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A REVIEW ON HYDROCARBON PRODUCING PLANTS

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ABSTRACT

World today experiencing the unpleasant effects of fossil fuels which roots different types of pollutions including air, water and soil. Some plants are having the potential of hydrocarbon production and acts as biofuels. These biofuels are comparatively chief, ecofriendly and easy to produce. In this article, efforts are taken to review some plants and their biomass producing hydrocarbons and containing the capacity to alter the fossil fuels. These plants are variously known as petrocrops, biodiesel plants and so on. Algae are the most common plants groups exploited as a source of hydrocarbons. It is need of time to conserve all such botanical sources and their bioprospecting practices.

KEY WORDS- Review, Hydrocarbon, Plants, Biofuel, Petrocorp's, Bioprospecting

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1. INTRODUCTION

Plant and microbial biofuels have caught remarkable attention of scientists as they can decline the world's dependence on fossil fuels. It is accomplished by meeting the rising energy demands, reducing the emission of greenhouse gases and overcoming other environmental pollutions. Biofuels have the potential to replace the fossil fuels and can achieve the cleaning of polluting environment. Scientists throughout the world have utilized some microbial strains of *Saccharomyces* sp., *Kluyveromyces* sp., *Clostridium* sp., and *Trichoderma* sp. to obtain a high yield of biofuel (Bhardwaj et.al, 2020).

During these days, worlds energy scenario is getting changed. Due to limited availability and its non-renewable nature, it is need of time to find an alternative for fossil fuels. Also day by day costs of fossil fuels increasing which are beyond the reach of common man. In other side dependence of man on fossil fuels is ultimately increased. Biofuels, can be a better substitute for the fossil fuels which are comparatively superficial in respect to their renewable nature, cost effective and eco-friendly nature. Only we need to explore such plants and convert them in to crops by the breeding and hybridization. Several workers throughout the world have successfully explored plants with hydrocarbon producing potential (Kalita,2008).

If human being start using plants as a source of hydrocarbon or fuel comprehensively, it would be fruitful in many ways. Now a day's worldwide utilization of fossil fuels is up to 95 %. Combustion of fossil fuels poses tremendous air, water and soil pollution which adversely affect ecology and biodiversity. As

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discussed earlier fossil fuels are non-renewable sources and highly expensive. Biofuels derived from biomass and living plants on the other hand are eco-friendly in nature having no very negligible or no ecological implications, are cheap, renewable and responsible for creation of employment to local people. On one hand, plants would produce biofuels and simultaneously will absorb increasing carbon from the atmosphere. In short plant originated biofuels are beneficial in all the spectrum of life. Only there is need of will and enhance technology to make biofuels from plants.

Hydrocarbon synthesis mechanism can be seen in variety of plants, algae and microorganisms. Actual hydrocarbon synthesis in different organisms takes place by various pathways. Some genetic factors are also responsible for this synthesis. Brown and Shank (2011), studied hydrocarbon synthesis pathways in plants, algae and microorganisms in detail.

Higher Angiosperms as a source of Biofuel

Higher angiosperm plants including *Plumeria alba, Calotropis proera, Euphorbia nerrifolia, Nerium indicum* and *Mimusops elengi* are having good potential of hydrocarbon production. Most of these species are wild so agro-technology for their cultivation need to be standardized. It can be achieved by hybridization, genetic engineering and by applying other advanced techniques (Kalita,2006). It is reported that, some plants have an ability to store the solar energy directly as hydrocarbons. *Havea brasiliensis* (Rubber tree) is a potential plant which produce hydrocarbons directly. Breeding practices and increased cultivation practices of rubber now a day resulting in barrels of oil/acre/year which ultimately reduces load on fossil fuels. Latex producing *Euphorbias* and *Asclepias* also appeared to be an excellent sources of gasoline. *Euphorbia tirucalli* and *E. lathyrus. E. trigona* are also used extensively for the hydrocarbon production. Larger domestication and commercialization of these plants may lead to minimise increasing pressure on fossil fuels (Calvin,1977, 1980).

Augustus et.al. (2002), reported some angiospermic plant species from Western ghats (India). They enlisted some plants containing more or less hydrocarbon concentration. *Sarcostemma brevistigma, Caralluma attenuate, Jatropha multifidi, Tylophora asthmatica, Euphorbia tirucalli, Cryptostegia grandiflora, Ficus elastica, Ficus glomerata, Carissa carandas, Euphorbia heterophylla, Jatropha gossipifolia, Artocarpus hirsuta* etc. are some of the species having hydrocarbon producing ability. The plants listed above were shrubs, climbers, woody climbers and trees by habit and with 1.5 % and more hydrocarbons.

Buchanan et.al.(1978) assessed 100 plants from United states and found 9 hydrocarbon producing plants. Lamiaceae is the dominant family bears three such plants. *Phalaris canariens, Monarda punctate, Pycnanthemum incanum, Teucrium canadense, Sassafras albidum,Pinus sylvestris, Ceanothus americanus, Prunus Americana* and *Populus tremuloides* are the plants having the potential of hydrocarbon producing potential.

During World war II several potential hydrocarbon plants have been selected in United states. These plants includes *Chrysothamnus spp, Cryptostegia sp., Parthenium argentatum, Taraxacum khok-saghiz* and *Solidago*. Further worldwide researches added *Larrea tridentate, Sassafras albidum, Euphorbia lathyrus and Asclepias sp. Simmondoia chinensis, Cucurbita foetidissima, Euphorbia lacteal, Calotropis procerato* to have efficient hydrocarbon producing potential (Benedict and Inman, 1979).

Biomass is an important source of fuel as it contains organic materials. Lignin is an Important component of plant based biomass. Lignin can be exploited for the production of biofuel via its hydrogenation.

Advanced technologies like development of stable genetically engineered microorganisms, improved gene cloning and sequencing technologies, characterization of new enzymes etc are effective for the conversion of lignin's in to value added products like, biofuel (Abdullah et al., 2017). Currently abundant lignocellulose biomass is sourced from agriculture, industries and municipal solid wastes. Thermostable cellulose degrading enzymes degrades the complex lignocellulose biomass into different forms like sugars and fuels. Cellulosomal enzymes as compare to free enzymes, have better efficiency catalysing various conversions. (Arora et.al., 2015, Tiwari et.al, 2018).

Algae as a Source of Biofuel

Algae are a varied group of single celled and multicellular organisms that have proved to be the potential source of transportation fuels. Most important feature of algae is, they can grow in a wide range of environments from freshwater to saline water. Due to their rapid growth, they produce large amount of biomass in a very limited period. Red, green, brown, blue-green, and diatoms are the different forms of algae which have a potential to produce large amount of biomass contain oils. Due to their single celled nature, most of algae can be manipulated to form highly efficient strains (Hannon et.al, 2010).

I. Microalgae

Microalgae are eukaryotic and prokaryotic (Cyanobacteria) unicellular, microscopic, photosynthetic representatives which lacks roots, stem, leaves, embryos, vascular system. Microalgae are proved as promising platform for the production of biofuels due to their lipid producing ability and fast growing nature. Biofuel can be synthesized from various microalgal species by stepwise manner. Most important step is identification of appropriate strain with hyper- lipid producing and fast growing capacity. Once proper strain is identified, it is mass cultured and biofuel is extracted by advanced techniques including combustion, pyrolysis, gasification, thermos-chemical liquefaction, biomethanation etc. (Mutanda et.al, 2011). Algal biomass is highly efficient for the production of different biofuels such as biodiesel, bioethanol, biogas, bio-hydrogen and other products. Algal biomass can be processed with different biochemical, thermochemical and chemical conversion methods for the production of biofuel. The biomass of different algal species including *Spirulina platensis, Nannochloropsis sp., Scendesmus salina* and *Chlorella marina* have been used for biofuel extraction. Transesterification, fermentation is the some of common methods applied for the extraction of biofuels in various forms from algae (Behera et.al, 2015).

Microalgae are diverse group of living organisms which possess novel metabolic features, which can be exploited for the synthesis of biofuels from them. Genetic engineering and transformation experiments have been practiced for some green, red and brown algal members to enhance their biofuel producing capacity. Transformation of DNA into algal cells can be achieved by variety of methods including electroporation, biolistic micro particle bombardment and *Agrobacterium* mediated gene transfer. Lipid biosynthesis in different types of algae have been achieved by expressing various genes and enzymes present in naturally lipid synthesizing plants like, Arabidopsis thaliana, Glycine max etc (Randor et.al., 2010). Lignocellulose from plant cell wall is also useful for the sustainable biofuel production. However, conversion of lignocellulose in to biofuel is quite expensive and difficult method. But current biotechnological approaches are used to modify the cell wall structure. It can overcome the problem of conversion by many folds (Quanzi et.al, 2014).

It is evident from research that, fatty acids naturally synthesized in the algae like *Chlamydomonas* Sp. and in cyanobacteria gets converted into alkenes by microalgal metabolic pathway. Alkanes or alkenes synthesized are the major components of gasoline, jet fuels and diesel fuels. Hydrocarbons derived cannot be used directly as an energy source because they contain high carbon number ie. > 25. Scientists now concentrated to the algae which produce shorter carbon chain compounds (C15- C19), So they can be used as a rich source of renewable energy. Microalgae, *Chlamydomonas reinhardtii*, *Chlorella variabilis* and *Nannochloropsis* operates a specific alkene producing pathway which contribute significantly to the oceans hydrocarbon cycle (Sorigue et.al.,2016). Microalgae, especially *Chlorophycean members, Carteria cerasiformis, Chlamydomonas sp., Chlorococcum sp., Lobochlamys segnis* shows considerable amount of lipids which is an important component of their metabolism and also essential components in human and animal nutrition. Lipid productivity is considered as the most suitable factor to find the biodiesel producing species (Zhou et.al, 2011). It is an indicator of biodiesel producing plants. Estimation of lipids of these algal species proved, they may be used for bioprospecting and can have biodiesel producing potential. Domestication and commercialization of the above micro algae may become an innovative source of biodiesel (Teronoi and Baruah, 2017). Botryococcus spp also reported to be useful for the production of long chain hydrocarbons (Hannon et.al., 2010).

Eibl et al (2014) with their work confirmed the biofuel potential of green alga *Scendesmus* spp. *Scendesmus* is acidophilic lipid rich green algae found grown abundantly in mine water bodies which can tolerate low pH growth conditions. This algal species has a strong growth profile and high lipid production ability which ultimately useful for the biofuel production.

The production of biofuel form microalgae such as *Chlorella pyrenoidosa, Scenedesmus sp., Hindakia sp., Chlorella sp., Chlamydomonas mexicana* etc. is achieved by some workers. These algal species were grown in different type of wastewaters including activated and digested sludge extract, settled sewage, dairy wastewater, carpet mill, municipal wastewater and piggery wastewater. It is reported that, some of these algae shows higher lipid productivity. Microalgal biofuel systems produce clean and sustainable, renewable fuels by their photosynthetic ability. Biofuel production by algae also can be coupled with carbon dioxide mitigation, wastewater treatment and production of high value chemicals. Many algal species are able to produce significant quantities of lipids which can be converted into biodiesel through the process of transesterification. Biodiesel produced from such algal species is characteristically similar to petroleum based diesel in respect to density, viscosity, flash point, cold flow and caloric value (Bhatt et.al., 2014).

II. Macroalgae

Macroalgae are the individuals which produce comparatively large amount of biomass and are most beneficial components of marine ecosystem. They are thalloid plants and do not bear root, stem and leaf. Macroalgae may be categorised into different groups according to their pigmentation. They can be grouped into Rhodophyta, Chlorophyta, Phaeophyta and so on the basis of pigments. Macroalgae are used worldwide for different purposes including cosmetics, medicine and as a source of biofuel. More than 200 species of various macroalgae are reported to be used for different purposes. Microalgal biomass is highly efficient for the synthesis of many bioenergy components including biodiesel. *Spirulina platensis* (Behera et.al. 2015), *Laminaria, Gracilaria, Sargassum, Macrocystis, Ulva, Kappaphycus, Gelidium* are some of the genera which are utilized for the synthesis of Methane, ethanol and hydrogen production (Rajkumar et.al, 2014).

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2. CONCLUSION

Bioprospecting practices of plants including algae is proved their hydrocarbon producing potential. Microalgae and their biomass is nowadays considered to be a good source of biofuels as they can accumulate high lipid content Plant based hydrocarbons are extremely applicable to cope up with ever-increasing costs and pollution causing sorts of fossil fuels. Hydrocarbons can be extracted from many algal and angiospermic species. It is also can be derived from various biomass. Hydrocarbon producing potential will boost the production of hydrocarbons useful in gasoline and other biofuels. It would be beneficial to overcome the current energy problems and will be the main focus of the future research.

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