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Production of Bioethanol from Waste News Papers

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ABSTRACT
The waste newspapers were collected from home and subjected to ethanol production by enriching the medium with various nitrogen sources such as peptone, corn steep liquor, and ammonium sulfate. Cellulolytic Saccharomyces cerevisiae was used as a fermenting organism. The fermentation was carried out for 5 days. Specific gravity and the amount of distillate from each flask were measured. Alcohol percentage and yield per 100 g of the waste newspaper was calculated. The alcohol percentage of ethanol produced by waste newspaper enriched with peptone as nitrogen source was found to be 3.06%, enriched with corn steep liquor as nitrogen source was found to be 4.67%, and enriched with ammonium sulfate as nitrogen source was found to be 2.9 %. Paper waste is an economically affordable source of cellulose that can be easily available for ethanol production. More studies should be carried out for the evolution of economically affordable nitrogen sources along with waste like papers for getting a better yield of ethanol.
***Key words**: Ethanol, Newspaper, nitrogen, peptone, ammonium sulfate, Cellulolytic Saccharomyces cerevisiae*

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INTRODUCTION

Increase in the population over the last century leads to the increase of the energy consumption worldwide. To meet the increased energy demand crude oil has been used as the major resource. The global oil production would decline to 5 billion barrels from 25 billion barrels per year approximately. Due to this unavoidable depletion of the world petroleum resources in the coming years the worldwide interested aroused in seeking an alternative non-petroleum based energy source. One of the best alternative fuels in order to beat severely energy crises is from biofuel. Biologically carbon fixation the energy is derived from biomass. The various factors like need for increasing energy security and hikes and gaining the scientific and public attention the biomass are driven. The main substrates for ethanol production include sugar, starch or cellulose. The Bioethanol is one of the environment friendly fuels, the effects on environment is less because the Ethanol contains oxygen. With comparison to the conventional gasoline the blends of E10 resulted in 12-25% less emission of carbon monoxide [1]. The sugarcane and corn are the first-generation bio-fuels substrates. Due to vast increase in the ethanol production using these crops they cause immoderate pressure on the global food supply. The second-generation biofuel substrates can be different sources of complex wastes like waste chicken feathers, cellulosic biomass food, and organic waste. The cellulosic biomass, such as agricultural residue and industrial waste are the most abundant and cheap source of renewable energy in the world.

The second-generation biofuels substrates may also include the fuels produced from mixed paper waste which is separated from the municipal solid waste, cash crops Jatropha, Hinge, Cotton, Maize, can be utilized to produce bioethanol. The third-generation biofuels can be produced from micro-organisms mainly Algal waste. The fourth-generation biofuels produced from vegetable oil, biodiesel.

In developed and developing countries municipal wastes have become severe problem during the last century. The shrinking of landfill capacity resulted in rising of landfill costs which is mainly due to the waste paper from the municipal waste. Because of the above concern the waste paper is used as cheap source for the production of bioethanol. Due to the shrinking landfill capacity, the tighter environmental control exists on their siting operation, construction landfills and the unwillingness of communities to have new landfill sites nearby is problem some. The tighter environmental regulations are responsible for the premature closure of existing landfills and higher costs for constructing new ones. Among the various components the municipal solid waste consists of Food waste, wood, leaf, garden or yard trimmings, rubber, textile, leather, metals (ferrous metals or Non-ferrous metals), glass and major of paper and paper boards. About 35% to 40% by weight of the municipal solid waste is made of the paper. Though the earlier combustion powered transportation vehicles were fuelled with ethanol, crude oil derivatives have provided the vast majority of transportation fuels throughout the 20th and 21st centuries. In 2006, global demand for petroleum and other liquid fuels was 85.0 million barrels oil equivalent per day (Mb/d) and this is forecasted to grow to 106.6 Mb/d in 2030, with the growth in transportation fuel use being responsible for 80% of the higher total crude oil use. Despite improvements in the energy efficiency standards in many countries & the dampened demand resulting from the global economic recession experience in 2008-09, global crude oil consumption is expected to increase by over 1% annually driven primarily by the growth in demand in India and China [2]. However, increasing demand of fossil fuels will likely to cause diminishing of world fuels reserve, which may lead to the scarcity of this type of fuels while also cause the price to increase dramatically. The release of carbon dioxide (CO_2) from vehicle and other industries is one of the largest potential contributors to global warming. Development of alternative energy source such as biofuels becomes important to reduce these problems. The only non-fossil liquid fuel currently of significance on a global scale is biofuels, including bioethanol & biodiesel. Utilization of bioethanol as transportation fuel and as a gasoline supplement has been proved to be more environmentally friendly. Bioethanol is a clean-burning, high octane number fuel that can readily substitute gasoline and its combustion results in significant reductions of toxic emissions such as formaldehyde, benzene and 1-3 butadiene, while blending ethanol with gasoline and can reduce carbon monoxide (CO) emissions by 10 30% [3]. When bioethanol is produced from renewable sources such as biomass it can both decrease urban air pollution and reduce the accumulation of carbon dioxide (CO_2), so called greenhouse gases (GHG). Thus, replacement of gasoline with ethanol, derived from renewable biomass feed stocks that sequester CO_2 during growth, is expected to reduce CO_2 emissions by 90 100% besides that, development of biofuels is expected to assure availability of new and renewable energy resources, increase the economic value of forest and also can reduce the poverty and unemployment problems.

Currently, bioethanol production is focused on sugar crops including sugar cane and sugar beets and also starch crops, including wheat, potatoes and sweet potatoes, which is often based on excess agricultural production and it is generally recognized that this volume is too small in comparison with the anticipated levels of production required for total conversion of transportation fuel markets from gasoline to ethanol. It is also apparent that there is a potential for competition with food production for both the sugar and starch feed-stocks and that prime agricultural lands normally required for producing foodstuffs should not be diverted for fuel production. Therefore, bioconversion of lignocellulosic biomass into bioethanol is very important to be developed since this resource is more economical and is available easily. Biomass resources obtained from lignocellulosic materials such as agricultural and forestry residues, municipal solid waste and various industrial wastes are still not well utilized, hence often present disposal problems. These residues can be found easily for bioethanol production Furthermore, woody and herbaceous energy crops can be planted and underutilized land can be employed to support indigenous production of such forms of biomass. Recently, special microorganisms have been genetically engineered which can ferment 5-carbon sugars into ethanol with relatively high efficiency [4].

Microorganism Used for Ethanol Production

According to [8] an ideal microorganism used for ethanol production must have rapid fermentative potential, improved flocculating ability appreciable osmotolerance and good ethanotolerance. Although no microbial strain has all these desirable qualities, few yeast strains have been found to possess appreciable characteristics for ethanol production [6]. The technological behaviours of industrial microorganism rename the main stay of industrial secret in fermentation industrial. .

MATERIALS AND METHODS

Collection of Waste Newspaper

The waste newspapers were collected from home. The waste newspapers were collected in a dust free and fungus Free State and were cut into small pieces (0.5 Cm dimensions) and stored in clean, plastic bags.

Alcohol Fermentation [7, 8, 9]

Pre-treatment of Waste Newspaper

Collection of Saccharomyces cerevisiae (Cellulolytic and alcohol fermentation strain from Lab culture collection)

Acid Hydrolysis and Saccharification Cellulose of Pre-Treated Paper Cuttings

Acid hydrolysis was carried out to break down the cellulose from paper. In 500 mL flask, 15-g of waste newspaper was added with 300mL of 5% dilute sulphuric acid and flask was kept for 4 days at 28^{0}c.

Measurement of Sugar Concentration

The percentage of sugar of hydrolysed broth was measured using hand refractometer. The drop of solution was taken on the glass of refractometer and result was noted and adjusted to 10-14 % by concentration.

Inoculum Preparations

The 100 mL of Sabouraud's broth was prepared. The loopful of yeast was inoculated into broth and was incubated for 2 days on the shaker for 48-h The broth was centrifuged at 6000rpm for 10 min to separate the yeast biomass which was then washed with sterile distilled water twice and final suspension was prepared in 100mL saline water.

Preparation of Media for Alcohol Fermentation

Optimization of Nitrogen Source

Three flasks of 100 mL hydrolysed paper broth were taken. One was added with 1% peptone and labelled as flask number1. Second was added with 15 mL corn steep liquor and labelled as flask number 2. Third Flask was added with 1% ammonium sulphate and was labelled as flask number 3. The pH of the media was adjusted to 5. All the flasks were inoculated with 10 mL of enriched Sabouraud's broth. All the flasks were incubated for 3 days at 28^{0}C

Determination of Residual Sugar Content of Fermented Broth

The sugar content of all the fermented flasks were measured by hand refractometer and results were noted down

Extraction of Ethanol

After the fermentation, the fermented broth from all the flasks were centrifuged at 6000 rpm for 10 min and cells were separated. Supernatants were collected and subjected to ethanol extraction. This was carried out by distillation method for 30 min. The distillate was taken in clean distillation flask. The amount of distillate from each flask were measured and noted down. Alcohol content of all the flasks was determined by specific gravity method [10].

Determination of Specific Gravity of Extracted Ethanol

The specific gravity of extracted ethanol was determined by using the specific gravity method after noting the value of X Y and Z. The calculation was done as below:

$$\text{Specific gravity of distillate} = \frac{\text{Density of distillate}}{\text{Density of Distilled water}} = \frac{\text{Weight of distillate in sp. gravity bottle}}{\text{weight of distilled water in sp. gravity bottle}}$$

X-Weight of empty specific gravity bottle.

Y= Weight of specific gravity bottle with water (D/W)

Z-weight of specific gravity bottle with distillate.

After the calculation of A value, the % of alcohol was determined from the table of relationship of percent yield of ethyl alcohol corresponding to apparent specific gravity of distillate.

RESULTS AND DISCUSSION

Results of Determination of Residual Sugar Concentration in the Fermented Broth

Before Fermentation

Sugar concentration in hydrolysed paper waste with % dilute acid treatment was 12%.

After Fermentation

Sugar concentrations in fermented flasks number of 1,2, 3 were found to be 3%, 2.5% and 3.5%, respectively.

Results of determination of yield of alcohol are shown in Table -3

It can be seen from above Table -2 that the amount of distillate obtained from flask no.1, enriched with peptone was found to be 120 mL, and that of flask 2, enriched with corn steep liquor was found to be 130 mL. The amount of distillate obtained from flask 3, enriched with ammonium sulphate was found to be 120 mL. On the basis of alcohol % in distillate, distillate volumes and the amount of paper used in fermentation medium(5-g), then amount of pure ethanol produced from 100-g of paper is given in Table-3 which shows that with peptone 100mL, with corn steep liquor 110 mL and with Ammonium sulphate as nitrogen source 100 mL ethanol is produced by using pre-treated paper.

Table-1: Results of Determination Amount of Distillate Obtained

S. No	Name of microorganism	Flask no.1 Distillate amount mL	Flask no. 2 Distillate amount mL	Flask no.3 Distillate amount mL
1	Cellulolytic *S. cerevisiae*	120	130	120

Table 2: Sp.gravity, % Alcohol in the Distillates at Different Nitrogen Sources

Flask No	Specific gravity	Percentage of alcohol
1	0. 9884	4.06%
2	0. 9860	5.67 %
3	0. 9895	3.9 %

Table 3: Yield of Alcohol

Flask No	Nitrogen sources used	Amount of distillate obtained from 100mL medium containing 5g paper waste (mL)	Pure Alcohol yield per 100 gm of paper (mL)
1	Peptone	120 (5-mL pure ethanol)	100
2	Corn steep liquor	130 (5.5-mL pure ethanol)	110
3	Ammonium sulphate	120 (5-mL pure ethanol)	100

CONCLUSION

Peptone, corn steep liquor and ammonium sulphate were found to be good nitrogen sources with pre-treated paper waste as substrate. The corn seep liquor was found to be best nitrogen source probably due to its more nutritive contents as compared to peptone and ammonium sulphate.

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