Utilization of Banana and Beetroot waste for Bioethanol Production

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Abstract :
Alcohol is more demanded chemical in various areas including fuel and industrial applications. To fulfill the demand, fermentation and production of alcohol receives special attention. In present study attempts made to use fruit waste and *Saccharomyces cerevisiae* to produce alcohol. In all five combinations of media, banana peels, beet waste and 5th, 10th, 15th and 20th days incubations were studied for higher alcohol production. Standard media and dextrose inoculated with *S. cerevisiae* produced highest alcohol in all incubations except 15th day, this was followed by media and beet waste showed maximum i.e. 1.98% production on 15th day. On the other side banana peels and beet waste in distilled water inoculated with *S. cerevisiae* produced least amount of alcohol percent. This study showed the easiest method to produce alcohol from banana and beetroot waste.

IndexTerms **- Alcohol, Banana peels, Beetroot waste.**

I. INTRODUCTION

Ethanol has wide applications in various industries and industrial purposes like solvents, cleaning agents and preservatives. Moreover starting from alcohols, a number of organic compounds can be prepared such as alkyl halides, aldehydes, ketones, carboxylic acids, ethers, etc; in industries. Alcohols are also served as solvents for many organic reactions as well as in crystallization.

The production of ethanol by fermentation of corn and other food feed crops is well-known technology. Many countries including United States desperately need a fossil oil replacement in future. The oil use projected to peek by 2007 and the supply is then reach to the extremely limited in 40-50 years (Pimentel D et al 2005). Several forms of biological recourses are available (starch or sugar crops, weeds, agricultural, forestry and municipal waste) but among all cellulosic resources represent most abundant (Park et al, 1995). Another source of liquid fuel from different sources have been attempted to find. Cost of the raw material is also act on the production and is significant factor affecting the economy of alcohol. Recently efforts are more concentrated on using cheap and abundant raw materials (Chand et al, 2009).

Ethanol production from biomass can be summarized briefly into following steps: depolymerization of holocellulose polymer into monomeric fermentable substrate, fermentation of depolymerized substrate, and the distillation of the fermentation broth to obtain dehydrate ethanol (Matharashi et al, 2018).

Depleting reserves and competing industrial needs made global emphasis in alcohol production by fermentation. Fermentation depends on the use of ideal microbial strain. An ideal microorganism must have various qualities including rapid fermentative potential, good flocculation ability, enhanced alcohol production and good thermo tolerance (Brook, 2008). Among different microorganisms few yeast strains have been found to posses appreciable characteristics for alcohol production (Hacking et al, 1984).

Recently the several researchers are working on the production of alcohol from natural sources by fermentation method. This is the new and easy method where the alcohol production is possible at low economical budget. Although from ancient period the alcohol is being used for various purposes the most frequent application of alcohol is for beverage purpose. The general methods from the last 5 decades which are constantly used are fermentation of grapes, fruits and many plants extracts (Patil, 2020). Unlike fossil fuels, ethanol is a renewable energy source produced through fermentation of sugars and used as a partial gasoline replacement in a few countries in the world. Ethanol production through fermentation may provide an economically competitive source of energy (Wang et al, 1999).

Bananas are the main fruit in international trade and the most popular one in the world for their contents which are used for the bioethanol production. According to Food and Agricultural Organization (FAO) statistics, India is the largest producer of banana in the world and accounts for nearly 30% of the total world production of banana. Banana peel is a fruit residue, it accounts for 30 40% of the total fruit weight (Emaga et al, 2008). Banana peels and beet waste are agricultural waste, yet they seem to be under utilized as potential growth medium for local yeast strain, carbohydrate and other basic nutrients may be used as supportive medium for yeast growth (Hueth & Melkonyan 2004).

Recently, Banana peel has been utilized for various industrial applications including bio-fuel production, bio-sorbents, pulp and paper, cosmetics, energy related activities, organic fertilizer, environmental cleanup and biotechnology related processes (Morton, 1987).

Beetroot (*Beta vulgaris*) is a traditional and popular vegetable in many parts of the world including India. It is the taproot portion of the beet plant. It is especially rich in fiber as well as in sugars and has a moderate caloric value. It also has several bioactive compounds like betalains, carotenoids and is a powerful dietary source of nutrients (Dhawan & Sharma 2019). The processing of sugar beets to make bioethanol can be a convenient process, if it has ecological benefits and can be produced on large scales without affecting food provisions (Vucurovic,et al. 2012). Red beets in Mexico are used in the colorants industry, but their juice and bagasse can be sources of carbohydrates for ethanol production. The microorganisms that can be used for ethanol production include fungi such as *Mucor indicus* (Karimi et al, 2006, bacteria such as *Zymomonas mobilis* (Rogers et al, 2007) and

yeast such as *Kluyveromyces marxianus* (Sansonetti et al, 2011). However, *Saccharomyces cerevisiae* is the most commonly used yeast in industrial ethanol production (Benjaphokee et al, 2012).

Bioethanol from agricultural and biodegradable wastes provides a viable solution to multiple environmental problems by simultaneously creating sink for waste and renewable energy production as well. Using ethanol blended fuel for automobiles can significantly reduce petroleum use and greenhouse gas emissions (Wang et al, 1999).

II) MATERIALS AND METHODS:

Source of Banana and Beet peels Pretreatment of raw material:-

The ripe banana peels used in this study was collected from local market and beet waste was obtaining from local juice centre. The fresh peels were used within 24 hrs after collection. The collection of material was done in sterilized polythene bags. It was washed with sterile distilled water cleaned, chopped (3-5 cm) and disinfected with 70% ethanol.

De-Pectinazation of Banana Pulp Using Pectinase Enzyme

Pectinase enzyme was added to the banana paste/pulp at a concentration of 0.0003% (w/v) and left for 5-6 hours in incubation at 38°C, with occasional stirring.

Preparation of media and waste combination

Different combination of media and waste were prepared as per Dhabekar & Chandak (2010) and given in table no. 1. Each combination prepared was inoculated with 1% culture of *Sacromyces cerevisiae*. All the flasks were incubated at 36°C for 20 days. Production of ethanol was estimated at interval of 5^{th}, 10^{th}, 15^{th} and 20^{th} day. All this methods were performed thrice and the mean of the data collected were considered for the final result.

Estimation of ethanol production:-

Estimation method used by (Dhabekar & Chandak 2010) was applied to estimate the ethanol produced. Alcohol sample is treated with known volume of dichromate, part of this dichromate is used in this reaction and the remaining part of it is titrated against hypo solution (Sodium thiosulphate). The utilized dichromate is calculated and concentration of alcohol present in the given distillate can be easily determined. 5ml of dichromate was added to 1ml of filtrate and kept the test tube in ice bath, 5ml conc. H_2SO_4 was added to it slowly with constant stirring and kept in boiling water bath for 5-7 min cooled transferred to an flask containing 1gm of KI, mixed and titrated against hypo solution by adding drop of starch indicator until appearance of brown color, calculated from 1ml of filtered fermented broth.

Titration:- After equal time intervals; readings were taken by titration through percentage by volume ratio; by using following formula

Alcohol Factor = Normality of hypo x vol. of hypo/ Normality of dichromate solution.

Gram % of alcohol = Y x alcohol factor x100

III) Results and Discussion

In present study it is clearly observed that media and banana peels produces 1.75%, 1.78%, 1.87% and 1.82% product on 5^{th}, 10^{th}, 15^{th} and 20^{th} day respectively, among the incubations 1.87% was observed highest percent on 15^{th} day. In distilled water banana peels fermentation process 0.65% was the highest concentration on 15^{th} day, same combination with beetroot waste shows production of 0.56% alcohol production on 15^{th} day. Most significant results were observed in media and beetroot waste i.e 1.98% on 15^{th} day.

The result of the present study showed that the fermented banana peels and beet waste produced a significant amount of ethanol. The volumetric production of ethanol was varied according to the variations in Incubation period. It is clear from the present study that media and beet combination produced highest amount of alcohol i.e. 1.98 on 15^{th} day as compare to others (Table No. 1) similar results was also obtained by (Dhabekar & Chandak 2010).

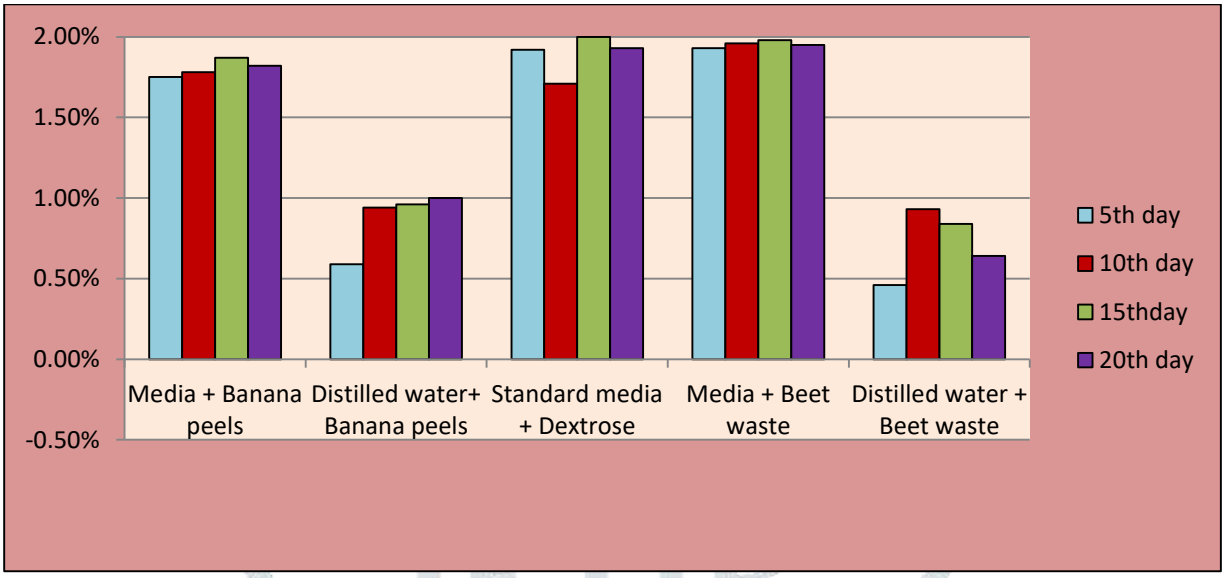
Singh et al, (2014) also obtained the increasing percentage of ethanol with increasing incubation period production using banana peels and combination of yeast and *Aspergillus niger*. It was found that the production of alcohol increased till the 15^{th} day but found decrease in concentration on 20^{th}. It is also clear from the study that media as substrate is important for production of alcohol as combination of distilled water and banana peels and beet waste produced lowest amount of alcohol i.e. 0.59% for banana peels and 0.46% for beet waste respectively (Graph 1). Among all the highest percentage of alcohol was observed in standard media with dextrose i.e. 1.92%, 1.71%, 2.00% and 1.93% respectively. It is also clear from the present study that production of alcohol is more in beetroot as compare to banana waste Table 1.

Patil, (2020) extracted high amount of alcohol from beetroot, the obtained product were tested against *Escherichia coli* and *Bacillus cereus* by agar diffusion method. The obtained product showed significant results i.e. 8mm and 16 mm zone of inhibition against *E. coli* and *Bacillus cereus* respectively.

Table No. 1: Production of Alcohol (GM %)

Sr. No.	Media + Substrate used	Incubation Period (in days)			
		5^{th} day	**10^{th} day**	**15^{th}day**	**20^{th} day**
1	Media + Banana peels	1.75%	1.78%	1. 87%	1.82%
2	Distilled water + Banana peels	0.59%	0.62%	0.65%	0.61%

3	Standard media with Dextrose	1.92%	1.71%	2.00%	1.93%
4	Media + Beet waste	1.93%	1.96%	1.98%	1.95%
5	Distilled water + Beet waste	0.46%	0.53%	0.56%	0.52%



Graph 1: Amount of alcohol obtained after various incubations period.

Another aspect on effect of temperature on production of ethanol was studied; it is observed that the 36°C was the optimum temperature to obtain maximum amount of product (1.96%) in media and banana peels. On the other hand 36°C was the optimum temperature to obtain maximum amount of product (1.68%) in media and beetroot peels. It is observed that increase in temperature leads to lower the production alcohol. (Table 2).

Table 2. Effect of temperature on production of ethanol

Temperature	Media + Banana peels	Media + Beetroot waste
30°C	1.89%	1.54%
36°C	1.96%	1.68%
40°C	1.23%	1.15%

Conclusion

Based on the results of the present study, we conclude that the banana peel and beetroot wastes offers new way for bio-ethanol production. Bioethanol from agricultural and biodegradable wastes provides a viable solution to multiple environmental problems by simultaneously creating sink for waste and renewable energy production as well. Using ethanol blended fuel for automobiles can significantly reduce petroleum use and greenhouse gas emissions (Wang et al, 1999). The choice of newer substrate for the production of ethanol is being a non-seasonal fruit available throughout the year. The waste from the plant can be efficiently utilized based on overall economics and energy. Production of bioethanol from agricultural waste residues using indigenous yeast isolates is very economical, especially when the fermentation conditions are optimized.

From the present study it is concluded that the production of alcohol is more convenient by using beetroot and media as the result showed more production of alcohol as compare to banana and media. It is also clear from the present study that the concentration of alcohol is more in standard media and dextrose combination, so it is necessary to modify the present combination of media and improved strain of *Saccharomyces cerevisiae*.

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