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Baseline study on biodiesel potential of onion waste

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ABSTRACT

Onion waste is an all-year round waste material that is bound to be generated in huge quantities supposedly in every nook and corner of the world. This study attempts to utilize onion waste to recover bound energy contained in onion waste and convert it into a biofuel via enzymatic hydrolysis as well as vindicate the research potential for its commercialization. Saccharomyces cerevisiae (yeast) was used to breakdown the cellulose content present in onion waste juice. The experimental results transpired that biodiesel could optimally be produced from onion waste under controlled conditions of temperature and pH value, when the biodiesel was obtained in the range of 2-3% (200- 300 ml/liter) from the analysis of the prepared sample solutions.

Keywords:

Biodiesel
Onion waste
Enzymatic hydrolysis
Temperature
pH

1. Introduction

The pursuit of sustainable energy to meet global energy consumption is prompted by the rise in living standards. The use of fossil fuels as a major source of energy, on the other hand, has resulted in global concerns such as pollution and global warming. As a result of these efforts, the government, industry, and energy sector have discovered ecologically friendly, renewable, and sustainable energy. Due to the depletion of existing fossil fuels, rising petroleum prices, and environmental concerns, the quest for alternative renewable fuels has received a lot of attention in the past few years. The conversion of onion (waste) into (Biodiesel), the cleanest liquid fuel alternative to fossil fuel, has received a lot of attention. Pretreatment, hydrolysis, and fermentation are all typical procedures in biodiesel manufacturing. Temperature, sugar content, pH, duration of fermentation process time, rate of agitation, and size of inoculum all influence biodiesel production during fermentation. Immobilizing yeast cells improves the efficiency and productivity of biodiesel production. Ultimately, the experiments showed that each waste would have a profit, and that because different waste products had varied compositions, industries should have been interested in sorting them in order to exploit them as sources of diverse bioactive

compounds. However, this potential has not been fully utilized thus far. Processing onion waste products has more benefits than just improving the nutritional content of foods, according to the authors. They went on to say that if the creation of new products from waste onions is successful, "environmental issues" may be addressed as well. In the light of above discussion, the present study was conducted,

- To convert maximum waste to obtain valuable product of Biodiesel.
- To increase the yield percentage by maintaining its temperature and pressure comparison with previous studies on manufacturing of Biodiesel.
- To determine onion waste sample characterization.
- To investigate Biodiesel yield on different parameters.

2. Methodology

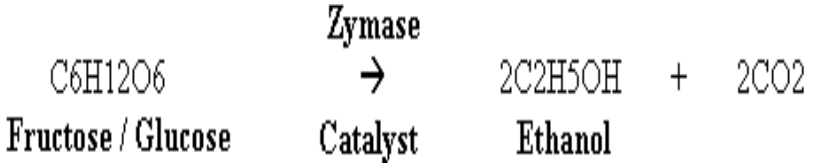
2.1 Enzymatic Hydrolysis

Biodiesel is made by the fermentation of sugars, starches, or cellulose by microbes and enzymes. Although yeast is one of the most essential microbes in the manufacture of biodiesel, many other microorganisms may now be used in this process [1].

We utilized enzymes to break down the biomass in a similar way to hydrolyze it into sucrose. This technique, however, is very costly and is still in its early phases of development [2].

2.2. Sugar Fermentation Process

The hydrolysis process converts the cellulose portion of the biomass or maize into sugar solutions, which may subsequently be fermented to produce Biodiesel. The solution is then heated, and yeast is added. Invertase is a yeast enzyme that aids in the conversion of sucrose sugars to glucose and fructose (both $C_6H_{12}O_6$) by acting as a catalyst. Biodiesel and carbon dioxide are produced when the fructose and glucose sugars combine with another enzyme called zymase, which is also found in yeast. The chemical process for converting Glucose/Fructose to biodiesel in the presence of a catalyst is as follows:



The fermentation process usually takes three days or 72 hours and takes place at a temperature somewhere between 25 ºC and 30 ºC [2]

2.3. Materials

Onion Waste

A sample of wasted (useless) onions were collected from the Hyderabad grocery market and prepared to produce Biodiesel from them, the details are given in table 01.

Table 01: Different compounds and their amount present in onion waste [3]

Parameters	**Quantity (mg/l)**
Organic acids	4830
Free amino acids	4438
Sucrose	26300
Fructose	30400
Glucose	20600
Potassium	1900
PO	4458
Magnesium	82.3
Calcium	77.2
Sodium	10.0
Manganese	2.1
Zinc	1.0
Iron	0.8
pH	6

Inoculum Media Composition

The substances present in the inoculum media with their weight percent are listed in table 02.

Table 02: Different substances and their weight percentage present in Inoculum Media.

Substance	**Weight Percent**
H_2PO_4	0.1
KCl	0.1
Sucrose	2
Distilled Water	47.8
pH	5

Yeast Extract

The term yeast extract refers to a variety of processed yeast products created by extracting the cell contents. Here, it is used as nutrients for bacterial culture media. We used Saccharomyces cerevisiae as yeast; especially it is one of the oldest organisms because of their distinct genetics and physiology, they have a wide range of applications. Yeast extract, i.e. In bacterial culture media, the output of yeast cells is widely employed as a nutritional resource. Presently, 3% by weight of Saccharomyces cerevisiae were used for the preparation of enzyme.

2.4. Procedure

The main method which was carried out to obtain Biodiesel was enzymatic hydrolysis. The process starts from washing of raw onion skins to the centrifugation.

Following are the steps performed to obtain biodiesel from onion waste by enzymatic hydrolysis process in the presence of catalyst;

Washing and Cleaning of Raw Material (wasted Onions)

After the collection of onion sample, it comes to the washing and cleaning first. The sample was washed with distilled water and then allowed to dry for few hours.

Crushing and Milling:

Waste onions were crushed at laboratory using common type of crusher to get smaller size so that extraction of juice for further process could become easy.

Juice Extraction and Filtration:

After milling, juice was extracted by squeezing the crushed sample. After the extraction, filtration was done to remove the off-size remaining material in it. We used thick filter paper by which only pure juice of waste onions passed through.

Inoculum Media Preparation:

While extracting the waste onion juice, inoculum media was being prepared, whose composition is shown above in table 2.

Sterilization of Equipments / Materials:

It is necessary to sterilize all the equipment before use, in order to kill or to deactivate other unwanted microbes and cease their activity. We sterilized all the glass wares used, along with onion juice using the autoclave which was operated at temperature 121°C and Pressure 15 Psi for 20 Minutes.

Inoculum Media Sterilization:

After the sterilization of all equipment, materials and making the proper proportions, we sterilized inoculum media to avoid the growth of other unwanted microorganisms.

Addition of Yeast Extract:

Yeast extract is a mixture of amino acids, peptides, water soluble vitamins and carbohydrates and can be used as additive for culture media. Some of these microbes require vitamins and other growth factors from their plant or animal hosts and yeast extract is rich in vitamins, minerals, and digested nucleic acids. After the inoculum media sterilization, we then added (3% by Weight) of Yeast Extract, we used Saccharomyces Cerevisiae here.

Mixing of Inoculum Media:

In order to well mix, increase reaction rate and create homogenized solution of enzyme, we shook the inoculum media with the yeast at 200RPM at a Temperature between 16°C – 20°C for 24Hours.

Production of Biodiesel (Mixing of Inoculum with Onion Juice):

Production process of Biodiesel begins by dealing with all its prerequisites of making the enzyme. The enzyme is eventually mixed with the amount of sterilized onion juice for its conversion into Biodiesel. The enzyme present in the solution will decompose the carbohydrates/sugars and make the products; Biodiesel and carbon dioxide.

Peptons 0.1%, MGSO4 0.1% and 0.5grams of (NH4)2 SO4 are mixed with 15ml of waste onion juice and inoculum 10ml in order to increase the yield rate and amount of product as well.

Mixing:

For the conversion of above-mentioned solution into Biodiesel, amounts of enzyme and onion juice were shacked at 200RPM, a temperature between 16°C – 20°C for the time period of 48Hours.

Centrifugation:

Centrifugation was done in the last to separate the heavy particles down to the bottom. That centrifuge was further sent for final analysis of the product.

3. Results

Process was carried out to produce Biodiesel from waste onions, the main purpose behind the process was to utilize the waste to obtain something valuable in results.

Through a series of experiments following the proper steps and strategies, we obtained 2 percent of Biodiesel from given sample of onion waste as analyzed by Ebulliometer equipment at MATOL distillery MATIARI.

3.1. Effect of pH on Biodiesel Yield

The biodiesel yield at different pH is plotted in Fig. 01, it can be seen that with increasing the pH, biodiesel yield was increased. Thus, the highest Biodiesel yield obtained at pH 5.

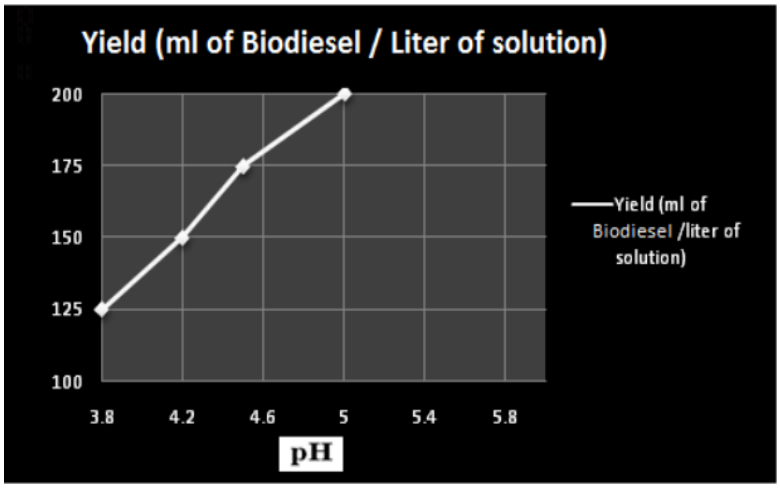


Fig. 01: Effect of pH on Biodiesel yield

3.2. Effect of Temperature on Biodiesel Yield

Temperature is one of the most important elements in the production of biodiesel. Fig. 02 shows the Biodiesel concentration in weight (%) that obtained at different temperature. Based on the result obtained, the increasing temperature exhibited a positive effect on the yield of Biodisel, thus maximum biodiesel yield was obtained at temperature of around 37 ºC

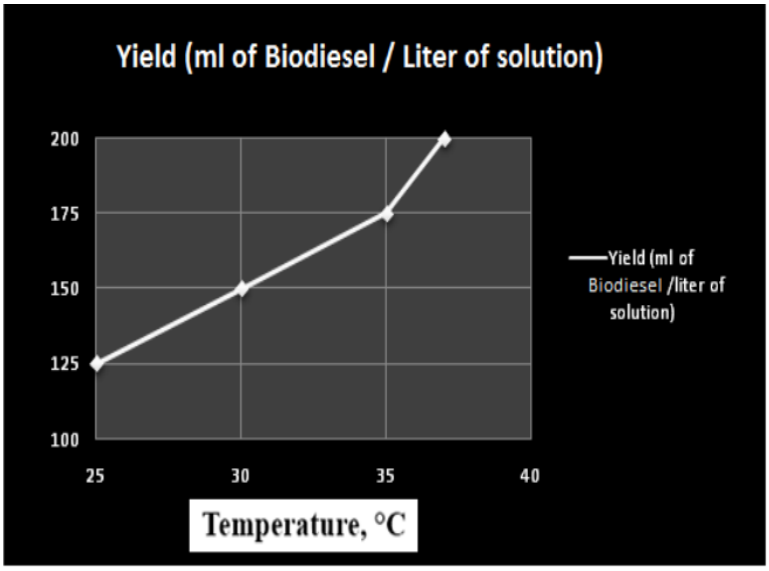


Fig. 02: Efect of temperature on the Yield of Biodiesel.

4. Conclusion

Pakistan is the agricultural country, producing large amount of agricultural vegetables, onion is one of them, research on the Sindh province shows "According to provincial agriculture department estimates, 666,764 metric tonnes of onion were harvested in Sindh in 2014-15 on an area of 49,934ha, compared to 697,276 metric tonnes harvested in 2013-14 on 52,908ha". Utilizing little resources and generating such a large volume of Biodiesel is advantageous to Pakistan's economy, as it reduces the number of bio-fuel requirements, as the globe moves toward the alternative sources of energy.

In this study, it was found that both the pH and temperature showed a positive effect on the yield of biodiesel. Moreover, findings of past and present work suggest that onion waste has good potential to convert into useful energy source.

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