Int.J.Curr.Microbiol.App.Sci (2017) *6*(1): 271-281

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 1 (2017) pp. 271-281**
Journal homepage: http://www.ijcmas.com

Original Research Article http://dx.doi.org/10.20546/ijcmas.2017.601.033

Studies on Biodegradation of Shrimp Farm Wastes by Using of Seaweeds

N. Santhi[1]*, B. Deivasigamani[2] and Vasuki subramanian[2]

[1]Department of Biotechnology, New Prince Shri Bhavani Arts &Science College, Medavakkam, Chennai, India
[2]CAS in Marine Biology, Annamalai University, Parangipettai-608502, India
Corresponding author:

Keywords

Biodegradation, Shrimp Farm Wastes, Seaweeds.

Article Info

Accepted:
18 December 2016
Available Online:
10 January 2017

A B S T R A C T

Biological treatment aims at using plants and animals to reduce nutrients load and particulate matter in shrimp farm discharge. Although extensive literature is available on the different types of shrimp culture practices, its advantages and disadvantages including the impact caused due to enormous application of chemicals such as antibiotics and use of robotics, he information available on the treatment of effluent in general and biological methods in particular are very scarce. The extensive search of literature revealed that only a few works are available in the direction and the following works are worth mentioning. Some researchers used Halophytes for the treatment of aquaculture effluents and the solid management and removal for intensive land based aquaculture production system. However, information on the commercial utilization of coastal organisms and their possible extent of removal of water from the culture pond by growing them as secondary cultivars are wanting. Biodegradation of farm wastes could be accelerated by employing biological treatment using various important cultivable organisms such as edible seaweeds and similar others. Hence these organisms can be effectively cultured as secondary species to provide added income to the shrimp farmers apart from cleaning the discharge waters.

Introduction

Shrimp farming is a growing, high value enterprise in the coastal areas of the all countries. It has expanded considerably and has significant impacts on the environment and natural resources and a number of concerns have been expressed by the environmental activists and scientists (Dierberg and Kiattisimukul, 1996). The main environmental concern is about the increased levels of nutrients in the discharge water. Shrimp aquaculture wastewater comprises both living and dead plankton, feed waste, faecal matter and other excretory products of the animal (Krom and Neori, 1989). Though biodegradable, the soluble nutrients can result in nutrient enrichment and eutrophication in the receiving water bodies. The impact may be significant where large numbers of shrimp farms are established in areas with poor flushing capacity. The most commonly reported impacts in poorly flushed areas are increased sedimentation of suspended solids, turbidity, eutrophication, algal and microbial blooms and higher demand for biological and chemical oxygen. Long term increase in nutrients and suspended solids in open waters can be avoided by adopting good management practices (Boyd, 2003).

Biodegradation of farm wastes could be accelerated by employing biological treatment using various important cultivable organisms such as edible oysters, mussels, clams, seaweeds and similar others (Chandrapal, 2003).

The Aquaculture Authority of India (AAI) has made it mandatory that all shrimp farms of 5ha area and above, located within the Coastal Regulation Zone (CRZ) and 10ha water spread area and above located outside CRZ should have an effluent treatment system (Aquaculture Authority, 2001). Considering the above, suitable biological methods were identified for the treatment of discharge water from a *Penaeus monodon* farm. The suitability and the extent of waste removal by the individual groups were studied under field trials by development of microcosms adjacent to the experimental culture ponds.

Materials and Methods

The development of microcosm was carried out in the buffer zone between experimental culture ponds at Marakkanam in front of artificial mangrove cover in Uppanar. The tanks were circular, 1.2 m in depth with a diameter of 1.5 m and with a capacity of 2121 liters. Commonly available species of seaweed (*Enteromorpha compressa*, *Chaetomorpha linum*) were collected from Marakkanam uppanar estuary and stocked in individual tanks. Algae (*E. compressa*, *Chaetomorpha linum*) were stocked at the rate of 5 kg wet weight. Cleaning continued every month and foulers and borers were checked. A portion of the suspended solids in the pond discharge settles at the floor of the biponds especially, where seaweeds were stocked. This sludge was periodically removed to prevent the deterioration of the water quality and building up of microbes.

Experimental culture ponds were ploughed and liming was done. After pumping the water, disinfection was done using bleaching powder and left for a week. Fertilization was done with urea and super phosphate for establishment of bloom. The pond was stocked with healthy *Penaeus monodon* seeds tested for SEMBV using PCR after proper acclimatization. Stocking was done at the rate of 35,000 per pond (0.3 ha) and culture was carried out for a period of 4 months. Water exchange in ponds was done every ten days and effluent water was filled into individual tanks containing secondary cultivars. A control tank was maintained throughout the culture period devoid of any secondary cultivars. Water samples were collected from the bioponds on 1 DOC and at an interval of 10 days or during every water exchange for nutrient analysis.

Water quality parameters were monitored twice daily. Important water quality parameters such as dissolved oxygen, pH, salinity and temperature were recorded. For analysis of Total Suspended Solids (TSS), 100 litre of the sample water was filtered through filter paper in a Millipore apparatus. Pre weighed filter paper was used for filtration. After filtration, the paper was dried in a hot air oven at 105°C for 1 hr. The dried filter paper was weighed again and TSS was calculated using the formula

$$\text{mg total suspended solid/l} = \frac{(A - B) \times 100}{\text{Sample volume (ml)}}$$

where A = weight of filter+ dried residue(mg) and B = weight of filter (mg).

Nutrients such as inorganic phosphate, nitrite, nitrate and reactive silicate were estimated adopting the methods described by Strickland and Parsons (1972). Total phosphorus and total nitrogen were estimated using the persulphate oxidation method of Menzel and Corwin (1965). Ammonia was estimated following the methods of Solorzano (1969).

To ascertain the growth of bivalves in the bioponds, random samples were taken weekly. Total length of oysters, mussels and clams were measured to the nearest millimeter using a scale. The wet weight of seaweeds was also measured to the nearest milligram after proper washing and cleaning the silt, debris and other foreign materials.

Results and Discussion

The DO values ranged from 3 to 6.5 mg/l. The BOD values varied from 4.2 – 7.6 mg/l in both the ponds (Figs. 1-5). pH values were from 7.8 to 8.9. Salinity was high during the initial days of culture and reached up to 45ppt and decreased to 21ppt due to the sudden rains. Temperature varied between 23.4^{o}C to 33.9^{o}C.

Macro algae removed the nutrients effectively. TSS was not absorbed but settled on to the thalli, which got dispersed on disturbance. TN, TPO_4, NO_2, NO_3, NH_3 and SiO_3 were reduced to 10.5 ppm, 0.56 ppm, 0.069 ppm, 1.55 ppm, 0.55 ppm, and 0.12 ppm respectively in ten days. In oyster treatment TN, TPO_4, SiO_3 and TSS were decreased to 16.86 ppm, 0.82 ppm, 0.18 ppm and 17.83mg/l respectively. NO_2, NO_3 and NH_3 were found to increase to 0.35 ppm, 5.58 ppm and 1.85 ppm respectively in ten days.

It is quite evident from the present study that macroalgae and oysters reduced nutrients at a higher rate followed by clams and mussels. Bivalves were quite effective in reducing particulate organic matter and macroalgae in removing dissolved organic matter. Seaweeds showed an average wet weight increase of 1.5 kg per month. To prevent overcrowding and obtain maximal production of seaweeds, harvesting was done monthly to maintain the stock in the bioponds.

The negative impact of aquaculture is mainly due to particulate and dissolved nutrients from animal excretion and uneaten food (Krom and Neori, 1989). Effluents from pond aquaculture resemble non-point sources of pollution and application of Good Management Practices (GMPs) could be a reasonable and affordable alternative to improve the quality and reduce the volume of the effluents (Boyd, 2003).

Current techniques for reducing the particulate matter in waste water involve mechanical removal by sedimentation and microseiving (Gowen *et al.,* 1989; Cripps, 1991). But sedimentation was found to be ineffective and microseives are expensive and require regular maintenance (Heerfordt, 1991). Moreover, most water treatment methods used in intensive or recirculating systems result in relocation of nutrients and organic matter and not in an overall reduction in discharges (Piedrahita, 2003). Thus traditional methods of wastewater treatment were found to be ineffective and highly expensive for application in treating shrimp farm effluents (Hopkins *et al.,* 1995a). A potential viable alternative with minimum environmental impact was the biological treatment of farm effluents using macroalgae.

The concept of developing an environmentally clean aquaculture practice based on an integrated fish-mollusc-seaweed system has been tried at the National Centre for Mariculture in Israel. In the model, water from the fish ponds drains through an earthen sedimentation pond, a bivalve filtration unit and a seaweed filtration or production unit and is finally discharged into the sea (Shpigel *et al.*, 1993). Folke and Kautsky (1992) have also proposed a model for integrated coastal aquaculture linking species from different trophic levels such as salmon, mussels and seaweeds. We tested the efficiency of commonly available seaweeds in shrimp farm discharge. Discharge water was fed to individual tanks, stocked separately with the secondary cultivars. The results are promising and they proved that macroalgae effectively reduce nutrients to higher levels Macroalgae were efficient in removing dissolved organic load. Similar observations were also made in a three stage effluent treatment system, where particulate organic matter was reduced through natural sedimentation, particulates and their associated nutrients were reduced by filteration of *Saccostrea commercialis* and the macroalgae, *Gracilaria edulis*, absorbed dissolved nutrients (Jones *et al.*, 2001).

Fig.1 Dissolved oxygen concentration

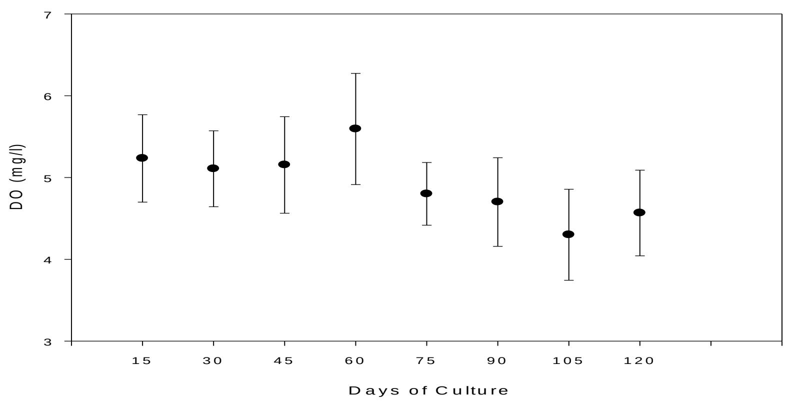


Fig.2 Biochemical oxygen demand

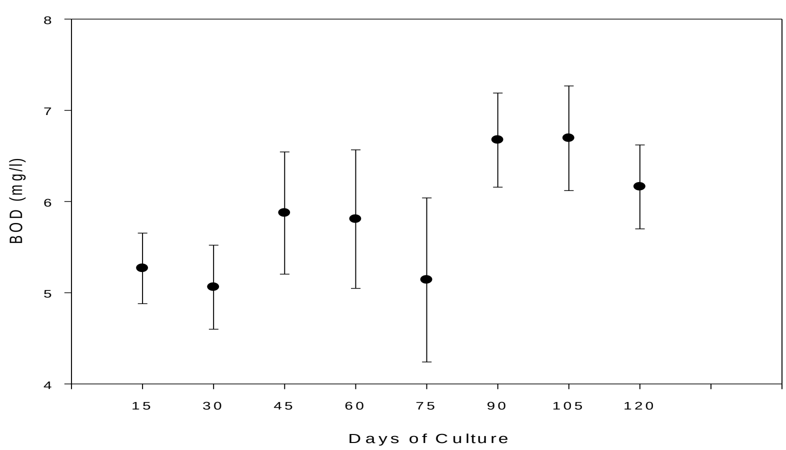


Fig.3 Range of pH levels

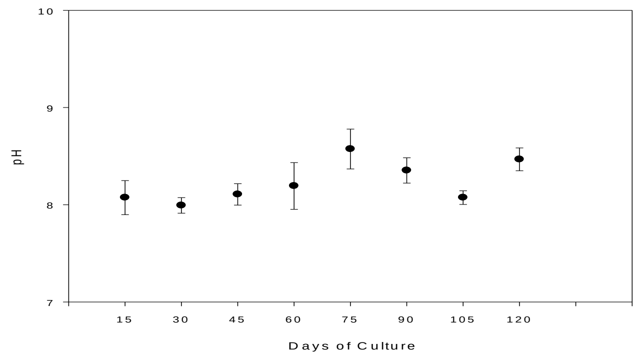


Fig.4 Range of salinity

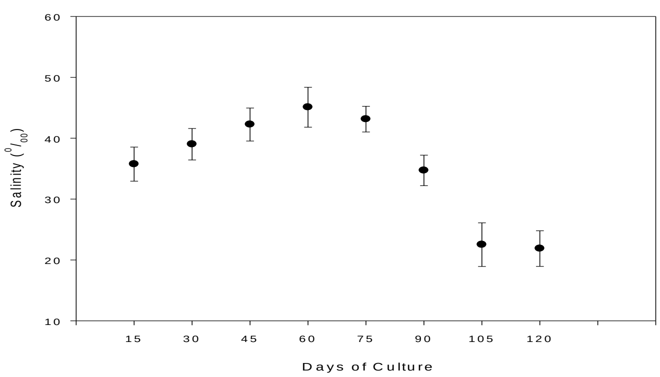


Fig.5 Range of temperature

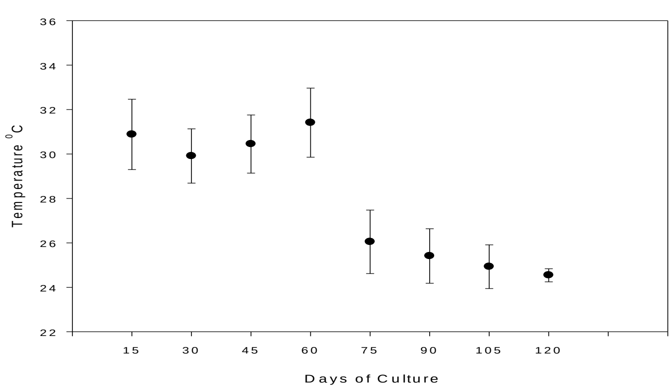


Fig.6 Total nitrogen levels in the control pond

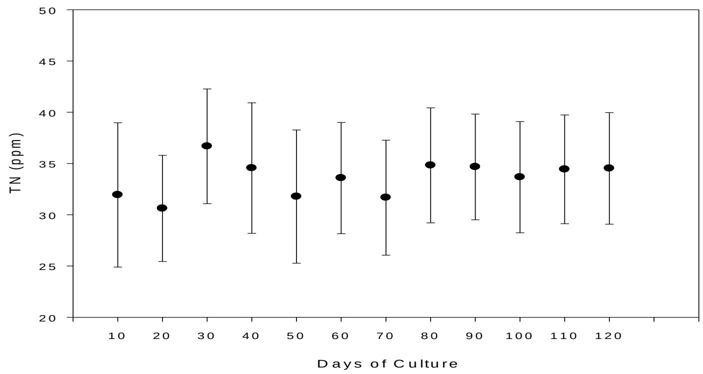


Fig.7 Total nitrogen levels in the algal pond

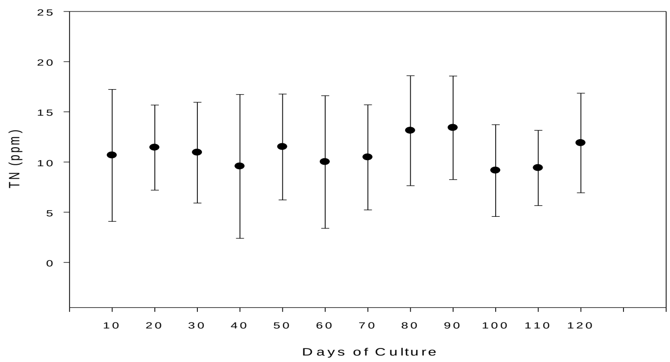


Fig.8 Total phosphate levels in the control pond

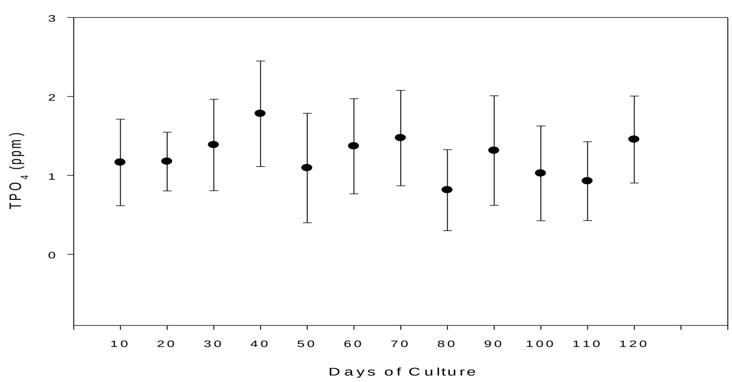


Fig.9 Total phosphate levels in the algal pond

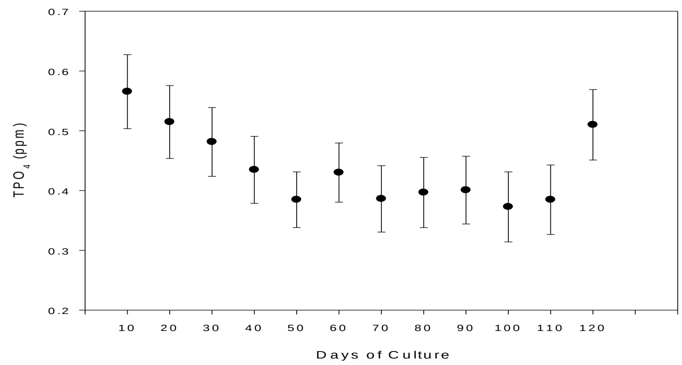


Fig.10 Nitrite levels in the control pond

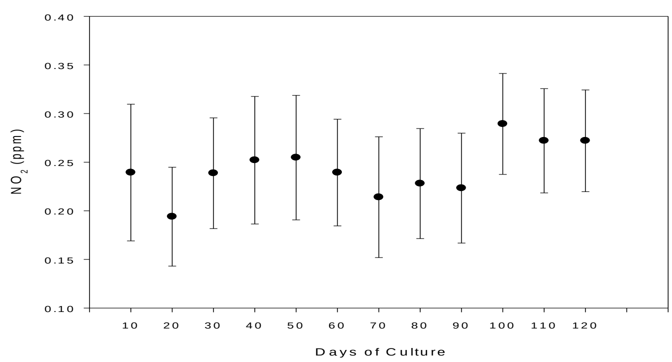


Fig.11 .Nitrite levels in the algal pond

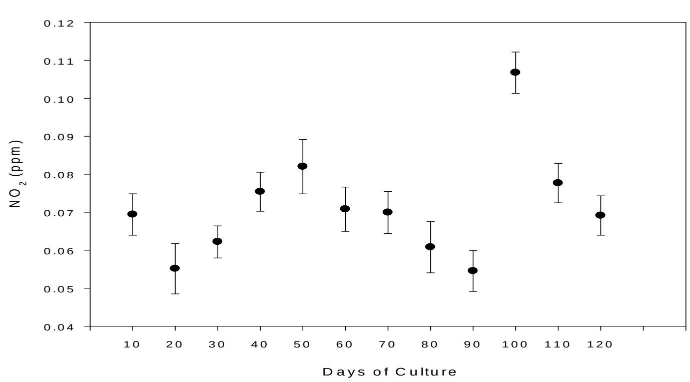


Fig.12 Nitrate levels in the control pond

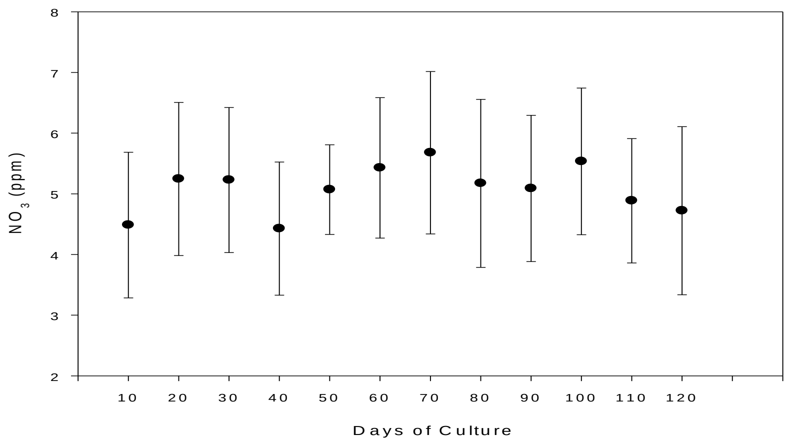


Fig.13 Nitrate levels in the algal pond

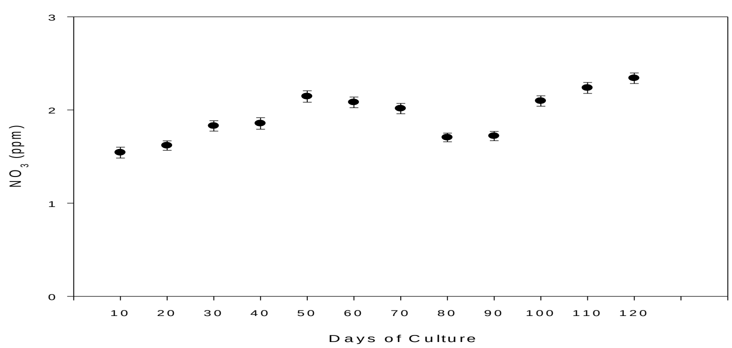


Fig.14 Ammonia levels in the control pond

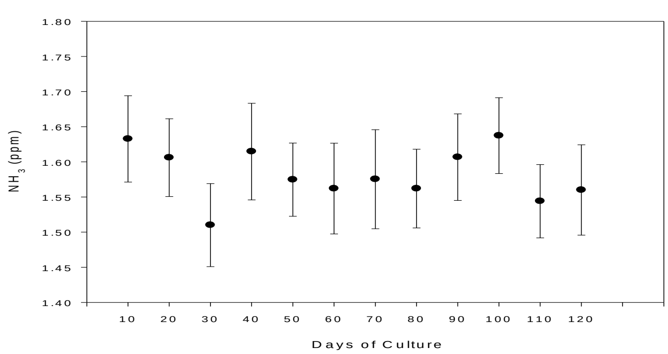


Fig.15 Ammonia levels in the algal pond

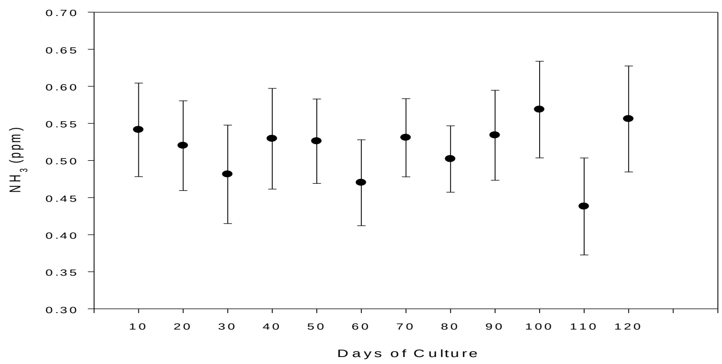


Fig.16 Silicate levels in the control pond

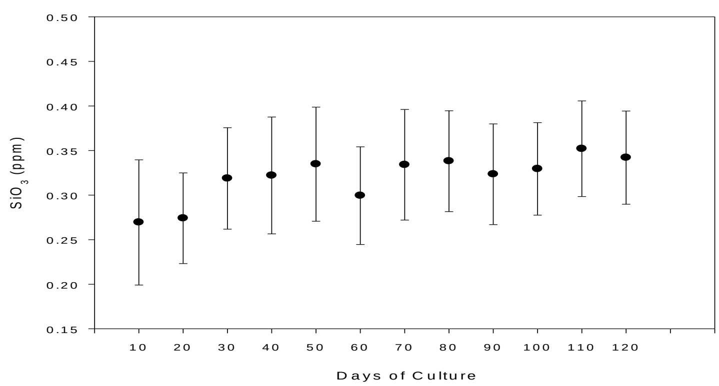


Fig.17 Silicate levels in the algal pond

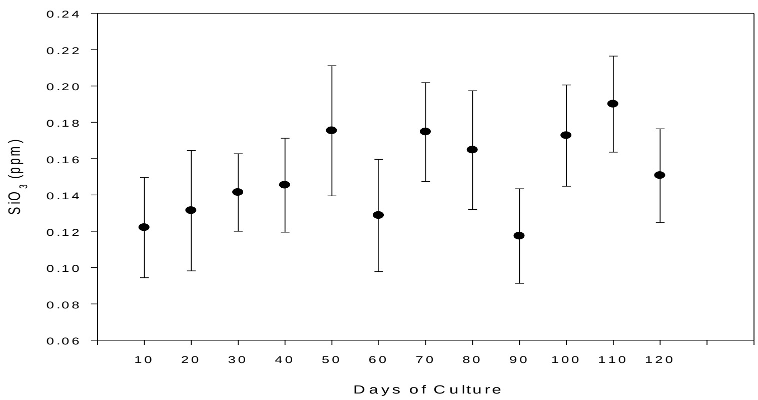


Fig.18 Total Suspended Solids (TSS) levels in the control pond

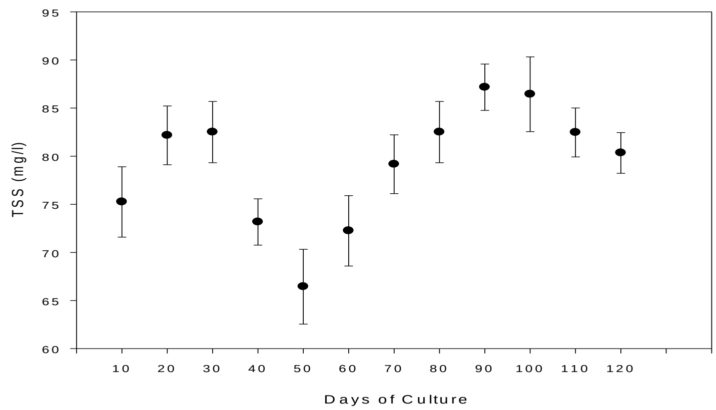
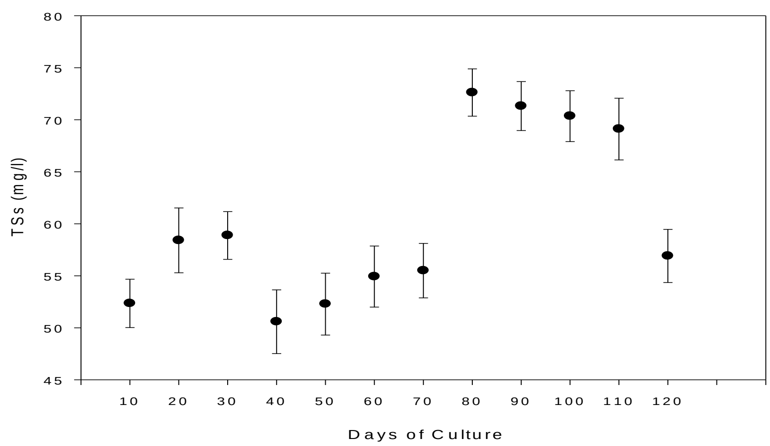


Fig.19 Total Suspended Solids (TSS) levels in the algal pond



Macroalgae were found to effectively treat fishpond effluents producing useful algal biomass and recorded a daily growth rate of 1.17±0.4% and 1.05±0.25% for *Gracilaria crassa* and *Ulva reticulata* respectively (Msuya and Neori, 2002). *Gracilaria* sp. grown in oyster farm effluents also removed 500μmoles/m^3/day of ammonia with 90% efficiency in optimal conditions. Seaweeds remove upto 90% of the nutrient discharge, when integrated with fish farm effluents thereby reducing problems of eutrophication and possibility of their year round cultivation (Luning and Pang, 2003). Phytotreatment ponds containing *U. rigida* used for treating effluent from seabass and seabream culture ponds also exhibited an active process of nitrification, a 15% reduction of soluble reactive phosphorus, sharp reduction in organic fraction and an appreciable improvement in physico chemical parameters. The present study showed an encouraging growth of seaweeds at an average wet weight of 1.5 kg/month. The good growth of the macroalgae in the present study may be attributed to the nutrient rich discharge and plankton production. Hence these organisms can be effectively cultured as secondary species to provide added income to the shrimp farmers apart from cleaning the discharge waters.

References

Boyd, C.E., 2003. Guidelines for aquaculture effluent management at the farm level. *Aquaculture*, 226: 101-112.

Chandrapal, G.D. 2003. Applying effluent standard to small-scale Farms. *Aquaculture Authority News,* India.

Cripps, S.J., 1991. Comparison of methods for the removal of suspended particles from aquaculture effluent. EAS (European Aquaculture Society) Special Publication No. 14, 80 pp.

Dierberg, F.E. and W. Kiattisimukul, 1996. Issues, impacts, and implications of shrimp aquaculture in Thailand. *Environmental Management*, 20, pp.

Folke, C. and N. Kautsky, 1992. Aquaculture with its environment: Prospects for sustainability. *Ocean and Coast. Manag.*, 17: 5-24.

Gowen, R.J., R. Rosenthal, T. Makinen and I. Essi, 1989. Environmental impact of Aquaculture activities. EAS (European Aquaculture Society) Special Publication No. 10, 300 pp.

Heerfordt, L., 1991. Test of the efficiency of alternative treatment system on the effluent from traditional trout farms in Denmark. *EAS (European Aquaculture Society) Special Publication.* No. 14, 140 pp

Krom, M.D. and A. Neori, 1989. A total nutrient budget for an experimental intensive fish pond with circulatory moving seawater. *Aquaculture*, 88: 345-358.

Luning, K. and S. Pang, 2003. Mass cultivation of seaweeds: current aspects and approaches. *J. Appl. Phycol.,* 15: 115-119.

Menzel, D.W., and N. Corwin. 1965. The measurement of total phosphorus in seawater based on the liberation of organically bound fractions by persulfate oxidation. *Limnol. Oceanogr.* 10: 280-282

Msuya, F.E. and A. Neori, 2002. *Ulva reticulata* and *Gracilaria crassa*: macroalgae that can biofilter effluent from tidal fish ponds in Tanzania. Western Indian Ocean. *J. Mar. Sci*. 1: 117-126.

Piedrahita, R.H., 2003. Reducing the potential environmental impact of tank aquaculture effluents through intensification and recirculation. *Aquaculture*, 226: 35-44.

Shpigel, M., Neori, A., Popper, D.M. and Gordin, H. 1993. A proposed model for "environmentally clean" land-based culture of fish, bivalves and seaweeds. *Aquaculture,* 117: 115-128.

Solarzano, L., 1969. Determination of ammonia in natural water by the phenol hyphochlorite method. *Limnol. Oceanogr.*, 14: 799-801.

Strickland, J.D.H. and T.R. Parsons, 1972. A practical hand book of sea water analysis. *Bull. Fish Res. Bd. Canada,* 167: 301 pp.

How to cite this article:

Santhi, N., B. Deivasigamani and Vasuki Subramanian. 2017. Studies on Biodegradation of Shrimp Farm Wastes by Using of Seaweeds. *Int.J.Curr.Microbiol.App.Sci.* 6(1): 271-281.
doi: http://dx.doi.org/10.20546/ijcmas.2017.601.033