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# Sustainable Biofuels

*Opportunities and Challenges*

A volume in Applied Biotechnology Reviews

Book - 2021

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# About the book

## Description

Sustainable Biofuels: Opportunities and challenges, a volume in the "Applied Biotechnology Reviews" series, explores the state-of-the-art in research and applied technology for the conversion of all types of biofuels. Its chapters span a broad spectrum of knowledge, from fundamentals and technical aspects to optimization, combinations, economics, and environmental aspects. They

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## Key Features

Covers current technologies and advancements in biochemical, thermochemical, and hydrothermal conversion methods for production of various types of biofuels from conventional and nonconventional feedstock

Examines biotechnology processes, including genetic engineering of microorganisms and substrates, applied to biofuel

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# Details

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# Algal biofuels—technologies, scope, opportunities, challenges, and applications

16

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## 16.1 Introduction

The world energy reliance on fuel now stands at approximately a whopping 70% of the total global energy demand(s). Therefore developing other sustainable alternative $CO_2$ neutral fuels is an urgent need for researchers, policy makers, and manufacturers. This is due to the increase in the global warming and consequential climatic changes associated with the use of primary fossil fuels (Gouveia, 2011). The effects of global warming have made it imperative to rethink the concepts of environmental and economic sustainability with technological approach. In developing countries, most of the current biofuels are derived from feedstocks of human food crops that may then lead to food shortages (Ray and Ramachandran, 2018). In this aspect, algal biofuels can be considered as the alternative fuels in the current bioenergy economy, which can be produced from micro or macroalgae through an integrated biorefinery technology approach (Chandra et al., 2019).

Different bioenergy feedstocks have been classified into four generations: first generation (1G), second generation (2G), third generation (3G) and fourth generation (4G) (Azad et al., 2015, 2016). Algal biomass is coming under the third-generation feedstocks that have already proved to be comparative in recent times to overcome the challenges associated with 1G and 2G feedstocks (Behera et al., 2015). Algae are very diverse and often possess many possibilities; however, they have other applications in the production of animal feeds, biofertilizers, wastewater treatment, pollution control, and human nutrition (Choi et al., 2012; Kligerman and Edward, 2015). Due to their abundance and renewable nature, algal biomass has been seen as an excellent alternative substrate for the production of several value-added products (Kumar et al., 2020). Due to the growth of algae in brackish, saline, and wastewater, they are considered as the most promising feedstocks than the terrestrial crops that mainly depend on fresh water (Daroch et al., 2013; Beal et al., 2015; Acien et al., 2017). Several biofuels such as bioethanol, biobutanol, biogas,

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# BIO-CIRCULAR ECONOMY: OPPORTUNITY FOR DIVERSIFICATION FOR SUGAR MILLS IN WASTE TO ENERGY (BIOFUELS) FIELD: COMPRESSED BIOGAS (CBG) AND ORGANIC FERTILIZER

Sanjay Patil[1], Sukhendra Singh, Shuvashish Behera and Kakasaheb Konde

***ABSTRACT***

*Press mud cake (PMC) is one of the world's most abundant sugarcane based wastes and in an Indian context 8-10 million tonnnes per annum is produced. The current use of PMC is restricted to use as filler material in bio-composting process or directly as fertilizer to improve soil fertility without any previous recovery of value-added products. However, considering its potential, only fertilizer use is not the best valorization route. Due to lack of transportation, press mud is unused and left in piles in most sugar mills, leading to blockage of drains and becoming a cause of water pollution. At the same time increasing consumption of fossil fuels and environmental concern has led to increased use of compressed natural gas (CNG) in the transportation sector. Keeping in view limited resources of CNG, biogas is advised as potential fuel to provide continuous supply of CNG in the form of bio-CNG or Compressed Biogas (CBG). Therefore, to decrease the imports of crude oil and natural gas requirement and to increase the economic sustainability of sugar mills, utilization of wastes (spent wash and PMC) for biogas production through anaerobic digestion (AD) and further purification to produce CBG (a purified form of Biogas) will definitely generate additional revenue for sugar mills in India. This paper aims to produce a strong outlook on the importance of CBG production through anaerobic digestion and its purification. Further, an out sketch of five models have been designed showing the possibility to produce maximum CBG using existing biogas plant (sugar mill complex) with addition of a new biogas plant. Production of value added CBG and recycle of digestate on organic fertilizer is a perfect case of bio-circular economy.*

## INTRODUCTION

India has a total reserve of 763 Million Metric Ton of crude oil and 1,488 Billion Cubic Meter of natural gas (Ministry of Petroleum and Natural Gas, GoI). The country currently imports nearly 77% of its crude oil requirement and about 50% of natural gas requirement, compelling the GoI to set a target of reducing this import by at least 10% by 2022. Further, it has set a target of increasing the contribution of gas in India's energy mix from existing 6.5% (global average is 23.5%) to 15% by 2022. GoI would like to promote waste / biomass sources like agricultural residue (sugarcane trash), cattle dung, sugarcane press mud cake (PMC), municipal solid waste and sewage treatment plant waste, etc. for production of biogas through the process of anaerobic decomposition (Buraimoh et al. 2020; Sarker et al. 2017).

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The common forms of chromium found in nature are trivalent chromium Cr (III) and hexavalent chromium Cr (VI). Hexavalent Chromium is highly toxic and carcinogenic. It is extensively being used electroplating, glass, ceramics, fungicides, rubber, fertilizers, tanning, mining, metallurgical etc. Its ability to react with other elements makes hexavalent chromium a health hazard. Cr (VI) is highly mobile and is considered acutely toxic, carcinogenic and mutagenic to living organisms, and hence more hazardous than other heavy metals. The tanning process is one of the largest polluters of chromium all over the world. Present investigation was an attempt to find low-cost hexavalent chromium adsorption using different saw dust in a lab-scale adsorption column. Results indicated 94.1%, 66.04%, 88.03% and 80.04% reduction of chromium concentration by Sakhu (Shorea robusta), Sheesham (Dalbergia sissoo), Eucalyptus (Eucalyptus globules) and Mango (Mangifera indica) saw dusts respectively; at 25oC and retention time of 40 minutes with flow rate 0.1 mL/sec.

**Keywords:** Hexavalent Chromium, Saw dust, Adsorption, Adsorbent, Electroplating.

## Estimation of workplace particulate pollutants in sugar industry

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Workplace air pollution is more harmful and poses greater health hazards because on an average, a person spends nearly 8 to 12 hours at workplace. Even though workplace air pollutants are usually the same as the outdoor ones and are emitted in smaller quantities, they are more significant. This is because cannot escape easily due to lack of proper ventilation and thus their concentration often reaches higher levels as compared to outdoor pollutants. Sugar industry is the second largest agro-based industry in India and it is a major source of livelihood for people living in rural areas. There are many processes in sugar industry which emit fugitive emissions of particulate matter at various locations such as packing house, mill section, bagasse yard, etc. In the present study, the work place air was sampled from sugar packing house, mill area, bagasse yard, ash handling unit, sugar godown from two sugar mills in Maharashtra. The PM10 value in at most sampling locations exceeds the standard prescribed by NAAQS and OSHA. It is concluded that, PM10 values are higher at mill section, sugar godown & packaging house and efforts need to be taken to reduce these.

**Keywords** – Sugar industry, particulate matter, workplace, NAAQS

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**Application of phenomics to differentiate response of sugarcane genotypes to depleting soil moisture and bio stimulants**

Vinay Hegde[1*], Debasmita Mohanty[2], Madhavi Sonone[4], Shubhangi Maraskole[4], Himaj Deshmukh[2], Rohit Babar[2], Krishna Jangid[2], Lalit Aher[2], Neeru Jain[5], Sunil Dalvi[3], Tarasingh Rathod[1], Jagadish Rane[2**]

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The occurrence and magnitude of abiotic stresses are increasing due to global climate change. Among the various abiotic stresses, the drought, featured by depleting soil moisture, is major limiting factor for productivity of crops including sugarcane. In addition, it is necessary to minimise water consumption in sugarcane, the major driver of rural economy of the nation. This can be achieved through both the genetic improvement and the resource management approaches. In this context, bio stimulants are gaining importance due to their potential to alleviate soil moisture stress in plants. Hence, experiments were planned to employ high throughput phenomics protocols to assess the threshold of soil moisture tolerance of sugarcane during soil moisture depletion in three genotypes of sugarcane viz., Co 86032, CoM0265, VSI 08005. Images acquired through high resolution (visible range), thermal (IR) and Near InfraRed (NIR) imaging systems at National Plant Phenomics Facility at ICAR-NIASM were analysed to assess stress responses of shoots. Image parameters that could differentiate the treatment effects were selected to determine the threshold of stress tolerance and to identify promising bio stimulants. The phenomics protocol could help in identifying the most resilient genotype and bio stimulant non-invasively. Chitosan and silixol, used as bio stimulants, could help in enhancing threshold level of tolerance by retaining high tissue water content and absolute green area in plant. This study suggested that the green leaf area, brown leaf area, dry leaf area and yellow leaf area out of more than forty image parameters assessed, could reveal the threshold of stress tolerance of different genotypes of sugarcane and also the efficacy of bio stimulants in alleviating moisture stress at initial growth stages.

# Sugarcane Transgenics: Developments and Opportunities

K. Harinath Babu, R. M. Devarumath, A. S. Thorat, V. M. Nalavade, Mayur Saindane, C. Appunu, and P. Suprasanna

**Abstract**

Sugarcane is an important, commercial crop with potential industrial and bioenergy perspective. Despite considerable advancements in varietal improvement made using conventional breeding programmes, further genetic improvement of elite sugarcane genotypes is necessary. However, genetic improvement is restricted due to the genetic complexity, low fertility, non-flowering nature, and long duration of the crop. In this context, sugarcane biotechnology offers a valuable tool to introduce commercially important traits into elite genotypes. Redesigning of sugarcane varieties with tolerance to biotic (pathogen and insect pests), abiotic stresses (herbicide, drought, salinity, salt, etc.) and quality parameters (sucrose accumulation) by using genetic engineering offers a better way for tailoring the genetic architecture of plants. Advanced methodologies are now available to generate transgenic sugarcane with novel genes for desirable agronomic attributes. Genetically modified sugarcane has been approved for commercial cultivation in Indonesia and Brazil, and in other countries, transgenic products are in different stages of field trials and/or commercialization. These include transgenics with genes conferring resistance to diseases and pests, salt and drought tolerance, and high sucrose or herbicide tolerance. Sugarcane is also considered as a "biofactory" for the production of high-value bioactive com-

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