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EFFECT OF ACID SOIL AND AMENDMENT ON PROXIMATE AND ELEMENTAL COMPOSITION OF FLUTED PUMPKIN (*Telfairia occidentalis*) (Grinn)

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ABSTRACT

Soil degradation resulting from acidification poses a significant challenge to agriculture, impacting negatively on plant growth and nutrients accessibility. This study investigated the effects of acidic soil and substrate amendment on proximate and elemental composition of fluted pumpkin (*Telfairia occidentalis*). The evaluated crop was grown on acidic soil of pH 3.0 and 0 was used as the control. Growth on acidic soil was achieved by irrigating soil with acidified water, simulated by mixing sulphuric and nitric acids in a 2:1 ratio. Soils were subsequently amended with agricultural lime, organic manure, and a combination of both, with 50 g of each amendment mixed with 5 kg of each soil. The experiment was conducted in a completely randomized design (CRD) in three replicates, and data collected were analyzed using statistical package for social sciences (SPSS) version 20.0. Results of physico-chemical properties revealed that acidic soils treated with a combination of agricultural lime and organic manure improved the soil pH towards neutrality (from pH 3.0 to 7.37). Effective cation exchange capacity showed improvement in soils amended with organic manure and a combination treatment. Organic carbon (1.62), nitrogen (3.36) and phosphorus (389.62) concentrations were higher in soils amended with organic manure and agricultural lime compared to unamended soils (control) values of 1.18, 2.24 and 196.00 respectively. The mineral composition was comparable, calcium was significantly ($P<0.05$) higher in *T. occidentalis* grown on unamended acidic soils (pH 3.0) with values ranging from 2022.3 % to 5962.3 % compared to amended soils values of 1326.3 % to 1381.3 %. This study has revealed that these amendments not only enhanced growth, yield and the proximate composition of *T. occidentalis* but also positively impacted the soil physico-chemical properties and nutrients availability.

INTRODUCTION

Background of the study

Fluted pumpkin (*Telfairia occidentalis*) GRIN, is a widely cultivated leafy vegetable in West Africa. It is known for its high nutritional value and economic importance.

Fluted pumpkin is a rich source of essential vitamins, minerals, and antioxidants, contributing significantly to food security and health (Agogbua, *et al.,* 2022). However, its productivity and nutritional quality has been significantly affected by soil acidity, which restricts nutrient uptake and metabolic activities (Akpasi, *et al.,* 2023).

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Acidic conditions not only limit the absorption of essential macronutrients like nitrogen and potassium but also affect the uptake of micronutrients such as iron and zinc. The application of appropriate soil amendments may improve the proximate and elemental composition of Fluted pumpkin leaves by enhancing soil conditions and nutrient bioavailability (Zewide, & Sherefu, 2021).

In line with the increasing global emphasis on food security and sustainable agriculture, understanding how soil acidity influences crop yield and nutritional composition is crucial. Research on acid soil management strategies will not only improve crop productivity but also contribute to sustainable farming practices (Agegnehu, *et al.,* 2021). This study seeks to investigate the effect of acid soil and substrate amendment on the proximate and elemental composition of Fluted pumpkin (*Telfairia occidentalis*). Soil acidity is a major factor limiting agricultural productivity, particularly in tropical and subtropical regions. Acid soils, which is characterized by low PH levels, negatively affect plant growth by reducing nutrients availability and increasing the toxicity of elements such as aluminum and manganese (Butterfly *et al.,* 2022). In such soils affected with acidity, essential nutrients like phosphorus, calcium and magnesium are often deficient, leading to poor crop yields and reduced nutritional quality of plants (Michael, 2021). The effects of soil acidity on plant growth are particularly pronounced in regions with high rainfall, where leaching further increases nutrients depletion. One common method to improve the fertility of acidic soil is substrate amendment, which involves the application of materials such as organic manure and lime to neutralize soil acidity and enhance nutrient availability (Garbowski *et al.,* 2023). Organic amendment improve soil structure, increase microbial activity, and provide essential nutrients for plant growth. Lime application is one of the most widely methods to increase PH, thereby reducing aluminum toxicity and improving phosphorus availability. This study aimed to determine the effects of soil amendment on proximate and elemental composition of fluted pumpkin (*Telfairia occidentalis*) grown on simulated soil pH (3.0).

MATERIALS AND METHODS

Study area/ Experimental site

This study was carried out in the department of Botany, University of Calabar. Calabar is located between latitude 4º78¹ and 5º09¹ and the longitude 8º15¹ and 8º26¹ E and lies between the valley of two rivers. The great Qua river on the Eastern side and the Cross River on the West. The total annual rainfall for the area is 2109.5mm and 4168.7mm. The experiment was carried out in a Green house in the Department of Botany, Faculty of Biological Sciences, University of Calabar, Calabar.

Seed collection and planting materials

Seeds of *Telfairia occidentalis* (Fluted pumpkin) was obtained from the Nigerian Institute of Horticultural Research and Training (NIHORT), Ibadan . Polyethene bags (planting bags) were obtained from the Ministry of Agriculture, Calabar. Agricultural lime was obtained from Cross River Agricultural

Development Project (ADP) and organic manure was obtained from the Zigger poultry farms in Calabar south, Calabar,Cross River State.

Field Investigation

Topsoil (0–20 cm depth) was collected from Esuk- Atu Community in Calabar Municipality. The collected soil was air-dried, crushed, and sieved through a 2 mm mesh to remove stones and debris. The physico-chemical properties of the soil, including pH, organic matter, and nutrient contents, were analyzed before and after treatment application (Table 1).

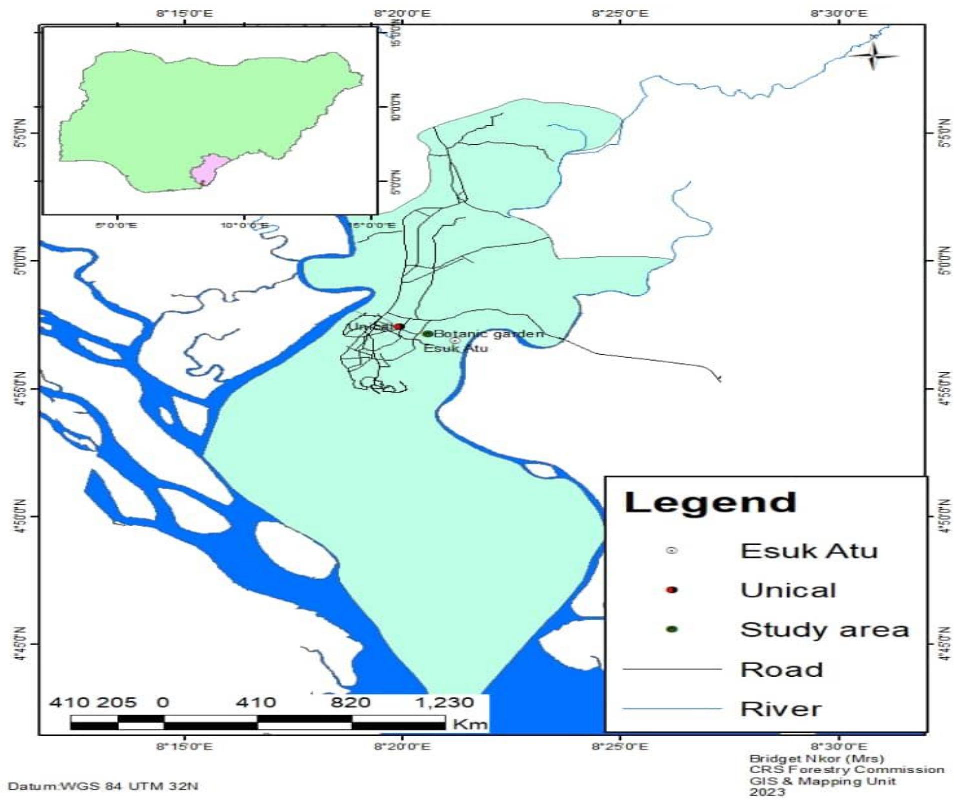

FIG. 1: Geolocation of soil sample and the study areas
Source: Culled from Nigeria Data (2023).

Preparation of simulated soil pH (3.0)
The pH 3.0 of soil used in this study was prepared by irrigating the soil with acidified water simulated by mixing sulphuric and nitric acid in a ratio of 2:1. The acidic solution was then calibrated using distilled water with a deluxe pH meter to get the desired pH and 0 as control.

Application of soil amendments
The growth medium (pH 3.0) were amended with agricultural lime, organic manure and a combine treatment comprising of agricultural lime and organic manure (1:1); a control without amendments, 50 g of each amendment was added to 5 kg of soil sample and labeled appropriately.

Planting procedure and treatment application
Twelve perforated polyethylene bags (16 cm internal diameter) were used in planting. The bags were divided into three groups of 4 bags each. The subgroup of 4 bags represented triplicates of soil pH and amendments as follows: Control, agricultural lime, organic manure, and a combination of agricultural lime and organic manure (1:1). The polyethylene bags were labeled appropriately. Five kilograms (5kg) of soil sample was weighed into each polyethylene bag accordingly and placed in a screen house allowed to stay for two weeks before planting. This time lapse before planting was to allow for microbial activities and interaction within treatment combinations. Each planting bag was sown with three seeds of *Telfairia occidentalis* accordingly. Plants were observed for germination, and established seedlings were allowed to grow for ten weeks.

Determination of physico-chemical properties of soil
The physico-chemical properties of the soil sample were determined before and after treatment. This include soil pH, exchangeable cation, moisture content, base saturation, clay, silt, organic matter and effective cation exchange capacity (ECEC). Also, soil sample was analyzed for mineral contents including organic carbon, total nitrogen, available phosphorus, calcium, magnesium, potassium, sodium, aluminum and hydrogen

Determination of soil pH
The pH of the soil sample, amended and unamend, was determined using a deluxe pH meter. The soil sample was divided into three portions each. Ten (10) grams of soil sample was placed into 100 ml beaker. To this, was added 50 ml of distilled water and stirred vigorously with a glass rod for 20 minutes. The mixture was allowed to stand for 30 minutes. The pH was read by immersing the electrode of the pH meter into the upper part of the suspension (AOAC, 1996).

Determination of soil organic carbon

Organic carbon content of soil sample was determined using dichromate wet oxidation method as described by Eno *et al.* (2009). One gram of each sample was dispersed with 10 ml of 1N Potassium dichromate ($K_2 Cl_2O_4$). The organic matter in the mixture was oxidized using 20 ml of sulphuric acid ($H_2 SO_4$). The resulting solution was allowed to stand for 30 minutes and diluted with 200 ml of distilled water. Also 1 ml of diphenylamine indicator was added before titrating with 1 N ferrous sulfate ($F_e SO_4$).

Determination of total nitrogen

The total nitrogen of each soil sample was determined using the Kjeldahl method as described by Bremner and Mulvancy, (1982). Ten grams of each soil sample was weighed into a Kjeldahl digestion flask. To this, was added 10 ml of distilled water. After 30 minutes, sulphuric acid and selenium mixture were added, carefully mixed and digested for 3 hours until a colourless or clear solution was observed. The digest was then diluted with 50 ml of distilled water and allowed to cool. The digest was made up to 100 ml with distilled water and mixed very well. An aliquot of 10 ml of the digest was transferred to the reaction chamber and 20 ml of 40 % NaOH solution was added followed by distillation. The distillate obtained after distillation was collected over 4% boric acid. The distillate was titrated with 0.02 N HCL solution using bromocresol green as an indicator. A blank distillation and titration were also set to take care of traces of nitrogen in the reaction as well as the water used. Nitrogen in the samples was calculated using the formula:

$$\text{Weight of N in the soil} = \frac{14 \times (A - B) \times N}{1000}$$

Where;

A = Volume of standard HCL used in the sample titration

B = Volume of standard HCL used in blank titration

C = Normality of Standard HCL

Available phosphorus

The acid-soluble forms of phosphorus from the soil sample was extracted with Bray No. 1 solution as described by Olsen and Sommer (1982). Phosphorus was determined using a spectrophotometer (210 VGP Back Scientific) by the blue ammonium molybdenum with ascorbic acid as a reducing agent. Five gram of soil sample was weighed into 100 ml extraction bottle and 35 ml of Bray 1 solution (0.03 M NH_4F and 0.025 M HCl) was added. The extraction bottle was placed on a rotary shaker and agitated for 10 minutes and then filtered through a Whatman No.42 filter paper. A 5 ml aliquot of the filtrate was pipette into a 25 ml flask and 10 ml of ammonium paramolybdate (colouring reagent) was added followed by a small amount of ascorbic acid. After mixing, the mixture was allowed to stand for 15 minutes to develop a blue colour. The colour was measured spectrophotometrically at 660 nm wavelength.

A standard series of 0, 1.2, 2.4, 3.6, 4.8 and 6.0 mg/L were prepared by pipetting 0, 10, 20, 30, 40 and 50 mg P/L respectively in 100 ml volumetric flask and made up to volume with distilled water. The initial available phosphorus was extrapolated from the standard curve which gave 6.91 mg/kg. Phosphorus content in soil samples was calculated by the formula:

$$\text{P (mg/kg)} = \frac{(a-b) \times 35 \times 15mcf}{g}$$

Where;

a = mg P/l in the sample extract

b = mg P/l in the blank

g = Sample weight in grams

mcf = moisture correction factor

35 = volume of extraction solution

15 = Final volume of the sample solution

Determination of exchangeable cations (bases)

Exchangeable bases were extracted by leaching 5 g of each soil sample into density bottle using NH_4 OAC (ammonium acetate) solution at pH 4.0 for an hour (Benson *et al.,* 2010). The filtrate obtained after 30 minutes centrifugation at 200 rpm was used for calcium and magnesium content determination by titration with 0.1 EDTA solution using NA_4Cl buffer, and Calcium and KOH in the first and second titrations (Benson *et. al.,* 2010).

Determination of exchangeable Potassium

Potassium (K) in the percolate in each soil sample was determined using the flame photometry as described by Helmke and Sparks, (1996). Series of potassium standard were prepared by diluting 100 mg/l. Different portions (0, 5, 10, 15 and 20 ml) of the 100 mg/l standard solutions were put into 200 ml volumetric flasks. One hundred milliliters of 0.1 M NH_4 OAC solution was added to the flask and made to 200 ml with distilled water.

The standard series of 0, 2.5, 5.0, 7.5, 10.0 mg/l were obtained for potassium. Potassium in percolate was measured directly by flame photometry at wavelength of 766.5nm.

Exchangeable potassium was computed using the formula:

$$\text{Exchangeable k (cmol (+)/ kg soil)} = \frac{(A-B)\times 250\times mcf}{10\times 39.1\times g}$$

A = mg/l K in the diluted sample
B = mg/l K in the blank sample
G = air-dried sample weight of soil in grams
Mcf = Moisture correction factor

Exchangeable calcium and magnesium determination

Twenty-five milliliter of extract was measured into a conical flask and the volume constituted to 50 ml with distilled water. Potassium ferrocyanide (1 ml), potassium cyanide (1 ml) at 25 (from a burette), thanolamine buffer (10 ml) and 0.2ml Eri-chrome Black T solution were added. The mixture was titrated with 0.01 M turquoise blue colour. Twenty mils (20 ml) of 0.01 M ethylene diamine tetra acetic acid (EDTA) to a clear EDTA with the aid of 23 ml of 1.0 M ammonia acetate solution was added of 23 ml of 1.0 M ammonia acetate for titration and the titre value recorded. The titre value of calcium was subtracted from this value to get the titre value of magnesium.

$$\text{Ca + Mg (cmol(+)/kg)} = \frac{0.01\times (V_1 - V_2)\times 1000}{0.1\times w}$$

V_1 = ml of 0.01 M EDTA used in the sample
V_2 = ml of 0.01 M EDTA used in the blank titration
W = weight in grams of soil extracted
0.01 = Concentration of EDTA used

Experimental design layout

The experimental design was laid out using a complete randomized design (CRD) with three replicates.

Planting procedure and Substrate amendment

Four soil treatments were established:
Control (Unamended Acidic Soil) – No amendments applied.
Lime Treatment – Application of Agricultural lime (50g) was applied.
Organic Amendment (Compost) – Addition of (50g) compost by weight was applied to acidic soil.
Combined Amendment (Lime + Organic manure) (50g + 50g) were applied to acidic soil.
Each treatment was replicated three times and arranged in a Complete Randomized Design (CRD). Each treatment was grown in perforated pots filled with the respective soil-amendment mix. Three seeds were sown per pot and later thinned to one healthy seedling per pot. Following the germination, seedlings stalks were watered and grown for Eight (8) weeks.

Harvesting and sample collection

At the end of the vegetative stages (10 weeks after planting), fresh leaves of *Telfairia occidentalis* were harvested for analysis. Leaf samples was washed, dried in an oven at 60°C, and ground to a fine powder for chemical analysis.

Proximate composition analysis

The dried leaf samples were analyzed for proximate composition according to the AOAC (2016) standard procedures:

Moisture content – oven drying method

Moisture content was determined by drying a known weight of the sample in a hot air oven at 105°C until a constant weight was achieved. The loss in weight represented the amount of water present in the sample, expressed as a percentage of the original sample weight.

Crude protein – Kjeldahl Method

Total nitrogen in the sample was measured using the Kjeldahl digestion method, where nitrogen was converted to ammonium sulfate, distilled, and titrated. The nitrogen content was multiplied by a protein conversion factor (typically 6.25) to estimate the crude protein content (Chang *et al.,* 2017).

Crude fiber – acid and alkali digestion

Crude fiber was determined by sequential digestion of the defatted sample with dilute sulfuric acid and sodium hydroxide. The residue was filtered, dried, and ashed to remove mineral content. The difference in weight gave the crude fiber content.

Crude fat – Soxhlet extraction method

Crude fat content was determined by extracting the dried sample with a non-polar solvent (usually petroleum ether) using a Soxhlet extractor.

The solvent was evaporated, and the remaining fat was weighed to determine the fat content.

Ash content – muffle furnace incineration

Ash content, representing total mineral content, was measured by incinerating the sample in a muffle furnace at 550°C until a white or gray ash was obtained. The weight of the residual ash was expressed as a percentage of the original sample.

Carbohydrate – by difference

Carbohydrate content was calculated indirectly by subtracting the sum of the percentages of moisture, crude protein, crude fat, ash, and crude fiber from 100%. This method assumes that the remaining portion of the sample consists of carbohydrates.

Mineral contents determination

Calcium (Ca), Iron (Fe), magnesium (Mg) and zinc (Zn)

The contents of Ca, Fe, Mg, and Zn were determined using Atomic Absorption Spectrophotometry (Pye Unicam SP8-190, Spec. UK) as outlined in AOAC (1995). To 2 g of each sample in a digestion flask was added 20 ml of acid mixture (65 ml conc. HNO_3 8ml of perchloric acid and 2ml conc. H_2SO_4) and heated gently (50-70^0) on a Stuart hot plate until clear digest was obtained. This was made up to 100 ml with deionized water. Appropriate dilutions (2.0 ppm, 4.0ppm, 6.0 ppm, 8.0 ppm, and 10.0 ppm) were made for each element. For Ca and Mg determination, strontium chloride ($SrCl_2$) was added to yield a 1500 mg/ml of Sr^{2+} in the final solution. Internal standards were prepared for each element. The concentration of the elements was determined using the internal standards obtained spectrophotometrically using the appropriate wavelengths (as specified in the instruction manual of the instrument) for each the elements.

Sodium (Na) and potassium (K)

Sodium and potassium were obtained by flame photometry (Jahway Flame Analyzer P. F7, UK). The digestion procedure was as described for atomic absorption spectrophotometry. The stock solutions for Na (1000 ppm Na^+) and K (100 ppm K^+) were prepared by dissolving 2.542 g of NaCl and 1.907 g of KCl in 1000ml deionized water. Working standards (2.0 ppm 4.0 ppm, 6.0 ppm, 8.0 ppm and 10.0 ppm) from the stock solutions were prepared. The absorbance for Na (at 589 nm) and K (at 767nm) were obtained using the flame photometer. Sodium and potassium concentration in the samples were obtained by reference to standards the results were expressed in milligram per 100g sample.

Phosphorus

Phosphorus content was determined as described by AOAC (1995). To 0.5 ml aliquot of the mineral digest was added 9.5ml of 10% trichloroacetic acid in a test tube. The mixture was agitated, centrifuged (Censaur 2 MSE, UK) for 5 min and then filtered through a Whatman filter paper. Five mil (5ml) of the filtrate and 5ml of the working standards prepared as previously described from phosphorus stock solution (4.32g KH_2PO_4 in 250ml of deionized water and made up to 1 liter) were measured into two cuvettes to which 0.5 ml of molybdate reagent (prepared by adding 200 ml distilled water to 83 ml of conc. H_2SO_4 and 25.0 g ammonium molybdate tetrahydrate made up to a litre by the addition of deionized water) was add.

RESULTS

Results obtained from this study revealed that amendment of acidic soil with organic manure and combine treatment of organic manure and agricultural lime was effective in neutralizing soil acidity thereby improving the growth performance of the plant. These results are presented as follows:

Physico-chemical properties of growth media

The physico-chemical properties of the growth media (pH 3.0), amended (Agricultural lime (AL), organic manure (OM), and a combination of both (AL+OM)) and unamended, used in this study is presented in Table 1. The pH of acidic media shifted towards neutrality with amendment, particularly when amended with a combination of agricultural lime and organic manure. Electrical conductivity was lower in media amended with organic manure. Also, effective cation exchange capacity (ECEC) and organic matter was higher in soil amended with the combined treatment of agricultural lime and organic manure.

Mineral content of growth media

Organic carbon was higher in acidic soils amended with organic manure. Nitrogen, phosphorus and calcium were also higher in soils amended with organic manure, and a combination of agricultural lime and organic manure (Table 2). However, magnesium was higher in unamend soils.

TABLE 1: Physico-chemical parameters of growth media

Soil pH Amendments	3.0 CTRL	AL	OM	AL:OM
pH	3.00	6.77	6.00	7.34
Moisture (%)	2.80	2.02	3.96	4.97
EC (%)	156.50	172.20	135.90	186.10
ECEC (%)	9.26	28.25	5.59	21.63
BS (%)	91.82	98.16	87.84	98.15
Sand (%)	73.00	68.00	69.00	68.00
Silt (%)	19.00	25.00	25.00	25.00
Clay (%)	8.00	7.00	6.00	7.00
OM(%)	2.21	2.28	2.55	3.03

CTRL: Control; AL: Agricultural lime; OM: Organic manure; AL+OM: Agricultural lime: Organic manure; EC: Electrical conductivity; ECEC: Effective cation exchange capacity; BS: Base saturation; OM: Organic matter

TABLE 2: Mineral content of growth media

Soil pH Amendments	3.0 CTRL	AL	OM	AL:OM
OC(%)	1.28	132	1.48	0.76
TN (%)	2.24	2.24	3.36	2.24
AP (mg/ kg)	196.0	66.13	307.40	375.32
Ca (cmol/ kg)	4.60	26.60	4.00	19.20
Mg(cmol/ kg)	3.60	0.80	0.60	1.80
Na (cmol/ kg)	0.22	0.12	0.21	0.02
K (cmol/ kg)	0.11	0.21	0.10	0.21
Al (cmol/ kg)	0.56	Trace	0.32	Trace
H (cmol/ kg)	0.20	0.52	0.36	0.40

CTRL: Control; AL: Agricultural lime; OM: Organic manure; AL+OM: Agricultural lime: Organic manure; EC: Electrical conductivity; ECEC: Effective cation exchange capacity; BS: Base saturation; OC: Organic carbon; TC: Total nitrogen; AP: Available phosphorus; Ca: calcium; Mg: Magnesium; Na: Sodium; K: Potassium; Al: Aluminum; H: Hydrogen

Influence of soil amendment on mineral content of Fluted pumpkin grown using acidic soil media

Calcium content in seedlings of Fluted pumpkin was significantly (P≤0.05) improved following amendment with agricultural lime with AL+OM significantly (P≤0.05) improved calcium in pH 3.0 soil (Figure 1).

Magnesium, phosphorus, sodium and potassium content of the studied species were mostly comparable both in amended and unamend soils.

Influence of soil amendment on nutrient content of Fluted pumpkin grown using acidic soil media

Protein, ash, fiber, fat and moisture content of Fluted pumpkin (Figure 2) seedlings grown using acidic soil media was comparable in the amended and unamend soils.

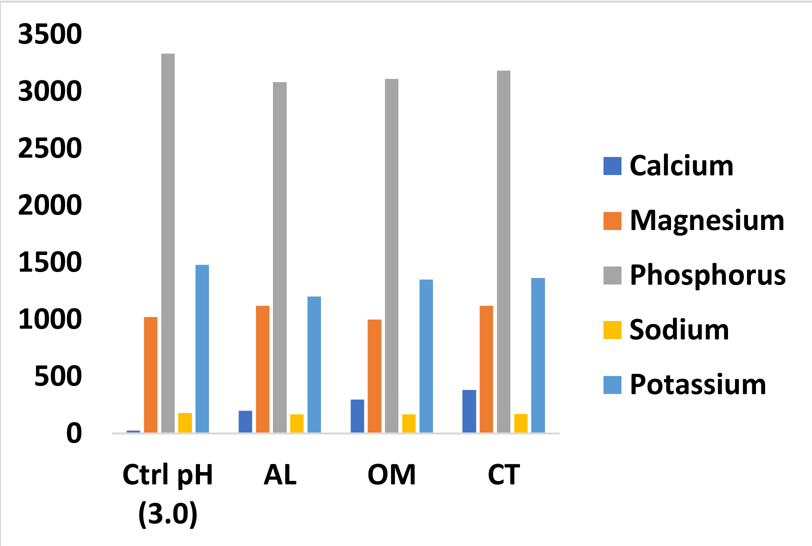

FIG. 1: Effect of soil amendment on mineral content (%) of Fluted pumpkin grown using acidic soil
Ctrl: Control; AL: Agricultural lime; OM: Organic manure; CT: Composite treatment

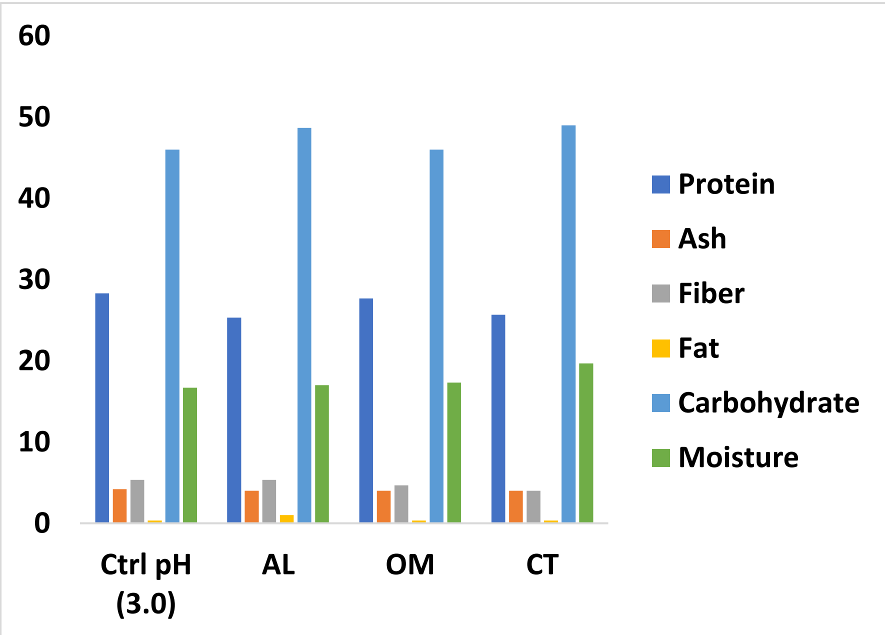

FIG. 2: Effect of amendment on nutrient content (%) of Fluted pumpkin grown using acidic soil
Ctrl: Control; AL: Agricultural lime; OM: Organic manure; CT: Composite treatment

DISCUSSION

Effects of acidic soil and substrate amendments on proximate and elemental composition of *Telfairia occidentalis* was studied. Results of the soil physico-chemical properties of acidic soils investigated at pH 3.0 level before and after substrate amendment (agricultural lime and organic manure singly and in combination) revealed that the soils were generally low in organic carbon content before application of the different treatments which was similar to low organic matter earlier reported by Bello and Ukut (2015). However, the application of organic manure and agricultural lime successfully improved organic carbon and organic matter of the soils indicating the effectiveness of the manures in improving the soil fertility.

The nitrogen content rating of the different soils according to Landon (1991) ranged from 1.68 to 3.92. Nitrogen is a major component of chlorophyll as well as helping to bulk amino acid of protein in plant. It can be said that the amount of nitrogen content in the soils can assist the plant in growth and subsequent yield production. Exchangeable cation including calcium, potassium, magnesium, sodium, aluminum and hydrogen ions ranged from medium to high. According to Bello and Ukut, (2015), this is an important reaction in soil fertility in correcting soil acidity or basicity, in changes altering soil physical properties and as a mechanism of purifying or altering percolating waters. Phosphorus, magnesium, potassium are all major elements in the formation of plant nutrients. The present study indicated that these elements were in adequate quantity in soils studied following amendment with organic manure singly and in combination with agricultural lime.

The result of the present study on Fluted pumpkin revealed that the plant is a reservoir of essential nutrients and minerals. In early research, Yellavila *et al.* (2015) reported crude protein in the range of 20.69-23.08 %, crude fat (0.59-1.14 %), crude fibre (4.06-5.64 %), moisture (9.19-11.83 %) and carbohydrate (54.31-59.64 %). The variation here may be due to differences in soil content between the study location, variation in protein content and other nutrient content of the plant can also be attributed to different environmental conditions, genotype and method of analysis (Yellavila *et al.,* 2015). Additionally, nutrient compositions of the plant are sensitive to rainfall, light intensity, length of growing season, day duration, temperature and agronomic practices (Bampidis *et al.,* 2011). Thus, these factors must have contributed to the differences observed in the nutrient composition of the plant. In terms of the treatments, it was generally observed that OM and combination of AL+OM enhanced the nutrient composition of the seeds than the control. This is a clear suggestion that the application of these biofertilizers had contributed immensely to nutrients availability in the soil for the plant uptake and utilization in food production.

Moisture content estimates directly the water content and indirectly the dry matter content of the sample while crude fibre accounts for indigestible plant material (Yellavila *et al.,* 2015). The present study reported a moisture content of 15-47% which was higher than 9.19-11.83 reported by (Yellavila *et al.,* 2015) in lima bean. However, the crude fibre of 3.33 to 6.67% was similar to the range of 4.06-8.86% by Yellavila *et al.* (2015). It was also in agreement with many other earlier submissions (Fasoyiro *et al.,* 2006; Iheanacho, 2010; Moses *et al.,* 2012). The ash content of both plants was higher than 2.57 % reported in lima bean by Seidu *et al.* (2014). Whereas, the carbohydrate content in *T. occidentalis* under the different soil amendment were similar to the report of 47.52 % reported by Seidu *et al.* (2014). Assessing the nutrient content of the plant material is fundamental in understanding their abundance in relevant nutrients that can be used to manage and mitigate nutrient related illness. The protein content of legume grains ranges from 17 to 40 g/100g which is much higher than that of cereals (7-11.8 g/100g) and approximately equal to the protein content of meat which is 18-25 g/100g (De Oliveira, 2006).

In this study, different elemental contents of *T. occidentalis* was studied. It was revealed that the calcium content was significantly higher in all the control plants of *T. occidentalis* and application of AL+OM and OM alone significantly increased Ca content in the plant used under simulated soil pH 3.0 level. The results of the present study suggest that *T. occidentalis* is a good source of calcium and its consumption could serve as a cheaper source of calcium to meet daily body requirement for bone development and disease prevention. Notably, planting this vegetable with OM or combination of AL+OM will significantly improve calcium content of the plant. This is a suggestion that *T. occidentalis* is generally a good source of iron and may not necessarily require soil amendment with AL and OM for its production. It can be suggested that consumption of Fluted pumpkin could provide the body with iron requirements. Therefore, the consumption of Fluted pumpkin could help tackle iron deficiency, which is a common disorder worldwide affecting a large proportion of women and children in developing countries (Yellavila *et al.,* 2015). Iron contents in the plant under the soil simulation pH 3.0 were higher than the range of 2.45 to 2.67 mg/100m^{-1} reported by Yellavila *et al.* (2015) and Kathirvel and Kumudha (2011).

Magnesium plays a key role improving insulin sensitivity, protect the body against diabetes complications and reduces blood pressure (Haq and Ullah, 2011). It is also involved in many enzymatic reactions of oxidative metabolism of nutrients and cell constituents' synthesis, transmission of nerves impulses, production and the formation of healthy bones and teeth (Kartika *et al.,* 2011). The amount of magnesium deposited in the seeds of *T. occidentalis* plant suggest the effectiveness of the plant in providing the body with adequate quantity of Mg after consumption.

Zinc as a trace element is necessary for the growth and multiplication of enzymes responsible for DNA and RNA synthesis, for skin integrity, bone metabolism and functioning of taste and eyesight (Saracoglu *et al.,* 2009)

Phosphorus helps build and protect the bones and teeth, as part of DNA and RNA, helps convert food into energy (Yellavila *et al.,* 2015).

Sodium is concerned with the conduction of nervous impulses, muscles contractility and control of heart muscle condition (Aziza *et al.,* 2019). Following the results obtain in this study, it is submitted that *T. occidentalis* has a higher sodium content especially when grown on soil amended with AL+OM treatment.

By implication, the consumption of *T. occidentalis* provides the body with all the health benefits associated with the plant material (Yellavila *et al.,* 2015) reported a range of 19.99 to 21.33 mg/100 g in pumpkin accession which was lower than values obtained in the present study. It was also lower than those reported by many previous researchers (Fasoyiro, *et al.,* 2006; Ikechukwu & Madu, 2010; Kathivel and Kumudha, 2011).

Potassium was higher in *T. occidentalis* treated soil at pH 3.0. It was therefore revealed that the combined treatment of AL and OM was the best in enhancing potassium in *T. occidentalis*. Potassium plays vital role in reducing hypertension and maintaining cardiac rhythm. In the human body, K is helpful in many physiological reactions and its deficiency can result in adverse effect in human health. The present findings suggest adequate consumption of *T. occidentalis* for its nutritional values especially potassium. The potassium content of the plant in this study were higher than 50.04 to 52.08 mg/100 g reported in Fluted pumpkin. It was also different from 55.85 mg/g reported by Effa *et al.* (2019).

Macro and micro elements are nutrient source for growth, life cycle and biological functions in plants. These in turn facilitate food production in plant for direct and indirect use by heterotrophs in the environment. Therefore, measures to improve these elements in plants are of utmost importance in plant agronomy.

CONCLUSION

Based on the findings of this study, it can be deduced that *T. occidentalis* plant possesses abundant nutrients and minerals that hold significant potential for utilization by humans. Furthermore, the enhancement of acidic soils through the application of organic manures, as well as a combination of organic manures and agricultural lime, resulted in improved nutrients and minerals of the studied fluted pumpkim species.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1) Farmers are encouraged to employ a blend of agricultural lime and organic manures when cultivating *T. occidentalis* on acidic soils.

2) The use of soil amendments in limes and organic manures is recommended as a safer and environmentally friendly substitute for inorganic fertilizers to promote the growth and yield of the crops.

3) Future research should explore the varying effects of different concentrations of agricultural lime and organic manures on leguminous crop.

REFERENCES

Agegnehu, G., Amede, T., Erkossa, T., Yirga, C., Henry, C., Tyler, R. and Sileshi, G. W., 2021. Extent and management of acid soils for sustainable crop production system in the tropical agroecosystems: a review. Acta Agriculturae Scandinavica, Section B—Soil and Plant Science, 71(9), 852-869.

Agogbua, J. U., Okonwu, K., Akonye, L. A., and Mensah, S. I., 2022. Studies on nutrient and mineral contents of Fluted pumpkin grown in NPK solution. European Journal of Agriculture and Food Sciences, 4(2), 52-57.

Association of Official Analytical Chemist AOAC, 1995. Official Methods of analysis, 16th ed. Washington D. C. Press.

Association of Official Analytical Chemist AOAC, 1996. Methods of analysis of soils, 12th ed. Washington D. C. Press.

Aziza, S. Siddiqueb, A. B., and Uddic, S. J., 2019. Proximate and mineral composition of leaf, stem, flower and seed of Cassia sophera Linn. International Journal of Pharmaceutical Science, 57(1), 49-54.

Bampidis, V. A., and Chvistodoulou, V., 2011. Chickpeas (Cicerarietinum) in animal nutrition: A review. Animal feed Science and Technology, 168, 1-20

Bello, O. S., and Ukut, E. Y., 2015. The physico-chemical properties and microbial isolates of Cross River State Estuary soils. Mayfair Journal of Soil Science, 1(1), 15-27.

Benson, C. H., Oren, A. H. and Gates, W. P., 2010. Hydraulis conductivity of two geosynthetic clay liners permeated with a hyper alkaline solution. Geotextiles and Geomembranes, 28,206-218.

Bremner, J. M. and Mulvancy, C. S., 1982. Total nitrogen. In: A. L. Page, R. H. Miller and D. R. 2. Chemical and microbiological properties. American Society of Agronomy and Soil Science Society of America. Madison, Wisconsin Incorporated.

Butterly, C. R., Amado, T. J. C., and Tang, C., 2022. Soil acidity and acidification. In Subsoil Constraints for Crop Production (pp. 53-81). Springer International Publishing.

Chang, S. K. and Zhang, Y., 2017. Protein analysis: Kjeldahl method. Journal of Food Science,82 (5), S1448-S1456. Doi: 101111/1750-3841.13724.

De Oliveira, A. C., 2006. Chemical composition, dietary fibre and resistant starch contents of raw and cooked pea, common bean, chick pea and lenthil legumes. Food Chemistry, 94, 327-330.

Eboibi, Akpokodje, O. I. and Uguru, H., 2018. Growth performance of five bean, Phaseolus spp. Varieties as influenced by organic amendment. Journal Applied Science Environmental Management, 22(5), 759-763.

Eno, J. U., Trenchard, O., Ibia, J. A. Ogunwale, A., Ano, O. and Ivara, E. E., 2009. Manual of soil, plant and water analysis. Sibon Books Limited.

Fasoyiro, S. R., Ajibade, A. J., Omole, O. N., and Farinde, E. O., 2006. Proximate, minerals and antinutritional factors of some underutilized grain legumes in south- western Nigeria. Journal of institute of agricultural research and training, Obafemi Awolowo University, P. M. B 5092, Moor plantation, Ibadan, Nigeria. Nutritional and Food Science, 36(1), 18-23.

Garbowski, T., Bar-Michalczyk, D., Charazińska, S., Grabowska-Polanowska, B., Kowalczyk, A., and Lochyński, P., 2023. An overview of natural soil amendments in agriculture. Soil and Tillage Research, 225, 105462.

Haq, F., and Ullah, R., 2011. Comparative determination of trace element from Allium sativum, Rheum autrale and Terminalia chebula by atomic absorption spectroscopy. International Journal of Biology, 1(5), 77-82.

Helmke, P. A., Schulze, E. D. and Wale, D. M., 1996. Methods of soil analysis. Part 3, Chemical methods – Soil Science Society of America. Wisconsin Incorporated.

Iheanacho, K. M. E., 2010. Comparative studies of the nutritional composition of soybean (Glycine max) and lima bean (Phaseolus lunatus). Scientia Africana, 9(2), 29-35.

Ikechukwu, E. E., and Madu, D. I., 2010. Biochemical composition and nutritional potential of Ukpa: A variety of tropical lima beans (Phaseolus lunatus) from Nigeria- A short report POI. Journal of Food Nutrition and Science, 60, 231- 235.

Kartika, H., Aziza, U., and Olaleye, O., 2011. Nutrient and mineral composition of dried mamalci leaves (Pipturus albidus) and infusions. Journal of Food Composition and Analyses, 24(1), 44-48.

Kathirvel, P., and Kumudha P., 2011. a comparative study on the chemical composition of wild and cultivated germplasm of Phaseolus lunatus L. International Journal of Applied Biology and Pharmaceutical Technology, 2(4), 298.

Khan, V. Y., 2019. Element content analysis of plants of genus Ficus using atomic absorption spectrometer. African Journal of Pharmacy and Pharmacology, 5(3), 317-321.

Landon, J. R., 1991. Booker tropical soil manual. A handbook for soil survey and agricultural land evaluation in the tropics and sub-tropics. John Wiley and Son Incorporated.

Michael, P. S., 2021. Role of organic fertilizers in the management of nutrient deficiency, acidity, and toxicity in acid soils–A review. Journal of Global Agriculture and Ecology, 12(3), 19-30.

Moses, O., Olawuni, I., and Iwouno, J. O., 2012. The proximate composition and functional properties of full-flat flour, and protein isolate of lima bean (Phaseolus lunatus), 1. 349.

Saracoglu, S., Tuzen, M., and Soyiaye, M., 2009. Evaluation of trace element contents of dried apricot samples from Turkey. Journal of Hazardous Materials, 167 (1-3), 647-652.

Seidu, K. T., Osundahunsi, O. F., Olaleye, M. T., and Oluwalena, I. B., 2014. Amino acid composition, mineral contents and protein solubility of some lima bean (Phaseolus lunatus L. Walps) seeds coat. Food Research International, 73, 130-134.

Yellavila, S. B., Agbenorhevi, J. K., Asibuo, J. Y., and Sampson, G. O., 2015. Proximate composition, minerals content and functional properties of five lima bean accessions. Journal of food security, 3(3), 69-74.

Zaiden, I., and Sherefu, A., 2021. Review paper on effect of micronutrients for crop production. Journal for Nutritional Food Process, 4(7), 1-8.