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Production of Bio-ethanol as a Bio-Fuel

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SUMMARY

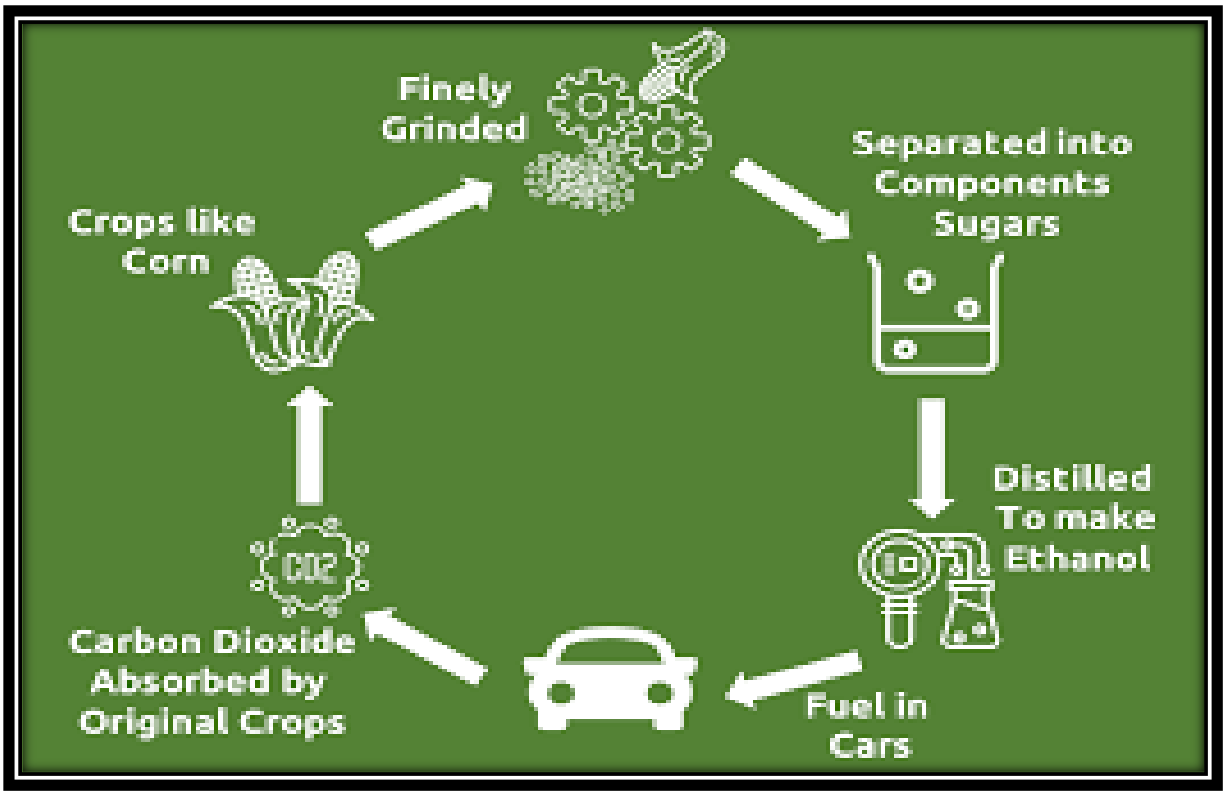
Bio-ethanol fuel has an important role in the field of environmental conservation by justifying global warming and conserving fossil fuel. It is an alcohol made up of carbohydrates through a fermentation process. The production of bio-ethanol from biomass or waste is one of way to reduce both the consumption of crude oil and environmental pollution. Ligno-cellulosic biomasses (corn, sugar and molasses, etc.) derived from nonfood sources such as grasses and trees are also being utilized as feed stocks for ethanol production. The physical and chemical characteristics of bio-ethanol are similar to ethanol; they just require different resources for production. Bio-ethanol in its purest form is a colorless clear liquid with a mild characteristic odor that boils at 78°C and freezes at –112°C.We can now easily replace the use of fossil fuels with ethanol.

INTRODUCTION

India is among the highest emitters of greenhouse gas (GHG) and its cities are among the most polluted in the world. India has undertaken several initiatives over the years towards its goal of net zero emissions of greenhouse gas (GHG) as part of Paris (COP21) commitments. It has been successful in enhancing the growth of renewable energy and is now looking at other ways to reduce emissions, one of which is to produce bio-ethanol on a large scale. India has the potential to become one of the major ethanol producers in the world due to the large quantities of sugarcane that are grown in the country. Ethanol is a low-hanging fruit solution that can enable a greener, more sustainable economy. Sugarcane ethanol is an alcohol-based fuel produced by the fermentation of sugarcane juice and molasses. Because of its clean, affordable and low-carbon bio-fuel, sugarcane ethanol has emerged as a leading renewable fuel for the transportation and industrial processes. As a part of the Ethanol Blended Petrol (EBP) programme, various factories were allowed to produce ethanol from molasses and sugarcane juice. An indicative target was set for 20% blending of ethanol in petrol and 5% blending of biodiesel in diesel by the year 2030. In 2020, this target was sharpened to 10% ethanol-blending by 2022 (10% of ethanol mixed with 90% of petrol) and 20% by 2030. In January 2021, India advanced the target of achieving 20% ethanol-blending with petrol by five years to 2025. Achieving this will require around 12 billion liters of alcohol/ethanol. For this harvest season, the sugar industry plans to divert 6 million tones of surplus sugar to produce around 7 billion liters of ethanol, while the remaining 5 billion liters will be produced from excess cereal grains.

One of the main operations to obtain fuel-grade ethanol is the distillation of fermented broths. Distillation is an energy intensive consuming operation, which separates ethanol from fermented broths and accounts for a relevant share of bio-ethanol production cost, particularly for conventional distillation/ dehydration operation. It is worth mentioning that one of the main characteristics of conventional distillation columns is the recovery of ethanol with low energy efficiency, which is limited by the azeotrope formed with water. Due to the importance of distillation in the processing of ethanol, several environmentally friendly and energy saving approaches have been proposed to improve this operation. Most of the strategies are based on the physicochemical properties of the ethanol–water mixture and the equipment configuration such as heat integrated distillation, membrane-assisted vapor stripping and feed-splitting.

Raw materials for bio-ethanol production:



Different types of biomass have a potential as raw materials for bioethanol production. They mostly form three groups: Carbohydrate sources (depends on chemical composition)
(*i*) *Sugar-containing raw materials*: e.g. sugar beet, sugarcane, molasses, whey, sweet sorghum,
(*ii*) *Starch-containing feed stocks*: grains such as corn, wheat, root crops such as cassava, and (*iii*) *Ligno-cellulosic biomass*: straw, agricultural waste, crop and wood residues.

However, these sugar- and starch-containing feed stocks (first generation) compete with their use as food or feed, thus influencing their supply. Therefore, lingo cellulosic biomass (second generation) represents an alternative feedstock for bio-ethanol production due to its low cost, plentiful availability, wide distribution and it is not competitive with food and feed crops.

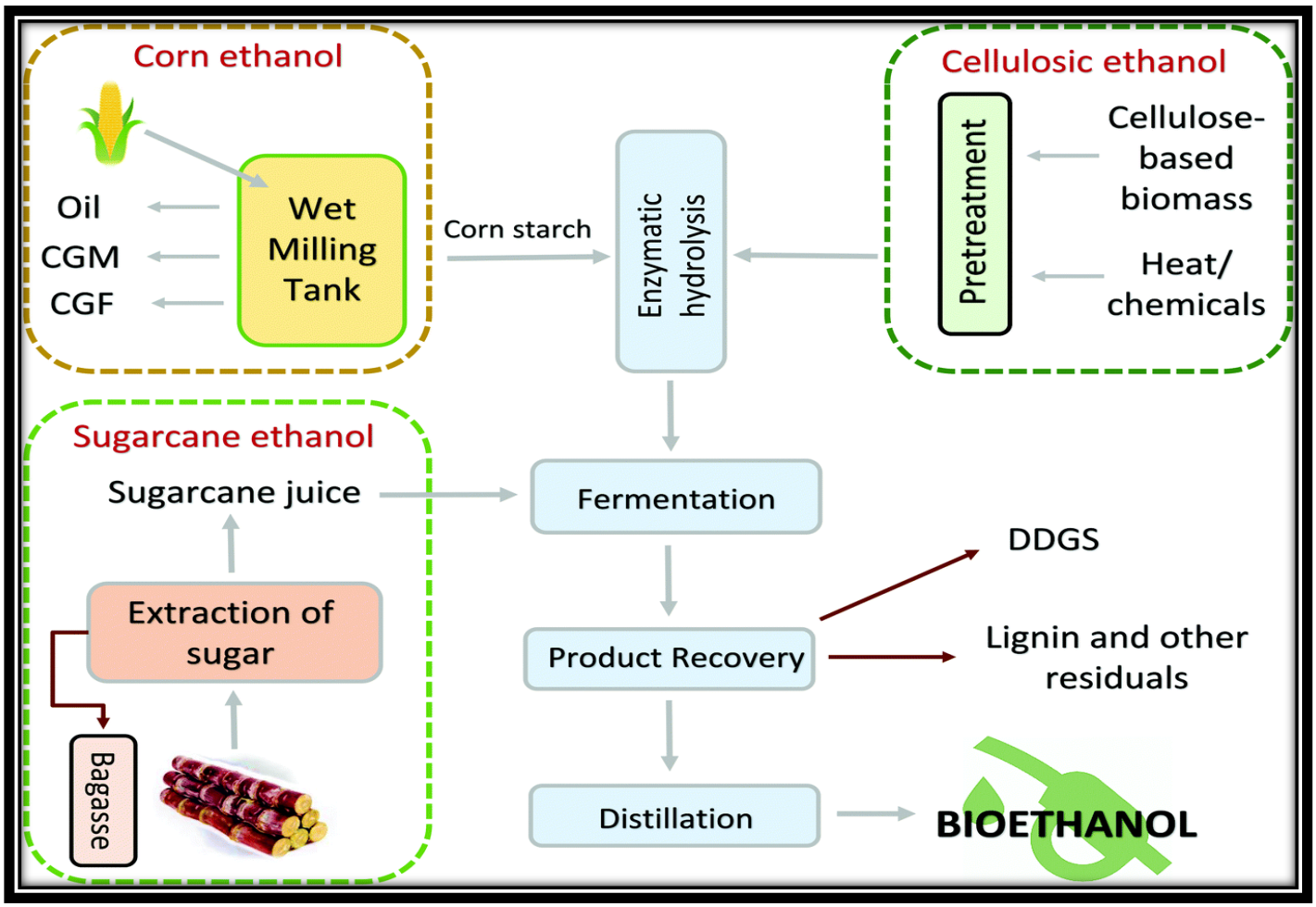
Techniques of bio-ethanol production:

Corn dry-milling process:

Cleaning and break down the corn kernel into fine particles. Sugar solution is produced when the powder mixture (corn germ/starch and fiber) is broken down into sucrose by utilizing dilute acid or enzymes. Finally yeast is added to ferment the cooled mixture into ethanol.

Corn wet-milling process:

Corn kernel is soaked in warm water. Proteins broken down and starch present in the corn is released (thus, softening the kernel for milling process). Microorganisms, fiber and starch products are involved to produced ethanol by distillation process.



Sugar fermentation:

The biomass cellulosic portions were broken down to form sugar solutions by hydrolysis, which would be fermented to form ethanol. Yeast is added in inoculums and the sugar solution was heated. Invertase enzyme was acts as a catalyst, which converts the sucrose sugars into glucose and fructose. The fructose and glucose sugars react with zymase to produce ethanol and carbon dioxide.

Bio-ethanol properties:

- Colorless and clear liquid.
- Used to substitute petrol fuel for road transport vehicles.
- One of the widely used alternative automotive fuel in the world.
- Much more environmentally friendly.
- Lower toxicity level.

The top five ethanol producer countries in year 2022:

- United States - 876 thousand barrels per day
- 2. Brazil - 403 thousand barrels per day
- 3. China - 043 thousand barrels per day
- 4. Canada - 033 thousand barrels per day
- 5. France - 017 thousand barrels per day

CONCLUSION

Ethanol production from biomass, especially waste biomass, and the use of such ethanol as fuel can reduce fossil fuel consumption and ameliorate the hidden costs of burning fossil fuels such as its environmental impact. However, bio-ethanol production suffers from several limitations such as being energy-intensive and generating a sizeable amount of waste. This review briefly describes the aspects related to bio-ethanol production and focuses on both theoretical and practical approaches for process improvements. Several green emerging distillation techniques, such as ohmic-assisted hydro distillation, membrane assisted distillation, and heat integrated techniques, are shown to be energy-saving alternatives to the conventional distillation processes. Besides, a number of valuable components, such as pectin and bioactive compounds (e.g., phenolic compounds), have been recently isolated from the waste materials of bio-ethanol plants through various environmentally friendly valorization methods. These emerging distillation and extraction techniques can be integrated to evolve a greener bio-ethanol production process in the future

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