International Journal of Applied Engineering Research ISSN 0973-4562 Volume 16, Number 3 (2021) pp. 210-213

Techno-Economic Study for Production of Bioethanol from Deoiled Castor Cake

Minal P. Deshmukh*, Ashwini M. Pande*, Anant B. Marathe**

**Dept. of Petroleum and petrochemical Engineering. MIT Pune, India*

*** Principal, of HVPM College of Engineering, Amaravati, India*

Abstract

The deoiled Castor Cake obtained from biodiesel plant as a waste gives the effective yield of bioethanol with biological & chemical pretreatments followed by fermentation with optimized manufacturing cost is USD 0.62 per liter. The chemical and enzyme pre-treatments followed by fermentation with S. Cervisae with dilution ratio 1:2 gives 84% of Bioethanol concentration, Ethanol was separated by vacuum distillation at 75 psi & 30° C which gives 25ml of ethanol from 100 g of castor deoiled cake. Hence on large scale calculation, 250 L of Ethanol can be obtained per ton of castor deoiled cake. The concentration of obtained bioethanol was analyzed by UV spectrophotometer.

Keyword: Deoiled Castor Oil, Fermentation, UV Spectrometer, Vacuum distillation, Bioethanol

Introduction

The rapidly depleting fossil fuels has increased interest in alternative sources of energy. The need for petroleum-based fuels in the existing market is expected to be depleted before 2090. In order to respond from its over-exploitation in the use of, significant environmental concerns such as global warming have been created [1]. Therefore, in order to deal with such issues, it is mandatory to look towards renewable fuel alternatives. Bio-Ethanol is one of the source of alternative energy which can be efficiently used to combat fuel crisis.

The Government of India has made it mandatory for all petroleum refineries to blend 10% ethanol with refined petroleum products out of which 5% with immediate effect. To fulfill this requirement, it is an uphill task for the government to provide and supply bulk ethanol to petroleum industries at affordable rates. At present bio-ethanol is being produced in India only by converting sugar molasses to ethanol at industrial level, which is not even sufficient to cope up with the demands of chemical industries and breweries (2). At the same time large quantities of nonedible oil seeds like, Castor, Jatropha, Karanja are processed to manufacture biodiesel and other chemical derivatives leaving behind deoiled cake as waste.

Every ton of Biodiesel results in about 2 tons of deoiled cake. Nonedible deoiled cakes of jatropha, karanja, and castor obtained as waste from nonedible vegetable oil or biodiesel production is often a serious waste disposal problem after expelling oil from seed. The cake neither can be used for animal feeding nor directly can be used in agricultural farming due to its toxic nature. The potential of availability of nonedible deoiled cake is as shown in table no.1.

Conversion of nonedible deoiled cake to bioethanol can serve as a waste minimization technique. There are number of possibilities for use of some types of solid agricultural wastes, but there is no evidence that any of these are economical (3).

Thus the time has come to increase the production of alcohol using nonedible deoiled cakes, in addition to molasses and grains, as agricultural wastes are abundantly available. We have worked upon a microorganism/ chemical technology which can convert nonedible deoiled cakes to bio-ethanol and residual solids into organic manure. Biogas from cake provides energy for heating, cooking, lighting and engine operation and digested cake slurry can be directly put for agricultural farming (4)

The castor seed production in India is maximum as compared to other countries hence the availability of nonedible deoiled cakes of castor seeds is in vast quantity. It also has the good potential for producing biofuel so Castor deoiled cake has been selected for production of Bioethanol.

Chemicals & Reagents

Samples of nonedible deoiled cake castor are taken from the Jayant agro organics Ltd." and dried at 50◦c for 24 hours.

The unprocessed oil from cake is extracted on Soxhlet extractor to deoiled it. The other chemicals /enzymes used for the work are as follow

1) Sulfuric acid (CheMBL572964)
2) Thyonil Chloride
3) Calcium carbide (6352-Pubchem)
4) Tricoderma (Fungai - Sordariomycetes)
5) Cellulase /Amylase (Aspergillllus niger)
6) Saccromycess Cervisae (Yeast).

Analytical Methods Analysis of feed material

I Estimation of moisture content

By using standard method, the moisture content of deoiled cakes was found.

II Estimation of total solids

After calculating initial moisture content, moisture free amount

of deoiled cake was considered as total solids.

III Estimation of reducing sugar

The reducing sugar was analyzed by DNSA method with 1:2 dilutions. (5)

Reducing sugar analysis (DNSA method)

Different Concentration on sugar 30%, 40%, 50%, 60%, 70% were taken in YPD media. 24hr old inoculums (0.1 ml) of yeast will be added for the study of sugar tolerance of yeast S. cervisae. pH will be adjusted to 5. Optical density will be taken after 48 hr on digital colorimeter at 600nm.

Methodology

The deoiled castor cake was obtained from "Jayant Agro organics Limited" It was analyzed for moisture content and balance was taken for total solids content.

Initial reducing sugar content in castor cakes was analyzed by DNSA method and found tobe10.5gm.This sugar content was increased up to 63.5g by the Saccharification of starch with combined chemical and enzyme treatment with dilution 1:1. Fermentation was done by using S. Cervisae at 30^0c and pH maintained was 6, reaction time given is 72hr. Ethanol was separated by vacuum distillation which gives 25ml of ethanol from 100 gm of castor deoiled cake.

Hence on large scale calculation, 250 L 0f Ethanol can be obtained per ton of castor deoiled cake. The sample analyzed on gas chromatography has shown 84% purity. The waste residue of hydrolysis and fermentation process was analyzed. It indicates the absence of starch in the solid residue and has the composition as carbon, phosphorous, magnesium and sodium.

Results & Discussions

Table 1: Reducing Sugar conversion and alcohol obtained from castor cake

Time Interval (hr)	pH	Sugar Percentage(%S)	Alcohol Production (ml)
0	6.5	63.5	0
12	6.5	55.8	7.5
24	6	40.8	11.5
36	5.5	31	17
48	6	25	21.5
60	5.5	19.5	26
72	5.5	8.5	30
84	5.5	8.5	30

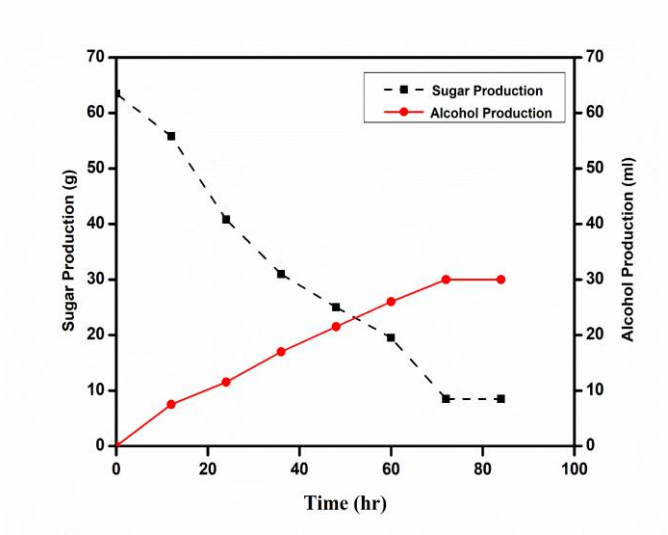


Fig.1: Fermentation Kinetics

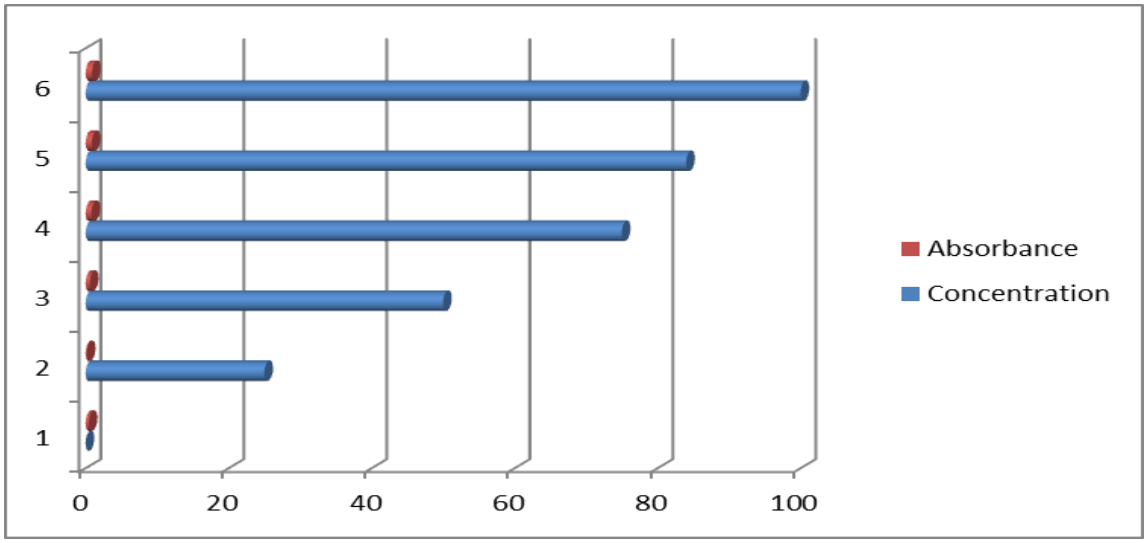
Table 2: Analysis of Bioethanol from Castor Deoiled Cake (DOC) separated by vacuum distillation at optimized condition

Sr.no	Fermented Castor DOC (g)	Cellulase (g)	Trichoderma (g)	Bioethanol Distillate (ml)	Concentration of Bioethanol (%)	Residue (g)
1	100	0.01	0.55	25	84	70
2	500	0.05	2.75	123.5	84.5	400
3	1000	0.1	5.5	250	84	730
Optimized process parameters for vacuum distillation; Temperature: 30 °C, Pressure: 75 psi, Reaction time: 72 hr						

Table 3: Analysis of Ethanol separated by Vacuum Distillation [UV Spectrophotometer LT-2900, Wavelength range-190- 1100NM]

Standard Ethanol samples(%)	Wavelength	Absorbance
100	292	0.901
75	276	0.828
50	271	0.596
25	209	0.170
0	270	0.436
Sample 1 (1:1)	280	0.865
Sample 2(1:1)	278	0.866
Sample 3(1:1)	281	0.862
Bioethanol concentration is taken as average of above 3 samples ie 84%.		

Fig.2 Bioethanol analysis on UV spectrophotometer for castor DOC



CONCLUSION

Nonedible deoiled Castor cake can be used as best resource for the production of Bioethanol by fermentation. Fermentation was done by using S. Cervisae at 30^0c and pH maintained was 6, reaction time was 72 hr. Ethanol was separated by vacuum distillation which gives 25ml of ethanol from 100 g of castor deoiled cake. Hence on large scale calculation, 250 L 0f Ethanol can be obtained per ton of castor deoiled cake. The sample analyzed on gas chromatography has shown 84% purity with optimized manufacturing cost USD 0.62 per liter.

Considering the increasing generation of waste associated with production of oil from oil seeds, the utilization of deoiled cake for co-generation of ethanol could be integrated to the transesterification process, reducing cost, and giving solution to destination to deoiled cake residue.

AUTHOR INFORMATION

Corresponding Author: Dr. Minal Deshmukh, Email: minal.deshmukh@mitwpu.edu.in, Phone: 09552737384

ACKNOWLEDGMENTS

The authors acknowledge Department of Science & Technology, Govt. of India, for financial support under sanction number SP/ YO/2019/1589 (G)

REFERENCES

1) Kumar, D, Pant, K.K, 2015. Journal of analytical and applied pyrolysis. *115*,77-86.

2) Stanbury, P.F, Whitekar, 2000. Principles of Fermentation Technology. 45-67.

3) Marathe, A, Deshmukh, M, 2013. International Journal of Engineering Research & Technology. 2, 1-5

4) Linger Vora, V.C, 2004. American Journal of Oil and Chemical Technologies. 108,39- 102

5) Deshmukh, M, Deshpande R.S, Tandon G.D,2010. International journal of Chemical Engineering Research. 2,197-217