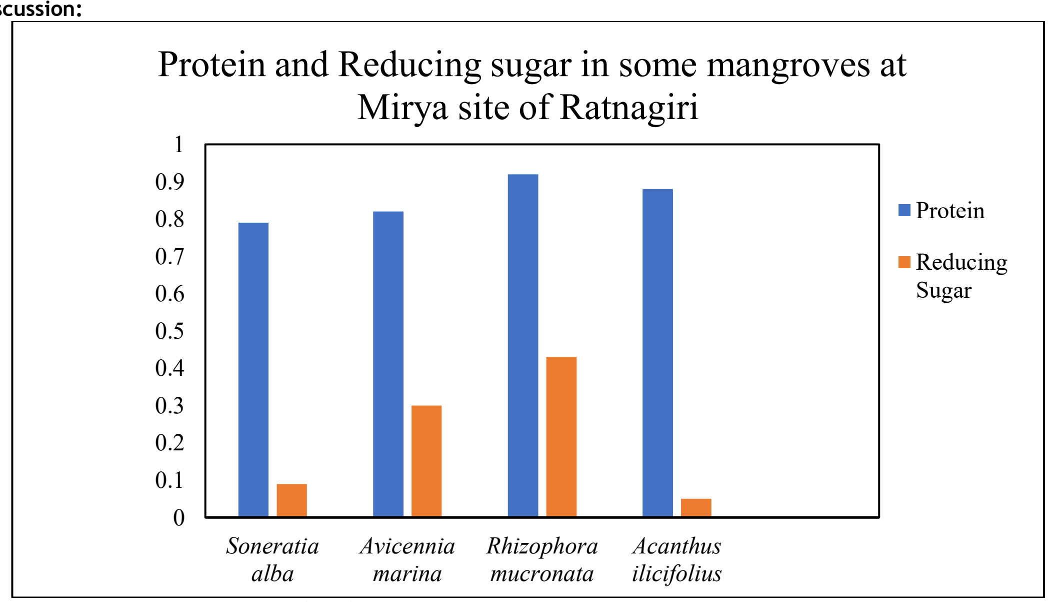

Fig.1 Protein and Reducing sugar in some mangroves at Mirya site of Ratnagiri.

The present work aimed at studying the protein and reducing sugar content in different mangrove species viz., *Sosnneratia alba*, *Avicennia marina*, *Rhizophora mucronata* and *Acanthus ilicifolius* from Mirya site of Ratnagiri. A remarkable variation was found in the content of the biochemical components in the studied species. The protein contents were highest in *Rhizophora mucronata* (0.92 mg/gm) followed by *Acanthus ilicifolius* (0.88 mg/gm), *Avicennia marina* (0.82 mg/gm) and *Sonneratia alba*

(0.79 mg/gm) among the four mangroves. Similarly *Rhizophora mucronata* had the highest content of reducing sugar (0.43 mg/gm) and *Acanthus ilicifolius* recorded the lowest (0.05 mg/gm) as shown in fig.1.

Our results are consistent with previous reports indicating that protein buildup is the general response of plants under salinity. Under saline conditions, the synthesis of specific proteins related with osmotic adjustment, nitrogen storage and stress protection is induced in the plants (Ali *et al.*, 1999; Mansour, 2000; Pareek *et al.*, 1997). The increased protein contents in *R. mucronata* could also suggest better adaptive strategies in terms of salt stress tolerance perhaps through de novo synthesis of stress related proteins (Singh *et al.*, 1987; Serrano *et al.*, 1999). Similar findings have been observed in other halophytes including *Sesuvium portulacastrum* (Venkatesalu *et al.*, 1994a) and *Suaeda maritima* (Rajaravindran and Natarajan, 2012) where the protein content also increases upto a maximum salinity level.

On the other hand, these mangroves varying decreasing sugar contents provide information about how they regulate osmotic pressure. Nimbalkar and Joshi (1975a) and Rathert (1983) suggest that lowering sugars might be crucial for osmotic adjustment in situations involving salt stress. The high reducing sugar content in *Rhizophora mucronata*, which implies that soluble carbohydrates may help sustain cellular turgor pressure and contribute to osmotic equilibrium. However, the low sugar content of *Acanthus ilicifolius* may suggest a dependence on other physiological systems or a diminished ability to control osmotic pressure through carbohydrates.

However, *Acanthus ilicifolius* had the lowest decreasing sugar amount despite having a high protein content. This negative association suggests a possible change in stress-reduction tactics, favoring responses mediated by proteins rather than sugars. Parida *et al.* (2004) reported a similar finding in the salt-secreting mangrove *Aegiceras corniculatum* which indicated species-specific biochemical responses to salt exposure by exhibiting slight changes in protein concentration during salinity stress. These mangrove species varied physiological and biochemical responses to salty conditions are reflected in the observed variations in their protein and sugar profiles. These biochemical markers are useful indications of salt tolerance capability and their potential applications in coastal ecosystem restoration.

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