



## Effects of Farming Conditions on the Nutritional Contents of *Manihot esculenta* Planted in four Regions of Niger Delta, Nigeria

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**ABSTRACT:** All through human existence, the ability to cultivate crops to better human life has been affected by the nature of the soil; different crops thrive in different regions. The relationship between humans, the earth and food production affirms soil as the foundation of crop production. Hence, the objective of this paper is to study the effects of farming conditions on the nutritional contents of *Manihot esculenta* planted in four regions of Niger Delta, Nigeria. Using appropriate standard methods. Data obtained revealed that the moisture contents varied in the order; herbicide > oil-spilled > inorganic fertilizer > normal. The amount of water-soluble vitamins varied in the order; normal > oil spilled > inorganic fertilizer > herbicide. The amount of crude lipids varied in the order; herbicide > normal > inorganic fertilizer > oil-spilled. The amount of hydrogen cyanide varied in the order; inorganic fertilizer > herbicide > oil-spilled > normal. The amount of carbohydrate varied in the order; inorganic fertilizer > oil-spilled > normal > herbicide. The amount of crude protein and fiber varied in the order; herbicide > normal > inorganic fertilizer > oil-spilled. Root tubers from the normal practice were most abundant in ash contents, while that from the use of herbicide was the least. These results indicated that the normal practice showed commended amount of moisture content, water soluble vitamins and ash content; the herbicide induced land produced cassava tuber with the highest amount of crude lipids, crude fibre and crude proteins; that with the use of inorganic fertilizer produced the highest amount of hydrogen cyanide. All practices were adoptive for carbohydrate formation, except the herbicide induced soil.

DOI: <https://dx.doi.org/10.4314/jasem.v28i3.30>

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**Cite this Article as:** EKPO, I. E; ORJI, I; PATRICK, B. F. (2024). Effects of Farming Conditions on the Nutritional Contents of *Manihot esculenta* Planted in four Regions of Niger Delta, Nigeria. *J. Appl. Sci. Environ. Manage.* 28 (3) 901-907

**Dates:** Received: 18 January 2024; Revised: 24 February 2024; Accepted: 12 March 2024 Published: 29 March 2024

**Keywords:** Cassava; root tuber; farming conditions; food contents; fertilizer

The breeding environments of living organisms contribute immensely to their morphologies as suitable environments give strong matching structures while unsuitable environments give weak matching structures. This may also have reciprocating effects on the composition of substances in the organisms. Because of the delocalized nature of animals' growth, it is more difficult to trace the sources of the various compositions of substances present in them. However, it is easier to trace that of plants because they are more localized in nature. It is speculated that different agricultural practices create diverse breeding

environments for agricultural crops. This work focusses on the effects of farm practices on the cultivation of cassava (*Manihot esculenta*). Cassava is a root tuber and a source of staple foods in the study area; this may be traced to the fact that its root is valued for production and storage of carbohydrate than any other crop in the region (El-Sharkawy, 2004; Fermont *et al.*, 2009; Jarvis *et al.*, 2012). Wang, *et al.* (2015), examined the effects of growing crops on sewage irrigated soil in China. It was observed that some metal concentrations were found in quantities above permissible limits in wheat and rice crops as the

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results of plants intake from the soil; this suggested danger to the health of local communities that consume these farm products. Studies have shown that the use of herbicide in plants cultivation have effects on the phytotoxicity of such plants; though the function of destroying targeted weeds are achieved, the herbicide should be administered in recommended amounts so as to ease the phytotoxicity limits in the desired agricultural crops. An investigation of the intake of heavy metals by vegetables around an industrial zone showed that the concentration of heavy metals in the vegetables were above minimum permissible limits; envisaging health effects to consumers (Enyong *et al.*, 2021).

The different farming conditions or farm practices employed in cassava farming in Nigeria are meant to improve the yields of the cassava root tuber so as to provide enough quantities for the population. Where the farmers are restricted to a particular planting area using the same piece of land in every planting season, the soil fertility is degenerated and there is a need to introduce inorganic or organic fertilizer to improve the fertility of the soil (Nguyen *et al.*, 2001; Ayoola and Makinde, 2007). Some regions are left with the only option of cultivating cassava on petroleum spilled lands, even when quality yield of the farm produced are not obtained (Oyem, 2001). Most regions practice hand weeding against the application of herbicides by few others. According to some published works, the used of herbicides had enabled sustainable production of cassava (Adesina, *et al.*, 2009). It is necessary to assess the variation of food nutrients in cassava root tubers with the conditions of farming or farm practices; this work is designed for this purpose. Therefore, the objective of this paper as to the effects of farming conditions on the nutritional contents of *Manihot esculenta* planted in four regions of Niger Delta, Nigeria.

## MATERIALS AND METHODS

*Sampling/Sample preparation:* The samples were root tubers of cassava obtained from four areas with different farm practices or farming conditions. The farm practices or farming conditions considered were that which does not introduce any foreign chemical or substance to the soil (normal condition), area that introduces herbicides to the soil during cultivation (herbicide), area that introduces inorganic fertilizer to the soil during cultivation (Inorganic fertilizer) and area that had been exposed to petroleum spillage (oil spilled).

The samples were washed severally with deionized water and peeled to obtain the utilized root tuber that is used as food. The samples were sliced into 10 mm

thickness, then air dried with temperature of 20 – 25 °C on the laboratory table desk; the drying continued for several days until constant dried weight were obtained for all the four samples. The dried samples were ground into powder with laboratory mortar and pestle.

100 g of the four dried samples of cassava powder were mixed differently in 100 ml of distilled water, stirred for a minimum of 30 minutes and allowed to stand for another 30 minutes. The mixture was filtered with a Whatman 4 filter paper on a vacuum filtration apparatus. The filtrates and residues were collected differently and stored until there were required for further works (Jiang, 2014).

### *Analysis of water soluble Vitamins C, B1, B2 and B3:*

The amount of vitamin C (Ascorbic acid) was obtained for each sample by taking 10 ml of the filtrates and mixed with 1 ml ferric chloride solution in a 50 ml beaker and 4 drops of 1,10-phenanthroline was added. The solution in the beaker was stirred continuously for two minutes; until a dark red colour solution was formed. The absorbance was set at 430 nm on the digital screen of the spectrophotometer and amount of vitamin C in the sample was displayed in mg and its concentration recorded in mg/100g (Mushtaq, 2022). Vitamin B1 (*Thiamine hydrochloride*) was determined by taking 5 ml of the standard and filtrates into marked test tubes. In each test tube, 5 ml NH<sub>4</sub>OH (0.1M) and 0.5 ml 4-Amino phenol solutions were added and mixed well, then kept for 5 minutes and 10 ml chloroform was added with the solution stirred, this was separated into chloroform layer. The amount of vitamin B1 was determined with the chloroform layer at 385 nm against the blank. For Vitamin B2 (Riboflavin), 5 ml of the filtrates were taken into four 50 ml beakers. In each beaker, 2 ml of 1.0 M hydrochloric acid, 2 ml of glacial acetic acid, 2 ml of hydrogen peroxide, 2 ml of potassium permanganate (15% w/v) and 2 ml phosphate buffer (pH 6.8) were added and mixed well, then its concentration determined with spectrophotometer with an absorbance of 444 nm against the blank. The amount of vitamin B3 (Nicotinamide) was determined with 2 ml of the filtrates, sample and blank solution was taken in marked test tubes. In each test tube, 5 ml sulphanic buffer (pH 4.5), 5 ml water and 2 ml cyanogen bromide solution (10% w/v) were added and mixed well and the absorbance set at 450 nm against the blank and the result recorded in mg/100ml.

*Analysis of Crude lipid:* 2 g of the prepared powdered sample was placed in a beaker, washed five (5) times with 20 ml of deionized water with stirring and filtering to remove all water-soluble components. The

washed sample was dried to constant weight and the weight of content and beaker recorded as  $W_1$ . Diethyl ether (40 ml) was introduced into the beaker and the beaker set for distillation with a 5 to 6 drops per second until the diethyl ether was completely dried, the weight of the residue and the beaker was recorded as  $W_2$ , the amount of crude protein was calculated using the expression in Eqn. 1 (Analytical Technique in Aquaculture Research, 2024).  
Calculation:

$$\text{Crude Lipid (\%)} = \frac{(W_1 - W_2)g}{2g (\text{weight of sample})} * 100 \quad (1)$$

**Analysis of ash contents:** The sample obtained after the crude fibre analysis was turned into crucible, then weighed and recorded as  $W_3$ . The crucibles were heated on a furnace at 550 °C overnight, then cooled in a desiccator and weighed as  $W_4$ , the ash content was calculated using Eqn. 2 (AOAC, 2000).  
Calculation:

$$\text{Ash Content (\%)} = \frac{(W_3 - W_4)g}{2g (\text{weight of sample})} * 100 \quad (2)$$

**Analysis of Crude Fibre:** The ash from the crucible in the previous analysis was emptied into a beaker that was used in inception and the weight of ash and beaker recorded as  $W_5$ . Residue from the analysis of crude lipids and beaker recorded  $W_3$  was used for calculation of crude fiber as shown on Eqn. 3 (AOAC, 12; Fiber.01, 2018; Analytical Technique in Aquaculture Research, 2024): The calculation is in equation (3):

$$\text{Crude Fiber (\%)} = \frac{(W_3 - W_5)g}{2g (\text{weight of sample})} * 100 \quad (3)$$

**Analysis of moisture content:** Moisture content of the cassava root tuber was determined using gravimetric method of analysis. Aluminum dish was used as a sample cell. The dish and its lid were pre-heated at 105 °C in an oven for 6 hours. Five (5) grams of the sample was weighed into the aluminum dish and its weight marked  $W_6$ . The sample in the dish was dried to constant weight in an oven set at 105 °C and the weight

of sample and dish after drying marked  $W_7$ . The percentage of moisture content was calculated using the formula in Eqn. 4:

$$\text{Moisture (\%)} = \frac{(W_6 - W_7)g}{5g (\text{weight of sample})} * 100 \quad (4)$$

**Analysis of Total Carbohydrate:** Total carbohydrate was calculated by subtracting the percentage sum of moisture, ash, crude protein, crude fibre and crude lipid from 100 % (Eqn. 5).  
Calculation:

$$\begin{aligned} \text{Carbohydrate content (\%)} \\ = 100 \% - (\% \text{moisture} + \% \text{ash} \\ + \% \text{protein} + \% \text{fibre} + \% \text{Lipid}) \quad (5). \end{aligned}$$

**Analysis of hydrogen cyanide:** A UV-Visible Spectrophotometry analysis using the design of Bradbury *et al.*, (1999) was used; concentration of hydrogen cyanide was read on the UV-Vis meter at 510 nm wavelength (Muleta and Mohammed, 2017).

## RESULTS AND DISCUSSION

It was observed that the moisture contents of the samples vary with the farming conditions in the following increasing order; Normal farming < Inorganic fertilizer applied soil < oil spilled farm < herbicide applied soil (Table1). This could be due to the facts that soil microorganisms and other soil boring insects have been destroyed by the presence of herbicides, inorganic fertilizers and spilled petroleum in the soil, thereby reducing the soil water diffusivity as well as water evaporation from the soil as a result of inadequate soil bore. This might have caused increase in water uptake by the root tuber of cassava (Whalley, *et al.*, 2018). The effect is most severe with the application of herbicides followed by application of inorganic fertilizer and lastly with the petroleum spilled soil. The work of Hariyadi, *et al.*, (2024), revealed that increasing the concentration fertilizer on soils gives a corresponding increase in the yield of the crop; increase in moisture contents is also an observable evaluation for increased in yield.

**Table 1:** Amounts of moisture and Water-Soluble Vitamins Present in Samples for Farming Conditions Considered

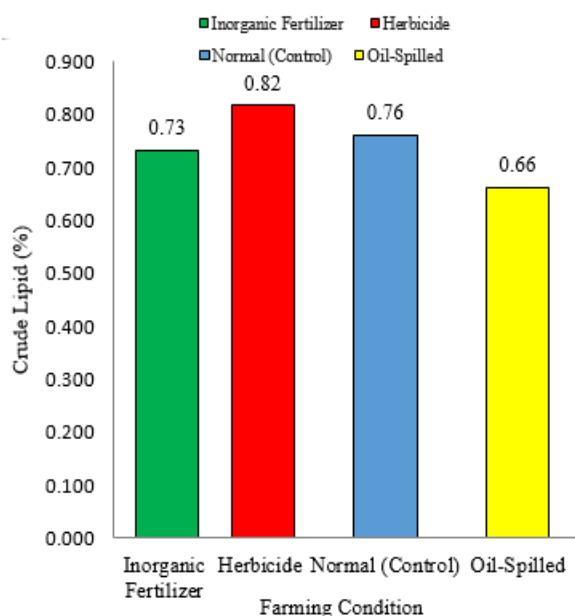
Farm Practice / Analysis	Inorganic Fertilizer	Herbicide	Normal	Oil-Spilled
Moisture Content (%)	8.410±0.020	9.820±0.110	8.110±0.010	8.710±0.050
Vitamin C (mg/100g)	1.160±0.009	0.180±0.006	1.330±0.008	1.250±0.005
Vitamin B1 (mg/100g)	0.270±0.007	0.870±0.003	1.300±0.004	0.500±0.001
Vitamin B2 (mg/100g)	1.320±0.008	1.260±0.009	1.480±0.003	1.380±0.005
Vitamin B3 (mg/100g)	0.830±0.004	0.180±0.003	1.370±0.007	1.130±0.003

Values are represented with mean ± standard deviation (SD)

The water soluble vitamins C, B1, B2 and B3 (Table 1) of the root tubers showed similar trend in variation

with conditions of farming; the application of herbicide on the soil have the most inhibitive effect on

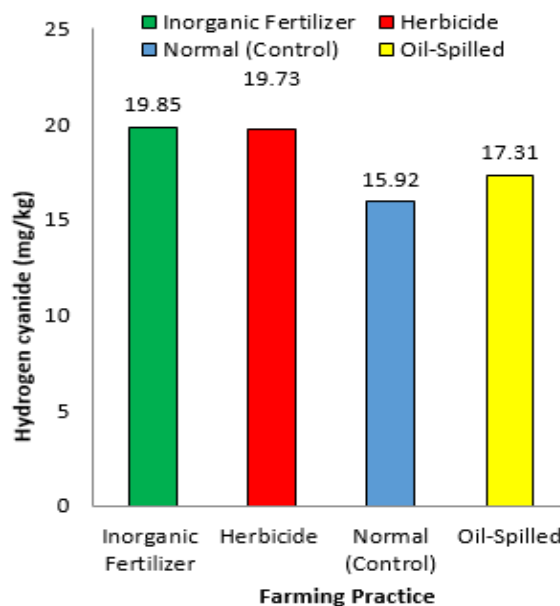
the generation of these vitamins followed by application of inorganic fertilizer and the least effect was observed with the cassava plant cultivated on petroleum spilled soil. In all the farming conditions which cassava was cultivated, the normal practice that was devoid of the application of external substances to the soil generated the highest amount of the water-soluble vitamins that are investigated in this study. This may be due to the fact that the chemical contents in the herbicide, inorganic fertilizers and petroleum spillage interfered with the formation of water soluble vitamins in the cassava tuber; the works of Pudza *et al.*, (2020) and Montgomery and Biklé (2021), had shown that organic and inorganic fertilizers have adverse effects in the formation of vitamins in crops. It was observed that the farm practices with the use of herbicide, produced the highest amounts of crude lipids followed by the normal practice that did not involve the use of external substance, while the farm land spilled with petroleum gave cassava tuber with the least amount of crude lipids (Fig. 1).



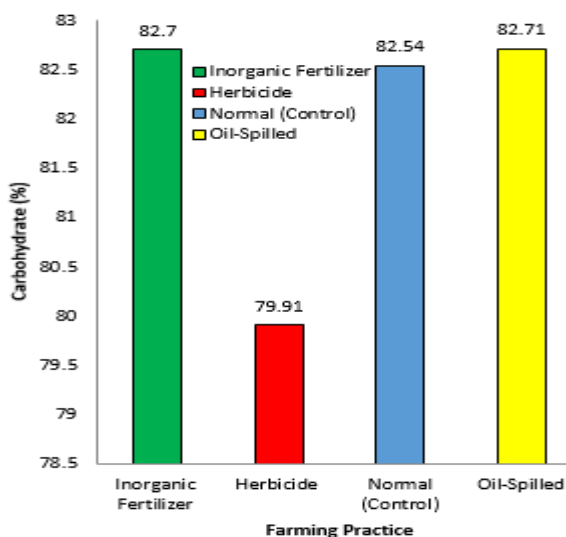
**Fig 1:** Amounts (%) of crude lipid in cassava for the different farming conditions

Fig. 2 shows that cultivating cassava stem for tuber gives the highest hydrogen-cyanide (HCN) contents for the samples from inorganic fertilizer used soil, then herbicide induced soils followed by that from the oil spilled soil. While the root tuber from the normal soil gave the lowest HCN content; this showed that the use of inorganic fertilizers and herbicides as well as petroleum spillage on soils during the cultivation of cassava may lead to the formation of more HCN in the root tuber than when these substances are not

introduced. This may be due to the reason that HCN is secreted in the root tuber of cassava to regulate pathophysiological activities during the life cycle of the plant; the introduction of these external chemicals might send signals to the plants mechanism sensing them as pathogens (García, 2023).



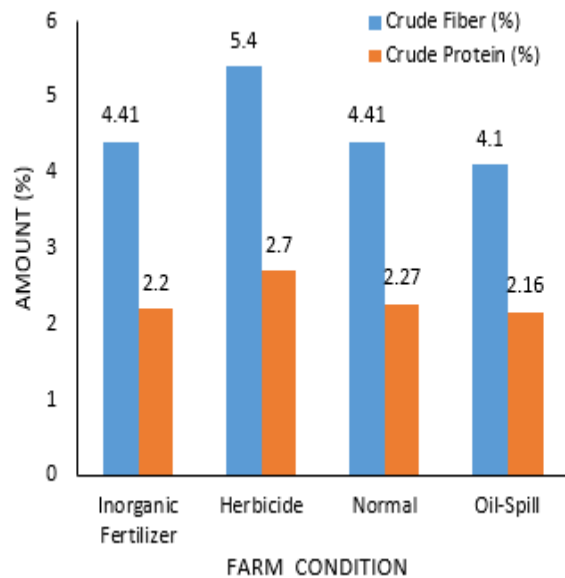
**Fig 2:** Amounts (mg/kg) of Hydrogen cyanide in Cassava for the different Farming Conditions



**Fig 3:** Amount (%) of carbohydrate in cassava for the different farming conditions

From the results obtained and presented on Fig. 3, there is no significant difference in the amounts of carbohydrate formed with the three farming conditions; farming with soil exposed to inorganic fertilizer, oil spilled soil and the normal practice. The

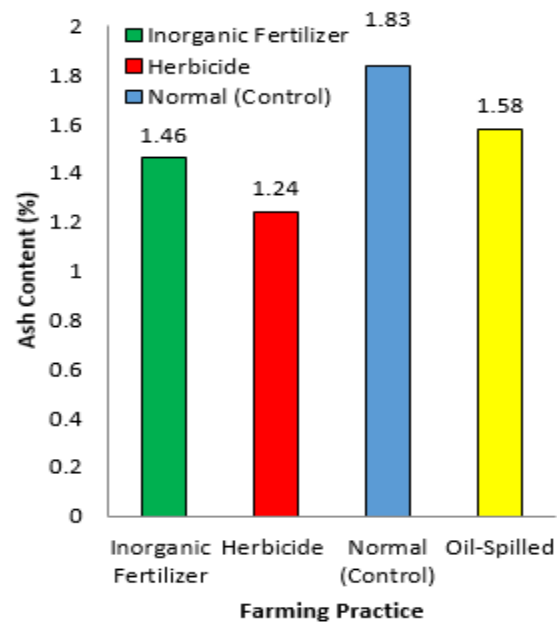
least amount of carbohydrate was observed for soil exposed to herbicides. Researches have shown that herbicides could inhibit cell division in plants, thereby hindering the formation of main components of plants; inorganic fertilizer applied to the soil did not show such effect because of the plant nutrients used during its formulation so as to aid cell division and boost plants growth. Similarly, hydrocarbons present in the petroleum spilled soil did not show any deteriorating effect on carbohydrate formation (Badr, 1986; Kumar, 2012).



**Fig 4:** Amount of crude fibre and crude protein (%) in cassava for the different farming conditions

Fig. 4 shows that the percentage of crude protein in the soil varies depending on the farming practice or condition used. The crude protein content of the four farming practices investigated ranged from 2.16 to 2.71 % with significant difference between the highest value of 2.71 % for the herbicide used soil and the lowest value 2.16 % for the oil spilled soil. It may be due to the fact that substances present in the herbicide aid to improve the protein contents more than that of the inorganic fertilizer and oil spilled. Cultivation of cassava on the normal farm without the addition of external substances showed the second best protein content of 2.27 %. The oil spilled soil on the other hand, may be harmful to the bacteria that break down organic matter, or aid in nitrogen fixing in the soil such that providing inadequate nutrients for the formation of protein in the cassava tuber. Khan *et al.*, (2006), in their study have identified that the effects of herbicide on protein contents of plant depends on the chemical constituents of the herbicide; Sulfosulfuron containing herbicide at higher concentration gave higher amount of protein compared to the control (without herbicide

dosage), while Atrazine containing herbicide give lower protein content at high dosage rate. From the data obtained and shown on Fig. 4, the amount of crude fiber was highest in the root tuber that was cultivated on soil treated with herbicide, followed by the soil that was treated with inorganic fertilizer then the normal practice (no fertilizer or herbicide). Cassava obtained from the soil that was spilled with petroleum had the lowest amount of crude fiber.



**Fig 5:** Amount of ash (%) in cassava for the different farming conditions

As observed on Fig. 5, the ash content of cassava tuber varies with the farming conditions. The normal land gave the highest amount of ash, followed by the oil spilled land while the herbicide induced land gave the least amount of ash. This may be due to the reason that the cultivation of cassava without the use of herbicide and inorganic fertilizer (normal farm practice) enhances the ability of the tap root system to absorb mineral nutrients. It would have been expected that the cassava cultivated on the herbicide or inorganic fertilized soils should have had the highest ash content because the substances introduced contain chemical elements that would be absorbed and added to the soil mineral composition. However, a study on the comparison of the mineral contents of the soils before and after cultivation could give a comprehensive view of the causes of the unexpected variation in the ash contents of cassava root tuber in this study. Comparing the amount of ash contents in this study and that of other authors; the Ash content values obtained in this study ranged from 1.24 – 1.84 %, which was lower than those of peeled bitter cassava 4.44% dry weight basis (Okigbo, 1980) and higher than those of root

tubers 0.84% reported by (Bradbury and Holloway 1988).

**Conclusion:** Application of herbicide to the soil during the cultivation of cassava, produced cassava root tuber with the highest amounts of protein, lipid and moisture contents; the lowest amounts of carbohydrate, ash and water-soluble vitamins. Inorganic fertilizer used soil produced cassava root tuber with the highest amounts of carbohydrates and HCN and the lowest amounts of moisture content. The root tuber from the oil spilled soil had the lowest amounts of lipid, protein and fibre. The normal practice (without the application of any external substance deliberately or accidentally) had the highest amounts of water-soluble vitamins and ash contents, with appreciated amounts of lipid, protein and carbohydrate amongst the other farming conditions as well as low and lowest amounts of moisture and HCN respectively. It is recommended that to boost the nutritional contents of cassava root tuber, the use of farm practices that have green sources of plant nutrients should be implemented; this will also reduce the production of hydrogen cyanide in cassava root tuber, as it is a known toxin to human.

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