Removal of Nitrate from Wastewater Using Trentepohlia Aurea Microalgae

Laila Al-Balushi, Nitin Rout, member, *IAENG*, Sahar Talebi, Ahmed Al Darmaki, Maryam Al-Qasmi

***Abstract*—Wastewater treatment using microalgae is an advanced new method of wastewater treatment. Experiments on removing of nitrate (NO_3^-) from wastewater using Trentepohlia aurea microalgae were reported under continuous light in batch and continuous system. Moreover, after several trails and experiments the results provide that in batch system the removal of nitrate from wastewater under continuous light of about 3500 Lux was more remarkable than in continuous system. The results show the removal efficiencies of some nutrients such as nitrogen, phosphorous and nitrate from wastewater reached high efficiencies. In addition, the efficiency of chemical oxygen demand (COD) rose dramatically and reached 97.11% during a period of six days as far as the pH which increases rapidly from 7.5 up to 10.9. When the microalgae were placed in medium with wastewater it showed a high growth in Trentepohlia aurea microalgae. The growing rate of microalgae had been noticed to be very fast with very high concentration of nitrate in water. NO_3^- is a water-soluble molecule made up of nitrogen and oxygen. It is formed when nitrogen from ammonia or other sources combines with oxygenated water. A special type of microalgae called Trentepohlia aurea which growth on tree branches and rocks with brown color used for removal of NO_3^- from wastewater. The experimental data show that the percent of NO_3^- removed using Trentepohlia aurea microalgae is 37% during 30 days. From these results, Trentepohlia aurea microalgae are consider as a potential for wastewater treatment.**

***Index Terms*— Nitrate, Trentepohlia aurea microalgae, wastewater treatment**

I. INTRODUCTION

Several researches in many countries found different process of wastewater treatment by growing several types of microalgae in different kinds of wastewater. As a result of this process it is found that each kind of microalgae can remove a certain nutrients. The nutrients consider as a feed for microalgae and this can be approved from the increasing in number of microalgae cells.

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A biofuel can be extracted from microalgae that used to treat wastewater by different physical processes. In nature, nitrate is found in vegetables and plants in different concentrations depending on the growing conditions. These laws apply to all cities and villages water supplies and are used as an advisory for private wells. Nitrate contained in agricultural effluents domestics and industrial discharges are the main cause of eutrophication. Nitrate, nitrites, ammonia and phosphate are the most contaminates contained in wastewater. These consider as nutrients for algal growth. This can be noticed in seas, swimming pools, lakes and other water sources. As consequence, wastewater treatment process must apply in order to get the stander regulation of nitrate in drinking water. The nitrate enter well water depends on the type of soil and bedrock present and on the depth and construction of the well. State and federal laws set the maximum allowable level of nitrate-nitrogen in public drinking water at 10 milligrams per liter NO_3^--N (10 parts per million NO_3^--N)[8]. Figure below shows microscopic picture of Trentepohlia aurea microalgae.

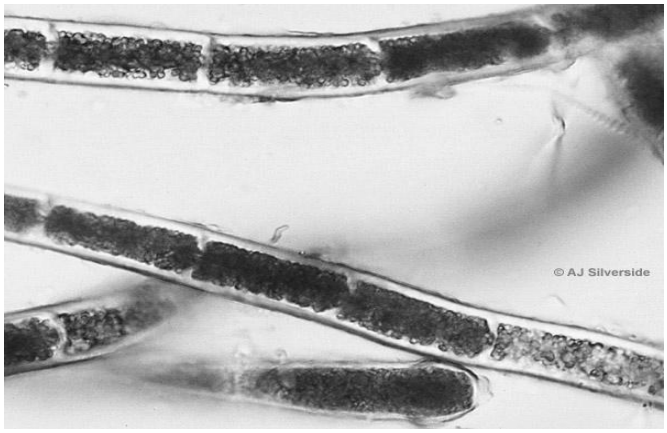

Fig. 1. Trentepohlia aurea microalgae cells under microscope [4]

II. NITRATE REMOVAL PROCESS

Removal of nitrate uptake by immobilized cells has also been tested and the feasibility of biological with cyan bacterial cultures. Trentepohlia species occur mainly in tropical regions and grow on concrete surfaces exposed to full sunlight. They should therefore have a high tolerance and adaptability to severe conditions such as desiccation and high temperature[10]. It has previously been reported that Trentepohlia aurea showed a significant increase in growth rate and chlorophyll content in a liquid medium containing peptone as an organic nitrogenous. Trentepohlia aurea microalgae are collected in bold'sbasals (BB) medium using $NaNO_3$ under certain conditions at room temperature (25 C°)

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and using cool-white fluorescent lamps (43 _mole photon m−2 s−1) [2]. The Trentepohlia aurea microalgae growth is determined to be faster with high concentration of $NaNO_3$[7]. This result approve that, Trentepohlia aurea microalgae have potential of wastewater treatment.

III. ADVANTAGES OF USING MICROALGAE ON WASTEWATER TREATMENT

- Microalgae can grow very fast in medium with wastewater.
- High efficiencies in removing of nutrients.
- Low cost of energy.
- Low equipments and maintains requirements.
- Green source of energy can be extracted from microalgae.

IV. SIDE EFFECTS OF NITRATE

Wastewater which include nitrate is very effectible on health. The amount of nitrate can get from food that eaten daily such as celery, lettuce, spinach and beets. If the nitrate is eaten as a part of food so nitrate will not be harmful. Studies found that women drinking contaminated nitrate water during pregnancy more likely to have babies with birth defects. People who have medical problems like heart disease or cancers are more sensitive to the effects of nitrate than others. Expert believes people who drink water with high concentration of nitrate for long-term are more likely to have certain type of cancers. Unlike temperature and dissolved oxygen, the presence of nitrates usually does not have a direct effect on aquatic insects or fish[5]. However, excess levels of nitrates in water can create conditions that make it difficult for aquatic insects or fish to survive. Algae and other plants use nitrates as a source of food. Meanwhile, there are many effects of nitrate on animals and plants. All of these reasons and effects of nitrate on human and environment required removing of nitrate from water up to certain value. There are different methods of removing nitrate from wastewater in addition of using microalgae for example:

- Bio-electrochemical
- Ion exchange
- Reverse osmosis
- Electro dialysis

V. RESULTS AND DISCUSSION

The experiments done on the effect of nitrate ion (using $NaNO_3$) on the growth of Trentepohlia aurea microalgae is represented mainly in the figures below . Figure 1 shows the biomass density after 40 days decreased slightly with increase in the nitrate concentration. In addition, in the medium in the absence of nitrate, the rate of algal growth exhibited to be same as the growth through long lag phase. Figure 2 represent the time course of removal ratio of ammonium and nitrate ions from the medium, when the alga was cultured in modified (BB) medium with 504 mg NO_3-N L−1. The alga essentially dominated nitrate ion uptake after 10 days growth. The efficiency of chemical oxygen demand (COD) rose gradually and reached 97.11% as well as pH with significant increasing from 7.5 up to 10.9 [6]. It is noticed that the concentration of nitrate in water decreased as the number of microalgae increased [3].

In summary, the Trentepohlia aurea microalgae are able to remove actively nitrogenous (nitrate, nitrite, and ammonium ions) and phosphate compounds from wastewater for growth [8]. The algal cells were able to consume high concentrations of nitrate ion and, therefore, can possibly contribute to purification of industrial and domestic wastewater[1].

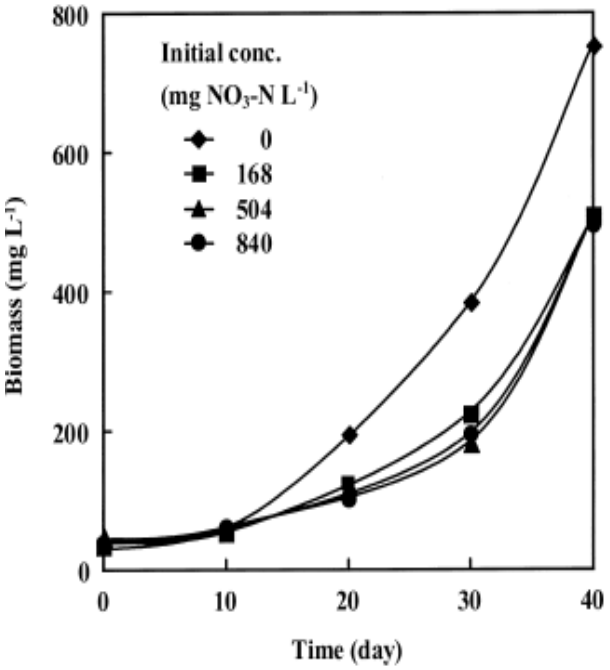

Fig. 2. Effect of nitrate ion in the growth of Trentepohlia aurea microalgae culture was carried out at (42 mol photonm^{-2} s^{-1}) at 25 C° with bubbling air for 40 days [9].

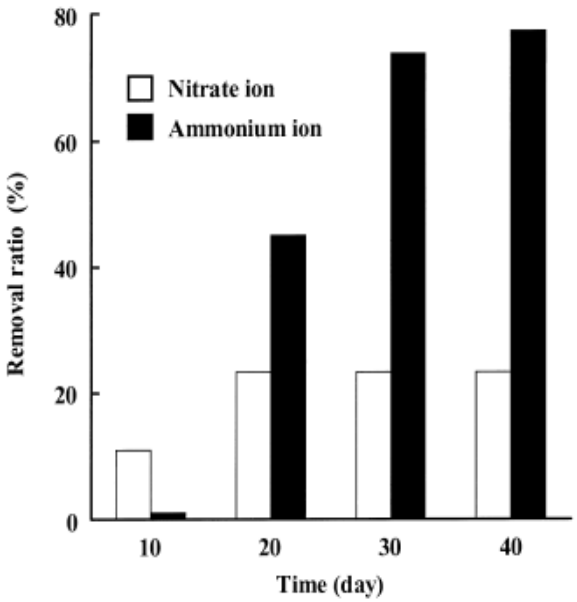

Fig. 3. Time course of removal ratio of ammonium and nitrate ions from modified (BB) medium. Initial concentration of ammonia and nitrate were 262 mg NH_4-N L^{-1} and 504 NO_3-N L^{-1}, respectively [9].

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VI. CONCLUSION

The results of this study showed that Trentepohlia aurea microalgae are potential for purification of water and effectible on the removal of nitrate and some other nutrients from wastewater. In brief, the amount of Trentepohlia aurea microalgae cells are increased considerably in wastewater contains high concentration of nitrate. In the other hand, the amount of nitrate decline significantly as same time as the microalgae cells increased. Furthermore, this method of wastewater treatment can yield clean and green source of energy such as bio diesel or bio ethanol.

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