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Mini Review

Camelina sativa Biodiesel Cope the Burning Issue of Global Worming; Current Status and Future Predictions

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Abstract

Camelina sativa possesses high potential for biodiesel and ethanol production. It has more biodiesel potential per unit area of land than many other crops with minimum usage of inputs. This is very useful for effective spring moisture utilization. Biofuels appear to be a potential alternative "greener" energy substitute for fossil fuels. About 84% savings in GHG emissions were obtained with camelina jet fuel, compared with petroleum jet fuel. This shift from fossil fuels to biofuels has the potential to reduce global warming emissions, lessen the country's dependence on petroleum import and create new jobs for rural and urban communities.

Keywords: Camelina; Biodiesel; Energy; Global warming; CO_2 emission

Introduction

Camelina sativa L. Crantz is a broad leaf flowering plant, belongs to *Brassicaceae* family [1]. Camelina plants germinate in early spring before other cereal grains. This is very useful for effective spring moisture utilization and competitiveness with weeds. It require low water and pesticides as compared to other traditional oil seed crops i.e. rapeseed, canola, soybean, sunflower and jatropha. It has an ability to thrive in cool, arid climates and nicely adapted to the water scarce areas [2,3]. The oil from camelina is not only beneficial for human health but it is also better than Jatropha oil in terms of its use as biodiesel [3]. The increasing population is thereby creating a sharp increase in the consumption of energy specifically fuel which is used to develop other energy sources. The energy crisis has witness uncertainties in two directions from the last decades. Firstly, the rising of price has the load on the economy. Secondly, the CO_2 produce during the burning of fuel cause the problem of global warming. The exploitation of various sources as alternative fuels is in high focus due to the increasing threat of depletion of fossil fuel reservoir and adverse effects on environment. Among the alternative sources, biodiesel is an important and promising resource. This shift from fossil fuels to biofuels has the potential to reduce global warming emissions, lessen the country's dependence on petroleum import and create new jobs for rural and urban communities [4]. Biodiesel is the renewable energy resource which has opened up a new horizon for using a wide range of feed stock as biofuel raw material like Jatropha and Camelina form combustion engine [5]. But Jatropha is a poisonous plant and can be utilized only for the biofuel production. Its oil is carcinogenic for human skin, the seed is poisonous for human as only 4-5 seeds ingestion is enough to cause death. Moreover, its allelepathic response and adaptability to a range of soil types and environmental conditions has made it the best available choice to change the face of agriculture in problematic soils [4,6].

Camelina sativa oil composition

Camelina oil can be used to produce low freezing point biodiesel, blends of biodiesel, or bio-lubricants that can compete with diesel products both in cost and performance [7]. The oil percentage in camelina seed is about 30-40%. The camelina oil contains 64% poly unsaturated fatty acids, 30% monounsaturated fatty acids and 6% saturated fatty acids. It also contains Omega-3 fatty acid and gamma tocopherol. Gamma-tocopherol is anti-oxidant due to which its shelf life is long. All these things make Camelina oil suitable for the edible purposes and beneficial for human health [8,9]. These beneficial

fatty acids good for heart, reduce the LDL-cholesterol level in the blood and cardiovascular health [10]. Transesterification reaction convert the Camelina oil into biodiesel.

Camelina sativa biodiesel cope the burning issue of global worming

The world energy demand has, for the last two decades, witnessed uncertainties in two dimensions. Firstly, the price of conventional fossil fuel is too high and has added burden on the economy. Secondly, combustion of fossil fuels is the main culprit in increasing the global carbon dioxide (CO_2) level, a consequence of global warming. The scarcity and depletion of conventional sources are also cases of concern and have prompted research world-wide into alternative energy sources for internal combustion engines. Biofuels appear to be a potential alternative "greener" energy substitute for fossil fuels. This shift from fossil fuels to biofuels has the potential to reduce global warming emissions, lessen the country's dependence on petroleum import and create new jobs for rural and urban communities [11]. In the present scenario, the climate shift is the major issue in the world. The environment temperature increasing due to the global warming. The scientist observed that many species endangered and going to death because it is susceptible to temperature. The estimated showed that I million species become extinct due to climate shift. The global temperature increase up to 2% due to global warming. The CO_2 concentration increase in the environment. It is assessed that the CO_2 Concentration enhanced in the atmosphere about 4.1 billion metric ton till 2020. It is the big amount which participated to enhance the greenhouse effect. The future prediction shows that the CO_2 will be 8.6 billion metric ton till 2035. The major source of carbon dioxide in the world is transport sector. It is estimated that the 4th part of CO_2 comes from this sector during 2007 to 2008 because it is major fuel consumption sector. The road transport add the 10% CO_2 in the atmosphere. In the current scenario the CO_2 emission increase day by day due the increase the number of vehicles [12]. Many scientist searching the other source of fuel reservoir due to the danger of the depletion of the fossil fuels and related problem in the environment. The alternative of fossil fuel is the biodiesel which produced from the plant oils. The camelina is the best alternative source from the all other oil seed and biodiesel crops [12]. The existing issue in the environment and depletion of fossil fuel reservoir should be tackle from the use of biodiesel in the place of fossil fuel. Biodiesel is the good alternative of fossil fuels which can be used in the engine with little modification. The biodiesel is the methyl ester which were produced chemical reaction of alcohol with oil extracted from the seeds of different plant. Biodiesel produced from the transesterification and the product which obtained were glycerol and biodiesel [12]. The potential of using vegetable oil as fuel for combustion engines [5] opened up a new horizon for using a wide range of feed stock as biofuel raw material like Jetropha and Camelina. But Jetropha is a poisonous plant and can be utilized only for the biofuel production. Its oil is carcinogenic for human skin, the seed is poisonous for human as only 4-5 seeds ingestion is enough to cause death, its negative impact in case of monocropping in flora and fauna of terrestrial and equatic life has been reported. It has been decleared the natural disaster by the environmentalist.

Therefore, it is known as hell oil. As for as the comparison of jetropha with camelina for biofuel production is concerned a detailed study in Thailand (one of the biggest grower of Jatropha) showed that camelina has the net energy ratio as high as 5.22 as compared to the Jetropha with 3.74 [10]. *Camelina sativa* have positive energy balance even for the production of biodiesel ester only (net energy ratio=1.47) whereas Jatropha has negative energy balance based on such criterion (net energy ratio=0.68). One of the myths about jetropha is that it can grow anywhere without care but studies have shown that in the initial 3-4 years it needs more irrigation water than any other cultivated crops [3,13]. The cultivation of Jetropha is not economical unless proper inputs are provided. Therefore, the world is searching alternate feed stocks and *C. sativa* is at the top of the list of various raw material for biofuel due to less input requirements and its best quality for combustion engines and emission gases. It belongs to the *cruciferacae* family. From the Roman Empire to the discovery of gas and, electricity, its oil was the favorite to be used in oil lamps and as a common edible product [14,15].

Camelina has branched smooth or hairy stems that become woody at maturity and range from 25-100cm high. Leaves are arrow-shaped, 5-8cm long with smooth edges. Each stem bears many small yellow flowers each with 4 sepals and petals. The seeds, borne in pear shaped, capsules are 0.7-2.5mm in diameter and orange to brown in colour [15]. It is adaptable to a wide range of climate and environment [16] along with the advantage of having allopathic characteristics [6]. Camelina has both summer annual and winter hardy biennial forms. It is drought tolerant and low input requiring crop. As a result, it can be shown to have a higher net return than crops such as Canola. Camelina oil can be used to produce low pour point biodiesel, biodiesel blends, or bio-lubricants that can compete with traditional petroleum products both in cost and performance [7]. In recent years *Camelina sativa* was cultivated in Austria on about 50ha set aside land as a raw material for liquid biofuel production. On good soils, 2,600kg/ha (wet weight) was harvested. Camelina, is already grown as an oilseed to a limited extent in the UK. There have been scattered hectare-ages in Europe mostly in Germany, Poland, Montana (USA) and the USSR. Sustainable Oils, Inc. (a joint venture between Targeted Growth, Inc. and Green Earth Fuels) is a producer and marketer of renewable, environmentally clean, and high-value Camelina-based biodiesel fuel. Camelina biodiesel has been produced and evaluated by many commercial biodiesel manufacturers. Camelina biodiesel performance appears to be equal in value and indistinguishable from biodiesel produced from other oilseed crops such as soybean [17]. A European Union study demonstrated that camelina seed oil produced a maximum power at the road wheels of 43.25KW and returned 12.57Km/L compared to 38.50KW and 14.03Km/L for mineral oil. At an engine speed of 2000rpm and high loading, Camelina seed oil was found to produce 50% less CO_2 and smoke opacity than mineral oil emissions [4]. Camelina jet fuel exhibited

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one of the largest greenhouse gas (GHG) emission reductions of any agricultural feedstock-derived biofuel. About 84% savings in GHG emissions were obtained with camelina jet fuel, compared with petroleum jet fuel [18]. The biofuel derived from C. sativa has recently proved its worth in driving the Japan Airlines test flight for one hour. The blend of biofuel used in this test flight was 84% camelina, 16% jatropha, and less than one percent algae [19].

Current status

In recent years *Camelina sativa* was cultivated in Austria on about 50ha set aside land as a raw material for liquid biofuel production. On good soils, 2,600kg/ha (wet weight) was harvested. Camelina, is already grown as an oilseed to a limited extent in the UK. There have been scattered hectare in Europe mostly in Germany, Poland, Montana (USA) and the USSR. Approximately 50,000 acres are currently cultivated in Canada [20]. The Camelina Association of Canada projects Canada estimates that 1 to 3 million acres could be planted in the future. Several factors challenge the spread of camelina cultivation in Canada: it does not have government crop classification, and camelina meal is not approved as livestock feed. In early 2010, Health Canada approved camelina oil as a food in Canada [3]. In 2014, camelina was included for the first time in Canada's Advance Payments Program (APP), commonly known as the cash advance program [21,22].

Concluding remarks and future predictions

World faced repeated fuel and energy crisis. With the exception of hydroelectricity and nuclear energy, majority of the energy needs are met through petrochemical sources, coal and natural gas. All of these sources are finite and at certain usage rate will be consumed by the end of next century. A huge amount of foreign exchange is spent to fulfill the fuel requirements of the country. The need for fuel is draining our economic reserves causing high inflation rate and demand is increasing by each passing day. The increased demand of fuel has given birth to another problem of high electricity rates and load shedding which is swallowing up our industry at a terrible rate. This regrettable situation requires special and immediate attention both from researchers and from higher authorities. In order to solve the problem of high priced fuel there is need to explore alternative sources. World is diverting from high priced pollution producing fossil fuel to the alternate renewable energy resources like biofuel. Scientists throughout the world are exploring different feed stocks to be used as raw material for biofuel. *Camelina sativa* is one of the raw materials for biofuel production. Biodiesel has arisen as a potential candidate for the diesel substitute due to the similarities, it has with petroleum based diesel. Developing renewable energy is national strategy of developing country like Pakistan, India and Bangladesh, which does not have plentiful fossil oil deposits. This big developing country with rapid economic growth needs more energy than before. The oil sector is looking for indigenous sources to reduce its dependence on imported crude oil and there can be no better source than biodiesel. The list of various raw materials for biofuel production is increasing day by day ranging from bacteria, algae, Jetropha to the maize. The major concern attached to the biofuel production in a developing country like Pakistan is that how can we sacrifice our agriculture land, resources and edible feed stocks to produce biofuel instead of food commodity which is already scarce. For that Pakistan has vast areas which are not cultivable including sea shores, desserts, saline, waterlogged soils and marginal lands. These areas can be utilized for the cultivation of a hardy low input requiring biodiesel feed stock like *Camelina sativa*. Its production cost is almost half as compared to other oilseed crops. C. sativa is getting more attention as biofuel feed stock worldwide due to its hardy nature capable of cultivation without supplemental irrigation and fertilizer with better oil quality and contents than canola and soybean. The plant appears very adaptable to climate and soil type, it has been shown to be allopathic. It may change the face of agriculture in problematic soils and the land, which is useless due to harsh environment and the non-availability of the water especially in rain fed areas and the Cholistan.

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