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Plant design, optimization, and ethanol production from *Zea maize* L.

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Abstract. Ethanol production from corn grain is taken a point of convergence as an alternative fuel development recently. Herein, we studied the production of ethanol from Zea maize L with designing the production plant and optimization process, respectively. As an additional source, the maize grains are processed to a fine flour and then exposed to liquefaction, where the temperature was maintained at 85 ° C for 4 hours. Furthermore, it was exposed to saccharification for 4 hours at 50°C with subsequent refining. The ethanol yield acquired from the process was observed to be 10.6, with the purity of 95%. The distinctive ethanol properties are likewise evaluated with the specific gravity, relative thickness and the refractive index were 0.79, 0.85, and 1.4, respectively.

Keywords: Amylase, fermentation, glucoamylase, saccharification, Saccharomyces cerevisiae.

1. Introduction

Energy is humans fundamental prerequisite, and it is a definitive gift for all essentials. Fuels from food serve as a great deal of vitality for regular day to day existences in various manners. The more significant part of our vitality prerequisites is met from non-inexhaustible sources such as non-renewable energy sources [1]. As a result of the wasteful usage of the world's oil assets, we have confronted a few emergencies before and are confronting a comparative circumstance soon. Bioethanol is viewed as one of the most reasonable fuel where numerous nations, including the United States, Brazil, and China, have permitted the mixing of bioethanol into fuel [2-4]. At present, most bioethanol is created from starch or sugar-based feedstock, for example, corn grain (US and China) and sugar stick (Brazil) [5].

Maize is not just utilized as food and feed, besides as feedstocks for sustainable fuel ethanol creation [6]. Fuel ethanol production through organic aging of sugars removed from sugar-rich yields, (for example, sugar stick) and boring harvests, (for example, maize, and wheat) is effective in practice today. Ethanol from lignocellulosic materials is still in the early formative/trail stages [6, 7]. Maize production in India accounts for the third-largest harvest after rice and wheat. Maize that gives food, feed, and grub and fills in as a wellspring of essential crude materials for a few mechanical items, principally starch, maize oil, maize syrup, mixed drinks, beauty care products, and biofuel [8, 9]. Harvest yields held pace with quickly expanding worldwide populace. The available biomass can be used for improved cellulosic innovations like plant rearing that guarantee to improve both the quality and amount of grain. Because of the profitability, India now the giant producer of the maize. This pattern is probably going to proceed, and the overabundance from the food gracefully can be utilized to make sure about us on the vitality stage and to expand the future fuel request of the nation as an individual and overall [1].

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2. Methodology

Ethanol is created by fermenting 6-carbon sugars (principally glucose) through the glycolytic pathway. Corn starch is utilized as a feedstock for hydrolysis, where glucan is changed over to glucose by catalyst hydrolysis and glucose aging to ethanol by yeast [6]. The detailed process was described in Figure 1 with slight modification described previously [5, 6, 10].The mature pound is isolated into ethanol and deposits (utilized for feed creation) by refining. Fine corn flour is mixed with water to form slurry called "mash." The liquefaction of corn flour is carried out in a 1-liter flask with 500 g total mixture. α-amylase is added, then the temperature of cornflour slurry is reduced to 85 °C and is maintained for 4 hours at a waterbath. The saccharification by the glucoamylase enzymes, the glucose syrups were produced by the hydrolysis of remaining oligosaccharides.

Furthermore, the conditions were maintained at the temperature of 55–60°C and pH 4.2–4.5 for glucoamylase activity. After the saccharification of the mash, the Mash was cooled and transferred to a fermenter. *Saccharomyces cerevisiae* was added to the fermentation process, where the whole process requires 48-72 hours, with the concentrate rate up to 10-12% of ethanol. Further, separation of the solid and liquid phase of the mash, the distillation process was performed. The remaining liquid content in the Mesh was removed by dehydration [5], and the available DDGS can be used as animal feed (Figure 2).

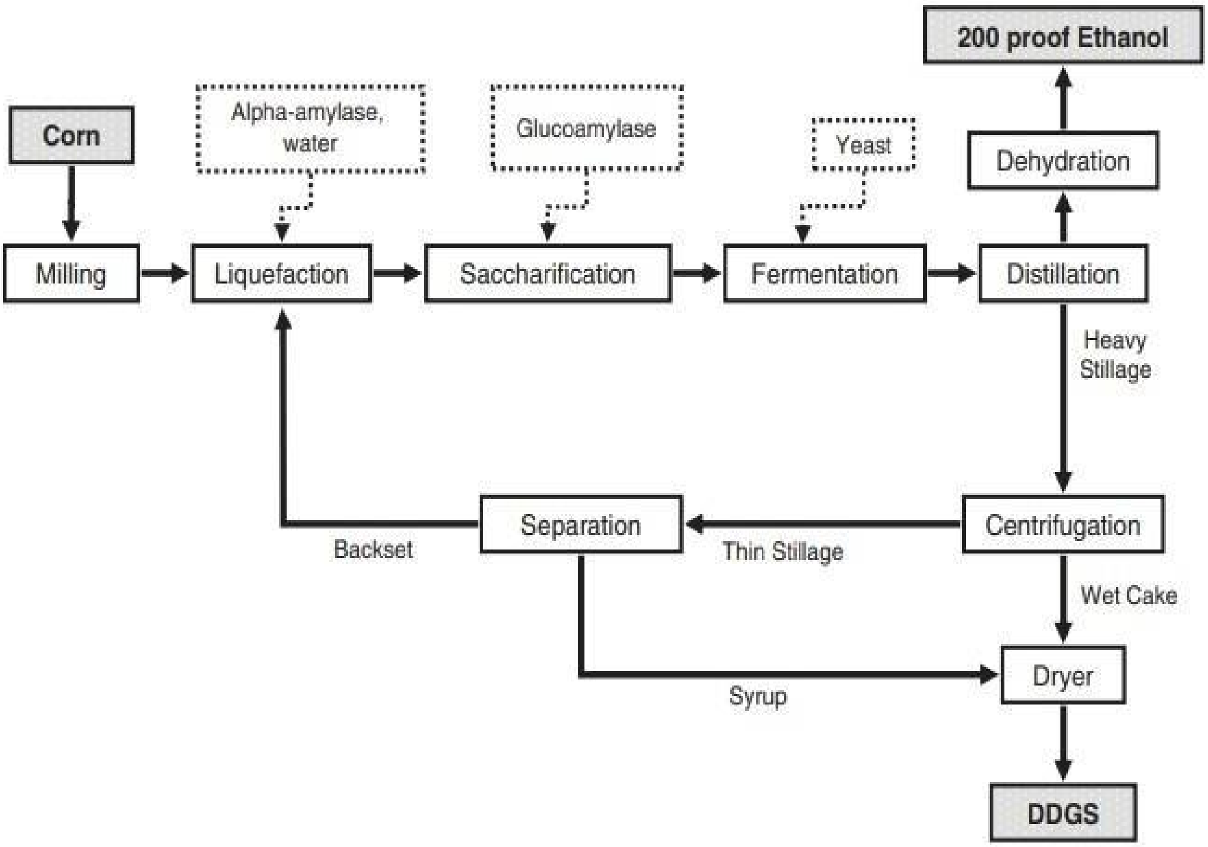

Figure 1. Process followed for ethanol production

3. Plant Design

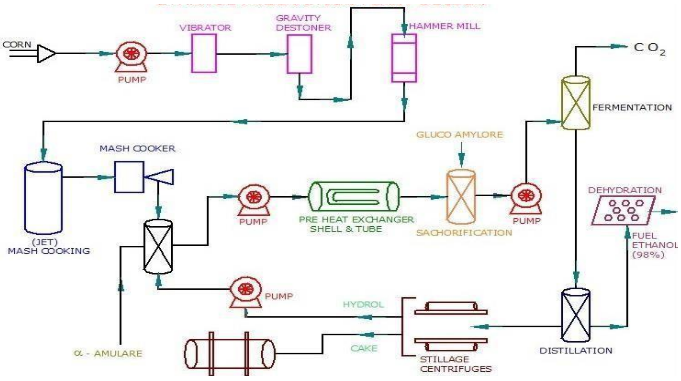

Figure 2. Plant design for ethanol production

4. Result and Discussion

All our critical experimental procedures were conducted at room temperature. The level of bio-ethanol yield (%) and specific gravity (SG) was calculated by the formula (1) and (2), respectively. The parameter for each process was carefully considered, as recorded in figure 3. The values of the quantitive test for alcohol product was analyzed (Table 1). A comparative analysis with standard alcohol with the current alcohol production was presented the table 2.

$$\%\text{yeild} = \frac{\text{weight of sample (corn)used}}{\text{weight of distillate (ethanol)}} \quad (1)$$

Where the weight of sample: 885g; the weight of beaker:55.1g; the weight of distillate beaker: 129.72g; the weight of distillate:129.72 – 55.1g = 83.49g

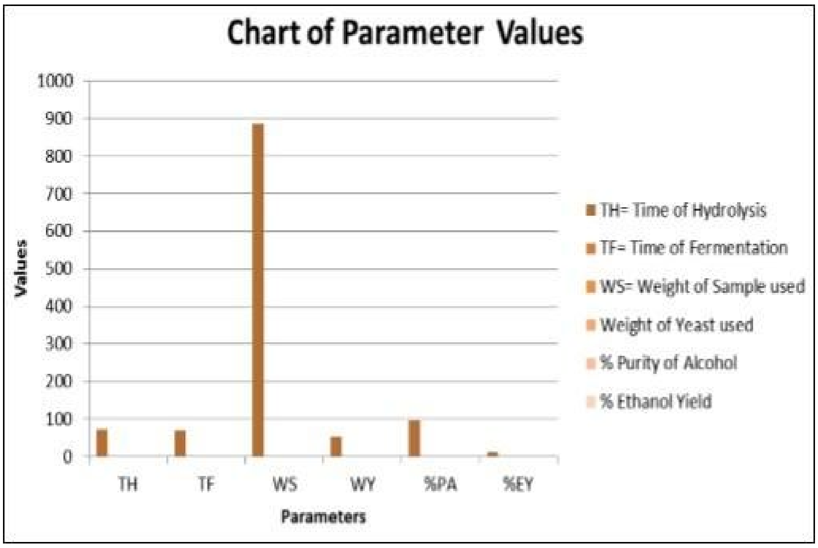

Figure 3. Process scaled on the parameters against achieved values

Specific gravity

$$S.G\ of\ ehanol = \frac{weight\ of\ ethanol}{weight\ of\ water} \quad (2)$$

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Weight of SG bottle: 7.9g; weight of S.G bottle +water : 29.87g; weight of S.G bottle + ethanol: 23.6g S.G of ethanol : 23.6/29.87 : 0.79

Table1. Values for the quantitative test of alcohol

Parameters	Values
Temperature (°C)	29
pH	9.2
Refractive index	1.35
Specific gravity	0.85
Relative density	0.73
Boiling point (°C)	783.7
Melting point (°C)	-1114°C
State at 25°C	Liquid
Color	Colorless
Odor	Characteristics

Table 2. Comparative quantitative analysis of standard and experimental alcohol produced from Maize

Parameters	Standard value	Experimental
Temperature	27	29
pH	9.2	7.30
Refractive index	1.40	1.35
Specific gravity	0.79	0.85
Relative density	0.8	0.73
Boiling point (°C)	780-787	783.70
Melting point (°C)	-1150 °C	-1114°C
Colour	Colorless	Colorless

The production of ethanol from corn by utilizing the straightforward refining process was adopted. The available corn grains are gathered as a crude material, which was initially hydrolyzed for 72 hours to convert starch to maltose completely. At the aging time frame of about 96 hours, the complete conversion of all the glucose, fructose absolutely, and sucrose into cell vitality and in this way to deliver ethanol and carbon dioxide as metabolic waste pro-weight. The total amount of corn utilized for the production of ethanol was 885 grams. This critical measure of corn test was utilized to guarantee that a considerable amount of ethanol was extricated. The amount of *Saccharomyces cerevisiae* was added is 52.2g to help advance the pace of aging of corn. The level of ethanol produced was evaluated to be 10.6 percent. The low yield of ethanol shows that the corn has less ethanol content in contrast with potatoes, where the ethanol yield was observed at 38 to 45% [11]. Moreover, corn as a crude material for ethanol production could not be affordable because of its low rate yield. The level of virtue of liquor production was resolved to be 95% [8]. Furthermore, the ethanol from potato has a parentage virtue of 95%, which is similar to corn ethanol. This observation determined that ethanol from corn has a similar caliber to that of potato. The quantities analysis it was revealed that the temperature of the liquor was 29 ° C, in contrast to RT of 27 ° C. The pH was esteemed at 9.2, showing that ethanol is exceptionally basic. With the specific gravity (S.G) of 0.79, ethanol from corn is slightly heavier than water (0.85). Other analysis, such as boiling point (78°C), and melting point (1114°C) shows that the liquor is mostly unpredictable. At the temperature of 25°C, the ethanol was found to be at a liquid state.

5. Conclusion

India is a developing economy and is the fourth largest client for petroleum product on the planet, with the imports of around 70%. The mission for ecologically economical and sustainable power source alternatives like ethanol can be mixed with gas that could be utilized as biofuel. India, on the other hand, the largest in the world for maize production. This reason India developing alternative fuels form the plant product that is grown. Besides, comparative production from different harvests which contains more starch also makes their place as a source for alternative fuel production. Maize, herein we produced, can also be used for the production of ethanol, which can benefit economically as well as for the value-added products.

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