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An Overview on Biofuels and Their Advantages and Disadvantages

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Blazing of fossil energy resources generally changes the global climate. Speeding up of global temperate nowadays is an important aspect. Emission of greenhouse gases mainly from blazing of fossil energy resources is one of the most important sources. So, to carry the significant energy and to reduce air pollution, biofuels might be a substitute energy sources. The unnecessary utilization of fossil energy resources or fuels results deficient in the storage in underground earth then people naturally have to depend on biofuels. Consequently increasing demand for the manufacture of biofuels will put a huge burden on agriculture and food prices. Biofuels generally attributed as liquid fuels which are made from the biomass. This consists of mostly wood, vegetable oils, forestry products, agricultural crops, agricultural residues or municipal garbage, residues of domestic animal wastes and aquatic plants. In this review, we summarized the different types of biofuels including biodiesel and their comparative study, production and uses from an ecological perspective.

Keywords: Biofuels, Food biomass, Bioenergy, Algae fuel, Vegetable oil.

INTRODUCTION

Biofuels are mainly obtained from biological materials, mostly from plants, animals, wastes and microorganisms [1]. Biomass is organic components are the source of substitute energy and it contains all classes of biofuels like solid, gaseous and liquid fuels. These can be achieved from biomass [2,3]. Biomass for alternative energy might be engaged in various ways. An outline of the different possible options to use biomass [4] is presented in **Scheme-I**. Solid biofuels are mostly firewood, charcoal and fibrous matters. Fossil fuels like firewood and charcoal are extensively utilized as a primary fuel domiciliary purpose that is cooking. Fibrous type of material can be obtained from sugar cane processing and it is widely used for power generation and preparation of steam [5]. Methane and producer gases are mainly the gaseous biofuels and these can be obtained by fermentation of domestic animal wastes and from the pyrolysis [6] or gasification of agricultural wastes and wood. Different kind of liquid biofuels like methanol, ethanol, organic oils and the methyl esters are generally attributed as biodiesel [7]. Solids and liquids biofuels are used widely for energy inception since of their large prosperity, tremendous energy and low price. Coal and petroleum fossil energy resources or fuels take million of years to produce biofuels in short time with appreciable yield though both are coming from biomaterials [8].

Nowadays, it is important to discuss how much we should use biofuels and fossil fuels in our daily life because both are necessary in our future generation [9]. The price of necessary goods including oil is soaring highly. In this circumstance the biofuel can be most preferable alternative to fulfil the demand of human need using fuels in necessity. It takes the place of fossil energy sources and the deteriorating fossil fuel then reserves. The result becomes as a way to alleviate the possessions of climate change and to have a renewable, reliable resource of energy. Biofuels are ever lasting and renewable resource because these are incessantly refilled. Fossil fuels are not perpetual and renewable, they drain out from our underground earth since it requires millions of years to form [10]. So, the burden comes to people to restore them for not having to face problematic situation due to lack of storage. It is blessing of science to have biofuel as an alternative. However, our viewpoint is to discuss

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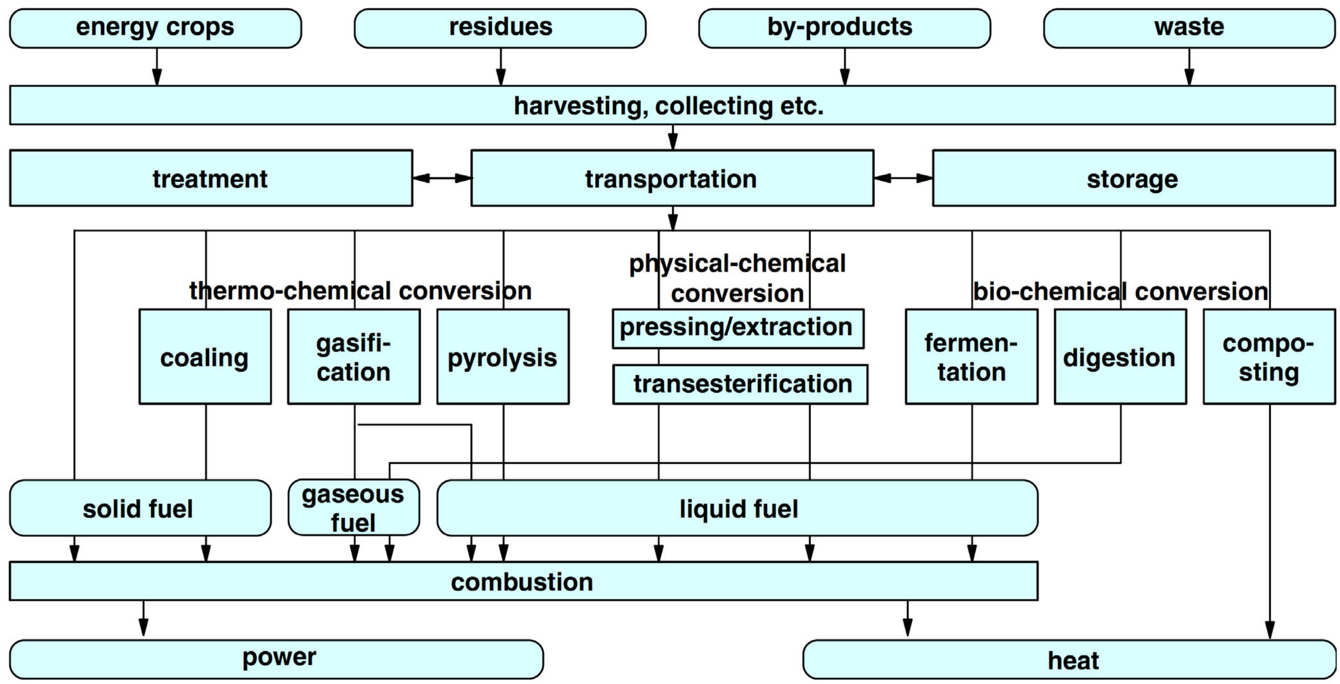

Scheme-I: Possibilities to provide heat and power from biomass

the different biofuels and their comparative study for a better understanding to the general audiences to grow interest about this serious matter which may drive the future generation throughout the world. The authors think that this review will go some way towards reinforcing this need for a whole-systems approach to those who are already working in this field. However, above all, we hope that this review will educate and inspire those new to the field and encourage them to make their own contributions to this fascinating and rapidly changing area.

Generation of biofuels: The fuels which are produced by biological process are known as biofuel. The involved different biological sources like agriculture and anaerobic digestion but not formed by geological processes like formation of fossil fuels. Primary biofuels are mostly fuel wood, wood chips, pellets and organic materials which are generally used for heating generation, cooking or electricity purposes in a crude appearance. Secondary biofuels which are acquired from cultured biomass and consist of liquid biofuels that are extensively used in transportation and industrial purposes. Herein, we discussed the generation of biofuel, advantages, drawback and compared each others in detail.

First generation biofuels: First age groups of biofuels are on the market in substantial amounts today. Sugarcane ethanol, 'corn' ethanol, starch-based biodiesel and pure plant oils are the examples of first generation biofuels. The ingredients for producing 1st generation biofuels mainly consists of sugar, starch and oil bearing crops or sometimes animal fats. These might be used as food and feed or consists of food residues which are prepared from sugar, starch, vegetable oil or animal fats using usual technology like fermentation, esterification and distillation processes. These processes are well-settled scientifically and have been utilized for hundreds of years in many uses, such as in making alcohol. The most familiar and important first-generation biofuels are vegetable oils [11,12], bio-alcohols (most commonly ethanol) [13], bio-diesel [14], bio-gas [15], solid bio-fuels [16,17]. The technique used to make biodiesel is called transesterification [18], since it is a procedure of converting one type of ester into other.

Vegetable oil: It has been found that the uses of vegetable oils as fuel have economical, environmental and energetical related benefits. Although, it can rarely considered in authorized energy statistics but it is already the fourth leading resource of energy in the world. Vegetable oils generates heat approximately 90 % like that of diesel fuel. It can easily convert as biodiesel from this biomass, widely accessible and can frequently be used directly in diesel engines with little modification. Recent report informs the use of waste cooking oils and vegetable oils are representing motivating alternative fuels for diesel engines in some precise applications [18]. Corsini *et al*. [18] studied the engine recitation and productions in bi-fuel systems using vegetable oils as fuels in diesel engine. However, there is some drawback of vegetable oil using as biofuel since it is a valuable feedstock. Use of unrefined oil can damage the engine through carbon deposition owing to unfinished combustion. On the other hand, the replacement of elderly growth jungle with oil palms increase carbon emission and consequently damages biodiversity.

Bio-alcohol: Bio-alcohol *i.e*. ethanol is mainly acquired by fermentation of cane sugars and starches. Butanol and propanol are formed as co-product during bio-alcohol preparation. Ethanol is predominantly significant first-generation biofuel which is well studied a renewable energy resource [19]. Corn is the main source of the World's fuel ethanol and most of that corn comes from the United States [11]. The utilization of ethanol-blended fuels like E85 can reduce the net emissions of green house gases by as much as 37.1 %. E10 (10 % ethanol and 90% gasoline) ethanol-blended biofuels decreases green house gases emission by up to 3.9 % [20]. Generally, there are two procedures to produce fermentable carbohydrate from corn. One of them is dry milling which is the lowest-cost route to a fermentable intermediate and another one is wet milling which produces a highly refined pure glucose but requires substantial capital and operating investment [21]. However, by using low-capital dry-mill fractionation [22], it can be separated 90 % of the phosphorus from fermentable starch with coproduction of protein and oil containing corn germ (Fig. 1).

Dry-mill corn fractionation enables low-cost separation of food- and animal feed-quality germ and fibre from fractionated corn mash [23].

The effects of ethanol come to results in an overall diminish in ozone formation, an important environmental alarm. It profits energy protection as it shifts the need for some foreign-produced oil to domestically-produced power sources. Ethanol burns more diffidently (more complete combustion). Ethanol reduces the degree of high-octane additives. The fuel spills from ethanol are more simply biodegraded or diluted to non-toxic concentrations. Production of ethanol requires important energy and vast amount of territory. The fuels having more than 10 % ethanol content are not compatible with non E85-ready fuel scheme mechanism and may possibly cause of deterioration of ferrous components [24]. It may affect electric fuel pumps by growing inner wear and unwanted spark creation. It is not well-matched with capacitance fuel plane gauging indicators. It may result incorrect fuel quantity sign in vehicles that is used in the system. Despite its comparatively high price as a food crop, soybean is still a most important feedstock for the production of biofuel. In this case soybean is used for better production of biodiesel rather than ethanol. Soybean is most likely the awful feedstock for biofuel manufacture.

Bio-diesel: Biodiesel is simple like the normal diesel fuel. Bio-diesel is serene of mono alkyl esters containing long chain fatty acids made from vegetable oil or animal fats. So, it is significant to trace low-cost feedstock from natural sources. To increase the biodiesel production, various novel technologies are accepted in the area of bio energy research. Current research on this topic mainly focuses on the economical, abundant feedstocks, novel manufacture and purification technologies for bio-diesel [25]. These feedstocks are mainly classified into four categories are edible vegetable oil, non-edible vegetable oil, waste or recycled oil and animal fats. It is comparatively less inflammable than the normal diesel. It is easy to use as a mixer with normal diesel fuel. Bio-diesel is biologically degradable and hence less hazardous for the environment. It does not contain sulphur which is mainly liable for acid rain. Biodiesel is appropriate for catalytic convertor in many cases. The engines, in which bio-diesel is used as fuel, are generally long-lasting. Its refineries are comparatively simpler and environmental-friendly. Biofuels are higher octane containing and lubricity scoring compounds than the uncontaminated petroleum based diesel fuel. It can improve engine efficiency and operating life cycle of the machine.

Comparatively bio-diesel is costlier than the ordinary diesel fuel. The availability of feedstock for making bio-diesel depends on the local climate, geographical position, local soil environ-ment and agricultural tradition of any country [26]. It tends to trim down fuel economy. Biodiesel is generally less appropriate for use in lower temperature. Bio-diesel is impossible to transport through pipelines like normal diesel. It releases nitrogen oxide during its combustion which may cause environmental pollution. There are only a few petrol stations which are offering biodiesel-fuel. It can merely be utilized in diesel-powered engines. Sometimes bio-diesel may be cause of flatten of internal fuel tubes of older vehicles to be defeated their lifelong qualities. It is more probable than the normal petroleum diesel to attract humidity.

Bio-gas: In everyday life, waste materials production is an undeniable part of human activities. The wastes are formed by a number of segments including medical, industries, agriculture, forestry and municipalities. Different varieties of polymers and inorganic materials are accessible in various waste materials. Natural materials like lipids, starch, glycogen, collagen, keratin, chitin and lignocelluloses, as well as synthetic polymers such as polyethylene, polyesters, and polypropylene are the examples of such types of polymers. Lignocelluloses are frequently a chief or sometimes the only components of different waste streams from various sectors. Hydrolysis is the main step for these materials for digestion to biogas (methane) and sometimes fermentation to ethanol [27]. Biogas is produced from digestion process under anaerobic conditions and its application is rapidly promising as a workable means for giving incessant power generation [28]. Methanogenesis is the process by which organic substrates are digested into methane in the nonexistence of oxygen. Through a consortium of organisms, these organic substrates are hydrolyzed, fermented, and finally converted into biogas which is known as methanogens.

It is found that major parts of the renewable energy are created from European cultivation and forestry. More than 25 % of all bioenergy in near future can originate from biogas,

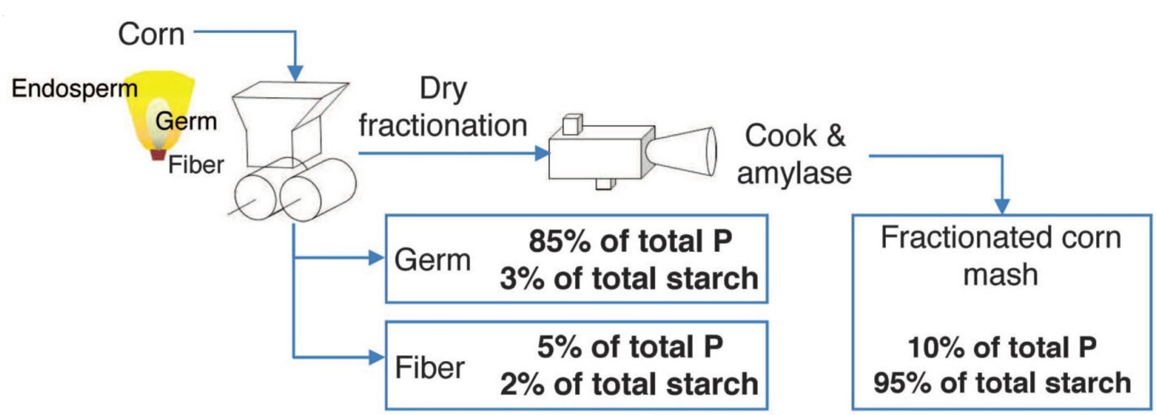

Fig. 1. Robust-enabled grain-to-lipid fermentation

produced from wet organic materials like animal manure, entire crop silages, wet food and feed wastes, *etc*. [29]. Biogas is mainly applied to produce electricity, and a very small number of projects produce bio-based compressed natural gas (CNG) to power natural gas vehicles. Biogas composition varies significantly depends on the substrate, but it is typically composed of 40-65 % methane, 30-40 % carbon dioxide and various impurities, including hydrogen sulphide, ammonia and siloxanes [30,31]. Recent studies [32] have shown a little amount of H_2S (< 5 ppm) present in biogas streams generated from agricultural residues (soybean residue, corn stover, miscanthus and bagasse). Biogas produced from wastewater tends to have higher methane content (higher specific energy), while biogas produced in a landfill tends to have a higher percentage of CO_2 (lower specific energy).

Solid biofuel: The word "solid biofuel" be able to be speck deceptive as people connect biofuels with superior calming and chemical methods. Actuality, a biofuel can be any renewable, biological material used as fuel. From the definition, it is clear that things like wood, leaves, sawdust and even dried animal dung all constitute biofuels. So far solid biofuels are mainly vital bioenergy carrier. But a closer investigation shows very undoubtedly that the utilization of solid biofuels within the energy system is currently limited to particular markets. These markets are classified by different circumstances as well as different fuel requirements: solid biofuels with low variations of fuel properties, medium variations of fuel properties, high variation of fuel properties [33].

Advantage: Generally, biofuels have some positive effects to be discussed like these are expected to have large financial crash especially for local performer. Biofuel production opens new market opportunities and helps to expand agricultural products and thus new income showers on farmers enlarging the socio-economic condition. Consequently, in future agriculture will play a great role both in food production and also in energy provision. The increased feedstock production is expected to strongly contribute to the multi-functionality of the agricultural sector. Nevertheless, it is difficult to assess the real dimension of additional employment in production centre relating biomass and impact on local economy in the biomass sector. It is significant for ethanol dispensation than for manufacture of pure plant oil and biodiesel. This benefit for lipid derived fuels is particularly vital for small scale agricultural producer and small and medium-sized enterprises (SME′s).

Another advantage comes in the fermentation of sugar and starch-bearing plants, co-products as necessary supplement is produced in large quantities. Necessary supplements such as fodder, fertilizer, heat fuel, industrial raw material or as substrate for biogas plants can be used. An excellent example how co-products from ethanol production can be used is the bagasse, the fibrous residuals of sugar cane after pressing. In Brazil, bagasse is burned and the heat is used for the distillation process and for electricity generation. It′s a good exemplification of biofuels advantage. Similarly, biodiesel and properties of pure plant oil known as lipid derived fuels are received in a lagged number. For instance, press cake from rapeseed oil extraction is a high value and protein enriched fodder. In biodiesel production glycerine is a valuable, usable co-product for industrial purposes.

Limitation: The main source of first generation biofuels is the feedstock. The major component of feedstock is food crops such as corn and sugar beet. They create a hazard to food prices since the biomass are used for biofuels preparation. Prices for food and animal feeds which are the first-generation biofuels have been increased due to several factors [34,35]: (a) more use of biofuels places a depressing contact on biodiversity and competition for water in some regions; (b) biomass for first generation biofuels requires lots of land to cultivate and this provides only limited greenhouse gases fall; (c) they also provide a small profit over fossil fuels in regards to greenhouse gases since they still require high amounts of energy to develop, accumulate, and procedure. Current production practice use fossil fuels for power; (d) first generation biofuels are also a costlier alternative than gasoline, making it reasonably poor; (e) finally, biodiesel almost always comes from used oils from restaurant, as different to virgin oils, so the supply is limited by restaurants′ oil utilize.

Second generation bio-fuels: Second generation biofuels are the more developed industrial edition than that of first generation types, we can say that they′re characteristically not imitative from food crops but this fuel is also produced from sustainable feedstock like first-generation fuels. Basically, these types of feedstocks are not generally used for human utilization. That is, second-generation feedstock does not come to use of human beings. Though it is a food crop but they are no longer useful for consumption. Second-generation biofuels are known as "advanced biofuels" because extraction of fuels from this source is very difficult. Non-food feedstocks sources of biomass for 2nd generation biofuels include wood, agricultural residues, organic waste, food waste and specific biomass crops together with cellulosic, hemicelluloses or lignin [1]. This biofuel can either be combined with petroleum based fuels combusted in existing internal combustion engines and swelled through existing infrastructure or is dedicated for the use in slightly adapted vehicles with internal combustion engines (*e.g.* vehicles for DME). This species holds plants together to formulate fuel. BTL-diesel (biomass-to-liquids) and lignocelluloses ethanol are the main sources in second-generation biofuel.

Second-generation biofuels are not made commercially until now, but a substantial number of pilot and manifestation plants declared or set up in current years, with research activities occurred mostly in North America, Europe and a few rising countries (*e.g*. Brazil, China, India and Thailand). To make second generation, substantial amounts of biomass have to be provided that will need an analysis of active and potential biomass sources well before the start-up of large-scale production [36].

Well known second generation Fischer-Tropsch fuels [37,38] are obtained by a group of substance reactions that convert a mixture of carbon monoxide and hydrogen gas into liquid hydrocarbons. It was discovered by Franz Fischer and Hans Tropsch. Lignocellulose process means to plant waterless material that is forest material (biomass) [39]. It is obtainable in large quantities raw material on the world for the construction of biofuels, mostly bioethanol. It is made of carbohydrate polymers (cellulose, hemicelluloses), and an aromatic polymer (lignin). Poplar trees are required to undergo a pre-treatment process, and a sequence of elemental reactions that crash lignin. Lignin is the ingredient of the cell walls of all dry earth plant. Lignin is the only polymer that is not collected of carbohydrate (sugar) monomers. Lignin is an aromatic functionality and unique in that sense it is the only large-scale biomass source for 2nd generation. It is collected of up to three different phenyl propane monomers depending on the species. Thermochemical or biochemical reactions which are the initial steps that unlock the sugars surrounded in fibres of the plant. After the completion of the reaction, plant ethanol is obtained which is resembles that of 1st generation ethanol manufacture.

Furthermore, another second-generation biofuel is bio-SNG, a synthetic gas similar to natural gas [40]. Straw and other plant residue produces synthetic gas involving a several thermochemical stages. Synthetic gas is a mixture of carbon monoxide, hydrogen and other hydrocarbons [41]. Hydrogen is used as a fuel and the other hydrocarbons are used as for the production of gas oil.

Different types of second generation biofuels

Waste vegetable oil: Waste vegetable oil has no food value and it may help to reduce the environmental pollution. Some diesel engines are designed in such a way that the obtained biofuels from this biomass is used directly without blending or refining [42]. There are some advantages of such substance like it doesn′t releases sulphur in the environment, since it is a used product and it doesn′t perturb the arable crops, besides, it costs nothing in use of land. Some of the limitations are also there such as this biomass can damage to diesel engines if it is not accurately purified before use, it is difficult to collect because it is located in many points.

Grasses: Grass cultivation mainly depends on location. For example, Southeast Asia uses Miscanthus, whereas United States uses Switch grass. This grass need to be planted only once, because it is permanent. This biomass grows on marginal land very quickly and yields of crops are obtained in a number of times a year. Less fertilizer is required for cultivation and it can be used instantly without further processing as biomass. There has some drawback which are: (a) use of direct biomass sometimes comes good and then grasses turning into biodiesel are not favourable; (b) process to turn grasses into alcohol is also complicated than others; (c) while they′re easy to plant, their seedlings should be constantly secured from the much stronger species of weeds naturally grown around them; (d) substantial humidity levels largely suit in their growing and they can't grow on arid soils; and (e) None can make crops to be dense enough within the first few years [43].

Seed crops: This biomass can be cultivated on the marginal land in a considerable amount but energy value of biofuels is very much less than the biofuels from soybeans biomass. Other difficulties have been achieved in growing such crops on farmland and that is why its popularity has been reduced in a substantial amount.

Municipal waste: Nowadays this kind of biomass is utilized for making of biofuels. It includes all kinds of solid waste matter comes from human waste, grass, landfill gas and leaf clippings, *etc*. The following fuels are acquired from the second-generation biofuels:

Cellulosic ethanol: It is obtained *via* fermentation of sugars derived from the cellulose and hemicellulose fractions of ligno-cellulosic biomass.

Biobutanol: It is prepared in a process like to ethanol but with different microorganisms. Presently, the fuel yield is lower than that of ethanol, but biobutanol can be used as a call on replacement for gasoline without blending.

Biomass to liquids (BTL) technology: It is started with gaseous cation to prepare a synthesis gas (syngas) followed by Fischer-Tropsch process to gasoline, diesel and jet fuel.

Alcohol: Methanol, dimethyl ether (DME) and mixed alcohols can also be prepared from syngas *via* catalytic synthesis. Alcohols are also obtained by fermentation of syngas by some specialized microorganisms [44].

Biosynthetic natural gas (Bio-SNG): Any way renewable natural gas can also be obtained via gasification and then followed by catalytic methanation and purification. Biogas can be made by an anaerobic digestion with microorganisms. This gas is composed of mainly methane and carbon dioxide. It can then be used as compressed natural gas (CNG) or liquefied natural gas (LNG) in vehicles or injected into the existing natural gas cylinder [45].

Hydrotreated vegetable oil: It is a used as a diesel substitute that has very popular fuel properties like high cetane, non-aromatic and does not contain sulphur.

Pyrolysis oils (known as biocrude): This is obtained by ash pyrolysis (rapid heating to about 1,000 ºF followed by rapid cooling). Refining and upgrading generate liquid fuels for transportation or stationary applications (boilers, turbines) [46].

Advantages: The profit of second generation biofuels is various and 2nd generation biofuels are to be better to 1st generation biofuels due to various reasons [47]:(a) they use a non-food feedstock (like lignocellulosic biomass materiel, such as earth crops residues, forest products residues, or fast-growing devoted energy crops). So, the second-generation biofuels are different from first generation biofuels because they don't come directly from food crops like corn and soybean; (b) the fuel is a call on replacement for conventional petroleum based fuels, meaning there are no limits on blending, or they can be used as is (without blending) in existing vehicles; (c) second generation biofuels are more environmentally friendly and produces less greenhouse gases; (d) they do not produce co-products like animal feeds; and (e) less requirements of land are applicable here so the competition for land with other agriculture fields comes to lessen; food fibre and water are also less required.

Disadvantages: (a) Second generation fuels are not yet produced on commercial scale. Due to high production costs and this process is not proven technically; (b) current harvesting, storage and transport systems are in adequate for processing and distribution biomass in large scales; (c) requirement of clear and long-term policy frame work is to ensure that industry and financers can endow with assurance; (d) agricultural/forestry sector alters need to supply biomass feed stock from residues and crops imply a significant transfer in the current business model and as well as trade of feedstock and biofuel and (d) the most favourable approaches and locations for 2nd generation facilities should be recognized that maximum GHG reductions while minimising cost and impacts on the environment and other agricultural markets. So, the use of these fuels associated with less concern leading to food crisis in developing countries, or harmfully affecting consumer prices in developed nations.

Comparison between 1st and 2nd generation biofuels: If the 1st and 2nd generation biofuels may be submerged then second generation biofuels address many issues which are linked with 1st generation biofuels. They don′t race between fuels and food crops because they come from separate biomasses. Second generation biofuels create higher energy yields per acre than 1st generation fuels. They allowed for use in inferior quality land where food crops may not get appropriate support to grow. The technology is fairly immature, so it still has prospective of cost reductions and increased production efficiency as scientific advances take place surprisingly. However, some biomasses for second-generation biofuels still compete with land use since some of the biomass grows in the same climate as food crops. This leads to farmers and policy makers with the tough decision of which crop to grow. Cellulosic sources that grow alongside food crops could be used for biomass, such as corn stover (leaves, stalk and stem of corn). However, this would deduct too many nutrients from the soil and would need to be replenished through fertilizer. In addition, the procedure to manufacture of second generation fuel is more complicated than first generation biofuels since it need retreating the biomass to liberate the trapped sugars. This involves more energy and materials.

The great advantage of these fuels is the vast range of feedstock that can be employed for biofuel manufacture as well as the compact feedstock (*e.g.* cellulose crops) costs. By using a holistic approach, biofuels offer large economic advantages over fossil fuels, but direct cost comparisons are difficult. Negative externalities connected with fossil fuels tend to be feebly quantified, such as military expenditures and expenses for health and environment. However, biofuels includes the potential to create many constructive externalities, such as reduced greenhouse gas emissions, reduced air pollution and job creation. At the same time biofuels decrease dependency from crude oil imports. As a result, biofuels are more socially, economically and environmentally desirable. Usable liquid fuel is often ignored in direct-cost calculations. Therefore, biofuels often seem uncompetitive although a biofuel market may actually offer durable economic benefits when comparing environmental and social costs [48].

Third generation biofuels: The well accepted meaning for third-generation biofuels is fuels that would be produced from algal biomass, which has a characteristic growth yield as compared with conventional lignocellulosic biomass [49]. Algae fuel or algae is the major source of third generation biofuels [1]. It produces more than 30 times energy per acre than the land crops such as soybeans. Normally, algae are a various group of prokaryotic and eukaryotic organisms [50]. Algae can be classified either autotrophic or heterotrophic. The conversion technologies for operating algal biomass to energy sources can be classified into three different ways, *i.e.*, biochemical, chemical and thermochemical conversion and construct an algal biorefinery [51]. For the growth of autotrophic algae, the following inorganic compounds such as CO_2, salts, and a light energy source are necessary. While the heterotrophs are non-photosynthetic that requires an external source of organic compounds such as nutrients as energy source [49]. Microalgae are very little in size and typically measured in a scale of micrometers. These species are generally grown at faster rate in water bodies or ponds and contains more lipids than macroalgae. In case of algae the main advantage is the short harvesting cycle where as for usual crops having harvesting cycle of once or twice in a year. Therefore, the foremost attention has been carried out on algal biomass for its relevance in biofuel area. The fuels that can be derived from algae are biodiesel, butanol, gasoline, methane, ethanol, vegetable oil, jet fuel.

Algae can be cultured in a various methods and it can be developed in any of the following ways:

(a) **Open ponds:** This is a simple way in which algae is developed in the open-air ponds. Algae can be cropped simply and have low assets costs but are less proficient than other systems. Other organisms can pollute the pond so they are much concern even if from potentially damage having a fear to kill the algae.

(b) **Closed-loop systems:** This system is alike open ponds, but it is not uncovered to the atmosphere and use a disinfected supply of carbon dioxide. It has large potential because it may be directly linked to carbon dioxide released into the atmosphere in every use.

(c) **Photo-bioreactors:** These are the most advanced and thus most difficult systems to implement, that comes with result in high capital costs. The proficient photobioreactors are necessary to grow and spout the potentials of algae. Although, till now, sufficient amount of photobioreactors have been projected but only a little of them can be practically used for mass making of algae. One of the most important factors that bound their realistic application of algal mass cultures is mass transfer [52]. Thus, a methodical accepting of mass transfer rates in photobioreactors is essential for well-organized action of mass algal cultures. However, their advantages in conditions of yield and control are still unrivaled.

Advantages: (a) It has capability to grow throughout the year; therefore, algal oil productivity is higher in touch relationship to the usual oil seed crops; (b) there is a higher acceptance to high carbon dioxide content; (c) the consumption rate of water is very a low in algae cultivation; (d) necessity of herbicides or pesticides in algal farming is not needed; (e) the expansion potential of algal species is very high in comparison to others; (f) different sources of wastewater containing nutrients like N_2 and phosphorus can be developed time to time for algal cultivation apart from providing any additional nutrient; (g) it has the capability to grow under insensitive conditions like saline, brackish water, coastal seawater, which does not affect any conventional agriculture in producing [51]; (h) they are biodegradable, so very naturally and comparatively safe to the surroundings if spill is one benefit of many biofuels over most of the other fuel types. Third age groups biofuels are also called superior biofuels (i) in algal biofuels like low land necessity for biomass preparation and high oil content with high productivity were taken as the best resource, which can substitute the liquid petroleum fuel (j) a good yield per acre (upto 10 times greater with other biofuels) and the reality that algae do not vie for land or drinkable water with forestry or agriculture;

and (k) one of the main benefits of algae is that they can use in various arrangement of carbon resources. Most notably, algae might be fixed directly to carbon emitting sources (power plants, industry, *etc*.) where they could openly switch secretions into usable fuel which has been suggested. This leads that no carbon dioxide would be released from these settings and thus total emissions would be cut down considerably.

Disadvantages: (a) the higher agriculture development cost compared to other traditional crops; (b) comparatively more energy input is required for harvesting of algae and it is approximately about 20-30 % of the whole cost of manufacture; (c) a number of techniques like flocculation, floatation, centrifugation, sedimentation, and filtration are usually applied for producing and concentrating the algal biomass [53]; and (d) although algae are grown in wastewater, require large quantity of water, nitrogen and phosphorus to cultivate.

Comparison between 2nd and 3rd generation biofuels: The 3rd generation biofuels are comparatively more energy intense than 1st and 2nd generation biofuels per area of harvest. They are cultured as low-cost, high-energy, and fully renewable sources of energy very resourceful to us. Algae are profitable in that it can grow in areas unsuitable for 1st and 2nd generation crops, which would lessen strain on using water and arable land used. It can be easily developed using sewage, wastewater, and salt water, like oceans or salt lakes. Due to this, a need to use water that would otherwise be applied for human spending is not necessary. However, further research still needs to be execute to further the removal process in order to make it financially competitive to petro diesel and other petroleum based fuels. For an economic process in comparison to others, a cost-effective and energy efficient harvesting methods are necessary with low energy input. For making low-cost micro algal biofuels needs superior biomass producing techniques, high biomass manufacture with reputed oil productivity through genetic modification, which will be the hope of algal biology. Therefore, the usual algal harvesting methods in use, bio-refinery concept, advances in photo-bioreactor design and other downstream technologies will further decrease the price of algal biofuel production, which will surely be a competitive resource in the near future. The funds and operating disbursements of third-generation production are so high. So, some sub-sectors are required for additional research and development to reach the level of being a sustainable process of consistent biofuel construction on an industrial scale, but the potential is highly talented.

Fourth generation biofuels: The ecological footprint and economic performance of the current suite of biofuel production methods make them insufficient to displace fossil fuels and reduce their impact on the inventory of Green House gases in the global atmosphere. Algae metabolic engineering forms the basis for 4th generation biofuel production which can meet this need [54]. The agricultural products such as corn or sugarcane are the main sources of first-generation biofuels. In case of second generation biofuels, which is generally based on (lingo) cellulosic biomass. For third and fourth generation of biofuel, it actively involved with "algae-to-biofuels" technology: the earlier is fundamentally processing of algae biomass for biofuel creation, while the latter is about metabolic engineering of algae for making biofuels from oxygenic photosynthetic microorganisms. Fourth generation biofuels will be based on raw resources that are fundamentally inexhaustible, cheap and extensively available [1]. This type of biofuel depends on the conversion of vegoil and biodiesel into gasoline [11].

Advantages: Fourth generation biofuels are more superior than third because these algae are obtained with elevated yield and along with high lipid contain. It has more CO_2 capture capability and high manufacture rate than other biofuels.

Disadvantages: The major disadvantage of algae production is involved the high rate of initial investment. Research for algae production is now at its preliminary stage. The fourth-generation biofuel research has been started from 2006 and significant result has not been published yet in peer-review journals.

Conclusion

The need of energy never comes to an end so; the challenge is to procure power source sufficient to offer for our energy needs. Besides, this energy source must be dependable, renewable, recurring and non-contributing to climate change. First generation biofuels show a movement toward cleaner, renewable energy. However they stay behind gasoline due to energy density and economic factors. They also present a moral dilemma moral dis-adjustment with regards to use of food crops, as there are millions of people starving and suffering causing by situation around the world. This is especially to the point in nations with huge populations where corn grown such as China, Brazil and Mexico (2nd, 3rd and 4th biggest firms of corn, 1st, 5th and 11th largest country populations, respectively). Some benefits are also provided from second generation type′s biofuels but the biomass requires adaptable steps and competes with food crops over arable lands in several parts of the earth. The third generation biofuels correspond to the most expectation, however lots of research still desires to be done to cut down manufacturing costs and make this type of fuel production commercially, inexpensively practicable.

The renewable resource of energy still having limitations and their technological progress refers good and bad effects. First generation biofuels lag behind as they arrive from biomass that is also a food resource in world. This causes a difficulty when there is not sufficient food to feed everyone. It is true that the 2nd generation type's biofuels come from mainly non-food biomass; although still compete with food production for land use. On the other 3rd generation type′s biofuels present the best possibility to get an opportunity for substitute fuel because they don't compete relating with food. It is found that the fourth group biofuels are more advanced than third. Algae metabolic engineering forms the basis for 4th generation biofuel production. These algae are obtained with elevated yield and along with eminent lipid surround. It has more CO_2 capture capability and high manufacture rate than other biofuels. Though, there are still some challenges in presenting them economically more viable.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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