Cultivation and Characterization of Microalgae for Wastewater Treatment

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***Abstract*— In the recent past considerable interest have been seen all over the world in employing microalgae for wastewater treatment. The technology is at a maturing stage. The treatment along with its energy generation potential makes microalgae based treatment more an interesting form a commercial perspective. This paper reviews the characterization and cultivation of microalgae for wastewater treatment**

***Index Terms*— microalgae, wastewater, bioenergy, photobioreactor, TBP**

I. Introduction

Microalgae are group of unicellular or simple multicellular photosynthetic microorganisms. It's divided in four group (red, green, brown and diatoms microalgae).Microalgae are one of most important plant in kingdom plants, it has high photosynthetic process. So, algae can be grown very fast and it has high reproduction. Human can be build a shining future from microalgae for us and to the next generations in different sectors in our life such as energy source, food, fertilizers, Nutraceuticals, Cosmetics, Pharmaceuticals, Aquaculture purpose and pollutions control. World research about good solutions to solve the waters pollutions problems. So, microalgae cultivation one of a good technology for wastewater treatment.

Microalgae cultivation in wastewater for wastewater treatment, pollution control and production of energy from biomass. Microalgae cultivation is one of good solutions to solving all the environmental problems in our environment such as global warming, the increase of ozone hole and climate changed because it consumes high quantity of carbon dioxide in Photosynthesis process to produce oxygen and glucose. Algae can adapt in any environment and under all the conditions. So, it can be grown in open ponds system, closed ponds system, photo bioreactors, marine environment and wastewater. However, closed pond system can be control by all the conditions such as CO2, gases, water, sun light supply and fertilizers (for example: photo bioreactors).

Also, it can live under all the conditions likes open ponds system. Additionally, I will grow the microalgae (green and brown) in both seawater and wastewater in closed pond system when all the conditions are under control. So, I will do analyses of waters pollution before and after the treated.

A. Classification of Algae

The Classifies algae according to many factors, including, device alsouti, and cell process of division, organelle structure and function. And the great similarity between groups of algae urged scientists to propose changes in the classification of algae, including: the level of division and classification, as is the case with the Kingdom at the level of classification, and flimsy for algae. For example, flagellar, micro tubular roots and roots of planned, the process of nuclear division (division), the process of cytoplasmic division (cytokinesis), covers the cell [1].

Table 1
Classification of algae

Division	Structure	Color
- Bacillariophyceae - Phaeophyceae - Xanthophyceae - Bacillariophyceae - Phaeophyceae, - Xanthophyceae.	Micromonadophyceae (Pleurastrophycea)	- Green - brown - Red - Diatoms

B. Factors Effecting Microalgae Growth

There are several factors that affect the growth and cultivation of algae, including: water and carbon dioxide, minerals and light. The requirements vary depending on the quality of the algae blooms. The basic reaction in water is carbon dioxide + water + light energy = glucose + oxygen + water.

Water is very important to cultivate microalgae because the algae absorb the nutrients from the water (waste water treatment) to produce biomass of microalgae and the nutrients are changed in different areas. There are many mechanical and chemical methods (biochemical, thermo chemical conversion and chemical reaction) to convert biomass of microalgae to biofuel for production of energy.

Manuscript received March 05, 2012; revised April 17, 2012. This work was supported in part by The Research Council, Oman and Sohar University, Sohar, Sultanate of Oman.

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ISBN: 978-988-19251-3-8
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

Wastewater is considered to be the best for use when production of biomass is needed.

C. Algal Chemical Composition

Cells of algae consist of a nucleus, organelles, chloroplasts and chlorophyll, which is the process of photosynthesis [2]. Algal preliminary contain proteins, carbohydrates, lipids, and nucleic acids. Some algae contain 40% of the fatty acid (oil). This is what is extracted from the diesel.

Table 2
Algal Chemical Composition

Cell of algae	Consist of a nucleus, organelles, chloroplasts and chlorophyll.
Algal preliminary	Contain proteins, carbohydrates, lipids, and nucleic acids.
Biomass of algae	contain 40% of the fatty acid (oil)

D. Algae Growth Cycle

Many life-cycle patterns are found in algae. However, there is no regular and fixed alternation of generation, as found in higher plants. In blue-green algae and certain chlorophyceae which reproduced asexually, there is an alternation generation.

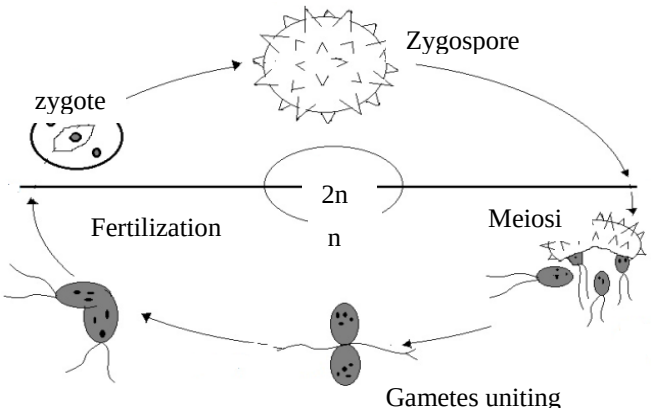

Fig. 1 Growth cycle of algae

E. Applications of Algae

Microalgae have varied applications as food, fertilizers, Source of energy, pharmaceuticals, nutraceuticals, cosmetics, and aquaculture purpose and pollutions control [3].

II. Source of Nutrients

Microalgae are fed by different nutrients in different environments as:

Freshwater as silica, iron and magnesium. Seawater nutrients such as sulphate, chloride, calcium, sodium, magnesium, potassium and other nutrients.

Wastewater nutrients are fed by different nutrients in the wastewater like nitrogen, phosphor, ammonia, sulfur, iron, toxins and all the metals (chemicals) in wastewater to production of microalgae biomass [3].

Table 3
Algae application

Food	Protein, amino acids, simple and complex carbohydrates, fatty acid profile, vitamins, minerals, and trace elements.
Fertilizes	Fertilizers, soil conditioners and source of livestock feed.
Energy	Biodiesel, Bioethanol and biobutanol. Hydrogen Heat and electricity.
Pollution control	wastewater treatment, reduce toxic chemicals reduce the percentage of carbon dioxide

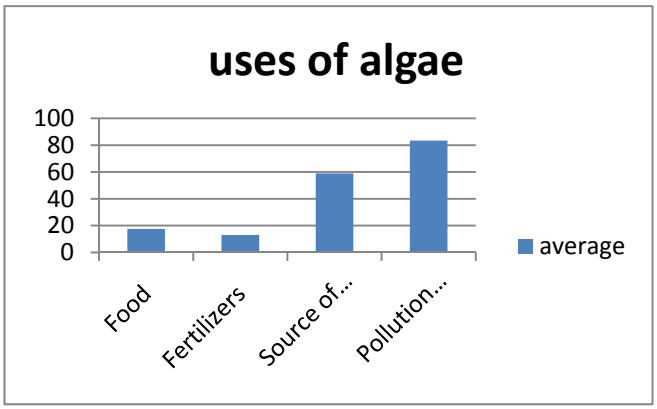

Fig 2 the uses of microalgae

III. Microalgae Cultivation Methods

As environments differ from place to place, many methods on how to grow these microalgae are available. In fact, they can be grown in closed pond system, open pond system, wastewater, marine environment and desert environment and under all the conditions [5].

A. Open ponds system

Proportioned Microalgae can be cultivated in open ponds system such as lakes, lagoons, ponds and artificial ponds or containers. Microalgae cannot be grown under control in open ponds system. One of the major advantages of open ponds is that they are easier to construct and operate than most closed systems. However, major defects in open ponds include poor light utilization by the cells, evaporative losses, diffusion of CO2 to the atmosphere, and requirement of large areas of land. Microalgae growth is effected by all pollutants in open ponds system.

However, it is not possible to control the productivity and the quantity of the microalgae. In addition, microalgae can only be grown during certain period of the year when all the conditions required for their growth are available.

Also, another one of the major problems of microalgae cultivation in open ponds system is the difficulty to harvest them.

ISBN: 978-988-19251-3-8
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

B. Closed pond system

Microalgae can be grown in closed ponds such as photo bioreactor and other types. One of the major features of closed pond such as all the conditions can be controlled like percentage of carbon dioxide, light utilization and not required for large areas of land. However, one of the major limitations in closed ponds is difficult to construct, operate and very costly.

Table 5
Open pond and closed pond system

Cultivation methods	Advantages	Disadvantages
Open pond system	Easier to construct	poor light utilization by the cells
	Easier to operate	poor evaporative losses and required large area
	Cheap	Poor diffusion of CO2 to the atmosphere
Closed pond system	Process Conditions controlled	difficult to construct
	Requires small area	Very costly
	Easier to harvest	Difficult to operate

IV. *Photo bioreactors*

Microalgae can be grown in closed ponds system like photo bioreactors. There are several reasons for the growth it in photo bioreactors such as, it can produce high productivity and it can be grown under control ,for example: carbon dioxide supply , water supply, gas supply rates, standard temperature and pressure, suitable lights, PH levels, culture density, and mixing regime [11].

Microalgae cultivation in photo bioreactor can be easier to harvest them than open ponds system. However, all the requirements to microalgae growth are available. Also, in photo bioreactor can protect the microalgae from all outside pollute. Therefore, it can be grown an anywhere and anytime inverse open ponds system. There are many limitations in photo bioreactors such as, capital cost is very high (industrial production), a lot of hinders to sterilizing these photo bioreactor and other defects.

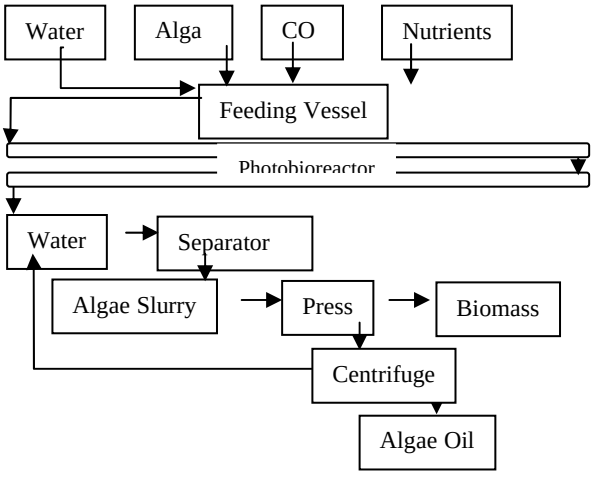

Fig.3. Schematic of a photo bioreactor

There are many types of photo bioreactors in the industry operation:

Flat-plate photo bioreactor
Tubular photo bioreactor

A. Flat-plate photo bioreactor

FPPB [6] is one of the most important types of photo bioreactors. In this part you will find general information about Flat –Plat photo bioreactor. These one of the major features for flat –plate photo bioreactor is Suitable for outdoor cultivation , good for immobilization of algae, Good light path, Good biomass productivities , very cheap, easy to clean, low oxygen build and can read tempered.

B. Tubular photo bioreactor

Also, tubular photo bioreactor is one of the most necessary in the industry that's for many reasons such as: very large illumination surface area, suitable for outdoor cultures, good biomass productivities, very cheap and other properties in TPB [2].

V. MICROALGAE CULTIVATION IN WASTEWATER

Microalgae can be grown in wastewater that's for several reasons such as:

- Cost effective treatment
- Low energy requirement
- Reduction in sludge formation
- Production of algal biomass

There are different types of wastewater as sanitary sewage, Commercial wastewater and industrial wastewater [7]. Microalgae can be using to treatment both of municipal and industrial wastewater. However, Microalgae can be grown t in wastewater to removal all pollutes and chemical toxic from wastewater such as removal of nitrogen, phosphorous, nitrite, silica, iron, magnesium and other chemicals. Microalgae have high capacity to accumulate the heavy metals and heavy toxic compounds to form microalgae biomass.

There are several steps to do purification for wastewater by microalgae, bacteria or by another thing: primary is removal of light organic matter; secondary, biological oxidation is oxidation of remaining organic matter and sedimentation is removal excess organic matter; tertiary, optional additional treatment to improve effluent quality.

VI. MICROALGAE CULTIVATION IN MARINE ENVIRONMENT

Microalgae cultivation in marine environment is one of the most important types of open ponds system. There are two types of marine microalgae, green and brown while the common name of all marine microalgae called "seaweeds" in cloud: Tetraselmis, Synechococcus sp, Chlorococcum littoral, Chlamydomonas sp, Nannochloropsis saline, Dunaliela tertiolecta, Botryococcus brainier. However, marine algae exist in two forms: some of them, which are called microalgae or seaweeds, are very small and can only be seen using a microscope, when others, which are called

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macro algae, are very large reaching up to 60 m in length.

There are several reasons for microalgae cultivation in marine environment such as, seawater already contains salts, more economical than fresh water and all nutrients needed already present in SW. Therefore, seawater contains more than 70 elements can be conclude in 6 elements, calcium, sodium, potassium, magnesium, sulphate and chlorine. What's more should be cleaned the seawater from all undesired microalgae and other pollutes will effects on desired microalgae [8].

Microalgae cultivation in marine environment is less nutrient requirement, more economical and does not contain toxins.

VII. Microalgae cultivation for CO2 capture

Microalgae cultivation can reduce considerably the percentage of carbon dioxide in atmosphere layer since they need plenty of CO_2 and NO_2 to perform their photosynthesis. Industrial operations release high quantity of carbon dioxide, nitrogen dioxide and other chemical exhaust gases, especially cement plant producing 1.25 metric tons of CO_2 for every ton of cement, hence microalgae grow rapidly in these places [10, 12].

VIII. Conclusion

Microalgae can be grown in open ponds system like lakes, lagoons, ponds and artificial ponds or containers. Also it can be grown in closed pond system like photo bioreactors. There are many advantages and disadvantages for both systems as presented in table 2. Photo bioreactor (PBR) is one of most important method for microalgae cultivation in closed pond system, because it has many features for microalgae cultivation.

There are many types of photo bioreactor for microalgae cultivation such as Flat-plate, tubular and vertical column photo bioreactors with its advantages and disadvantages.

There are many technologies for wastewater treatment and microalgae cultivation one of them. So, microalgae can be grown in wastewater to treat both of municipal and industrial wastewater. There are important aspects of microalgae cultivation in wastewater such as, requirement of low energy, effective cost and production bio mass to production biofuel. Therefore, microalgae can be used to remove all the contaminants from wastewater to produce liquids and solids suitable for discharge to the environment or for rues.

Microalgae can be grown in marine environment because all the nutrients already available there such as sulphate, chloride, calcium, sodium, magnesium and potassium. So, sea water is better than fresh water because SW it's economical than FW. There are four groups of algae in kingdom of plants (red, green, brown and diatoms) only two from this group (red and green) it can be grown in marine environment. Finally, microalgae can be grown near industrial areas to reducing the quantity of CO2 that is being launched from plants such as cement plant, power plant, fertilizer plant and steel plant.

Acknowledgement

The authors express their gratitude and thanks for the help and cooperation from the Faculty of Engineering, Sohar University and The Research Council, Oman for sponsoring and funding the research project titled "Harnessing Clean and green energy via integrated treatment of wastewater ".

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ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)