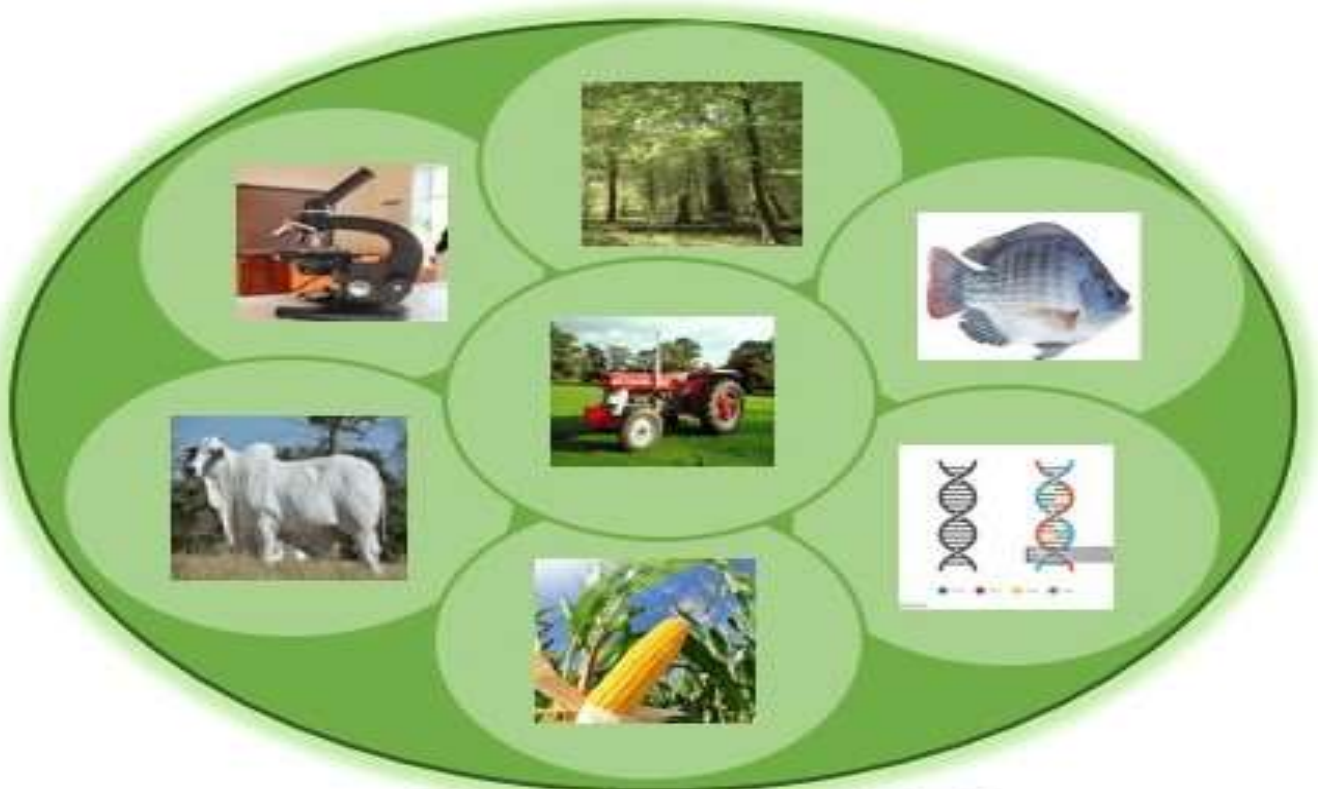




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CONTACT:

The Editor-in-Chief,
Kebbi Journal of Agriculture and Natural Sciences,
Faculty of Agriculture,
Kebbi State University of Science and Technology Aliero,
PMB 1144, Birnin kebbi, Nigeria.
Email: kejaanseditor@ksusta.edu.ng, kejaans.foa@gmail.com.
Phone: +234 8039370546

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The first page of the manuscript should contain the title of the article, which should be concise and explicit, typed with upper-case, bold, 14 font size, TNR and not more than 21 words. The surname and forenames (in full) of authors, affiliation of each author should be provided. Phone number and email address of the corresponding author (identified by an asterisk) should be provided. Superscripts should be used to relate authors to their affiliations.

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Avoid the use of figures /numbers at the beginning of a sentence. Write out one through nine unless a measurement, a designator, or a range (e.g five seeds, 8cm, 3yr, 5-11 flowers)

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ENERGY POTENTIALS OF SWITCH GRASS (*Panicum Virgatum*) FOR BIO-ETHANOL PRODUCTION

Abdulsalam A. A^{1x}, Adejumo Mutiu.², Oladele S.M³.

^{1,2}Department of Science Laboratory and Technology, Kebbi State Polytechnic, Dakingari, Kebbi State

³Department of Fisheries Technology, Kebbi State Polytechnic, Dakingari, Kebbi State.

^xCorresponding author: solidfoundationdkg@gmail.com

ABSTRACT

The release of greenhouse gas emission, climatic change, environmental degradation, rising cost and scarcity of fossil fuel has been a concern to the government and researchers. The negative impact of the gasoline has prompted to seeking for alternative source of energy that is renewable, environmentally friendly, and attractive for sustainable development. Bioethanol has emerge has the most promising alternative to gasoline, affordable and reduce dependence on traditional fuel and compensate for fuel scarcity. This research was carried out to study the potential of switch grass (panicum virgatum) as a suitable feedstock for bioethanol production. Switch grass, a lignocellulosic biomass was collected and treated. The chemical composition of the grass was carried out to identify the potentials of the grass as a viable resources for better yield of sugars. The results revealed 39.42±0.52% cellulose content, hemicelluloses content 20.25±0.01%, lignin content 11.22±0.62%, ash content 2.30±0.34%, and moisture content 28.64%. The results of the analysis indicates that switch grass has a high viability for sugar yield and its sustainability for bioethanol production.

Keywords: Bioethanol, Renewable energy, Lignocellulosic biomass, Sustainability, Switch grass.

Introduction

The increase in demand for energy and the negative impacts of fossil fuels such as global warming, greenhouse gasses emissions, and the fast depletion of fossil resources have resulted in an increased interest in the research of alternative energy or sustainable energy such as biofuel (Muhammad and Saha, 2020). Combustion of fossil fuel has offered a numerous advantages to our life and it also lead to GHG which cause global warming and climate change.

The production of biofuel has been proposed as a suitable alternative for energy

generation in order to reduce the usage of fossil fuels which causes global warming, greenhouse effect, and environmentally friendliness (Dey *et al.*, 2020). Among all, bioethanol is one of the most attractive as it can substitute gasoline (Efemwenkiele *et al.*, 2019).

Lignocellulosic biomass is an abundant and renewable resources from plant mainly composed of polysaccharides (cellulose and hemicellulose) and an aromatic polymer (Lignin) which has a high potential as an alternative fossil resources to produce second generation biofuel.

Lignocellulose resources consist of virgin biomass comprises all naturally growing terrestrial plants, including herbaceous plants (annual, biennial, and perennial plants) and woody plants (trees, bushes, and dwarf shrubs), as well as aquatic plants (water hyacinth, water fern, water lettuce, and duckweed). Energy crops include perennial grasses and other dedicated energy crops that produced a high yield of lignocellulosic biomass (switch grass, giant, reed, elephant grass, and miscanthus). Waste biomass is a low-value by-product of different industrial sectors such as agriculture (bagasse, cereal, straws, stover, and husks), forestry (branches from dead trees, pruning, and thinning residues), and wood and paper production (bark, sawdust, and wood chips). It also includes an organic portion of municipal solid wastes (Arefin *et al.*, 2021). Lignocellulosic biomass is mainly composed of three polymers, cellulose ($C_6H_{10}O_5$)_n, Hemicellulose ($C_5H_8O_4$)_m, and lignin ($C_9H_{10}O_3(OCH_3)_{0.9-17}x$) along with pectin. The cellulose, hemicelluloses and lignin content in a typical lignocellulosic biomass falls within the range of 30-60, 20-40 and 15-25% (Rezania *et al.*, 2020). However, the composition of these major component varies depending on the source. Switch grass, a lignocellulosic biomass with high amount of cellulose and hemicelluloses is a promising substrate for bioethanol production (Dev *et al.*, 2022).

Pre-treatment process, disrupt the structure of lignocellulosic biomass and the cellulose fibre is exposed. This is carried out to overcome recalcitrance through the combination of chemical and structural changes to the lignin and carbohydrates (Singh *et al.*, 2017). The hydrolysis of lignocellulosic biomass results in the release of various reducing sugars which are highly valued in the production of biofuel such as bioethanol, biogas, various organic acids, phenols and aldehydes. This pre-treatment has lead to the

development of various pre-treatment techniques utilizing various physical, chemical, physico-chemical and biological approach.

Materials and Methods

The herbaceous grass used for the research work was Switch grass (*Panicum virgatum*)

List of Chemicals and Reagents

The followings are chemicals that were used.

- Calcium hydroxide
- Calcium oxide
- Hydrochloric acid
- Ammonium hydroxide.

List of Equipment/Apparatus

The followings are equipment that were used:

- Weighing balance
- Incubator
- Digital pH Meter
- Thermometer
- Measuring cylinder
- Beakers
- Oven
- Dropping pipette
- Magnetic hot plate stirrer regulator

Sample Collection and Treatment

The switch grass was collected in farming areas in Dakingari, Kebbi State, Nigeria.

Sample Treatment

The switch grass was cleaned with water to wash the particles, cut into tiny pieces. The samples were sundried for two to three weeks. The samples were then ground, sieved, and placed in air tight sample bottle (Tambuwal *et al.*, 2018).

Analysis of the Samples

Proximate analysis of the sample as recommended by the Association of Official Analytical Chemists (AOAC, 2016).

Moisture Content

Principle: This was based on loss of weight of sample in an oven.

Procedure: weight of the dish W_0 , was 2.0g. The sample in a dish and weighed as W_1 . The dish and sample was placed in an oven at 105°

C. The dish and content was then placed in a desiccator to cool and reweighed as W_2 . Each sample was repeated in triplicate. The percentage of moisture content calculated using equation.

Mass of evaporating dish W_0
Mass of sample + evaporating dish..... W_1
Mass of dry sample + evaporating dish..... W_2

$$\text{Moisture content (\%)} = \frac{w_1 - w_2 \times 100}{w_1 - w_2} \dots\dots\dots 1$$

Ash content

Principle: This is the residue that remains on ignition of the sample .

Procedure: Two gram (2.0g) each of the ground sample was weighed and placed in a dry clean empty dish. The dish containing sample was weighed as W_1 . The crucible

containing sample was put in a muffle furnace for two hours at 600°C . The sample was placed in the desiccator to cooled and the dish containing the dried sample was measured (W_2). Each sample was repeated in triplicate. The ash content was evaluated by equation (2).

Mass of empty evaporating dish..... W_0
Mass of evaporating dish + dried sample..... W_1
Mass of evaporating dish + ash content..... W_2

$$\text{Percentage ash content (\%)} = \frac{W_1 - W_2 \times 100}{W_1 - W_0} \dots\dots\dots 2$$

Determination of Crude Fibre Content

Principle: This was determine on the principle of loss of fibre on ignition after digestion with acid and base.

Procedure: Crude fibre was determined by acid-base digestion. The sample 5.0g was placed in a 100ml conical flask and weighed (W_0). The quantity 200ml of 1.25% of H_2SO_4 solution was added to the sample and boiled for 30min under reflux. The mixture was filtered, and then rinsed with water. The fibre was collected into a conical flask and 200ml of

1.25% NaOH was added and boil for 30minutes. The sample was again filtered through muslin cloth. The sample was then washed with water and then with 10% HCl and methylated spirit. The sample was then again rinsed with petroleum ether (BP $40-60^\circ\text{C}$). The sample was air dried and weighed (W_1). It was then ash at 55°C for 90minutes in a muffle furnace, allowed to cooled and weighed as (W_2). The percentage crude fibre was calculated using the expression (AOAC, 2006) in equation 6.

Mass of dish + residue..... W_3
Mass of dish + ash..... W_2
Mass of sample..... W_1

$$\text{Crude fibre content (\%)} = \frac{W_1 - W_2}{W_0} \times 100 \dots\dots\dots 6$$

Carbohydrate Content

The carbohydrate content was calculated to percentage by adding ash content, protein content, lipid content and crude fibre (Udo and Ogunwale, 1986) as shown by equation (7)

$$\% \text{ Available carbohydrate content} = 100 - (\% \text{ ash} + \% \text{ crude protein} + \% \text{ crude lipid} + \% \text{ crude fibre}) \dots\dots\dots 7$$

Chemical Composition of the Samples

The biomass was subjected to gravimetric method of analysis according to the standard method of analysis.

Extractives:

The raw biomass of 2.5g was placed into the cellulose thimble of the soxhlet extraction apparatus containing 150ml of acetone as the extracting agent. The extraction process was regulated to 70 °C for 25min on the heater for 4hrs. The samples was air dried and weighed until a constant mass is achieved. The percentage (w/w) of the extractives was evaluated by subtracting the weight of the raw extractive biomass and the extractive-free biomass. (Lin *et al.*, 2010).

Hemicellulose

The extracted dried biomass of 1g into a 250ml conical flask. 150ml of 500mol/m³ of sodium hydroxide added. The solution was heated for 3.5h on a heating mantle. The mixture

was cooled and filtered off through vacuum filtration and washed until the mixture becomes neutral. The residue was placed into a conventional oven and dried into a constant weight at 105°C. The hemicelluloses content (% w/w) was evaluated by subtracting the weight of sample before and after treatment (Lin *et al.*, 2010).

Lignin

Three 3ml of 72% H₂SO₄ was added to 3g of dried extracted raw biomass in a glass test tube. The mixture was carefully shaken for 2hrs at 30min interval and kept at ambient temperature for complete hydrolysis. Then, 84ml of water into the mixture and heated for 1hr at 121 °C. Furthermore, the slurry in tube was air dried and the hydrolysates filtered. The insoluble lignin was obtained by heating the residues at 105 °C, recovering the content by heating the hydrolysed sample at 575 °C. The soluble lignin content was evaluated by UV-Visible of the hydrolysed sample at 320nm. The lignin content was the sum of insoluble lignin and soluble lignin according to (Sluiter *et al.*, 2008).

Cellulose Determination

The percentage cellulose was evaluated according to (Lin *et al.*, 2010).
Percentage cellulose = 100 - (sum of hemicelluloses, lignin and ash content).

Results and Discussion

Table 1: Proximate analysis of switch grass (*Panicum virgatum*)

CONTENT	Moisture content	Crude fibre	Ash content	Carbohydrate
PERCENTAGE %	7.54	11.56	3.82	68.43

Table 2: Chemical composition of switch grass (*Panicum virgatum*)

CONTENT	Hemicellulose	Cellulose	Lignin
PERCENTAGE %	28.96	34.92	13.48

Discussion

The result presented in table 1 showed that the switch grass have high percentage of carbohydrate content of 68.43%, 7.54% of moisture content and low percentage of ash content respectively. The results indicate that switch grass is a better option as a feed stock for bioethanol production. The results presented in table 2, shows the chemical composition of the carpet grass. The results revealed that the percentage of cellulose with 34.92%, 28.96% for hemicelluloses and lignin having 13.48%. The high percentage of cellulose and hemicellulose indicate high yield of sugars. The sugars during hydrolysis can be converted to bioethanol. The results also shows that switch grass with high percentage of cellulose and hemicellulose indicated a better yield of sugars and on fermentation given a high yield of bioethanol. The results of the two tables, indicates that switch grass is a better option for the production of bioethanol

Conclusion and Recommendations

Perennial switch grass is an excellent grass species for the production of bioethanol. The results of the proximate analysis and chemical composition of grass is an indication of an alternative substrate for high yield of bioethanol.

From the results of the analysis, it will be recommended that further research should be

conducted on using switch grass for the production of bioethanol using acid hydrolysis. The bioethanol produced will serve as substitute and enhancing cheap biofuel production, reduce reliance on fossil fuel, scarcity of fuel and brings about be ethanol of cost effective.

Also, research should be done using non-acid hydrolysis as an alternative to chemical methods to reduce toxicity.

Bioethanol should be produced on industrial scale so as to provide a lasting solution to the gradual depleting ozone layer as a result of greenhouse gasses emission.

More research should be conducted on the production of bioenergy which are renewable.

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