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Utilization of bioresources for sustainable biofuels: A Review

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ABSTRACT

The global energy demand has been increasing rapidly due to depletion of fossil fuels, continuous growth of world population and industrialized economy. India has surpassed to Japan and Russia and become the third largest oil consumer in the world. Unfortunately, India's primary energy consumption has increased due to reduced oil and gas production. The increased consumption of imported oil could lead to turbulence in economic growth. Due to increasing demand of oil fuels and consequent impact of global warming issues, development of alternate energy is a top priority in research and developments sector. The bioenergy produced from the biomass is being a sustainable alternate energy source which received high acceptance in various sectors include public, industries and government policies. from the Government, public, industries and researches for its sustainability. This review focuson bioprospecting of biomass from terrestrial and marine resources for non conventional energy production and the stepping stones of biofuel for near future. These carbohydrates can be converted into various forms of biofuels either directly or indirectly by exploiting microorganisms. However, the production process and chemical transformation is being an expensive process and therefore commercial supply of biofuel in largescale is not yet successful. Hence an economic and efficient production process is essential to commercialize biomass based biofuels. This article highlights the overview of sustainable and renewable resources for biofuel and stepping stones of biofuel commercialization.

1. Introduction

1.1. Over view of Biofuel

In current situation fossil fuel is being a primary energy and its contribution around 80% in which transport sector takes share of 58% [1]. The sources of these fossil fuels and oil reserves are depleting very fast and they are found to be major contribution for emission of harmful gases. These gases leads to negative effects like, receding of glaciers, loss of biodiversity, climate change, rise in sea level, etc. High demand for this fossil fuel is also affecting the global economic activities as there is increase in the prices of crude oil. The high-speedy modern world travels by both industrialization and motorization and it is being a main cause for the unpredictable fuel demand [2]. Many alternative energy sources have been already available include biofuels. Researchers are continuously working in the biofuel production from the sustainable biomass since it is being an efficient alternative to replace non renewable fuels [3].

The advantages of biofuels over petroleum fuels are (a) they can be easily extracted from the biomass, (b) they are sustainable due to biodegradable property, (c) its combustion based on carbon-dioxide cycle, (d) more environment friendly. The share of biofuel in automobile market will grow rapidly during the next decade because of its environmental merits. This will definitely result strong growth in agriculture sector for more production and associated by-products [4,5].

Biofuels which are produced predominantly from biomass are referred to solid, liquid and gaseous fuels. The biofuels are classified into three generations as first, second and third based on the chemical and complex nature of the biomass. The first generation fuels, biodiesel and vegetable oils has been produced from the crop plants and the second, bioethanol and biohydrogen has been produced from agricultural by-products and energy plants which requires fertile lands for growth. The marine resources, seaweeds and cyanobacteria are attractive sources for the third generation biofuels production (biogas, bioethanol and biobutanol) as they produce large biomass in a stipulated time period and it doesn't require land for growth [5,6].

Biomass has been reported as a fourth largest available energy resource of the world [7]. Biomass can also be referred as natural and inexpensive form of storage device for energy and that energy could be utilized at any time [8,9]. The current annual availability of biomass in India is estimated around 500 million metric tons, which includes

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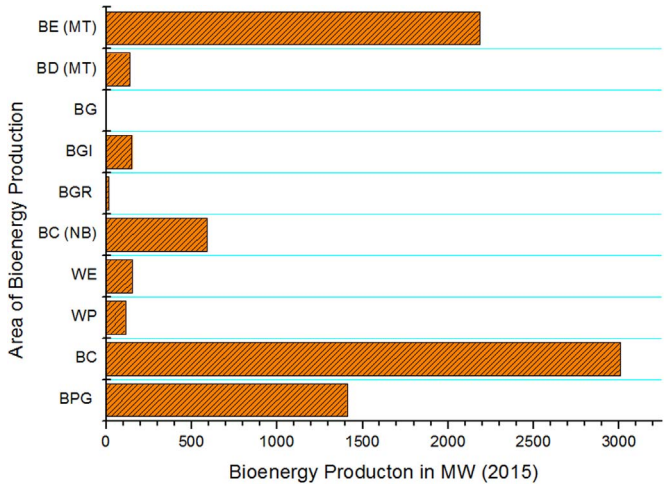

Fig. 1. Bioenergy production prospects from biomass utilization in India. Note: BE-Bioethanol, BD-Biodisel,BD-Biodisel, BG-Biogas, BGI-Biomass gasifier industrial, BGR-Biomass gasifier rural, BC (NB)-Biomass cogeration Non bagasse, WE-Waste to energy, WP-Waste to power, BC-Biomass cogeneration, BPG-Biomass power and gasification, MW-Megawatts, MT-Million tons.
Source: India Biofuel Annual 2015 [18].

Table 1.
Biomass generated from main agricultural crops in India.
Source: Agricultural Research Data Book 2016 (http://www.iasri.res.in) [17]

Crop	Biomass residue Million tons (2009-15)	Biomass average Million tons (2009-15)
Rice husk	303	50.5
Wheat straw	719.4	119.9
Maize cobs	39.1	6.51667
Pearl millet Straw	74.8	14.96
Sugarcane bagasse	675.3	112.55
Coconut shell	12.5	2.5
Coconut fiber	15.1	3.02
Coir pith	22.7	4.54
Groundnut shell	13.8	2.3
Cotton stalks	171.6	34.32
Jute sticks	13.2	2.642

agricultural and forest biomass and the energy potential of this biomass is estimated at around 18,000 MW [10]. In India the bioenergy production achieved from biomass was shown in Fig. 1. The researchers are finding the effective way to grasp the potential energy saved in the biomass though the mechanism of energy transfer mechanism is not appropriately exhibited yet. Tones of biomass generated from industry, forest, agricultural, marine and urban solid waste are decaying with uncontrolled mechanism and leading to environmental problems by unpredictable toxic gas emission [7,11,12]. The biomass generated from major agricultural crops of India is listed in Table 1. The effective utilization of these renewable resources would leads direct benefits as reducing GHG via utilizing the green fuels, reducing environmental pollutions, improving rural economy [13,14]. Of late, biorefineries or biomass refineries have been reported to produce the required energy (direct electricity generation in combined cycles), fuels (liquid bio-fuels), and chemicals (platform hydrocarbons extracted from biomass using an assortment of processing techniques) with less ecological foot prints [15].

Production of biofuels predominantly dependent on terrestrial plants, which have the limitation of cultivable land exploitation, marine biomass include seaweeds are new sources of biofuel feedstock produces highest percentage of biomass productivity in lesser time and therefore such bioresources can be exploited for renewable biomass based energy production. The various terrestrial and marine resources for sustainable and renewable resources for biofuel production are listed in Table 2.

The photosynthesis fuel has been initiated as another blooming field of biofuels. The plants and algae effectively utilizes the atmospheric CO_2 and stored the energy as biomass which be converted in to any form of energy in reverse. The photosynthetic microbe cyanobacteria has the ability to convert the CO_2 directly into ethylene a fuel chemical without production of biomass. The NREL research team developed genetically engineered cyanobacteria for hyper production of ethylene [16].

1.2. Global view

Globally, it has been observed that for future energy systems the estimates of biofuels are very high. If the share of biofuel in automobile market reaches to its maximum then the availability of bioresources for

Table 2:
Various terrestrial and marine resources for renewable and sustainable energy.

Terrestrial resources		Marine resources	
Energy Plants	Agricultural by-products	Macroalgae Seaweeds	Microalgae
Jatropha	Oil palm shells	*Acrosiphonia orientalis*	*Scenedesmus obliquus*
Switchgrass	Pineapple waste	*Ulva fasciata*	*Nannochloropsis oculata*
Alamo – WP	Forest (logging) residues	*Ulva lactuca*	*Dunaliella tertiolecta*
Alamo – leaves	Coir pith	*Enteromorpha compressa*	*Phaeodactylum tricornutum*
Alamo – stems	Sugarcane bagasse	*Caulerpa peltata*	*Tetraselmis suecica*
Blackwell – WP	Empty fruit palm bunches	*Valoniopsis pachynema*	*Chaetoceros calcitrans*
Cave-in-Rock – WP	Oil palm fronds	*Bryopsis pennata*	*Isochrysis galbana*
			Botryococcus brauni
Cave-in-Rock – WP (high yield)	Coconut husk	*Enteromorpha intestinalis*	*Chalmydomonas reinhardtii*
Cave-in-Rock – leaves	Soybean hulls	*Caulerpa racemosa*	*Euglena* sp.
Cave-in-Rock – stems	Corn stover	*Caulerpa sertularioides*	*Spirogyra* sp.
Kanlow – leaves	Wheat straw	*Padina tetrastromatica*	*Phormidium* sp.
Kanlow – stems	Oil palm fibers	*Dictyota adnata*	*Cyanobacteria*
Trailblazer	Oil palm trunks	*Lobophora variegata*	
Silver grass	Silk cotton	*Sargassum wightii*	
Bermuda grass	Rice husk	*Spatoglossum asperum*	
	Banana residues	*Centroceras clavulatum*	
	Paddy straw	*Gelidium pusillum*	
	Reed	*Grateloupia filicina*	
	Rapeseed	*Asparagopsis taxiformis*	
		Gracilaria corticata	