

# Effect Of Cassava Mill Effluent On The Physicochemical Properties Of Soil In Ikot Ekpene Local Government Area, Akwa Ibom State

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## Abstract

The effect of cassava mill effluent (CME) on soil properties in Ikot Ekpene Local Government Area, Akwa Ibom State, was studied by comparing effluent-contaminated soils with uncontaminated (control) soils. The findings showed that CME markedly altered soil characteristics. The pH of contaminated soil ( $4.60 \pm 0.20$ ) was significantly lower than that of the control ( $6.50 \pm 0.15$ ), indicating increased acidity. Acidity levels rose, while alkalinity declined from  $9.45 \pm 0.65$  mg/L in the control to  $2.02 \pm 0.38$  mg/L in the contaminated soil. Electrical conductivity was higher in the effluent-impacted soil ( $12.25 \pm 0.06$   $\mu$ S/cm) compared to the control ( $8.02 \pm 0.40$   $\mu$ S/cm), suggesting elevated salinity. Nitrogen content decreased in the contaminated soil ( $2.20 \pm 0.01\%$ ) compared to the control ( $4.81 \pm 0.03\%$ ), which may be attributed to microbial immobilization. In contrast, phosphorus content increased from  $1.02 \pm 0.19\%$  in the control to  $1.96 \pm 0.25\%$  in the contaminated soil, likely as a result of organic matter decomposition. Organic matter content also declined significantly, from  $5.77 \pm 0.60\%$  in the control soil to  $2.40 \pm 0.54\%$  in the contaminated soil, possibly due to enhanced microbial breakdown and leaching. Overall, the study demonstrates that cassava mill effluent significantly modifies soil physicochemical properties, resulting in acidification, increased salinity, reduced nitrogen, and lower organic matter content. These changes may adversely affect soil fertility and crop productivity. Consequently, proper treatment and disposal of cassava mill effluent are essential, alongside remediation measures such as liming and the application of organic amendments to restore soil quality.

**Keywords:** Cassava Mill Effluent, Soil, physicochemical properties, Soil Acidification, Organic matter

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## I. Introduction

Cassava (*Manihot esculenta-Crantz*) is a perennial woody shrub of the spurge family with edible starchy tuberous roots (Oladapo *et al.*, 2023; Ogieloro *et al.*, 2007). It is regarded as a typical subsistence crop in the tropics (Akpan *et al.*, 2011). According to Izah *et al.* (2018), cassava is the fourth longest staple food after rice, maize and wheat. Cassava is a drought tolerant staple food crop grown in areas where many people are suffering from under nutrition and as such is a potential valuable food source for developing countries (Montagnac *et al.*, 2009). Cassava is usually processed into delicious delicacies like garri, fufu and tapioca (Oladapo *et al.*, 2023). Cassava roots are a good source of energy (Montagnac *et al.*, 2009).

As observed by Santos *et al.* (2024), cassava has high levels of carbohydrate, fibres, minerals and vitamins. Certain commentary advocates that soluble fibres in cassava have nutraceutical values of which hypoglycemic and hypocholesterolemic effects required in diabetes managements are among (Onodu *et al.*, 2017).

Although cassava may have high levels of substances that are considered harmful to humans, about 80% of these harmful substances are removed during tuber processing (Onodu *et al.*, 2017). Cassava mill effluent (CME) is one of the by-products produced during the processing of cassava into garri. In Nigeria, the by-products are discharged into the ecosystem (Izah *et al.*, 2018). It has been observed that waste water of cassava processing units can result in environmental impacts on soil fertility, air quality and water (Elijah *et al.*, 2014).

Cassava mill effluent is known to alter the receiving soil (Izah., 2017). Since soil is one of the major recipients of cassava mill effluent (Orhue *et al.*, 2014), the discharge of cassava mill effluent into the soil results to changes in soil properties. (Nwakaudu *et al.*, 2012).

Cassava processing effluent is acidic and has high organic matter content and suspended solids. It contains cyanide which is toxic (Obob, 2006).

Studies have shown soil polluted with CME to have an increase in acidity, sodium, potassium, phosphorus and organic carbon, which calcium, magnesium and nitrogen decreased (Eghouge and Dada, 2004; Okoliet *al.*, 2018). Increase in pH, organic carbon and nitrogen were observed in a study, while P, K and Mg decreased (Akpan *et al.*, 2011).

Izah *et al.* (2018) reported that CME physicochemical quality often exceeds the limits for effluents discharge onto lands and surface water as recommended by Federal Environmental Protection Agency (FEPA).

The disposal of untreated CME into the soil and nearby water bodies in the rural areas of some developing countries is a common practice because of lack of waste treatment facilities (Okafor *et al.*, 2014). CME is rich in organic matter and contains cyanogenic glycosides which can break down into toxic compounds such as cyanide. Other chemical constituents like Ca, K, Mg and trace amounts of heavy metals are also present in CME (Orji *et al.*, 2010).

Given the increasing demand for cassava and the corresponding rise in cassava processing activities, it is important to understand the environmental consequences of cassava mill effluent on soil properties. This research was therefore designed to assess the impact of cassava mill effluent on soil properties with the aim to provide insight into how cassava mill alters soil quality and propose potential mitigation strategies for minimizing its negative impacts.

Understanding the impact of CME on soil properties is essential not only for monitoring soil health, but also for promoting sustainable agricultural practices in regions where cassava processing is prevalent. This study will contribute valuable information to environmental management efforts and offer solutions for preventing soil degradation while supporting the growing cassava industry.

## **II. Materials And Methods**

### **Sample Collection and Preparation**

Soil samples contaminated with cassava mill effluent and a control (soil free from effluent) were collected separately into clean polythene bags from a cassava mill site situated at Ikot Uboh in Ikot Ekpene Local Government Area of Akwa Ibom State. The samples were transported to the Chemistry Laboratory of the Department of Chemical Sciences, Akwa Ibom State Polytechnic for further treatment and determination of the various physicochemical parameters of interest.

### **Analysis of Physicochemical parameters**

#### **Determination of Soil pH**

10g of air-dried soil sample was weighed and transferred into a 50 ml beaker and 25 ml of distilled water was added to the soil and the mixture stirred for 10 minutes to allow the soil to reach equilibrium. The suspension was allowed to settle for about 30 minutes. Thereafter, the pH meter was calibrated using standard buffer solutions (pH 4.0, 7.0, and 9.2). Finally the pH meter electrode was inserted into the supernatant (clear part) of the suspension to record the pH value.

#### **Determination of Electrical Conductivity (EC)**

10 g of air-dried soil sample was weighed and transferred into a 100 ml beaker and 50 ml of distilled water was added and the suspension was stirred for 10 minutes. The solution was allowed to stand for 30 minutes, and was then stirred briefly again. The conductivity meter was calibrated using standard KCl solutions. Finally, the electrical conductivity of the supernatant solution was measured using the conductivity meter.

#### **Determination of Phosphorus (P)**

2.5g of the air-dried soil sample was added to a 50 ml flask. Then 50 ml of 0.5 M sodium bicarbonate solution (pH 8.5) was added and shaken for 30 minutes after which the extract was filtered using Whatman no. 2 filter paper. A coloured reagent prepared by mixing ammonium molybdate, sulfuric acid, and ascorbic acid was added to the filtrate and allowed to develop the colour before the absorbance was measured at 882 nm using a spectrophotometer. Finally, the concentration of phosphorus was determined from the calibration curve.

$$\text{Concentration of P (mg/kg)} = \frac{C \times V}{W}$$

Where:

C = Concentration of phosphorus from the calibration curve (mg/L)

V = Volume of the extractant used (50 mL or 0.05 L)

W = Weight of the soil sample (2.5 g or 0.0025 kg)

#### **Determination of Nitrogen (N)**

1g of the air-dried soil sample was weighed and transferred into a Kjeldahl digestion flask and 10 ml of concentrated sulfuric acid and a catalyst (copper sulfate) were added. The sample was digested at 350°C until the

solution became clear and was then allowed to cool before distilled water was added. The acid was then neutralized with sodium hydroxide. Thereafter, the solution was then distilled by trapping ammonia in boric acid. Finally, the nitrogen content was determined by titrating the distillate with standardized hydrochloric acid (HCl).

#### Determination of Soil Acidity

Extract of the soil sample was prepared by shaking 10 g of air-dried soil with 25 ml of distilled water for 30 minutes and was filtered to obtain the suspension. Thereafter, a few drops of phenolphthalein indicator was added to the filtrate before it was then titrated with 0.01 M NaOH until the solution turned pink which indicated the end point. Finally, the acidity of the soil was then calculated from the volume of sodium hydroxide used.

$$\text{Acidity of the soil} = \frac{V_{\text{NaOH}} \times M_{\text{NaOH}} \times 1000}{\text{Weight of the soil (g)}}$$

Where:

V<sub>NaOH</sub> = Volume of NaOH used in the titration (in ml)

M<sub>NaOH</sub> = Molarity of the NaOH solution (in mol/L), 0.01 M

Weight of the soil = 10 g

#### Determination of Organic Matter

1 g of the air-dried soil sample was weighed and transferred into a 250 ml Erlenmeyer flask. Thereafter, 10 ml of 1 N potassium dichromate solution and 20 ml of concentrated sulfuric acid were added and the flask swirled and allowed for the reaction to proceed for 30 minutes. The mixture was diluted with 100 ml of distilled water and 10 ml of orthophosphoric acid was added and the solution was titrated with ferrous sulfate until the color changed from green to brown. Finally, the organic carbon content was calculated by multiplying by a factor (usually 1.724) to estimate the organic matter content.

$$\text{Organic Carbon (\%)} = (V_b - V_s) \times N \times 0.003 \times 100 \{W\}$$

Where:

V<sub>b</sub> = Volume of ferrous sulfate used in the blank titration (ml)

V<sub>s</sub> = Volume of ferrous sulfate used in the sample titration (ml)

N = Normality of the ferrous sulfate solution (usually 1 N)

0.003 = The equivalent weight of carbon (12 g of carbon reacts with 1 mol of dichromate, and 1 ml of 1 N dichromate is equivalent to 0.003 g of carbon)

100 = A factor to convert to percentage

W = Weight of the soil sample used (in grams)

#### Determination of Soil Alkalinity

Soil extract was prepared by shaking 10 g of the air-dried soil sample with 25 ml of distilled water for 30 minutes and filtered to obtain the suspension. Thereafter, few drops of phenolphthalein indicator was added to the filtrate and titrated with 0.01 M HCl until the pink color disappeared. Finally, the soil alkalinity was calculated from the volume of acid used.

$$\text{Alkalinity (meq/100g)} = \frac{V \times N \times 100}{W}$$

Where:

V = Volume of HCl used for titration (in ml)

N = Normality of the HCl solution (0.01 M, which is equivalent to 0.01 N because HCl is a monoprotic acid)

W = Weight of the soil sample used (in grams, here 10 g)

The factor 100 is used to express alkalinity in milliequivalents per 100 g of soil.

### III. Results

The results of the physicochemical properties of the cassava effluent treated soil and the control soil in Ikot Ekpene are presented in Table 1.

**Table 1: Physicochemical parameters of the cassava effluent treated soil and the control soil in Ikot Ekpene.**

Parameters	Soil samples	
	Cassava effluent soil	Control soil
pH	4.60±0.20	6.50±0.15
Electrical conductivity (µs/cm)	12.25±0.06	8.02±0.40
Nitrogen (%)	2.20±0.01	4.81±0.03
Phosphorus (%)	1.96±0.25	1.02±0.19
Acidity (Mg/L)	4.90±0.11	6.10±0.81
Organic matter (%)	2.40±0.54	5.77±0.60
Alkalinity (Mg/L)	2.02±0.38	9.45±0.65

**Mean±S.D of Two Determinations**

**IV. Discussion**

The physicochemical properties of soil significantly influence its fertility, nutrient availability, and overall health. This discussion analyzes the results obtained from a study comparing the effects of cassava mill effluent (CME) on soil properties with the control soil. The key parameters assessed include pH, electrical conductivity (EC), nitrogen (N), phosphorus (P), acidity, organic matter content, and alkalinity.

The pH of the cassava effluent soil was measured at  $4.60 \pm 0.20$ , significantly lower than the  $6.50 \pm 0.15$  observed in the control soil. This decrease in pH indicates an acidifying effect of CME on soil (Ayoola and Agboola, 2013). The lower pH can be attributed to the presence of organic acids in the effluent, which release hydrogen ions ( $H^+$ ) into the soil solution, contributing to acidification (Igbinsosa *et al.*, 2012).

Soil acidity can adversely affect nutrient availability, particularly for essential nutrients like phosphorus, which tends to precipitate in acidic environments, thereby reducing its availability to plants (Ogbo and Okhuoya, 2011).

The electrical conductivity of the cassava effluent soil was found to be  $12.25 \pm 0.06 \mu\text{s/cm}$ , compared to  $8.02 \pm 0.40 \mu\text{s/cm}$  for the control soil. This increase in EC indicates a higher concentration of soluble salts in the effluent soil (Nwoko *et al.*, 2010). Elevated EC levels can result from the accumulation of nutrients from the effluent, which may enhance soil fertility. However, excessively high EC can lead to salinity issues, affecting plant growth and water uptake (Adelekan, 2010).

The nitrogen content in the cassava effluent soil was measured at  $2.20 \pm 0.01\%$ , significantly lower than the  $4.81 \pm 0.03\%$ , found in the control soil. This decline in nitrogen levels may be linked to the dilution effect of CME, which, despite its nutrient content, may not provide sufficient nitrogen to match the control soil's levels (Ayoola and Agboola, 2013). Nitrogen is crucial for plant growth and development, and its deficiency can result in stunted growth and reduced crop yields (Nwoko *et al.*, 2010).

Conversely, the phosphorus content in the cassava effluent soil was  $1.96 \pm 0.25\%$ , higher than the  $1.02 \pm 0.19\%$  found in the control soil. The increase in phosphorus levels in the effluent-treated soil may be attributed to the nutrient-rich nature of CME (Igbinsosa *et al.*, 2012). Phosphorus is vital for energy transfer and photosynthesis in plants, and the higher availability in CME-amended soil can enhance plant growth, provided that other factors, such as pH, are favorable for phosphorus solubility (Ogbo and Okhuoya, 2011).

The measured acidity was  $4.90 \pm 0.11 \text{Mg/L}$ , for the cassava effluent soil, compared to  $6.10 \pm 0.81 \text{Mg/L}$  for the control soil. The increased acidity in the effluent soil reinforces the earlier observation regarding the low pH. This acidic condition can negatively impact microbial communities and enzymatic activity in the soil, essential for nutrient cycling and organic matter decomposition (Igbinsosa *et al.*, 2012).

The organic matter content in the cassava effluent soil was  $2.40 \pm 0.54$ , significantly lower than the  $5.77 \pm 0.60$  found in the control soil. This may possibly be due to enhanced microbial breakdown and leaching. However, while organic matter is beneficial, excessive application of effluent can lead to imbalances and toxicity, particularly in terms of nutrient loading (Nwoko *et al.*, 2010).

The alkalinity of the cassava effluent soil was measured at  $2.02 \pm 0.38$ , compared to  $9.45 \pm 0.65$  for the control soil. This reduction indicates a decrease in the buffering capacity of the soil, which can influence its ability to resist pH changes. The lower alkalinity may result from the increased acidity and the higher levels of organic matter in the effluent-treated soil (Adelekan, 2010).

**V. Conclusion**

The application of cassava mill effluent has notable effects on the physicochemical properties of soil, resulting in significant changes in pH, electrical conductivity, nitrogen, phosphorus, acidity, organic matter content, and alkalinity. While CME can improve phosphorus availability, its acidifying effect and potential for nutrient imbalance warrant careful management to ensure sustainable agricultural practices. Therefore, proper treatment and disposal of cassava mill effluent are recommended. Additionally, soil remediation strategies such as liming and the application of organic amendments should be employed to restore soil health and productivity.

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