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# A Study On Cultivation Of Micro Algae For The Alternative Production Of Biofuel Using Dairy Waste Water

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## ABSTRACT

The algae species are considered as one of the most reliable natural resources with a lot of valuable substances which meet the requirement of food and energy. In the present conceptual study, the global potential of the cultivation of microalgae in dairy wastewater (DWW). Hence, the present day necessities and requirements have emphasized the need for a renewable and alternate energy source is very needy basis. Besides, the present technologies of energy resources possess a potential threat to the environment by emitting greenhouse gases (GHGs) etc. The present study primarily discussed about the use of dairy wastewater as a culture medium for microalgae and established methods i.e., Open Race Ways Pond (ORWP) and Photo Bio Reactor (PBR) methods for pilot scale cultivation of microalgae and further for industrial production of Biofuel. The DWW derived from the dairy have a Potential to provide Cost – Effective and Sustainable means of algal growth for the biofuels. The study concluded that the dairy wastewaters would be used for algal cultivation and final products of algal biomass may be used as a possible feedstock for Biodiesels or fuel Production.
**Keywords:** Biofuel Production, Dairy Waste Water (DWW) and Microalgae.

## I. INTRODUCTION

The manufacturing of Biofuel and Bio products from algal Biomass has been hampered due to lack of reliable and cost effective technology for the production and harvesting of large quantity of algal Biomass. It consists of various industry applies and produce waste water and if this waste water is liquidated in aquatic system without proper treatment, superfluous nitrogen and phosphorus in discharged wastewater can lead to downstream eutrophication and ecosystem damage. Due to diminishing fossil resources, energy insecurities, accumulation of greenhouse gas emissions and current high prices for fuel transportation and global warming. Moreover, the negative effects of such nutrient overloading of receiver aquatic system include Biological oxygen demand (BOD), Chemical oxygen demand (COD) fish kills, objectionable pH shift and cyanotoxin production; the chemical and physical based technologies are offered to eliminate these nutrients are yet to be cost effective.

Microalgae are photosynthetic microorganisms that require solar energy fertilizer required for their production are enormous. One alternative to the use of synthetic fertilizers is to use domestic, municipal, agricultural, industrial, aquaculture wastes and waste waters which are rich in organic and inorganic pollutants such as nitrogen and phosphorus. The cultivation of microalgae using wastes and wastewaters for biomass production and pollutants can be removed from the aquatic environment. Thus, treatment of the wastes and wastewaters occur through removal of the pollutants. It is compared to physical and chemical treatment processes, algae based treatment can ecologically safer way with the added benefits of resource recovery and recycling.

Microalgae have many potential uses i.e., pharmaceuticals, food, animal feed, chemical, cosmetics, biofuels and bio fertilizers can be produced. It is also an important biological resources that have wide range of biotechnological applications due to their high nutritional value microalgae are useful for bioremediation of agro industrial waste water and as a biological tool for assessment and monitoring of environmental toxicants such as heavy metal pesticides as biological tool and in pharmaceutical. In recent years, it has been attracted much interest due to their potential use as a feedstock for bio diesel production. However, cultivation of micro algae in industrial wastewaters has to face many challenges as this water contains variable constituents to their intrinsic properties of relatively unbalanced nutrient profile and high toxic components, various studies have been analyzed the potential of micro algae grown on several industrial waste waters for algal biomass production.

Dairy industry is one of the major industries having economic importance in agricultural sector. India is sharing about 17.68 percent of the total milk produced in the world (Kumbhar Vijay, 2017). There are about 286 large and small scale dairy industries in India responsible for large quantities of waste production like solid and liquid. Dairy wastewater is characterized by strong color, offensive odor, high BOD (40–48,000 mg/ l), high COD (80– 95,000 mg/l) (Kushwaha et al., 2011) and variable pH (Kothari et al., 2011). It also contains sufficient nutrient like N (14–830 mg/l) and P (9–280 mg/l) required for biological growth (Gavala et al., 1999). It gives a huge potential to be used in wastewater treatment plants towards microalgae. The dairy effluents consist of milk, milk products and enormous quantity of water as well as the pH of the effluent is alkaline and the organic content is significantly high. The effluent affects the inventive value of the receiving water its alkaline pH causes damage to aquatic life (Jin Hur et al., 2010). The present study focus on utilization of dairy wastewater for algal cultivation and final products of algal biofuel can be used as a possible feedstock for biodiesel production.

## II. REVIEW OF LITERATURE

**Clarens (2010)** the study has been harvested algal biomass can be used as feedstock for biofuel and high-value byproducts purpose, further reduce the costs of such algae-based wastewater treatment system. The study is found that the Algae grown on dairy wastewater media are a potential source of low-cost lipids for production of liquid biofuels. Microalgal distribution, richness and its depends on the quality of the wastewater (Deval, 2014).

**Felipe Hansen et.al (2017)** Showed that there is potential in using dairy effluents for microalgae growth in order to treat these effluents and improve the finances of small and medium dairy forms. It also needed to optimize CMC and SMCs systems before upscaling and result showed that the Chlorella grew better in wastewater with high organic and ammonium loads.

**Hee-Jeong Choi (2016)** studied the biomass production and dairy wastewater treatment using Chlorella vulgaris. The study results revealed that the maximum percentages of biochemical oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS), total nitrogen (TN), and total phosphorus (TP) were removed by 85.61 percent, 80.68 percent, 29.10 percent, 85.47 percent, and 65.96 percent dairy effluent within 10 days. Hence, the study concluded that the using dairy effluent for microalgae cultures could be a useful and practical strategy for an advanced, environmentally friendly treatment process.

**Jitha and Madhu (2016)** presented an integrated approach to cultivate microalgae in dairy wastewater and investigated that the capability of the organism for biodiesel production. The study was carried out using tolerant strains of microalgae collected from dairy effluent treatment plant in Kochi by selected blue green algal strains for mass cultured in the laboratory and adapted by using different concentrations of synthetic effluent. The experiment was conducted and suggested that the reduction of physical impurities and the nutrients for the cultivation of blue green algae in dairy wastewater by utilizing the extra nutrients strongly supports its ability for biodiesel production.

**Kothari R, Pathak et.al. (2012)** the objective of their study was to develop an efficient treatment for nutrients and the production of biomass in dairy wastewater effluent and using dairy effluent for microalgae cultures. The study concluded that the biomass productivity was strongly influenced by the nutrient reduction in the dairy effluent.

**Mobin (2014)** stated that the microalgae production in wastewater treatment is potentially an economically viable feedstock for the biofuel production and also suggested that the technical feasibility of many algae production technologies has been extensively investigated and demonstrated with cost associated can cannot be overcome without technical breakthroughs through the innovative system integration. Furthermore, the study is identified that the using waste water as resources and combining waste water treatment with the production of algae based on bio products.

**Paran Gani et.al. (2015)** investigated that an important process to remove or minimize the contaminant before its discharge. Moreover, the research focused on the potential of microalgae can be used to treat the wastewater to remove chemical and organic contaminant that could be further processed to make biofuel, biodiesel and bio- hydrocarbon.

Microalgae have demonstrated the ability to remediate wastewater nutrients efficiently, with methods to further enhance performance through species selection and biomass concentration. However, the Algae grown on wastewater media has a potential source of low-cost lipids for production of liquid biofuels. From the above conceptual study, it gives an idea about the study entitled on **"A Study on Cultivation of Micro Algae for the Alternative Production of Biofuel Using Dairy Waste Water".** The main objective of the present study to grow high biomass algae in dairy waste water for biodiesel production and treatment of waste water for processing and also the great potential of mass production of algal biomass for biofuel production based on the waste waters of dairy.

**Biofuel Production from Dairy Waste water Grown Micro algae:** Species selection, optimization of growth, lipid content, and harvesting at large scale are the important factors which govern the commercialization potential of algal biofuels. The algal biomass produced and harvested from these wastewater treatment systems could be transformed through a variety of pathways to biofuels. Presently, key bottle neck of biofuel production from microalgae do not allow an economic and sustainable biofuel production at today's energy prices.

**A) Dairy Waste Water (DWW):**

Dairy wastewaters can be remediated through assimilation of nutrients into algal biomass, which can be used as a resource material for various kinds of valuable products including pigments, biohydrogen, etc. There are a large number of studies on the treatment of industrial, municipal and agricultural waste waters by algal culture systems (Samori, 2013). The dairy wastewaters in India has produced during the processing of liquid milk, milk products and the detergent used for cleaning. The amount of dairy wastewater production specific water usage, and it's approximately 0.5 – 18 L of the waster per liter of the processed milk products. A small high protein content, a lower heavy metal content. It was non - toxic and easily biodegradable. Moreover, its small amount, dairy wastewaters from its industry may pose a serious risk to human beings, the environment and aquatic life. If it is not properly treated prior to consumption or disposal. Hence, the treatment and safe disposal of DWW has become an important aspect for the running of the dairy industry in the toxic environment (Jeong, 2016). There are numerous methods and techniques are available to be used for the treatment of dairy waste waters (DWW). Then, the most important method of the criterion for selecting which treatment system to install are that it is flexible enough to overcome the constant fluctuations in the organic load and it keeps the process economically viable. It is also excellent capability of micro algae gives it a huge potential to be used in wastewaters plants. The pH of the effluent is alkaline and the organic content is considerably more. The effluent affects the aesthetics value of the receiving water its alkaline pH causes damage to aquatic life (Jin Hur et.al. 2010).

**B) Strains – Micro Algae:**

In our day to day life, the need for energy is increasing rapidly and we depend on various sources of energy like electricity and fuels for industries, automobiles, households' activities and many of other basic needs. Among these sources, the fossils fuels account for near to eighty percent of primary biofuel production using microalgae through wastewater across the globe generally, particularly in India. During the modern scenario of the necessities and requirements have highlighted the need for the renewable and alternate energy source is very high. Moreover, the present day energy resources group potential threat to the environment by emitting Greenhouse gases (GHGs).

Micro algae, unlike fossil fuel, the $CO_2$ is taken out of the atmosphere and release oxygen in the environment by the algae cultivation (IEA,2013). Algae fuels have attractive features like it can generate with the help of wastewaters, biodegradable and relatively harmless in nature towards the environment incase spilled in oceans and can also bloom up with minimal environmental impact on fresh water resources (Brennan, 2010). However, the challenges lies in commercialization of microalgae biomass and its capacity towards the biofuel production. The main obstacle is to high production cost, low efficiency in terms of biofuel over biomass production and issues which are related towards the sustainability of this technology for a long term which are also equally important to the green environment.

In the connectivity of the present study is that the Micro algal strains are generally sensitive to various kinds of wastewaters due to the imbalance in nutrient profile, deficiency of few important trace elements and presence of toxic compounds in wastewaters streams and only limited number of strains within a few species can adapt well in different wastewaters environments. There is a great need to select more robust micro algal strains that are tolerant to specific types of wastewaters of interest. Most of the researcher demonstrated that the microalgae adapted to culture conditions familiar to where they were found and generally grew better than those purchased from algae banks. Hence, the Resistant Stains can be obtained through genetic engineering or breeding manipulation in order to obtain extra resistance to environment stress and improve oil synthesis (Mobin, 2014).

**Table 1.** Representation of Algal Species apt for growing in Wastewater

| Wastewater | Strains | Biomass (DW) Productivity (Mg $L^{-1}$ $day^{-1}$) | Lipid Content (% DW) | Lipid Productivity (Mg $L^{-1}$ $day^{-1}$) | Reference |
|---|---|---|---|---|---|
| Industrial | B. braunii | 34 | 13.02 | 4.50 | Chinnasamy et.al. 2010 |
| | Chrorella Saccharophila | 23 | 18.00 | 4.20 | |
| | Pleurochrysiscarterae | 33 | 12.00 | 4.00 | |

**Source:** Adopted from the Author's Articles.

There are different ways of strains can be cultivated, efficient and cost-effective via large scale cultivation of micro algae is essential for the success of strains biomass as a candidate in renewable energy. The Cultivation systems can be generally separated into two broad classified and it includes Suspended culture (Open and Closed Reactors) and Immobilized cultures (Matrix and Biofilms). The table 1 discloses that the Representation of Algal Species apt for growing in wastewater based on the industrial strains such as B.braunii, Chrorella and Pleurochrysiscarteare etc., The stains of Braunii has a value of biomass productivity of 34 Mg $L^{-1}$ day $^{-1}$ Chrorella with value of biomass productivity of 33 and 23 for Pleurochrysiscarteare respectively. The braunii has been actively highlighted because of the high levels of hydrocarbons productions with 30 – 70 percent of dry weight.

Open raceway pond method has been used for over 60 years with is extensive knowledge and experience in their operation. It is not more than 30 cm deep to allow for efficient penetration of sunlight. Although open systems are generally easy to operate and use sunlight as an energy source, they have several disadvantages. The principal drawback is the lack of any real control over the environmental conditions encountered. For instance, temperature is not controlled and will vary seasonally and diurnally. Furthermore, open pond productivity typically fairly low unlike closed photo bioreactors, which are more expensive to construct and operate but offer more control over culture conditions. It is sub classified as Vertical, Horizontal and Helical photo reactors. Compared to open ponds, tubular photo bioreactors can give better pH, nutrient dosing and temperature control, better protection against culture contamination, better mixing, less evaporative loss and higher cell densities. Consequently, the present research study is highlighted that the most common large scale production systems in practice are high rate algal ponds or race way ponds.

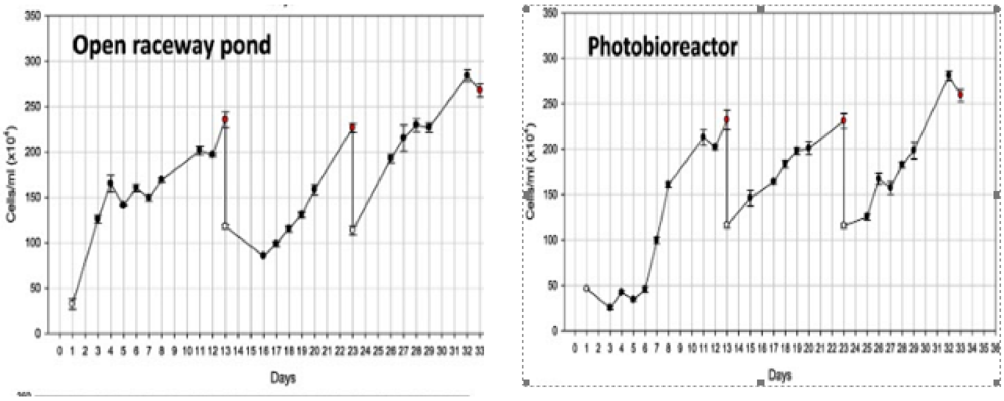


**Figure 1**

As shown in the figure, the photo bioreactor can play a dual role while using wastewater as nutrient source for producing biomass. It can be cultured in dairy effluent as a nutrient source for biodiesel production. The figures above shown are relatively high growth rates in wastewater revealed that the growth rate was reduced by the treatment in the primary photo bioreactor whereas in the open raceway pond but the blue green algal filaments as well as the filter bed performed in a better way. Furthermore, the present study is observed careful considerations of various design parameters of micro algae for biodiesel production. The Open race ponds studies with pilot scale photo with bioreactors would be carried out in further study.

**Open pond System** **Tubular System**

**Figure 2**

The figures are shown above compared to open ponds with the tabular photo bioreactors, which gives better pH, nutrient dosing and temperature control, better protection against culture contamination, are the significant challenges of using raceways and tubular photo bioreactors for bio mass recovery. Likewise, Due to their construction cost and ease of operations, open way ponds will likely to be systems of chance for mass microalgae cultivation resulting the biofuels production in the form of dairy wastewaters.

**A) Biofuel Production:**

The most prevalent way of making biofuel from microalgae is to produce biodiesel from algal lipid (Oil) through transesterification. In most cases, Biofuels can be directly combusted in a standard diesel engine without the issue of blending with regular diesel. Total lipid levels are commonly the most vital factor by considering the applicability of algae biomass for biodiesel production. In recent years, biodiesel production from algae has gained at most attention. Due to the scarcity of natural sources there is an emergency to find an alternative to replace the exhausting fossil fuels which lead to the raise of alternative biofuels (Perlack et al. 2005). Biodiesel production has been started during ages but with different feedstock like vegetable oils, animal fats etc. But the life cycle assessment from first generation biofuels frequently approached those of traditional fossil fuels mainly due to the high feed cost of vegetable oil (Antolin et al., 2002; Lang et al., 2001). Hence, the biofuels have been raised and the goal was to improve the amount of biofuel that can suitability produced by using biomass. Since, it is a burning issue a number of researchers were going through several innovative applications using microalgae as a tool; easily degradable, and algae biodiesel does not contain Sulphur and while the microalgae have become a boon to the present biodiesel production strategy. Wastewater has organic and inorganic supplements required for algal growth. The coupling of microalgae with wastewater is an effective way of waste remediation and a cost-effective microalgae biofuel production. .

## III. CONCLUSION

Microalgae employed for dairy wastewater treatment is in order to achieve the biofuels production. The present methods are unlikely that microalgae will produce biofuel, which is cost competitive with fossil fuels without major advances in technology. The most significant improvements are expected to be in the area of strain selection, cultivation, harvesting, and oil extraction for the dual purpose of remediation and biofuel production, which accelerate the commercialization of algae biofuel. The study results revealed that the biofuels production are energy rich which can be further processed to make biofuel, biodiesel, and other bio-hydrocarbon. The algae biomass also used to obtain different bio-based products such as Bio-Plastics, Fertilizers, Micro-beads and Animal food etc., Microalgae cultures from wastewaters can be significantly contribute to the management of water ecosystems by providing an expensive, environmentally and also sociable system for waste water treatment.

In India, to meet the ecological regulation towards biofuel production, all types of waste water need to be treated before its discharges into the river. DWW treatment is the vital important process to avoid the contaminant. Therefore, the potential of microalgae need to be treated with the wastewater to remove the chemical and organic contaminants, heavy metal pollutants pathogen, the waste waters rich in CO2. Moreover, it is also provided conductive growth medium for microalgae to assimilate those contaminations. Wang et.al., 2010, established that the sufficient amount of nitrogen and phosphorus for impurities can be utilized micro algal growth. Generally, the dairy wastewaters (DWW) can treated in anaerobic digesters to remove the high organic loads that are a potential source of organic carbons. These organic carbons are largely used by microalgae for their metabolic requirement. The research study also pointed that the use of microalgae in treatment and recycling of wastewaters have attracted with great interest due to their role of carbon dioxide fixation and bioremediation. Hence, the study concluded that the microalgae is essential to perform the dual role of wastewater treatment and high lipid containing biomass production which will eventually leads to a promising route towards the developments of an economical production of biofuel.

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