Growth Performance of *Telfeira occidentalis* (Hook F.) In Fresh and Weathered Soil-less Spent Mushroom Substrate (SMS) In Home Garden

Nmom, F. W., Agbagwa, S. S. and Worlu, C. W.
Rivers State University, Nkpolu-Oroworukwo, P. M. B. 5080, Port Harcourt
samuelagbagwa@gmail.com

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Abstract
Telfeira occidentalis (Hook F), commonly known as fluted pumpkin is a staple leafy vegetable, grown and cherished for its nutritious leaves and seeds in the Southern and Eastern Nigeria. It is implicated with several medicinal importance in traditional medicines; which is the prompting of this study designed to investigate the use of soil-less Spent Mushroom Substrate (SMS) to enhance the growth of the vegetable. The method of Oyebamij et al was adopted to investigate and evaluate the germination, growth and general luxurious vigour of the vegetable in the period of study. Results obtained revealed that all the substrates used (SMS and loamy soil – control) were in acidic state. It also revealed that the SMS contained more nutrient elements than the control. Similarly, the results revealed that seed germination was faster and highest in the soiless SMS, a clear conformation with scholarstic advocacy for the use of SMS as a soiless culture system to support efficient water usage by plants and ensure product quality for agricultural sustainability.

Key Words: *T. occidentalis, Soil-less Culture, Fresh and Weathered Spent Mushroom Substrate (SMS), Loamy Soil.*

INTRODUCTION

Telfeira occidentalis (Hook F.) is an essential tropical leaf and seed vegetable crop, a family member of the cucubitaceae. It is indigenous to Southern and Eastern regions of Nigeria (Akoroda, 1990). *T. occidentalis* is commonly known as fluted gourd or pumpkin and cultivated for its culinary and medicinal purposes (Agwa *et al.,* 2018). It is variously known by different ethnic group in Nigeria, such as Ugu (Ibo); Ewe Awokoro (Yoruba); Kabewa (Hausa) and Ikon-Ubong (Efik and Ibibio) (Nwanna *et al.,* 2008). It is reported that the seeds are high in protein and fat as such can contribute to a well-balanced diet (Nwite, *et al.,* 2012). They also affirmed that fluted pumpkin is a recurring subject in Igbo folklore as a blood builder with the potential for preventing and healing of some notable ailments (Fubara-Manuel *et al.,* 2012).

It is a favourite vegetable, highly nutritious and reported to contain some essential minerals such as calcium, potassium, magnesium, iron, folic acid; as well as some vitamins such as vitamins A, C and K. These altogether are reported to prevent cancer and reduce cholesterol levels (Akang *et al;* 2010; Adegenwa *et al.,* 2011); Udousoro and Etuk, 2012 and Ndor *et al.,* 2013).

Egbekan *et al.* (1998) and Balogun *et al.* (2006) also reported that the plant contains considerable amounts of some anti-nutrients such as phytic acid, saponin and tannin which help to enhance health benefits.

Telfeira occidentalis requires well-drained loamy soil, rich in organic matter, with soil pH of 4.0 – 6.0. It also requires certain mineral nutrients such as nitrogen, phosphorus and potassium, hence nitrogen promotes green growth with numerous vines and leaves (Olaniyi and Odedere, 2009; Habibi *et al.*, 2011).

The crop prefers loose, friable with ample humus and under shade (Fubara, 1983; Okoro, 2006). However, the soils of the southern and Eastern Nigeria where the vegetable is grown in surplus have movement of gravitational water running slow due to poor permeability that leads to surface run-offs with high evaporation of the rainfall in which only small fractions perculates into the root zone to sustain plant growth; the situation that leads to nutrient deficiency (Fubara, 1983 and Opuwaribo, 1990). This condition is not always very common to find which could make the crop to grow in less favourable condition (Putra and Yuliando, 2015).

However, nitrogen is reported to be essential for adequate vegetation of the crop and should ideally be made available to the crop in the form of manure applied either before planting or in the process of growth (Akanbi *et al.*, 2007; Olaniyi and Odedere, 2009).

This implies that soil enhancement is paramount. The soil enhancement can be achieved by the use of field inventory (inorganic fertilizers), but these are not desirable because of their residual effects and consumer concerns (Nmom and Ajuru, 2020). As a result of that, organic soil enhancement will make a better alternative; such as the use of soilless culture system with Spent Mushroom Substrate (SMS) for soil enhancement, hence it is reported to be rich in nitrogen, phosphorus, potassium to mention but a few (Onwueme and Schippers, 2002, Putra and Yuliando, 2015).

Spent mushroom substrate (SMS) is the organic material on which mushroom graos for a period of several weeks and are removed from mushroom house when the substrates get exhausted of nutrients to support mushroom production (Weber, 1999). The SMS could be 'fresh', if disposed immediately after mushroom cropping from mushroom house; or weathered, if allowed for several weeks or months, over the windows for further composting before use (Lohr & Coffey, 1987; Peter Oei, 2007).

It is reported that SMS contains high organic matter which allows soil to retain moisture in dry season and shed it during the wet season (SMS Brochure, 2006). According to Levanon and Danai (1995), the organic content of SMS improves the soil structure and buffer crops from extremities. They also reported that SMS releases nitrogen slowly to the plant acting as sponge in gravel and creating air spaces in clay soils, permitting them to drain.

In 2006, it was reported in SMS Brochure that SMS is weedfree in nature due to extensive composting and pasteurization that kill weed seeds and prevent them from entering the product. Chorover *et al.* (2000) also reported that SMS is a rich source of nitrogen, carbon and other essential elements which altogether make it suitable for SMS to support luxurious plant growth. Robbins *et al.* (1986) and Samnath Roy *et al.* (2015) suggested that SMS can be used as a very good soil condition for the cultivation of fruits, foliage crops, flowers and vegetables, such as fluted pumpkin.

There are numerous reasons why SMS is advocated as organic fertilizer; They include:-

a) Spent Mushroom Substrate has high water and nutrient holding capacity.
b) There is no nitrogen drawdown problem, unlike wood and paper wastes; SMS has already been supplemented with nitrogen.

c) Absence of heavy metals. This reduces consumer concerns. SMS supports plant growth and it is a good soil amendment for farming.
d) It is consistently, formulated and homogenous.
e) It does not leach from the ground, but remains in soil, and if applied correctly, it does not contribute to groundwater pollution, unlike field inventory (SMS Brochure, 2006).

The drive to improve the cultivation of fluted pumpkin will benefit from using SMS as a source of soil enhancement. It is therefore on this premise that this study is designed to use spent mushroom substrate as source of enhancement of soil quality as soil-less system in growing the vegetable in home garden setting for agricultural sustainability.

MATERIALS AND METHODS

Sources of Samples: The study was carried out at Rivers State University, Port Harcourt, Nigeria. The spent mushroom substrate (SMS) was obtained from Dilomat farm and services limited; situated in the University; while the pumpkin seeds were procured from Eleme market, in Port Harcourt.

The loamy soil used in the study was obtained from the University demonstration farm. The size of the experimental polyethene bags measured 27 x 12cm. All the samples and materials were assembled at the University botanical screen house, where the study was carried out.

Seed Planting: Into experimental polyethene bags, containing 2kg of loamy soil, each were sown 2 seeds of fluted pumpkin and into a total of 10 bags. Altogether, 20 seeds were sown. The same procedure was followed in setting up the planting into soil less SMS experiment. This implies that another sets of experiments were set up. The experimental polyethene bags contained 2kg of fresh and weathered SMS respectively. In each of these sets, 2 seeds per bag were sown into 10 bags of each SMS (fresh and weathered). Altogether, 3 sets of experiments were set up. The experimental polyethene bags contained 2kg of fresh and weathered SMS respectively. In each of these sets, 2 seeds per bag were sown into 10 bags of each SMS (fresh and weathered). Altogether, 3 sets of experiments were set up with the loamy soil serving as a control. All the experimental bags were variously performed for adequate aeration and they were watered at four days interval for efficient water usage. Observation for germination followed thereafter.

Percentage Germination: The method of Oyebamij *et al.* (2019) was adopted to evaluate the rate at which germination of the seeds occurred from the experimental bags and evaluated as:

$$\% \text{ germination} = \frac{\text{Total Number of Seeds Germinated}}{\text{Total Number of Seeds Sown}} \text{ X } \frac{100}{1}$$

Growth Studies: The method of Orluchukwu *et al.* (2016) was adopted to determine the length and width of leaves of the vine of the fluted pumpkin with the aid of centimeter rule. Data obtained were subjected to mean and standard deviation for analysis.

Sample Analysis: For proper studies on the growth performance of the sample, it was necessary to make the analysis of the growing substrates which are the loamy soil, fresh and weathered SMS.

Soil P^H Analysis: The pH of the soil sample was determined with a glass electrode in a 1:2:5 soil water suspension (Mclean, 1982). Soil pH determinination was done by mixing 10g of well homogenized soil in a beaker with 25ml of distilled water and stirred thoroughly. The mixture was kept to stand for one minute; after which the pH probe was dipped into the mixture in the beaker and the reading recorded. Prior to measuring the pH

of the soil in the mixture; the pH meter was first standardized by dipping its probe into a buffer solution of pH.

The probe was rinsed with distilled water before and after taking each reading.

Total Nitrogen: The total nitrogen content of the substrates was determined by the Macrokjedahl method, where 5g of air-dried and sieved soil samples were weighed into separate dry 500ml Macrokjedahl flasks and 20ml of distilled water added. The flasks were swirled for a few minutes and allowed to stand for 30 minutes. One gram (1g) of potassium sulphate mercuric oxide (KSO_4 – HgO) mixture catalyst and 10g of K_2SO_4 added; as well as 30ml of concentrated sulphuric acid (H_2SO_4). The flask was heated at low heat on the digestion stand. When the water was removed and the frothing ceased, the heat was increased. Until the digest became clear. Then the mixture was boiled for 5 mins with the heating being regulated so that the H_2SO_4 condensed up to half way up the fask. The flask was left to cool and 100ml of water was slowly added. The digest was transferred into another Macrokjedahl falsk. 50ml of 2% boric acid (H_2BO_3) indicator solution was added into a 500ml Erlenmeyer flask which was placed under the condenser of the distillation apparatus. The 500ml Kjedahl flask was attached to the distillation apparatus and 150ml of 10N Sodium Hydroxide (NaOH) was poured through the distillation flask by opening the funnel stopcock. Distillation commenced immediately and the condenser kept cool, allowing sufficient water to run through; while the heat was regulated to reduce frothing and reflux. The distillate was collected and distillation discontinued. Ammonium Nitrogen (NH_4 – N) in the distillate was determined by titrating with 0.01N HCl. A change in colour, from green to pink was an indication of the presence of total nitrogen. Percentage (%) nitrogen was calculated as:

$$\% \text{ n} = \frac{\text{T x M x 1.4 x 100}}{\text{Weight of amount of soil used}}$$

Where:

T = Titre value
M = Molarity of acid (Hcl)

Available Phosphorus: This was determined by No. 1 method as modified by Oslen *et al.* (1982). Reagent A was made by mixing 12g of Ammonium molybdate, (NH_4) 6 MO7024 in 250ml distilled water and 0.2908g of potassium antimony tartarate ($KbdOC_4H_4O_6$) in 100ml distilled water and 5N H_2SO_4 (Prepared by diluting 148ml of concentrated H_2SO_4 in 100ml distilled water). Reagent B was made by dissolving 1.056g of Ascorbic acid to every 200ml of reagent A.

Standard curve was prepared by pipetting 5ml of 100ppm standard phosphorus stock solution into a 100ml volumetric flask and the volume made up with distilled water. This solution contains 5ppm (ug p/ml). Then, 2, 4, 6, 8 and 10ml of the diluted solution each, was pipetted into 50ml flask; distilled water was then added to bring the volume to 35ml. 8ml of reagent B was added and mixed thoroughly. It was made up to volume with distilled water. After 30 minutes, the absorbance of the solution was ready on a spectro-photomer at 382nm wavelength. The standard curve was prepared by plotting absorbance against concentration of the solution.

The substrate extract for analysis was prepared by weighing 3g of air dried sieved substrate samples into a 250ml plastic beaker and adding 20ml of 0.5 Hcl and 460ml of distilled water. The soil suspension was shaken on an orbital shaker. The suspension was filtered, using Whatman no. 1 blotter paper into a clean 250ml beaker. 5ml of the filtrate was pipetted into a 50ml volumetric flask, and distilled water was added to bring the volume to 40ml. 8ml of reagent B was added and thoroughly mixed. After 30 minutes, the absorbance of the solution was read on a spectrophotometer at 882 wavelength. The

amount of phosphorus in the samples was determined by reading from the standard curve previously prepared.

Potassium (K): Exchangeable K of the substrates' samples extracted with neutral normal ammonium acetate buffered at P^{H}_{7} after shaking for 2 hours. 10g of air-dried samples were weighed into conical flasks, 100ml of neutral NNH_4OAC was added and agitated for 30 minutes in a mechanical shaker.

The suspensions were left to stand overnight and on the following day; the suspensions were filtered with Whatman blotter paper number 42. The leachates were used for determination of exchangeable bases.

Twenty parts per million (20ppm) K was prepared by pipetting 0, 2, 5, 7 and 10ml of 100ppm with NH_4OA_C solution. Potassium filter was inserted into the flame photometer, which was calibrated by setting the meter needle to zero and aspirating OPPM standards and setting the meter needle to 100% emission with the highest concentration of standard. The rest of the standards were aspirated one by one and the emission readings recorded. A calibration curve was prepared by plotting emission readings against concentration of standards. The NH_4OA_C extract (diluted and undiluted) were aspirated in the flame photometer and the concentration of the extract was determined from the meter readings and calibration curve. Corresponding sodium and Potassium were calculated thus:-

Concentration of Na in the diluted NH_4OA_C

Amount of Na in the 100m diluted extract $= \frac{50 \text{ x C x } 100g}{10}$

$$\frac{50}{10} \text{ X } \frac{C}{103} \text{ X } \frac{100mg}{103} = \frac{C \text{ x } 50 \text{ x } 100mg}{10 \text{ x } 103 \text{ x } 23}$$

This quantity was present in 20g of samples;

Therefore, 100g content $= \frac{C \text{ x } 50 \text{ x } 100mg}{104 \text{ x } 23 \text{ x } 20}$

Total Organic Carbon: The Total Organic Carbon (TOC) was determined by wet combustion method of Walkley and Black (1934) as modified by Juo, (1979) in selected methods for soil and plant analysis. Organic carbon was oxidized by potassium dichromate in the presence of concentrated sulphuric acid. Ferrous ammonium sulphate was then added and the excess back-titrated with standard potassium permanganate. The values of organic matter was obtained by multiplying the organic carbon values by 1.724 (Van Bemmelem factor), based on the assumption that the soil organic matter is 58% of carbon.

The analysis were undertaken for all the substrates, SMS – (fresh) and (weathered) and loamy soil-control as growth media.

RESULTS AND DISCUSSION

Table 1: Nutrient status of the Weathered, Fresh SMS and Loamy Soil Used in the Study

Sample Treatment Substrate	pH (Solvent)	Total Nitrogen (m/kg^{-1})	Available Phosphorus ($mg/kg^{-1)}$	Potassium in ppm	Total Organic Carbon (%)	Organic matter (%)
WSMS	6.62	79.5	14.035	3.54	34.860	60.098
FSMS	6.69	84.8	20.351	5.95	34.866	60.109
Loamy Soil	7.32	72.4	27.368	2.79	3.003	5.177

(Control)

Key:WSMS=Weathered Spent Mushroom Substrate, FSMS=Fresh Spent Mushroom Substrate

Table 2: percentage germination of the crop in the days of study.

Treatment Sample	Day of 1st Emergence	Last day of Germination	% Germination
WSMS	6.62	79.5	14.035
FSMS	6.69	84.8	20.351
Loamy Soil (Control)	7.32	72.4	27.368

Key:WSMS=Weathered Spent Mushroom Substrate, FSMS=Fresh Spent Mushroom Substrate

Table 3: Growth Performance showing length of vine and leaf width in the days of study.

Treatment Samples	Parameter	Days of Study 5	10	15
WSMS	Length of Vines	4.03±1.43	6.40±0.97	7.90±1.30
FSMS		8.2±0.86	9.06±0.80	10.90±0.94
Control		4.9±0.30	8.60±0.74	11.43±1.00
WSMS	Width of Leaves	26±0.80	4.80±0.94	5.25±0.25
FSMS		4.80±0.32	7.20±0.84	7.50±0.90
Control		4.5±0.71	6.33±0.60	6.96±0.44

Key:WSMS=Weathered Spent Mushroom Substrate, FSMS=Fresh Spent Mushroom Substrate

Table 4: Showing the number of leaves in the days of study

Treatment Samples	Number of Leaves in Days of Study 5	10	15
WSMS (Soil-less)	6.00	8.00	10.00
FSMS (Soil-less)	7.00	12.00	16.00
Loamy Soil (Control	6.00	10.00	12.00

Key:WSMS=Weathered Spent Mushroom Substrate, FSMS=Fresh Spent Mushroom Substrate

The results of this study are presented in Tables 1 – 4. The results showed that the pH of all treatments (substrates) used were acidic. It also revealed that levels of mineral nutrients were high; however, organic carbon and the accompanying organic matter were considerably low in the control (loamy soil). These are indicated in Table 1.

The results of the germination of the fluted pumpkin seeds showed that germination was highest in the weathered soil-less mushroom substrate at 95% and this was closely followed by the fresh spent mushroom spoil-less substrate at 90%. Total germination occurred between day 8 after planting through day 15 with no germination loss. Although

germination rate was high, the results revealed, it was faster in FSMS and highest in the WSMS, followed by the control; as indicated in Table 2, hence germination started from day 5 and continued to day 20 for all emergence.

The results of the length of vine and leaf width are presented on Table 3. It revealed that the highest length of vine in day 5 had the value of (8.2 ±0.86) and at day 10 (9.06±0.80). These were recorded for the fresh SMS; however, highest length of vine in the study was recorded for the control on day 15; but it was lowest as recorded for weathered SMS for days; 05, 10 and 15.

The results also revealed the width of the fluted pumpkin grown for 25 days. Highest leaf width 4.0±0.32; 7.20±0.84 and 7.50±0.90 were recorded for days; 5; 10 and 15 respectively for the fresh SMS; while lowest leaf width were recorded for weathered SMS.

The result of number of leaves in 15 days during this study is presented in Table 4. It revealed highest number of leaves (7.00, 12.00 and 16.00) for days 5, 10 and 15 respectively were recorded for the fresh SMS; while lowest number (6.00; 8.00 and 10.00cm were recorded in day 5 for the weathered SMS and the control; However, the weathered SMS recorded lowest number of leaves (8.00 and 10.00) compared to other substrates.

The results of this study revealed that all the substrates (Spent Mushroom Substrate – SMS and loamy soil) were all in acidic state of pH 6. It also revealed high levels of mineral nutrients such as nitrogen, phosphorus, total organic carbon and organic matter in the SMS; however, the total organic carbon and organic matter were low in the control substrate (loamy soil). These seem to be in line with the suggestions of Chorover *et al.* (2000); who reported that in using SMS, a pH (6) is considered important, especially in uniform application as was experimented in this study. Additionally the results of the study affirm their suggestion that; SMS is a rich source of nitrogen, carbon and other elements.

The findings of the study is agree with the report of Putra and Yuliando (2015) who advocated for the use of soil-less culture system of SMS for efficient water use and product quality.

The results of the study is not a surprise to note that organic carbon and organic matter contents were low in the control substrate (the loamy soil) as it makes an affirmation and agrees with the reports of Fubara (1983) and Opuweribo (1990) who reported that soils of Southern and Eastern Nigeria where the fluted pumpkin is in surplus of cultivation have movement of gravitational water which is slow due to poor permeability that leads to high surface run-off; high evaporation of the rainfall in which only small fraction infiltrates and pecolates into the root zone to sustain plant growth. These conditions according to them, inform nutrient deficiency; the reason for the advocacy for the use of SMS for nutrient enhancement.

The results also revealed that germination of the fluted pumpkin seeds was fastest and highest in the spent mushroom substrate; which clearly agrees with the report of SMS Brochure (2006); that SMS allows good aeration and porosity of the substrate, allowing water to drain steadily and slowly; a situation deficient in the control substrate. It could also be that SMS may have acted as sponge in gravel or sandy soil, creating air spaces as in clay or laomy soil and permitting them to drain. This is also in clear support and in line with the reports of Levanon and Danai (1995) who reported that the organic content of SMS improves soil structure and buffer crops from extremity.

Generally, the results of this study on the use of SMS to enhance yield of fluted pumpkin which was occasioned by nutrient deficiency of the regions where the vegetable is grown

in surplus has implicated that the yield of the vegetable can be enhanced and sustained using soil-lees SMS whcih agrees with the advocate of Putra and Yuhando (2015).
The fear of high solute content expressed by Sendi *et al.* (2013) and Topcough (2011) as being detrimental to plant growth, hence seedlings tend to be sensitive to high Electrical Conductivity (EC) is allayed by the weathering of the spent substrate; and as such makes the weathered substrate suitable for profitable agricultural productivity of vegetable crops. Since fresh SMS undergo passive weathering of the pilled compost material, the material becomes a sure way for treating spent compost before use. This is in line with the report of SMS Brochure (2006). Additionally, the result is also in line with their further report that passive leaching of the excessive high solute of the fresh compost controlled by rainfall is another vital method of treating the fresh SMS before use to avoid adverse impact of high solute in the compost material spent substrate is a good alternative to field inventory, hence it releases nitrogen slowly and steadily for constant nutrient supply for growing the vegetable without customers' concern.

CONCLUSION

The results of this study on the use of SMS to enhance the yield of fluted pumpkin which was occassionied by poor nutrient availability to sustain the production of the crop for elaborate local market has shown that the vegetable can perform effectively using soiless SMS as some scholars like Putra and Yuliando (2015) earlier advocated.
Based on the fore-goings, the study recommends the use of soiless SMS for enhanced productivity of vegetable crops in home garden setting.

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