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Short Communication

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Improvement of waste water quality by application of mixed algal inocula

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Abstract

Present study aim to investigate application of microalgae for improvement of physiochemical parameters of waste water and improvement of treatment process through reducing the pollutant concentrations including coliform bacteria through their ability to uptake nutrients. Aquatic cultures were conducted in container with dimensions of 1.5×3sq ft. and wastewater samples 5 Litre samples were collected in plastic cans from Sukhnar drain and algal samples were collected from Bhaini Sigyain Village near Ravi Siphon, Lahore. The one experimental treatment lasted for 10 days to make 50% 5 liter water added concentration and 200g of inocula of algae were grown in wastewater container for experiments to optimize at room temperature as local outdoor cultures conditions for wastewater treatment. Total experiment repeated thrice and completed in 30 days. Results show that treatments improved the physiochemical parameter after week. Turbidity (NTU), total suspended solids (mg/L), total dissolved solids (mg/L), nitrate (mg/L), phosphate (mg/L) decrease ($P < 0.05$) after treatment. However, pH not significantly decreases ($P \geq 0.05$) pre-treatment values 6.56±0.05 (mg/L) and post-treatment 6.53± 0.057(mg/L). Maximum total coliform disinfection ($P < 0.05$) was indicated with 200 g of algae was pre-treatment 1602± 6.8 (MPN) and post treatment 1447±39.5 (MPN) observed.

Keywords: Algae; Phycoremediation; Physico-chemical parameters; Wastewater; Water quality; Coliform bacteria

Introduction

Water adversely affected by a wide range of domestic, industrial, commercial or agricultural activities in anthropogenic ways is termed as wastewater and most concerning from an environmental health point of view (Matamoros *et al*., 2016). Integration of microalgal cultivation system nutrient concentrations and availability vary across the wide range of wastewaters available and considered for the cultivation of algae for sustainable biomass and bio-products, including bio fuels and wastewater remediation (Gupta *et al*., 2016). Studies revealed that the major cause of water pollution in the form of pathogens and metals contaminants from domestic and industrial other activities is the discharge of sewage without any treatment directly into water bodies like rivers, canals and seas is a destructive deed (Ruin-Marin *et al*., 2010; Assayed, 2014; Khan *et al*., 2017).

Mainly the municipal wastewater contains various categories of pathogenic agents including bacteria, helminthes, viruses and several protozoan and fungi. There are a number of harmful diseases and health problems including water borne diseases in the developing nations that can caused by these of pathogens which are frequently occur in municipal wastewater categories in those areas where sanitation is improper or deprived. (Awuah, 2006; Unnithan *et al*., 2014). There is group of bacteria known as coliform bacteria which are used as indicators for various disease producing pathogens. Water quality can checked for disease causing pathogen of human by the presence coliform bacteria. Coliform bacteria are faecal indicators for microbial contaminations (Abreu-Acosta and Vera, 2010; Brasil *et al*., 2016). Thermo tolerant coliform bacterial group exist in several environments linking with sewage pollution and Klebsiella spp. originate by degradation in plant in different defensive mechanisms (Schnurr *et al*., 2015; Matamoros *et al*., 2015).

In addition, microalgae have an ability to assimilate nutrients from the environment (Pearson *et al*., 1987; Davies-Colley *et al*., 1999). In natural and constructed wetlands recently studied bacteria removal by algae-based systems have been studied (Nascimento, 1987; Gabrhelov *et al*., 1991; Mara *et al*., 1992; Von Sperling, 2005). Although, there are large number of wastewater treatment techniques and facilities such as adsorption methods, chemical techniques, precipitation, constructed wetlands and other processes are present but the most suitable is biological method because of its least expensiveness for third world countries particularly (Wei, 2008). In areas where there is land, algae based

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wastewater treatment is a better choice (Zhang and Farahbakhsh, 2007). Open ponds and closed photo bioreactors of various designs with algal growth used for wastewater treatment (Oswald, 1995). Algae are vital photosynthetic organisms that can live in different climate conditions such as seawater, freshwater and soil of very hot or cold region environment. Half of the oxygen on earth produces due to algal photosynthesis. Algal growth and development rates are significantly higher compared to that of terrestrial plants significantly (Li *et al*., 2008; Tabatabaei *et al*., 2011).

In algae-based system bacterial degradation and processes decay for several factors affecting bacterial elimination involved sunlight exposure, filtration, adsorption and metabolic activity of biofilm, dissolved oxygen concentration, pH (Seidel, 1976; Gopal and Goel, 1993; Vincent *et al*., 1994; Kadlec and Knight, 1996; Ottov´a *et al*., 1997; Brix, 1997; Davies-Colley *et al*., 1999; Graggs *et al*., 2004; Mayo, 2004; Monfet and Unc, 2017). The objective of the present study is to investigate the role of mix algae inocula in the improvement of physiochemical parameters and reduction of total coliform in urban wastewater.

Materials and methods

Wastewater Sampling

Waste water 5Litre for each container were collected in plastic cans from Sukhnar drain near G. T road Shalimar Garden, Lahore. Tests were performed immediately or the sample was refrigerated (at 4 ^{0}C) for further analysis. 5 liter distilled water added to make 50% concentration. Treatments were conducted in plastic container with dimensions of 1.5×3 sq ft.

Algal Sampling

Algal samples were collected from fresh water pond along River Ravi in Bhaini village near Ravi Siphon, Lahore. The experiment lasted for 10 days 200g of inocula of algae were grown in wastewater container for experiments to optimize at room temperature as local outdoor culture conditions for wastewater treatment.

Estimation of growth rate of algea

The rate of growth of these Inocula of algae species was measured by the estimation of dry weight. These samples were dried in an oven at 80 °C for 36 hours to calculate its dry weight.

Physical parameter analysis of wastewater

Samples pH, turbidity (NTU), total suspended solids (mg/L) and total dissolved solids (mg/L) were determined immediately after sample collection with digital meter as mentioned in APHA (1998) standard methods.

Total coliform estimation

Total coliform was determined throughout the experiment by MPN/100 method. Culture media was prepared by adding 17.5 g LT-broth into 500 ml then added distilled water. In pre sterilized test tubes poured 5 ml of culture. To remove contamination of air cotton plugged test tubes covered with standard aluminum foil and autoclaved at 120 ºC for 20 minutes after allow to cooled at room temperature. Cotton plug removed from test and filled with waste water 1 ml test tubes except one blank tube without waste water to compare total coliform MPN/100 after incubation period (APHA, 1998).

Statistical analysis

The data were analyzed using Graph Pad Prism version 5.00 for Windows, Graph Pad Software, San Diego California USA, and www.graphpad.com. An unpaired t-test is used to compares parameters of waste water to determine which differences are significant.

Result and discussion

Total experiment repeated thrice and completed in 30 days. Each experimental treatment lasted for 10 days for before and after treatment with 200g of algae. Different physiochemical parameter of waste water analyzed were total coliforms (MPN), pH, turbidity (NTU), total suspended solids (mg/L) and total dissolved solids (mg/L), phosphate $(PO_4)^{3-}$ and nitrate (NO^{3-}).

Total dissolved solid decrease ($P < 0.05$) pre-treatment 2186±18 (mg/L) and post-treatment 12.34±16.37 (mg/L). Total suspended solids results in pre-treatment 652.7±11.85 (mg/L) and post-treatment 607.7± 16.44 (mg/L). Similarly pH not significantly decease pre-treatment 6.56±0.05 (mg/L) and post-treatment 6.53± 0.057(mg/L) and turbidity pre-treatment 68.33±1.528 (NTU) and post treatment 54.67±1.5 (NTU). Maximum total coliform reduction was indicated with 150 g of algae was found to be most favorable option. Reduction in total coliforms observed pre-treatment 1602± 6.8 (MPN) and post treatment 1447±39.5 (MPN). Present study revealed that algae for wastewater treatment are very effective for reduction of coliform bacteria along with other various parameters from municipal wastewater.

For more than half a century urban waste treatment has been a significant subject of attention in microalga research (Beuckels *et al*., 2015). However the treatments complexity due to nutrient enrichment of waterbodies is a nuisance for safe water supply and potential microalga research. Use of algal based systems application increased over the past few decades for better environmental management (Khan *et al*., 2017). Excessive and rapid development of algae as consequently negative impact on of aquatic life and but zero

Table I. Comparison of physiochemical parameter of samples pre and Post treatments (A) Total coliforms (MPN), (B) Turbidity, (C) Total suspended solids, (D) Total Dissolved Solids, (E) pH , (F) Phosphate$(PO_4)^{3-}$ (G) Nitrate $(NO)^{3-}$

	Coliforms (MPN)	Turbidity (NTU)	Total suspended solids (mg/L)	Total dissolved solids (mg/L)	pH		(mg/L)	(mg/L)
Pre -treatment (Mean ± SD)	1602± 6.8	68.33±1.528	652.7±11.85	2186±1883	6.567 0.033	±	1.900± 0.1000	8.333± 0.5774
Post -treatment (Mean ± SD)	1447±39.5	54.67±1.528	607.7± 16.44	12.34±16.37	6.533 0.033	±	1.665± 0.06	6.665± 0.5994
P value	0.0026	0.0004	0.0184	< 0.0001	0.5185		0.0239	0.0240
P value summary	**	***	*	***	ns		*	*
Are means signif. different? (P < 0.05)	Yes	Yes	Yes	Yes	No		Yes	Yes

death beneficial consequences by limited algal presence (Wang *et al*., 2009; Unnithan *et al*., 2014; Assayed *et al*., 2014).

Mixed microalgae culture for waste water nutritional contents related with removal of nitrate and phosphate because these nutrients of levels positively affect the growth of algae species (Fried *et al*., 2012; Ruiz-Martinez *et al*., 2014) and The use of immobilized microalgae in waste water processing is very adequate and offers significant advantages (Wang and Lan., 2011; Arashiro., 2015; Krustok *et al*., 2016). Nutrients total suspended solids and total dissolved solid particles and oxygen concentration improved due to the active photosynthesis consumption taking place in the containers with a high concentration of photosynthetic of microalgae (Doucha and Lívanský, 2006).

The efficacy of algae on the removal of faecal bacteria in free water surface (FWS) wetlands and wastewater treatment facilities and are past two decades well documented in different research studies (Curtis, 1990; Curtis *et al*., 1992; Van der Steen *et al*., 2000; Garcia *et al*., 2008; Valigore *et al*., 2012). Bacteria in the pound aquatic environment attaches to solid surfaces by secreting consents of extracellular polysaccharides as its attachment properties (Sanin *et al*., 2003; Awuah, 2006).

Total coliform reductions of 90–99% have been investigated in submerged surface flow systems depending on the involved sunlight exposure, hydraulic retention time and species of macrophytes applied (Moshiri, 1993; Karathanasis *et al*., 2003; Vymazal, 2005), However, a higher bacteria removal has been observed in previous experiences with Scirpuslacustris planted in submerged surface flow wetlands total californiabout 99.999%. Removal efficiency (>99.9%) for fecal coliform in effluents of submerged surface system combined with other treatment like waste stabilization ponds, vertical flow wetlands (Ansola *et al*., 2003; Kimwaga *et al*., 2004; Keffala and Ghrabi, 2005).

Conclusion

Present study revealed that algae for wastewater treatment are very effective for reduction of coliform bacteria along with other various parameters from municipal wastewater. The results showed that algae for wastewater treatment experiment lasted for 10 days after treatment reduction total coliforms (MPN), turbidity (NTU), total suspended solids (mg/L) and total dissolved solids (mg/L) concentrations were increasing. Phosphate $(PO_4)^{3-}$, Nitrate $(NO)^{3-}$ activity was decreasing that indicated with mix algae inocula was found to be most favorable and very active coliform bacteria disinfection performance in urban wastewater along with other various parameters from municipal wastewater to reduced health risk in poor sanitation areas. Wastewater treatment system by algal based proved cost-effectiveness system and effective alternative and improvement to the conventional wastewater treatment facilities to bring waste water pollutants into their permissible limits in developing countries.

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