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Influence of ammonia-nitrogen on the diversity of microalgae in clean and highly concentrated wastewater

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Abstract

The diversity of microalgae can be affected by different factors serving as source of their nutrients. The most promising factor which is highly variable for different clean and waste-water bodies is Ammonia-nitrogen (NH_4-N). The NH_4-N studied for different locations of the district Malakand showed a variation in their values in respect to different seasons. The areas studied has NH_4-N value ranges from 0.4-3 mg/L for stagnant water, 0.1-0.8 mg/L for running water and 2.1- 4.4 mg/L for wastewater. The highest values were found to be in summer season for all the water bodies studied. The NH_4-N values were enhanced by warm temperature in stagnant and waste water bodies, while there was no temperature effect on NH_4-N of running water. NH_4-N is a basic source of nitrogen for microalgae growth and stagnant clean water has sufficient NH_4-N which is best suitable place for a variety of microalgae growth. Because of high temperature summer season could provide sufficient NH_4-N in these water bodies. Excessive amount of NH_4-N in a water body could limit microalgae variation and only tolerant species could develop which is a source of algal blooms.

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Introduction

Algae are a powerful biological tool for sewage treatment (Bogan, 1961). They are not only an essential component of marine ecosystem (Setchell, 1917), but also the inhabitants of fresh water, salty water and damp haunt. Biologically they may be seen as water loving, autotrophic organisms having no sterile layer of jacket cells around their reproductive organs and lacking true embryogenesis (Shameel 2003). Algae are good source of food and energy. Among them the unicellular algae have a major contribution as food source (Geoghegan, 1951). Chlorella is a rich source of nutrients for chicks (Combs, 1952) and the most useful organism to fix atmospheric nitrogen, especially, the blue green algae (Allison and Morris, 1930). Nitrogen fixing blue-green algae has a positive effect on the growth of rice (Watanabe *et al.,* 1951). Certain algae help in utilization of nitrogenous organic compounds and sodium salts of organic acids like some of the soil inhabiting algae (Skinner and Gardner, 1930). Algae are also the inhabitant of areal habitat (Brown *et al*., 1964) and marshy areas (Anderson, 1909). The algal flora was studied for their species composition and the important factors which determined the growth of these algae were taken into account. The most important factor Ammonia-nitrogen was calculated for different clean and highly concentrated waste water bodies of district Malakand. To investigate the effects of Ammonia-nitrogen as one of the most important growth factor of microalgae in the research area, various sites were selected from District Malakand on the basis of adequate water bodies present. These sampling sites were based on the kind of water i.e. stagnant/running, number of water bodies, profundity of water bodies, seasonality, contamination and turbidity of water bodies. The main sites selected for current work were Thana, Batkhela, Malakand, Dargai and Shergarh areas of district Malakand. Sample collection was done from various water bodies of these five major areas.

Materials and methods

Regular monthly algal samplings were made (January 2012-January 2013) using planktonic net, hand picking, scratching of various materials in water, and taking water in bottles from the surface and at the depth of 2-3 meters below for the study of physico-chemical characteristics of water and identification of phytoplankton. Duplicate samples were also collected from each sampling spot at 10:00 am and 2:00 pm with a phytoplankton net of mesh size for the microalgae and estimation of growth factors i.e., Ammonia-nitrogen. Ammonia nitrogen (NH_4-N) of water was determined according to Hach DR 5000 Spectrophotometer Manual (Hach, 2008).

Results and discussion

Ammonia has a crucial role in the growth of algae for a particular habitat. The direct forms of nitrogen for microalgae growth are ammonium, nitrites and nitrates (Barsanti and Gualtieri, 2006). Most of the nitrogen was in the form of ammonia-nitrogen in the research locations studied and was readily consumed by the microalgae. Some of the algae, like *Chlorella* sp, can utilize almost all of the NH_4-N available in the media in a laboratory condition (Wang *et al*., 2010).

The NH_4-N studied for different locations of the district showed a variation in their values in respect to different seasons. The area of Thana has NH_4-N value ranges from 0.7-3 mg/L for stagnant water, 0.1-0.7 mg/L for running water and 2.1- 4.1 mg/L for wastewater. The highest values were found to be in summer season for all the water bodies studied. The region of Batkhela was also observed and the NH_4-N was recorded to be 0.5-2.8 mg/L for stagnant water, 0.1-0.7mg/L for running water and 2.4- 4.2 mg/L for wastewater. The NH_4-N values were enhanced by warm temperature in stagnant and waste water bodies, while there was no temperature effect on NH_4-N of running water

The research location Malakand also showed a variation in NH_4-N value in different water bodies in different parts of the year. The stagnant water showed a variation from 0.4-2.7 mg/L, while the running water was 0.4-0.9 mg/L and that of wastewater were 2.2-4.2 mg/L. The higher values recorded for here was also during the summer months. Dargai region showed the NH_4-N value for stagnant water as 0.9-2.6 mg/L, for running water as 0.3-0.8 mg/L and that of wastewater was 2.7-4.4 mg/L respectively. Like all other regions summer season favored the enhanced values for NH_4-N. Similarly the region Shergarh was also calculated for their NH_4-N values the stagnant water showed 0.9- 2.7mg/L, running water showed 0.1-0.5 mg/L while wastewater showed 2.9-4.9 mg/L values of NH_4-N. This area was also influenced by the temperature and the amount of NH_4-N in water bodies was directly affected by the high temperature.

The present research work suggests the amount of NH_4-N in the water bodies and its effect on the microalgae growth with respect to different seasons. Three water bodies were selected for NH_4-N observation which could be markedly different from each other. These were running water, stagnant water and wastewater bodies. The amount of NH_4-N was found to be very low in running water which resulted in a very little variation of algal species. Due to fast flow of water in these water bodies in summer season amount of NH_4-N was lower with respect to winter season. Therefore species variation was more in winter than in summer. The warm temperature could enhance the nitrogen up-taking capabilities of microalgae by as much as 20% compared with the cold temperature (Zimmo *et al.*, 2004).

Similarly the stagnant water was found to be best for algae growth and species variation. This was because most of the species need sufficient amount of NH4-N for their balance growth. The summer season was favorable for the growth of microalgae in the stagnant water as compared to winter season. The basic reason for its common occurrence in summer was due to dissolving of organic and inorganic nutrients by the rise in temperature of air which in turn increased the temperature of these water bodies (Leghari *et al.*, 2001)

The nutrient contents of waste water were higher than the optimum values for growth in the studied research locations. This resulted in very less species diversity and high algal blooms. This was because of the species which could assimilate more NH_4-N and could be tolerant existed there. The high algal bloom is associated with increased amount of ammonia in water bodies which also results in decrease in zooplankton and bacterial growth (Arauzo *et al.*, 2000). This disturbs the current structure of that water body.

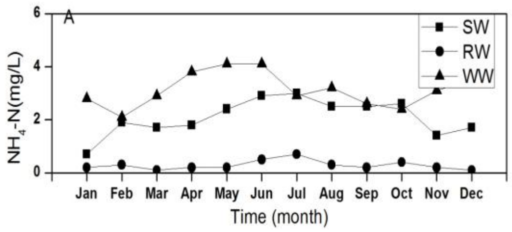

Fig. 1 Monthly NH_4-N variation in research area of Thana.

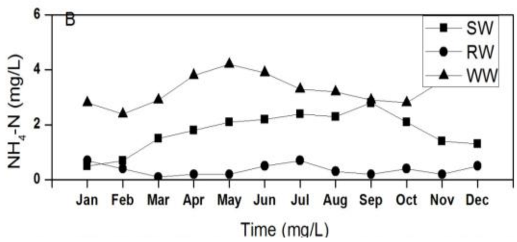

Fig. 2 Monthly NH_4-N variation in research location of Batkhela.

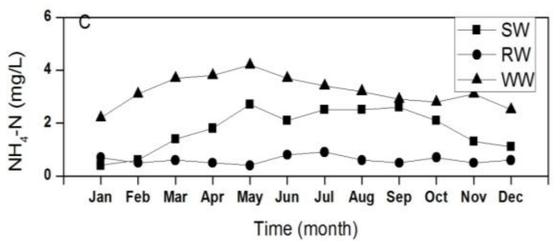

Fig. 3 Monthly NH_4-N variation in research location of Malakand.

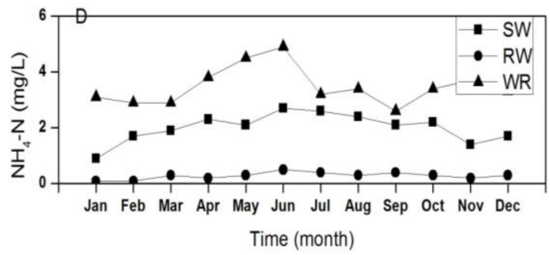

Fig. 4 Monthly NH_4-N variation in research location of Dargai.

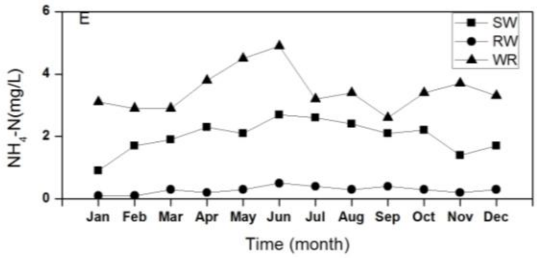

Fig. 5 Monthly NH_4-N variation in research location of Shergarh.

Conclusion

It could be concluded from the above discussion that NH_4-N is a basic source of nitrogen for microalgae growth and stagnant clean water has sufficient NH_4-N which is best suitable place for a variety of microalgae growth. Because of high temperature summer season could provide sufficient NH_4-N in these water bodies. Excessive amount of NH_4-N in a water body could limit microalgae variation and only tolerant species could develop which is a source of algal bloom.

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