**American Journal of Engineering Research (AJER)**
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-03, Issue-05, pp-110-116
www.ajer.org

Research Paper Open Access

# "A Step Towards Environmental Waste Management And Sustainable Biofuel (Ethanol) Production From Waste Banana Peelings"

Nazim Ali[1], Pravin Ubhrani[2], Mohit Tagotra[3], Manohar Ahire[4]
[1](Chemical, University of Pune, India)[2](Chemical, University of Pune, India)
[3](Chemical, University of Pune, India)[4](Chemical, University of Pune, India)

***Abstract:*** - Most nations, whether economically advanced or at different stages of development are facing two major challenges, energy crisis and proper waste disposal. In this paper a study has been done on environmental waste management and sustainable biofuel (ethanol) production from waste banana peelings. The peels of BASRAI variety of bananas are taken as they are rich in cellulose and are kept in hot oven at 338K and dried sample is taken and is dissolved in hot water for starch extraction through soxhlet extractor. This solution is treated with amylase enzyme for hydrolysis of starch to occur. Solution obtained is then subjected to fermentation process by inoculation of S.cerevisiae for 4-5 days at 300K which results in the production of ethanol. The ethanol formed is characterized by potassium dichromate method .The effect of pH; sugar content and rate of ethanol production were studied for 8 days. After extraction of starch the banana powder is than burnt with butane flame. We get potassium carbonate solution after gravity filtration. The residue left can be used as fertilizers.

***Keywords:*** *-Banana peel, Biofuel, Ethanol, Potassium carbonate, S. cerevisiae.*

## I. INTRODUCTION

Production of green energy from waste material has played an important role in recent days due to the depletion of non-renewable energy resources. Ethanol which is found useful widely as an alternative fuel for engines. In view of the rising demand of the ethanol there has been increasing worldwide interest in searching its alternative source for production. [1].Biofuel has been gaining momentum in terms of research and development. Since there are various factors such as recent rise in oil prices, Increase in demand of fossil fuels, depletion of the mineral oil reserves , demand of the energy increases with the increase of the world population and urbanization. The negative impacts of fossil fuel on the environment and the unstable oil market are the factors that lead to the constant search for alternative fuels [2]. Alternative liquid fuels from various sources have been sought for many years and since the cost of raw materials which can account up to 50% of the total production cost is one of the most significant factors affecting the economy of biofuel, nowadays efforts are more concentrated on using cheap and abundant raw materials [3].

According to the Food and Agriculture Organization of the United Nations India is the largest banana producing nation (Table-1) [4].As the production of banana is more the waste generated is also more. According to scientists, approximately one tons of wastes are produced for every ten tons of bananas [2] **.**Most nations, whether economically advanced or at different stages of development are faced with the problem of disposal and treatment of wastes. Wastes could be treated in many ways as by reducing its bulk or by recovering and reprocessing it into useful substance to meet sanitary standards. To avoid Wastage, this banana wastes can be turned into a new energy source [5].

So, the banana peel can be converted into glucose which can be used as feedstock to produce ethanol by fermentation and distillation. Furthermore, ethanol by fermentation offers a more favorable trade balance, increased energy security, and a major new crop for a depressed agricultural economy. It is considered biodegradable and sulphur free. Ethanol is considerably less toxic to humans than is gasoline. In addition, the low flame temperature of ethanol results in good engine performance [6].

Although ethanol is both solvent and fundamental feedstock for the synthesis of other products, it also a safer alternative to methyl tertiary butyl ether (MTBE), the most common addition to gasoline use to provide cleaner combustion [7]. According to Environmental protection Agency (EPA) announced the beginning of regulatory action to eliminate MTBE in gasoline because it is a toxic chemical compound and has been found to contaminate group water. Hence, the demand for ethanol could increase further ifMTBE is eliminated from gasoline [5]. The objective of this study was to produce ethanol from wastes such as banana peels, which are abundant and do not interfere with food security using co-culture of *Saccharomyces cerevisiae*. In addition, Potassium carbonate (k2co3) is obtained as the byproduct which is advantageous for many applications as softening hard water, buffering agent in the production of mead or wine, soap and glass production and synthesis of other products. The effect of pH and rate of ethanol concentration was studied for 8 days at room temperature.

## II. MATERIALS AND METHODS

### *2.1 Malting process.*

In the malting process, the substrate (BASRAI variety) is prepared for fermentation process. The banana peel used in this study was obtained from local market, and then the analysis of peel (per100gram) was conducted. It contains as shown in (table-2) [8]. Small amount of monosodium glutamate was sprayed on the collected banana peel and kept in hot air oven at temperature of 338K for 72 hours. Dried sample obtained was cut in small pieces using knife and measured before starch extraction

### *2.2Extraction of starch.*

The starch extraction was carried out from the dried sample using soxhlet apparatus. In soxhlet extraction the procedure, the sample is loaded in the main chamber of soxhlet apparatus. The soxhlet apparatus is placed over a flask containing the extraction solvent (water) (Fig-1(a)).The soxhlet is than equipped with a condenser. The solvent used for the extraction of starch from dried sample was water. Starch present in the dried sample was dissolved in hot water (Fig-1(b)). Soxhlet extraction is a continuous and self-recovery process having high efficiency of extraction

### *2.3 Starch hydrolysis.*

Starch obtained is a polysaccharide made up of α-D glucose subunits. It exists as a mixture of two forms linear (amylase) and branched (amylopectin), which is too large to pass through bacterial cell membrane. Therefore, to be off metabolic value to the bacteria it must first be split smaller fragments or individual glucose molecule. Amylase enzyme obtained from high media was used to hydrolyzed 1000ml starch containing solution.10 gram amylase was dissolved in 100ml of water and was kept in shaker at 298K for 2 hours and mixed with starch containing solution. The overall reaction is complete hydrolysis of polysaccharide to its individual α-glucose subunits (1), [9].Reducing sugar was determined by Brix refractometer.

STARCH amylase GLUCOSE
(Polysaccharide) ⟹ (Monosaccharide) OR MALTOSE
( Disaccharide )

Equation 1. Starch hydrolysis by α-amylase

### *2.4 Inoculum preparation and fermentation procedure.*

Inoculum of Saccharomyces *cerevisiae* was prepared for fermentation process. 24 gm. of potato dextrose broth was dissolved in 100ml of the distilled water. Before addition of yeast spores potato dextrose broth was autoclaved at 121°C and15psi.Yeast spores were added to the potato dextrose broth (PDB) Inoculums was allowed to grow for 24 hours in cotton plugged conical flask [10].

The flask containing the glucose media was autoclaved and inoculated with burners in laminar flow (Fig-2(a)).The inoculated medium used for ethanol production was kept for fermentation at room temperature 298K for 8 days. Production of ethanol takes place which was recovered by simple distillation method (Fig-2(b)).

## III. ASSAY TECHNIQUES

### *3.1Ethanol determination.*

Ethanol content in the sample was determined by using an instrument Dujardin-Salleron Ebulliometer. The Ebulliometer finds the ethanol content by determining the difference in boiling points between solution and pure water. The percentage ethanol can be found based on comparison using calculating dial [11].

#### *3.1.1 Procedure:*

Step 1-Determing the boiling point of water

For determining the boiling point of water lamp was filled with 95% reagent. Alcohol was rinsed and 20 mL pure water measured with the sample vial filled to the mark "Eau" was poured through opening "A" (Fig.3 (a)). Thermometer was placed in position by inserting into opening "A" (Fig.3 (a)). Alcohol burner was lighted and placed under "B" (Fig.3 (a)). Soon after applying heat the thermometer will sense some movement and steam will come of vent. Wait till thermometer reading comes to stable and soon after read the temperature. This is the temperature reading for the water which is to be used for this set of calculations [11].

Step 2- Determining the alcohol concentration.

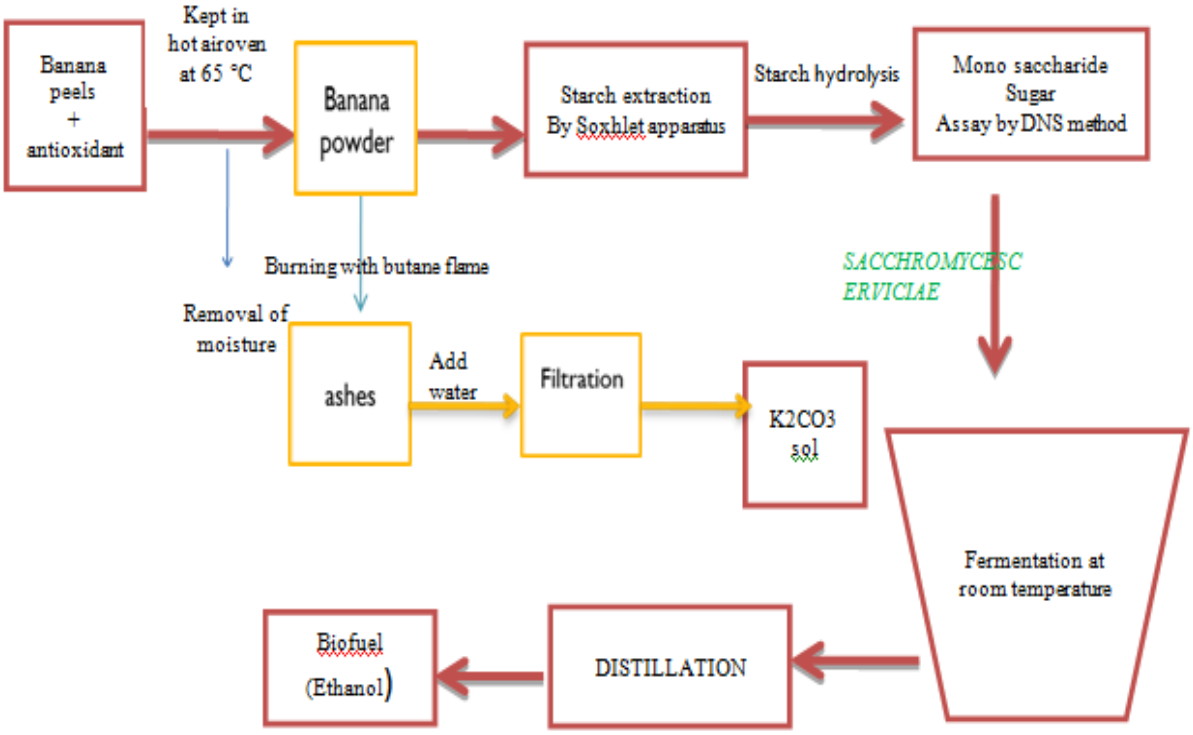
Stop cock "F" (Fig.3 (a)) was opened to drain the water and empty the boiler and condensed steam was cleared away by rinsing with some ethanol to be tested, poured out again and blown through upper tube"C". (Fig.3 (a)).Thermometer was placed in "A" (Fig.3 (a)) condenser "D-E" (Fig.3 (a)) was filled with the cold water and heated as previously discussed. The mercury will rise and stabilize and finally note down the temperature [11].

Step 3- on calculating dial(Fig.3 (b)), by setting zero on boiling point of water, corresponding ethanol % for the boiling of sample was found (Table-3), [11].

***3.2Potassium carbonate determination.***

Banana peel obtained after extraction of starch was dried in hot air Owen at 373K for 2-3 hours. The dried peels are then burnt with butane flame. The ashes obtained was added with water and then filtered (Fig-4).The solution obtained after filtration had the pH of 10.3 which shows the presence of $K_2Co_3$ and then solution was heated to get $K_2Co_3$ crystal.

## IV. OVERVIEW OF PROCESS




## *V.* RESULTS AND DISCUSSION

The effect of pH, sugar content and rate of ethanol formation were studied for 8 days as shown in (Table-3)

***5.1Rate of ethanol production.***

The results of ethanol yield obtained from the substrate are shown in(Fig-5(a)).During the fermentation period , the ethanol yield of substrate were found to increase gradually from the 1st day to the 8th day having the highest yield of 4.1%(V/V).The fermentation activity of *Saccharomyces cerevisiae*is significantly depended on the composition of sugar. As the ethanol yield increases reducing sugar concentration decreases as shown in (Fig-5(b) and (Table-3)

### *5.2. Effect of pH*

The effect of pH on the ethanol production was studied by using banana peel as substrate. By conducting experimenting pH were found to decrease gradually from 1st day to the 8thday.As ethanol production increases pH decreases from 4.2 to 3.5 (Fig-6).

## *VI.* FIGURES AND TABLES

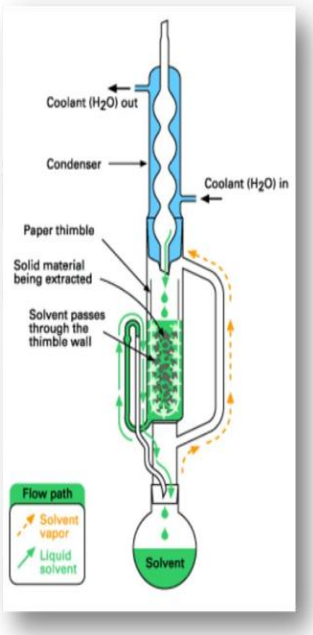



Figure 1. (a)Soxhlet apparatus (b).Extraction of starch Figure 2. (a) Laminar flow


Figure 2. (b) Simple distillation Figure 3. (a) Dujardin-Salleron Ebulliometer

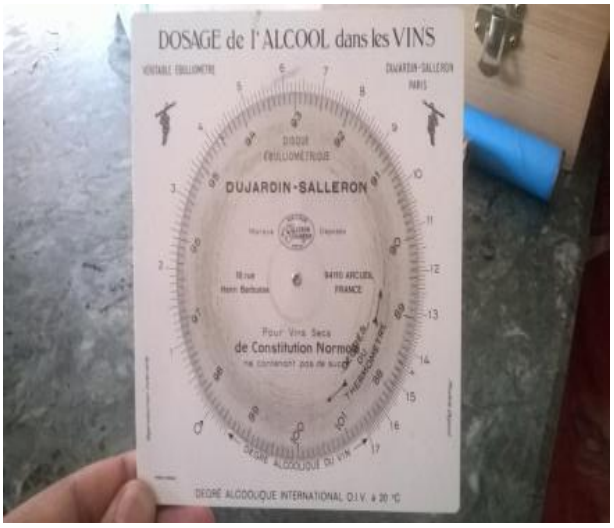



Figure 3. (b) Calculating dial

Figure 4.Gravity filtration

TABLE ITABLE II

**LARGEST BANANA PRODUCING NATION IN 2011 IN TONES'GRAM.(FAO, 2011)**

| Countries | Millions of tones | Percentage of world total (%) |
|---|---|---|
| India | 29.7 | 20 |
| Uganda | 11.1 | 8 |
| China | 10.7 | 7 |
| Philippines | 9.2 | 6 |
| Ecuador | 8.0 | 6 |
| Brazil | 7.3 | 5 |
| Indonesia | 6.1 | 4 |
| Colombia | 5.1 | 4 |
| Cameron | 4.8 | 3 |
| Tanzania | 3.9 | 3 |
| All other countries | 49.6 | 34 |
| Total world | 145.6 | 100 |

**ANALYSIS OF PEEL PER 100 METRIC**

| Content | In grams |
|---|---|
| Moisture | 79.2 |
| Proteins | 0.83 |
| Fat | 0.78 |
| Minerals | 2.11 |
| Fibers | 1.72 |
| **Starch content** | **5.00** |
| Rest(unidentified) | 10.36 |

TABLEIIIIIIV**Result of Ethanol yield, pH and sugar content**

| Days | Date | Ethanol (%v/v) | pH | Sugar content ($^{o}$Brix) |
|---|---|---|---|---|
| 1 | 09/4/2014 | 0 | 4.2 | 10.5 |
| 2 | 10/4/2014 | 1.6 | 4.2 | 9.8 |
| 3 | 11/4/2014 | 2.3 | 4.0 | 8.5 |
| 4 | 12/4/2014 | 3.8 | 3.9 | 7.2 |
| 5 | 13/4/2014 | 4.1 | 3.9 | 7.1 |
| 6 | 14/4/2014 | 4.1 | 3.8 | 7.0 |
| 7 | 15/4/2014 | 4.1 | 3.7 | 7.0 |
| 8 | 16/4/2014 | 4.1 | 3.5 | 6.0 |

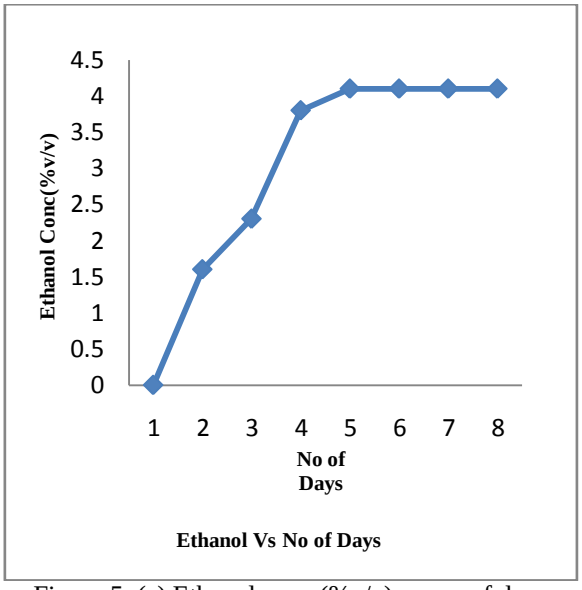



Figure 5. (a) Ethanolconc. (%v/v) vs. no of days

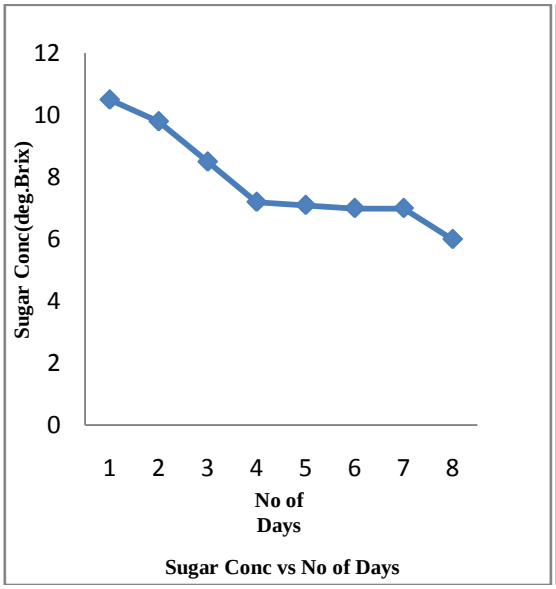



Figure 5. (b) Sugarconc. (deg.brix) vs. no of days

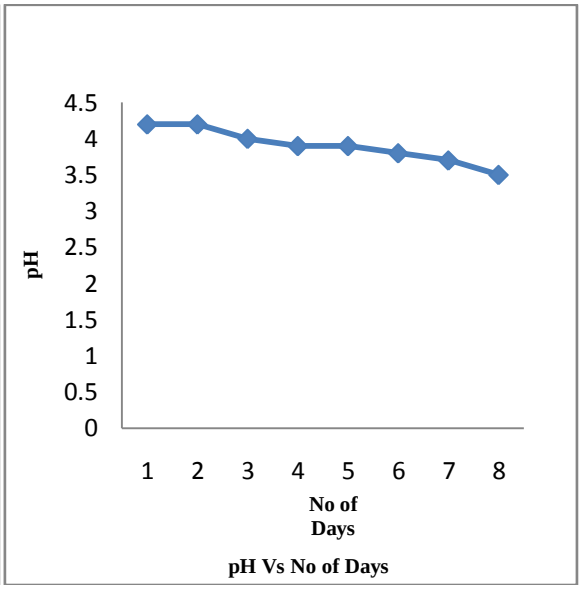



Figure 6. pH vs. no of days

## VII. CONCLUSION

Ethanol can be produced efficiently by controlled fermentation technique from banana peel waste using *Saccharomyces cerevisiae* .The optimum pH we have found to be 3.9.Potassuim carbonate can be obtained as byproduct which has various applications. These studies may be extended by optimizing the factors such as pH, temperature during the fermentation process, Optimizing the solubility of starch in different solvents for better starch extraction, increasing the tolerance of the ethanol and genetically modifying Saccharomyces *cerevisiae* culture to improve the yield of ethanol

## VIII. ACKNOWLEDGEMENTS

We wish to thank the Department of microbiology and Department of Chemistry of RYK College Nasik, Gargi institute of wine technology Nasik. Dr.Abdul Wadood Ansari sir (head chemistry department,k.k.wagh college, Nasik),Tahsin S.Kazi mam (MSc.(Gold medalist), RYK Science College ,Nasik),Swati Bhausar mam (PhD. Microbiology, RYK Science College, Nasik),Dr.Khandelwal sir(Vice principal,RYK Science college ,Nasik).For providing the chemicals ,materials and their support during the course of this work.

## REFERENCES


[1] Kimberly R. Librero, Catherina A.Barcel and Martin.L.2010, Ethanol from waste banana peelings, Technical Report, The Department of Science& Technology at School of Engineering Institution, Philippines.

[2] Hossain, A.B.M.S., Ahmed, S.A., Ahmed, M.A., Faris, M.A.A., Annuar, M.S.M., Hadeel, M., and Norah, H. Bioethanol Fuel Production from Rotten Banana as an Environmental Waste Management and Sustainable Energy. 5(6)2011, 586-598.

[3] L. R. Venkateswar and P.chand, Thermo tolerant yeasts for Bio-ethanol Production using Lignocellulosic substrates, Yeast Biotechnology: Diversity and Applications, vol. 111, 2009, 551-588.

[4] FAO (2011).Food and Agriculture Organization [online].Available: http://en.wikipedia.org/wiki/bnana.

[5] J. Itelima, F. Onwuliri, E. Onwuliri, Isaac Onyimba, and S. Oforji ,Bio-Ethanol Production from Banana, Plantain and Pineapple Peels by Simultaneous Saccharification and Fermentation Process, International Journal of Environmental Science and Development, 4(2), 2013,212-216.

[6] Latika Bhatia*, Sonia Johri and Rumana Ahmad, An economic and ecological perspective of ethanol production from renewable agro waste: a review, AMB Express, vol. 2, 2012, 2-19.

[7] S. O. Jimoh, S. A Ado, and J. B. Ameh, Simultaneous Saccharification and Fermentation of Yam peel to Ethanol by Co-culture of Aspergillusniger and Saccharomyces cerevisae, Biol. and Journal for the Tropics, 6(1), 2009, 96-100.

[8] Rahuljain, B.Vingesh, C.Thunuguntla, jayannathan.K. 2008. “Improving yield of bioethanol from banana peels”. Technical Report. SASTRA University at School of Chemicals and Biotechnology.

[9] [online].Available:http://www.hccfl.edu/media/680327/starch%2520hydrolysis.

[10] A. Reddy and M. M. Abouzeid, Direct Fermentation of Potato Starch to Ethanol by Co-Culture of Aspergillus niger and Saccharomyces cerevisiae, Journal of Applied Microbial. vol. 52.1986, 1055-1059.

[11] [Online].Available: http://www.enartisvinquiry.com.