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PRODUCTION OF BIODIESEL USING BIOMASS OF CORN STALK AS A CASE STUDY

Milliscent Orok Ededet [1], Asibong Asibong Icha [2], Emmanuel Ugbong Akumaya [3]

Department of Department of Wood Products Engineering
University of Cross River State, Calabar.
Phone Number: 07030240995 Email: milliscentmail@gmail.com

Abstract

The quest to reduce emission of fossil fuel has necessitated this study. The chemical evaluation of *corn stalk* was carried out to ascertain the proximate composition and physicochemical properties of the biodiesel produced from *corn stalk*. Standard Analytical Methods were employed in the analysis. The result of the proximate composition was shown to be moisture (4.00%), ash (6.00%), fat (40.00%), fibre (8.00%), protein (27.65%) and carbohydrate (18.35%). The corn stalk yields 432 ml which represents 36% of the extracted oil without any catalyst. Physico-chemical analysis of the biodiesel produced gave a flash point of (87 min.), specific gravity of 0.87, FFA (18.06 mgKOH/g), viscosity (3.8 mm^2/s^{-1}), iodine value (110 mg/I_2), peroxide value (0.30 mg/I_2), saponification value (189 mgKOH/g), refractive index 1.26 and density (0.89g/cm^3). This study revealed that *corn stalk* has low moisture content, high fat and protein and could be a good source of oil for biodiesel production.

Keywords: Biofuel, Biomass, Physiochemical, Corn stalk,

1.0 **Introduction**

Biofuel is an organic material that is derived from both plants and animals (Dong *et al.* 2019). It is a source of energy that is limitless in supply thus, it is renewable (Mamphweli *et al*. 2019). 85% of the global energy demand are met through fossil fuel. Energy demand will grow by about 50% in the year 2025. The demand is as a result of population increase, economic growth and urbanization (Idusuyi, 2015). It is reliable, sustainable and less harmful to the environment when compared to some other sources like coal and crude oil. The challenge of climate change due to over-dependence on fossil fuel has necessitated the shift towards renewable fuel (biofuel) (Irena, 2015). Biofuels which are alternative fuels derived from biomass include gaseous, liquid or solid fuels like biogas, biobutanol, biodiesel, bioethanol, bio-oil that are produced from biological materials. Biofuels can be used for generating power and heat (Agbro and Ogie, 2012) which gives rise to the research. Biomass can be defined as a material derived from living organisms which include plants, animals and their by-products, e.g. manure, garden waste and crop residues (Asfar, 2014). Biomass has been regarded as one of the renewable energy sources which has the potential of meeting the global energy targets. They can be used in a variety of applications, such as transportation, electricity generation or heating. Biofuel production with corn stalks can contribute to energy security by reducing dependence on foreign oil and increasing domestic production. This can make countries less vulnerable to fluctuations in oil prices and disruptions to supply chains.

2.0 Literature Review

2.1 Biofuel

The combustion of fossil fuels such as coal, oil and natural gas for the conventional method of producing fuel for transportation, chemicals, and power, has been established for many years. This method is a significant global concern as it releases greenhouse gases (GHG) particularly carbon dioxide (CO_2) into the atmosphere. Petroleum consumption for road transportation is currently the largest source of CO_2 emissions. It accounts for 23% of CO_2 emissions worldwide and 59.5% of CO_2 emissions in Nigeria.

However, biofuel are renewable sources of energy that are produced from biological materials, such as plants, algae, or animal waste. These fuels have gained widespread attention as a potential solution to global environmental problems caused by fossil fuel consumption, such as climate change, air pollution, and dependence on non-renewable resources. production with corn stalk lies in its potential to provide a sustainable source of energy, the objective is to evaluate the potential of corn stalk biomass as a sustainable feedstock for the production of biofuels.

Production of Biofuel

The world's energy consumption has reached 14 billion tons of oil equivalent and in 2018 fossil fuels consisted of more than the 80% of the world's energy demand. The main cause of the huge greenhouse gas (GHG) emissions in the atmosphere is ascribable to the continuous utilization of fossil fuels for energy generation. Today, environmental policies are pushing for the reduction GHG emissions, and thanks to the support of innovative advances in crop engineering and fermentation processes, bioethanol, biodiesel, and biogas production represent viable and sustainable surrogates for petroleum-based fuels (Liu *et al,* 2021).

Additionally, new incoming technologies are focused on the CO_2 capture and conversion into carbon-neutral value-added products, for instance, via microbial electro synthesis (MES). Generally, the main feedstock use for bioethanol production is represented by sugar containing edible crops, such as sugar cane, sugar beet, and sweet sorghum. The use of edible crops for the production of biofuels give rise to many concerns for their potential competition with food and feed supplies. In addition, the insecure supply chain of biomass feedstock due to regional and seasonal variations is considered as one of the critical constraints for hindering the commercialization of biofuels in many countries.

3.0 Materials and Methods

Sample collection and preparation

The major feed stock of the study is corn stalk; the feed stalk was source locally for the production of biofuel. The feed stalk was given a preliminary treatment by cutting to 150mm and air dry. The feed stalk was then cooked under a control temperature of 150^{0}C and then sieve the feed stalk from the liquid that shows some bio-oil of corn stalk on the surface.

Table 1: List of chemical and reagents used

1	Methanol
2	Acetic acid
3	Chloroform
4	Per-chloric acid
5	Sulphuric acid
6	Nitric acid
7	Hydrochloric acid
8	Phenolphthalein indicator
11	Potassium hydroxide
12	Starch solution

Table 2: List of Equipment/apparatus

Name	Manufacturer
Refractometer	GallenKamp
Beaker	Pyrex
Boiling point apparatus	Griffin
Viscometer	Gallenkamp
Hydrometer	Pyrex
Thermometer	Pyrex
Magnetic stirrer	Gallenkamp
Conical flask	Pyrex
Evaporator Flask	Pyrex
Water bath	Assembled
pH meter	Rex pHs
Oven	Thimble
Digital weigh meter	Gallenkamp
Desiccators	Pyrex

Method for the extraction of volatile (essential) oil from corn stalk (steam distillation method)

The already dried corn stalk sample was homogenized using a homogenizer. About 20g of the homogenized corn stalk sample was weighed into a boiling flask of about 250ml capacity. This was followed by the addition of 100ml of distilled water and the distillation apparatus was set up by connecting a reflux condenser to the flask and a conical flask was placed at the collection end. The hot plate was set to about 100^{0}c were the steam from the biomass gradually rise up the flask and condenses in the condenser and the liquid containing the volatile oil was collected in the conical flask. This process was allowed to continue until about 75ml of the liquid was collected. The liquid which contains the essential oil was extracted by pouring the liquid into a separatory funnel and about 10ml of hexane was added. After shaking for 30 minutes, the separatory funnel was clamped in a restored stand and after a while two distinct layer was observed.

The organic phase which contains the essential oil and hexane use for the extraction was at the top and the aqueous phase was at the bottom. The aqueous phase was discarded while the organic phase was emptied into a beaker. The hexane was allowed to flare off while the remaining oil in the beaker is the essential oil which was later used for further laboratory analysis.

Determination of specific gravity

An empty 50 ml of measuring cylinder was washed, dried and weighed. The weight labeled as (w_o) 20 ml of oil sample was transferred into the cylinder and weighed (w_1). The weight of the oil was determined by subtracting the weight of the initial empty cylinder from the weight of the final measuring cylinder filled with oil. The specific gravity of the oil was obtained by the expression below (vieira, 2020)

$$\text{Specific gravity} = \frac{\text{weight of oil}}{\text{weight of water}}$$

$$\text{Specific Gravity} = \frac{W_o - W}{W_1 - W}$$

4.0 Results and Discussions

TABLE 3: Result for the Proximate Composition of *corn stalk*

S/N	**Parameters**	**Raw Values (%)**
1	Moisture content	4.00± 0.028
2	Ash content	6.00± 0.41
3	Crude fat content	40.00± 0.42
4	Crude Fibre content	8.00± 0.10
5	Protein content	27.65 ±3.01
6	Total carbohydrate content	18.35 ±1.08

The results of the analysis (Table 3) show the moisture to be 4.00%, ash 6.00%, lipid 40.00%, Fibre 8.00%, protein 27.65% and carbohydrate 18.35%.

The result of the analysis shows the moisture content of the seed to be 4.00%. The result of the analysis the moisture content of the seed to be 4.00%. This composition shows that *corn stalk* has a high content of minerals. The result analysis shows the fibre content of the seed to be 8.08%. Fibre helps in the maintenance of human health and has been known to reduce cholesterol level in the body. The result shows the protein content of the seed to be 27.65%. The result of the analysis shows the carbohydrate content of the stalk to be 18.35%. However, this result revealed that corn stalk is not a good source of carbohydrate.

Oil extract from *corn stalk*

The result of oil content of *corn stalk.* The oil yield of *corn stalk* from the analysis was found to be 36% (wt/wt) which is higher than the oil content of some conventional oil seed crops; cotton (15.0–24.0%), soybean (17.0–21.0%) and mustard (24.0–40.0%). This variation in oil content across species and locations might be attributed to the environmental and geological conditions of varied regions, With this relative high percentage oil yield of 36% in the present study, *corn stalk* is a good oil source for biodiesel production.

Reading (Ml)	**1st**	**2nd**	**3rd**
Final Reading	2.10	4.30	6.50
Initial Reading	0.00	2.10	4.30
Vol. of 0.1N NaOH used	2.10	2.20	2.20

$$\text{Average titer value} = \frac{2.10 + 2.20 + 2.20}{3}$$

$$= 2.17\text{ml}$$

$$\text{Acid value of E. Oil} = \frac{\text{Aw} \times \text{N(KOH)} \times 56.1}{\text{Wt of sample}}$$

$$= \frac{2.17 \times 0.1 \times 56.1}{1}$$

$$= 12.17\text{mg/g}$$

Saponification value

Reading (Ml)	**1st**	**2nd**	**3rd**
Final Reading	9.80	19.50	29.60
Initial Reading	0.00	9.80	19.50
Vol. of 0.5N HCL used	9.80	9.70	10.10

$$\text{Average titer} = \frac{9.80 + 9.70 + 10.10}{3}$$

$$= 9.87\text{ml}$$

Saponification value (mgKOH/g)

$$= \frac{56.01 \times (Vb - Vt) \times 0.5}{2}$$

Reading (Ml)	**1st**	**2nd**	**3rd**
Final Reading	18.90	37.20	18.70
Initial Reading	0.00	18.90	0.00
Vol. of 0.5 HCL used	18.90	18.30	18.70

$$\text{Av} = \frac{18.9 + 18.3 + 18.7}{3}$$

$$= \frac{55.9}{3}$$

$$= 18.63\text{ml}$$

Saponification value (MgKOH/g)

$$= \frac{(18.63 - 9.87) \times 56.1 \times 0.5}{2}$$

$= \underline{\underline{122.90}}$ mgKOH/g

Density

Wt of empty SG Bottle (W_1) =26.80g

Wt of SG Bottle +Distilled H_20(W_2) =80.569g

Wt of SG Bottle + Sample (W_3) =81.870g

$$\text{Density of samples} = \frac{W_2 - W_1}{W_3 - W_1} = \frac{\text{Mass of liquid}}{\text{Mass of eq. vol. of liquid}}$$

$$= \frac{80.569 - 26.80}{81.870 - 26.80} = \frac{53.769}{55.07}$$

$= \underline{\underline{0.976}}$g/ml

$$\text{Viscosity} = \frac{P_2 \; t_2}{P_1 \; t_1} \times n_1$$

Where:

P_1 = Density of H_20 (g/ml)

P_2 = Density of test sample

n_1 = Viscosity of water

n_2 = Viscosity of sample

t_1 = Meantime of flow of H2O

t_2 = Meantime of flow of sample

Viscosity of water at room temperature

Density of water = 0.997g/ml

Viscosity of sample

= P_1= 0.997 t_1=25Sec

n_1 =0.997

P_2 =0.882 t_2=593

n_2 =?

Viscosity of sample

$$= \frac{0.882 \times 593}{0.997 \times 25} \times 0.997$$

$= \underline{\underline{20.98}}$ Centipoise

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