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Comparism of Biogas Production by Maize and Sorghum Staiks in Pankshin Local Government Area of Plateau State: Implication for Household Energy Supply

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Abstract: This study was undertaken to compare biogas production by maize and sorghum stalks for house hold energy supply in Pankshin local government area of Plateau state. An experimental research design was used. The experimental procedure included the growth of maize and sorghum stalks for two months (60 days) the stalks were selected and harvested while still succulents. The stalks were washed, cut into pieces using clean knives, pounded into pastes using mortar and pestles. An empty metal bucket with known weight was used, the pastes of each was weight and equal number of each bucket was put inside each digester accordingly from the top. The top was then sealed with super glue and the digesters were each painted with black oil paint. As a result of the size and volume of the digesters, the set up stayed for 14 days and being monitored daily. Findings indicate that for the Maize stalk there was no gas generated in day one as such the Bunsen burner did not burn. It burns for 50 seconds in day two, 1.5 minutes in day three and it rises steadily to 4 minutes in day eight. Then it started dropping to 3.5 minutes in day nine, 2.7 minutes in day ten, then it drops steadily to 0. 00 minute in day fifteen. For the Sorghum Stalk, days one and two no gas was generated as such the Bunsen burner did not burn. It burns for 1 minute in day three, 1.5 minutes in day four, then it rises steadily to 2.2 minutes for days 7 and 8 then to 2 minutes in day 9 then it started falling steadily to 0.00 minute in days 14 and 15. This implies that energy in form of biogas can be generated from maize and sorghum stalks. Exploring this can meet the increasing energy of man. Based on the results it was recommended amongst others the study can also be replicated with other varieties of common grass using standardized digesters. This is because grass is a weed and do not have other economic value like stalks from food crops. It was concluded that energy in form of biogas can be generated from maize and sorghum stalks. Exploring this can meet the increasing energy need of man. It is recommended that; the study can be carried out with the stalk of other crops such as rice, millet, cow pea and others.

I. Introduction

The concept of energy comes from the Greek word energeia meaning "in" or "work". It first appears in the work of Aristotle in the 4th century B C (Wikipedia the free Encyclopedia, 2015). To Aristotle, energy is needed to do work. Human existence is hinged on energy, be it of any form. Energy is needed for daily human activities for both industrial and domestic uses. Uyigue and Archibong (2009) posit that humans need energy to drive human socio-economic activities and technological development. This probably informed why the world energy needs have continued to increase on a daily basis. That is to say that energy is very crucial to human survival. Okebukola and Akpan (2003) attribute the increase demand for energy to the increase in human activities and demand for alternative sources of energy.

Duguryil (2016) asserts that one of the major sources of energy required for humans is from the food they eat. This food is converted in the body as chemical energy. The energy plants (Maize and Sorghum) get is from the sun light by a process called photosynthesis, where carbohydrate, simple sugar ($C_6H_{12}O_6$) is manufactured by using absorbed mineral salts from the soil, which combined with carbon (iv) oxide gas (CO_2) from the atmosphere in the green parts of the plants leaves and stems with sun light. Ahmad and El-Mukhta (2007), describe the energy in plants as biomass, which is a form of stored solar energy by the process of photosynthesis in growing plants. That this stored energy is in form of carbohydrate and oil and can be recovered as biofuels e.g., Ethanol, biogas (CH_4) and biodiesel. Pia-Maria, Mats and Guido (2013) assert that the biogas can be used to produce heat or electricity or it can be upgraded to transportation fuel.

Generally, all living things use energy in everything they do whether active or at rest. The seeds of maize and that of the sorghum planted inside the soil need energy to germinate to produce the stalks, which can be used for biogas production. Energy produced in whatever forms can be transformed and conserved into different forms of energy. Energy transformation involves changing one form of energy into other forms of energy. Examples heat energy can be transform into light energy, electrical energy among others.

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Energy conservation on the other hand means that energy can neither be created nor be destroyed by itself but can be transformed or changed into other forms of energy. In energy transformation the total inflow of energy into a system must equal the total out flow of energy out of the system, plus the change in the energy contained within the system.

Energy can be obtained from various sources such as, stored energy from batteries and wind, others are from organic matter like; plants (corn stalks), food, fuel. There are two major sources of energy, non-renewable and renewable sources of energy. Non-renewable sources of energy cannot be replaced once used up. Example of non-renewable source of energy include; fossil fuel, coal etc. To Pia-Maria, Mats and Guido (2013) fossil-based fuels (non-renewable energy) especially oil dominate the transport sector, and alternative to fossil fuels will become necessary as the number of vehicles that use it increase especially in countries with rapidly growing economies.

Renewable sources of energy such as biomas can be replaced when used up. To Ahmad and El-Mukhta (2007) energy generated from biofuel is called biomass, and biofuel is any fuel from biomass, it is a renewable energy source. Akinbobola (2007) opined that biomass refers to all the earth's vegetation with other products that come from it, it's a renewable energy via photosynthesis, and that the chemical potential energy in the carbohydrate remains when plants are processed into other materials like biogas. Bio-energy sources depend on availability of biomass feed stocks, which are biological materials from which gas, liquid fuel, heat, electricity can be generated. There are five feed stocks. They include; agricultural residues (corn stalks, cobs, wheat straw, leaves, trees, shrubs, grasses), forest residues (wood products), primary mill residues (wood wastes from saw mills), Urban wood wastes (wood portions of wastes disposed of in municipal), and solid wastes (Landfills).

Biomass is a source of energy from, wood, crop wastes like decaying plants; maize and Sorghum stalks, animal wastes like Cow dung, these are simply called organic materials, which can be burned (aerobic or anaerobic) to provide energy, like heat energy. In Africa most people in urban and rural areas including Pankshin Local Government Area used (plants), wood as the major source of energy from felling of trees, collecting of maize and sorghum stalks by burning them to generate heat and light energy. Organic matter decays through the action of bacteria, the decomposition uses oxygen (aerobic) and in biogas production the decaying becomes oxygen-deficient where the natural breakdown of the organic matter by organisms (bacteria) occur without free oxygen (anaerobic) digestion. To Okebukola and Akpan (2003) it comprises of three stages, first stage, sugar (Glucose $C_6H_{12}O_6$) is produced, second stage they are converted into fatty acids, Acetic acid by Acetogenic bacteria and finally into methanogenic acid by the bacteria under anaerobic conditions by breaking down the organic acid into biogas (Methane, CH_4). Pia-Maria, Mats and Guido (2013), opine that microorganisms degrade organic materials into biogas during anaerobic digestion, almost all organic materials can be biodegraded.

Burning of fossil fuels to give energy, this method increases th e production of carbon (iv) oxide gas (CO_2) which is one of the greenhouse gases. Greenhouse gases increase global warming which negatively affects weather and agriculture and the farmer is badly affected. The world faces problems with greenhouse gases and diminishing oil resources, the use of biofuels such as bioethanol and biogas can decrease the production of greenhouse gases and reduce dependence on oil (Pia-Maria, Mats & Guido, 2013). Hence, the need to evolve strategies that the energy from plant materials can be properly channeled to produce useful energy not greenhouse gases that is harmful to man.

Purpose of the Study

The purpose of the study was to compare the quantity of biogas produced by maize and sorghum stalks in Pankshin Local Government Area of Plateau State

Research Question

The study sets out to answer this question

To what extend do maize and sorghum stalks differ in their biogas production?

II. Statement of the Problem

The over dependence on firewood, coal and charcoal may lead not only to the depletion and extinction of biodiversity but will also to global warming which affects agriculture and climate. If this is not checked, the future generation may not have the privilege to have access to such valuable resource. Petroleum products and electricity are expensive and not affordable by the common rural dwellers this also leads to the search for alternative clean and affordable energy source such as biogas for both rural and urban areas.

Man uses biomass for food, fuel, constructions of roads and houses, the negative effects include habitat destruction, environmental pollution. After farmers have harvested crops from the farm like maize and sorghum the residues like the stalks are also remove either as firewood or burn on the farm, this encourages soil erosion, depletion of Nitrogen from the soil, encourages desertification

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and increase in the presence of carbon (iv) oxide (CO_2) gas in the atmosphere as plants are removed photosynthesis which removed carbon (iv) oxide (CO_2) gas is reduced, thus, the need for clean safe and affordable energy.

III. Methodology and Materials

Methane gas (Marsh Gas, CH_4) can be produced from organic materials like fresh maize and sorghum stalks, maize and sorghum stalks can be grown at any season of the year in Pankshin Local Government Area of Plateau State. The methodology used in this study involves the following steps

Feasibility Study of the Site

Instead of using the botanical garden of the Integrated Science Department, the farm land at the Dam site of MILE 8 in Pankshin was used, this was for adequate and control supply of water as it was dry season also for proper growth of the Maize and the Sorghum stalks.

Site Clearance

A research assistant was employed whose duties, responsibilities and stipend to be given were agreed upon. The research assistant cleared the site in February 2022, of dried stalks with other wastes. Using thorns and other things the boundary was secured to prevent cattle and other stray domestic animals from entering the site unnoticed and interfering with the study. A two inches water pump engine was used in watering the site,

Making of Ridges and Planting

The marked-out area was watered to make it wet, then the next day ridges were made in form of beds for good water retention since it was dry season. The particular type of maize and sorghum seedlings commonly grown in Pankshin were acquired and planted. Periodical watering was done under the supervision of the researchers. Inorganic fertilizer was applied appropriately for good nourishment of the plants. The growing of the plants lasted for two months (60 days).

Construction of Two Digesters, Painting, Pipe Work and Others

A Mason was used in making the concrete floor where the two digesters were constructed this gave them balance and stability. The two digesters were constructed directly behind one of the windows of Integrated Science Laboratory. Steel iron sheets of 8ft by 4ft of 16 gauge was used given a volume of 456dm^3, (see Figure 1), the construction of the digesters was done by a welder and a plumber. At the lower area of the digesters there were provisions for the evacuation of the waste pastes after the study, the waste was used as manure in vegetable production. At the upper areas of the digesters metal pipes were fixed with gauge for taking reading and taps for gas delivery into the laboratory and any gas produced was tested in the laboratory. Where any metal pipes fixed, taps and gauges fixed super glue was used in sealing any joints to prevent any form of gas leakages. Directly on top of each digester provision was made for inserting the prepared maize and sorghum paste from the stalks. The Digesters were labelled accordingly maize stalk and sorghum stalk.

Figure 1: The Two Digesters Used for the Maize and the Sorghum Pastes

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Security of the Digesters

Since the digesters were situated outside the Integrated Science Laboratory, they were fence, with an entrance door which can be locked to prevent tempering with the set up by unwanted persons, also the laboratory was guard by the college security personnel this provides additional security for the digesters.

Preparation of the Stalks and Feeding of the Digesters

The stalks were grown for two months (60 days) the stalks were selected and harvested while still succulents, and convey to the digesters site. The stalks were washed, cut into pieces using clean knives, pounded into pastes using mortar and pestles. An empty metal bucket with known weight was used, the pastes of each was weight and ten number of each bucket was put inside each digester accordingly from the top. The top was then sealed with super glue and the digesters were each painted with black black oil paint. (See Figure 2) where the bottoms of each digester was opened to exposed the used pastes after the study. As a result of the size and volume of the digesters, the set up stayed for 14 days and being monitored daily, and on the 14th day both were tested for any gas production.

Figure 2: Digesters Opened at the Bottom to Show the Pastes Used

IV. Results and Discussion

Results of biogas produced from Maize and Sorghum Stalks is shown on Table 1.

Table 1. Time taken for Biogas to Burn

DAY	MAIZE	SORGHUM
1	0 Min	0.00 Min
2	50 Sec	0.00 Min
3	1.5 Min	1 Min
4	2.5 Min	1.5 Min
5	3 Min	2 Min
6	3.5 Min	2 Min

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7	3.8 Min	2.2 Min
8	4 Min	2.2 Min
9	3.5 Min	2 Min
10	2.7 Min	1.8 min
11	2.5 Min	1.8 Min
12	2 Min	1.5 Min
13	1 Min	0.5 Min
14	0.5 Min	0.00 Min
15	0.00 Min	0.00 Min

FIGURE 3

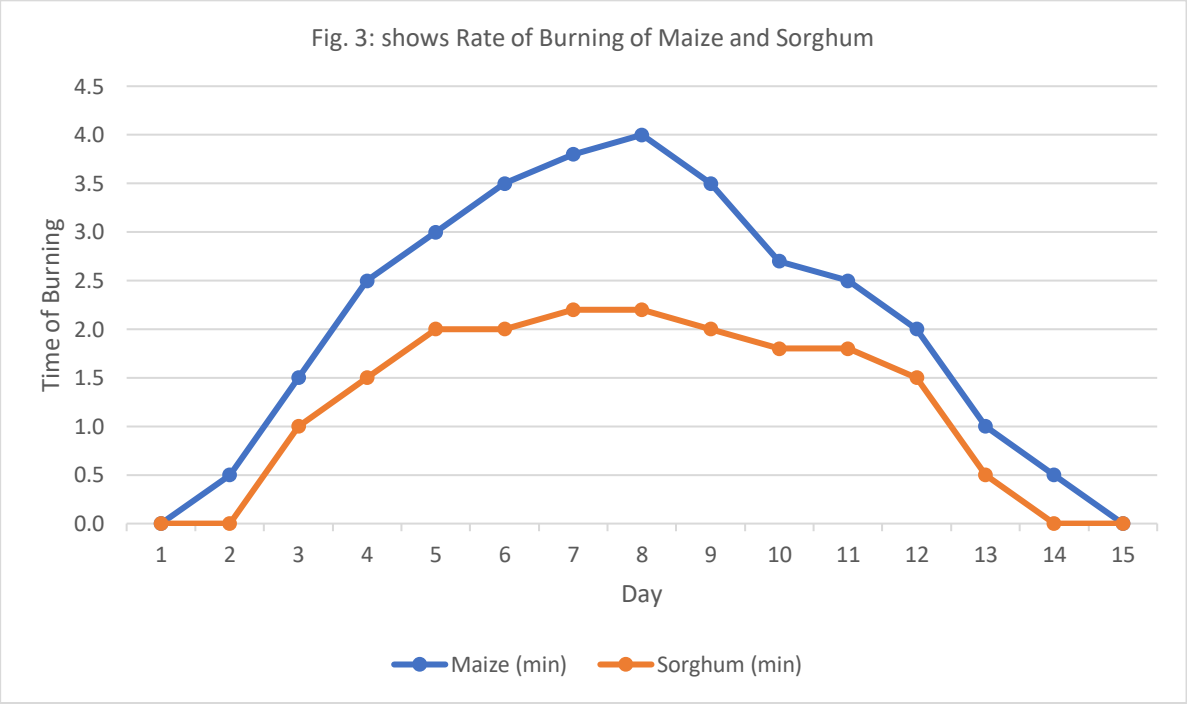

Figure 3, describes the number of minutes and days it took the biogas to be generated from the Maize and the Sorghum Stalks. For the Maize stalk there was no gas generated in day one as such the Bunsen burner did not burn. It burns for 50 seconds in day two, 1.5 minutes in day three and it rises steadily to 4 minutes in day eight. Then it started dropping to 3.5 minutes in day nine, 2.7 minutes in day ten, then it drops steadily to 0. 00 minute in day fifteen.

For the Sorghum Stalk, days one and two no gas was generated as such the Bunsen burner did not burn. It burns for 1 minute in day three, 1.5 minutes in day four, then it rises steadily to 2.2 minutes for days 7 and 8 then to 2 minutes in day 9 then it started falling steadily to 0.00 minute in days 14 and 15.

This result agrees with the study of Ekpenyong, Mawak, Zumbes, Siaka, Sanni and David (2011), where they conducted a study on , evaluation of Maize and Sorghum stalks, wood and food in a mini pilot plant. They found out that biogas generation for each of Maize and Sorghum stalks was zero on day one. This rises steadily for both in day two. The daily production progressively attains a maximum on day three for sorghum and day four for maize and then both gradually attain their minimum gas production on day twelve (zero for Sorghum).

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The bio-gas generated in this study is small compared to the quantity generated in similar studies that uses similar materials. This may be because the digesters used in the present study were improvised ones as such some of the gas might have escaped because of a possible fault in the construction of the digester.

V. Recommendations

Based on the results it was recommended amongst others that:

1. The study can also be replicated with other varieties of common grass using standardized digesters. This is because grass is a weed and do not have other economic value like stalks from food crops.
2. It was concluded that energy in form of biogas can be generated from maize and sorghum stalks.
3. Exploring the study with the stalk of other crops such as rice, millet, cow pea and others.

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