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Potential Using of Mixed Microalgae in the Bioremediation of Domestic Effluents

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Abstract

Microalgae widely used for bioremediation of inorganic ($NH_4$and PO_4) nutrients as single isolates. This study aims to use a mix microalgae isolated from Dijlah river for bioremediation of municipal waste water .The experiments had been start with two different concentrations of nutrients. NH_4-N values were 23.4 and 31.7mg/l, phosphorus PO_4-P 6.7and 10.7 mg/ l and BOD_5 were 66 and 83 mg/l. both cycles of treatment showed complete removal for NH_4-N and PO4-P levels after treatment were 1.7 and 0.7 mg/l for both of treatment cycle .Biological oxygen demand reduced to lowest value were18.9 in 2nd cycle while in 1st cycle of treatment reduced to21.3mg/l.The results showed that mix microalgae have the ability to remove nutrients and organic pollutants at different levels even at pH variation during experiment.

Keywords: mix microalgae, bioremediation, inorganic nutrients, BOD5

امكانيه استخدام مزيج الطحالب في المعالجه الحيويه لمياه الصرف المنزلي

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الخلاصه

استخدمت الطحالب بصوره عامه بشكل عزلات منفرده في معالجه الملوثات اللاعضويه مثل الفوسفات والامونيوم.تهدف الدراسه الحاليه استخدام مزيج من الطحالب المعزوله من نهر دجله في معالجه مياه الصرف المنزلي حيث تم تنفيذ تجارب المعامله الحيويه مرتين لمياه الصرف المنزلي مع اختلاف تركيز الملوثات اللاعضويه في كل مره حيث بلغت قيمتها 23.4و31.7 ملغم لكل لتر للامونيوم اما الفوسفات فكانت قيمها 6.7 و10.7 ملغم / لتر في بدايه التجربه .كذلك تم قياس المتطلب الحيوي للاوكسجين حيث بلغت قيمته66 و83 ملغم / لتر للمحاوله الاولى والثانيه . بينت نتائج الدراسه في المحاوله الاولى والثانيه بان المزيج الطحالب المستخدم كان فعالا في ازاله الامونيوم بنهايه التجربه بينما الفوسفات وصلت الى 1.7 و0.7 ملغم / لتر .اما المتطلب الحيوي للاوكسجين فقد انخفض الى ادنى قيمه له الى 18.9ملغم / لتر في المعالجه الثانيه ,بينما في المعالجه الاولى تم اختزال المتطلب الحيوي للاوكسجين الى 21.3 ملغم/لتر .يستنتج من ذلك بان مزيج الطحالب كان فعالا في ازاله االملوثات اللاعضويه والتلوث العضوي وبمستويات مختلفه على الرغم من التغاير في قيمه الحموضه في نهايه التجربه .

Introduction

Phycoremediation by microalgae is low-cost effective method for removing nutrients that concomitant with eutrification problem in surface and underground water bodies[1].Eutrification has negative effects on whole ecosystem species component with heterogeneous increasing algae and aquatic plants .Domestic waste water consists water and wastes disposal from houses, commercial

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(restaurants) and some industrial facilities .Wastewater contain microorganisms, organic matter and nutrients so it is represent a low-cost substrate for algal biomass production and nutrient elimination[2]. The main mechanism for algae in removing the nutrient in wastewater is intake by algal cells and stripping ammonia through increasing the pH, that concomitant with increase in algal biomass[3] . Many of studies have focused on bioremediation through monocultures of algae such as *chlorell*a ,*sendusmus spirulina* [4 ,5 , 1]. *Chlamydomonas* used as feed stock and nutrient removal [6]. Microalgae also plays an important role in removing organics for wastewater by providing oxygen through photosynthesis which lead to promote degradation of organic waste through algal-bacterial symbiosis [7],they studied on settled domestic wastewater which BOD_5 reduced to 97%with *Chlorella* and *Nitzchia* .In rinse water for olive- oil industry BOD_5 reduced to 13-67% through biomass culture for *Scenedesmus obliqus* [8].

Few studies reported that mixed cultures of algae even more efficient in nutrient removal and lower in cost Su,y.et al[9] who studied on mix of three types of algae *C.reinhardtii*, *S.rubescens* and *C.vulgaris* . Mixed cultures also is better for complete removal of organic acids ,nitrate, ammonia and phosphate [10].There were few studies on mix isolation of phytoplankton available naturally like remediation of crude oil[11] .Al-bestawi[12] studied on remediation mixed domestic –industrial wastewater through indigenous cyanobacteria isolated frome lake Mariut which is very cheap and efficient process to remove pollutants.

This study aim to investigate the nutrients (NH_4, PO_4) and BOD_5 remediation by using mix microalgae isolated naturally from a fresh water and culture them grow in domestic wastewater.

Material and methods:

Mix of microalgae mainly compose of Green algae, Blue-green algae and few diatoms were collected from Dijlah river.These algae were cultivated and grew as stock culture in filtered domestic waste water with addition bold base nutrient salts as enriched media for one week before starting the experiments to obtain heavy growth . The experiments had been done twice for Domestic waste water collected from drainage near Abu-Nuwas in different period in February and in April for 1st and 2nd trail respectively containers .The experimental containers filled with 2.5 Liter of domestic wastewater, with addition 50-55 ml of cultured algae and the samples were analyzed every 48 hr.

Experimental containers were set up out door and sheltered from rain by corrugated acrylic roof fixed at high 1.5metre above containers. Five replicates of containers were set up for each control and treatments.

Perkin Elmer lambada uv/vis spectrophotometer used for ammonium NH_4-N and PO_4-P content analysis .Ammonium (mg/LNH_4-N) and orthophosphate(mg/L PO_4-P)measured by phenate and ascorbic acid method respectively [13].pH with the growth of algal biomass were measured as dry weight at first day and at the end of experiment [14] .The efficiency of algal bioremediation was assessed also by Biological oxygen demand (BOD_5) measured in the 1st day and last day determined by modified iodimetric method[13] .Statistical analysis were performed in ANOVA at $p \leq 0.05$ to detect any significance for treatments.

Result and Discussion:

The initial concentration of main nutrientsNH_4-N and PO_4-P for collected municipal wastewater were moderate for first trail and second trail (Table 1).

NH_4-N and PO_4-P removal

The reduction in the concentration NH_4-N in 9 days (1st trail) is as shown in Figure-1a. %79.2 from the initial concentration of NH_4-N has reduced in 3 days and the reduction was significant in 2nd day when compare to control the reduction was not significant in the same day. Even the second trail NH_4-N was higher in concentration the reduction reach to75.5% within 3 day,but totally NH_4-N removed in day5 in the 2nd trail while in 1st trail NH_4-N totally removed in day 7 . The pH value was (> 7) in 2nd trail because of photosynthesis activity (consumption CO2) lead to elevation in pH at the end of experiment [16] also denitrification process causes pH rise lead to release H from conversion of NH_4 to NH_3. pH value changes through the experiment lead to effect on algal composition and growth. The pH value range from 6.4 to 7.71 for first trail and 7.5 to 10 for the second trail as mention in Table-1.The high pH affect on algal composition especially in second trail which dominated by cyanobacterial species like *spirulina sp*. and *Oscillatoria sp*. While in 1st trail green algae species where the dominated on other algal groups because the neutral pH.

The algal growth mentioned as dry weight in first and last day when nutrient depleted in each trail in Table-1.Generally algae prefer neutral to alkaline pH for optimal growth [15] as shown in 1st and 2nd experiment.

Table 1- Mean concentration for experimental parameters before and after treatment for 1st and 2nd trail

Parameters Mg/L	Initial	Final
Exp.1		
BOD5	66±1.15	21.3±1.4
PO4-P	10.7±0.95	1.7±0.6
NH3-N	23.4±0.9	ND
Dry weight(g/l)	0.7±0.04	1.5±0.05
Exp.2		
BOD5	45.3±1.15	18.9±1.8
PO4-P	6.74±0.12	0.7±0.1
NH3-N	31.7±1.9	ND
Dry weight(g/l)	0.7±0.02	1.65±0.02

±Standard deviation

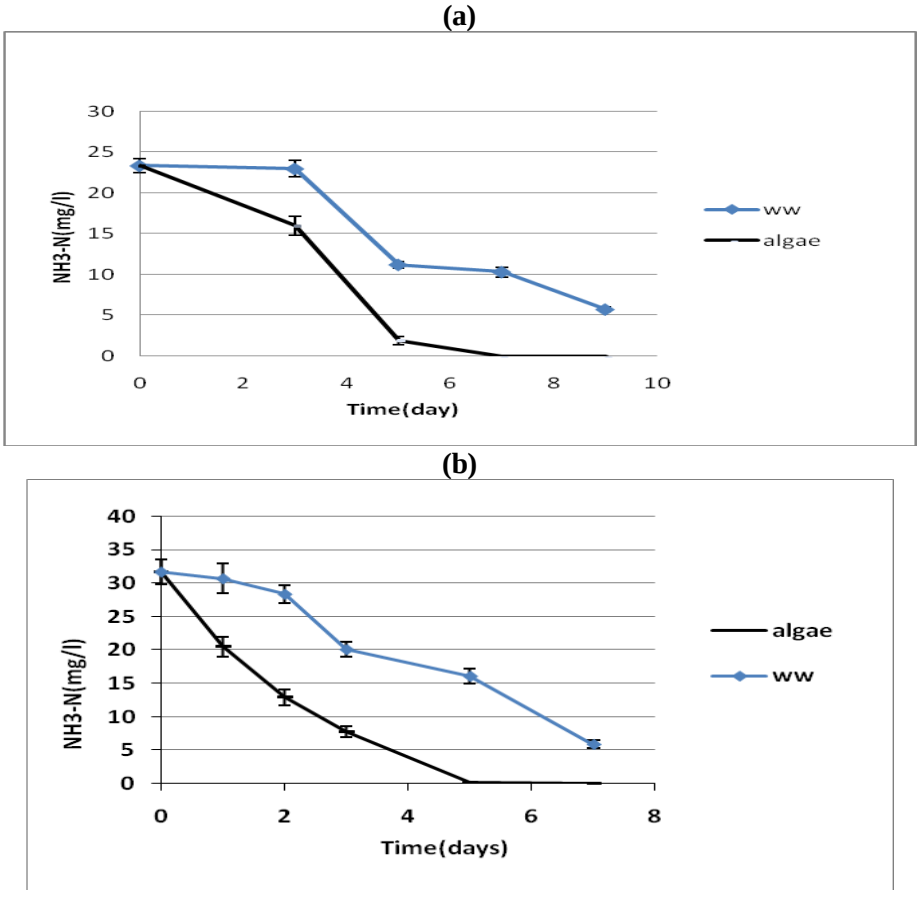

Figure 1- NH4- N reduction in 1st trail (a) and 2nd trail (b)

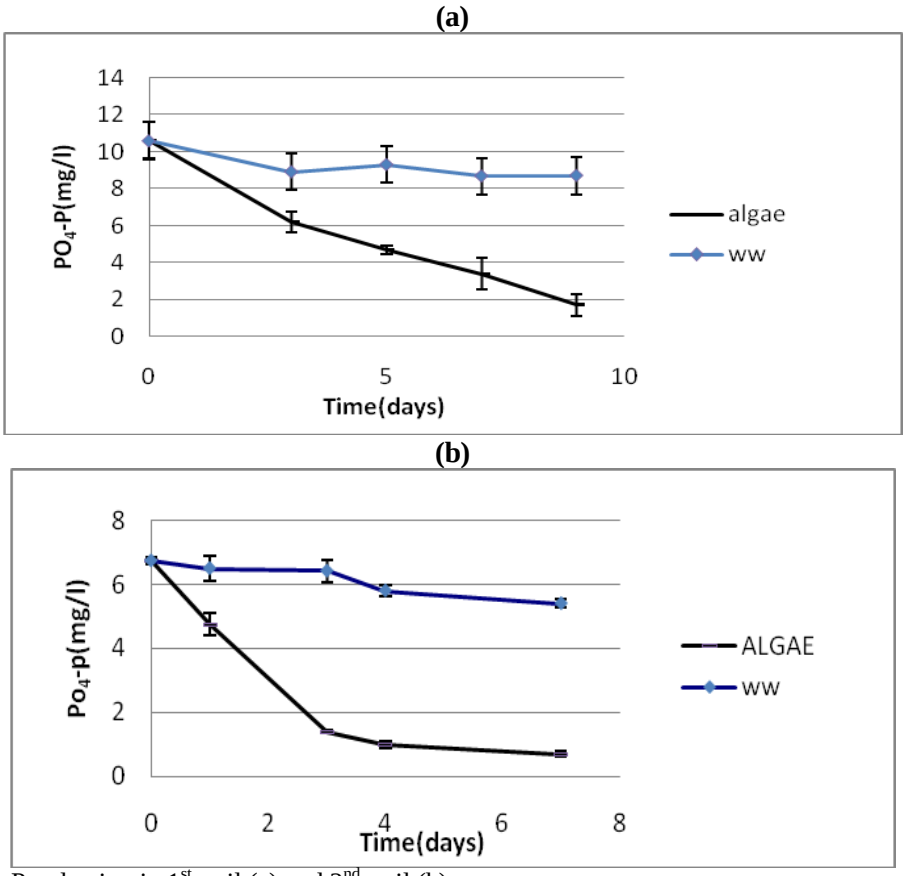

Figure 2- PO_4-P reduction in 1st trail (a) and 2nd trail (b)

In Figure-2 the PO_4-P reduced to (1.7) mg/l in last day (9 days) and to (0.7mg/l) within 7 days in 2nd trail due to algal up take. The highest reduction reached to 89.6% in 2nd trail and in 1st trail reach to 84%, the reduction were not significant in control for both trails (no algal inoculums). The highest removal by algae for PO_4-P in 2nd trail considerable to assimilation process which led to increase the pH at the end of experiment pH (>9) and cause phosphate perception. This a biotic process increases in phosphorus fraction removal that's agreed with Laliberte´ et al. [17] and Lodi, A. et al.[18].

The results indicate that micro algae preferred uptakeNH_4 as Nitrogen Source, lead to faster growth for mixmicroalgae in 2nd trail ,this mention by [19].The arrangement of nutrient uptake by microalgae is Ammonium>Nitrate>urea . Because uptake of ammonia in a passive way was less consumption for energy than nitrate.

BOD

The biological oxygen demand (BOD) was found high to deposit in river or to reuse for agriculture purpose. According to table (1) the reduction was significant for both trails compare to control (no algal inoculums) .Reduction percentage was 68% for algae after 9 days in 1st trail while 58% for 2nd trail . The comparable reduction was observed in *Phormidum* when it cultured in sewage waste water in third week of remediation [20].Microalgae use nutrients for growth and provide oxygen to bacteria in the same time by photosynthesis, which leads to increase its action for reduction organic pollution. The samples became more transparent after reduction inorganic and organic pollutants.

The advantage of use mix microalgae is effective and economic biological treatment since it is efficient to remove all the inorganic nutrients completely with short time even pH rise at the end of experiment .Also through the experiment mix microalgae ensure to remove the organic pollution at the end of experiment in spite of the algal composition has been drift .

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