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Effect of Coconut Husk Retting on Three Backwater Regions along the Southwest Coast of India

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ABSTRACT

Hydrogen sulphide (H_2S) is a respiratory poison that suffocates organisms at high concentrations. Fishing and coir-making are two important sources of livelihood for the inhabitants of the coastal areas of the southernmost state of India, Kerala. The continued and intensive exploitation of the backwaters for retting of coconut husk has a deleterious effect on the inland fishery resources of the state. Pectinolytic activity of certain groups of bacteria causes offensive odors generating H_2S, which emanate from the retting zone besides causing turbidity and oxygen depletion. Thus, there is a clash between the coir and fishing industries in the state. The present study focused on three backwaters, Kadinamkulam, Veli and Poonthura, located around the state capital, Trivandrum in Kerala, which have been productive locations for fisheries in the past. Three stations (riverside, middle and bar mouth) were selected in each backwater area. Samples were collected from the surface and the bottom of these backwaters in the morning hours every month over a period of 12 months (April 2007 to March 2008), beginning before the monsoons of one year (June–September) and ending before the monsoons of the following year. H_2S and dissolved oxygen levels were analyzed quickly after sample collection and their monthly and seasonal variations are presented in this paper. In the present study, high concentrations of H_2S observed exceeded the tolerance limit (0.2 mg/L) fixed by the Indian Statistical Institute (ISI). This reflects the dangerous situation existing in the estuaries as sulphides are highly toxic and capable of destroying all organisms except for anaerobic bacteria in ecosystems.

Keywords: coir, dissolved oxygen, hydrogen sulphide, pectinolysis, pollution

INTRODUCTION

Estuaries are highly productive doorways between the land and the sea, serving as a good nursery and breeding ground for many of the commercially important species of fin and shell fishes. Pollution of the entire backwater system and the adjoining mouths of the rivers in Kerala have serious adverse effects on the livelihood of poor fishermen (Khurshid *et al*. 1998) Coconut husk retting is a common practice in most backwaters along the southwest coast of India and is a major source of organic pollution. This retting leads to depletion of dissolved oxygen and production of hydrogen sulphide (H_2S), which destroys the habitat of many species of aquatic organisms. Dumping of suspended solids from yards in which coconut husk retting takes place along with ret liquor cause imbalances in these ecosystems High concentrations of H_2S and prolonged periods of anoxia have been noticed in coconut husk retting areas (Olorunnisola 2008), which alter the chemistry and geology of these areas by their chemical composition (Anila Kumari 1996). The present study was designed to obtain a clear understanding of the pollution of these ecosystems due to these toxic gases and also to determine how to minimize the destruction of these natural water bodies through a human agency. This paper reports on the H_2S and dissolved oxygen (DO) levels in three backwater regions (Kadinamkulam, Veli, Poonthura) on the SW coast of India, where coconut husk retting and coir-making activities are very intense. Although it was not well-defined in the manuscript, retting is a curing process during which the coconut husks are kept in an environment (e.g. freshwater or seawater) that promotes the action of indigenous microorganisms. This action partially decomposes the husk's pulp, allowing it to be separated into coir fibres and a residue called coir pith. Coir fibre is generally used to make doormats, brushes, mattresses, floor tiles and sacking. Coir fibre-making processes not only affect the H_2S and DO concentrations of waters but also cause important changes in their chemical (major and trace element) compositions (Olorunnisola 2008).

The retting process

The basic process in the manufacture of coir is coconut husk retting. The raw material for the coir-making industry is the entire fibrous material covering the coconut fruit which constitutes both the exocarp and the mesocarp. Thousands of coconut husks are filled in big coir nets known as 'malis' and they are buried in the shallow brackish waters for a period of 4-12 months. Retting is brought about by the pectinolytic activity of microorganisms, especially bacteria and fungi, liberating large quantities of organic substances like pectin, pentosan, fat, and tannin into the surroundings. Bacteria implicated in the retting process include micrococci, *Aerobacter* spp., bacilli, *Escherichia* spp., *Paracolobactrum* spp. as are the yeasts of *Rhodotorula* and *Cryptococcus* species. Polyphenols are constantly leached out during coir fermentation and their oxidation releases a diffusible melanin-like pigment into the medium. During pectinolysis, turbidity, oxygen depletion, gas formation and offensive odors including that of H_2S are observed in the retting zones (Olorunnisola 2008).

MATERIALS AND METHODS

Samples were collected every month from the bottom and the surface of these waters in the morning hours for a period of one year (April 2007 to March 2008) and analyzed for H_2S and DO levels. Bottom and surface samples were collected from a mean length of

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Research Note

Table 1 Monthly mean dissolved oxygen distribution in Kadinamkulam, Veli and Poonthura backwaters. Values in mg/L.

Sites	Station I		Station II		Station III		Mean
	Surface	Bottom	Surface	Bottom	Surface	Bottom	
Kadinamkulam	5.08 ± 1.13	4.65 ± 0.59	4.54 ± 0.86	4.42 ± 0.77	5.08 ± 0.64	4.89 ± 1.00	4.78 ± 0.28
Veli	5.72 ± 2.59	5.66 ± 2.34	6.80 ± 3.14	6.43 ± 2.88	6.80 ± 2.44	6.70 ± 2.25	6.35 ± 0.53
Poonthura	5.12 ± 3.46	5.00 ± 3.35	1.67 ± 1.53	1.14 ± 0.63	5.38 ± 3.56	5.38 ± 3.38	3.95 ± 1.98

Table 2 Monthly mean hydrogen sulphide concentrations in the Kadinamkulam, Veli and Poonthura backwaters. Values in mg/L.

Sites	Station I		Station II		Station III		Mean
	Surface	Bottom	Surface	Bottom	Surface	Bottom	
Kadinamkulam	0.33 ± 0.30	0.33 ± 0.29	0.34 ± 0.32	0.35 ± 0.32	0.34 ± 0.29	0.33 ± 0.29	0.34 ± 0.01
Veli	0.34 ± 0.30	0.34 ± 0.31	0.35 ± 0.32	0.34 ± 0.31	0.34 ± 0.31	0.34 ± 0.31	0.34 ± 0.01
Poonthura	0.58 ± 0.49	0.58 ± 0.48	0.98 ± 1.08	0.80 ± 0.76	0.38 ± 0.32	0.36 ± 0.31	0.61 ± 0.24

1 m. Three estuarine systems (the Kadinamkulam backwater, Veli lake and Poonthura backwater), which surround the state capital, Trivandrum, and which have been good locations for fisheries until now, were chosen as the sites of analysis. Three different stations were selected in each of these sites to determine H_2S concentrations. Spectrometric determination of H_2S in natural waters has several advantages over Lauth's Violet procedure: 1) the use of a single reagent; 2) superior reagent stability at low sulphide concentrations; 3) applicability to a wide range of H_2S concentrations; 4) increased sensitivity; and 5) is completed within minutes *in-situ* using a portable spectrophotometer. In the present study also H_2S was analyzed by spectrophotometry (Clark *et al*. 2007). Dissolved oxygen was determined by classic Winkler's method (Trivedy and Goel 1986).

RESULTS AND DISCUSSION

The Kerala backwater systems are ideal for fish culture. However, recent indiscriminate use of backwaters for retting of coconut husks poses a serious threat to the fisheries, mostly due to the evolution of H_2S. The rotten egg smell as well as qualitative assays of the samples proved the evolution of H_2S in the concerned site. Inorganic compounds such as sulphates and sulphites may also be reduced to H_2S under anaerobic conditions by heterotrophic bacteria in the presence of organic materials.

The reduction in oxygen levels observed in these backwaters during the premonsoon months was mainly due to the addition of deoxygenated water from the retting grounds. Depletion of oxygen to such an extent suggests that there was an influx of a heavy organic load in the recent past (Padmavathi and Satyanarayana 1999). In the present study, the oxygen levels (**Table 1, Fig. 1**) in the Poonthura backwaters were the lowest of those of all three estuaries due to high H_2S content (more or less 1 mg/L) which exceeds the tolerance level in post monsoon months. In 1996, Kumari had also reported the depletion or gradual decrease in oxygen concentrations (anoxic conditions) to the high concentrations of H_2S.

The mean H_2S concentrations in the surface and the bottom of each of the three estuaries were nearly identical in this study, probably due to the shallowness and circulation of the water mass. However, the mean H_2S content of the Poonthura backwater was very high when compared to the other two estuaries due to more and continuous retting process. In 1995, Yogendra reported in his general view that prolonged anoxic periods with high concentrations of H_2S in coconut husk retting zones. In the present study, this situation was observed in the Poonthura estuary. Kumari (1996) reported that a high H_2S (>1 mg/L) concentration is an important feature associated with sewage created from the retting process of the coconut husk. The H_2S content was more or less similar in the Kadinankulam and Veli backwaters and high during summer (**Table 2**). In the present study, high levels of H_2S were recorded during the premonsoon season due to the H_2S resulting from the retting process and a gradual decline in oxygen concentrations (**Fig. 2**). The lower values in the monsoon season, especially in

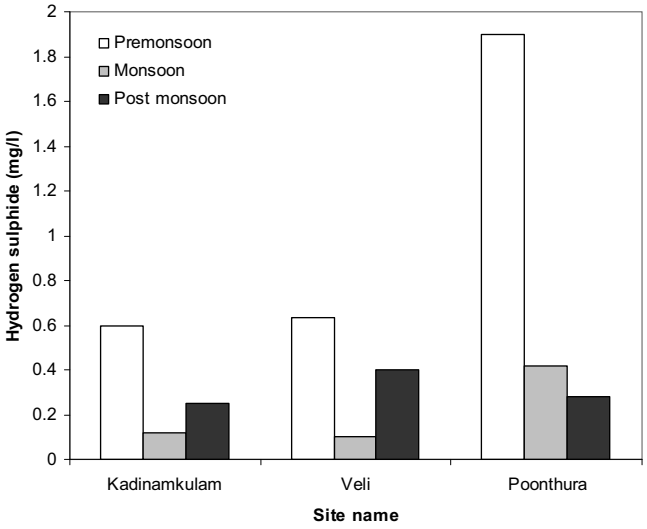

Fig. 1 Seasonal changes of mean hydrogen sulphide concentrations (mg/L) in the Kadinamkulam, Veli and Poonthura backwaters.

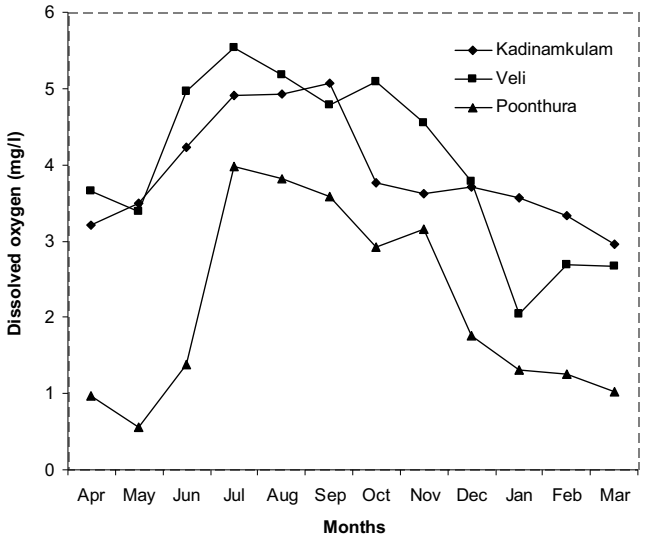

Fig. 2 Mean station concentrations of dissolved oxygen in the Kadinamkulam, Veli and Poonthura backwaters.

September, however, were due to the heavy freshwater discharge and dilution of concentrated organic contaminants after the rains. Thus, the post monsoon recordings showed lower values than pre-monsoon values due to lower salinity and diluted pollutants. The trend of H_2S concentrations suggested that the pre-monsoon is a period of very high concentrations with reasonable stability due to less and stable water level without any mixing. In the early part of the monsoon, the concentrations were high and declined sharply towards the end of the monsoon (Jayachandran and Joseph 2007). Hence, the postmonsoon season was the

period of recovery of the aquatic habitats in these backwaters.

The concentrations of H_2S observed exceeded the tolerance limit (0.2 mg/L) fixed by the Indian Statistical Institute (ISI). The dangerous situation existing in the estuaries as sulphides are highly toxic and capable of destroying all organisms except anaerobic bacteria in ecosystems are reflected in the present study. Thus, the careless and disorganized growth of the coir-making industry is posing a serious threat to capture fisheries in the backwaters of the coastal state of Kerala. The biodiversity studies of such ecosystems prove that the rich fishing grounds of the Kerala backwaters are thus on the verge of destruction because of 25% decline of catch in a year, rendering them useless for natural fishing (Chattopadhyay 2005). So the present practices adverse to aquatic biota should be minimized in the near coming future.

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