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MICROALGAE- A NEW TOOL FOR TREATING WASTE WATER

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ABSTRACT:

Water scarcity and waste water, these two problems are interconnected and one of biggest globally facing issue. Waste water, even after repeated primary and secondary treatments is heavily loaded with many organic, inorganic pollutants, heavy metals etc., thus making the already treated water harmful for further consumption. To overcome the above mentioned problem, use of microalga in waste water treatment is a boon and has number of advantages. The present study illustrates the efficiency of microalgae based treatment system. Specialized system having microalgae as a key component for treating waste water are highly capable of eliminating wastes like Heavy metals, phosphorous, nitrogen ,BOD,COD and other impurities by simply utilizing sunlight and CO_2. The microalga based treatment systems are economical, green and environment friendly. It is highly recommended to use and install microalga based waste water treatment plants to meet the worldwide challenge of accurate demand and usage.
Keywords: Microalgae, wastewater, sunlight, nutrients.

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INTRODUCTION:

Due to excessive human interference in the naturally occurring environment, the basic concentration or proportion of naturally occurring substances is undoubtedly increasing to a greater extent in the ecosystem leading to the heavy loss of flora, fauna and global climate too. Now a days, maximum naturally occurring resources are highly polluted and contaminated hence unsafe to use. Direct release of Xenobiotic (Pesticides, cosmetics, drugs, industrial effluents,) in the natural environment without any primary and secondary treatment cause global health hazards ,which ultimately leads to severe environmental conditions.(Mouchet et.al., 1986).Water is the biggest reason behind the earth, being the only planet for the survival. But the globally accepted truth is that water is the only resource which is maximum polluted now a days. Water quality degradation and water scarcity are directly proportional to each other. Especially in the Middle East countries, water scarcity is the biggest issue now a days due to many factors including population growth and density, economic situations, industrialization ,urbanization etc. Surface water problem is the issue which almost every country and continent is facing.

After basic primary and secondary treatments of waste water, effluents are discharged into the nearby water bodies. Primary treatment is only responsible for removal of materials which either settles down due to gravity (being heavily weighed) or floats at the top (being lighter). Few physical processes which are carried out in the primary treatments are Screening, commination, removal of grit and sedimentation etc. Whereas, removal of soluble organic matter and suspended solids left from primary treatment is done in the secondary treatment. Fine particle removal and removal of nitrate is performed in the tertiary treatment (Oswald et.al., 1995). Operating cost and maintenance cost of these treatments is highly expensive (Sen et.al., 1988).The effluent even after treatment contains an excess amount of nitrogen, phosphorous and pathogens in higher amount. These nutrients are the biggest cause of eutrophication which ultimately leads to algal blooms.

After observing the severity of the problem, many academicians and researchers worldwide studied and emphasized on the use of microalgae for treating waste water. Microalgae has a tendency and property to absorb nitrogen and phosphorous from waste water thus increasing DO content and decreasing pathogenic level in waste water before discharging into the nearby water bodies.

During the past few decades, biological waste water treatment systems having microalgae as a key component are globally implemented with greater results and now it is widely accepted that microalgae- based waste water treatment systems are highly recommending, eco-friendly, cheap and are as effective as conventional systems of treatment. (Walid Elshorbagy et.al. 2013).

ALGAE AS A BIO-INDICATOR:

A bio indicator is a group of species whose population, function and presence gives a clear indication of qualitative scenario of that particular environment.

Algae are an ecologically important group in most aquatic ecosystems and are one of the major component of environment monitoring programs. The main purpose of using bio-indicators is to identify and evaluate the effect of pollutants in that particular environment.Bioindicators somehow also explains the cumulative effect of different pollutants and also a brief idea about how long that particular problem is going to persist.

Any biological species can be a bio-indicator, but microalgae because of its peculiar features is always considered as a highly rated bio-indicator, when it comes to pollution type detection and appropriate treatment

Algae are autotrophic and placed at the interface between the habitat and the biotic component of the food web

Few special features of microalgae, which makes it a good bio-indicator are:

*Algae has a wide and temporal distribution.

*It gives quick response the changes occurring in the environment due to pollution.

*It is easy to detect and sample.

*AvailabIlity throughout the year.

*All algae have short life-cycle so, have a rapid response to change.

Algae of many kinds are really good indicators of water quality and many lakes are characterized based on their dominant phytoplankton group. Many desmids are known to be present in oligotrophic waters. Whilst a few species frequently occurs in eutrophic bodies of water (Brook et.al., 1965).

FACTORS /PARAMETERS AFFECTING ALGAL GROWTH:

SUNLIGHT: Microalgae being a unicellular anphotosynthetic organisms, completed dependent on the sunlight to perform the process of photosynthesis. However, some algae are able to grow in the dark using simple organic compounds as energy and carbon source. Sunlight is the major parameter for the growth of algae, without which microalgae can’t survive hence leading to reduce or no growth. Microalgae requires both light and dark regimes for productive photosynthesis. It requires light for photochemical phase for synthesizing Adenosine Triphosphate (ATP), Nicotinamide adenine dinucleotide phosphate (NADP) and dark phase for bio-chemical phase (Benjamin et.al, 2012)

Many investigators have revealed that increase in the duration of light intensity directly increases the growth rate of microalga (Al-Qasmi et.al., 2102 and Borowitzka et.al., 1988).

TEMPERATURE:

Average temperature around the globe is increasing rapidly due to human intervention and leading to gaseous imbalance. Thus leading to greenhouse effect around the planet. It is forecasted that before the end of 21st century, global temperature of sea surface would be 1.4^o C to 5.8^o C (Tait et.al, 2013).In the countries having highly fluctuating temperatures, algal growth is one of the crucial and challenging task. High temperature is good for algal growth but only up to a certain limit beyond which either growth rate decreases or ceases completely. In order to perform the algae based experiments accurately, control of temperature is the primary preference (Raven et.al, 1988).Most commonly cultured species of microalgae tolerates temperature between 16 and 27degree Celsius (Laura et.al, 2006).

Temperature affects the gross photosynthesis activity of microalgae by undergoing cellular division which ultimately affects the biomass productivity of algae (Bhalamurugan et.al, 2018). Depending on the prevailing temperature conditions, microalga strains should be adequately selected as this enhances the growth of the strains under study (Slocombe et.al,2016).In most cases, increasing temperature increases the growth of microalgae up to an optimum value and then decreases with any further increase in the temperature (Cassidy et.al,2011).Temperature $<16^0$ C and $>35^0$ C are considered to be detrimental for micro algal growth (Pacchiappan et.al,2015).Kessler et.al,1985 studied growth rate versus optimum rate of *Chlorella Sp*. and revealed that they grew successfully between 26^0 C to 36^0

NUTRIENTS (nitrogen, phosphorous and other minerals)

Growth rate of algae is directly proportional to the uptake of some limiting nutrients .These nutrients have a direct influence on the growth rate of algae and it is well described by the Michaels-Mentis Equation:

$$\mu=\mu_{max} [S/S+K],$$

Where,

μ is the growth rate

μ_{max} maximal growth rate

S is the concentration of limiting nutrient

K is the concentration that leads to half-maximal growth rate (Titman, 1976).

Nitrogen is considered as a building block for proteins and nucleic acids, whereas phosphorous forms the phospholipids. The metabolic pathway tends to be shifted if these nutrients are limited (Juneja et.al, 2013).A set of experiments was conducted by Paes et.al. *Chlorella Vulgaris* and *Nannochloropsis* and revealed that supply of nitrogen is directly proportional to the lipid synthesis, whereas no effect on the growth pattern of microalgae was observed. Similar studies were carried out by many researchers and academicians. Phosphorous limitations in *Scendesmus Sp.* (from 2.0 to 0.1 mg/L) led to the increase in lipid content from 23% to 53%,but the growth was low(Juneja et .al,2013 and Xin et.al,2010).

Table: I. Summary of major nutrient removal efficiencies by algal cultivation [Wang et al., 2010]

Algae Spices	**Wastewater Characteristics**	**N (%)**	**P%**	**Carbon**	**Retention time**
Algal–bacterial symbiosis (Chlorella + Nitzchia	Settled domestic sewage	92	74	97% BOD, 87% COD	10 h
Chlorella pyrenoidosa	Settled domestic sewage	93.9	18	NA	30 Days
Cyanobacteria	Secondarily treated domestic effluent + settled swine wastewater	95	62	NA	1 Day
Chlorella vulgaris	Diluted pig slurry (suspended solids content to 0.2%)	54-98	42-89	BOD_5 98%	4.5 days
Chlorella pyrenoidosa	Domestic sewage and industrial wastewaters from a pig farm and a palm oil mill	60-70	50-60	80-88 % of BOD, 70-82 % COD	15 days
Mixed culture of Chlorella and diatom species	Wood-based pulp and paper industry wastewater	NA	NA	58%	42 days
NA-Not applicable					

pH

Cell metabolism and formation of biomass of biomass in microalgae is highly affected and controlled by PH .Majority of microalga species flourish maximum in the neutral PH and almost all strains of microalga have an optimal pH range (Lutza et.al,2012).Effect of PH on microalga growth has been studied by many researchers and revealed that algae can survive both in acidic and alkaline pH(Ying et.al,2014).Vast studies on *Chlorella Vulgaris* revealed that microalga shows stunted growth in acidic (3.0-6.2)and alkaline (8.3-9.0)PH and optional growth was observed between 7.5 to 8.0(Rachlin et.al,1991).Another study by Sanchez et.al.,(2008) revealed that *Scendesmus almeriensis* grow effectively at PH 8.0.

CARBON-DI-OXIDE

Due to urbanization, industrialization and population growth 75% energy used is satisfied by burning fossil fuels, which emit harmful gases and add on to the greenhouse, which ultimately damaging the atmosphere. Many researchers and academicians have studied and suggested the measures to minimize the harmful effects caused by human activity in increasing greenhouse gases (Minillo et.al, 2013).

As per recent studies, CO_2 is one of the major cause of global warming. It is very important to fix the CO_2 level in the atmosphere. The concentration of carbon-di-oxide in the air is directly proportional to the microalgal growth (Salih et.al, 2011). Increase in CO_2 in the air will definitely increase the microalgal growth. Microalgae has a tendency to fix atmospheric CO_2 greater than any terrestrial plant. A detailed experimental study has been carried out on *Chlorella Vulgaris* ARCI and growth was observed under different CO_2 concentrations ranging between 350 and 200,000 ppm (0.036% to 20%) and results showed that *Chlorella Vulgaris* has the capacity to sequester 38.4 ppm (mg of CO_2 L/day) at elevated CO_2 concentration of 60,000 ppm (6%) hence, increases the growth of microalgal biomass (Chinnasamy et.al, 2009)

CONCLUSION

After review of literature and studies of different contributors in this field, authors highly recommend microalgae for the treatment of industrial or domestic waste water. Microalgae has an incredible capacity of absorbing nitrogen and phosphorous from already treated effluents, thus reducing BOD, inhibiting coliforms population ,removal of heavy metals. Use of microalga as a tool for cleaning wastewater is cheap, economic and eco-friendly. Nitrogen and phosphorous serve as nutrient source for algal biomass production. This algal biomass can further be used in different processes, either for methane production, composting or inn aquaculture. So, authors conclude the review paper by highly recommending the microalgae as a boon to the water treatment technologies and should be implemented globally.

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