ANALYTICAL STUDIES ON PRAWN FARM WASTEWATER GENERATED AT THIRUPERUNTHURAI AREA OF THE BATTICALOA

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ABSTRACT

The world's aquaculture industry has in recent times grown rapidly to satisfy the demand for seafood, which cannot be met by wild fisheries harvesting. Uncontrolled expansion of aquaculture industries has for some countries like Sri Lanka, resulted in adverse environmental impacts and degradation of coastal environments. Prawn farms near the coastal area of Sri Lanka are one of the profit-oriented industries and those are constrained by problems related to environmental degradation. This study was undertaken in 2004 and examined the wastewater from the prawn farms located at the Thiruperunthurai area of the Batticaloa district. Quality parameters such as Chemical Oxygen Demand (COD), Turbidity, Nitrate, Phosphate, Total Suspended Solids (TSS), pH, Temperature and Salinity were monitored in the prawn farm wastewater. The wastewater discharged from the prawn farms to the Batticaloa lagoon showed that relatively higher concentrations of TSS, Turbidity, COD and Salinity with mean concentrations of 34833 mg/l, 94 FAU, 1451 mg/l and 25%, respectively. Further, large volume of prawn farm wastewater was discharged directly to the lagoon water without any treatment processes. Therefore, lagoon water in Batticaloa showed high turbidity values and found some algal growth near the prawn farms. It is proposed that secondary treatment systems or wetlands to be introduced to improve the quality of prawn farm effluents before discharged into the lagoon to minimize the environmental impact of the prawn farm industry.

Key words: Chemical Oxygen Demand, Turbidity, Wastewater, Wetland

INTRODUCTION

Sri Lanka, an Island of about 65,000 square kilometres of area, lies at the tip of the Indian subcontinent. The island is margined by a narrow coastline of about 1200 square kilometres above which are found a large number of rivers, lagoons, bays (Munasinghe, 1984). There are considerable number of lakes and artificial reservoirs. These bodies of water provide ample potential for a flourishing aquaculture industry in the country. The smaller lagoons especially in the South Eastern and Eastern regions generally remain closed by sand bars throughout the year. Some like Batticaloa lagoon, however, has connections with the sea for a short period during the rainy season.

Wastewater can be classified either domestic or industrial. Domestic wastewater comes from residences, commercial buildings and institutions such as schools and hospitals. While industrial wastewater come from manufacturing plants (Rao, 1991). In Batticaloa the lagoon receiving large quantities of wastewater from many industries like prawn farms, rice mill, hospitals, service stations and hotels (Sugirtharan and Thiruchelvam, 2003). Normally wastewaters are conducted to treatment plants for removing undesirable components, which include both organic and inorganic matter as well as soluble and insoluble material. These pollutants if discharged directly or with improper treatment can interfere the self-cleaning mechanisms of water bodies. Discharge of wastewater into the surroundings is a major problem to the environment. This untreated wastewater is hazardous to the living beings, which are present in the water bodies. Further, Sugirtharan and Thiruchelvam (2003) reported that, the Batticaloa lagoon receives large quantities of wastewater from prawn farm than the rice mills and domestic wastewater from three divisional secretariat of the Batticaloa district.

The first government initiated prawn culture farm commenced in Batticaloa in the late 1970's. However due to civil disturbances in the North and East of the country, the industry (now fully privatised), was diverted to the North Western province in the early 1980s (Samaranayake, 1986). Now there has been a rapid expansion on prawn cultivation during recent years in the Batticaloa areas of Sri Lanka especially in the Thiruperunthurai, Manmunaithurai area. Total area presently developed for prawn farming in study area is approximately 50 acres.

Batticaloa lagoon is the main source of water for these prawn ponds. Unfortunately this lagoon is also the main water body receiving not only the effluents from prawn farm but also from other industries operating in the city. Therefore, there is a scarcity of quality water source for future cultivation. The rapid expansion of prawn culture industry in these area based on this semi enclosed water system has consequently, led to increasing concern over the effects of prawn farming on the water environment.

Therefore, this study aimed to determine the physico-chemical characters of the prawn farm effluent, which are collected at the point of discharge from prawn farm to the Batticaloa lagoon, and to identify the effects and problems caused by the prawn farm wastewater to the Batticaloa lagoon.

METHODOLOGY

This study was undertaken from April to August 2004. This means that, replicate wastewater samples were collected at the point of discharge in a week interval and these were analysed for Phosphate, Nitrates, Chemical Oxygen Demand (COD) and Turbidity by using HACH 2010 spectrophotometer. Temperature and pH were recorded at the point of discharge using digital pH meter combined with the thermometer. Salinity was measured using refractrometer and Total Suspended Solids (TSS) determined by standard oven dry method. The data obtained for each analysis was pooled and the means were obtained. Information and data regarding effects by wastewater to the lagoon water were collected during sampling visits by direct observations and by the personal interview with the fishermen.

RESULTS

Water quality data for the wastewater from prawn farm for a typical 5 weeks culture period are presented in table 01.

The mean values of Phosphate concentrations varied between 0.42 mg/l and 0.63 mg/l. Mean concentrations of Nitrate varied between 6.2 mg/l to 8.5 mg/l (Table 01). Nitrate content showed higher value in fifth sampling, this may due to the higher stocking density, biomass and the microbial processing of the nitrogen released by them. The mean

levels of TSS in effluent from prawn farm are given in table 01. The observed mean total suspended solids level ranged between 30674 mg/l to 36310 mg/l. The reason for the observed value may be due to the stocking rate and the organic matter present in the effluent. The Salinity level of the effluent also measured, it varies from 21 to 29.4%.

Table 01. Characteristic of prawn farm effluent at the point of discharge (Mean Values)

Parameter	Sampling period (5 weeks)					Mean
	1st	2nd	3rd	4th	5th	
Phosphate (mg/l)	0.58	0.42	0.63	0.59	0.52	0.55
Nitrate (mg/l)	6.2	7.9	8.3	8.2	8.5	7.82
Salinity (%)	29.4	28	24.5	24	21	25.38
COD (mg/l)	1587	1186	1418	1610	1456	1451
pH	7.23	7.76	7.53	7.8	7.25	7.514
Temperature (°C)	30.6	29.1	30.9	29.8	31.2	30.32
TSS (mg/l)	35920	36310	35450	35810	30674	34833
Turbidity (FAU)	104	108	92	98	79	96.2

Further, COD strength of the wastewater was also measured. This is a measure of the requirement of oxygen for the complete breakdown of organic matter to CO_2 and water. This is directly affecting the dissolved oxygen content of the water. Mean value of COD strength varies from 1186 mg/l to 1610 mg/l in prawn farm effluent. Other than these parameters pH and Temperature also measured at the point of discharge. These mean values showed that, there were no any serious problems caused to the lagoon by considering the pH and Temperature.

The lagoon near the city of Batticaloa receives higher volume of prawn farm effluent, which constitutes of the above mentioned pollution parameters. The direct effect of these types of effluent and problems faced due to the discharge of prawn farm effluent to the Batticaloa lagoon is discussed in next chapter.

DISCUSSION

The quality of the wastewater from prawn farm is dependent on several factors like stocking density, farm management practices, feeding rate, water exchange rate and aeration etc. (Phillips, *et al.*, 1990; Tiensongrusmee and Phillips, 1994).

Due to limited access to water in the near city area prawn farms are restricted to taking the source of water from the same lagoon that they discharge their farm effluent into. Further, due to unplanned construction

of the pond, the outlet of one's farm is located very closer to the other one's inlet. As a result of this, discharge of effluent from one prawn farm is the intake of the other. This phenomenon is becoming widespread in the prawn farms present near the Batticaloa lagoon. In the Batticaloa areas the prawn farm effluents discharged directly to the lagoon without any treatment. Some of the farms having a separate pond are to allow the effluent water to stand for some days prior to discharge. However, these settling ponds are very small in size and they are not properly used and maintained.

Data reported from the study made in prawn farm effluent, showed that Nitrates, Total Suspended Solids and Turbidity were higher with mean salinity levels of 25.38%. Salinity level of the Batticaloa lagoon water is fluctuating not only by the opening of lagoon mouth during the rainy season but also due to the mixing of wastewater with lagoon water which, has high salt content like prawn farm wastewater. This will affect the fish population in the receiving lagoon because some can tolerate the high salinity level but some can't.

Higher amount of organic matter accumulated in the prawn farm water mainly due to the metabolic waste produced by the prawns themselves and by degradation of excess food. Therefore, the oxygen required to breakdown this organic matter would be higher. In Batticaloa prawn farmers are exchanges 50 percent of the volume of water every 2 days interval. Therefore, higher volume of wastewater with higher organic matter content frequently mixed with the lagoon water. This will cause severe reduction in the dissolved oxygen at the lagoon. Dissolved oxygen is essential for sustain the plant and animal life in any aquatic system. For an example warm water fish require a minimum dissolve oxygen level of at least 5 mg/l. If the dissolve oxygen level drops below the level necessary to sustain life, then the aquatic system is classified as polluted (Rao, 1991).

Small amounts of nitrates and phosphates occur in all aquatic systems and these are sufficient to maintain a balanced biological growth. The principal source of Nitrogen (other than intake waters) in prawn farm discharge is from feed introduced into ponds. Nitrogen in discharge waters is derived from uneaten feed, excreta, ammonia and algae. Prawn farms are not a major source of phosphorous. The sources of phosphorous with prawn farms are from uneaten food, solid excreta and soil particles, the majority of which can be effectively managed by settlement ponds/ systems. By examination of wastewater from prawn farm showed that

the mean values of nitrate and phosphate contents were 7.82 mg/l and 0.55 mg/l respectively. These compounds may enter the lagoon water directly from the prawn farms. Thus large concentrations of these nutrients are mixed with lagoon water. This produces an excess growth of algae in the form of green slime layer over the surface of the water body and subsequently leads to Eutrophication. Acute Eutrophication events normally observed in the Batticaloa lagoon near the prawn farms. This slime layer reduces light penetration and restricts the oxygen exchange between atmosphere and the water body. The dense algal growth eventually dies and the subsequent biodegradation produces an oxygen deficit, which can result in fowl smelling anaerobic conditions.

The mean levels of TSS and Turbidity in effluent were 34833 mg/l and 96.2 FAU respectively. Irrespective of location, monitoring of prawn pond wastewater has shown that, suspended solids are the main constituents in the wastewater. Sources of the suspended sediment include upstream soil erosion due to agriculture and other land clearing activities. During the early part of the production cycle farm ponds can act as sediment sinks resulting in effluent with lower concentrations of suspended solids than in the influent. However, as production season progress, the action of pond aerators causes sediment, re-suspension and bank erosion. This results in a net export of suspended solids when water is discharged from ponds. The reasons for the observed turbidity results are unclear but may be related to the suspended matter contained in the wastewater are largely organic. Presence of these parameters in higher values will definitely affect the light penetration into the water stream. Increase in turbidity will reduce the photosynthesis of the aquatic plants thus it may leads to the reduction in dissolved oxygen. The majority of this material can be effectively removed from the waste stream by the incorporation of a proper, efficient settlement pond system. The efficiency of the design of such systems is based on the retention time and the settling characteristics of the influent stream.

Other than these effects, prawn farm pollutes the lagoon due to the pesticides which are used in prawn culture to control larvaecious fish and other unwanted species in the lagoon environment and threatening the biodiversity. They are not poisonous to prawn at a particular concentration but could be harmful to the fish. Also, they are using many chemicals during the growth period such as prawn's food, dolomite and $CaCO_3$. These types of chemicals also mixed with the lagoon water during the disposal.

CONCLUSIONS

Aquaculture interacts with the environment. It utilizes resources and causes environmental changes. Most interactions have beneficial effects likewise prawn farm industry has the potential to produce and generate income contributing to social and economic well being. The major risk of environmental harm following the establishment of prawn farms is from the discharge of pond waters containing elevated levels of nutrients, organic matter, salinity, suspended solids, and low dissolved oxygen concentrations into lagoon water. This may lead to unwanted changes, such as nutrient enrichment of receiving waters. However, it is apparent from this study, some of the water quality parameters like COD, TSS, turbidity and salinity were in higher concentrations in the effluent and adversely affects the receiving stream especially the Batticaloa lagoon near the prawn farms. There is an evidence of much localized effects of reduced concentrations of dissolved oxygen in lagoon waters close to prawn farm sites. Because of very high organic and nutrient load can be expected in effluent during harvesting, draining and cleaning of prawn ponds.

The knowledge regarding the effects can help to the farmers in improving the pond management. It has yielded a better understanding of prawn farm discharges and recommended ways to minimize their environmental impact while increasing production.

REFERENCES

Munasinghe, H. (1984) Socio economic conditions of small scale fishermen in Sri Lanka, *Fisheries, Marga Quaterly Journal*, Special Issue, 7, (2&3):13.

Rao, C.S. (1991), Environmental Pollution Control Engineering, Pp. 277-307.Sarder Patel Renewable Energy Research Institute, India (ISBN 81-224-0301-8).

Sugirtharan, M., and Thiruchelvam, T., (2003) Waste water generation in the Batticaloa Regions., Journal of the Faculty of Agriculture, Eastern University, Srilanka. *AGRIEAST* , 4:1-12.

Samaranayake, R.A.D.B., (1986) Status and Prospects for Brackish water aquaculture in Sri Lanka. *Journal of inland fisheries*, , Ministry of Fisheries, Sri Lanka, 3:17

Phillips, M.J., Lin, K.C. and Beveridge, M.C.M. (1990) Prawn culture environment: Lessions from the World's Most Rapidly Expanded Warm Water Aquaculture Sector. Paper presented at ellagio Conference on Environment and Aquaculture in Developing countries. Bellagio, Italy, Pp26.

Tiensongrusmee, B. and Phillips. M.J. (1994) The Environmental Management of Coastal aquaculture: A study on prawn culture in Southern Thailand. The Network of Aquaculture Centers in Asia-Pacific (NARA), Bankok, Thailand,Pp.169.