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Morphological Characters and Soil Characteristics of Potential Horticultural Plants Growing in the Wild

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study investigated the variations observed in morphology of four (4) potential horticultural plants: *Callichilia stenosepala* Stapf*, Clerodendrum splendens* G. Don, *Combretum bracteatum* Herb. Madr. ex Wall and *Combretum indicum* (L.) Defillips and the soil characteristics of their habitats. Plants samples were obtained within University of Uyo Main Campus, Use Offot village in Uyo Local Government Area and Ifiayong Usuk Village in Uruan L.G.A. of Akwa Ibom State. Soil samples were obtained around the base of the studied plants before collection. Plants'

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morphological characters were extensively described and the soil samples analyzed using standard methods. The results revealed that these plants thrive on slightly acidic soils (6.31±0.07 to 6.75±0.05). Soils supporting *Callichila stenosepala* recorded the highest electrical conductivity (18.2±4.10), organic carbon (5.28±0.80), total nitrogen (4.86±0.52), calcium (164.00±10.20), magnesium (74.36±6.21) and exchange acidity (2.88±0.07) values, soils supporting *Clerodendrum splendens* recorded the highest pH (6.75±0.05), bulk density (1.88±0.004), phosphorus (2.08±0.003), sodium (18.40±4.09), potassium (32.18±7.02) and clay (34.00±6.10). Also, *Combretum indicum* was supported by soils having higher sand (62.00±7.10) and silt (23.00±4.30) contents while *Combretum bracteatum* occurred on soils with lower values of base cations, basic nutrient elements and soil physical properties. In conclusion, there are plants with potential horticultural values found within the study area and there are significant differences in the soil properties at the locations in which they are found. A better ecological investigation is needed in order to provide useful insights needed for the adoption, management, mass production, and better utilization of these potential horticultural plants within the study area.

Keywords: Morphology; soil characteristics; horticultural plants; growth.

1. INTRODUCTION

Plants are found all over the world, even where humans do not live. Plants are an integral part of the ecosystem [1,2]. Plants are essential and co-exist with humans and other living things. They are useful for food, medicine, and industrial purposes [3,4]. Horticulture is a science, as well as, an art of production, utilization, and improvement of horticultural crops, such as fruits and vegetables, spices and condiments, ornamental plants, plantations, and medicinal and aromatic plants [1,2,3,5]. According to Hopkins [6,7,8], horticultural crops require intense care in planting, carrying out intercultural operations, manipulation of growth, harvesting, packaging, marketing, storage, and processing. Crops involved in horticulture are the vine, perennial bush and tree nuts, vegetables (roots, tubers, shoots, stems, leaves), fruits, edible flowers, aromatic and medicinal plants, cut flowers, potted ornamental plants, bedding plants, trees and shrubs, turf and ornamental grasses. Horticulture can be divided into food and ornamental horticulture. Plants have played a major role in the evolution and sustenance of human existence.

Achieving aesthetics is one of the most encouraging ways to save plants and provide a wider knowledge of the various species of plants available in the locality. Most wild plants were introduced for nutrient or fiber production, or for ornamental purposes [9, 10]. Some plants occur naturally as wild ornamental species within their natural range and have ornamental features such as brightly colored floral parts, foliage, and fruits and may also have other culinary uses [11,12,13]. They play an important role in the environmental planning of urban and rural areas for abatement of pollution, medicine, social and rural forestry, wasteland management, afforestation, and landscaping of outdoor and indoor spaces [14]. Most of the present dayflowers have come from wild progenitors and a few of which still exist in natural habitats [15]. More attractive wildflowers have long been prized for their beauty and planted in the garden around mankind's dwelling places. These ornamental plants exert a strong, positive influence on human behavior [15]. Umoh [16] reported that plants such as *Mimosa pudica, Clerodendrum splendens, Combretum racemosum* and *Centrosema pubescens* could be useful as ornamentals due to their beautiful and persistent flowers and all-season flowering habit.

The importance of plants as food, medicine, fiber, fuel, timber, and other uses often has been treated by many researchers, but studies linking the aesthetic dimensions of plants and ethnobotanical information were very limited [17,18,19]. In some specific cases, the ornamental aspects of plants constitute a starting point to evaluate their food, medicinal, and/or toxic properties [20,21]. Thus, there is a need to identify more wild ornamental species within the study area in order to harness their full potential. This could possibly be due to the fact that most of the wild species are rarely domesticated. Landscape planting plays an important role in urban and public open spaces [22], and one of the elements targeted in landscape design is to establish a balanced interaction between humans and nature and to reflect the natural environment in urban environments. Another element is to create an aesthetic, functional, and ecologically sustainable landscape. However,

urbanization leads to a higher number and proportion of alien species in plant communities [23,24] and the possible emergence of urban habitats with unique diversity. Since the soil in urban sites is different when compared to the original habitat, and local plants have evolved to tolerate these conditions and it is inaccurate to believe that native plants would automatically fit better than wild plants [25]. Furthermore, wild species could be more preferred since they are known to be more tolerant to environmental stressors such as compact and limited soil, are often fast-growing, and have attractive flowers [26,27]. Most of the plants used in public institutions, recreation areas, traffic islands, and especially in herbal gardens are wild plant species of foreign origin; and these wild plant species when compared to domestic plants may exhibit higher expansion potential especially when suitable growth conditions are present.

Harmful effects of non-native species is known to be one of the greatest threats to biodiversity globally [28] and more than 40% of widespread invasive plant species include horticultural plants [29,30]. Invariably, horticultural plant preference is often associated with species' physical and chemical properties including the appearance of the plants, nutrient richness, the adequate balance of nutrients contents, and/or phytochemical potentials in line with standards of commercialization and consumption [31]. It is known that knowledge of the ecological preferences of wild species may ease the large-scale adoption and domestication of such` plants. Therefore, information on soil nutrient status is essential for the proper adoption, and management commercialization of studied plants within the area. Upon this premise, this research seeks to establish the basis for the identification of some common wild plants with potential horticultural significance using diagnostic character description of species, give information on soil tolerance range and highlight some ethnobotanical relevance of the same. It is believed that this may go a long way to facilitate the wide domestication and further harnessing of the untapped value of studied plants within and beyond the study area.

2. MATERIALS AND METHODS

2.1 Study Area

This study was carried out in the University of Uyo (UNIUYO) Main Campus, Use Offot Village in Uyo Local Government Area, and Ifiayong Usuk Village in Uruan L.G.A. all of which fall within the Uyo metropolis of Akwa Ibom State, Nigeria. (Longitude 7° $57^{'}$ $29^{"}$ E and latitude 4° $55^{'}$ $38^{"}$ N). The surrounding topography is undulating with sparsely distributed homesteads and cultivated land. Akwa Ibom State lies entirely on the coastal plain of south-eastern Nigeria, where no part constitutes an area of appreciably high relief. The climate is characterized by two seasons, the rainy and dry seasons. The rainy season is from March to mid-November) and the dry season is from mid-November to March. The total annual rainfall varies from 4000 mm along the coast to 2000 mm inland. Temperature values are relatively high in Akwa Ibom State throughout the year, with the mean annual temperatures varying between 26°C to 36°C. Akwa Ibom State has relative humidity, which ranges between 75 % to 95 % with the highest and lowest values in July and January, respectively [32].

2.2 Plant Collection and Identification

Specimens of four (4) potential ornamental plant species: *Callichilia stenosepala* Stapf*, Clerodendrum splendens* G. Don, *Combretum bracteatum* Herb.Madr. ex Wall and *Combretum indicum* (L.) Defillips, were collected within the University of Uyo Main Campus, Use Offot village in Uyo Local Government Area and Ifiayong Usuk Village in Uruan L.G.A. of Akwa Ibom State using the methods stated by Umoh and Bassey [33] and Bassey et al. [34].

2.3 Soil Sampling

2.3.1 Soil collection and laboratory analysis

The soil sample from the location of the plants was collected at a depth of 0-15 centimeters with the aid of a soil auger and temporarily preserved in a zipploc bag according to the methods described by Ogbemudia and Mbong [35] and transferred to the Laboratory for analyses following the standard procedures outlined by the Association of Official Analytical Chemist (AOAC) [36].

2.4 Statistical Analysis

Data on variations in soil characteristics were obtained in triplicates for each location. The entire dataset was arranged based on location and was subjected to a one-way analysis of variance (ANOVA). Significant means were

separated using Duncan multiple range test. The results were presented as mean ± standard deviation and the probability level was set at $P<0.05$. Both Descriptive and inferential statistics were carried out using Statistical Package for Social Science (SPSS) Version 20 (IBM Corporation, Armonk USA).

3. RESULTS

Four wild plants that showed potential uses in horticulture were collected and identified. The list is summarized in Table 1.

3.1 Morphological Characters of *Callichilia stenosepala* Stapf.

3.1.1 Stem features

It is an erect shrub with no hairs present at the stem and an absence of fluid. The shape of the stem is cylindrical and it has a mild foul smell.

3.1.2 Leaf features

The apex of the leaf is acute with an elliptic shape, arcuate venation, and rounded base and the margin was observed to be entire. The leaf arrangement is opposite and the length measures between 9.4 cm – 1.0 cm and the breadth 5.1 cm – 6.5 cm. The petiole is greenish and very short. It measures 0.7cm. The leaf has a smooth texture.

3.1.3 Floral features

3.1.3.1 Bracts

The bract is conjoined with the down part of the flower. The bract measures 0.3 cm – 0.5 cm.

3.1.3.2 Calyx

It is about five and they are fused together at the base of the flower and attached to the corolla.

3.1.3.3 Corolla

The texture of the Corolla is very smooth. The corolla is an open petal fused towards the base and forming a petal tube. The corolla is in salverform, having a cylindrical elongated tube. The flower has a butter-like scent.

3.1.3.4 Androecium

The filament is attached to the walls of the petal tube. It is about five with a triangular-shaped head.

3.1.3.5 Gynoecium

It has a single gynoecium that is attached to the base of the calyx.

Fig. 1. Pictorial Representation of *Callichilia stenosepala* Stapf.

3.2 Morphological Characters of *Clerodendrum splendens* G. Don

3.2.1 Stem features

It is a scrambling shrub slightly hairy with short brown hairs. These short hairs are mostly found on the young stem. When the stem is broken, there is an absence of exudate. A clear cut made through the stem shows the shape of the stem to be angular and there are nodes observed to be scattered all over the stem. The stem is also observed to be scented.

3.2.2 Leaf features

The leaves are arranged in an opposite direction with arcuate venation, an elliptic shape, and an acuminate apex. The base of the leaf is rounded and the margin was observed to be entire. When measured, the length of the leaf was between 10.3 cm – 14.5 cm and the breadth of the leaf ranged from 6.0 cm – 9.0 cm. The petiole is deep green in color while in some it is brown and it ranges from 0.8 cm – 1.3 cm.

Table 1. Potential horticultural plants, their location, and their ethnobotanical uses

S/N	Botanical Name	Family	Common Name	Location	Coordinates	Ethnobotanical uses
1	*Calichillia stenosepala* Stapf.	Apocynaceae	Not available	Uniuyo, Nwaniba	Long: 7:58:38.9300 Lat: 5:2:14.6899	Treatment of different kinds of fever and in the management of toothache [37].
2	*Clerodendrum splendens* G. Don	Lamiaceae	Glory-bower	Uniuyo, Nwaniba	Long: 7:58:39.9500 Lat: 5:2:14.6868	Labor inducement, Treatment of jaundice, snake bite, typhoid, wounds, anemia, malaria, rheumatism, asthma, and inflammatory disease [38].
3	*Combretum bracteatum* Herb.Madr. ex Wall.	Combretaceae	Palmwine of the sun-bird	Ring-road 3	Long: 7:57:57.9500 Lat: 4:59:56.2200	Treatment of malaria, diabetes, boils, and sexually transmitted infections [39].
4	*Combretum indicum* (L.) Defillips	Combretaceae	Ragoon Creeper	Ekamba Nsukara	Long: 7:58:47.9623 Lat: 5:3:16.3210	Management of rheumatism, fever, deworming agent, and treatment of skin infection [40]

3.2.3 Floral features

3.2.3.1 Bracts

Possess some scanty bracteoles, they are slightly visible due to their scanty nature. The bracts are slender. It measures around 0.2 cm – 0.5 cm. It is slightly maroon and green in color.

3.2.3.2 Calyx

It is quite tiny when attached to the flower but when it matures to fruit, it becomes broader and when the fruit ripens, the calyx changes color from maroon and green to black and it gently wilts off. It measures 0.6 cm – 0.8 cm. The calyx is five in number and conjoined down to the part of the plant.

3.2.3.3 Corolla

It is open and fused towards the base of the flower. The Corolla is in salverform. It has a cylindrical elongated tube. The corolla is five in number, and in dissecting the elongated tube of the corolla there was the presence of transparent fluid.

3.2.3.4 Androecium

It is carefully buried into the tube of the corolla and it spreads across the upper region of the corolla. The androecium is 4 in number, and it measures between 1.9 cm –21 cm.

3.2.3.5 Gynoecium

It is not attached to the walls of the elongated corolla. The gynoecium has a light green color at the low region, a maroon color at the middle part and the top it has a green color, measuring between 3.5 cm – 3.8 cm. The gynoecium can be easily pulled out from the flower. The flower of this plant matures to fruit. The young fruit is scented and completely greenish. The length of the fruit measure between 0.4 cm – 0.7 cm, while the breadth is between 0.8 cm – 1.1 cm. When the fruit is squashed there is the presence of transparent liquid. The fruit is shaped into a four-compartment.

3.3 Morphological Characters of *Combretum Bracteatum* Herb.Madr. ex Wall

3.3.1 Stem features

Combretum bracteatum is a semi-deciduous and scandent shrub of up to 7–10 m high, with a rounded crown, branched, and often with twisted trunks. The bark on the younger stem is whitish and hairy; stems have prominently thickened nodes, smooth and flaking; small twigs are reddish and drooping. When the stem was broken, it was noticed to have the presence of transparent fluid. The shape of the stem is cylindrical, it had a mild foul smell and no hair was found.

Fig. 2. Pictorial Representation of *Clerodendrum splendens* G. Don

3.3.2 Leaf features

The leaves have an arcuate venation and elliptic shape with an opposite leaf arrangement. The apex of the leaf is accuminate and the margin is entire. It has an acute base and the length of the leaves measures between 7.6 cm – 15.0 cm while the breadth measures between 3.0 cm – 6.3 cm. The petiole is green in color with the presence of short hairs, it was also observed that some have a brownish color.

3.3.3 Floral Features

3.3.3.1 Bract

The bract is attached to each axis of the flower. Some of the bracts are colored and are attached to each flower. It measures between 1.6 cm - 13.4 cm and the breadth is between 0.5 cm - 6.2 cm. Note: The inflorescence is a panicle.

3.3.3.2 Calyx

The calyx appears as a petaloid, taking the shape of the petal. It has a peach color. It is about five calyx joined together at the base of the flower and separated approaching the tip of the corolla. It measures within 1.6 cm - 2.1 cm. The calyx is tubular and the surface is dry with whitish hair.

3.3.3.3 Corolla

In the corolla, there is the presence of short white hairs and it is attached to the walls of the calyx measuring between 0.7 cm - 1.0 cm and the breadth is 0.3 cm.

3.3.3.4 Androecium

They are attached to the walls of the sepal and the stamen is about 11 some could be 8 - 10. It measures between 1.8 cm - 2.1 cm.

3.3.3.5 Gynoecium

It is firmly attached to the ovary and it measures between 3.0 cm - 3.2 cm. In the ovary, there is the presence of short white hairs on the axis of the inflorescence.

Fig. 3. Pictorial Representation of *Combretum bracteatum* Herb.Madr. ex Wall

3.4 Morphological Characters of *Combretum indicum* (L.) Defillips

3.4.1 Stem features

It is a scandent shrub. It possesses short white hairs at the younger part of the stem. This is visible when viewed under a microscope. There is no fluid present in the stem. The shape of the stem is cylindrical. The stem has a foul smell when it is broken.

3.4.2 Leaf features

It has an arcuate venation with alternate leaf arrangements. The texture of the leaf is rough. The apex of the leaf is acuminate and the* margin is entire. It has an acute base and the length of the leaves measures between 6.3 cm - 9.7 cm while the breadth measures between 3.8 cm - 5.0 cm. The petiole is green in color with the presence of short hairs; it was also observed to have been brownish.

3.4.3 Floral features

3.4.3.1 Bract

It is present in this species and it measures within 1.0 cm-1.2 cm.

3.4.3.2 Calyx

The calyx is joined to the base.

3.4.3.3 Corolla

The corolla is not fused together; the younger ones are observed to be whitish in color while the matured ones are pink. It has short white hairs with a velvety texture. The corolla is five in number and it measures between 1.0 cm-1.5 cm.

3.4.3.4 Androecium

The stamen is about 10-15 and attached to the walls of the corolla.

3.4.3.5 Gynoecium

It is only one present and it is attached to the wall of the calyx.

The physicochemical properties of the soil supporting the growth of the studied species are presented in Table 2. The pH of the soils was slightly acidic ranging from 6.31±0.07 to 6.75±0.05. Soils of *Calichillia stenosepala* had the highest values for electrical conductivity (18.2±4.10 ds/m), organic carbon (5.28±0.80 %), total nitrogen (4.86±0.52 %), calcium (164.00±10.20 mg/kg), magnesium (74.36±6.21 mg/kg) and exchange acidity (2.88±0.07 mg/kg). Soils of *Clereodendrum splendens* had the highest values for bulk density (1.88±0.004 g/cm^3), available phosphorus (2.08±0.003

mg/kg), sodium (18.40 ±4.09 mg/kg), potassium (32.18±7.02 mg/kg) and clay (34.00±6.10 %) while soils of *Combretum indicum* had the highest values for sand (62.00±7.10%) and silt (23.00±4.30 %). On the other hand, soils of *Calichillia stenosepala* had the least values for bulk density (1.26±0.07 g/cm^3), available phosphorus (0.88±0.001 mg/kg), sodium (9.20±1.13 mg/kg) and sand (48.00±5.01%). Similarly, *Combretum indicum* had the least values for organic carbon (4.72±0.78 %) and clay (15.00±3.10 %), whereas *Combretum bracteatum* had the least values for total nitrogen (3.68±0.72 %) and potassium (13.70±0.42 mg/kg). Soils of *Clereodendrum splendens* had the least values for electrical conductivity (11.00±1.86 ds/m) and silt (11.00±1.60 %).

Fig. 4. Pictorial Representation of *Combretum indicum* (L.) Defillips

4. DISCUSSION

From this study, it is clear that there are some wild plants with horticultural potential within the study area. As observed, the selection and characterization of this species are based on the persistent and attractive nature of their flowers and leaves. These morphological features were also high lightened in [12,16,41]. Umoh [16] also revealed that *Combretum* species on investigation possessed uncommon ornamental feature that makes them suitable for shades and landscape use. Ornamental plants are grown usually for beautifying the environment [42]. This is well represented by the plants presented in this study. However, these plants do not only have aesthetic values but several other therapeutic and culinary uses. For instance, the leaves of *Clerodendrum splendens* are used in the form of poultice to treat burns and wounds, while *Combretum indicum* is used in stopping diarrhea, treatment of parasitic skin infections, pain relief, and treatment of rheumatism [43], hence they can be cultivated at home gardens for both ornamental and medicinal purposes.

Soil properties especially nutrients are known to influence plant species richness and distribution. The presence and availability of nutrients may define a species' potential to survive in a given area. Hence, the gaps in nutrient levels and textural properties of the soil as reported may be the reason for the availability or absence of these plants within and outside the studied location [44]. Productivity generally increases with increasing

Table 2. Physicochemical properties of the soils

	Calichillia stenosepala	***Clereodendrum. splendens***	***Combretum bracteatum***	***Combretum indicum***
pH	6.31±0.07^a	6.75±0.05^a	6.48±0.06^a	6.57±0.09^a
E. Conductivity (ds/m)	18.2±4.10^b	11.0±1.86^a	10.6±0.63^a	14.30±0.45^a
Organic Carbon (%)	5.28±0.80^a	4.98±0.51^a	4.82±0.47^a	4.72±0.78^a
Total Nitrogen (%)	4.86±0.52^a	4.22±0.60^a	3.68±0.72^a	4.41±0.60^a
Bulk Density (g/cm^3)	1.26±0.07^a	1.88±0.004^a	1.32±0.06^a	1.63±0.04^a
Avail. Phosphorus (mg/kg)	0.88±0.001^a	2.08±0.003^a	2.04±0.41^a	1.02±0.36^a
Calcium (mg/kg)	164.00±10.20^b	20.00±4.61^a	31.00±3.62^c	34.00±2.36^c
Magnesium (mg/kg)	74.36±6.21^b	9.96±1.08^a	23.60±4.00^c	13.6±1.05^a
Sodium (mg/kg)	9.20±1.13^b	18.4±4.09^a	11.8±2.14^b	10.5±1.98^b
Potassium (mg/kg)	16.82±2.03^b	32.18±7.02^a	13.70±0.42^b	24.10±3.62^c
Exchange Acidity(mg/kg)	2.88±0.07^a	1.98±0.01^a	2.00±0.05^a	2.05±0.40^a
Sand (%)	48.00±5.01^b	55.00±3.05^a	53±8.02^a	62.00±7.10^c
Silt (%)	20.00±3.60^b	11.00±1.60^a	16.00±2.41^c	23±4.30^b
Clay (%)	32.00±5.00^a	34.00±6.10^a	31.00±7.20^a	15.00±3.10^b
Textural class	Silt clay loam	Clay	Loam	Sandy loam

± Standard error Means with different superscript along the same row are significantly different (p = 0.05)

nutrient availability and, as such, nutrients and rate of nutrient supply are commonly used as proxies for estimating productivity [44,45]. This is quite evidenced in this study as variations were observed in the soil properties where the four plant species are found. This variation relates to the fact that plant species adapt differently to changes in topographic, anthropogenic, and edaphic factors in their environment [46] also different species growing together under similar environmental conditions varied in their response and adaptability to nutrient limits [47].

Furthermore, this may entail that woody species vary in their soil nutrient return and also exert great influence on soil nutrient compositions. This had been documented by several scholars in previous studies [48,49,50,51]. Mbong, et al. [52] reported that changes in soil biotic and abiotic conditions created by plants cause legacy effects in the soil that not only affect the performance of co-occurring plants of the same and other species but also the offspring of these species. In this way, soil conditions that were altered by a plant can affect the establishment, growth, performance, or reproduction of the later arriving plants.

5. CONCLUSION

From the research, evidence abounds that there are some wild species with potential horticultural values within the study area. Also, there is a marked significant ($P<0.05$) difference in the physical and chemical conditions of the soil with respect to the study locations. In this research, the properties of the soil samples revealed that these four species could thrive in varied to moderate conditions. The proof presented herein confirms that each of these plants has several morphological features which are diagnostic to the taxa. It is concluded that environmental aesthetics could be improved by massive adoption and use of these plants in the locality as outdoor plants for walkway decoration because the flowers of the species possess a colorful display and the plants' blooms all year round hence making it visually appealing when introduced in lawns, front yards, and balcony sit outs. Aside from the fact that this design can aid proper relaxation due to its stem arrangement as a shrub, its leaves may be spread across to provide shade. This research has also shown that aside from the ornamental perspectives, the massive cultivation of these plants within the study area is needful due to other ethnobotanical potentials.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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