



Evaluation of black plum (*Vitex doniana* Sweet) pomological variations, mineral and phytochemical compositions in Eastern Nigeria

**Okocha, I. O.¹, Ezeogo, J. I.², Okonkwo, P. N.³, Urom, A. O.³,
Okpani, F. M.¹, Okorie, H. A.⁴ and Christo, I. E.⁴**

¹Horticulture and Landscape Technology Department, Akanu Ibiam Federal Polytechnic, Unwana, P.M.B. 1007, Afikpo, Ebonyi State

²Science Laboratory Technology Department, Federal Polytechnic, Ngodo-Isuochi, P.M.B. 300 Isuochi, Umunneochi LGA, Abia State

³Agricultural Technology Department, Akanu Ibiam Federal Polytechnic, Unwana, P.M.B. 1007, Afikpo, Ebonyi State

⁴Crop Science and Biotechnology Department, Imo State University, Owerri, Imo State
([gentleokocha@yahoo.com](mailto:genteokocha@yahoo.com), ji.ezeogo@fpi.edu.ng, +2349132402919, +2348063104525, +2348065476591, +2348030983945, +2348126602676, +2348038715639)

Abstract

The study on evaluation of black plum (*Vitex doniana* Sweet) pomological variations, mineral and phytochemical compositions was carried out in 2021. It evaluated the pomological variations of black plum and also determined the mineral and phytochemical compositions of its young leaves and fruit pulp. The characterization studies carried out were in three different States in Eastern Nigeria (Ebonyi, Abia and Imo States). All the data were analysed using Genstat statistical software package. The number of fruits per rachis, number of fruits per branch, fruit colour before ripening, fruit colour after ripening, weight of ripe fruits, weight of fruit pulp, weight of fresh seeds and weight of dried seeds constituted the pomological characteristics. The mineral and phytochemical compositions of black plum young leaves and fruit pulps were determined. The results revealed that seed location had no significant ($P \leq 0.05$) effects on all the parameters measured under pomological characteristics. The greatest number of fruit per rachis was recorded on Imo State monitored plants whereas, the greatest number of fruits per branch and heaviest dried seeds were obtained from plants monitored in Ebonyi State. The heaviest ripe fruits, fruit pulp and fresh seeds were obtained from plants monitored in Abia State. The mean values for number of fruits per branch were 655.33, 585.00 and 336.67 fruits for Ebonyi, Imo and Abia State, respectively. The respective mean values of calcium and magnesium contents were 86.16 and 52.73mg 100g⁻¹ for the young leaves while the fruit pulps calcium and magnesium contents were 32.88 and 27.59mg 100g⁻¹ respectively. The young leaf of black plum also contains very

high amount of flavonoids and alkaloids and moderate amount of saponins, phenolics and tannins while the fruit pulp had very high amount of flavonoids and moderate amount of alkaloids.

The result indicates that the young leaf contains more mineral and phytochemical compositions than the fruit pulps. The results showed that *Vitex doniana* young leaves are good source of calcium, and magnesium. The mineral and phytochemical compositions of *Vitex doniana* were higher in the young leaves than in the fruit pulps, which attribute more important to the consumption of the young leaves than the fruits.

Keywords: Black plum location, pomological variation, mineral and phytochemical composition

Introduction

Black plum (*Vitex doniana* Sweet) is a plant widely used by various communities in Eastern Nigeria for many purposes. It is also known as African black plum. In Hausa language, it is called 'dinya', Fulanis call it 'galbihi'. In Yoruba, it is known as 'oriri' or 'orinla' and in Ibo language it is called 'uchakokoro' or 'mbembe' (Ekundayo and Okigbo, 1991; Burkill, 2000). In Nigeria and many other parts of Africa, black plum is of great socio-economic interest especially for its extensively documented food and medicinal properties (Oladele, 2011; N'Danikou *et al.*, 2015). The fruits are eaten or used for juices and jams when ripe. The immature leaves are mostly used and consumed as a leafy peri-vegetable. Hence, it is valued in rural and urban areas as local spinach (Mapongmetsem *et al.*, 2012; Kranjac-Berisavljevic and Gandaa, 2013). The young leaves, barks and roots of black plum are used in the traditional treatment of several human diseases (Sanogo *et al.*, 2009; Amegbor *et al.*, 2012; Adetoro *et al.*, 2013) as well as animal diseases (Suleiman and Yusuf, 2008; Njidda, 2012). Every part of the plant has one economic use or another and may be harvested in the wild for household use or sale to raise income. The seed inside the fruits stone is also edible (Dadjo *et al.*, 2012). *Vitex doniana* is widely used in traditional system of medicine. For example, it is reported that the bark and root are used in traditional pharmacopoeia. In the same way, an infusion of its leaves is said to cure arterial hypertension (Elujoba *et al.*, 2005). The leaves, fruits, roots and seeds of the plant have been used as medication for liver disease, anodyne, stiffness, leprosy, backache, hemiplegia, conjunctivity, rash, measles, rachitis, febrifuge, as

tonic galactagogue to aid milk production in lactating mothers, sedative, treatment of eye troubles and kidney troubles (Dadjo *et al.*, 2012; Elujoba *et al.*, 2005). It has also been used for treatment of disease conditions such as infertility, anaemia, jaundice, dysentery, gonorrhoea, headaches, diabetes, chickenpox, rash and fever. The leaf sap is used as an eye drop to treat conjunctivitis and other eye complaints (Dadjo *et al.*, 2012).

Adejumo *et al.*, (2013) found that the moisture content in *Vitex doniana* young leaves was high. Minerals such as sodium, calcium, iron, Magnesium, Zinc, Copper were reported to be present in *Vitex doniana* young leaves. They suggested that its moderate calcium value could be used for the management of osteomalacia. *Vitex doniana* is widely distributed in the eastern and western parts of Nigeria and various parts of the plant are used by traditional medicine practitioner in Nigeria for the management and treatment of several disorders which include rheumatism, hypertension, cancer and inflammatory diseases (FAO, 1996). Black plum has numerous utilizations with promising economic potential for poverty alleviation in rural and urban areas in Nigeria (Mapongmetsem *et al.*, 2005). African black plum can make a great contribution to the local, regional and national economy of many West African countries (Codjia *et al.*, 2003). Phytochemical screening revealed the presence of saponins, tannins, anthraquinones, terpenoids, flavonoids and alkaloids in the leaf extracts of black plum (Agbafor and Nwachukwu, 2011). Several authors have evaluated the phytochemical composition of *Vitex doniana*. They showed the presence of flavonoids, tannins, saponins, anthraquinones, naphthoquinones, and

resin in methanol, ethanol, aqueous root, stem bark and leaf extract of *Vitex doniana* (Iwueke, 2006).

Despite the widely known nutritional, medicinal and economic uses of *Vitex doniana* products, the species are still under-utilized and un-improved (Glew *et al.*, 1997; Osum *et al.*, 2013). There is little scientific data on the tree, but African Horticulturalists, Livestock Keepers, Laboratory scientists and Foresters stand to benefit from in-depth research and commercial development of this species (Kristensen and Lykke, 2003). There

is scarcity of information on black plum in areas of species variability and characterization despite the fact that it is a high-value utility crop with promising economic potentials. Hence, the urgent need to evaluate the pomological variations, and as well as the mineral and phytochemical compositions of this very important indigenous tropical fruit trees species (TFTS). The major objective of this study is to evaluate the pomological variations, mineral and phytochemical compositions of black plum (*Vitex doniana* Sweet) in Eastern Nigeria.



Plate 1: *Vitex doniana* unripe and ripe fruits

Materials and Methods

Site Location and Field Characterization Studies of Black Plum (*Vitex doniana* Sweet)

Survey work and nursery experiments were carried out in 2021. Field survey trips were undertaken in three (3) different States of Eastern Nigeria where the species naturally occur. The States selected from the Eastern Nigeria were

Ebonyi, Abia and Imo States from where the field characterization studies were carried out and the species evaluated (Table 1). The field studies were carried out during the normal fruiting period of Black plum in Eastern Nigeria, which is between the months of February and October. Black plum (*Vitex doniana* Sweet) trees growing in the forests, distant and nearby farms were used for the field study.

Table 1: Study areas where the field surveys were carried out

States	Number Evaluated
Ebonyi	30
Abia	30
Imo	30
Total	90

Materials used for the survey study

The materials used for the survey study were machet, climbing rope, long graduated pole of 10m (it is an improvise for Relascope machine), electronic weighing balance (S. Mettler model, K-600g/0.1g sensitivity), graduated rule, measuring tape, exercise book, photo camera and pen.

Sampling and Sampling techniques

Pomological observations and studies were made on a total of 90 black plum trees (uchakokoro or mbembe as it is called in Igbo) across the three (3) States. A total of 30 black plum trees were observed, recorded and studied in each State.

Data collection on field characterization studies

Measurements, photographs and pomological observations were made on the pomological characters of the species. The measurements were taken at random while fruit samples were collected and used for the mineral and phytochemical analysis. The pomological characters studied across the three States were number of fruits per rachis, number of fruits per branch, colour of pulp before and after fruit darkening, fruit weight, fresh seed weight, dried seed weight and fruit pulp weight.

Determination of mineral composition

The minerals in the young leaves and fruit pulps were analysed from the solution obtained when 2.0g of the samples were digested with concentrated nitric acid and perchloric acid in ratios 5:3, the mixtures were placed on a water bath for three hours at 80⁰C. The resultant solution was cooled and filtered into 100ml standard flask and made to mark with distilled water and then used to analyze for the individual minerals using Atomic Absorption Spectrophotometer (Buck Scientific AAS Model 210, equipped with single slot burner and airacetylene flame) (Asaolu, 1995).

Determination of phytochemicals composition

The black plum young leaf and fruit pulp extracts used for this investigation were subjected to phytochemical analysis to determine their chemical components using standard methods. The extracts were evaluated for the presence of flavonoids, saponins, steroids, phenolics, terpenoids, glycosides, alkaloids and tannins (Okerulu and Ani, 2001).

Statistical Analysis

Data collected was subjected to analysis of variance (ANOVA) for Complete Randomized Design using Genstat 2014 release 10.3DE software package (GENSTAT, 2014). Separation of treatment means for significant effects was by the use of Fishers Least Significant Difference (F-LSD) and Standard Deviation (Sd) as described by Obi (2012).

Results

Pomological characteristics of black plum (*Vitex doniana* Sweet) in three States.

The comparative study of pomological characteristics of black plum in the three states monitored is shown in Table 2. The results indicated that the three states monitored had no significant ($P \leq 0.05$) effects on all the pomological characteristics measured. The mean number of fruits per rachis produced were 18.23, 17.67 and 20.53 fruits for Ebonyi, Abia and Imo States respectively. Plants monitored at Imo State recorded the highest fruits of 20.53 fruits per rachis while those monitored at Abia State recorded the least mean value of 17.67 fruits per rachis and they were statistically ($P \leq 0.05$) the same. The mean number of fruits per branch recorded were 655.33, 336.67 and 585.00 fruits for Ebonyi, Abia and Imo States respectively. Ebonyi State produced the highest fruits (655.33 fruits) per branch which had no significant ($P \leq 0.05$) effects on the mean fruits number of 585.00 and 336.67 fruits per branch gotten from Imo and Abia States respectively. The heaviest mean pulp

6.15g, ripe fruits 14.56g and fresh seed 8.38g were obtained from Abia State and the least mean value of pulp weight 6.07g was gotten from Imo State whereas Ebonyi and Imo States recorded the same least mean values of 14.38g and 8.29g for ripe fruits and fresh seed respectively. These were

statistically ($P \leq 0.05$) similar. Ebonyi State recorded the heaviest mean dried seed of 3.83 while Abia State had the least mean dried seed of 3.71 and they did not differ statistically ($P \leq 0.05$).

Table 2: Mean pomological characteristics of black plum (*Vitex doniana* Sweet) in three States

Parameters	States			
	Ebonyi	Abia	Imo	Sd
Number of fruits per rachis	18.23 ^a	17.67 ^a	20.53 ^a	±1.52
Number of fruits per branch	655.33 ^a	336.67 ^a	585.00 ^a	±167.41
Weight of ripe fruit (g)	14.38 ^a	14.56 ^a	14.38 ^a	±0.07
Weight of pulp (g)	6.09 ^a	6.15 ^a	6.07 ^a	±0.05
Weight of fresh seed (g)	8.29 ^a	8.38 ^a	8.29 ^a	±0.05
Weight of dried seed (g)	3.83 ^a	3.71 ^a	3.74 ^a	±0.06
Colour of fruit pulp before ripening	Green	Green	Green	
Colour of fruit pulp after ripening	Purplish Black	Purplish Black	Purplish Black	

Means having different superscript letters along the column differed significantly ($P \leq 0.05$).
Sd = Standard Deviation

Mineral composition of Black plum young leaf and fruit pulp in three States

The results of mineral compositions of young leaf and fruit pulp of *Vitex doniana* in the three states is presented in Table 3. The young leaf of black plum contains relatively much higher potassium, calcium, magnesium, phosphorus and sodium

than the fruit pulp. The respective young leaf mean values for potassium, calcium, magnesium, phosphorus and sodium were 103.07, 86.16, 52.73, 48.93 and 19.50mg 100g⁻¹ while that of the fruit pulp were 47.91, 32.88, 27.59, 22.36, 8.42mg 100g⁻¹ respectively. The corresponding Iron values for the young leaf was 4.04mg 100g⁻¹ while the fruit pulp was 3.10mg 100g⁻¹ (Table 3).

Table 3: Mineral composition of black plum (*Vitex doniana* Sweet) leaves and fruit pulp in three States

Constituents (% of dry matter)	State/Young leaf mg 100g ⁻¹				State/Fruit pulp mg 100g ⁻¹			
	Ebonyi	Abia	Imo	Mean	Ebonyi	Abia	Imo	Mean
Calcium	86.40	86.19	85.90	86.16	32.45	33.08	33.10	32.88
Sodium	19.60	19.60	19.30	19.50	8.40	8.45	8.42	8.42
Potassium	102.40	103.91	102.90	103.07	48.32	47.22	48.20	47.91
Phosphorus	49.04	49.02	48.72	48.93	22.11	22.80	22.18	22.36
Iron	4.08	3.92	4.11	4.04	3.20	2.95	3.15	3.10
Magnesium	52.30	52.78	53.10	52.73	27.65	27.60	27.52	27.59

Phytochemical constituents of young leaves and fruit pulps of *Vitex doniana* in three states

The quantitative and qualitative phytochemical constituents of black plum young leaves and fruit pulps in the three states is presented in Table 4a and b respectively. The results revealed that the young leaves and fruit pulps contains high amount of flavonoids. The young leaf also contains high amount of alkaloids 22.95mg 100g⁻¹ while the fruit pulp contains moderate amount of 20.43mg

100g⁻¹ alkaloids. The young leaf contains moderate amounts of phenolics 13.43mg 100g⁻¹, saponins 9.42mg 100g⁻¹ and tannins 9.21mg 100g⁻¹ while the fruit pulp contains small amount of phenolics 15.52mg 100g⁻¹, saponins 7.56mg 100g⁻¹ and tannins 6.98mg 100g⁻¹. However both the young leaves and fruit pulps contains terpenoids, glycosides and steroids in small amount except steroids that was absent in the fruit pulp.

Table 4a: Quantitative phytochemical constituents of black plum young leaves and fruit pulps in three States

Constituents (% of dry matter)	State/Young leaf mg 100g ⁻¹				State/Fruit pulp mg 100g ⁻¹			
	Ebonyi	Abia	Imo	Mean	Ebonyi	Abia	Imo	Mean
Flavonoids	10.56	11.05	10.69	10.77	16.56	16.50	16.70	16.59
Saponins	9.45	9.38	9.42	9.42	7.59	7.49	7.61	7.56
Steroids	1.52	1.45	1.40	1.46	-	-	-	-
Phenolics	13.49	13.20	13.60	13.43	15.30	15.44	15.83	15.52
Terpenoids	3.89	3.90	3.91	3.90	3.28	3.40	3.39	3.36
Glycosides	0.89	0.91	0.95	0.92	0.82	0.78	0.80	0.80
Alkaloids	22.67	23.08	23.10	22.95	6.89	7.10	6.94	6.98
Tannins	9.19	9.24	9.20	9.21	4.01	3.92	3.98	3.97

Table 4b: Qualitative phytochemical constituents of black plum young leaves and fruit pulps

Constituents (% of dry matter)	Young leaf mg 100g ⁻¹	Fruit pulp mg 100g ⁻¹
Flavonoids	+++	+++
Saponins	++	+
Steroids	+	...
Phenolics	++	+
Terpenoids	+	+
Glycosides	+	+
Alkaloids	+++	++
Tannins	++	+

Key

- ... = absent
- + = present in small amount
- ++ = present in moderate amount
- +++ = present in high amount

Discussion

Effect of plant locations on pomological characteristics on black plum (*Vitex doniana* Sweet)

From the field survey, the results indicated that plant location had no significant ($P \leq 0.05$) effect on all the pomological characteristics of black plum measured. Since all the pomological characteristics of the species examined in three different locations of these three States showed no significant ($P \leq 0.05$) differences, this suggest that environment has relatively no influence on the species pomological characteristics when compared to the genotypic effects.

Effect of seed locations on mineral composition of black plum

The analyzed results revealed that both the young leaves and fruits of *Vitex doniana* contains relatively high levels of potassium, calcium and magnesium irrespective of location. Whereas the young leaves are relatively higher in potassium and calcium, ranging from 102.40 to 103.91mg 100g⁻¹ and 85.90 to 86.40mg 100g⁻¹ respectively. The mean potassium and calcium values for the young leaves are 103.70 and 86.16mg 100g⁻¹ and the fruits are 47.91 and 32.81mg 100g⁻¹, respectively. Black plum leaves are also higher in magnesium compared to the fruits. The mean values are 52.73 and 27.59mg 100g⁻¹ for the young leaves and fruits, respectively. This finding is in conformity with the report by Adejumo *et al.*, (2013) who found that the moisture content in *Vitex doniana* young leaves was high and that minerals such as Sodium, Calcium, Iron, Magnesium, Zinc, Copper were present in *Vitex doniana* young leaves.

Effect of plant locations on phytochemical composition of black plum (*Vitex doniana* Sweet)

The results revealed that both the young leaves and fruits of *Vitex doniana* Sweet contains relatively high levels of flavonoids irrespective of

location. Whereas the young leaves are moderately higher in Saponins and tannins, ranging from 9.38 to 9.45 mg⁻¹100g⁻¹ and 9.19 to 9.24mg⁻¹100g⁻¹ respectively, the fruits had moderate higher phenolics values ranging from 15.30 to 15.83mg⁻¹100g⁻¹. The mean flavonoids values for black plum young leaves and fruits are 10.77 and 16.59mg⁻¹100g⁻¹ respectively. Black plum young leaves are moderately higher in Alkaloids compared to the fruits. The mean values are 22.95 and 20.58mg⁻¹100g⁻¹ for the young leaves and fruits respectively. This observation agreed with the report by Agbafor and Nwachukwu, (2011) who stated that the phytochemical screening of black plum leaf extracts revealed the presence of saponins, tannins, anthraquinones, terpenoids, flavonoids and alkaloids.

Summary and Conclusion

The field characterization study which was carried out in Ebonyi, Abia and Imo States revealed intra-specific variations within black plum (*Vitex doniana* Sweet). The pomological characteristics of *Vitex doniana* in the three States were not significantly ($P \leq 0.05$) influenced by plant location. However, the mean weight of ripe fruits, fruit pulps and fresh seeds gotten from Abia State were higher than the mean values obtained from Ebonyi and Imo States whereas, the number of fruit per branch and weight of dried seeds obtained from Ebonyi State were higher than the values obtained from Imo and Abia States. The evaluation of nutrient composition of black plum showed that it is highly rich in nutrients and therefore good for human consumption to maintain health and vitality. Its calcium content especially the young leaves make it nutritionally a good source of plant calcium; this validates its use in diet. The presence of its phytochemical constituents is of great important in pharmaceutical industries. Generally, the young leaves of *Vitex doniana* had more mineral and phytochemical compositions than the fruit pulps. Black plum young leaves has extraordinarily high levels of potassium and

calcium ranging from 102.40 to 103.91mg 100g⁻¹ and 85.90 to 86.40mg 100g⁻¹ respectively.

Having noted the importance of black plum to Nigerians especially Igbo communities and standing on the position of this plant nutritional resources in cushioning health, food, income and job security of those agrarian rural communities of the Nation, it becomes imperative to create more awareness on the domestication and consumption of black plum (*Vitex doniana* Sweet). However, introducing the consumption of black plum in our daily diet will go a long way in enhancing the health status, vitality and longevity of Nigerians.

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