OPEN ACCESS
Global Journal of Research in Agriculture & Life Sciences
ISSN: 2583-4576 (Online)
Volume 04 | Issue 05 | Sept.-Oct. | 2024
Journal homepage: https://gjrpublication.com/gjrals/

Original Research Article

Implication of Planting Media / Initial Soil Nutrient to the Quality Parameters of Flour Produced from Some Selected Yam Varieties for Processing and Export

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DOI: 10.5281/zenodo.13890553 **Submission Date:** 25 Aug. 2024 | **Published Date:** 04 Oct. 2024

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Abstract
To combat insufficient space for planting food, insecurity and to ensure the availability of adequate food nutrients crops are grown in different media. In this study, three yam varieties: *Dioscorea alata, Dioscorea rotundata, and Dioscorea cayennesis* were sourced from a local market in Ebonyi State and divided into two portions. One portion was processed into flour and was evaluated the second portion of the yam was planted in two different planting media: soil and bag and their nutrient composition was assessed. The result generated the mineral composition of Mg, P, K of the yam samples were better improved and retained when planted in direct soil than in bags, except DR in which the P content was better retained in DRB than DRS. The mineral composition of calculi is retained better when planted in bags than in direct soil except in DR.

Keywords: Planting media, direct soil, bag planting, varieties. *Dioscoreaalata, Dioscorearotundata, and Dioscoreacayennesis.*

INTRODUCTION
Over the years, yam planting has been done in the soil by tilling, weeding, fertilizer application, and other agronomic practices adopted to get a better yield and boost nutritional quality and income generation. The availability of the required nutrients in the soil and applying fertilizer or poultry manure make for high yield and positive implications in the quality parameters. When utilizing natural fertilizer, keep in mind that mineral components potentially available to plants are released gradually over 2-3 years, so natural fertilization cannot be administered to a given soil every year Wieremiej 2017.

Poultry manure is traditionally regarded as waste and its application to cropstorecycle soil nutrients mainly, nitrogen (N), phosphorus (P), and potash (K) Hoover *et al.*, 2019.Poultry manure contains many nutrients and elements, including nitrogen, phosphorus, potassium, copper, zinc, calcium, cobalt, iron, selenium, molybdenum, manganese, and boron. When compared to other types of animal waste, poultry dung shows the best Dróżdżet *al*., (2020) higher levels of nitrogen, phosphorus, and calcium. This can be supported by the findings ofthose who reported that chicken manure is more highly sourced than other animal manures (e.g. pig manure, kraal manure) because of its high content of nitrogen, phosphorus, and potassium Schjegel, (1992), Dikinya, and Mufwanzala (2020). The composition of these elements varies based on breeding system, seasonality, breed type, and production group.

In the ecosystem, the application of poultry manure is consideredinthe crop yield, soil nutrients, and water quality, as well as the economic impact of integrating poultry manure for cropping. The overall results of poultry manure on crop yield, when compared to inorganic fertilizer application, depend on soil types, tillage, method of application, and cropping system. Lin *et al*., 2019.Recently due to a lack of planting space, food insecurity, and hunger, some crops are now been planted in different media. The growth and yield of crops after planting is determined by the initial nutrient content of the soil and the availability of more nutrients during the period of planting to maturity.

Flour is the finely ground cereal grains or other starchy portions of plants, used in various food products and act as a basic ingredient of baked goods. Flour is the basic ingredient for the processing of baked products, and it is also exported, whichever way it must be of good quality to meet the standard of the export market. The study will consider the quality parameters of different varieties of yam flour planted in different media for food production and export market.

MATERIAL AND METHODS

Three yam varieties, which are *Dioscorea alata*, *Dioscorea cayennesis*, and *Dioscorea rotundata*, were sourced from a local market in Ebonyi State. The yam samples were divided into two portions. One portion was processed into flour by washing, peeling, and size reduction for easy drying. They were later dried at $60^{O}C$ for 10 hours and milled into flour after drying. The functional properties of the flour were evaluated. The second portion of yam was planted in two different media of soil and bags. Before planting the initial soil nutrient, poultry manure was investigated. The harvested samples were processed into flour, and the mineral; composition, and functional properties were investigated again. Water and oil absorption capacities were determined by the method of Abbey and Ibeh (1988), while the bulk density, swelling index and foam capacity were determined using the method of Onwuka and Onwuka (2005)., Mineral content was determined by Absorption Spectrophotometer as described by AOAC (2005).

Data generated were subjected to statistical analysis using SPSS 22.0 and the charts were plotted with graph pad prism 5.

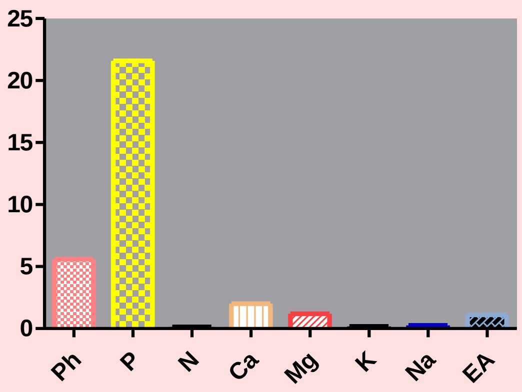
RESULTS AND DISCUSSION

Table 1: Textural class of the soil

SAMPLES	SAND	SILT	CLAY	
ISC	69.40	22.60	8.0	Sandy loam
FSC	74.40	13.26	14.34	Sandy loam
FSCB	61.40	17.20	21.40	Sandy loam

Key; ISC Initial soil class, FSC final soil class and FSCB final soil class in bag

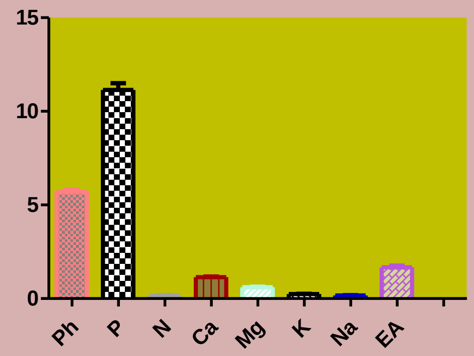
Table 1: Represents the textural class of the soil samples (sandy loam) utilized in the experiment. Soil texture assesses soil quality in tropical agro ecosystems, it defines the granulometric fraction and influences soil function which changes the intensity of ecological soil processes (Vinhal-Freitas *et al.*, 2017). The textural class is also important for soil aggregation and porosity, assisting in the gas exchange between the soil and the atmosphere. According to the table, there isa high proportion of sand across the textural class of the soil samples (sandy loam) when compared with the silt and clay. The Final soil class (FSC) has the highest proportion of sand (74.40) followed by the Initial soil class (ISC) (69.40) and the Final soil class in the bag (FSCB) (61.40) the least. The Final soil class (FSC) rank the lowest in the silt content across the textural class of the soil samples with a proportional level of (13.26) followed by the Final soil class in the bag (FSCB) (17.20) and the Initial soil class (ISC) (22.60) being the highest. As regards the clay across the soil samples, the Final soil class in the bag (FSCB) scores the highest with the proportional level of clay (21.40) followed by the Final soil class (FSC) (14.34) and Initial soil class (ISC) (8.0) the least.



Fig;1 Chemical composition of initial soil sample (% and Cmol.kg-1)

Fig. 1: Represents the chemical composition of the initial soil sample and their level of concentrations. According to the figure, the pH level of the initial soil sample is acidic in nature. Phosphorus was ranked highest in the level of concentration when compared with the other chemical compositions such as N, Ca, Mg, K, Na, and EA in the soil.

Fig. 2: Represents the chemical composition of the poultry manure and their level of concentrations. Soil pH is a key indicator of a soil's chemical characteristics, influencing crop growth and nutrient uptake. According to the chart, the concentration of the pH level of the poultry manureis 8.00% which is basic. This conforms with the finding of Dikinya, O., and Mufwanzala, 2010 whose Ph value of dried poultry manure was recorded at 7.9%. In a solution culture experiment, the concentrations of N, P, K, Ca, Mg, and Mn generally increased in rice leaves with increasing pH values, while, Fe, B, Zn, and Mnhave been shown to decrease at high pH levels Alam *et al.*, 1999. The concentration level of phosphorus in the poultry manure is ranked highest when compared with the other chemical compositions such as N, Ca, Mg, K, and Na. In the reverse trend, there was no presence of EA in the poultry manure.



Fig;1 Chemical composition of final soil sample (% and Cmol.kg-1)

Fig. 3: Represents the chemical composition of the final soil sample and their level of concentrations. According to the chart, the level of concentration of the pH value in the final soil sample is acidic.

The application of poultry manure caused an increase in the Ph. That is a decrease in the acidic level of the soil. This conforms with the work of Kobierski *et al.,* 2017 who reported an increase in soil samples from 5.00 to 5.59 after the application of poultry manure, the increase recorded can be traceable to the high Ph level of poultry manure. This will thus lead to a yield increase *Manickam et al.,* 2015, Albdu *et al* 2018, an increase in cation exchange capacity (CEC) and an improved water holding capacity as well as soil structure Albdu *et al*., 2018.

The phosphorus concentration level in the final soil sample is far above the concentration of every other chemical composition of the soil sample such as N, Ca, Mg, K, Na, and EA. The nutrients evaluated here are depleted compared to the initial soil nutrients and the nutrients in the poultry manure. The crop must have utilized the nutrient and hence the low value identified in the final stage.

Table 2: Mineral composition of yam samples planted in soil and in bags

Sample	*Calcium*	*Potassium*	*Magnesium*	*Phosphorous*
DA	57.55±1.26b	270.00±4.32f	71.38±1.14a	121.50±2.08a
DC	55.80±0.88c	254.00±1.41h	60.45±0.74c	117.25±0.96b
DR	61.85±1.22a	259.25±1.71g	69.58±0.77b	115.50±1.29c
DAS	36.60±0.00h	380.48±0.02b	53.10±0.12f	66.27±0.05d
DAB	40.53±0.61d	372.11±0.13d	52.53±0.02g	58.70±0.02g
DCS	37.70±0.23g	386.76±0.05a	53.40±0.02ef	64.20±0.04e
DCB	39.30±0.23e	360.30±0.04e	51.53±0.03h	62.06±0.06f
DRS	38.35±0.29f	375.32±0.04c	55.03±0.03d	61.60±0.02f
DRB	37.20±0.23gh	370.85±0.04d	54.21±0.01e	63.79±0.02e

Values are mean± SD of 3 replications. Means within a column with the same superscripts were not significant difference (P>0.05). Key: DA (Dioscoreaalata). DC (Dioscorea cyennesis), DR (*Dioscorea rotundata*), DAS (*Dioscorea alata*) planted in the soil, DAB (*Dioscorea alata*) planted in the bag, DCS (Dioscorea cyennesis) planted directly in the soil, DCB (Dioscorea cyennesis) planted in bag, DRS (*Dioscorea rotundata*) planted directly in the soil and DRB (*Dioscorea rotundata*) planted in the bag.

Table 2: Presents the mineral composition of the initialyam samples and the composition obtained after planting in the direct soil and bags. The result showed that there were significant differences ($p<0.05$) across the mineral composition of the different yam samples planted in direct soil and bags. From the table, the mineral composition of the initial yam samples (control) was higher than that of the yam samples planted in direct soil and bags except in potassium. This tends to suggest that there are mineral reduction of calcium, magnesium and phosphorus in the yam samples planted in direct soil and bags when compared with the initial yam samples (control). The calcium content recorded in this study is lower than the values reported by Akin-Idowu, *et a*l. (2009) whose values ranged from 13. 97 to 98.40.

Potassium is an essential nutrient for plant growth, which activities involve the movement of water, nutrients and carbohydrates. Other include activation of enzymes found within the plant, which affect protein, starch and adenosine triphosphate (ATP) production. Production of ATP affects photosynthesis and if not guided will cause stunted growth in plants Oosterhuis, *et al*., 2014.

Samples planted in direct soil have a higher level of potassium content than the initial sample and those planted in the bag. The high potassium content recorded may be a result of the soil moisture, soil aeration oxygen level and tillage. Higher soil moisture usually means greater K availability. Increasing soil moisture increases K's movement to plant roots and enhances availability. Also, the potassium content of the sample planted in the soil and bags is higher than the initial potassium content. This can be attributed to the high level of potassium content of the poultry manure.

The calcium. Phosphorus and magnesium showed a decrease in value after planting with poultry manure compared to the initial yam samples before planting. This is in line with the finding of Ezeocha*et al*., (2014) who recorded a decrease in phosphorus, calcium and magnesium in yam samples planted with 3t/h and 4t/h of poultry manure compared to zero treatment with higher values of minerals.

In the reverse trend, the mineral composition of potassium in the initial soil samples (control) were lower compared with the potassium composition of the yam samples planted in direct soil and bags. This tends to suggest that there was an improvement in the level of potassium composition in yam samples planted in direct soil and bags when compared with the initial yam samples (control).

Similarly, the mineral composition of calcium in DAS and DCS with the values (36.60±0.00) and (37.70±0.23) were lower compared with the values (40.53±0.61) and (39.30±0.23) obtained from DAB and DCB respectively. This showed that DAB and DCB retain more nutritional calcium than DAS and DCS when compared with the control with the values (57.55±1.26) for DA and (55.80±0.88) for DC respectively. In the reverse trend, the mineral composition of calcium in DRS with the value (38.35±0.29) is higher than that in DRB with the value (37.20±0.23). This tends to suggest that DRS retains more nutritional calcium than DRB when compared with the control (61.85±1.22).

The mineral composition of magnesium in DAS, DCS and DRS with the values (53.10±0.12), (53.40±0.02) and (55.03±0.03) were higher than that obtained in DAB, DCB and DRB with the values (52.53±0.02), (51.53±0.03) and (54.21±0.01). This tends to suggest that DAS, DCS and DRS retain more nutritional magnesium than DAB, DCB and DRB when compared with the control with values (71.38±1.14) for DA, (60.45±0.74) for DC and (69.58±0.77) for DR respectively.

The mineral composition of phosphorus in DAS and DCS with the values (66.27±0.05) and (64.20±0.04) were higher compared with the phosphorus in DAB and DCB with the values (58.70±0.02) and (62.06±0.06) respectively. This tends to suggest that DAS and DCS retains more phosphorus than DAB and DCB when compared with the control with the values (121.50±2.08) for DA and (117.25±0.96) for DC respectively. Conversely, the mineral composition of phosphorus in DRB with the value (63.79±0.02) was higher than the phosphorus obtained in DRS with the value (61.60±0.02). This tends to suggest that DRB retains more phosphorus than DRS when compared with the control (115.50±1.29).

The mineral composition of potassium in DAS, DCS and DRS with the values (380.48±0.02), (386.76±0.05) and (375.32±0.04) were higher than the mineral composition of potassium obtained in DAB, DCB and DRB with the values (372.11±0.13), (360.30±0.04) and (370.85±0.04). This tends to suggest that the mineral composition of potassium obtained in DAS, DCS, and DRS had a better improvement in nutritional potassium than that obtained in DAB, DCB and DRB when compared with the control with the values (270.00±4.32) for DA, (254.00±1.41) for DC, and (259.25±1.71) for DR respectively.

Table 3: Functional properties of the initial yam samples and that obtained after planting in direct soil and bags

Samples	BK %	OAC %	WAC %	SI %	GT %
DA	0.87±0.03[b]	7.36±0.46[e]	6.53±0.16[g]	6.18±0.13[ab]	83.98±7.32[a]
DAS	0.84±0.09[b]	7.34±0.25[e]	5.52±0.30[h]	5.28±0.24[d]	84.10±1.41[a]
DAB	0.66±0.10[c]	7.21±0.37[e]	6.38±0.69[g]	5.68±0.19[c]	84.83±1.87[a]
DC	0.87±0.01[b]	26.51±0.01[bc]	38.00±0.00[e]	6.00±0.00[ab]	62.00±0.00[bc]
DCS	0.92±0.02[ab]	27.55±0.00[a]	41.49±0.02[d]	5.55±0.00[cd]	64.53±0.04[bc]
DCB	1.0±0.01[a]	21.52±0.03[d]	66.03±0.04[a]	3.08±0.11[f]	71.22±0.00[b]
DR	0.87±0.02[b]	26.06±0.08[bc]	32.47±0.05[f]	7.14±0.03[a]	60.48±0.04[d]
DRS	0.95±0.00[ab]	23.05±0.07[c]	61.08±0.11[b]	4.30±0.03[e]	68.10±0.14[bc]
DRB	0.92±0.02[ab]	27.00±0.00[b]	43.06±0.08[c]	5.42±0.03[cd]	66.40±0.03[bc]

Values are mean± SD of 3 replications. Means within a column with the same superscripts were not significant difference (P>0.05). Key: DA (Dioscorea alata). DC (Dioscorea cyennesis), DR (*Dioscorea rotundata*), DAS (*Dioscorea alata*) planted in the soil, DAB (*Dioscoreaalata*) planted in the bag, DCS (Dioscoreacyennesis) planted directly in the soil, DCB (Dioscorea cyennesis) planted in a bag, DRS (*Dioscorea rotundata*) planted directly in the soil and DRB (*Dioscorea rotundata*) planted in the bg.

Table 3: Presents the functional properties of the initial yam samples (control) and those obtained after planting in direct soil and bags. According to the table, statistical differences (p<0.05) exist in the functional properties of the initial yam samples (control) across the varieties except the bulk density (BK), oil absorption capacity (OAC) in DC (26.51±0.01) and DR (26.06±0.08), and the swelling index (SI) in DA (6.18±0.13) and DC (6.00±0.00).

Compared with the control, the bulk density (BK) in DAS (0.84±0.09) and DRS (0.95±0.00) is greater than DAB (0.66±0.10) and DRB (0.92±0.02). This tends to suggest that DAS and DRS retain and improve better in their bulk density than DAB and DRB respectively when compared with the control with the values (0.87±0.03) for DA and (0.87±0.02) for DR. In the reverse trend, the bulk density (BK) in DCS (0.92±0.02) is less than the bulk density (BK) in DCB (1.0±0.01) and this tends to suggest that DCB improves better in bulk density (BK) than DCS when compared with the control with the value (0.87±0.01) for DC.

The oil absorption capacity (OAC) in the DCS (27.55±0.00) is greater than that in DCB (21.52±0.03) while the oil absorption capacity (OAC) in DRS (23.05±0.07) is less than that obtained in DRB (27.00±0.00). This tends to suggest that DCS has more oil absorption capacity (OAC) than the DCB while DRB has more oil absorption capacity (OAC) than that obtained in DRS when compared with the control with the values (26.51±0.01) for DC and (26.06±0.08) for DR. In the reverse trend, the oil absorption capacity (OAC) in DAS (7.34±0.25) and DAB (7.21±0.37) were statistically (p>0.05) the same when compared with the control with the value (7.36±0.46) for DA.

The water absorption capacity (WAC) in the DAS (5.52±0.30) is less than that in the DAB (6.38±0.69) and the water absorption capacity (WAC) in DCS (41.49±0.02) is less than that in the DCB (66.03±0.04). This tends to suggest that the water absorption capacity (WAC) in DAB and DCB had better improvement than that obtained in DAS and DCS when compared with the control with the values (6.53±0.16) for DA and (38.00±0.00) for DC. In the reverse trend, the water absorption capacity (WAC) in DRS (61.08±0.11) is greater than that in DRB (43.06±0.08). This tends to suggest that DRS had a better improvement in water absorption capacity than that obtained in DRB when compared with the control with the value (32.47±0.05) for DR.

The swelling index (SI) in the DCS (5.55±0.00) is greater than that in the DCB (3.08±0.11) and the swelling index (SI) in DRS (4.30±0.03) is less than that in the DRB (5.42±0.03). This tends to suggest that DCS and DRB had a better swelling index (SI) than that obtained in the DCB and DRS when compared with the control with the values (6.00±0.00) for DC and (7.14±0.03) for DR. In the reverse trend, the swelling index (SI) in the DAS (5.28±0.24) and DAB (5.68±0.19) are statistically (p>0.05) the same when compared with the control with the value (6.18±0.13) for DA.

The gelation temperature (GT) in the DCS (64.53±0.04) is less than that in the DCB (71.22±0.00) and the gelation temperature (GT) in DRS (68.10±0.14) is greater than that in the DRB (66.40±0.03). This tends to suggest that DCB and DRS had a better gelation temperature obtained in the DCS and DRB when compared with the control with the values (62.00±0.00) for DC and (60.48±0.04) for DR. In the reverse trend, the gelation temperature in the DAS (84.10±1.41) and DAB (84.83±1.87) are the same statistically (p>0.05) when compared with the control with the value (83.98±7.32) for DA.

CONCLUSION

According to the result:

- Table 1: the textural class of the soil samples {initial soil class (ISC); final soil class (FSC); and the final soil class in bags (FSCB)} is dominated by sand

According to the figures:

- ✓ The pH level of the initial soil sample is acidic and phosphorus ranked highest in concentration over the other chemical compositions.
- ✓ The pH level of the poultry manure is basic and phosphorus ranked highest in concentration over the other chemical compositions.
- ✓ The pH level of the final soil sample is acidic and phosphorus still ranked highest in concentration over the other chemical compositions.

- Table (2) showed that:
- ✓ The mineral composition of Mg, P, and k of the yam samples were better improved and retained when planted in direct soil than in bags except DR in which the P content was better retained in DRB than DRS.
- ✓ The mineral composition of calcium is retained better when planted in bags than in direct soil except in DR.

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CITATION
Kanu A.N, Nwohu O.N, Njoku R.N, Onwuziribe C.S, & Omodamiro R.M. (2024). Implication of Planting Media / Initial Soil Nutrient to the Quality Parameters of Flour Produced from Some Selected Yam Varieties for Processing and Export. In Global Journal of Research in Agriculture & Life Sciences (Vol. 4, Number 5, pp. 78–83). https://doi.org/10.5281/zenodo.13890553