ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Comparative Study of Ethanol Production from Different Industrial Waste and its Managerial Benefits.

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ABSTRACT

In the quest of a search for an alternative to the petroleum products, Ethanol has effectively fulfilled the need as an alternative to petrol .The necessity to find effective, feasible, affordable and cheaper sources for its production are coming into focus. This work is that done in this perspective where various sources are been tested in their ability to support the growth of yeast and in turn in the production of ethanol. Sources like Sugarcane baggasse, Cassava waste, potato waste, Wheat bran, Corn stalk and leaf and various combinations between themselves are tested for the production of ethanol by various alterations in pH..

Keywords: ethanol, pH, fermentation,waste

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ISSN: 0975-8585

INTRODUCTION

The fermentation of sugars to ethanol is a very old and well-known process, which has great industrial importance. The process is still the subject of much research and development in research institutes with the aim of getting higher product and lower by-product yields. The present work is mainly concentrated on the production of this ethanol using various alternative and feasible substrates [1].

The use of ethanol as a transportation fuel has as long a history as the car itself. It began with the use of ethanol in the internal combustion engine invented by Nicholas Otto in 1897. Many countries started programs to study and develop fuels in an economic way from available raw materials [2]. On the present fuel market, it should be emphasized that ethanol, and some of the other alternative fuels, are not primarily substitutes to gasoline, but rather additives, which improve the efficiency and environmental impact of the fuel. Ethanol performs well as a fuel in cars, either in a neat form or in a mixture with gasoline.

An important reason for interest in renewable energy sources is the concern for the greenhouse effect. According to the Kyoto, developed countries should decrease the net emission of CO_2 [3]. Development of ethanol as a transportation fuel can work to fulfill this commitment. A final point to be mentioned is the fact that the global demand for fuel in the 21st century is predicted to be more than the capacity of global oil production [4].

Ethanol is a clean-burning, renewable, domestically produced product made from fermented agricultural products such as corn. Ethanol contains oxygen, which provides a cleaner and more efficient burn of the fuel. When used in vehicles, ethanol reduces carbon dioxide, a major contributor to global warming. Although burning ethanol still releases carbon dioxide during production and combustion, it is recycled by the crops that produce ethanol. This creates a cycle in which greenhouse gases are used instead of being emitted into the environment [5].

E85 is a blend of 85 percent ethanol and 15 percent unleaded gasoline. E85 is not compatible with all motor vehicles. These automobiles, called Flexible Fuel Vehicles (FFV) can run on a combination of ethanol and gasoline of up to 85 percent ethanol blend.

Ethanol Production by Fermentation

Ethanol can be produced by fermentation from different kinds of raw materials. The raw materials are classified into three categories of agricultural raw materials: simple sugars, starch and cellulose. Some sugars can be converted directly to ethanol, whereas starch and cellulose must first be hydrolyzed to sugar before conversion to ethanol. Most of the polymeric raw materials are available at prices lower than refined sugars. Consequently, each country may preferably develop ethanol production based on the available raw material in that country [6].

Urban wood waste, municipal solid waste (MSW), forest residue, mill waste, manufacturing wastes, fruit and nut industries, used as raw material for production of ethanol [7].

ISSN: 0975-8585

Batch cultivation is the simplest method of fermentation (of hydrolyzates), with the simplest control system, in comparison to other modes of operation. After inoculating the medium, nothing is added in the batch fermentation, except possibly base for pH control. The medium has essentially the same composition as the hydrolyzed with the exception of possible additions of minerals or other supplemental nutrients [8]. Continuous cultivation has been considered for the fermentation of the hydrolyzates. Chung and Lee (1985) tried to ferment acid hydrolyzates. However, they reported a 90% decrease in the viable cell number after only three residence times. Lee et al. (1996) suggested a continuous cultivation with total cell retention (using an internal filter system with pore size of 2 µm) to ferment the hydrolyzates. Overall, continuous cultivation probably gives better performance than batch cultivation in the fermentation of slightly inhibiting hydrolyzates[9]. Yeast strain has high sugar consumption rate and productivity, minimal nutrient requirement, high salt tolerance, high shear tolerance, thermo tolerance, safety for humans and no spore formation .*Saccharomyces cerevisiae* has several essential and desirable characteristics for fermentation of hydrolyzates, which are widely cited in the literature. It gives a high ethanol yield, has a high ethanol productivity and tolerance, and has no oxygen requirement[10] . The present study was to compare the ethanol production from different waste used as substrates and by altering the pH of the fermentation medium.

MATERIALS AND METHODS

Ethanol can be prepared by fermentation process of any carbohydrate rich waste containing fermentable sugars using *Saccaromyces cerviceae*. The different substrates like sugarcane waste, cassava waste, wheatbran, potato pulp, tomato pulp and wheat bran collected as industrial waste. The innoculum medium contains malt extract(10%), glucose(20%) yeast extract(3%) and Peptone(50%).Medium is maintained at room temperature and pH is maintained at 5[11].

Fermentation Medium

Different ranges of fermentation medium were prepared using wastes of sugarcane, cassava, wheat bran ,potato, tomato and corn stalk. All these fermentation media and inoculum media (1000ml) were sterilized in autoclave for 15 to 20 min and at 15lbs pressure.After sterilization yeast granules were added into each of the inoculum media. The inoculum medium is incubated at room temperature for 24 to 28 hrs. After 28hrs of incubation 5ml of the inoculum media is added into each one of fermentation medium. The fermentation medium is kept for incubation for 48 to 72 hrs at 26ºC.On the fifth day of the incubation the amount of ethanol is estimated by potassium dichromate method colorimetrically.

Table 1: Different proportions of fermentation medium

Nutrients	Batch 1	Batch 2	Batch 3	Batch4	Batch5	Batch 6	Batch7
Substrate(20%)	Glucose	Sugarcane waste	Cassava waste	Wheat bran	Potato waste	Tomato waste	Corn stalk
Malt extract	2%	5%	10%	2%	2%	1%	2%
Yeast extract	6%	6%	6%	6%	6%	10/%	20%
Peptone	10%	25%	10%	10%	10%	10%	10%
pH	5,6	3,4,5,6	5,6	5,6	5,6	5,6	5,6

ISSN: 0975-8585

RESULTS

The different substrates like sugarcane waste, cassava waste, wheat bran, potato, tomato waste and corn stalk were subjected into fermentation medium. The production of ethanol was carriedout with different waste using yeast. The maximum yield of ethanol was observed in potato waste. Potatoes are rich in carbohydrates which easily fermented into produce ethanol. The low amount of ethanol was extracted from tomato waste. This was due to the presence of lycopene and carotenoids in tomato (Table2).

The efficiency in supporting the production of Ethanol does need a rich presence of carbon moiety in the source, but a keen study on the pH effects says that an optimum pH can only allow the source to support the production of Ethano [12].

Sugarcane waste was subjected into various pH parameters [3, 4, 5 ,6 & 7].The maximum yield of ethanol found to be pH5 and 6.The remaining samples were carried out in pH5 and 6. Out of all the results, obtained potato extract produced a concentration of 92mg / ml of ethanol production at pH 6 depending upon the standard graph, which was nearly 25% more when compared with other sources(Fig1). The next highest production value belonged to corn stalk and wheat bran both at pH parameters 6 and 5 respectively. By this one can easily predict that the pH 6 [5-6] was supporting a better production of ethanol in various sources provided the sources is naturally rich carbohydrate moiety [13].

Table.2 Production of Ethanol using different substrates.

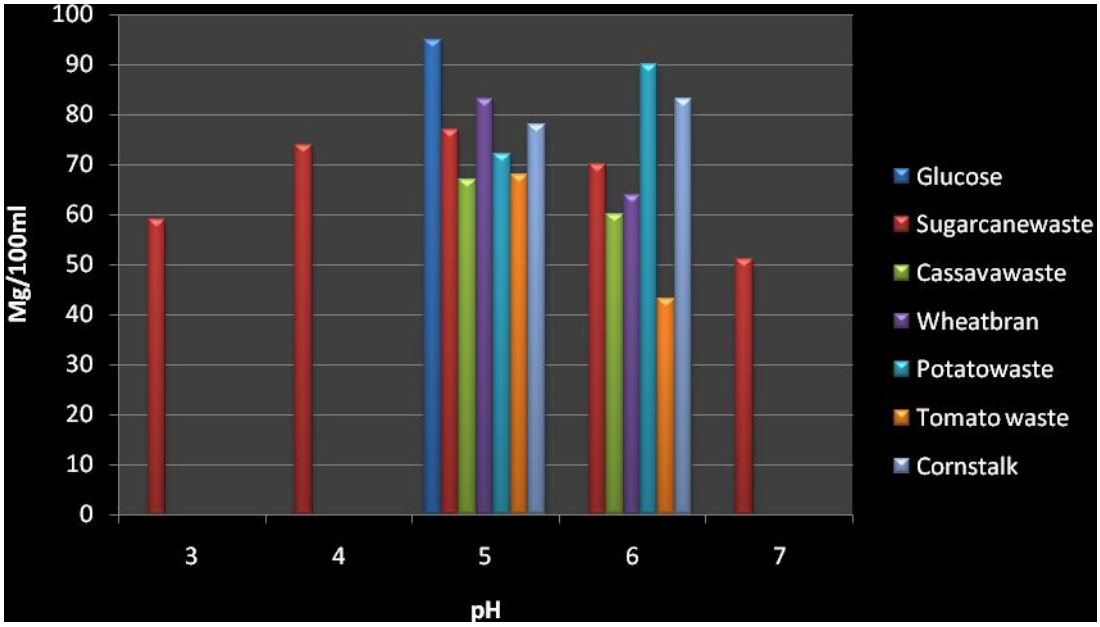
S.No	Substrate	Ethanol production(mg/100ml)
1	Glucose	95
2	Sugarcane waste	**77**
3	Cassava waste	63
4	Wheat bran	82
5	Potato waste	92
6	Tomato waste	43
7	Corn stalk	83

Managerial Benefits

Every organization tries to minimize their cost of production. Trying to cut down the cost by optimum use of waste is a costing strategy to reduce the cost by producing or using it for byproducts. Producing ethanol by using the industrial waste gives the benefits such as eliminating hazardous materials, using technology to the production process, equipment, lay out in different operating conditions. Further it reveals the Production managers to control inventory and the wastages are also used in a beneficial way.

ISSN: 0975-8585

Fig 1: The Production of Ethanol by various sources at various pH values.



CONCLUSION

There are so many industries discharged their waste directly into river or sewage which harmful to the environment. In order to reduce such problems, effluents can be reused into alternate biomass in the form of fertilizer, irrgation and ethanol production etc using microbes. In this study, different industrial waste can be used as substrate to yield ethanol. This ethanol is mixed with gasoline to produce automobile fuel at a cheaper rate in order to reduce the demand of petrol and will enhance the economy of the country.

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