PRODUCTION OF BIOETHANOL FROM BANANA PEEL

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***ABSTRACT*:** Fossil fuel and conventional fuel resources are currently declining. Bioethanol can be used as an alternative source to meet the fuel's requirements. Banana peels are used in the manufacturing of bioethanol, a renewable energy source. Bioethanol can be produced from lignocellulose agricultural waste. Pre-treatment and hydrolysis are essential processes in the synthesis of bioethanol. Both methods are used. H2SO4 was used in the hydrolysis process. The active strain that ferments sugar to produce bioethanol is S. Cerevisiae. The potassium dichromate method's absorption spectra at 600 nm were used to determine the amount of bioethanol. The pre-treatment stage is crucial to the production of bioethanol. In Bagalkot, there are numerous farms with banana plantations, and the trash from these farms is readily available and economically viable throughout the year.

KEYWORDS- Banana peels, Bioethanol, Fermentation.

INTRODUCTION:

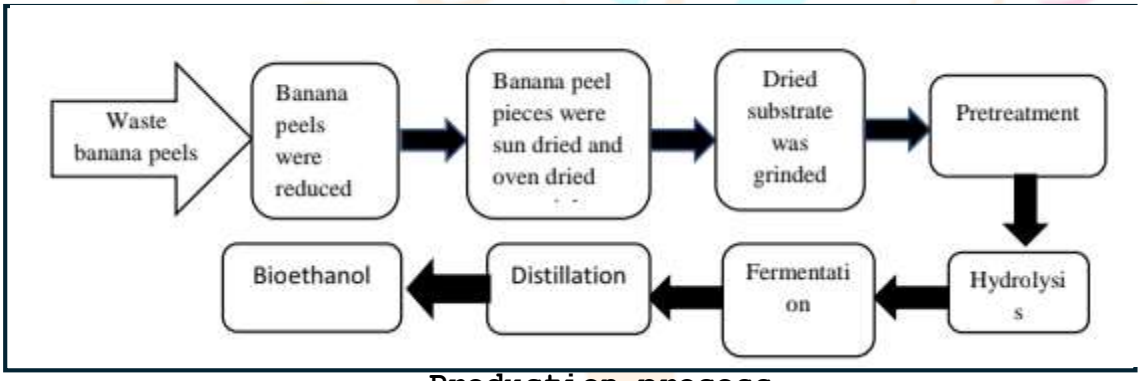
The growing global energy demand and the need to mitigate climate change necessitate a shift towards sustainable, renewable fuels. Due to the depletion of fossil fuels, bioethanol has drawn particular attention globally as an alternative energy source. The primary raw material used to produce ethanol in India is sugar cane molasses. However, the primary obstacles to its utilisation are its limited supply and rising expense. Although cellulosic resources are more readily available and less expensive, the process of turning them into ethanol is costly and requires several processes.

In these situations, using renewable substrates like fruit waste requires a new strategy. After rice, corn and milk, bananas rank fourth among the most important foods in the world and are one of the main food resources (INIBAP, 2002). According to Mamma et al. (2008), the majority of fruit peels and residues are dried, crushed, and palletised before being supplied to feed manufacturers at a low cost. According to FAO data, India is the world's biggest banana producer, making up around 30% of global production. Of bananas. Despite being a fruit leftover, banana peel makes up 30 to 40 percent of the fruit's weight (Emaga et al., 2008) and has substantial levels of fibre, proteins, and carbs. Despite having a high carbohydrate content and other essential ingredients that can promote yeast growth, banana peels are an easily accessible agricultural waste that is underutilised as a possible growth medium for yeast strains (Brooks, 2008; Essien et al., 2005; Hueth and Melkonyan, 2004). Banana peels could be an excellent substrate for the manufacturing of value-added products like ethanol because they contain lignin in small amounts (Hammond et al., 1996).Research studies are currently focused on two areas: the production of ethanol from less expensive raw materials and the investigation of novel microorganisms or yeast strains effective in ethanol production (Favela-Torres et al., 1986; Pandey et al., 2000; Akin-Osanaiye et al., 2008) in order to make the fermentation process cost-effective and to meet the high demand for ethanol. In this regard, ethanol can be produced at a low cost using affordable raw materials as cellulosic, agricultural, fruit, vegetable, municipal, and industrial wastes (Park and Baratti, 1991; Schugerl, 1994; Joshi et al., 2001; Akin-Osanaiye et al., 2008). Using the right microbial strain, fermentation substrate, and process technology will increase the yield of ethanol produced by microbial fermentation. Rapid fermentative potential, enhanced flocculating ability, acceptable somnolence, improved ethanol tolerance, and strong thermo tolerance are all necessary for an optimal microbe employed in ethanol production (Benitez et al., 1983; Divanya et al., 1992). In the

majority of these research, The S. Cerevisiae has been a favoured option for the industrial production of ethanol. Additionally, yeast can create ethanol that is uncontaminated by other substrate products (Jones et al., 1981). A three-step process is typically used to produce industrial and fuel ethanol from starchy biomass (Laluce and Mattoon, 1984): (i) liquefaction of starch by an endoamylase like -amylase; (ii) enzymatic saccharification of the low-molecular-weight liquefaction products (dextrin's) to produce glucose; and (iii) fermentation of glucose to ethanol

In order to manufacture fuel alcohol from starchy materials, commercial amylases—typically those made by Aspergillus species—are utilised for the liquefaction and saccharification of starch. Since most perishable fruits are currently lost during their journey through the agrifood chain due to spills, physiological decay, water loss, mechanical damage during harvesting, packaging, and other factors, efforts have recently been focused on using inexpensive and renewable agricultural sources, like banana peel waste, as an alternative substrate for the production of alternative biofuel like ethanol. This study aims to evaluate a single-step system for the enhanced fermentation of banana peels to ethanol using symbiotic cocultures of Aspergillus Niger and Saccharomyces cerevisiae, as well as to eliminate the enzymatic liquefaction and saccharification step using amyl lytic and sugar-fermenting organisms.

BIOETHANOL PRODUCTION PROCESS:



Production process

The conversion process is modular and requires optimization at each stage for maximum sugar recovery and fermentation efficiency.

1. Pre-treatment (Step of Decrystallization) By dissolving the peel's inflexible structure, pre− treatment makes cellulose and starch more accessible to enzymes.

- Diluted Acid Hydrolysis: Applies high-temperature diluted HCl or H_2SO_4. Extremely successful in hydrolysing hemicellulose, yet it may result in the production of inhibitory substances such furfurals.
- Alkali Treatment: The biomass is swelled and lignin is removed using NaOH. Because there is less inhibitor production, this is desirable, although it can eventually call for larger enzyme loading.
- Hydrothermal Pre-treatment: This environmentally friendly alternative uses steam and hot water, however it is frequently less successful than chemical techniques.

2. Hydrolysis by Enzymes (Saccharification) Following pre-treatment, a mixture of enzymes, mainly celluloses and amylases, hydrolyse the treated peel to produce fermentable sugars (glucose). Enzyme loading and incubation conditions are compared in reviews.

3. Methods of Fermentation (Ethanol Conversion) : A. Separate Fermentation and Hydrolysis (SHF) This comprises successive steps and two different vessels. High sugar concentrations during the hydrolysis step can result in end-product inhibition of the enzymes, even though it is simpler to optimise temperature and pH at each stage.

B. Saccharification and Fermentation at the Same Time (SSF) This makes use of a single tank where yeast and enzymes operate simultaneously. Higher total ethanol yield and lower capital costs result from the yeast's constant elimination

of glucose, which reduces enzyme inhibition. According to numerous reports, SSF is the most effective method for converting banana peels.

MATERIALS AND METHODS:

Isolation of microorganisms and its Maintenance :

At three different locations, soil samples were taken at random from the top two centimetres of the soil profile. From each location, about 50 g of soil were gathered, placed in plastic bags, and transported to the lab. For 24 to 48 hours, soil samples were allowed to air dry at ambient temperature (27±1°C). Stones and plant remnants were eliminated from the dried soil samples. Five millilitres of sterile saline (0.9% NaCl) were added to labelled test tubes holding 100 mg of each soil sample (Knudsen et al., 1995). 30 mg/l of streptomycin was given to inhibit the development of microorganisms. The test tubes were combined using a vortex. A spreader was used to evenly distribute 100 µl of each suspension onto PDA plates, which were then incubated at 27±1°C. After five to seven days, mixed colonies were seen on the plates. The streak plate method was used to establish a pure culture of Aspergillus niger. After that, it was kept at 4 orc on PDA slants. We purchased Saccharomyces cerevisiae (Bakers yeast) from the local market in Kwality, India. It was kept at 4oC on PDA slants.

Starch hydrolysis test of isolated strains of Aspergillus niger :

A sterile starch agar plate was streaked with an inoculum from a pure culture. For five to seven days, the infected plate was incubated at 27°C. The growth was then flooded with iodine reagent. The colonies' ability to digest the starch was confirmed by the presence of a clear zone surrounding them, which also suggests the presence of alpha-amylase.

Pre treatment of Banana peel substrates :

Banana peel wastes were procured from local market in Allahabad, Uttar Pradesh, India. Before processing ripe waste banana peels, it was cleaned, chopped (3-5 cm) and disinfected with 70% ethanol. It was sun dried for 7 days and ground to fine powder.

Simultaneous Saccharification and Fermentation (SSF) of Banana peels :

In 200 ml flasks with 5g of powdered banana peels and 96 ml of distilled water, ethanol fermentation was conducted. Aspergillus niger (4% v/v) and Saccharomyces cerevisiae (3% w/v) inoculums were introduced to the flasks after they had been autoclaved for 30 minutes at 121°C to sterilise them. The amount of ethanol was measured every 24 hours during the seven days of fermentation.

Effect of temperature, pH and yeast Inoculum on ethanol production :

Banana peels were fermented at various temperatures (20°C to 50°C) and pH levels (4 to 7) at 30°C. The ideal pH and temperature found throughout the experiment were employed for fermentation at various yeast concentrations, ranging from 3% to 12%.

Estimation of ethanol content by gas Chromatograph :

The ethanol concentration was measured using a gas chromatograph (Chemito, 2000) with a flame ionisation detector (FID) and a data collecting system with computer software (IRIS 32). A 30-meter capillary column was installed. For the liquid sample, temperature programming was used. Analysis. The oven temperature was kept at 80°C throughout the examination. The temperatures of the injector and detector were 120°C and 160°C, respectively. The carrier gas (nitrogen) flow rate was set at 30 millilitres per minute. The volume of the injection sample was 0.2 l. 0.2 µl of normal ethanol was utilised. It was discovered that the area of normal ethanol was 1500. The data points were presented for each set of experiments.

RESULT :

The investigation's findings demonstrated that a sizable amount of ethanol was created by the fermented banana peels. Variations in temperature, pH, and yeast concentration all affected the volume of ethanol produced. Additionally, it was changed according on the fungal strains and fermentation duration.

CONCLUSION:

The study shows that fermenting banana peels can produce bioethanol, which could be a low-cost substitute for fuel and energy production. Banana peels can be used to reduce pollution and biologically convert cellulose to fermentable sugar for the environmentally friendly production of bioethanol.

CHALLENGES AND CONSTRAINTS :

1. Toxicity of Inhibitors Fermentation inhibitors may be released during pre-treatment. Before adding the yeast, it is crucial to detoxify the hydrolysate using techniques like over liming, activated charcoal, or resin treatment.

2. Pentose Sugar Utilisation Hemicellulose is the source of xylose, a pentose sugar found in banana peels. Lower yields result from the inability of conventional Saccharomyces cerevisiae yeast to metabolise xylose. To use the whole sugar fraction, research is concentrating on genetically altered xylose-fermenting microbes.

3. Financial Sustainability The primary obstacles to industrial-scale adoption continue to be the high cost of cellulase enzymes and the energy required for pre-treatment and distillation. Commercialisation requires enhanced enzyme technology and process integration.

BIOREFINERY CONCEPT: PROSPECTS FOR THE FUTURE :

Future research must move from basic waste-to-ethanol to a lignocellulose bio refinery in order to make the process economically viable. The goal of this model is to value each component:

- activated carbon from leftover lignin/solids;
- High-value compounds (such as xylitol and organic acids) from hemicellulose;
- Ethanol from starch and cellulose.

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12. Bio-Ethanol Production from Banana peel by Simultaneous Saccharification And Fermentation Process using cocultures Aspergillus niger and Saccharomyces cerevisiaeAjay Kumar Singh*, Sanat Rath, Yashab Kumar, Harison Masih, Jyotsna K. Peter, Jane C. Benjamin, Pradeep Kumar Singh, Dipuraj, Pankaj Singh