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Production of Ethanol from *Opuntia monocantha* By Means of the Exploitation of Commercial Yeast

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Abstract

In arid regions, the cactus (Opuntia monocantha) is an invasive species. Numerous studies on the physicochemical characteristics of its cladodes have been conducted, which supports their value as a novel energy source. Furthermore, in addition to being a medical plant, Opuntia monocantha may also be the source of novel materials like leather, plastic, and so forth. Our study's objective is to evaluate the potential for producing bioethanol from Virudhunagar district Opuntia monocantha. We employed a number of procedures for this manufacture, including raw material reduction, grinding, gelling, fermentation, and distillation. To determine whether the yeast used the glucose to produce ethanol, the amount of glucose in cladodes is tested both before and after fermentation. The glucose is estimated using the Anthrone method. The ethanol produced at 78.3°C is clarified by the distillation process and examined using the quantitative potassium dichromate technique. However, correction and other modifications are required before this product may be commercialized.

Keywords: Cactus, Fermentation, Ethanol

Introduction

The energy problem calls for research into and the development of novel methods for producing renewable chemicals as alternate energy sources, including an important substitute is the production of ethanol from renewable resources. Since ethanol is similar to gasoline

fuel in many ways, it is really being investigated extensively as a renewable fuel source. (Jones AM *et al.* 1994) Due to this circumstance, ethanol, particularly from cacti, is being used as fuel in numerous nations, including Brazil. Many biomass sources are now being investigated as raw materials for the synthesis of biofuels, particularly ethanol. (Armanul N *et al*. 2017) The CAM (Crassulacean Acid Metabolism) metabolism, high water retention capacity, and other adaptations of the *cactaceae* family allow prickly pears to be grown in desert conditions. (Damyanov A *et al*., 2019) The morphological and physiological alterations that led to the CAM photosynthetic process, which gives the plant extraordinary drought resistance, are primarily responsible for the unique ability of prickly pears to adapt to their surroundings. A range of commercial goods that can be sold domestically, regionally, and internationally can be made in India using sugarcane resources as well as abroad. The three products that are particularly significant from an economic and environmental standpoint are energy, ethanol, and sugar. In light of its nontoxicity, high oxygen content accumulation to improve combustion and reduce exhaust emissions, and high octane rating to provide a high resistance to engine knock, ethanol is an environmentally friendly fuel that has a significant advantage over conventional gasoline as a transportation fuel. (Randremahitsimanana FT *et al*., 2022) Our study aims to highlight the potential of several cactus cladode components for bioethanol synthesis.

Material and methods

Sample Collection

Cactus cladodes were gathered from the Virudhunagar district's T.Kallupatti. Commercial Yeast was purchased from shop situated at Virudhunagar.

Exposed plant parts

Cladodes were the plant sections that were considered for our experiments. Cladodes were selected according to their maturity. Due to the fact that mature cladodes contain more sugar than young ones.

Pre-treatment of Cactus

Shaving toward raw materials

Selecting high-quality raw materials is a step in the reduction of raw materials. They were compared in terms of nature, maturity, origin, and sugar rate.

Turning

In this process, the raw materials are crushed using an electric centrifuge in addition to a mixer or mortar. This will make fermentation easier.

Fermentation

The process by which organic substances, like sugars, break down into alcohols like bioethanol is called fermentation. For the fermentation procedure, basic commercial baker's yeast can be utilized. The bakery yeast is added to the mixture after the cladodes have been crushed. The liquid is then combined and dumped into a closed tank that has an outlet inserted into the water. The limitations of fermentation result from the fact that the yeast used to ferment glucose is more effective than the bacterial strains used to ferment pentoses.

Estimation of Glucose of Cactus

Reagent preparation

Anthrone 200mg was dissolved in 100ml of 75% of Sulphuric acid. After the reagent was prepared it is left for 45. It is freshly prepared one.

Stock solution

100 mg of Glucose was dissolved in 100ml of distilled water, which is kept as stock solution.

The Working standard

The working standard was diluted as 10:100.

Procedure

- Different volumes of Glucose solution such as 0.2ml, 0.4ml, 0.6ml and etc were pipetted out into dry clean test tubes.
- The volume of the solution were made upto 1ml using distilled water.
- A blank was prepared using the 1ml of distilled water.
- The Cactus extract was also processed by the above manner.
- To all above solutions including 4ml of Anthrone was added and vortex, cover the tubes with aluminum foil and secure it with rubber bands.
- The tubes were placed in a boiling waterbath for 10 minutes.

After cooling, the optical density was measured using a UV spectrophotometer at 630nm and a standard graph was plotted.

Synthesis of Bioethanol

The technique of producing bioethanol is similar to that of a distillery but has amazing scale. The raw components must first be reduced and then fluidified if they are not yet sweet and liquid. They mold the raw material. The Enzymes must first convert all the carbohydrates in this mixture into sugar. The must then begins to ferment as yeasts convert the sugar in it to alcohol. Following the completion of fermentation, distillation is used to separate the alcohol from the must.

Distillation

The method of distillation, also known as classical distillation, involves selectively boiling a liquid combination of two or more chemically distinct compounds and then condensing the vapors in a still to separate the constituent elements.

Analysis of Ethanol

It was done by the Potassium di chromate method in Qualitative manner. Through the use of a redox titration, excess potassium dichromate in sulfuric acid reacts with ethanol to oxidize it to acetic acid. As the oxidizing agent, the dichromate is converted to chromium (III). This makes it possible to measure the amount of ethanol. It is indicate by the color change of orange to green.

Reagent Preparation

33.768g of $K_2Cr_2O_7$ is mixed with the 325ml sulfuric acid, then makeup to 1 liter by adding distilled water.

Result

Prior to fermentation, the cladodes had a sugar content of 135mg/ml, which has since decreased to 95mg/ml. After the combination has matured in the tank for four days, the distillation process starts. After fifteen minutes, the first drop of bioethanol is visible. It contains 0.08% of ethanol.

Table 1: Ethanol Production

Initial Mass	250g
Water	250ml
Inoculation of Commercial yeast	10g
Sugar level before fermentation	135mg/ml
Sugar Level after fermentation	95mg/ml
Temperature during distillation	78.3°C
First drop collected after	15minutes

Sample Collection

Sample was collected from the T.Kallupatti in Virudhunagar in the early morning. (Fig:1) Commercial Yeast is purchase from the near shop in Virudhunagar. (Fig: 2)

Fig: 1 Cactus

Fig: 2 Commercial Yeast

Fermentation

Fig: 3 Pretreatment

Fig: 4 Turning

Fig: 5 Fermentation tank

Estimation of Glucose

Table 2: Carbohydrate estimation before Fermentation

S.No	Tube Name	Volume of Glucose (ml)	Volume of water (ml)	Anthrone (ml)	At 630nm
1.	Blank	-	1	4	0
2.	0.2	0.2	0.8	4	0.545
3.	0.4	0.4	0.6	4	0.688
4.	0.6	0.6	0.4	4	0.840
5.	0.8	0.8	0.2	4	0.982
6.	1	1	-	4	1.17
7.	Sample	0.1	0.9	4	1.14

Table 3: Carbohydrate estimation after Fermentation

S.No	Tube Name	Volume of Glucose (ml)	Volume of water (ml)	Anthrone (ml)	At 630nm
1.	Blank	-	1	4	0
2.	0.2	0.2	0.8	4	0.344
3.	0.4	0.4	0.6	4	0.413
4.	0.6	0.6	0.4	4	0.503
5.	0.8	0.8	0.2	4	0.653
6.	1	1	-	4	0.714
7.	Sample	0.1	0.9	4	0.673

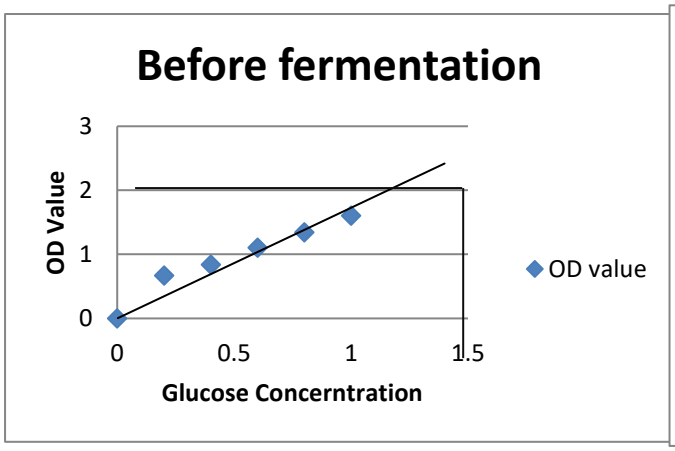

Fig: 6 Before fermentation

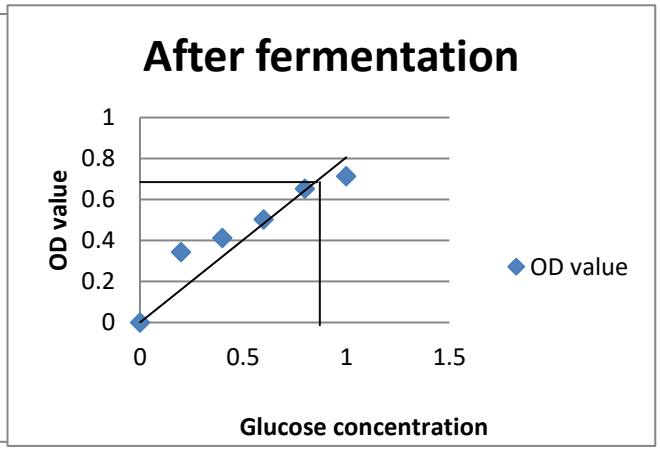

Fig: 7 After fermentation

Distillation process:

Fig: 8 Distillation process

Analysis of Ethanol

Potassium di chromate method

The orange to green color shift indicates the presence of ethanol**.** 30µl of distilled sample contains 0.8% of ethanol.

Fig: 9 Before adding Distilled solvent

Fig: 10 After adding Distilled solvent

Table 4: Ethanol Concentration

S.No	Concentration	Volume of ethonol	OD value
1.	2%	0.1ml	0.824
2.	4%	0.2ml	1.62
3.	6%	0.3ml	2.5

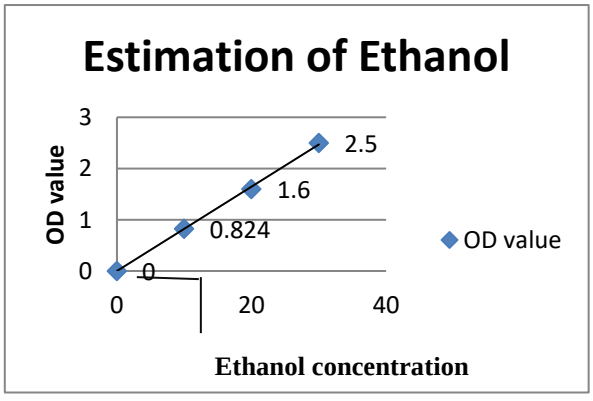

Fig. 11: Ethanol analysis

Discussion

To ensure effective fermentation, the crushed cladodes have been gelled. Gelation is the stage to use if you want a better outcome while extracting bioethanol from the cladodes of *Opuntia monocantha*. According to certain studies, which use enzymatic fermentation as their method, *Opuntia monocantha* is a good substitute for producing bioethanol in semi-arid areas at a reasonable cost. (Randremahitsimanana FT *et al*., 2022)

Conclusion

Given the important function that energy plays in a nation's economy, this project will be crucial to its growth. Because pear fig branches can be used as chemical fertilizer in addition to bioethanol and biogas, it might enable us to create new goods. Cacti are a preferred plant of arid regions because, out of all the thousands of plants that exist, they are the least thirsty. The present research demonstrated that bioethanol may be produced from the cactus *Opuntia monocantha*. Therefore, the exploit would be very advantageous as it gives us a lot of chances to produce a number of new subjects that will aid in the preservation of nature.

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