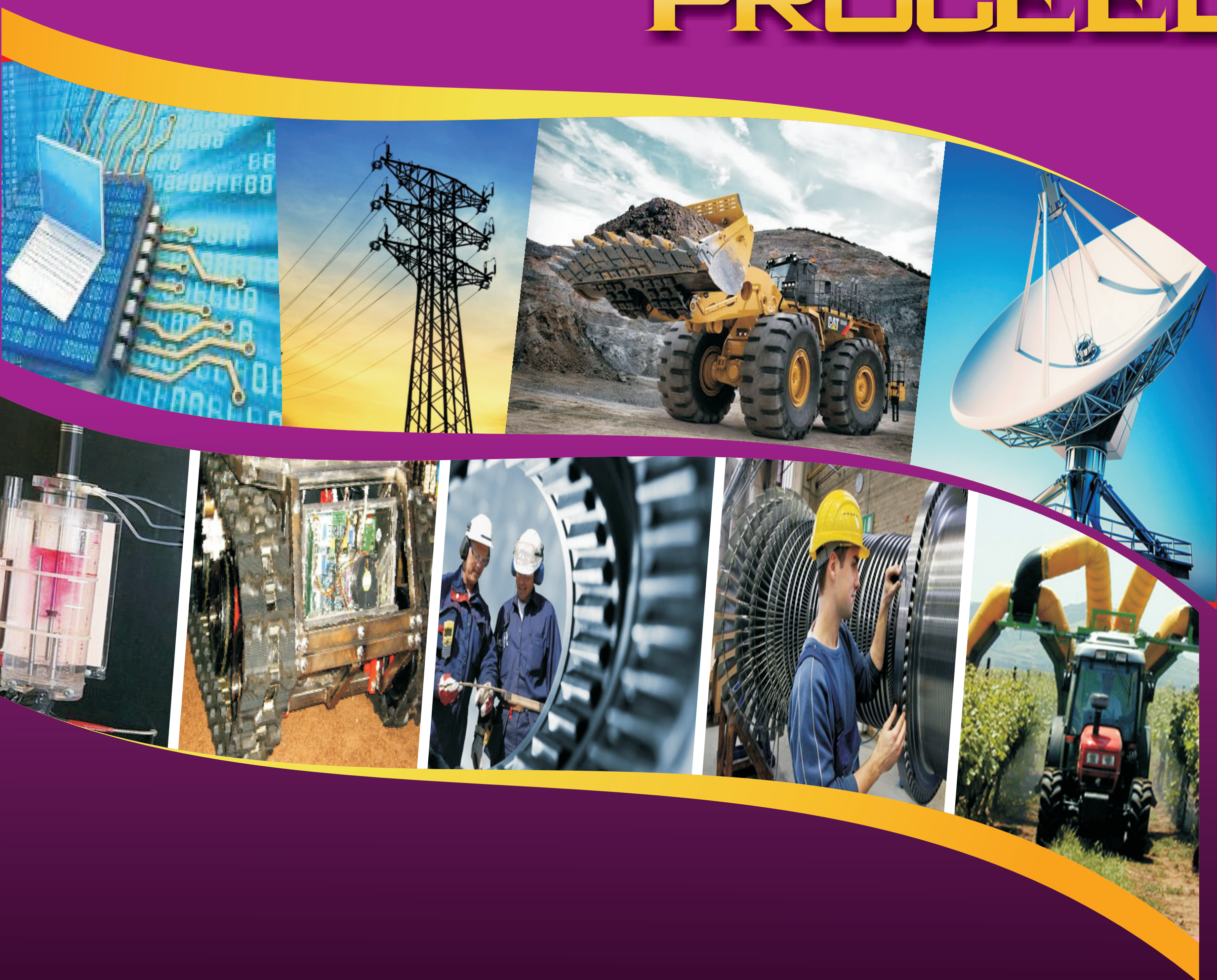
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

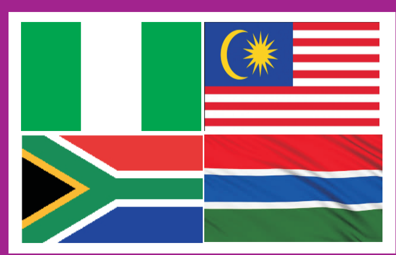
SCHOOL OF ELECTRICAL ENGINEERING AND TECHNOLOGY &
SCHOOL OF INFRASTRUCTURE, PROCESS ENGINEERING AND TECHNOLOGY

3rd INTERNATIONAL ENGINEERING CONFERENCE IEC 2019

THEME THE ROLE OF ENGINEERING AND TECHNOLOGY IN SUSTAINABLE DEVELOPMENT

BOOK of PROCEEDINGS





DATE:
24TH - 26TH SEPTEMBER 2019

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EDITED BY

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FORWARD

The School of Engineering and Engineering Technology, Federal University of Technology, Minna, organized the 1st and 2nd International Engineering Conference in 2015 and 2017 respectively. With the emergence of the new School of Electrical Engineering and Technology and the School of Infrastructure, Process Engineering and Technology, the two schools came together to organize this 3rd International Engineering Conference (IEC 2019) with the theme: "The Role of Engineering and Technology in Sustainable Development" considering the remarkable attendance and successes recorded at the previous conferences. The conference is aimed at offering opportunities for researchers, engineers, captains of industries, scientists, academics, security personnel and others who are interested in sustainable solutions to socio-economic challenges in developing countries; to participate and brainstorm on ideas and come out with a communiqué, that will give the way forward. In this regard, the following sub-themes were carefully selected to guide the authors' submissions to come up with this communiqué.

1. Engineering Entrepreneurship for Rapid Economic Growth.
2. Regulation, Standardization and Quality Assurance in Engineering Education and Practice for Sustainable Development.
3. Solutions to the Challenges in Emerging Renewable Energy Technologies for Sustainable Development.
4. Electrical Power System and Electronic as a Panacea for Rapid Sustainable Development
5. Promoting Green Engineering in Information and Communication Technology
6. Reducing Carbon Emission with Green and Sustainable Built Environment
7. Artificial Intelligence and Robotics as a Panacea for Rapid Sustainable Development in Biomedical Engineering
8. Petrochemicals, Petroleum Refining and Biochemical Technology for Sustainable Economic Development.
9. Advances and Emerging Applications in Embedded Computing.
10. Traditional and Additive Manufacturing for Sustainable Industrial Development.
11. Emerging and Smart Materials for Sustainable Development.
12. Big Data Analytics and Opportunity for Development.
13. Building Information Modeling (BIM) for Sustainable Development in Engineering Infrastructure and Highway Engineering.
14. Autonomous Systems for Agricultural and Bioresources Technology.

The conference editorial and Technical Board have members from the United Kingdom, Saudi Arabia, South Africa, Malaysia, Australia and Nigeria. The conference received submissions from 4 countries namely: Malaysia, South Africa, the Gambia and Nigeria. It is with great joy to mention that 123 papers were received in total, with 0.9 acceptable rate as a result of the high quality of articles received. Each of the paper was reviewed by two personalities who have in-depth knowledge of the subject discussed on the paper. At the end of the review process, the accepted papers were recommended for presentation and publication in the conference proceedings. The conference proceedings will be indexed in Scopus.

On behalf of the conference organizing committee, we would like to seize this opportunity to thank you all for participating in the conference. To our dedicated reviewers, we sincerely appreciate you for finding time to do a thorough review. Thank you all and we hope to see you in the 4th International Engineering Conference (IEC 2021).

Engr. Dr. S. M. Dauda
Chairman, Conference Organizing Committee

ACKNOWLEGEMENT

The Chairman and members of the Conference Organizing Committee (COC) of the 3rd International Engineering Conference (IEC 2019) wish to express our gratitude to the Vice Chancellor and the management of the Federal University of Technology, Minna, the Deans and all staff of the School of Electrical Engineering and Technology (SEET) and the School of Infrastructure, Process Engineering and Technology (SIPET) for the support towards the successful hosting of this conference. We also thank the entire staff of the university who contributed in one way or the other. We are sincerely grateful to you all.

Production and Optimization of Bioethanol from Watermelon Rind using Saccharomyces Cerevisiae

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ABSTRACT
Bio-fuels generation from waste forms is a good solution towards the waste management and generation of energy. The utilization of fruit rinds is preferable to all the costy starchy food. Watermelon rind was used to produced the bioethanol, they were dried, ground and pretreated then saccharification was carried out by enzymatic hydrolysis by Aspergillus Niger followed immediately by fermentation by yeast Saccharomyces cerevisiae. The amount of ethanol produced after fermentation was measured by Alcohol-Meter. The factors affecting fermentation process were varied, 15 runs was experimental design matrix designed by Design Expert software by RSM (Response Surface Method).The optimization of the variables was done by ANOVA (Analysis of Variance).The optimal value was obtained at 30 ^{O}C, 48 hours and 2 g/ml of temperature, time and substrate concentration respectively at 20.3% in volume ratio. From the result, the ethanol yields achieved are too low for marketing and organisms are not robust enough for applications in industries in both cases, but as science is going on, to produce sustainable fuels in future, engineering microorganisms could help to achieved it.
Keywords: ***Aspergillus Niger, Bioethanol, Fermentation, Optimization, Saccharomyces Cerevisiae, Watermelon rind*.**

1 INTRODUCTION

Dumping of waste in the world has become a very serious issue, harm or effect to plants and animal of the systems surrounding the dumping sites. The conception of production of renewable sources of energy from the used of wastages is a solution or as alternative for fossil fuel production which is very cheap, adoptable and efficient. Bio-polymer cellulose is one of the most abundant sources of energy in the modern world, forms the most plant and algal cells walls which are the major components. The organisms responsible to produce enzyme cellulose that enhance them to hydrolyze the cellulose into constituents glucose units are such; Species of Trichoderma,
Aspergillus, Clostridium etc. (Thiyam et Sharma, 2013).

The production of ethanol worldwide is approximately 51,000 million litres.The most efficient and low environmental degradation bio-energy sources is ethanol. Approximately 75% fuel are contained in a produced ethanol, while closely 20% and 15% beverage and industrial ethanol respectively (Sanchez *et* Carlos 2008).

The product of microbial fermentation is ethanol which also known as alcohol, there are some microorganisms which meets the requirement for the amount of energy to be used in conversion of carbon sources to the by-product as well, such as; carbon dioxide, lactic acid and ethanol. Since the fermentation reaction requires energy for conversion, it can be classified as an endothermic reaction. The organisms which are micro that enables the conversion of sugar to ethanol are Saccharomyces Cerevisiae, Zymomonas mobilis, Kluyveromyces Species and Schizosaccharomyces Pombe. There are various chemical based media and agro-based feedstock that can be used for fermentation of ethanol. Wheat, sorghum, sugar-cane, and corn are the mostly common and used type of feedstock for ethanol production (Balat *et al*, 2008).

According to (Nalley and Hudson 2003,USDA 2006).The carbon sources that are highly enriched or valued products as food sources are sugar cane, sugar beet and molasses which are feasible and have been used for fermentation of ethanol.

In this research, watermelon rind is used for production of ethanol. The most excellent sources of cellulose which can be used for production of ethanol via scarification followed by fermentation are fruit rinds (Mustafa et Sanjay,2014)

The fruit rinds can be Banana, orange, pineapple or watermelon rinds which are generally agreed that will be used in prospect as a primary source of simple hexoses. Such is watermelon rind. There are 2 main factors to be considered for possibly selecting watermelon rind as the feedstock for ethanol bio-fuel .One more or less than 20% of watermelon crop is rejected annually for fresh fruit marketing because of the spoilt appearance and which deforms the shape of the fruit, although the inside of the watermelon are sound and they are left in crop field. In 2007, the U.S farmer of watermelon lose about 360,000 tons which would have been a source of revenue of them which occurs as a results of above reasons (Agricultural Marketing Resource Center U.S 2007).

Converting watermelon rinds to ethanol cold at all time, provide additional on a farm-fuel to the grower or in some cases, it can be sold to the market as ethanol biofuel. Two neutraceutical value of components gotten from watermelon crop or rind could be employed as a fresh substrate to extract and produce these product. The significant antioxidant carotenoid that imparts the red colour to watermelon which has been shown to be important in prostate health is lycopene (Fang et *al*, 2002).

The botanical name for watermelon is Lanatus-Citrulline, naturally it contains amino acid that involved in removal of toxic substances for breaking down of ammonia compound and also serve as precursor for lanatus-arginine, the amino acid generally involved in the circulatory vasodilatation production of these two neutraceuticals from watermelon yields a waste stream that contains closely 10%(weight per volume) sugar that can be fermented to ethanol directly. The composition of a watermelon is about 60% flesh, approximately 90% of flesh is juice which contain closely 7%(weight per volume) sugar. However, more than 50% of the watermelon is almost fermentable liquid. In a real sense, watermelon juice processing waste stream would be would diversified into bioethanol production. Watermelon is a water based fruit ,the juice extracted from it could be serve as a diluents for concentrated fermentable sugar sources such as molasses that demands closely dilution to approximately 25%(weight per volume) sugar before fermentation. About the 7% to 10%(weight per volume) additionally are almost there to ferment sugars in watermelon(such as ; fructose, glucose and sucrose) would be additional the primary feedstock demands that are equivalent to the volume of watermelon juice to dilute the concentrated feedstock. The nitrogen supplement for yeast in the feedstocks are as a result of presence of free amino acid which is about 10 to 40 micromole per milliliters in watermelon juice such as sugar cane and molasses that have lack available nitrogen levels to stabilize the peak yeast growth and ethanol production. Investigation for optimization of parameters for watermelon rind as feedstock for fermentation has been carried in this research.(vanZyl *et* Lynd 2007).

According to (Kim et al 1984) reported on the factors that affects the fermentation of watermelon rind for the ultimate production of vinegar, but the optimization for maximal values of ethanol production was not only one of the it objectives. His purpose was to examine watermelon juice or rind as a whole or as a waste stream from neutral-ceuticals production, as a diluents feedstock and nitrogen supplement in production of ethanol biofuel systems.

2 METHODOLOGY

The following methods and materials used to carried the experiments were listed below:

2.1 SAMPLE COLLECTION

The watermelon rind was collected from watermelon sellers near Bosso Market, Minna Niger state. It was washed in order to remove the sand and dirt, and then it was cut into smaller sizes. After, it was sun dried for two days to reduce its water content before it was oven dried in hot air at 65^{O}C for 24 hours ant it was weighed to be 150grams.

2.2 Culturing of Saccharomyces Cerevisiae

Saccharomyces Cerevisiae yeast was separated from waste material from soil samples rich in vineyard such as overrippen or unwanted grapes. Sterilized container was used to collect the sample. The sample from soil was dissolved with distilled water and allowed to Settled, the supendant was diluted by dilution and yeast extract peptone, and Dextrose (YEPD) plates were used to inoculated the samples. The plates contain the sample was incubated at 30^{O}C for 48 hours. The yeast grown was separated and identified as Saccharomyces Cerevisiae (Kregervan *et* Eds, 1984).

2.3 Culturing of Aspergillus Niger

Aspergillus Niger was a fungal enzyme which was cultured and screened of local paddy and groundnut crop field from different soil sample. The fungus collected was cultured and maintained on medium of potato Dextrose agar at 30^{O}C.The fungal growth was identified as Aspergillus (Barnett *et* Hunter, 1998) and (Alexopoulous *et al*, 1996).

2.4 Preparation of 1% Sodium Hydroxide solution

10 grams of sodium hydroxide pellet was measured and weighed with weighing balance into a beaker and 1000ml of distilled water was added into the beaker and stirred thoroughly to obtain a homogeneous solution.

2.5 Pretreatment

After the watermelon rind was dried in hot dry air, the sample was ground into fine powder form, and weighed and recorded as 150 grams. The sample was transferred into a container, and then the prepared 1% NaOH was added into the container and soaked for two hours. After soaking, the sample was washed thoroughly to remove the remaining impurities with distilled water and filtered. The filtrate was discarded, then the residual was oven dried, then the sample was brought out, crushed and sieve to finer structure and sample was weighed to be 90.4 grams.

2.6 Simultaneous Saccharification and Fermentation procedure

As the method implies, fermentation takes place immediately after saccharification or hydrolysis, in this experiment 15 runs was carried out according to design expert software using Box-Behnken Design RSM (Response Surface Methodology) and 27 runs according to the factorial design experiment

3 RESULTS AND DISCUSSION

The results obtained from the fermentation of the hydrolysate using saccharomyces cerevisiae and characterization of the bio-ethanol produced. And the effect of temperature, substrate concentration and time on the fermentation process.

Effect of Temperature on Fermentation

From the graph shown on figure 1, it was observed that temperature is very important in fermentation.The highest value of ethanol yield percentage in volume ratio is 20.3 at the temperature of 30^{O}C.At higher temperature, the ethanol yield decreases.Therefore the ethanol yield is inversely proportional to the temperature.

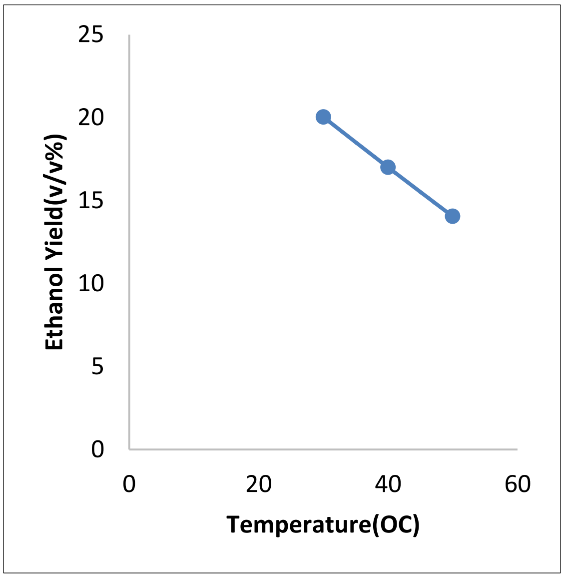

Figure 1: Graph of ethanol yield versus temperature

Effect of Substrate Concentration on Fermentation

The substrate concentation is also very important on fermentation.The highest ethanol yield on substrate concentation of 2 g/ml is 20.3 of percentage volume ratio.The above expression is shown in figure 2 below

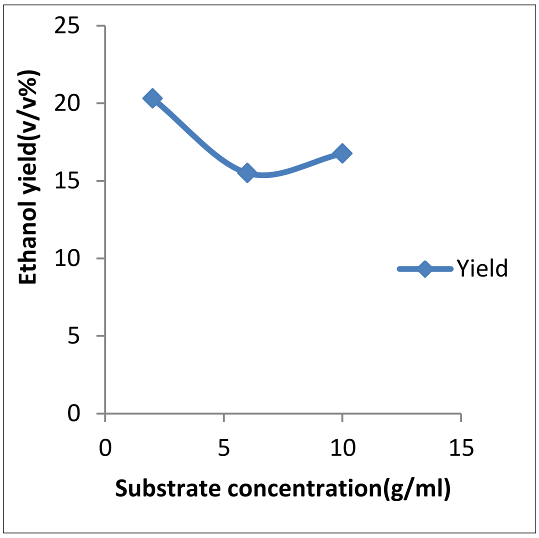

Figure2: Graph of ethanol yield versus substrate concentration

Effect of Time on Fermentation

From Figure 3 below, it was indicated that time is also important in varying the parameter for fermentation process.As the reaction time increases from 20-30 hours the ethanol yield increases. At the reaction time between 40-50 hours,the ethanol yield is highest at range 16-18 (v/v %).At the higher reaction time between 60-80 hours,the ethanol yield increases.

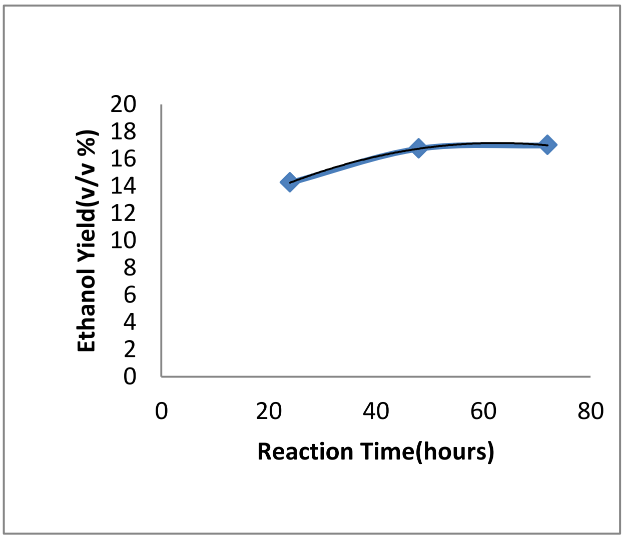

Figure 3: Graph of ethanol yield versus reaction time

3.1 EQUATIONS

ANOVA (Analysis of Variance)

ANOVA is a software used to optimise the variables to obtain the optimum (maximum and minimum) value. The optimization step was using 15-runs Box-Behnken design to identify the significant factors for fermentation process.Temperature, reaction time and substrate concentration

ANOVA for Response Surface Quadratic Model

The design and results of experiments were carried out by box-behnken design.The result obtained were submitted to analysis of variance on SASA package, with the regression model given as:

$$= 14.35 - 1.871X_1 + 1.5X_2 - 0.38X_3 + 1.19X_1X_2 + 0.70X_1X_3 - 1.06X_2X_3 + 0.00X^2{}_1 - 1.54X^2{}_2 + 1.75X^2{}_3 \quad (1)$$

The Equation (1) above is for coded factors.

$$Y = 27.696 - 0.52938X_1 = 0.18724X_2 - 1.576(6X_3 = 0.00494X_1X_2 + 0.01750X_1X_3 - 0.011068X_2X_3 + 0.000X^2{}_1 - 0.00266927X^2{}_2 + 0.10937X^2{}_3 \quad (2)$$

The equation (2) above is for actual factors.

Where Y is response value that is , ethanol yield production, and X_1, X_2 *and* X_3 are the coded and actual factors of temperature, time and substrate concentration respectively.The Model F-value of 4.97 implies the model is significant. Ther is only a 4.61% chance that a “Model F-value” this large could occur due to noise.Values of “Prob> F” less than 0.050 indicate model terms are significant.In this case $X_{1,}$ X_2 and X_3 are significant model terms.Values greater indicate the model terms are not significant.If there are many insignificant model terms (not counting those required to support hierarchy), model reduction may improve your model.

The analysis of variance of the quadratic regression model demonstrated that eq.1 was a hihly significant model, as was evident from the fischer’s F-test with a very low probability value [(P model > F) = 0.0111].The model’s goodness of fit was checked by determination coefficient (R^2). In this case, the value of the determination coefficient($R^2 = 0.8995$) indicate that only 4.61% of the total variationa were not explained by the model. The value of the adjusted determination coefficient [Adj(R^2)=0.7185.The Lack of Fit F-value of 1.81 implies the Lack of Fit is not significant relative to the pure to noise.There is 37.54% chance that Lack of Fit, a large value could occur due to noise.All the explanations are illusrated on Table I below:

3.2 TABULATION

Table 1: ANALYSIS OF VARIANCE FOR THE FITTED QUADRATIC POLYNOMIAL MODEL

Terms	Effect	SS	DF	F Ratio	P > F
X_1	-0.5293	27.940 0	1	15.4500	0.0111
X_2	0.18724	18.000 0	1	9.9500	0.0252
X_3	-1.5765	1.1600	1	0.6400	0.4590
$X^2{}_1$	0.0000	1	0.0000	0.0000	1.0000
X_1X_2	0.00495	1	5.6400	3.1200	0.1376
X_1X_3	0.01750	1	1.9600	1.0800	0.3455
$X^2{}_2$	0.00266	1	8.7300	4.8300	0.0794
X_2X_3	0.01106	1	4.5200	2.5000	0.1749
$X^2{}_3$	0.10937	11.310 0	11.310	6.2500	0.0545
Model	-	80.910 0	9	4.9700	0.0461
Error	-	2.4300	2		
Total	-		14		

Note: SS=Sum of square, DF=Degree of freedom

Effect of Temperature and Substrate Concentaration and their interactive effect on Ethanol production.

From figure 4 below,from the 3-D graph, the highest ethanol yield is 18.9(v/v%) with substrate concentration of 2g/ml and the temperature of 50^{O}C.

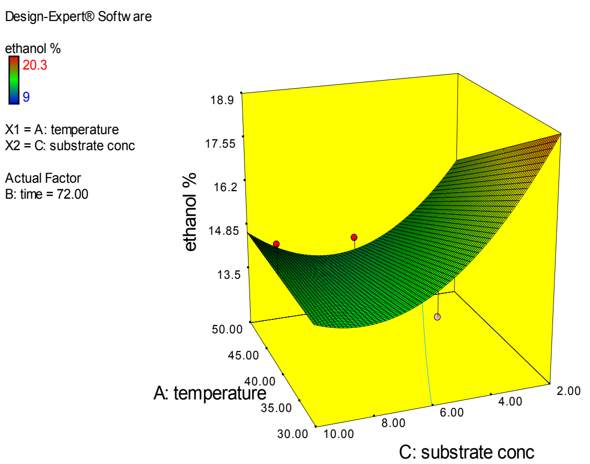

Figure 4: Response Surface plot of the interaction effect of Substrate Concentration and Temperature on the yield of ethanol.

Effect of Time and Substrate Concentration with interactive effect on Ethanol production

From the 3-D graph in figure 5 below, the highest ethanol yield is between 18.725-20.3 (v/v %) of the substrate concentration of 2g/ml and the reaction time of 48 hours

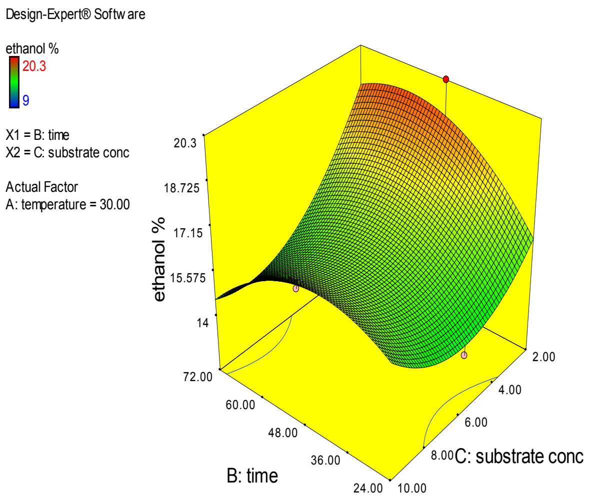

Figure 5: Response Surface plot of the effect of the interaction of the substrate concentration and time on the yield of ethanol.

Effect of Temperature and Time with their interactive Effect on Ethanol production

From the 3-D graph in figure 6 below, the ethanol yield is 14.5(v/v %) at the time of 48 hours and temperature of 30^{O}C

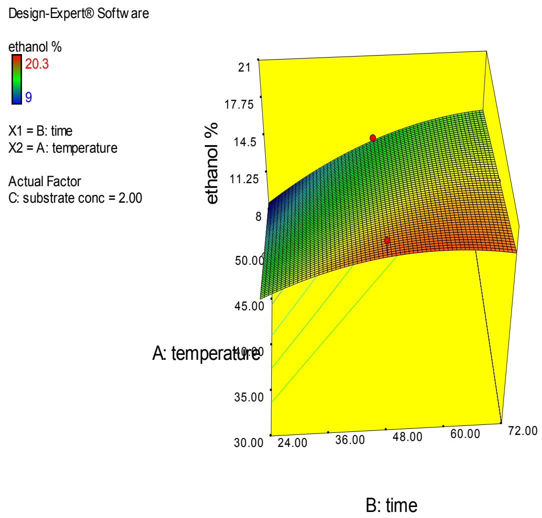

Figure 6: Response Surface plot of the effect of the interaction of the temperature and time on the yield of ethanol.

4 CONCLUSION

From the research carried out, it has been concluded that water melon rinds are suitable as a feedstock for production of bioethanol using *saccharomyces cerevisisae* as yeast the simultaneous saccharification and fermentation process and it given low cost and completion with food crops they are cost effective as raw materials even though starchy materials give a better yield.

The optimum ethanol yield in volume percent of water melon rind was observed to be 20.3% at 30^{0}C, 2g/mL for 48 hours.

The regression analysis analyzed for watermelon rind fermentation is at most fair representation of the process. The mathematical model developed for the fermentation of watermelon rind is also a very good representation of the process. The production of bioethanol from water-melon rind can provide sufficient and non-pollutant to compliment the current use of fossil and hydrocarbon based fuels. Since during the production of bioethanol from water melon rind, no odour was perceived. Then siting the plant for this will be friendly to human health and environment itself.

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