Technical Performance of VSI Member Distilleries in Maharashtra

Financial Year 2021-22 and 2020-21

SEAL OF THE VASANTDADA SUGAR INSTITUTE, PUNE
VSI
संशोधनेन संवृद्धिः

Principal
Vasantdada Sugar Institute
Manjari (Bk.), Tal. Haveli,
Dist. Pune - 412 307

VSI
संशोधनेन संवृद्धिः
ISO 9001:2015

VASANTDADA SUGAR INSTITUTE

Manjari (Bk.), Pune 412 307, Maharashtra, India

ISBN : 978-81-934198-2-3

3 Biotechnological Intervention in Sugarcane: Progress Made So Far

Gauri Nerkar and Madhavi Purankar
Molecular Biology and Genetic Engineering Laboratory, Vasantdada Sugar Institute, Pune, Maharashtra, India

Suman Devarumath
Vidya Pratishthan's College of Agricultural Biotechnology, Baramati, Maharashtra, India

Rachayya Devarumath and Harinath Babu
Molecular Biology and Genetic Engineering Laboratory, Vasantdada Sugar Institute, Pune, Maharashtra, India

CONTENTS

3.1 INTRODUCTION

Sugarcane (*Saccharum officinarum* hybrids) is an important sugar and biofuel-producing crop contributing to more than 80% of the world sugar production and approximately 40% ethanol production. It is C4 grass with high biomass content, growing in tropical and subtropical regions of the world. Sugarcane has a polyploid-aneuploid genome (2n= 100–130), and the cultivated sugarcane varieties are *Saccharum officinarum* hybrids arising from interspecific crosses between *Saccharum officinarum* and *Saccharum spontaneum*; with major contribution from the *Saccharum officinarum* (D'Hont et al. 1996). Sugarcane genome also has the contribution from its wild relatives *viz.S. robustum*, *S. sinense*, *S. barberi* and related grass genera such as *Erianthus*, *Miscanthus*, and *Narenga* (Daniels and Roach 1987). The conventional breeding programs have successfully developed elite cultivars with superior agronomic traits, such as high sugar content, high yield, resistance to pests and diseases, as well as improved ratooning ability (Ming et al. 2006). But, the breeding programs are often difficult and time-consuming due to the complex nature of sugarcane genome, low fertility, and narrow genetic base (Altpeter and Karan 2018; Nerkar et al. 2018). The biotechnological tools, like mutation breeding, marker-assisted selection,

DOI: 10.1201/9781003292425-3

MAKING INVERT SUGARCANE SYRUP: AN ALTERNATIVE SUBSTRATE FOR ETHANOL PRODUCTION IN SUGAR AND ALLIED INDUSTRIES

Shuvashish Behera, Tejaswini Patil, Sanjay Patil and Kakasaheb Konde*

ABSTRACT

Diversification of the product portfolio of sugarcane biorefineries through the use of sugarcane syrup for the production of ethanol through out the year will provide significant economic return to the Sugar and Allied Industries and further promote their economic competitiveness. Therefore, study was carried out to enhance the inversion efficiency (%) through optimizing different parameters like acid concentration, enzyme concentration, temperature and reaction time for sugarcane juice inversion. With the optimized conditions, it was possible to get 100% inversion efficiency at 120 min and 350 min reaction time, respectively for acid and enzyme method. It was also possible to get 93.47% inversion efficiency at 550 min reaction time through invertion of sugarcane syrup containing 60% of sucrose concentration. Further the syrup could be stored upto 10 Months of duration which is a good sign for Industries for its use during off-season for ethanol production.

Key words: Inversion; Sucrose; Sugarcane juice, Sugarcane syrup; Hydrochloric acid; Invertase; Glucose; Fructose.

1. INTRODUCTION

India currently ranks second in cultivation area (5.228 million ha) and sugarcane production (363.66 million tonnes) next to Brazil. Sugarcane being a rich source of sucrose (~10%), accounts for approximately 80% of global sugar production. In India, sugar cane juice can be the sources of sugar for fermentation into ethanol (de souzaet *al.*, 2015). Govt. of India have allowed for 1G ethanol production using sugarcane juice to achieve target of 10% blending of fuel ethanol with petrol by 2022 and 20% blending by 2025. However, sugarcane juice to ethanol production is fully dependent on the sugarcane harvesting season (October to April). Therefore, the hypothesis for concentrating sugarcane juice and making inverted sugarcane syrup with the help of acid or enzyme arises which usually make up to 75% of sucrose concentration in sugarcane syrup. The concentrated and inverted syrup can be stored and used in the off-season by the Sugar and Allied Industries for ethanol production. Inversion of sucrose present in cane juice is most economical method of producing equimolar mixtures of glucose and fructose (Nadeem *et al.*, 2015). Also, as per the literature, concentrated syrup cannot be easily attacked by the microbes which is a good sign for its storage. This thought process helps Industries to produce ethanol throughout the year.

* Corresponding Author, Email address: kakasaheb.konde@gmail.com; Department of Alcohol Technology and Biofuels, Vasantdada Sugar Institute, Manjari (Bk.), Pune-412307, India

Recovery of potash from incineration boiler ash

P Nikam, AB Deshmukh, D Abhale[1], KS Konde, K Bapat[2] and SV Patil
Department of Alcohol Technology and Biofuels, VSI
[1]KS Kale SSKL, Kolpewadi [2]O/o PSA to GoI, New Delhi

Introduction

Potassium (K) is one of the 17 essential nutrients required by plants for growth and reproduction. Like nitrogen (N) and phosphorus (P), potassium is classified as a macronutrient There are multiple potassium fertilizer sources, such as muriate of potash (KCl), sulfate of potash (K_2SO_4), double sulfate of potash and magnesium (K_2SO_4 $2MgSO_4$), and nitrate of potash (KNO_3). Potassium chloride (Muriate of Potash) accounts for most of the potash use in agriculture all over the world. It represents 96% of the world potash utilization. Potassium sulphate (Sulphate of potash), potassium nitrate and potassium-magnesium salt (Sulphate of potash magnesia) accounts for remaining potassium compounds. In addition to potash, these potassium salts also provide other essential nutrients. About 95% of potash produced worldwide is used in agriculture and remaining amount is used in several other industrial applications such as glass manufacturing, soaps manufacturing, plastics and pharmaceuticals etc.

India imports all potash for its fertilizer requirements. India is the second biggest consumer of nitrogenous and phosphate fertilizers (14.1% and 14.5% respectively of world consumption in 2012). India is the fourth biggest consumer of potassium fertilizers after China, Brazil and USA (7 % of world consumption in 2012). The global potash fertilizer industry turnover was around US$34 billion in 2014. India meets its Potassium chloride (commonly referred to as Muriate of Potash or MOP) requirements completely through imports from Canada (23%), Russia (22%), Belarus (15%), Israel (15%), Jordan (11%) and Lithuania (10%). MOP imports have increased by 26.8%.

In India, Sugar and allied industries generate significant amount of biomass waste such as press mud cake, bagasse and spent wash etc. It is very essential to dispose industrial waste without affecting human settlement, environment agricultural land and water bodies. Bagasse and concentrated spent wash is mainly used as a biomass fuels in incineration boiler for steam & power generation in the sugar and allied industries. To achieve Zero liquid discharge (ZLD) in distillery, incineration boilers are used to incinerate spent wash along with supplementary fuels (coal, bagasse, rice husk, etc.). Incineration process is controlled burning of materials at temperatures typically over 850 °C in the presence of air. Incineration can reduce solid waste to 85- 90 % of initial volume, or 65 –80 % initial weight. Incineration boilers generate huge amount of ash. Incineration boiler ash contains high levels of non-degradable elements such as potash salts, which have potential as crop fertilizers. Table 1. indicates the typical composition of incineration boiler ash

Table 1: Typical composition of incineration boiler ash

Combined ash analysis	
Parameters	**Values**
pH (5 % solution)	9.71
Moisture (%)	28.28
Total Nitrogen as N (%)	1.01
Total Phosphorus as P2O5 (%)	0.91
Total Potassium as K2O (%)	9.7
Organic Carbon (%)	1.47
Iron as Fe (%)	1.54
Calcium as Ca (%)	2.05
Magnesium as Mg (%)	3.48
Sulphur as SO4 (%)	8.58
Silica (%)	52.75
C : N ratio	15:01

ESP ash analysis	
Parameters	**Values**
pH	9.54
Conductivity (mS/cm)	57.10
TDS (g/L)	74.00
Potassium (K) (g/L)	32.83
Sulphate (SO4) (g/L)	11.54
Chloride (Cl) (g/L)	26.32
Potassium sulphate (K2SO4) (g/L)	20.98
Potassium chloride (KCl) (g/L)	55.41
Nitrogen (N) (g/L)	
Phosphorus (P) g/L)	-
Sodium (Na) g/L)	0.006
Magnesium (Mg) g/L)	-

Assesment of different hydrogen technologies

P Nikam, VP Ghule, AB Deshmukh, KS Konde and SV Patil
Department of Alcohol Technology and Biofuels, VSI

* *

Introduction

Hydrogen is one of the clean fuel options for reducing motor vehicle emissions. Hydrogen is not an energy source. It is not a primary energy existing freely in nature. Hydrogen is a secondary form of energy that has to be manufactured like electricity. It is an energy carrier. Hydrogen has a strategic importance in the pursuit of a low-emission, environment-benign, cleaner and more sustainable energy system. Combustion product of hydrogen is clean, which consists of water. Hydrogen has very special properties as a transportation fuel, including a rapid burning speed, a high effective octane number, and no toxicity or ozone-forming potential. It has much wider limits of flammability in air than methane and gasoline. This paper explores types of various methods of hydrogen production and their suitability for sugar industry.

Government of India (GoI) announced a "National Hydrogen Mission to make India a Global Hub for Green Hydrogen Production and Export", boost "energy self-reliance" and "inspire" "Clean Energy Transition all over the world" through Green Growth" and "Green Jobs" on August 15, 2021. The Ministry of Power announced on 17 February 2021 "phase one" of the policy, listing the initiatives for facilitating the manufacture of Green Hydrogen.

The source of energy and the production method used to make molecular hydrogen determines whether it is classified as grey hydrogen, blue hydrogen or green hydrogen. Table 1 shows the classification of different types of Hydrogen.

Table 1: Classification of different types of Hydrogen

Grey Hydrogen	Blue Hydrogen	Green Hydrogen
Hydrogen which is generated by combustion of fossil fuels such as natural gas is called grey hydrogen.	Hydrogen which is generated from non-renewable energy sources is called blue hydrogen.	Hydrogen which is generated using renewable energy sources is called green hydrogen.
High greenhouse gasses emission	Moderate greenhouse gases emissions	Low to zero greenhouse gas emissions
Generated from fossil fuels	Generated from nuclear power	Generated from solar or wind power

Different technologies for production of Hydrogen

Steam-Methane Reforming

Most hydrogen produced today is made via steam-methane reforming (using methane from fossil fuel source i.e. Natural gas), a mature production process in which high-temperature steam (700°C–1,000°C) is used to produce hydrogen from a methane source, such as natural gas. In steam-methane reforming, methane reacts with steam under 3–25 bar pressure in the presence of a catalyst to produce hydrogen, carbon monoxide, and a relatively small amount of carbon dioxide. Steam reforming is endothermic.

Subsequently, using water-gas shift reaction, the carbon monoxide and steam are reacted in presence of a catalyst to produce carbon dioxide and hydrogen. In a final process using pressure-swing adsorption, hydrogen gas is purified. Steam reforming can also be used to produce hydrogen from other fuels, such as ethanol, propane, or even gasoline.

Critical investigations in sugar juice to ethanol production

KS Konde

Department of Alcohol Technology & Biofuels, VSI

* *

Introduction

The sugar industry is passing through a very significant transformation in view of increasing sugar stocks and proactive steps have been taken by the Government of India to maximize the production of ethanol. Government of India (GoI) took a policy decision to continue ethanol blending programme (EBP) and has fixed target of 10% blending of fuel ethanol with petrol by 2022 and 20% blending by 2030. Now, it has been preponed it to 2025. The policy decisions taken by GoI will provide new opportunities to the sugar and distillery industry in the country. Government of India has taken decision in allowing fuel ethanol production from sugarcane juice/syrup, B-heavy molasses, sugar and damaged grains and has also offered attractive prices for fuel ethanol produced from various feedstock. Enhancing ethanol production using sugarcane juice and/or B-heavy molasses can help to reduce the sugar stock and increase the availability of fuel ethanol for blending with petrol. In year 2020-21, total 332 crore lit ethanol supplied to oil marketing companies (OMCs) for EBP (8.5 % ethanol blending in petrol) and diverted 1.84 million metric ton (MMT) of sugar. Maharashtra has supplied almost 80 crore liter of ethanol to OMCs and diverted 0.63MMT of sugar for ethanol.

To achieve 20% blending by 2025 and meet the requirement of industrial & potable purposes about 12000 million liters of alcohol would be required (Table 1). Out of which 9000 million liters would be required to achieve blending and 3000 million liters would be requirement of industrial & potable sectors. Out of total requirement of 12000 million liters, 6600 million liters is required to be supplied by sugar industry and another 5400 million liters need to be supplied by grain based distilleries.

In India, sugar mills have larger capacities and comparatively distillery capacities are smaller. To exploit the opportunity offered by GoI, it would be necessary to shift over to the Brazilian model where the distillery capacities are comparatively higher allowing easy diversion of sugar to ethanol production. To meet demand of ethanol in molasses based distillery, distillery need to utilize sugarcane juice/syrup as a feedstock due to limited availability of molasses.

As far as quality of feedstock with relation to its fermentability is concerned, sugarcane juice/syrup the cleanest feedstock. It is possible to achieve higher alcohol concentration in fermented wash. The quantities of spent wash generated from this feedstock are less and characteristics are quite dilute in terms of BOD/COD as compared to C-molasses/B-heavy molasses spent wash.

Sugarcane juice/syrup as feedstock provides few opportunities, however there are few challenges in utilizing it for ethanol production. In this paper, critical investigations are done for sugarcane juice/syrup as a feedstock for ethanol production.

Sugar juice/syrup options

Sugarcane juice/syrup can be utilized for ethanol production as sugarcane juice (12 to 15° brix) or sugarcane syrup (25-30° brix) and syrup (55-60° brix). Depending on type of sugarcane juice or syrup used, fermentation, distillation and effluent treatment performance will get affected.

Fermentation

In case of sugarcane juice (12 to 15° brix), alcohol concentration achieved in fermented wash will be 6-7% and spent wash generation will be 12-13 L/L alcohol. There will be no spent wash

Opportunity for increase in biogas yield by pre-treatment of spent wash by cavitation technology: a case study

MS Gharge[1], RV Burase[2], S Ranade[3], KS Konde[2], SV Patil[2]
[1]Aurangabad Distillery, Walchandnagar
[2]Department of Alcohol Technology and Biofuels, VSI
[3]Vivira Process Technologies Pvt. Ltd

Introduction

Over 55 % of global sugarcane production of ~1850 million tonnes (FAO-UN, 2017) was contributed by the top two producers, Brazil and India. Sugar is the primary product extracted from cane, however there are other by-products such as bio-ethanol using fermentation, and waste streams that are generated by the end of its life cycle. Indian distilleries mainly use sugarcane molasses as a preferred substrate for alcohol production due to its availability. During the alcohol fermentation process, large amounts of freshwater is used. Consequently, this process generates distillery wastewater, otherwise also known as spent wash, in the range of 10-15 m^3/m^3 alcohol produced, with the maximum permissible limits being 15 m^3/m^3 alcohol produced in the Indian context (Saha et. al., 2005, Central Pollution Control Board, 2010). Due to the volumes of spent wash generated, distilleries are considered as one of the tremendously polluting industries worldwide (Kim et al., 2010). Hence Central Pollution Control Board, Government of India has deemed distilleries as one of the major polluting industries (CPCB annual report 2003).

Spent wash volumes greater than 40 billion litres are generated in India annually (Padoley et. al., 2012). Such huge quantities containing hazardous and high organic content pose a threat to the environment. Typical chemical oxygen demand (COD) for spent wash ranges between 110,000 – 190,000 ppm, with the pH in the acidic range (Fito et. al., 2009; AIDA, 2019). Additionally, varying quantities of trace elements, heavy metals, anionic salts, phenolics and melanoidins responsible for the characteristic dark brown colour are also present. Variation in the composition and organic content of spent wash is seen due to its origin (España-Gamboa et.al, 2011). Typical average composition of raw spentwash is shown in Table 1.

Waste streams with high COD such as spent wash needs treatment prior to discharge and hence, government policies globally are enforcing industries to stricter discharge rules and eventually leading to a zero-discharge policy (CPCB, 2015). The most common industrial practices for the disposal of spent wash are fertirrigation, biocomposting, incineration, and anaerobic digestion (Fito et al., 2009; Cooper et. al., 2020). Amongst these, anaerobic digestion (AD) offers an attractive option for treating spent wash (Tiwari et. al., 2007). This is not only due to its low operating costs, robustness to handle varying feed compositions and government support for renewable biogas generation (Ministry of Petroleum and Natural Gas, Government of India, 2019), but also valuing the organics in spent wash as a resource rather than waste. AD is also preferred over aerobic treatment due the costs involved, and lower amount of sludge generated as the by product (Cooper et. al., 2020). Biogas generated upon AD could then be upgraded to biomethane to meet the requirements of transportation fuel. The digestate remaining upon AD can then be further composted or in some cases directly used as a fertiliser (Tiwari et. al., 2007).

Cane juice/syrup to ethanol: Opportunities for dryer technology in distillery

P Nikam, AB Deshmukh, DA Patil, KS Konde and SV Patil
Department of Alcohol Technology and Biofuels, VSI

Introduction

Spent wash is being generated by distilleries during the distillation and fermented molasses to ethyl alcohol using specific strains of yeast. In case of sugar cane juice/syrup as a feedstock for production of ethyl alcohol, the quantity of spent wash generated liter per liter of total alcohol production is about 3 L to 5 L and having low organic and inorganic load (Refer Table-1) as compared to other feedstock (i.e., B-Heavy or C-Heavy molasses). In case of syrup as feedstock, it is benefited to have raw spent wash biomethanation followed by BMSW evaporation followed by drying. Using this route distillery industry can achieve the ZLD of spent wash. Spent wash powder produced from the dryer can be further utilize in agricultural fields. This powder will enrich soil as well as provide essential plant nutrients like nitrogen, phosphorous and potash and also compensate the expenditure on fertilizers for crop growth. This practice will result in revenue generation and further lead to offsetting the costs substantially.

Distillery spent wash (SW) contains high level of COD and BOD and is dark brown in color (Table 1). If this effluent is discharged in to water streams, the suspended solids present in the effluent would impart turbidity to water, reduce light penetration and impair biological activity of aquatic life. Hence, an economically viable and environmentally safe means of disposal is needed to handle such large volumes of waste water.

Table 1: Typical characteristics of SW discharged from Indian Distillery

Sr.No.	Parameters	C Molasses	BH Molasses	Cane juice	Cane juice After recycle
1	°Brix	12.0	8.5	3.5	6.5
2	COD (mg/L)	120000	85000	35000	65000
3	BOD (mg/L)	70000	40000	16000	30000
4	Color	Dark Brown	Yellowish brown	Pale Yellow	Pale Yellow

As per the guidelines from CPCB, it is mandatory to achieve 'zero Spent Wash discharge'. To conform to discharge regulations, distilleries employ various form of primary, secondary and tertiary treatments. CPCB approved ZLD routes for Distillery effluent are as follows;

- **Route 1-** Biomethanation followed by multiple effect evaporation followed by bio-composting
- **Route 2-** Raw SW concentration by multiple effect evaporation followed by incineration
- **Route 3-** Biomethanation followed by multiple effect evaporation followed by dryer

Biomethanation followed by multiple effect evaporation followed by dryer (Route 3)

This article is focused on various dryer technologies can be used for route 3..

Drying technologies: In the dryer route, biomethanation of raw SW is used as a primary effluent treatment system followed by standalone multiple effect evaporation for concentration of biomethanated SW up to 40-50% T. S. as a secondary effluent treatment system. Concentrated biomethanated SW is dried in dryer up to 90-95 % T. S. to achieve "Zero SW Discharge". Three types of dryers employed in distillery industry enlisted below.

- Spray dryer
- Agitated thin film dryer
- Spin flash dryer

Advanced technologies for distillery plant and its downstream processes

RV Godage, DA Patil, SA Patil, ST Devkar,
SJ Patil, HA Pachpute, P Nikam and KS Konde
Department of Alcohol Technology and Biofuels, VSI

Introduction

Under Ethanol Blending Program, Government of India has taken initiatives to achieve 10% fuel ethanol blending with petrol throughout the country by 2022 and 20% by 2025. In year 2020-21, 8.5 % fuel ethanol blending with petrol was achieved. Therefore, in order to achieve the target set by the GoI by using optimal available resources (water, steam, electricity, etc), advanced technologies need to be adopted in future. Air cooled heat exchangers, Mechanical Vapour Recompressor (MVR) and Thermal Vapour Recompressor (TVR) technologies can be useful in the distillery plant and its downstream processes to enhance the energy efficiency.

Air-cooled heat exchangers

Air Cooled Heat Exchangers (ACHE) are frequently used in Process, Power, Steel, and several other Industries where a process system generates heat that must be removed, for which there is no local use. The main function of the Air Cooled Heat exchanger is the direct cooling of various process mediums by atmospheric air. These heat exchangers are also known as Air Fin Fan Coolers or Air Fin Coolers or Air Coolers or Fin-tube heat exchangers. These units are used to cool and/or condense process streams with ambient air as the cooling medium rather than water. Cooling with air is often economically advantageous, e.g., in arid or semi-arid locations, in areas where the available water requires extensive treatment to reduce fouling, or when additional investment would otherwise be required to expand a plant's existing cooling-water supply. Regulations governing water use and discharge of effluent streams to the environment also tend to favor air cooling.

Although the capital cost of an air cooled exchanger is generally higher, the operating cost is usually significantly lower compared with a water-cooled exchanger. Hence, high energy cost relative to capital cost favors air cooling. Air cooling also eliminates the fouling and corrosion problems associated with cooling water, and there is no possibility of leakage and mixing of water with the process fluid. Thus, maintenance costs are generally lower for air cooled exchangers.

In distillery plants air-cooled heat exchangers can be employed on a large scale as condensers of distillation columns or process coolers. Air-cooled heat exchangers are manufactured from finned tubes. Typical ratio of extended to bare tube area is 15:1 to 20:1.

As compared to cooling towers and shell and tube heat exchangers, Air Coolers are a "green" solution. They do not require an auxiliary water supply because of the lost water due to drift and evaporation. These are generally used in places, where there is no utility such as water available as a cooling medium. They are usually used when the outlet temperature is more than about 11 degree Celsius above the maximum expected ambient air temperature. They can be used with closer approach temperatures, but often become expensive compared to a combination of a cooling tower and a water-cooled exchanger. There are two basic types of ACHEs (Forced and induced draft). In forced draft ACHE, the fan is located below the process bundle and air is forced through the tubes. In induced draft ACHE, the fan is located above the process bundle and air is pulled, or induced, through the tubes.

Typically air-cooled exchangers consist of a finned tube bundle with rectangular box Headers on both ends of the tubes as shown in Figure 1. Finned tubes are efficient when the heat transfer

Beyond ethanol: biocircular economy and biorefining for sustainability of sugar industry

SV Patil
Department of Alcohol Technology and Biofuels, VSI

* *

Introduction

India currently ranks second in the sugarcane cultivation area, sugarcane production and suga production next to Brazil. With introduction of improved varities of sugarcane and possibility c assured income for farmers, sugarcane production is expected to grow gradually in the country. Th has resulted in increasing stocks above the actual domestic requirement of sugar in the country. T overcome the problems arrising out of increasing sugar stocks, GoI has planned an ambitiou programme of ethanol blending in petrol for which surplus sugar can be diverted. Through variou initiatives undertaken, GoI wants to achieve 10 % blending by 2023 and 20 % by 2025.

Most probably, the 20 % blending will be achieved in coming few years which will also provid oppertunity for sugar industry to improve its financial status. However, it is also necessary to star thinking of what can be beyond ethanol, sugar and cogeneration for the sugar sector.Fortunately the sugar Industry also generate plenty of biomass/wastes in the form of press mud cake (PMC) bagasse (SCB), trash (SCT), spentwash (SW) etc. It is desierable that each and every part o sugarcane crop as well as the wastes generated are valorized effectively.

Considering the valorization potential of SCB, cogeneration is not the best option under the changing scenario of availability of low cost electricity from alternate sources. SCB and SCT can be valorized to form several value added products such as 2G bio-ethanol, bio-butanol, sustainable aviation fules (SAF), CBG and chemicals such as lactic acid, succinic acid, gluconic acid, xylitol lignin derviatives, potash based fertlizers etc through a biorefinery approach which can play an important role in country's energy requirement in future. VSI has completed a vWa project with Indian and UK partners with aim to develope different value added products through biomass/wastes valorisation from sugar Industry (Fig. 1).

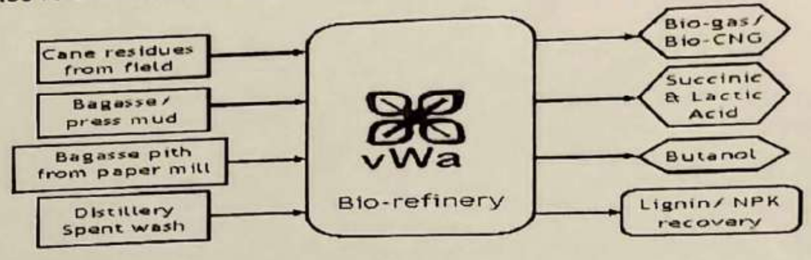

Figure 1: Diagram showing prospect of vWa project for different product devlopment through valorizing wastes from sugar industry.

A biorefinery is simply defined as refinery that converts biomass/waste to energy and other beneficial byproducts (such as chemicals). The International Energy Agency Bioenergy Task 42 defined biorefining as "the sustainable processing of biomass into a spectrum of bio-based products (food, feed, chemicals, materials) and bioenergy (biofuels, power and/or heat)". A circular bioeconomy is an economy powered by nature or in harmony with nature. It is an economic model that emphasizes the use of renewable natural capital and focuses on minimizing wastes, replacing the wide range of non-renewable, fossil-based products currently in use. Through this approach wastes produced are put back into the economy through options of reuse, refurbishing, recycling or remanufacturing. The "zero-waste" policy of circular bioeconomy has fueled the development of waste biorefineries. Sugar mills in future can become a biorefinery in which various value added

Access through your institution   Purchase PDF

ACADEMIC PRESS

Radiation-Processed Polysaccharides
Emerging Roles in Agriculture
2022, Pages 355-367

Chapter Fifteen - Studies on radiation processed polymers mediated biochemical and molecular responses and relevance to enhancing plant productivity

Sunil Dalvi [a], Penna Suprasanna [b] *

Show more

+ Add to Mendeley   Share   Cite

https://doi.org/10.1016/B978-0-323-85672-0.00003-9

Abstract

Climate change has severe impact on the incidence of erratic, extreme weather events leading to substantial effects on the world's ecosystems. Efforts are therefore required for enhancing crop resilience and adaptation to climate change for sustainable production, food and nutrition security. Multiple adaptation strategies are advocated for climate resilient agriculture and increasing farmers' income by incorporating plant bio regulators or biostimulants in agriculture. Use of oligochitosan in stress adaptation towards resilience and mitigation, has highlighted the need for understanding of biochemical and molecular mechanisms involved in enhancing plant productivity. Advances in nanobiotechnology methods have led to various chitosan based nanomaterials products for use in agriculture. Chitosan, a versatile, most promising biological macromolecule,

Chapter

Potential of biopriming with irradiated chitosan for sugarcane micropropagation

January 2022
DOI 10.1016/B978-0-323-85672-0.00014-3
In book: Radiation-Processed Polysaccharides (pp 179-204)

Authors:


Sunil Dalvi
Vasantdada Sugar Institute

Kartiki Wani


Dinesh Manohar Ithape
Vasantdada Sugar Institute


Suprasanna Penna
Bhabha Atomic Research Centre

Abstract

Large scale sugarcane micropropagation techniques ensure production of millions of plantlets to different agricultural sectors. However, several abiotic and biotic factors affect the micro plants during the micropropagation process viz. microbial contamination in vitro, browning of media, hyperhydricity, poor light efficacy, insufficient gaseous exchange and accumulation of ethylene, etc. These factors have a significant impact on efficiency of cultures during their in vitro growth. All these factors affect the production as well as product efficacy greatly the economic viability and sustainability of sugarcane micropropagation. Further, the morpho-