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# A review on Lactic acid production from Sugarcane bagasse: Advances in Simultaneous Saccharification and Co-Fermentation (SSCF) using Lactic acid bacteria

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***Abstract:*** *: Lactic acid( LA) is a precious platform chemical with different operations in food, medicinals, cosmetics, and biodegradable plastics. Its polymer, polylactic acid( PLA), serves as an eco-friendly volition to petroleum- grounded plastics, adding the demand for sustainable LA product. Sugarcane bagasse, a lignocellulosic derivate, offers a sustainable feedstock for LA product, aligning with indirect frugality principles. contemporaneous Saccharification and Co-Fermentation( SSCF) integrates enzymatic hydrolysis and microbial turmoil, perfecting process effectiveness. Advances in alkali and hydrothermal pretreatment styles have enhanced sugar release, while lactic acid bacteria( LAB) with advanced acid forbearance and substrate application have boosted turmoil effectiveness. This review highlights advancements in SSCF for LA product from sugarcane bagasse, addressing crucial challenges and unborn perspectives for optimizing bioprocessing strategies to support sustainable bio-based diligence.*

***Key Words:*** *Lactic acid, Saccharification, Co-fermentation, Sugarcane bagasse*

## 1. INTRODUCTION:

Lactic acid( LA) is a largely protean chemical with expansive operations in food complements, biodegradable plastics, medicinals and cosmetics. Its polymer, polylactic acid( PLA), farther enhances its mileage as an eco-friendly volition to petroleum- grounded plastics[1,2].The rising demand for LA, particularly for PLA product, has driven interest in sustainable product styles that use renewable coffers[3].Sugarcane bagasse, a lignocellulose-rich agrarian derivate, has surfaced as a promising feedstock for LA product. Its use offers several benefits, including the exercise of biomass, cost-effective product of precious chemicals, and the reduction of agrarian waste[1].This aligns with the principles of an indirect frugality and sustainability. Simultaneous Saccharification and Co-fermentation( SSCF) has gained recognition as an effective process for producing LA from lignocellulosic materials. This integrated approach combines enzymatic hydrolysis and turmoil into a single step, potentially reducing product costs and perfecting overall effectiveness[4,5]. Still, challenges remain in optimizing process parameters and opting suitable microorganisms for SSCF. Recent studies have concentrated on refining SSCF processes using colorful strains of Lactic acid bacteria. For illustration, *Lactobacillus pentosus* demonstrated high turmoil effectiveness in a mongrel process that combines SSCF with original enzymatic hydrolysis, achieving 65.0 g/ L of lactic acid with a yield of 0.93 g/ g and a productivity of 1.01 g/ L · h[6] . Studies have also explored new pretreatment styles, thermophilic bacteria for high- temperature turmoil, and optimized process conditions to enhance LA product from sugarcane bagasse[4,5,7]

This review focuses on exploring advancements in lactic acid production from sugarcane bagasse through Simultaneous Saccharification and Co-Fermentation( SSCF) using Lactic acid bacteria. It aims to punctuate recent inventions in pretreatment styles, enzymatic hydrolysis, and microbial turmoil strategies that enhance yield and productivity. Also, the review examines the challenges in SSCF, including substrate availability and process optimization, while a gitating unborn perspectives for sustainable biotechnological operations in bio-based lactic acid product.

## 2. SUGARCANE BAGASSE AS A FEEDSTOCK FOR LACTIC ACID PRODUCTION:

Sugarcane bagasse has gained attention as a feasible feedstock for lactic acid production, furnishing a sustainable volition to conventional high-chastity sugar sources. Composed substantially of lignocellulosic materialincluding cellulose, hemicellulose, and lignin, sugarcane bagasse requires pretreatment to enhance its availability for enzymatic hydrolysis and turmoil[8]. Pretreatment strategies have been explored to optimize its application. Alkali pretreatment is effective in reducing lignin content, perfecting glucose yield, and enhancing enzymatic hydrolysis effectiveness[9].Acid pretreatment using dilute sulfuric acid is another common approach; still, it can lead to lower overall sugar attention. Hydrothermal pretreatment styles, similar as bus- catalyzed(A-HTP) and sulfuric- acid- catalyzed(SA-HTP) processes, have been studied, with A-HTP showing favorable results without taking fresh acid successional pretreatment styles combining acid and alkali, or vice versa, have demonstrated high glucose release during enzymatic hydrolysis[8]. Also, hydrodynamic cavitation combined with alkali pretreatment has surfaced as an effective volition[9]. One of the crucial challenges in exercising sugarcane bagasse for lactic acid product is achieving productivity situations similar to those attained using refined sugars[5]. Among the colourful pretreatment styles, alkali pretreatment has yielded the loftiest L- lactic acid titer( 68.7 g/ L) and productivity(2.86g/L/h)(9). Farther advancements can be made by enhancing enzymatic hydrolysis effectiveness at elevated lactic acid attention and optimizing pretreatment conditions to balance sugar release while minimizing asset conformation[5,8] .

## 3. LACTIC ACID BACTERIA( LAB) FOR SSCF:

Lactic acid bacteria(LAB) have demonstrated significant eventuality for Simultaneous Saccharification and Co-fermentation(SSCF) processes, particularly in converting lignocellulosic biomass into precious products. A study exercising sludge stover and sludge stalks as feedstocks stressed the effectiveness of SSCF in enhancing D- lactic acid yield and productivity[10].This process employed an L- lactate-deficient mutant of *Lactobacillus plantarum* NCIMB 8826 and its secondary containing a xylose assimilation plasmid, achieving D- lactic acid attention of 27.3 g/ L from sludge stover and 22.0 g/ L from sludge stalks. The advancements in genomics and high- outturn technologies have strengthened our understanding of LAB metabolism and stress adaption, particularly in relation to acid forbearance[11].Strategies to enhance acid resistance in LAB include modifying cellular microenvironments, optimizing amino acid metabolism, introducing exogenous biosynthetic pathways, and overexpressing stress response proteins. These approaches are essential for sustaining cell viability and functionality in SSCF processes, where acidic conditions can negatively impact bacterial performance. The recombinant *L. plantarum* strain's capability to metabolize both hexose and pentose sugars are especially salutary for effective lignocellulosic biomass conversion[10]. The unborn exploration should concentrate on enhancing LAB strains' resistance to process- related stresses and broadening their substrate application range to further ameliorate SSCF process effectiveness.

## 4. SIMULTANEOUS SACCHARIFICATION AND CO-FERMENTATION( SSCF) PROCESS:

Separate Hydrolysis and Fermentation ( SHF) is a process analogous to Simultaneous Saccharification and Co-Fermentation( SSCF), where enzymatic hydrolysis and turmoil take place contemporaneously. Compared to Separate Hydrolysis and Fermentation (SHF), SSF offers several advantages, including reduced end- product inhibition, a shorter overall processing time, and a more straightforward turmoil process[12]. Also, SSF enhances productivity and effectiveness due to its intertwined approach[12]. A study compared lactic acid( LA) product using SHF and SSCF at a cellulose lading of 60 g/ L from bagasse sulfite pulp[15]. The SSCF process redounded in a 43.73 advanced LA attention while reducing processing time by 25.00 and lowering fungal cellulase lozenge by 33.3. Enzymatic hydrolysis was carried out using cellulase, and *Pediococcus acidilactici* was genetically modified to use both glucose and non-glucose sugars deduced from lignocellulosic biomass. The comity of enzymatic and microbial exertion at an optimal temperature(~50 °C) and pH(~4.8) contributed to the high LA titer of 107.5 g/ L and a productivity of 2.69 g/( L · h)(10).

## 5. CHALLENGES IN SSCF FOR LACTIC ACID PRODUCTION:

Simultaneous Saccharification and Co-fermentation (SSCF) for Lactic acid (LA) product presents several challenges. One major issue is the conformation of impediments during lignocellulosic biomass pretreatment, which can negatively affect microbial growth and enzyme exertion. Implicit results include exercising genetically modified feedstocks that produce smaller impediments and developing microbial strains with enhanced asset forbearance[13]. Also, end- product inhibition by LA significantly reduces turmoil effectiveness. This issue can be eased through periodic LA junking using anion- exchange resin columns, a fashion that has been shown to ameliorate both yield and productivity[14].

## 6. RECENT ADVANCEMENTS IN SSCF FOR LACTIC ACID PRODUCTION:

Recent advancements in SSCF for LA production with lactic acid bacteria have concentrated on optimizing enzyme phrasings and exploring co-culture turmoil ways. The addition of β- glucosidase has been set up to enhance turmoil kinetics and yields by precluding cellulase inhibition caused by cellobiose accumulation[14]. In situ product recovery styles, similar as membrane- grounded separation integrated with nonstop SSCF, have been proposed to offset substrate limitations, feedback inhibition, and end- product accumulation, eventually adding LA attention, productivity, and effectiveness[3].

## 7. CONCLUSION AND PROSPECTIVES:

The production of lactic acid (LA) from sugarcane bagasse through Simultaneous Saccharification and Co-Fermentation (SSCF) presents a promising and sustainable volition to conventional styles. SSCF offers several advantages, including reduced process time, bettered effectiveness, and cost-effective application of lignocellulosic biomass. Advances in pretreatment strategies, similar as alkali and hydrothermal styles, have enhanced sugar release, easing advanced LA yields. Also, the selection and inheritable revision of lactic acid bacteria (LAB) have bettered turmoil effectiveness, particularly in prostrating substrate limitations and end- product inhibition. Despite its eventuality, challenges remain, including enzyme inhibition, microbial forbearance to acidic surroundings, high wastewater product, elevated saccharification costs and the conformation of inhibitory derivations during biomass pretreatment. Addressing these issues through strain engineering, process optimization, sustainable waste operation practices and in situ product recovery ways can further enhance SSCF effectiveness. unborn exploration should concentrate on perfecting microbial robustness, optimizing enzymatic hydrolysis conditions, and integrating new bioprocessing approaches to maximize LA productivity. By enriching SSCF processes and using innovative biotechnological advancements, LA product from sugarcane bagasse can contribute significantly to the development of sustainable bio-based diligence and the indirect frugality.

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