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Advances and Developments in Biobutanol Production

Edited by
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ADVANCES AND DEVELOPMENTS IN BIOBUTANOL PRODUCTION

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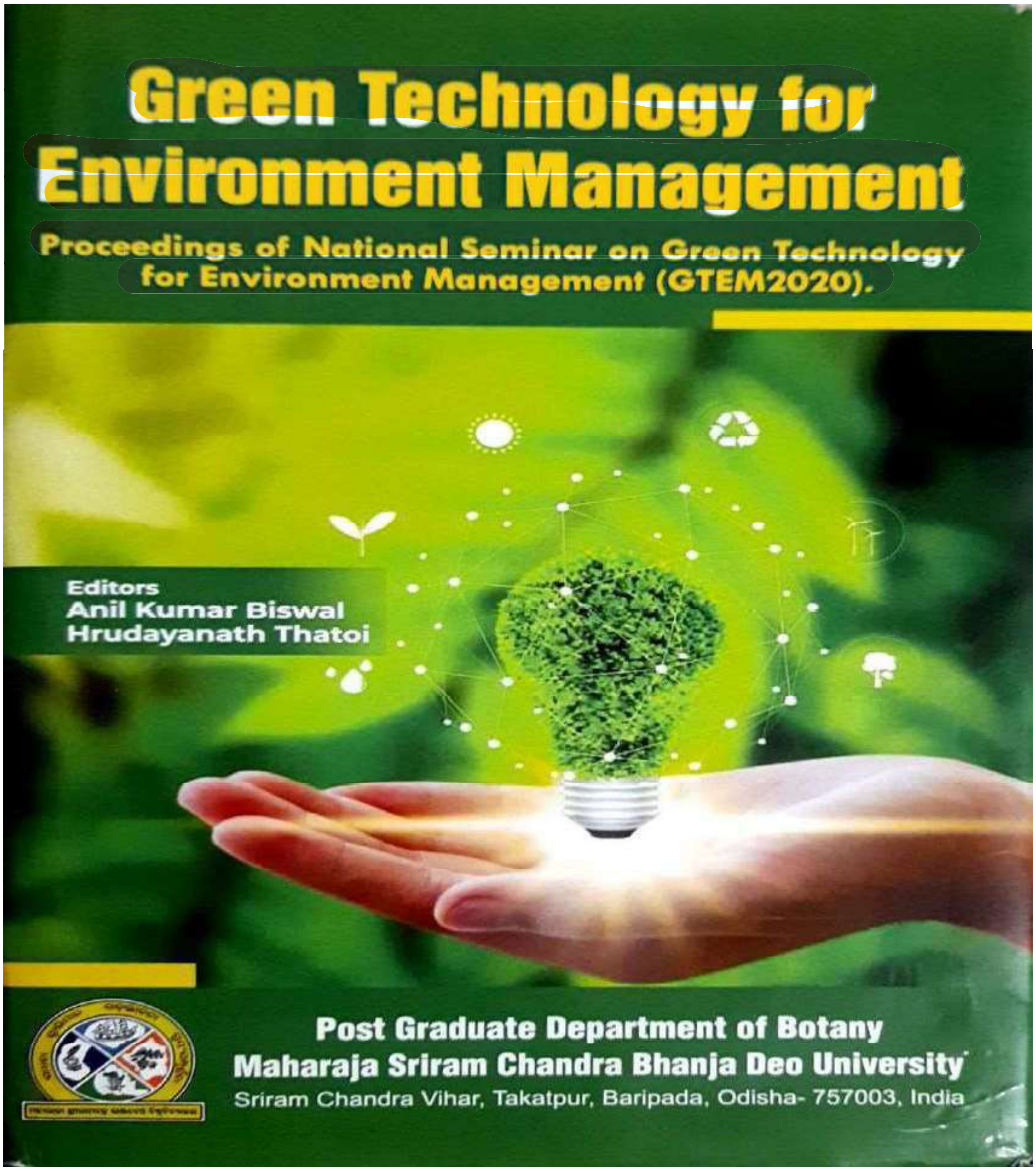

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- Editors -
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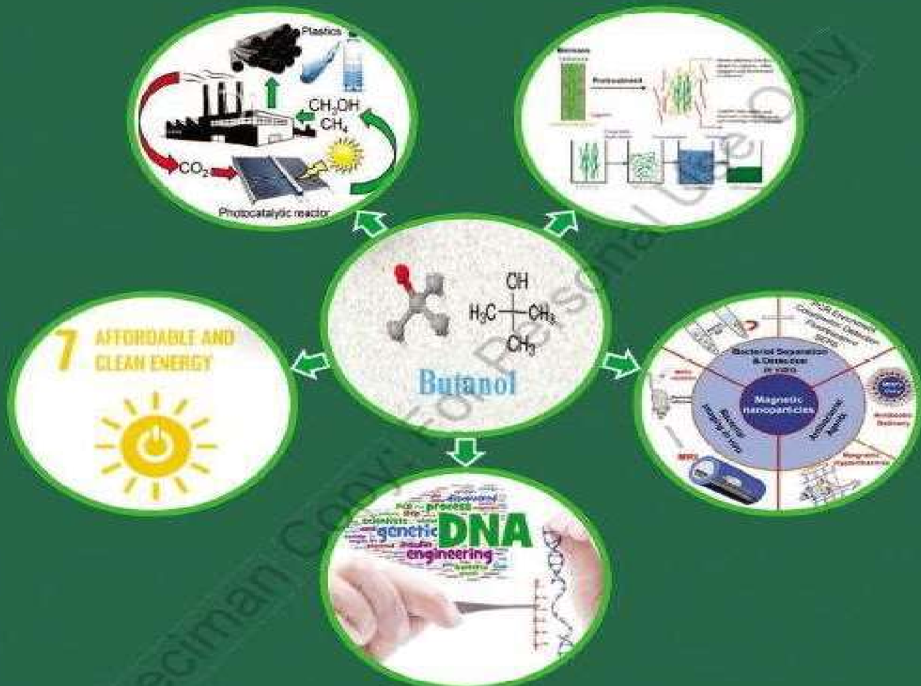
Sustainable Butanol Biofuels



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Sustainable Butanol Biofuels

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Contents

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Mechanisms and Applications of Biofuel:

Acetone-Butanol-Ethanol Fermentation

Ketaki Nalawade, Vrushali Kadam, Shuvashish Behera, Kakasaheb Konde* and *Sanjay Patil**

1. Introduction

The rapid diminishing of fossil fuel reserves and growing environmental concerns resulting from fuel emissions have made researchers explore alternative biofuel sources. The production of biofuels such as biobutanol and bioethanol using natural sources have appeared as propitious transportation fuels due to its sustainability and ecological benefits, reducing the reliance on crude oil. Nowadays, biodiesel and bioethanol are utilized as substitute fuels for gasoline and diesel as it decreases noxious emissions, that is, CO, HC and haze pollution from the exhaust (Yusoff et al. 2015). Bioethanol as fuel needs significant modifications made to conventional engines, and it is more corrosive than gasoline. Biobutanol and gasoline utilize similar feedstock for its production. Moreover, biobutanol is a viable biofuel for IC engines due to its physicochemical properties that enhance engine performances. The microbial biobutanol production is more multi-faceted than bioethanol, however biobutanol offers more merits than gasoline and bioethanol (Rathour et al. 2018, Karthick and Nanthagopal 2021, Timung et al. 2021).

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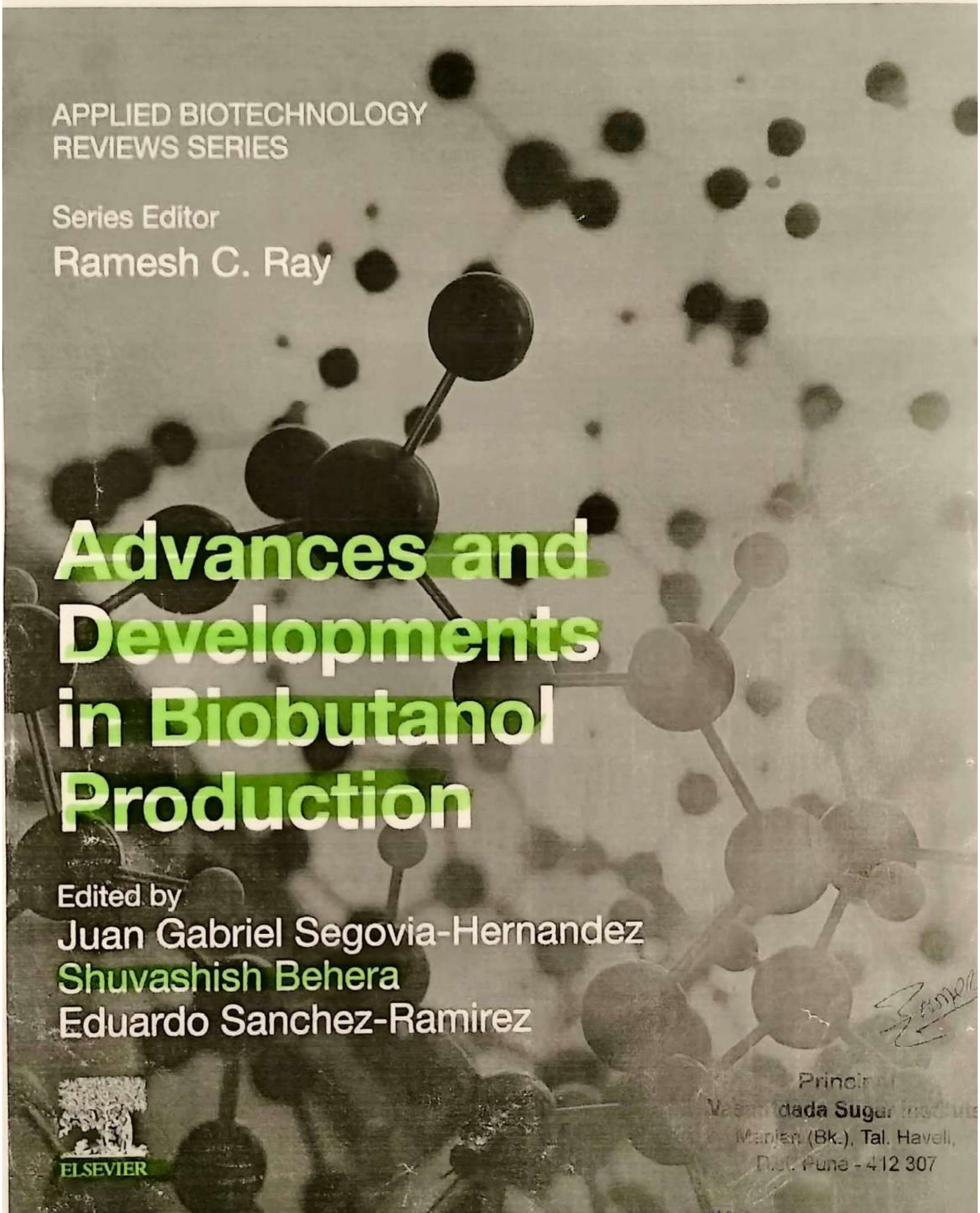
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10

Methods for bio-butanol production and purification

Shuvashish Behera, Kakasaheb Konde and Sanjay Patil
Department of Alcohol Technology and Biofuels, Vasantdada Sugar Institute, Manjari (Bk.), Pune, India

10.1 Introduction

As the requirement for energy increases day by day and as there is scarcity due to depletion of petroleum fuel reserves, which increases the environmental pollution and petroleum prices, it is necessary to focus on alternative fuel resources originating from plant biomass, as renewable sources of energy (Behera et al., 2019; Jang and Choi, 2018). Interest in the biological production of butanol is increasing day by day. Bio-butanol production through acetone-butanol-ethanol (ABE) fermentation using butanol-producing microorganisms has regained much attention recently (Veza et al., 2021). Bio-butanol has gained its attention as a transport fuel due to its high energy density, high flash point, less volatile, less corrosive, less hygroscopic, and low vapor pressure also it has certain applications in the production of antibiotics, vitamins, hormones, inorganic synthesis, chemical intermediate, processing of paint thinner and hydraulic and brake fluids (Alias et al., 2021; Behera et al., 2018; Behera et al., 2019; Dong et al., 2017; Nanda et al., 2017). All these features enhance its usefulness both as an additive to gasoline, as well as biofuels (Lapuerta et al., 2017). In order to reduce the cost of ABE fermentation and make it competitive in the petrochemical process, a lot of research is being done on increasing butanol production by metabolic engineering and reducing the substrate cost by using cheaper lignocellulosic biomass or agriculture residues as feedstocks (Shi et al., 2016; Swidah et al., 2015).

Solventogenic Clostridia species are usually the microorganisms used in ABE fermentation for bio-butanol production. There are mainly five metabolic products in ABE fermentation, two acids (acetic acid and butyric acid) and three solvents (acetone,

Advances and Developments in Biobutanol Production. https://doi.org/10.1016/B978-0-323-91178-8.00004-7

Chapter

Induced Mutation Technology for Sugarcane Improvement: Status and Prospects

April 2023

DOI 10.1007/978-981-16-9720-3_21

In book: Mutation Breeding for Sustainable Food Production and Climate Resilience (pp 645-668)

Authors:

Suprasanna Penna · Shriram Jagannath Mirajkar · M. V. Purankar

Ashok Nikam · Sunil Dalvi · Eknath Vaidya

Rachayya Devarumath

Abstract

Induced mutation technology is a powerful means to introduce novel genetic variability for use in crop improvement. Induced mutants have been developed in several crop plants and economic use of the mutant varieties has demonstrated their potential across the globe. Sugarcane is an important cash crop cultivated primarily for its distinctive sucrose

P-16

Hydrogen production opportunities in sugar & allied industry

Kakasaheb Konde, Pranav Nikam, Sangram Patil, Shuvashish Behera

Department of Alcohol Technology and Biofuels, Vasantdada Sugar Institute, Manjari (Bk.), Pune-412307, India

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Abstract

On 17th February 2022, GoI announced a National Hydrogen Policy. Hydrogen has proved to better fuel than petrol and diesel and is destined to be the fuel of the future. Hydrogen based vehicles shows three times better mileage than diesel engines. Hydrogen is a cleaner fuel which upon combustion produces water. However, other fuels produce carbon dioxide on burning and contributes in pollution and global warming.

Green hydrogen can play an important role in diversification of sugar industry product portfolio. It can provide significant economic returns and help to improve its financial position. It will create additional employment opportunities and pollution free environment for the society. Therefore, green hydrogen production will provide a win-win opportunity to the Sugar Industry as well as the Society.

Sugar Industry has plenty of resources which can be exploited for the production of green hydrogen. Sugar Industry is looking for economically viable alternatives for utilization of its excess electric power instead of exporting it to the grid. Hydrogen production using water electrolysis with this excess electricity can prove to be a lucrative option for the industry. Also, excess sugarcane bagasse which is available with the sugar mills can be used for hydrogen production through gasification process. Sugar Industry/Distillery is generating biogas using spent wash through anaerobic digestion. This biogas can be converted into hydrogen through Steam Methane Reforming process. Possibilities of implementation and preliminary techno-economic analysis of above technologies is discussed in the paper.

Keywords: Biofuels; Green hydrogen; Sugar & allied industry

Proceedings of the International Society of Sugar Cane Technologists, volume 31, 236–240, 2023

Poster paper

Microbial process to produce gluconic acid: a value addition to the sugar industry

Sanjay Patil, Shivani Suryawanshi, Sneha Patil, Shuvashish Behera and Kakasaheb Konde

Department of Alcohol Technology and Biofuels, Vasantdada Sugar Institute, Manjari (Bk.), Pune-412307, India, sv.patil@vsisugar.org.in

Abstract India has been producing excess quantity of sugar during the last 10 years. Diversification of the product portfolio of sugarcane biorefineries by using surplus sugar and surplus sugarcane juice for the production of valuable products such as gluconic acid will provide significant economic returns to the sugar industry and further promote their economic competitiveness. This study highlights bioprospecting of glucose for the production of gluconic acid in synthetic medium. Batch fermentation of gluconic acid from glucose was carried out using cells of *Aspergillus niger* NCIM 545.Two methods were followed to maintain the pH of the medium throughout the experiment. A titer of 99.67 g/L of gluconic acid with a yield of 1.0 g/g glucose and productivity of 0.69 g/L/h was achieved using 99.1 g/L of glucose in 500 mL Erlenmeyer flasks by the $CaCO_3$ method. A higher titre of 123.98 g/L with a yield of 0.95 g/g glucose and a productivity of 0.73 g/L/h was obtained with 129.32 g/L of glucose with the $CaCO_3$ method. Fermentations carried out in a 10 L fermenter resulted in 210 g/L of gluconic acid with a 1.01 g/g glucose yield and a 2.19 g/L/h productivity using 207.36 g/L of glucose with the KOH method. This efficacy for gluconic acid production using *Aspergillus niger* NCIM 545 can be commercialised to use surplus sugar and surplus sugarcane juice of sugar and allied industries. It will allow sugar mills to diversify towards gluconic acid production to improve their profitability.

Key words *Aspergillus niger*, gluconic acid, calcium gluconate, batch fermentation, pH control strategies

INTRODUCTION

India currently ranks second in area cultivated to sugarcane (5.228 Mha) and sugarcane production (363.66 Mt) to Brazil. Sugarcane being a rich source of sucrose (~10%), accounts for approximately 80% of the global sugar production (Melati *et al.* 2017). India has been producing excess quantity of sugar in the last 10 years (www.en.krishakjagat.org). Diversification of the product portfolio of sugarcane biorefineries using surplus sugar and surplus sugarcane juice for the production of valuable products such as gluconic acid will provide significant economic returns to the sugar industry and promote their economic competitiveness (Canete-Rodriguez *et al.* 2016). Sugar mills need to diversify towards gluconic acid production to improve their profitability.

Gluconic acid (GA) is used widely in chemical, pharmaceutical, food, beverage, construction and textile industries. The demand for gluconic acid is around 50,000-60,000 t/year and it is growing rapidly. The value of gluconic acid ranges from Rs. 200 to Rs. 1000 per kg (USD 2.45-12.25) depending on its purity. There are different approaches available for the production of gluconic acid, but fermentation is considered as the most efficient and dominant technique. Microbial processes are used to convert glucose to gluconic acid in submerged fermentation using the fungus *Aspergillus niger*. Glucose is considered as the main carbon source used by *A. niger* to produce gluconic acid (Purane *et al.* 2012).

Calcium gluconate is formed during the fermentation for gluconic acid production when the pH of the fermentation medium is controlled using $CaCO_3$. Similarly, sodium or potassium gluconate is formed during the fermentation for gluconic acid production when pH is controlled with the addition of NaOH or KOH. The concentration of gluconate in the fermentation medium is affected by the concentration of glucose and the pH control strategies. Addition of more glucose hampers the process of gluconic acid production through the limited solubility of calcium

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Nano-biotechnological approach for sustainable disease management in sugarbeet cultivation under changing climate

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Abstract: Sclerotium rolfsii is most destructive fungi in sugarbeet (Beta vulgaris L.), causes sclerotium root rot and responsible for about 50% damage of roots. Affected roots are unfit for sugar extraction causing major economic loss. Applications of chemical fungicide to manage the disease, cause serious environmental hazards of flora, fauna and human. Now a days, climate change is major problem and has a severe impact on the incidence of erratic, extreme weather events leading to substantial effects on the ecosystems. Efforts are therefore required for enhancing crop resilience and adaptation to climate change for sustainable agriculture production. The changing climate is unpredicted and increased diseases and pest infestations; thereby impose severe risks and potential crop failures. To tackle this problem, we synthesized chitosan and ⍰- glucan nanoparticles (yeast and S. rolfsii ⍰- glucan) in order to enhance plant immune stimulation against the pathogenic fungi S. rolfsii. Synthesis of nanoparticles was confirmed through FTIR, FE-SEM, TEM- EDS, XRD zeta size and zeta potential techniques. In-vitro antifungal study of these nanoparticle indicates that chitosan and both ⍰- glucan nanoparticles able to inhibit 100% of S. rolfsii growth at 600 ppm and 160 ppm respectively. Antifungal activity of nanoparticles also tested in Czapek- Dox liquid media, in that change in pH and dry weight recorded. Microscopic study shows that nanoparticle causes serious cytoplasmic leakage, cell wall disruption, necrosis and reduction in cytoplasm amount due to its leakage and coagulation in S. rolfsii. This preliminary research will help in developing a nano formulation strategy for sustainable disease management in sugarbeet.

Keywords: ⍰- glucan nanoparticles, chitosan nanoparticles, climate change, Sclerotium rolfsii, sugarbeet.

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