

## Using locally Isolated *Chlorella vulgaris* in Wastewater Treatment

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### Abstract

In this study locally isolated microalgae (*Chlorella vulgaris* Beijerinck) was used in wastewater treatment to reduce the pollutant parameters. Three parameters were studied to determine the efficiency of *Chlorella vulgaris* in reducing COD, BOD and PO<sub>4</sub> concentration. Samples of wastewater were taken from a primary station in Al-Rustomiya wastewater treatment station. Three different dilutions of wastewater were tested; 100% waste, 75%waste 25%waste with distilled water. Chemical oxygen demand (COD) values started with 370mg/l, 270mg/l and 200mg/l for samples A, B and C respectively, and it reached after 14 days to 112 mg/l, 88 mg/l, and 120 mg/l. Biochemical oxygen demand (BOD) started with 241mg/l, 200mg/l, and 170 mg/l for samples A, B and C respectively, and it declined to 110 mg/l, 61 mg/l, and 112 mg/l. Finally PO<sub>4</sub> started with 39.9 mg/l, 30 mg/l, 21 mg/l and it reached to 17.1mg/l, 8mg/l, 11.2mg/l for samples A, B and C respectively. Sample B showed the best removal values for COD, BOD and PO<sub>4</sub> which reached to 88 mg/l, 61 mg/l, and 8 mg/l respectively.

**Keyword:** Algae, Biotreatment, Pollutant parameters, Treated wastewater.

### استخدام عزلة محلية لـ *Chlorella vulgaris* في معالجة مياه الصرف

#### الخلاصة

استخدمت عزلة محلية لطحلب (*Chlorella vulgaris* Beijerinck) في معالجة مياه الصرف لتقليل مؤشرات التلوث. اختبرت ثلاثة ادلة لتحديد قابلية طحلب (*Chlorella vulgaris*) في تقليل تراكيز (COD, BOD, PO<sub>4</sub>). تم اخذ عينات من مياه الصرف في المرحلة الاولى من محطة معالجة مياه الصرف في الرستمية. اختبرت ثلاثة تخافيف من عينات مياه الصرف، خففت كلها مع الماء المقطر وهي (A) 100% فضلات و (B) 75% فضلات و (C) 25% فضلات. قيمة (COD) حددت بالتراكيز 370 ملغم/ لتر و 270 ملغم/ لتر و 200 ملغم/ لتر لكل من العينات (A, B, C) وبعد مرور 14 يوم وصلت التراكيز الى 112 ملغم/ لتر و 88 ملغم/ لتر و 120 ملغم/ لتر. و بدأت (BOD) (بالتراكيز 241 ملغم/ لتر و 200 ملغم/ لتر و 170 ملغم/ لتر للعينات (A, B, C) ثم انحدرت الى 110 ملغم/ لتر و 61 ملغم/ لتر و 112 ملغم/ لتر. واخيرا بدأت تراكيز (PO<sub>4</sub>) بالقيم 39.9, 30, 21 ملغم/ لتر

و ٣٠ ملغم/ لتر و ٢١ ملغم/ لتر ثم وصلت الى ١٧,١ ملغم/لتر و ٨ ملغم/لتر و ١١,٢ ملغم/ لتر للعينات (A, B, C). العينة (B) اظهرت افضل قيمة ازالة COD و BOD و PO<sub>4</sub> والتي كانت ٨٨ ملغم/ لتر و ٦١ ملغم/لتر و ٨ ملغم/لتر  
الكلمات المرشدة : الطحالب، المعالجة الحيوية، مؤشرات تلوث، مياه صرف معالجة.

## INTRODUCTION

Wastewater is a main word used to refer to the water with low quality that contains a lot of particles of pollutants and microbes [1]. If wastewater is responsible to the nearby water particles, it can cause a big and hard environmental and health problems to human beings [1]. Waste water could be made safe to drink by filtering it and killing the bacteria in it, but the heavy metals present in all waste water make that impossible, so the wastewater must be treated by reducing the pollutant particles and other contaminants that present in its [2]. Water pollution is one of the human problems in recent centuries. It is known as increasing some element concentration having poisonous potential from the standards, can produce irreparable environmental effects [2]. Microalgae are photosynthetic organisms that have the ability to fix CO<sub>2</sub>, so the light energy will transform to chemical energy inside the alga's cell [3]. They may be used in different ways, such as purification of waste water under either autotrophic or mixotrophic conditions [4]. The researches on using algae cultivation as an alternative method for wastewater treatment process started as early as in the 1970s [5]. There are a number of benefits of growing algae in wastewater as it absorbs nutrient, thus reducing the treatment cost of wastewater. Secondly, it assimilate large amount of organic carbon to produce its biomass, which can further be processed for biodiesel production. Growing Algal treatment methods are commonly used for the removal of nutrients, pathogens and other type of contaminants [6]. Heavy-metal-resistant microorganisms show us possible methods to prevent environmental contamination. The newly discovered metal sequestering properties of certain types of fungi and algae hold considerable promise [7]. Heavy metals can be eliminated from polluted environments by utilizing their natural heavy metal disposing abilities [8].

Algae species *Chlorella* was widely applied for wastewater treatment and had proven abilities of removing nitrogen, phosphorus, and chemical oxygen demand (COD) with different retention times ranging from 10 h to 42 days, mixing with bacteria or not. Recent studies have reported that many algal species, *Chlamydomonas* [9], *Botryococcus* [10], *Chlorella* [11], *Haematococcus* [12], *Spirulina* [13], *Scenedesmus* [14], were used to remove nitrogen, phosphorus and organic matter (biochemical oxygen demand, (BOD) and chemical oxygen demand, (COD) from raw wastewater. The mechanism involved in algal nutrient removal from wastewater was an uptake by the cells, and stripping ammonia through elevated pH [15]. Kim *et al.* Studied the removal of ammonia from wastewater by *Chlorella* figures as well as the quantized fixation of CO<sub>2</sub> [16].

## Materials and Methods

### Wastewater sampling

Wastewater samples were taken from the local wastewater station from preliminary sedimentation from AL-RUSTOMIYA station with characteristics shows in Table (1). Samples autoclaved at 121°C for 15 min to kill any microorganisms in the wastewater in order to show the effect of the *Chlorella vulgaris* on wastewater treatment. Three different dilutions of wastewater were tested; 100% waste,

75%waste 25%waste with distilled water and assigned as samples A, B and C respectively.

**Table (1). Characteristics of wastewater sample (pH = 7.41)**

Parameters	Average concentration (mg/l)
COD	370
BOD	241
PO <sub>4</sub>	39.5

### Isolated the microalgae and Cultivation

*Chlorella vulgaris* was collected from the Tigris River at Al-Jadriya area and Al-Rasheed area, Baghdad-Iraq. For isolating algae and purification, streaking on plate agar techniques was used in this study. Chu-10 media used for algae cultivation, that prepared from mineral nutrient salts divided into two parts macronutrients and micronutrients. 10 ml of isolated culture was added to a flask containing 100 ml of Chu-10 media and then the algae culture sample incubated for 14 days at 30°C, a photoperiod of L: D 14:10 then transported to 1000 ml of filtered and sterilized Wastewater sample [17], [18].

*Chlorella vulgaris* species were harvested by using the centrifuge method. The culture broth were centrifuged at 500-600rpm for 10 min, then a diaphanous liquid was collected and purified with diluted liquid like water to get concentration measured by turbidity meter 780NTU [19].

### Results and Discussion

#### COD, BOD and PO<sub>4</sub> removal

The wastewater measurement for Biochemical Oxygen Demand that its term is (BOD), Chemical Oxygen Demand that referred with (COD) and PO<sub>4</sub> were done using the standard techniques described by [20].

#### Removal of COD

Values of COD were measured for the three samples as shown in Figure (1). COD started with 370mg/l, 270mg/l, 200 mg/l for samples A, B and C respectively, sample A didn't show any significant change till the 6<sup>th</sup> day, in the 6<sup>th</sup> day it reduced to 333mg/l and then decreased to 112mg/l at the 14<sup>th</sup> day.

For sample B the value of COD was decreased to 250mg/l in the 2<sup>nd</sup> day and at the 6<sup>th</sup> day it reached to 200mg/l and in the 14<sup>th</sup> day it reached to 88mg/l. While sample C decreased from 200mg/l to 120mg/l during the 14<sup>th</sup> day

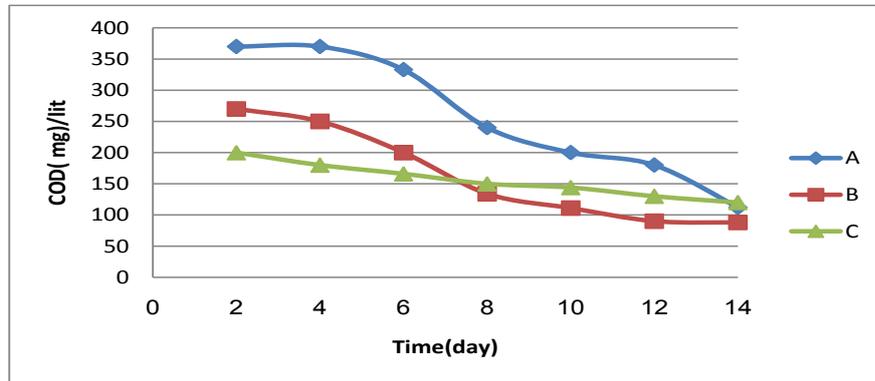


Figure (1). Transient removal of COD for the three samples. (A=100% wastewater. B=75% wastewater. C=25%wastewater)

**Removal of BOD**

BOD test was used to measure the ability of Alga to oxide organic material in the waste to CO<sub>2</sub> and water. Figure (2) shows the BOD removal for samples A, B and C. BOD is an indicator and assign of materials that can be degraded biologically, taking the dissolved oxygen and the time up to 14th days.

Sample (A) started with 241mg/l for the first two readings in a second and 4<sup>th</sup> day. On the 8<sup>th</sup> day the value reached to 188mg/l and continue to decrease till it reached to 110mg/l at the 14<sup>th</sup> day, while sample (B) started with 200mg/l and reduced to reach 61mg/l in the 14<sup>th</sup> day. For sample (C), BOD value was 170mg/l and it decreased to 112mg/l.

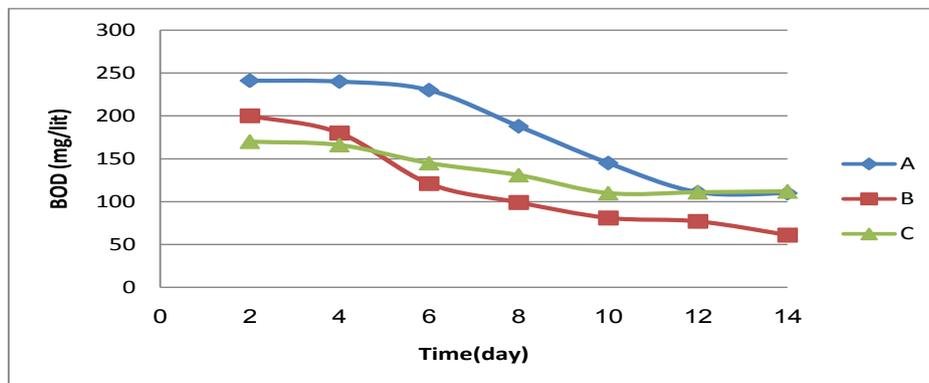


Figure (2). Transient removal of BOD for the three samples. (A=100% wastewater. B=75% wastewater. C=25%wastewater)

**Removal of PO<sub>4</sub>**

By examining Figure (3), it can be notice that sample A started with PO<sub>4</sub> concentration 39.5mg/l in and reached to 21.9mg/l at 6<sup>th</sup> day and the final value was 17.1mg/l at 14<sup>th</sup> day, while sample B started with 30mg/l and declined to 8mg/l. Sample C started with PO<sub>4</sub> concentration of 21mg/l and decline to 15mg/l at the 6<sup>th</sup> day till it reached to 11.2 mg/l at the end of the experiment which it takes 14<sup>th</sup> day.

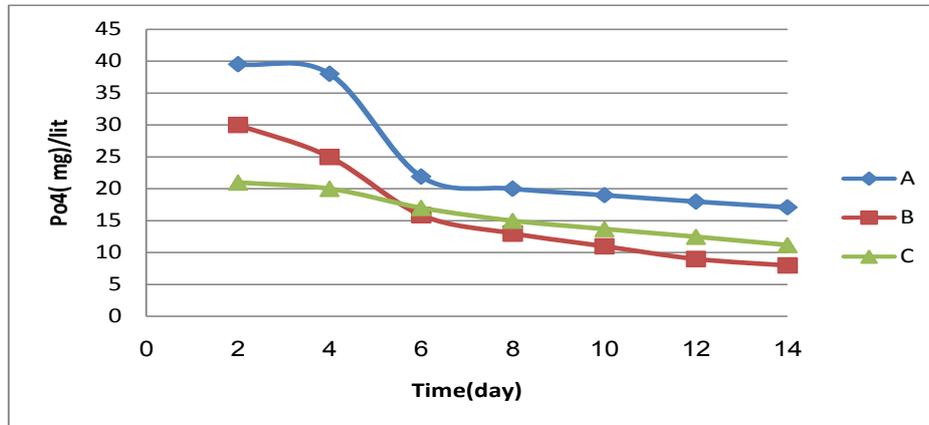


Figure (3). Transient removal of  $PO_4$  in three samples. . (A=39.5 mg/l  $PO_4$ , B=30% mg/l  $PO_4$ , C=21% mg/l  $PO_4$ )

### Conclusion

*Chlorella vulgaris* prompted increasing the loading in both BOD and COD values of the effluent and this could be attributed to the increasing of algal growth rate and that because of the good activity of photosynthetic. For sample (B) the final results of COD and BOD and  $PO_4$  were; 88mg/l, 61mg/l, 8mg/l respectively. So sample (B) shows the best removal efficiency of COD and BOD which reached to 55% and 70% respectively. While the percent removal of  $PO_4$  reaches about 75%. This behavior can be explained as the organic and nutrient concentration was in the suitable range to be taken by the Alga. So by dilution the wastewater, the nutrients reach to accepted concentration.

These results agree with McGriff [21] which found that using Algae in wastewater treatment can increase the removal efficiency of COD to 70-80%. Azeez [22] mention that the value of COD removal efficiency reaches to 83% by using *Chlorella vulgaris*. Hammouda [23] improved that 61% of efficiencies for COD can be removed by the micro algae *Chlorella Vulgaris* by using diluted ethanol and citric acid production from industry wastewater. Also in a study by Zhang [24] testify high efficiency for inorganic nutrients can be removed from domestic effluents.

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