International Journal of Horticultural Science 2023, 29: 53-59.
https://doi.org/10.31421/ijhs/29/2023/11020

Agromorphological and nutritional quality profiles of fluted pumpkin (*Telfairia occidentalis* Hook F.) as influenced by cultivar, growing medium and soil amendment source

Oyetunde, O. A.[1], Benson, G. A. S.[1], Oyetunde, A. K.[2], Olalekan, O. J.[3], Chukwu, C. U.[1] & Anari, K. O.[1]

[1]*Department of Crop Production and Horticulture, School of Agriculture, Lagos State Polytechic, Ikorodu, Nigeria.*
[2]*Department of Biological Sciences, Faculty of Science, Augustine University, Ilara-Epe, Lagos State, Nigeria.*
[3]*Forestry Research Institute of Nigeria, Ibadan, Nigeria.*
Author for correspondence: biyi.oyetunde@gmail.com

Summary: Fluted pumpkin (*Telfairia occidentalis* Hook F.) is popular as food and feed around the world. Sixteen treatments were developed from factorial combinations of three factors: cultivar (*ugu elu* and *ugu ala*), growing medium (garden soil (GS) and white sand (WS)), and soil amendment source (poultry manure, NPK, supergro and no amendment). A pot experiment was conducted to investigate the agromorphological and nutritional traits of fluted pumpkin obtained from the treatments. Fresh leaves were analyzed for crude protein, crude fibre, crude lipid, total ash, phytate and nitrate concentrations. Data were subjected to analysis of variance and principal component analysis. Mean plots were used to explain the effects of the three factors and profiling was done using the GYT biplot. There were significant ($p \leq 0.05/0.01$) mean squares for measured traits, suggesting the possibility of selection among the treatments. Plants in GS consistently out-performed those in WS for shoot weight, leaf length, and number of leaves per plant possibly due to greater availability of nutrients in the GS. Inconsistent patterns observed in the proximate concentrations of pumpkin from the 16 treatments showed the role of interaction among the three factors. Principal component analysis identified some traits as contributors to differences among the treatments which can be basis of selection. Treatments 2, 4, 6, 8, 10, 11, 12, 13, 14, 15, and 16 might be useful to improve vegetative yield while 1, 3, 5, 7, and 9 could improve nutritional values of the fluted pumpkin.

Oyetunde, O. A., Benson, G. A. S., Oyetunde, A. K., Olalekan, O. J., Chukwu, C. U., Anari, K. O. (2023): Agromorphological and nutritional quality profiles of fluted pumpkin (*Telfairia occidentalis* Hook F.) as influenced by cultivar, growing medium and soil amendment source. International Journal of Horticultural Science 29: 53-59. https://doi.org/10.31421/ijhs/29/2023/11020

Key words: fluted pumpkin, nutritional quality, nitrate, phytate, trait profile

Introduction

Fluted pumpkin (*Telfairia occidentalis* Hook F.) is a leafy vegetable in the Cucurbitaceae family. It is a tropical vine grown mainly for its green leaves, which are used as a vegetable (Osadebe et al., 2014). It is a high-climbing perennial cultivated as an annual under the traditional farming system in West Africa (Schippers, 2000) where it has various names including *ugu* in Nigeria (Ugwu, 2001), *krobonko* or *oroko* in Ghana, *kobori* in Cameroon and *pondoko* in Sierra Leone.

The vegetable is popular in the diets of households in all economic classes for its nutritional properties being a rich source of protein and fat at 29 and 18% respectively as well as minerals and vitamins up to 20% (Amao et al., 2018). In herbal remedies, the leave extract, being a rich source of iron, is administered to weak patients as blood tonic (Akoroda, 1990).

According to Amao et al. (2018), the nutrient quality of vegetables is a function of factors relating to production, such as level and type of chemical; herbicides, pesticides, used and fertilizer application. In all cases, farmers employ soil amendments using available resources such as crop wastes, farmyard manure and poultry waste alongside the use of inorganic fertilizers (Adediran et al., 2003) to improve soil fertility and enhance productivity. Nitrogen in soil amendment sources such as the compound fertilizer, NPK, has reportedly shown significant influence on vegetative growth of vegetables such as fluted pumpkin resulting in luxuriant growth with increased number of leaves (Akanbi et al., 2007). Thus, they are a choice source by profit-seeking farmers to boost the yield and earn the maximum revenue possible.

The use of inorganic soil amendments leads to the accumulation of chemical residues in harvested plant tissues. These residues could be of different characteristics and toxicity levels depending on the nature of the amendment used. Fluted pumpkin leaves are commonly consumed with little or no processing, such as squeezing to drink the extracted liquid, or blanching. The direct consumption of such plant materials in foods has been implicated in various health conditions including cancer and neurological, memory and skin disorder. It is, thus, important to investigate the nutritional quality of fluted pumpkin leaves produced from different treatments involving cultivar (genotype), growth medium and soil amendment sources with a view to identifying systems of producing the vegetable without attendant nutritional demerits. This study investigated the main and interaction effects of cultivar, growing medium and soil amendment source on the agronomic performance and leaf nutritional quality of fluted pumpkin with a view to identifying a system of production of fluted pumpkin leaves with high nutritional quality.

Materials and methods

Experimental site

The field experiment was conducted at the Teaching and Research Farm of the Department of Crop Production and Horticulture, School of Agriculture, Lagos State Polytechnic, Ikorodu during the 2021 main season. The area lies between latitude 5°10' N and longitude 3°16' E of the Greenwich meridian with an elevation of 50 m above sea level. It has a mean average temperature of 25 °C and 29 °C with an annual rainfall ranging between 1670 mm and 2200 mm and relative humidity of 65 to 68%. Crude protein, crude fibre, crude lipid, total ash, nitrate and phytate contents were determined at TETRA 'A' Analytical and Diagnostics Laboratory, Abeokuta, Ogun State.

Treatments, experimental design and field layout

Seeds of two cultivars of *Telfairia occidentalis* (*Ugu elu* and *Ugu ala*) were obtained from pods of two proven varieties from trusted farmers in Ebonyi State. Two different types of growth medium (Garden Soil and White Sand) were used. The white sand was obtained commercially while the loamy soil was obtained 1-15 cm depth in the Teaching and Research Farm of the Department. Soil amendment sources: NPK fertilizer and liquid organic fertilizer (supergro) containing % N and poultry manure. The NPK and Supergro were manufactured by EarthCare Nigeria Limited and Saponaria Industries Ltd respectively while the poultry manure was obtained from the Teaching and Research Farm of the Department of Animal Production Technology, Lagos State Polytechnic, Ikorodu.

The experiment was conducted using pots (polyethylene bags). Four pots were filled with 15 kg soil per treatment (64 bags in all). Pots were laid out in the screen house using completely randomized design. The experimental setup was replicated two times, with two pots per replicate and plant-to-plant spacing of 0.75 m. Data were taken on all plants.

The experiment was conducted with three factors forming a 2×2×4 factorial design. The three factors were (i) growth medium [two levels which were White sand (M1) and Garden soil (M2)]; (ii) Cultivar [two levels which were *ugu elu* (V1) – with purple vine and *ugu ala* (V2) with green vine]; and (iii) Soil amendment sources [four levels which were poultry manure (S1), commercial liquid organic fertilizer (S2), NPK fertilizer (S3), and no amendment (S4)]. The poultry manure, liquid organic fertilizer and NPK were applied at the rates of 10 t/ha (Achebe *et al*., 2014), 400 ml in 400l of water/ha (manufacturer's recommendation) and 250 kg/ha (Idem et al., 2012) respectively.

Field establishment and maintenance

Prior to planting, soil from 1-15 cm depth was obtained from the Teaching and Research Farm of the Department of Crop Production and Horticulture, School of Agriculture, Lagos State Polytechnic, Ikorodu, and mixed thoroughly using shovels. Fifteen (15 kg) of soil was filled into each bag. Nursery pots were filled with thoroughly mixed loamy soil using hand trowel and the seeds of the two cultivars were planted separately at two seeds per pot at a depth of about 4 cm. The seeds were covered and consolidated slightly with soil. The bags were kept moist through the period of nursery. After three weeks, seedlings were transplanted to the experimental site using naked-root system. It was transplanted with the bare root in order not to contaminate the experimental soil with the nursery soil. Fifty centiliters (50 cl) of water was applied to each seedling immediately after transplanting, to avoid loss due to transplanting shock. Pots were irrigated with equal volumes of water when necessary subject to environmental condition.

To enhance a synchronized release of nutrients to plants, dried poultry manure was applied to the experimental pots (75 g) a week after transplanting, NPK fertilizer was applied (3 g per plant) two weeks after transplanting using ring method, commercial liquid organic fertilizer was applied to the leaves of the plants (5 ml per plant) two weeks after transplanting. The manures and fertilizer were weighed using a sensitive weighing scale. The liquid fertilizer was measured using a graduated tube.

Vertical method of staking was carried out at three (3) weeks after transplanting. Each stake was 2.5 m long. The vine of the plants were trained round the stake in a clockwise manner and were closely monitored to prevent them from inter twinning around the stake. Weeding was carried out manually, subject to field inspection.

Data collection and analysis

Fresh leaves were harvested, packaged, labeled properly and taken to TETRA 'A' Analytical and Diagnostic Laboratory, Abeokuta, Ogun State, to determine the levels of the quality attributes crude protein, crude fibre, crude lipid, total ash, nitrate concentration and phytate concentration. Data collected were subjected to principal component analysis to determine the traits that are important to variation among the treatments. Pearson correlation and path coefficient analyses were used to study the relationship among the observed traits. All analyses were performed using Statistical Analysis System (SAS Institute, 2011).

Results

Analysis of variance of main and interaction effects of cultivar, medium and amendment source revealed significant ($p \leq 0.05/0.01$) mean squares for all measured agronomic traits (***Table 1***). Cultivar, medium and amendment main effects were significant all measured traits with the exception of shoot weight for which cultivar mean square was not significant. Significant mean squares were also observed in the interaction effects C × M, C × A, and M × A for all measured traits with the exception of cultivar effect on vine girth, number of leaves per plant and leaf breadth. There was significant interaction effect C × M × A on shoot weight, vine length, number of leaves per plant, and leaf length.

As displayed in ***Table 2***, all studied effects were revealed to be significant ($p \leq 0.05$ or 0.01) for crude protein, crude fibre, total ash, and phytate concentration while only the effect of amendment source and its interaction with cultivar and medium (i.e. C × M × A) were significant for nitrate concentration.

The mean plots in ***Figures 1-3*** revealed a distinct pattern in the effect of cultivar, growth medium and amendment source on shoot weight, leaf length and number of leaves per plant of fluted pumpkin. *Ugu elu* consistently out-performed *ugu ala* while plants grown in garden soil had higher estimates than

Table 1. Mean squares from analysis of variance of main and interaction effects cultivar, growth medium and soil amendment for agronomic traits of fluted pumpkin.

Source of Variation	Degrees of Freedom	Shoot weight	Vine length	Number of branches per plant	Vine girth	Number of leaves per plant	Leaf length	Leaf breadth
Cultivar [C]	1	167ns	1.292**	13.78**	1.05**	78.13**	14.14**	25.81**
Medium [M]	1	131713**	7.097**	26.28**	5.79**	253.13**	163.85**	92.00**
Amendment source [A]	3	485849**	6.854**	9.53**	2.47**	213.79**	27.93**	15.96**
C × M	1	14238**	0.062**	5.28**	0.26ns	0.12ns	1.99**	0.27ns
C × A	3	7101**	0.056**	1.78**	0.40*	16.46**	2.95**	0.80**
M × A	3	11967**	1.562**	9.12**	1.13**	18.46**	1.21**	2.46**
C × M × A	3	3552*	0.048**	0.28ns	1.01ns	55.40**	1.98**	0.11ns
Error	16	1088	0.008	0.16	0.09	1.63	0.12	0.08

* and **, significant at 5 and 1% probability respectively; ns, not significant

Table 2. Mean squares from analysis of variance of main and interaction effects of cultivar, growth medium and soil amendment for nutritional quality traits of fluted pumpkin.

Source	Degrees of freedom	Crude protein	Crude fibre	Crude lipid	Total ash	Nitrate	Phytate
Cultivar [C]	1	1.62**	0.49ns	0.02**	3.92**	0.0002ns	0.01**
Medium [M]	1	3.93**	0.59ns	0.004*	8.16**	0.00003ns	0.01**
Amendment source [A]	3	8.02**	2.61ns	0.029**	3.3**	0.0008**	0.01**
C × M	1	4.59**	0.06ns	0.045**	0.53**	0.0002ns	0.001*
C × A	3	3.26**	4.41ns	0.006**	2.39**	0.0001ns	0.013**
M × A	3	8.47**	1.19ns	0.020**	4.18**	0.0001ns	0.012**
C × M × A	3	1.20**	0.37ns	0.048**	5.59**	0.0008**	0.01**
Error	16	0.01	1.52	0.001	0.0004	0.0001	0.0002

* and **, significant at 5 and 1% probability respectively; ns, not significant

Table 3. Summary of principal component analysis of measured agronomic and nutritional traits of fluted pumpkin.

Measured trait	PC 1	PC 2	PC 3	PC 4
Agronomic				
Shoot weight	0.37	-0.21	0.22	0.09
Vine length	0.40	0.03	-0.05	-0.25
Number of braches per plant	0.36	-0.17	0.12	0.17
Vine girth	0.01	-0.06	0.61	-0.24
Number of leaves per plant	0.40	0.10	0.22	-0.10
Leaf length	0.43	0.19	-0.21	0.05
Leaf width	0.43	0.19	-0.23	0.06
Nutritional				
Crude ptotein content	-0.01	0.54	0.12	-0.23
Crude fibre content	0.18	-0.42	-0.04	-0.14
Crude lipid content	-0.04	-0.02	0.38	0.70
Total ash content	0.07	0.39	-0.14	0.48
Nitrate concentration	-0.12	0.18	-0.22	-0.11
Phytate concentration	-0.02	0.43	0.43	-0.14
Eigen value	4.06	2.35	1.54	1.20
Proportion of variation controlled (%)	0.31	0.18	0.12	0.09
Cumulative proportion of variation controlled (%)	0.31	0.49	0.61	0.70

PC, Principal component

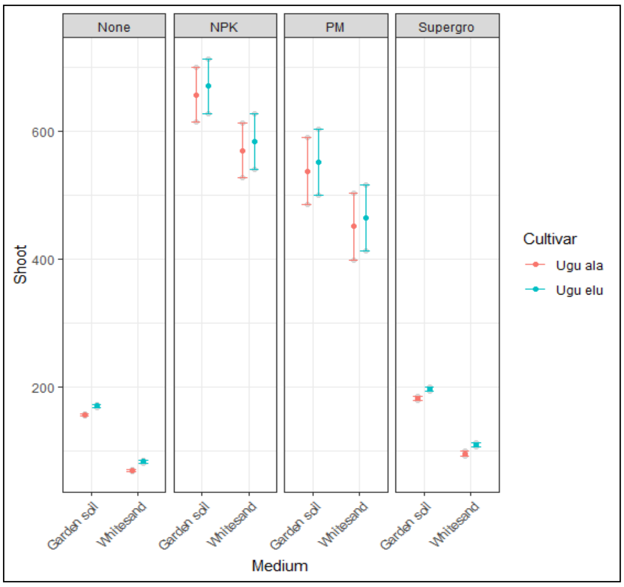

Figure 1. Mean plot of shoot weight (g per plant) of fluted pumpkin as affected by cultivar, growth medium, and amendment source.

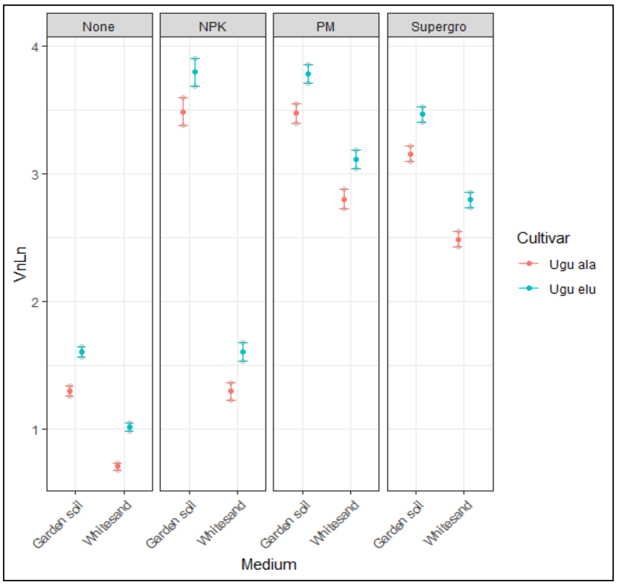

Figure 2. Mean plot of vine length (VnLn) (m) of fluted pumpkin as affected by cultivar, growth medium, and amendment source.

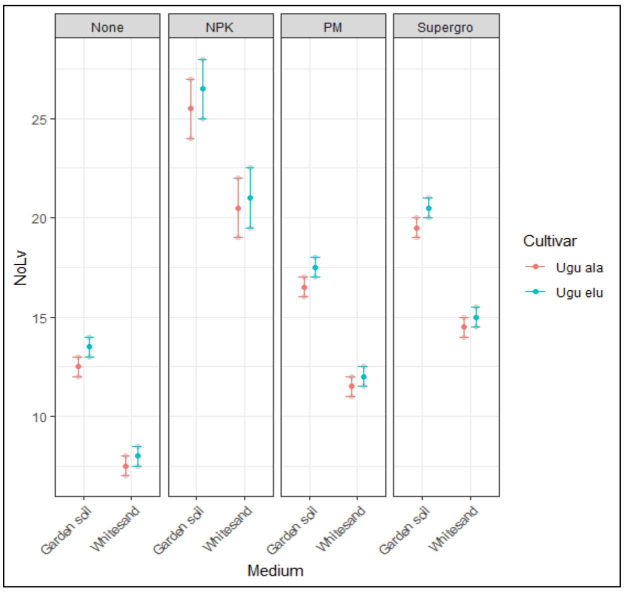

Figure 3. Mean plot of number of leaves per plant of fluted pumpkin as affected by cultivar, growth medium, and amendment source.

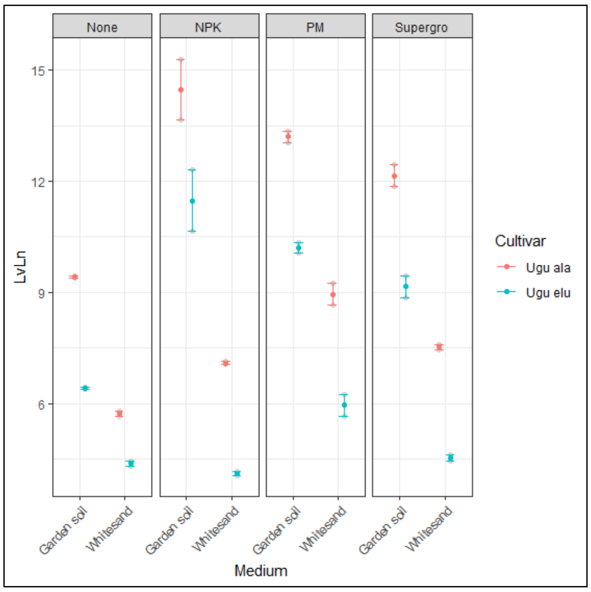

Figure 4. Mean plot of leaf length (cm) of fluted pumpkin as affected by cultivar, growth medium, and amendment source.

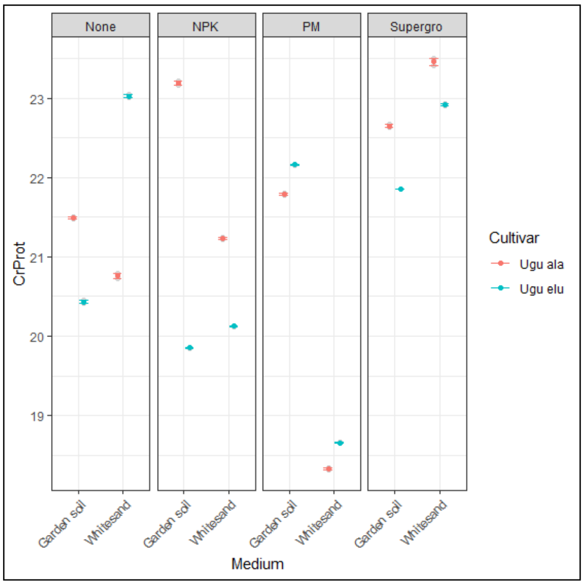

Figure 5. Mean plot of crude protein (%) of fluted pumpkin leaves as affected by cultivar, growth medium, and amendment source.

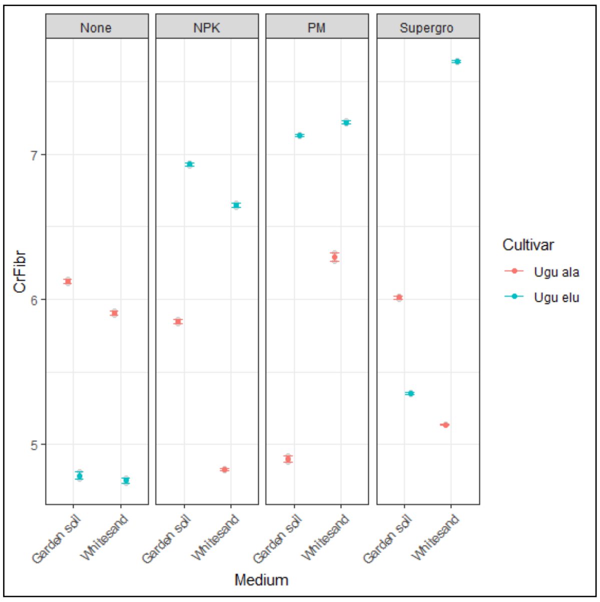

Figure 6. Mean plot of crude fibre (%) of fluted pumpkin leaves as affected by cultivar, growth medium, and amendment source.

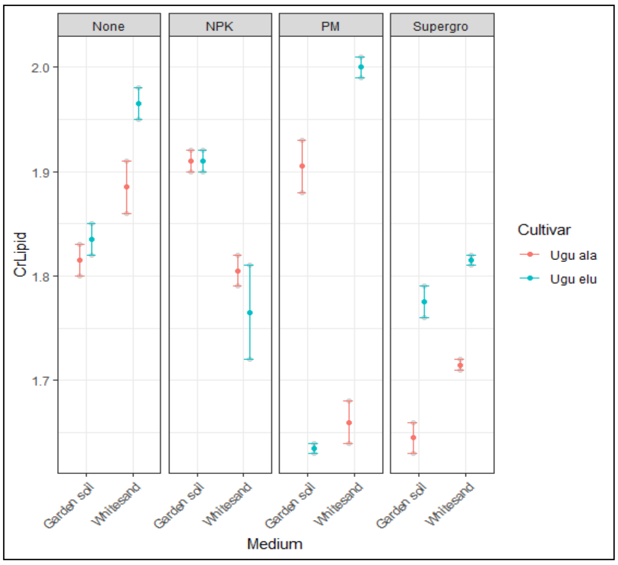

Figure 7. Mean plot of crude lipid concentration (%) of fluted pumpkin leaves as affected by cultivar, growth medium, and amendment source.

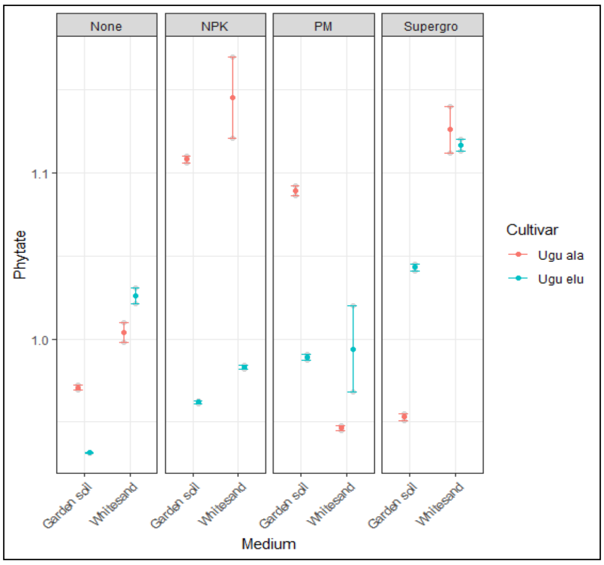

Figure 10. Mean plot of phytate content (mg/100g of fluted pumpkin leaves) as affected by cultivar, growth medium, and amendment source

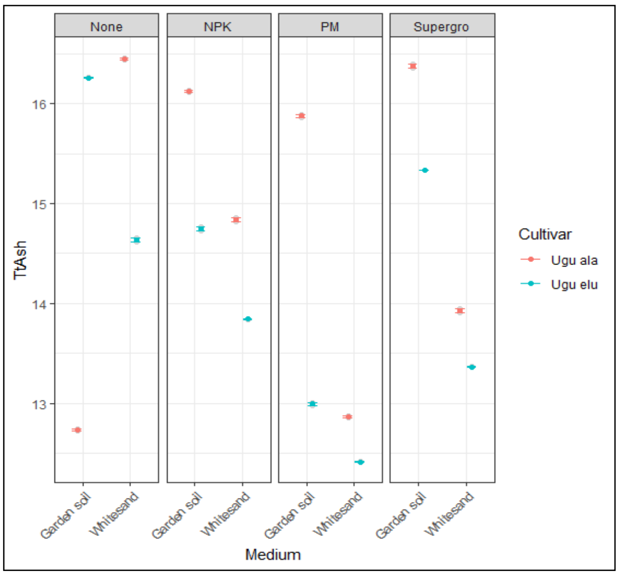

Figure 8. Mean plot of total ash content (%) of fluted pumpkin leaves as affected by cultivar, growth medium, and amendment source.

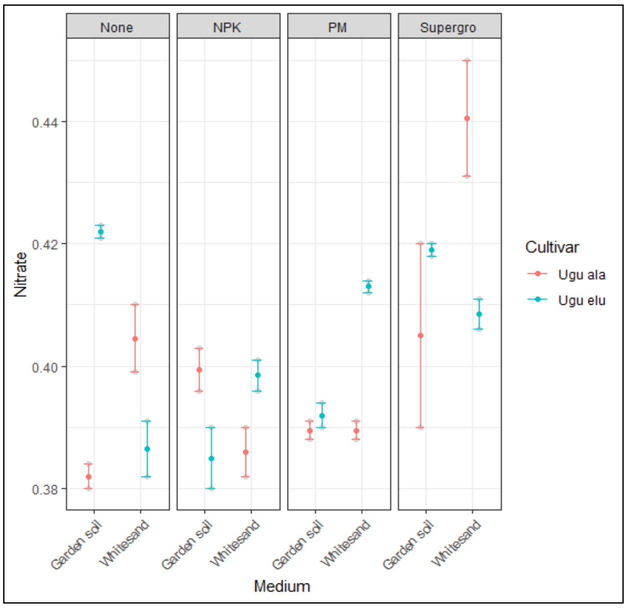

Figure 9. Mean plot of nitrate content (mg/100g of fluted pumpkin leaves) as affected by cultivar, growth medium, and amendment source.

those in white sand. Also, plants grown using NPK fertilizer and poultry manure recorded higher values than those from pots with supergro and the control treatments. Shoot weight ranged from ≈ 50 g to ≈ 650 g per plant for plants grown in white sand with supergro or no amendment to those grown in garden soil with NPK respectively. In the same vein, vine length ranged from < 0.5 m for *ugu ala* plants produced in white sand without amendment to ≈ 3.5 m for *ugu elu* plants produced in garden soil amended with NPK and poultry manure. Number of leaves per plant was also lowest (10 leaves) for *ugu ala* cultivar in white sand without amendment while *ugu elu* cultivar plants produced the highest of > 25 leaves per plant. A similar pattern to those obtained for shoot weight, vine length, and number of leaves per plant was also observed for leaf length except that *ugu ala* produced more leaves than *ugu elu* in all the research conditions (***Figure 4***).

Figures 5-10 of the means plots of crude protein, crude fibre, crude lipid, total ash, nitrate concentration, and phytate concentration did not reveal consistent patterns in the observed estimates for cultivar, growth medium and amendment source. Percentage crude protein ranged from < 15 to 23.5 for *ugu ala* plants grown in white sand amended with poultry manure and supergro respectively while crude fibre percentage ranged from < 5 for *ugu elu* plants grown without amendment to about 7.8 for *ugu elu* plants grown in white sand amended with supergro. Crude lipid contents were mostly higher in *ugu elu* plants, and ranged from about 1.625% to 2.0% found for *ugu elu* plants grown in garden soil and white sand respectively. *Ugu ala* cultivar plants consistently had higher total ash content except for the garden soil control treatments in which *ugu elu* plants had higher estimates. The nitrate concentration of the fluted pumpkin shoots ranged from 0.382 per 100 g in *ugu ala* plants grown in garden soil without amendment to 0.44 mg per 100 g observed for those grown in white sand with supergro amendment. Finally, phytate concentration (mg/100 g shoot) was lowest (about 0.93) for *ugu ala* grown in garden soil while *ugu ala* plants grown in white sand with NPK amendment had the highest phytate concentration of about 1.14.

The summary of the principal component analysis (***Table 3***) showed that the first four principal components (PCs) explained approximately 70% of the differences among the 16 treatments tested. The PCs 1, 2, 3, and 4 had Eigen values of 4.06, 2.35, 1.54 and 1.20 and accounted for 31, 18, 12, and 9%

of the differences respectively. Strikingly, PC 1 was characterized only by agronomic traits with loadings of 0.36, (for number of branches per plant), 0.37 (for shoot weight), 0.40 (for vine length and number of leaves per plant) and 0.43 (for leaf attributes of length and breadth). Conversely, PC 2 was characterized by nutritional quality traits total ash, crude fibre, phytate, and crude protein with components loadings of 0.39, -0.40, 0.43, and 0.54 respectively.

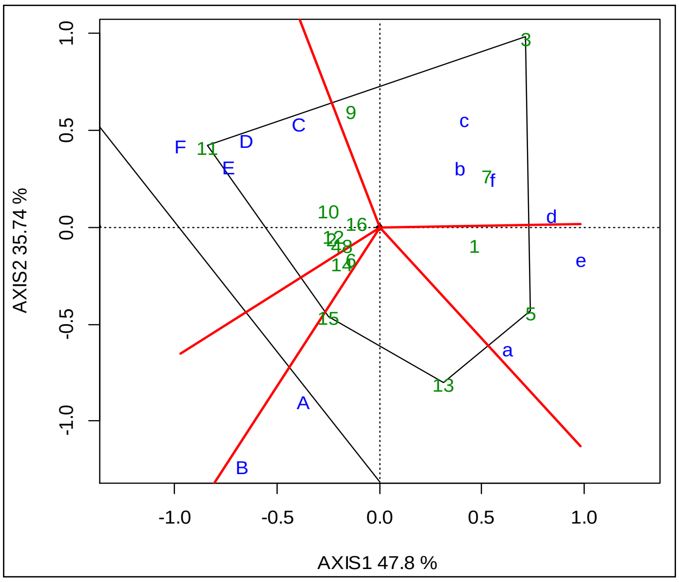

Figure 11. Association of treatment combinations (with accompanying key) with measured agronomic and nutritional quality traits of fluted pumpkin.

ID	Medium	Cultivar	Amendment
1	Whitesand	*Ugu ala*	Poultry manure
2	Whitesand	*Ugu ala*	SuperGro
3	Whitesand	*Ugu ala*	NPK
4	Whitesand	*Ugu ala*	None
5	Whitesand	*Ugu elu*	Poultry manure
6	Whitesand	*Ugu elu*	SuperGro
7	Whitesand	*Ugu elu*	NPK
8	Whitesand	*Ugu elu*	None
9	Garden Soil	*Ugu ala*	Poultry manure
10	Garden Soil	*Ugu ala*	SuperGro
11	Garden Soil	*Ugu ala*	NPK
12	Garden Soil	*Ugu ala*	None
13	Garden Soil	*Ugu elu*	Poultry manure
14	Garden Soil	*Ugu elu*	SuperGro
15	Garden Soil	*Ugu elu*	NPK
16	Garden Soil	*Ugu elu*	None
	Yield-trait combination (where Shootweight is taken as Yield)		
A	Shoot weight-Vine length		
B	Shoot weight-Number of branches/plant		
C	Shoot weight-Vine girth		
D	Shoot weight-Number of leaves/plant		
E	Shoot weight-Leaf length		
F	Shoot weight-Leaf breadth		
a	Shoot weight-Crude fibre		
b	Shoot weight-Crude lipid		
c	Shoot weight-Phytate		
d	Shoot weight-Crude protein		
e	Shoot weight-Total ash		
f	Shoot weight-Nitrate		

Table 4. Association of treatment combinations (with accompanying key) with measured agronomic and nutritional quality traits of fluted pumpkin.

Figure 11 and Table 4 is a biplot polygon view of the association of measured yield-trait combinations with 16 treatments designed in this study. The polygon view revealed four distinct sectors and associated the treatments with one or more measured traits. Sectors 1 and 2 were associated with agronomic traits while sectors 3 and 4 were associated with nutritional quality attributes. Sector 1 (clockwise) with treatment 3 as the vertex treatment also had treatments 9 and 7 as component treatments, and these are associated with crude lipid, crude protein phytate, and nitrate. Sector 2 composed of treatments 5 (at the vertex) and 1 is characterized by crude fibre and total ash. Sector 3 was composed by treatments 13 (the vertex treatment) and 15 and the treatments were associated with vine length and number of branches per plant. Sector 4 was composed of treatments 11 as the vertex treatment, with treatments 2, 4, 6, 8, 10, 12, 14, and 16 which were characterized by vine girth, number of leaves per plant, leaf length, and leaf breadth.

Discussion

The significant mean squares observed in cultivar, medium and amendment source, and their interactions for measured traits is an indication of substantial differences between the two cultivars, and between the two soil media, and among the amendment sources, and their interactions respectively in their impact on the measured agronomic traits, and that the interactions between these factors can have an even greater effect. This provides the possibility to make choices between/among the different sources of variations in the production of fluted pumpkin, and suggests that careful consideration should be given to the combination of these factors when attempting to optimize agronomic traits. Significant differences in the influence of sources and/or rates of fertilizer on growth, yield and nutritional properties of fluted pumpkin have been reported (Olatunji et al., 2012; Okeke et al., 2018; Idem et al., 2012). The results of this study can serve as a foundation for further research into the effects of different cultivars, mediums, and amendment sources on agronomic and nutritional quality traits of fluted pumpkin.

The fact that plants grown in garden soil consistently out-performed those in white sand for shoot weight, leaf length, and number of leaves per plant revealed the ability of garden soil to provide greater support to the growing vegetable. This could be due to the availability of nutrients in the garden soil compared to the white sand. This observation is comparable to the report of Idem et al. (2012). The inconsistent patterns observed in the proximate concentrations of pumpkin from the sixteen treatments indicated the role of interaction among the three factors employed in the study in the production of the measured nutritional quality traits. The fact that the principal component analysis identified measured traits as contributors to differences among the treatments is an indication that selections can be made among the 16 treatments based on the results of the principal component analysis. The fact that agro-morphological traits; except vine girth were identified as important to observed variation among the treatment suggested that agronomic traits are important in differentiating among treatments, while nutritional quality traits also play a role. This is especially evident in the high loadings of PC 2, which is strongly associated with nutritional quality traits. The results also indicated that there is considerable difference in the traits associated with the different treatments tested. This suggests that there are important differences in the agronomic and nutritional quality traits among these treatments, which could have implications for the quality of the food that is produced. This offers research opportunities to explore the differences in the traits associated with different treatments, and how these differences can be used to improve the quality of fluted pumpkin.

The biplot provided valuable insights into the various treatments and their associated traits, and can be used to optimize production processes and maximize yield-trait combinations. The importance of agronomic traits in fluted pumpkin has earlier been reported by Ezenwata et al. (2019) and Odiyi et al. (2014). Furthermore, the polygon view of the GYT biplot provides a case-by-case association of the 16 treatments with measured traits. Thus, treatments 2, 4, 6, 8, 10, 11, 12, 13, 14, 15 and 16 might be more useful in producing fluted pumpkin for agronomic considerations while treatments 1, 3, 5, 7 and 9 might could employed to improve nutritional values of the vegetable. There is a relationship between the degree of toxicity of food and nitrate concentration (Uddin et al., 2021). Thus, growing *ugu ala* in garden soil without amendments will most likely produce the safest pumpkin leaves and shoot for consumption.

References

Achebe, U. A., Udeora, S. N., Ilodibia, C. V. (2014): Growth and Yield Response of Telfairia Occidentalis (HOOK F.) as affected By Different Rates of Poultry Manure. https://www.ajol.info/index.php/naj/article/view/110057 /99790. Visited 2021/January/5.

Adediran, J. A., Akande, M. O., Oluwatoyinbo, F. I., Buari K. W., Yusuf, I. O. (2003): Soil amendments affect the release of P from rock phosphate and the development and Yield of Okra. Journal of Vegetable Crop Production. 19, 3-9.

Akanbi, W. B., Adebayo, T. A., Togun, O. A., Adeyeye, A. S., Olaniran, O. A. (2007): The use of compost as foliar spray nutrient source and botanical insecticide in *Telfairia occidentalis*. World Journal of Agricultural Science. 3, 642-652.

Akoroda, M. O. (1990): Seed Production and breeding potential of fluted pumpkin (*Telfairia occidentalis*). Euphysical. 49(1), 25-32.

Amao, P. A., Amujoyegbe, B. J., Akinpelu, B. A., Ojo, O. E., Oyedele, D. J., Amao, I. O. (2018): Nutrient Quality Studies of Fluted Pumpkin (*Telfairia occidentalis* Hook. F) Leaves as Influence byFertilizer Microdosing and Micro-Dosing Time. Asian Journal of Advances in Agricultural Research.6(4), 1-10.

Ezenwata, I. S., Makinde, S. C. O., Ogbuoka, R. C., Onyemeka, R. M., Anyaegbu, C. F., Oyetunji, O. S. (2019): Analysis of variation among genotypes of fluted pumpkin (*Telfairia occidentalis* Hook. F) using factor analysis and principal component analysis (PCA). International Journal of Engineering Applied Sciences and Technology. 4(7), 211-216.

Idem, N. U. A., Ikeh, A. O., Asikpo, N. S., Udoh, E. I. (2012): Effect of organic and inorganic fertilizer on growth and yield of fluted pumpkin (*Telfaria occidentialis* Hook F.) in Uyo, Akwa Ibom State, Nigeria. Journal of Agriculture and Social Research. 12(2), 74-84.

Odiyi, A. C., Fayeun, L. S., Makinde, S. C. O., Adetunji, A. T. (2014): Analysis of variation among fluted pumpkin (*Telfairia occidentalis*) accessions by factor analysis and principal component analysis. Canadian Journal of Plant Breeding.2(2), 80-86.

Okeke, V. N., Willie, E. S., Eteng, E. U., Akinmutimi, A. L. (2018): Comparative Effect of Chemical and Organic Amendments on Telfairia Occidentals in Coastal Plain Sands Derived Soil. Direct Research Journal of Agriculture and Food Science. 6(8), 197-207.

Olatunji, O., Ayuba, S.A., Anjembe, B.C., Ojeniyi, S.O. (2012): Effect of NPK and Poultry manure on Cowpea and soil nutrient composition. Nigerian Journal of Soil Science. 22(1), 108-113.

Osadebe, V. O., Echezoma, B. C., Bakare, S. O. (2014): Effect of weed management and cutting frequency on the leaf and biomass production. Journal of Agriculture and Environmental science. 3(4), 508-5021.

SAS Institute (2011)**:** SAS Institute Inc., SAS 9.1.3 Help and Documentation, Cary, NC: SAS Institute Inc., 2002-2004.

Uddin, R., Thakur, M. U., Uddin, M. Z., Rabiul Islam, G. M. (2021): Study of nitrate levels in fruits and vegetables to assess the potential health risks in Bangladesh. Scientific Report, 11, 4704. https://doi.org/10.1038/s41598-021-84032-z.

Ugwu, F. J. (2001): Studies on the anthology of the disease of fluted pumpkin in Nsukka Local Government of Enugu State. M.Sc thesis submitted to Department of Botany, *University of Nigeria, Nsukka*.