African Journal of Basic & Applied Sciences 7 (1): 11-15, 2015
ISSN 2079-2034

DOI: 10.5829/idosi.ajbas.2015.7.1.92174

Protein Value of Mangrove Litter: A Study from Indian Sundarbans

Subhashis Das and Moumita Paul

Department of Environmental Studies, Sir Gurudas Mahavidyalaya
(affiliated to University of Calcutta) 33/6/1, B.B. Ghosh Sarani,
Ultadanga-Muraripukur, Kolkata- 700067, India

Abstract: Mangrove forest produces protein rich detritus by shedding both leaf and non-leaf litter. This litter increases the calorific value of mangrove water which supports the pelagic food chain. Mangrove water is widely regarded as a potential fishing zone. This study aims to highlight the protein value of mangrove litter collected from two stations within the mangrove forest of Indian Sundarbans during May, 2014 which belongs to the pre-monsoon period. Hydrological parameters of adjacent mangrove water of two stations were also measured. Salinity and nutrient load of water were found to have impacted the protein value of litter.

Key words: Mangrove Litter · Protein Value · Hydrological Parameters · Indian Sundarbans

INTRODUCTION

Sundarban mangrove is a highly well balanced ecosystem which houses a wide diversity of floral and faunal species in its environment. Mangroves not only act as shelters for a huge assemblage of organisms but at the same time nourish them with adequate quantity of calorie rich nutrients by producing litter. In any mangrove wetland, whatever may be the dimension, the annual litter-fall bears a significant contribution in balancing the ecosystem. Litterfall has been estimated to account for 30-60 % of total primary production [1]. The green leaves, senescent leaves normally yellow in color as well as brown old decaying leaves, twigs, branches, flowers and fruits, dead insects, bark, parts of stem etc comprise the litter. Leaf-fall contributes nearly 75 % of total litter production [2]. Both the leaf and non leaf litter contribute to mangrove detritus which ultimately enters the aquatic environment making it nutrient enriched and thereby the water becomes a favorable site for varieties of organisms. The nutrient rich coastal water adjacent to the mangrove vegetation caters the need of organisms by providing them food. The primary consumers are fed by secondary consumers and the process continues up to the highest trophic level in ecological pyramid.

Mangrove litterfall enhances coastal fisheries by providing nutrients to omnivores, e.g. shrimps, crabs, juvenile fish [3]. The mangrove litter becomes nutritionally rich because of microbial action during decomposition [4]. Mangrove leaves are a poor food source for most animals. The leaves begin to contribute to fisheries productivity once they have been processed by a range of decomposers. This processing begins with leaching of soluble compounds, followed by colonization by decomposing microorganisms. The whole process takes months to years, but can be rapidly accelerated by crabs and other animals that feed on leaf litter directly, making it more accessible to other consumers of economic importance. Around 12% of the leaf litter processed by crabs is assimilated as crab biomass. A range of predators then feed on these crabs, including a number of fish species that are of high importance to fisheries [5]. Commercially valuable penaeid prawns are found in high abundance in mangrove systems as juveniles [6, 7]. Penaeid prawns spawn offshore, but their planktonic larvae drift and ultimately settle in estuarine waters where they spend a few months to a year before once again migrating off shore [8]. Mangroves are believed to be a particularly important part of this estuarine stage, providing them with both abundant detrital food

Corresponding Author: Subhashis Das, Department of Environmental Studies, Sir Gurudas Mahavidyalaya (affiliated to University of Calcutta) 33/6/1, B.B. Ghosh Sarani, Ultadanga-Muraripukur, Kolkata - 700067, India.

resources and a refuge from predation. To facilitate maximum growth and reproduction animals require an optimal level of protein in their diet [9]. Crustaceans and other aquatic animals generally require higher levels of proteins than do most terrestrial animals [10]. In recent years a good number of studies have already been carried out to establish the calorific value of mangrove litter. Our paper reports the protein content of mixed litter of four dominant mangrove species, common in the part of Indian Sundarban.

MATERIALS AND METHODS

Study Area: Two stations within the mangrove ecosystem of Indian Sundarbans located in south 24 parganas district, West Bengal were selected for the present study. The first station (Station I) was Lot 8 ferry ghat: Kakdwip (21° 52' 57" North latitude, 88° 9' 54" East longitude) and the second was (Station II) Henry's Island (21° 34' 19.9" North Latitude, 88° 17' 54.9" East Longitude). Both the stations are mainly dominated by mangrove species like Kakra (*Bruguiera gymnorrhiza*) and other mangrove species like *Avicennia officinalis*, *Acanthus ilicifolius*, *Rhizophora mucronata* etc. The high tide water of the river floods the mangrove mud flat twice a day.

Litter Collection: The field work was done in May, 2014 which belongs to the pre-monsoon period. Four dominant mangrove species were targeted for foliage litter collection: (1) *Bruguiera gymnorrhiza* Lamk. (Family: Rhizophoraceae), (2) *Buguiera sexangula* (Family: Rhizophoraceae), (3) *Rhizophora mucronata* Lamk. (Family: Rhizophoraceae) and (4) *Avicennia officinalis* Lamk. (Family: Acanthaceae). The old decayed (brownish) and senescent / matured (yellowish) leaves were collected from forest floor. Young green colored as well as matured leaves with petioles were directly hand picked from trees. The damaged and fragmented leaves were avoided. The samples were washed with ambient water in order to remove the adhered impurities. The collected litter was placed in plastic bags which were properly labeled and then brought to the laboratory for analyses. The litter was sorted into young, mature and old decayed leaves. They were then washed with distilled water and air dried. Litters from three different fractions and of four different species were weighed (fresh weight), then oven dried at 40° C ± 5° C overnight until the leaves became crumbly and again weighed to record the dry weight for estimating the moisture content. All the leaves were mixed together and then ground into fine powder with the help of mortar and pestle. The powder was analyzed for protein content. To get a detailed species-wise view, powder from young, mature, old decayed leaves and fruits were also individually analyzed for protein content.

Estimation of Protein: The total protein value of mangrove litter was determined following the Lowry's method [11] using bovine serum albumin as standard.

Analysis of Hydrological Parameters: Surface water samples were collected during high tide from two stations Kakdwip and Henry's Island in cleaned bottles and following analyses were performed. Surface water temperature was measured using a 0°C-100°C thermometer. Salinity was measured using a salinity refractometer on the spot and all the values were crosschecked in the laboratory following the method as outlined in Strickland and Parsons [12]. Water samples were analyzed for pH using a portable ph meter which was calibrated with pH buffer 7.0 before every use. Dissolved oxygen of the collected water samples was estimated in the laboratory following the Winkler's method. Nutrients, i.e., nitrate (NO_3), phosphate (PO_4) and silicate (SiO_3) content of water samples were measured by spectrophotometric method.

RESULTS AND DISCUSSION

Protein analyses of the four mangrove species, *Bruguiera gymnorrhiza, Bruguiera sexangula*, *Rhizophora mucronata* and *Avicennia alba* revealed that in case of *B. gymnorrhiza*, *B. sexangula* and *A. officinalis* protein content is higher in green young (c1) and old decayed leaves (c3) (Table I). The mature leaves (c2) showed a comparatively lower protein content. This trend is found to be similar with the study carried out by Untawale *et al*. [13] and Hoq *et al*. [14]. The comparatively higher value of protein in old leaves (c3), which were collected from forest floor in decaying condition, can be attributed to microbial decomposition. Microorganisms play a crucial role in decomposition of mangrove litter and produce protein rich detritus [15]. The undecomposed leaves are generally nutritionally poor and they become nutrient enriched due to microbial action during decomposition [4].

Some workers have estimated the total nitrogen content (N) of mangrove foliage to work out the total protein percentage (N x 6.25). Rajendran *et al*. [15]

Table 1: Protein content (%) of different mangrove leaves (species-wise) on dry weight basis of Station Ⅰ

Leaf-litter type	*Bruguiera gymnorrhiza*	*Bruguiera sexangula*	Avicennia officinalis	*Rhizophora mucronata*
Young leaf (c1)	7.51	10.28	7.21	NR
Mature leaf (c2)	5.40	7.80	4.89	13.93
Old leaf (c3)	6.67	9.22	5.91	7.64
Fruit (nl) (c4)	9.07	NR	NR	NR

nl means non leaf-litter. NR means not recorded. c1, c2, c3 and c4 refer to category 1, 2, 3 and 4 respectively.

Table 2: Protein content of mangrove litter (mixed in nature) of two stations

Station	Location	Protein Content (% of dry weight)
Ⅰ. Lot 8 ferry ghat: Kakdwip	21° 52' 57" N Latitude, 88° 9' 54" E Longitude	9.67
Ⅱ. Henry's Island	21° 34' 19.9'' N Latitude, 88° 17' 54.9'' E Longitude	8.1

Table 3: Hydrological Parameters of Station Ⅰ and Ⅱ

Station	Surface water temperature (°C)	Surface water salinity (‰)	Surface water pH	Dissolved oxygen (mg/l)	NO_3 (µgat/l)	PO_4 (µgat/l)	SiO_3 (µgat/l)
Ⅰ. Lot 8 ferry ghat: Kakdwip	32.0	12.06	8.32	5.86	6.11	12.62	68.22
Ⅱ. Henry's Island	32.1	21.00	8.00	3.89	1.66	0.419	21.25

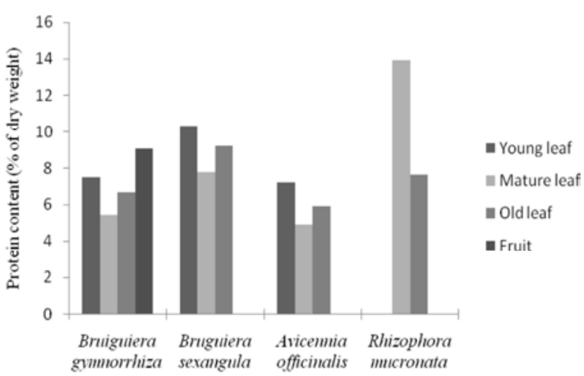

Fig. 1: A comparative account of Protein content (% of dry weight) of mangrove leaves

appeared to be of the view that rich nitrogen content in decomposing leaves can be due to nitrogen-fixing bacteria like azotobacters. They are of the opinion that azotobacters which play an important ecological role in raising the nitrogen level in decomposing mangrove leaves could be a major factor in determining the palatability of detritus food to detritivorous animals like prawns. In the present study, there is significantly high protein content (13.93 %) in *R. mucronata* (Red mangrove) mature leaves (c2) compared to *A. officinalis*, *B. gymnorrhiza* and *B. sexangula*. Fruit (a component of non- leaf litter) of *B. gymnorrhiza* also showed good protein value.

The protein content of mixed mangrove litter of two stations (composite in nature) was also recorded in this study. The protein value of mixed mangrove litter at Sta. 1 and Sta. 2 were 9.67% and 8.07% of dry weight respectively. The variation in the protein content at two stations may be due to difference in the values of hydrological parameters.

In this study, though the surface water temperature and pH of the selected stations were almost same, the salinity was entirely different (Table3). Station Ⅰ had a salinity of 12.06‰ (Kakdwip; 2014 pre-monsoon) and a salinity of 21‰ (Henry's Island; 2014 pre-monsoon) was recorded at station Ⅱ. The nutrient load in the water, i.e., nitrate, phosphate and silicate also varied between two stations. The values were found to be much higher in station Ⅰ compared to station Ⅱ. With increasing salinity in water, it was observed, that the nutrients concentrations came down in the water body. As the Sta Ⅱ had a high salinity; the nitrate, phosphate and silicate values were low compared to the values of Sta Ⅰ where salinity is much lower (Table Ⅲ). This finding is almost similar to the work carried out by Iwata *et al.* 2005 [16], who also observed a negative correlation between the salinity value and nutrient load in the water. A negative correlation between salinity in water and protein value of mixed litter at two stations has also been found ($r = -1$, $p < 0.01$) which suggests that with increasing salinity in water, protein value of mangrove leaves decreased. Parida *et al.* 2004 [17] reported that the total protein content of *Bruguiera parviflora* leaves gradually decreased with increasing concentration of NaCl.

A total of 24 species of true or major mangroves were recorded in the Indian Sundarbans [18]. Mangroves shed huge amount of litter as leaves and various other non-leaf components throughout the year. The microbial decomposition of this litter enriches its protein value. The litter's protein has immense ecological importance as both detrital and pelagic food chains are being sustained by the mangrove litter. The strong link between mangrove forest and fishery resource have been well documented in good number of communications. In Vedaranyam (southeast India), there was a 40% loss of mangrove forest, which coincided with an 18% decline in fishery resources within a 13 year period between 1976 and 1989 [19]. The shrimp production of the Cochin backwater has fallen almost to nil due to the clearance of extensive mangrove cover by the people living around the backwater [20]. Due to their characteristic location, the mangroves play an important role in the ecology of the coastal zone area and in support of the marine species that utilizes the mangrove environment during part or all of their life cycles. For instance, some prawn species may breed and complete their life cycle in shallow coastal mangrove waters [21].

CONCLUSION

The protein concentration of mixed mangrove litter in our study varied between 8.1% - 9.67%. Though species-wise protein content has also been monitored, in the real field, as a result of outwelling the entire mangrove litter gets flushed out to the adjacent aquatic system and therefore composite picture of protein percentage rather than individual species-wise protein percentage is more authentic in terms of ecology. More and more detailed study is essential because hydrological parameters which play a vital role in the litter decomposition process, get changed seasonally and also by anthropogenic activities. Inter-relationship between physicochemical properties of water and the level of biochemical constituents of mangrove litter is of immense importance and must be studied properly. A thorough investigation should be carried out in this field with the sole object to understand the noteworthy significance of mangrove wetland in a more definite way.

REFERENCES

1. Bunt, J.S. and K.G. Boto, 1979. A survey method for estimating potential levels of mangrove forest primary production. *Mar. Biol.*, 52: 123-128.
2. Siddiqui, P.J. and R. Qasim, 1990. Litter production and physicochemical conditions in mangrove *Avicennia marina* (Forsk), swamps at Karachi backwaters and Bakran creek. *Journal of Islamic Academy of Sciences,* 3(1): 15-21.
3. Ashton, E.C., P.J. Hogarth and R. Ormond, 1999. Breakdown of mangrove litter in a managed mangrove forest in Peninsular Malaysia. In: Dodd, R.S. (Ed.), Diversity and Function in Mangrove Ecosystems, *Hydrobiologia,* 413: 77-88.
4. Odum, E.P., 1971. Fundamentals of Ecology. WB Saunders, Philadelphia, USA, pp: 574.
5. Sheaves, M. and B. Molony, 2000. Short-circuit in the mangrove food chain. Marine Ecology Progress Series, 199: 97-109.
6. Rönnbäck, P., M. Troell, N. Kautsky and J.H. Primavera, 1999. Distribution Pattern of Shrimps and Fish among *Avicennia* and *Rhizophora* Microhabitats in the Pagbilao Mangroves, Philippines. *Estuarine, Coastal and Shelf Science,* 48(2): 223-234.
7. Vance, D., M. Haywood, D. Heales, R. Kenyon, N. Loneragan and R. Pendreyne, 2002. Distribution of juvenile penaeid prawns in mangrove forests in a tropical Australian estuary, with particular reference to *Penaeus merguiensis*. Marine Ecology Progress Series, 228: 165-177.
8. Potter, I., J. Penn and K. Brooker, 1986. Life cycle of the western school prawn, *Metapenaeus dalli* Racek, in a Western Australian estuary. *Marine and Freshwater Research,* 37(1): 95-103.
9. Guillaume, J., 1997. Protein and amino acids In Crustacean nutrition (D'Abramo, L.R. Conklin D.E. and Akiyama D.M. eds.) The Aquaculture World-69 - Society. Baton Rouge, pp: 26-50.
10. DeSilva, S.S. and T.A. Anderson, 1995. Fish Nutrition in Aquaculture. Aquaculture Series 1. Chapman and Hall, London, pp: 319.
11. Lowry, O.H., N.J. Rosenberg, A.L. Farr and R.J. Randall, 1951. Protein measurement with folin-phenol reagent. *J. Biol. Chem.*, 193: 265-275.
12. Strickland, J.D.H. and T.R. Parsons, 1972. A practical handbook of sea-water analysis 2^{nd} edition, *J. Fish. Res. Bd.* Canada, Bulletin, pp: 167.
13. Untawale, A.G., N.B. Bhosle, V.K. Dhargalkar, S.G.P. Matondkar and S. Bukhari, 1977. Biochemical changes in mangrove foliage during growth and decomposition. *Indian Journal of Marine Science*, 6: 104-106.

14. Hoq, M.E., M.L. Islam, H.K. Paul and S.U. Ahmed, 2002. Decomposition and seasonal changes in nutrient constituents in mangrove litters of Sundarbans mangrove, Bangladesh. *Indian J. Mar. Sci*., 31: 130-135.
15. Rajendran, N. and K. Kathiresan, 2007. Microbial flora associated with submerged mangrove leaf litter in India. *Rev. Biol. Trop*. (Int. J. Trop. Biol. ISSN-0034-7744) , 55(2): 393-400.
16. Iwata, T., Y. Shinomura, Y. Natori, Y. Igarashi, R. Sohrin and Y. Suzuki, 2005. Relationship between Salinity and Nutrients in the Subsurface Layer in the Suruga Bay. *Journal of Oceanography*, 61: 721-732.
17. Parida, A.K., A.B. Das, B. Mitra and P. Mohanty, 2004. Salt-stress Induced Alterations in Protein Profile and Protease Activity in the Mangrove *Bruguiera parviflora*. *Z. Naturforsch*.`59c: 408-414.
18. Barik, J. and S. Chowdhury, 2014. True Mangrove Species of Sundarbans Delta, West Bengal, Eastern India. *Check List,* 10(2): 329-334.
19. Padmavathy, M., 1991. In: Proceedings of National Symposium on remote sensing on environment. Chennai, Anna University, pp: 8-10.
20. Mastaller, M., 1996. Destruction of mangrove wetlands-causes and consequences. Natural Resources and Development. Institute for Scientific Co-operation, Tubingen, Federal Republic of Germany, 43(44): 37-57.
21. Sukardjo, S., 2004. Fisheries associated with mangrove ecosystem in Indonesia: A View from a Mangrove Ecologist *Biotropia,* 23: 13-39.
22. Hutchison, J., M. Spalding and P. zu Ermgassen, 2014. The Role of Mangroves in Fisheries Enhancement. The Nature Conservancy and Wetlands International, pp: 54.