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USE OF ZEOLITE BASED TECHNOLOGY FOR DEVELOPING LOW CARBON AQUACULTURE SYSTEM

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Abstract: Ammonia volatilization is a major process of N loss that affects the environment. Large quantum of ammonia emissions are from livestock production. The best way of capturing volatilized ammonia-N could be using zeolite as a good ion exchange medium before it gets either volatilized or nitrified. Thus captured ammonia-N could be used as a source of inorganic nitrogen in ponds to promote algal production without adding additional organic carbon and BOD. The present investigation was designed to study the zeolite based technology with an aim of developing a low carbon aquaculture system. The zeolite used for the study was a commercially available zeolite, (CLINZEX) which was a fine powder (CEC 3.9- 4 meq/g). The experiment was conducted to assess the difference between manure loaded system (control) and zeolite loaded system (treatment) in terms of water quality, TAN release and algal productivity. The difference between the BOD values recorded in both the controls and treatmental tanks using cowdug source of manure-N remained mostly above 10 ppm. All the treatments which received zeolite samples from Cowdug . The range of values of chlorophyll *a* (1029 – 5150 mg/m^3) recorded in the treatment tanks were higher than the values (54.6 – 1347 mg/m^3) of chlorophyll *a* in the control tanks. F-test analysis done using highest mean values of BOD, COD, TAN and Chlorophyll *a* showed a highly significant ($P<0.01$) variation between the treatment and control tanks and at the same time no significant variation was found between time intervals. High TAN release and its corresponding high algal production along with low organic load (BOD and COD) of zeolite loaded treatment tanks compared with low TAN content, low algal productivity and associated high organic load confirms the use of zeolite for transferring manure ammonia in the form of inorganic nitrogen for developing low carbon aquaculture system. The nitrogen transferring mechanism adapted in this study not only avoided nitrogen loss but also could generate biogas, an additional income to farmer. The low carbon aquaculture system developed and low Carbon Foot Print of the product, enhances the value of production system and the products. Further, the low carbon loading and their values in the production process will endorse the zeolite based N loading method as a thruthful means in the tropical aquaculture of many species in the world.

Key words: Zeolite, Low carbon aquaculture, Cowdug, Organic load, Inorganic nitrogen

INTRODUCTION

Nitrogen entering a farm through animal feeds ends up as ammonia in manure. Ammonia volatilisation is a major N loss process that affects the environment. The lost ammonia is important because it (i) is a direct loss of plant available N (ii) reduces N:P ratio in manure and (iii) contributes the eutrophication in aquatic ecosystem (Asman, *et al.*, 1994; Asman *et al.*, 1998; Sharpley *et al.*, 1998). The best way of capturing ammonia-N could be using a suitable ion exchange method before it gets either volatilized or nitrified. The ammonia loss from the manures could be captured through ion exchange using zeolite. Thus captured ammonia-N could be used as a source of inorganic nitrogen in ponds to promote algal production. This way of transferring manure ammonia not only improves the farm environment by reducing noxious odours and leaching out as nitrate but also recycles an otherwise lost nutrient for increasing farm productivity. Furthermore, by transferring ammonia from animal manures to zeolites and then applying the ammonia enriched zeolites to ponds, the farmer can fertilize ponds with manure-N without adding additional organic carbon and BOD.

Reduction in organic carbon input will mitigate major environmental risk of the creation of anoxic condition in the pond water. Knud-Hansen *et al.* (1993) reported that algal and fish productivity will be quite high in ponds without the risk of pond water deoxygenation if no additional BOD is added through manures. Further Kyoto protocol and Inter Governmental Panel for Climate Change (IPCC) obligates each and every sector of the society to promote low carbon technology. Hence the present investigation was proposed to design a zeolite based technology for transferring manure ammonia-N into freshwater ponds with an aim of developing low carbon aquaculture system.

MATERIALS AND METHODS

The zeolite used for the study was a commercially available zeolite of brand CLINZEX –DS of WOCKHARDT–a product of Biostadt Agrisciences. These zeolites are crystalline sodium or calcium aluminium silicates having pore sizes between 0.003 and 0.010 nm in diameter. This material has three dimensional framework structures in which silicon and aluminium atoms are tetrahedrally co-ordinated to oxygen atoms. The framework enfolds cavities containing water molecules and cations that are capable of undergoing dispersion and cation exchange. The zeolite used for the study is reported to have a high cation exchange capacity of 3.9 - 4 m.e/g. For the study, finely powdered zeolite (<0.053 mm) was selected so as to have more surface area. The selected zeolite was weighed about 1kg in a weighing balance and was packed in a cotton cloth of mesh size (150 nm) which was loosely tied with a rubber band so as to make a small zeolite bag. Fresh cowdung was collected from college cowshed. Freshness of these manures were ensured before making them into slurry as it is mandatory for the experiment. Before making the slurry, these manures were assessed for the physico-chemical characteristics following the methods of APHA (1995) (Table 1). Subsequently, the manure slurries were made following the methods of Batterson *et al.* (2002) in which each of the manure was made into slurry utilizing the equal amount of tap water. The zeolite bags prepared as said earlier were suspended in each plastic containers, poured with manure slurries

In this experimental set up, plastic containers of 120 litres capacity in duplicate were used as the outdoor algal culture tanks and 50 litre capacity plastic containers in duplicate were used for preparation of cowdung slurry. The plastic containers containing cowdung slurry were designated as CD1 and CD2. The zeolite subsamples were taken at the time intervals of 0.16 hr, 0.5 hr, 2 hr, 8 hr, 36 hr and 72 hr and transferred to outdoor algal culture tanks. The amount of zeolite subsamples to be transferred to the algal culture tanks were assessed based on the mean TAN content of the sample taken so as to ensure the same level of nitrogen (0.225 g) per tank.

Table 1. Physico-chemical characteristics of fresh cowdung

No.	Parameters	Values
1.	Moisture content (%)	87.26
2.	Dry matter (%)	12.74
3.	pH	7.8
4.	EC (µS)	374.2
5.	Total Dissolved Solids (ppm)	198.6
6.	Mineral content (%)	1.03
7.	Organic matter (%)	98.97
8.	Organic carbon (%)	48.49
9.	Total Ammoniacal Nitrogen (%)	1.44
10.	Biochemical Oxygen Demand (ppm)	11080
11.	Chemical Oxygen Demand (ppm)	168200
12	COD : BOD	15.18

These treatment tanks were supplied with triple super phosphate at the rate of 0.075 gm of phosphorus per algal culture tank so as to provide sufficient P for algal growth (Batterson *et al.,* 2002). The arrived ΔC:N ratio of each algal culture tank was 6.71. The control tanks directly received manures. The quantity of the manure to be added in these tanks were assessed based on the TAN content of the corresponding manure so as to bring the nitrogen level of the tank to the same (0.225 g) as that of the treatment tanks. Each treatment and control tanks were filled upto 100 litres with tap water and top layer of fish pond green water at the ratio of 2:1 (Batterson *et al.*, 2002). Water depth of these tanks were 0.8 m. Mean TAN content of the sample taken and the corresponding quantity of zeolite transferred to the respective treatment tanks (T_1 .... T_6) along with TAN content and quantity of manures transferred to the control tanks (C_1 .... C_6) are furnished separately for cowdung.

Water samples were taken from both treatment and control tanks everyday and tested for the

Cowdung

Hours / Designation of tank		0.16 (T_1)	0.15 (T_2)	2 (T_3)	8 (T_4)	36 (T_5)	72 (T_6)
Treatment	Mean TAN content of zeolite (%)	0.28	0.35	0.42	0.49	0.63	0.63
	Zeolite quantity transferred (g)	80.3	64.3	53.5	45.9	35.7	35.7

Hours / Designation of tank		0.16 (C_1)	0.15 (C_2)	2 (C_3)	8 (C_4)	36 (C_5)	72 (C_6)
Control	Mean TAN content of cowdung (%)	1.4	1.4	1.4	1.4	1.4	1.4
	Quantity of cowdung transferred (g)	16.0	16.0	16.0	16.0	16.0	16.0

water quality parameters. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) of these water samples were analysed as per the methods of APHA (1995). TAN content of manure, zeolite and water samples were determined by Kjeldahl nitrogen analysis (APHA, 1995). The Kjeldahl nitrogen analysis was done using the instrument. KELPLUS Nitrogen Estimation system (PELICAN - Model KES 12 L (Classic - Dx) (Plate 3). Chlorophyll a content of the samples were analysed following the procedures of Strickland and Parsons (1968).

The data collected were subjected to Two-way ANOVA test following the biostatistical methods of Christensen (1996).

RESULTS AND DISCUSSION

Biochemical Oxygen Demand (BOD)

The recorded BOD values in different treatments (T1, T_2, T_3, T_4, T_5, T_6) and their corresponding controls (C1, C_2, C_3, C_4, C_5 C_6) are furnished in the Figs. 1-6. In treatment T_2, the maximum value of BOD recorded was 3.12 ppm and at the same time, the corresponding control exhibited a mean BOD value of 11.7 ppm and above throughout the experimental period. Treatment T_3 utilizing cowdung as manure always exhibited a BOD value below 2.95 ppm. The lowest value of 2.46 ppm was recorded on the fifth day. The corresponding control showed a continuous increasing trend in BOD from the first day onwards and the maximum value of 14.2 ppm was recorded on the fifth day and beyond this a decreasing trend was noticed. Treatments T_4, T_5 and T_6 showed continuous increasing trend in BOD values right from the day one to day seven. The mean BOD values of these treatments showed a variation between 1.8 and 2.9 ppm and at the same time, the respective controls (C_4, C_5, C_6) showed a variation of BOD values between 11.1 ppm and 14.4 ppm. The difference between significant variation was observed in the time intervals.

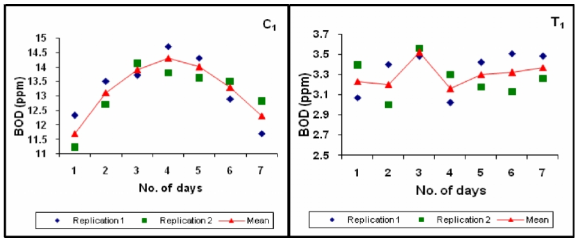

Fig.1. Variation in BOD measurements of C_1 and T_1

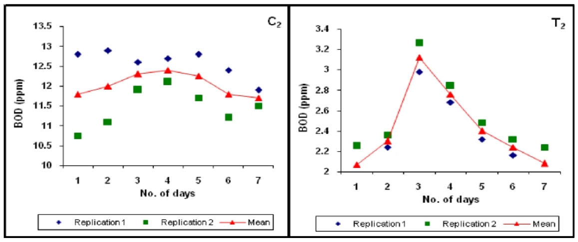

Fig. 2. Variation in BOD measurements of C_2 and T_2

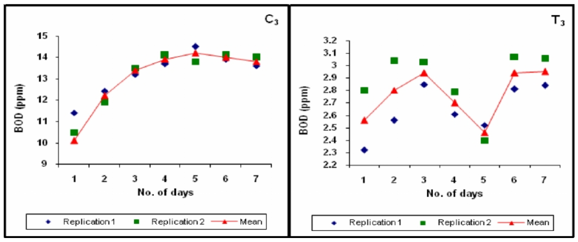

Fig. 3. Variation in BOD measurements of C_3 and T_3

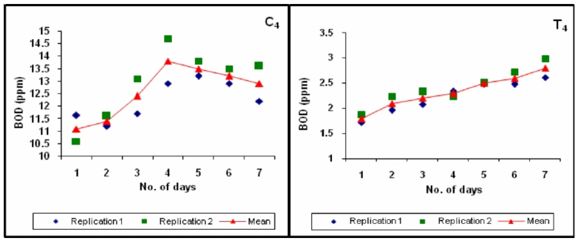

Fig. 4. Variation in BOD measurements of C_4 and T_4

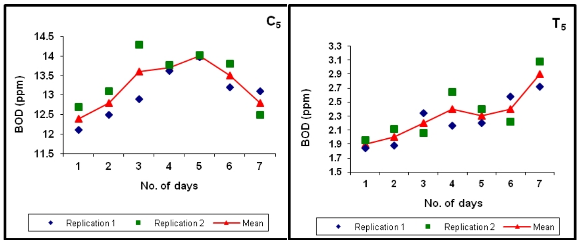

Fig. 5. Variation in BOD measurements of C_5 and T

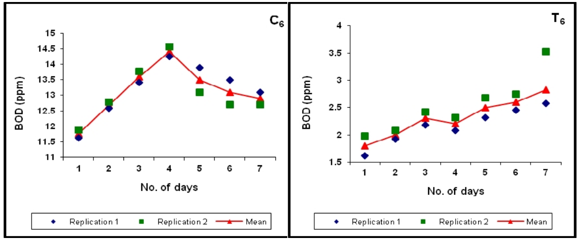

Fig. 6. Variation in BOD measurements of C_6 and T_6

Chemical Oxygen Demand (COD)

Variation in COD measurements of controls (C1 to C6) and treatments (T1 to T6) recorded for seven days in the experiments initated at the different time intervals utilizing cowdung as manure are given in Figs. 6-12. The range of variation of mean COD recorded for treatments T1, T2, T3, T4, T5 and T6 are 3.53 to 3.92 ppm, 2.88 to 3.92 ppm, 3.36 to 3.85 ppm, 2.6 to 3.6 ppm, 2.7 to 3.7 ppm and 2.7 to 3.7 ppm respectively. The respective control tanks (C1, C2, C3, C4, C5 and C6) for the above said treatments the range of variation of mean COD values from 12.1 to 14.7 ppm, from 12.1 to 12.8 ppm, from 12.2 to 14.5 ppm, from 11.4 to 14.2 ppm, from 12.9 to 14.3 ppm and from 12.2 to 14.8 ppm respectively. Mean COD value of the control tanks always remained above 11.2 ppm and at the same time, the corresponding treatment tanks showed COD values always below 3.92 ppm. The difference between mean COD values of control and treatment tanks are always remained above 7 ppm. Two-way ANOVA test carried out between control and treatment

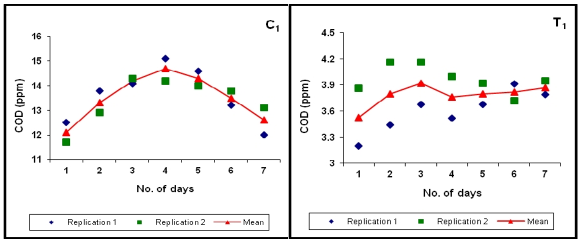

Fig. 7. Variation in COD measurements of C_1 and T_1

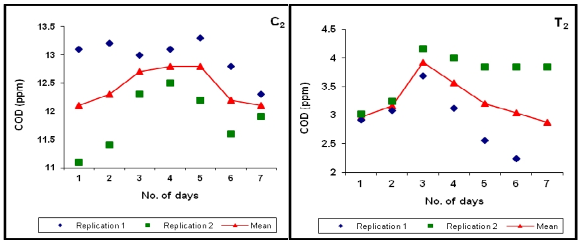

Fig. 8. Variation in COD measurements of C_2 and T_2

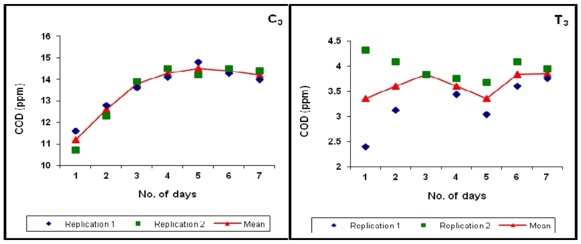

Fig. 9. Variation in COD measurements of C_3 and T_3

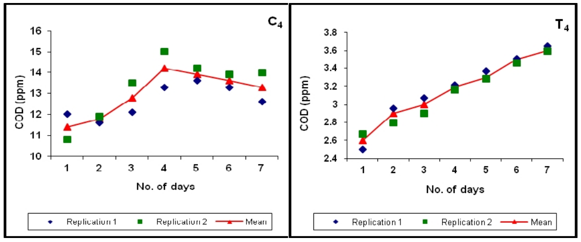

Fig. 10. Variation in COD measurements of C_4 and T_4

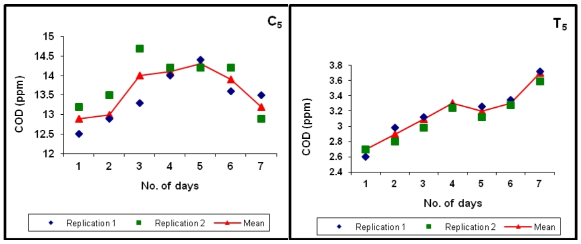

Fig. 11. Variation in COD measurements of C_5 and T_5

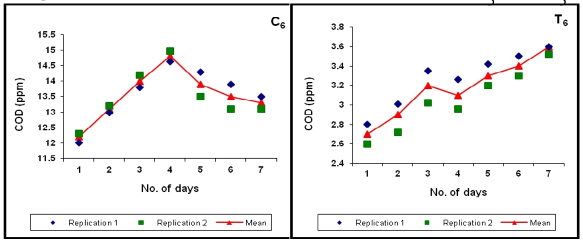

Fig.12. Variation in COD measurements of C_6 and T_6

systems for highest mean COD measurements recorded during experiment exhibited highly significant ($P<0.01$) variation between cowdung loaded and zeolite loaded systems and at the same time, no significant variation was observed in the time intervals.

Total Ammoniacal Nitrogen (TAN)

Variation in the Total Ammoniacal Nitrogen (TAN) values of the controls (C_1 to C_6) and treatments (T_1 to T_6) recorded in the experimental period for different time intervals utilizing cowdung as manure are given in Figs. 13-18. The mean TAN values recorded in control tanks fed with cowdung showed an overall increase in trend and at the same time, TAN concentration in treatment tanks were more or less same. The higher values of the TAN content recorded in the control tanks C_1, C_2, C_3, C-$_4$, C_4, C_5 and C_6 were 1.2 mg/l, 5.8 mg/l, 4.2 mg/l, 5.2 mg/l, 6.5 mg/l and 5.8 g/l respectively. All these values were recorded in the last day of the experiment. The TAN values recorded in the treatment tanks (T_1, T_2, T_3, T_4, T_5 and T_6) varied between 0.011 and 0.018 mg/l, 0.02 and 0.05 mg/l, 0.03 and 0.06 mg/l, 0.04 and 0.07 mg/l and 0.04 and 0.07 mg/l & 0.03 and 0.06 mg/l respectively. The F-test analysis carried out for highest mean TAN values between control and treatment systems showed highly significant difference between control and treatment systems. They also showed no significant relationship when this ANOVA test was made between different time intervals.

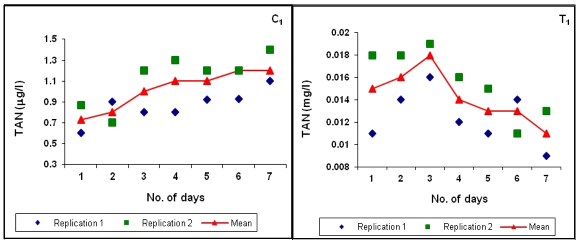

Fig. 13. Variation in TAN measurements of C_1 and T_1

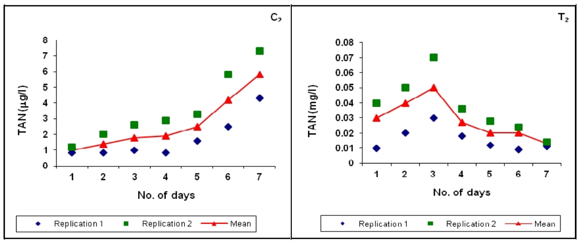

Fig. 14. Variation in TAN measurements of C_2 and T_2

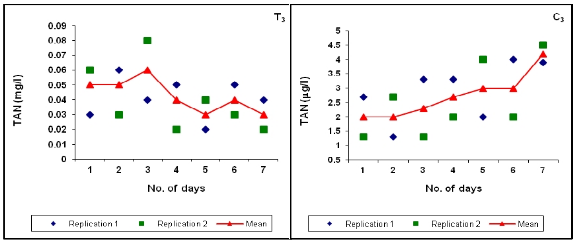

Fig. 15. Variation in TAN measurements of C_3 and T_3

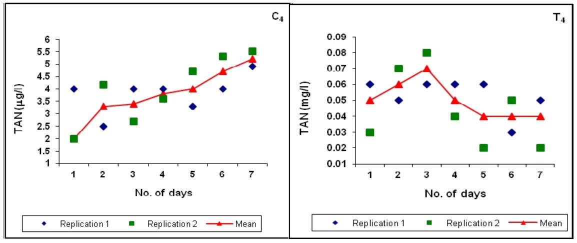

Fig. 16. Variation in TAN measurements of C_4 and T_4

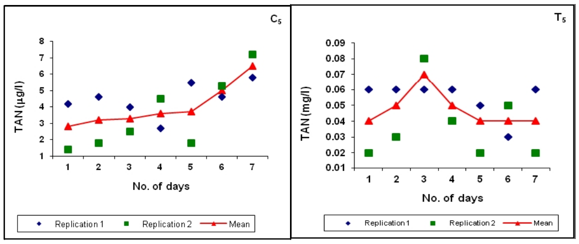

Fig. 17. Variation in TAN measurements of C_5 and T_5

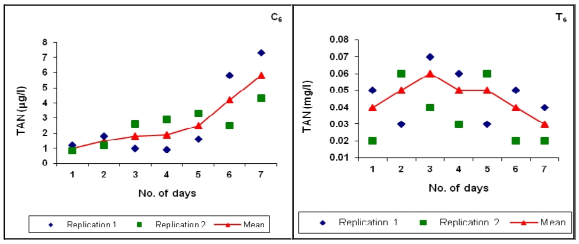

Fig. 18. Variation in TAN measurements of C_6 and T_6

Chlorophyll *a*

Variation of chlorophyll *a* contents recorded in the controls (C_1 to C_6) and treatments (T_1 to T_6) of outdoor algal culture experiments initiated at different time intervals utilizing cowdung as manure are given Figs. 19-24. The range of variation of chlorophyll *a* contents recorded in the above said experiments are also summarized in Table 2.

The highest values of range in the treatment tanks were recorded mostly after 24 hours after the initiation of the experiment and at the same time, the highest values of chlorophyll *a* in the control tanks were recorded mostly on third day.

Two-way ANOVA test carried out between control and treatment tanks using highest mean chlorophyll *a* values showed highly significant ($P<0.01$) variation between cowdung loaded and

Table 2. The range of variation of chlorophyll a contents

Control	Range (mg/m^3)	Treatment	Range (mg/m^3)
C_1	54.6-550.6	T_1	1632-3324
C_2	220-565	T_2	1029-1735
C_3	171-747	T_3	1080-2444
C_4	240-651	T_4	1472-2658
C_5	88.7-499	T_5	1492-3939
C_6	119-508	T_6	1703-4296

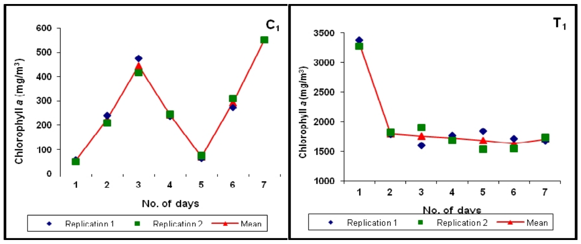

Fig. 19. Variation in Chlorophyll *a* measurements of C_1 and T_1

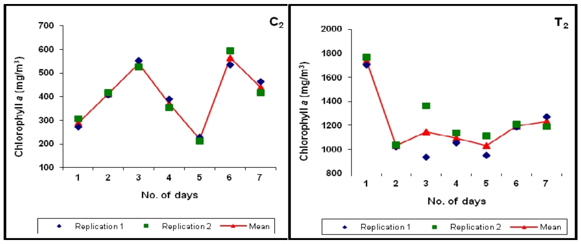

Fig. 20. Variation in Chlorophyll *a* measurements of C_2 and T_2

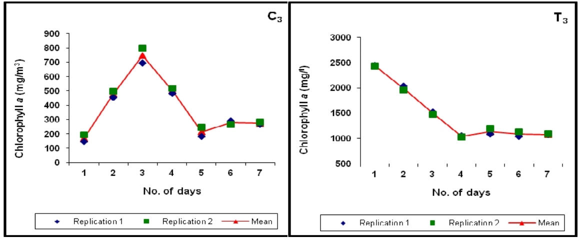

Fig. 21. Variation in Chlorophyll *a* measurements of C_3 and T_3

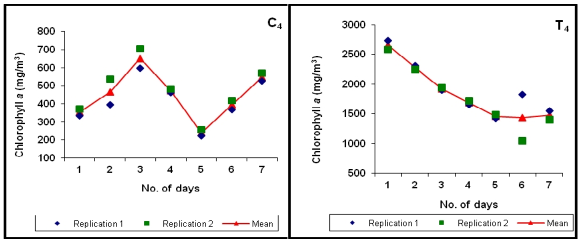

Fig. 22. Variation in Chlorophyll *a* measurements of C_4 and T_4

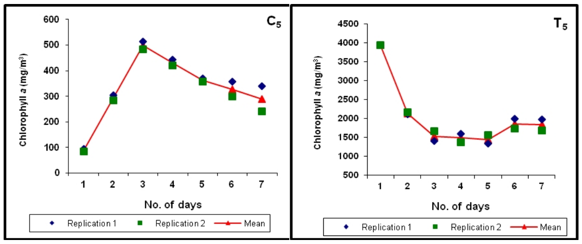

Fig. 23. Variation in Chlorophyll *a* measurements of C_5 and T_5

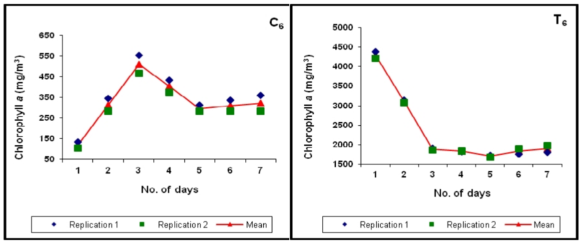

Fig. 24. Variation in Chlorophyll *a* measurements of C_6 and T_6

zeolite loaded system and at the same time, no significant variation was found between time intervals (Table 3).

Animal manures have long been used for pond fertilization because they contain the three major algal nutrients: Nitrogen (N), Phosphorus (P) and Carbon (C) (Wholfarth and Schroeder, 1979; Colman and Edwards, 1987). A major concern with manuring the ponds is the Biochemical Oxygen Demand (BOD) due to microbial decomposition of organic matter (Batterson *et al.*, 2002). Too much manure with little pond aeration can cause serious depletion of dissolved oxygen and significant mortalities of culture organisms. Applying zeolite technologies for manuring of fish culture systems should improve sustainability by increasing nutrient utilization efficiencies while reducing undesirable environmental problems. Hence the experiment is carried out for assessing the difference between manure loaded and zeolite loaded systems in terms of BOD, COD, TAN release and chlorophyll *a*. There are few studies that involve the use of zeolites in aquaculture field. The results are sometimes contradictory.

In early days of aquaculture, zeolite have been commonly used for removal of ammonia from waste waters (Braico, 1972; Konikoff, 1973;

Table 2. F-test analysis of water quality parameters recorded in the experiment for assessing the difference between manure loaded and manure-N transferred zeolite systems

Sl. No.	Type of manure	Parameters	Analysis between	DF	F value	Level of significance
1.	Cowdung	BOD	Time interval	5	0.9242	NS
			Manure loaded and zeolite loaded system	1	1084.4	P<0.01
2.	Cowdung	COD	Time interval	5	0.7274	NS
			Manure loaded and zeolite loaded system	1	1017.334	P<0.01
3.	Cowdung	TAN	Time interval	5	1.3734	NS
			Manure loaded and zeolite loaded system	1	47.059	P<0.01
4.	Cowdung	Chlorophyll *a*	Time interval	5	0.7877	NS
			Manure loaded and zeolite loaded system	1	34.980	P<0.01

Johnson and Sieburth, 1974; Sims and Hinden, 1978). Johnson and Sieburth (1974) suggested that removal of ammonia by ion exchange could be limited to freshwater systems as the ammonium removal capacities of natural and synthetic ion exchangers are reduced considerably by competing cations in seawater. Leonard (1980) concluded that zeolites are efficient in freshwater aquaculture systems and their efficiency is reduced in seawater. Hence for our study, freshwater culture system has been selected for the experiment which involves release of TAN and subsequent algal production. Although, many works have been carried out in zeolite for the removal of ammonia from aquaculture system, nobody has attempted the use of zeolite in transfer of manure ammonia-N but for Batterson *et al*. (2002) and this study also evaluated only the manure ammonia-N transfer, TAN release and its corresponding algal productivity.

Manure derived ammonium-N adsorbed by zeolite can be released into the water through diffusion and cation exchange reactions (Perrin *et al*., 1998). The results from the treatment tanks (T_1 to T_6) clearly showed a range of variation of TAN between 0.1 and 0.8 mg/l. This high concentration of TAN along with narrow range indicates sustained release of TAN from zeolite. Though initial high concentration of TAN as recorded in the treatment algal culture tanks, after third day onwards the range of variation of TAN becomes narrow which indicates sustained release of TAN which could be attributed to the characteristics of zeolite that acts as a slow release fertilizer. Zeolite saturated with ammonia-N have been commonly used as slow release fertilizers in agriculture (Barbarick and Pirela, 1984; Lewis *et al*., 1984; Dwairi, 1998). Similar to agriculture, Batterson *et al*. (2002) adapted the zeolite technology for capture of manure ammonia-N to use the same in aquaculture as controlled release fertilizer. Yields of microalgal culture have been improved by the addition of natural zeolites to the culture systems (Chaves-Sanz and Lopez-Ruiz, 1990; Lopez-Ruiz *et al*., 1995b; Voltolina *et al*., 1997; Nieves *et al*., 2000). The control tanks (C_1 to C_6) recorded a range of variation of TAN content from 1.2 to 6.5 µg/l. The difference in concentration of TAN between control tanks and treatment tanks is from 83-123 times. This indicates immediate availability of the nitrogen present in the treatment systems. The low concentration of TAN in control tanks could be attributed to the non-availability because the added manure in control tanks should undergo a process of mineralization for release of ammonia.

The chlorophyll *a* which is an indicator of the biomass of phytoplankton ranged from 54.6 mg/m^3 to 651 mg/m^3 in the case of control system.

At the same time, treatment tanks recorded a range of variation of chlorophyll *a* content from 1.02 g/m^3 to 4.3 g/m^3 (T_1 to T_6). The difference in chlorophyll *a* content between control and treatment tanks is around 3- 24 times. The high chlorophyll *a* content of the treatment tanks is mainly due to sustained release of TAN from zeolite into water through diffusion and cation exchange reactions (Perrin *et al.*, 1998) and its immediate bioavailability for algal production. Further, ammonia is the most preferential form of nitrogenous nutrient in freshwater ecosystems and urea ranks next to it followed by nitrate (Mc Carthy *et al.*, 1977). Hence capturing the ammonia using zeolite as vehicle will bring change in fertilization strategies of freshwater aquaculture.

As far as the chlorophyll *a* content is concerned, low values are recorded in the first day in control tanks and opposingly treatment tanks recorded high values of chlorophyll *a* after the first day. This clearly indicates the bioavailability of zeolite transferred ammonia-N for algal production right from the first day onwards. Low chlorophyll *a* content in the control tanks could be attributed to the non-bioavailability of TAN which is possible only through the slow mineralization process. By capturing the ammonia-N before it gets either volatilized or nitrified and using that nitrogen to promote algal productivity in ponds, the farmer not only improves the farm environment by reducing noxious odours and nitrate leaching, but recycles an otherwise lost nutrient for increased infarm productivity.

The present study conducted was not only to evaluate the efficiency of zeolite in transferring manure ammonia-N and its subsequent use as controlled release fertilizer, but also to understand the difference between the organic load of cowdung loaded vs manure-N transferred zeolite loaded systems. In manuring ponds, cowdung add a lot of oxygen consuming potential to the pond particularly to the bottom soil through soil respiration as it is used in solid condition. Soil respiration is an index of the activities of soil microorganisms. Respiration of organic soils is particularly important because it represents oxygen demand that can result in dissolved oxygen depletion in ponds and significant mortalities of culture organisms. The soil respiration recorded in freshwater fish culture systems of Fisheries College, Thoothu-kudi ranged from 0.11 to 0.77 g/m^2/day (Chitra, 2004). The BOD of the control tanks ranged from 10.1 to 14.4 ppm in the case of control tanks and at the same time, in treatment tanks, the BOD ranged from 1.25 to 2.95 ppm. The difference between the BOD of the control and treatment systems is approximately 8- 11 ppm. Similarly COD values recorded for the control tanks ranged from 10.9 to 14.8 ppm and for treatment tanks, the same COD ranged from 2.6 to 3.86 ppm only. The difference in COD measurements between control tanks and treatment tanks is also around 8 to 11 ppm. Though Batterson *et al.* (2002) promoted the use of zeolite technology in manure ammonia-N transfer; hither to no attempt has been made to study the organic loads of the systems.

Without considering the organic load, a stress for both algae and culture organisms, it is difficult to assess the real use of zeolite in developing low carbon aquaculture system. Our results, particularly, BOD and COD clearly indicates differences in organic load between control and treatment systems. High TAN release and its corresponding high algal production along with low organic load (BOD and COD) of treatment tanks compared with low TAN content, low algal productivity and associated high organic load of control tanks confirms the use of zeolite for transferring manure ammonia in the form of inorganic nitrogen for developing low carbon aquaculture system. Kyoto Protocol obligates to develop low carbon systems now a days so as to combat climate change. Manuring the pond directly with manures will not only increases the organic load but also will lead to the emission of Green House Gases (GHG). Hence, the present study has been carried out to develop a low carbon aquaculture systems.

The purpose of the study is not only to reduce the organic load in aquaculture system but also to capture the volatilized ammonia, a precursor to the air pollutant PM 10 (Bayon, 2007). Our study also suggests to use the fresh manure for this purpose hence storage of manure could be avoided which will ultimately reduce the emission of Green House Gases i.e., oxides of carbon and nitrogen. The purpose of manuring in the pond is to tap the nitrogen present in these manures and not for the carbon as nutrient. Alkalinity above 100 to 120 ppm is reported to be condusive for better algal production (Boyd, 1997). This range of alkalinity is common in freshwater aquaculture systems. Normally, aquaculture system will not require input of carbon unless otherwise it is highly eutrophic. Hence, the purpose of manuring is mainly for nitrogen. The phosphorus present in these manures will not be a sufficient enough to support algal productivity. Inorganic supply of phosphorus is essential to cater the need of the algal productivity. Manuring will promote only heterotrophic food web in the pond. Hence application of inorganic fertilizers in manuring ponds was emphasized by Schroeder *et al,* (1990) to ensure the high rate of biotrans-formation of nutritive element into fish biomass. So it is very clear that the required nutrient input for maintaining algal production in freshwater ponds are only nitrogen and phosphorus.

The manures need not be directly added to the pond and the carbon present in the manures could be conserved and directed for GHG destruction projects. The manures are good source for biogas generation. One ton of cowdung is capable of generating around 7000 ft^3 of biogas and similarly, one ton of poultry manure is capable of producing 22000 ft^3 of biogas (Overcash *et al.*, 1983). The recommended dosage of cowdung and chicken manure for fresh water aquaculture system are about 20 ton/ha/kg. The nitrogen transferring mechanism adapted in this study not only avoids the loss of nitrogen but also helps to generate biogas which gives additional income to farmer. Hence low carbon aquaculture system developed through this present investigation using zeolite as vehicle for transferring manure ammonia-N into freshwater aquaculture pond will have the following advantages (i) reduces ammonia and NO_x volatilization from manures (ii) reduces organic load in the pond (iii) reduces respiration rate of the pond and bottom soil (iv) increases bioavailability of nitrogen (v) supplies preferential form of nitrogen by algae (vi) sustains nitrogen content in the pond (vii) sustains high algal productivity (viii) increases fish production (ix) improves farm environmental conditions (x) reduces farm input (manure) (xi) conserves the carbon resource (xii) redirect the carbon resource for energy production (xiii) increases the economic output. Further, Carbon Foot Print (CFP) are measured for business purposes using calculations to help to determine GHG emissions (Bayon, 2007). The CFP calculator estimates how many kilos of GHG emissions measured in units of CO_2 generated by a kilo of fish by the time it reaches the consumer. The fish produced through this low carbon aquaculture system not only lowers the Carbon Foot Print of the product but also increases the consumer preference.

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