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# Morphological Comparison of Five Varieties of *Colocasia esculenta* (L.) Schott in Anambra State, Southeastern Nigeria

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## Abstract

**Comparative morphological study of five varieties of *Colocasia esculenta* (L.) Schott present in Anambra State, Nigeria was carried out, in order to furnish plant taxonomists with information which could be of great help in delimitation of the varieties. Significant difference was established at $p < 0.05$. The result showed that adaxial surface of "kochuo" had a purplish dot on the centre, abaxial leaf surface had a conspicuous purplish colour at the point of attachment to the leaf, and the cormels had numerous striking vertical purple stripes on the surface. There was presence of foliaceous (leaf-like) appendages at the veins of the abaxial surface of the leaf of "ogeriobosi". The leaf length ranged from 35.6 ± 7.70 cm ("kochuo") to 49.9 ± 3.55 cm ("ogeriobosi"). Petiole length of "ogeriobosi" was the highest (63.3 ± 3.83 cm), whereas the least was *Colocasia esculenta* var. *antiquorum* (26.67 ± 2.20 cm). The corm length ranged from 4.10 ± 0.10 cm (*Colocasia esculenta* var. *antiquorum*) to 8.60 ± 0.35 cm ("ogeriobosi"), while the cormel length ranged from 3.70 ± 0.96 cm (*Colocasia esculenta* var. *antiquorum*) to 7.03 ± 0.36 cm ("ogeriobosi"). This work has revealed diagnostic and differential morphological characters, which could be useful for identification and description of varieties of *C. esculenta*. In addition, it provided additional information which might be helpful in resolving the on-going controversy in the taxonomy of *Colocasia*, which would, in turn, probably lead to possible delimitation of *C. esculenta.***

## Keywords

***Colocasia*, Corms, Cormels, Diagnostic Characters, Foliaceous Appendages, Morphological Characters, Plant Taxonomy**

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## 1. Introduction

*Colocasia esculenta* (L.) Schott of the family Araceae are popular tuber crops in Southeastern Nigeria. *Colocasia esculenta* and *Xanthosoma sagittifolium* serve as staple food in Southeastern Nigeria, and are commonly known as cocoyam. Various ethnic groups in Nigeria have different names for *C. esculenta*, which attested to its nationwide distribution and use. It is known as ede/akaso/uli in Ibo, guaza in Hausa, koko in Yoruba, mkpon in Efik and ikereburu in Ijo [1]-[4].

The observed varieties of *C. esculenta* showed a lot of variability in morphological characters. This variability is common among crops that have been cultivated for a long time [5]. Currently, *C. esculenta* is considered as the major species with two varieties: *Colocasia esculenta* var. *antiquorum* (L.) (Schott) Hubbard & Rehder and *Colocasia esculenta* var. *esculenta* (L.) Schott [2] [6].

The knowledge of variability of *C. esculenta* is deficient and limited. In addition, there is paucity of literature on its taxonomy, which implies that thorough taxonomic research has not been done on *C. esculenta*. As a result, a morphological study on varieties of *C. esculenta* becomes a necessity; because morphological characters are the strongest tools used in taxonomic classification of plants, and this makes its application very crucial. The objective of this work, therefore, is to investigate the morphology of varieties of *C. esculenta*, with a view to exploring the macro-characters, which are the major criterion for plant classification.

## 2. Materials and Methods

### 2.1. Sources of Materials

Cormels of varieties of *C. esculenta* were obtained from the local farmers from the three senatorial districts in Anambra State, namely: Agulu in Anaocha LGA (Anambra North); Umuikwu-Anam in Anambra West LGA (Anambra Central) and Uga in Aguata LGA (Anambra South).

Five varieties were then selected from the three senatorial districts and grown in a common garden at Uga, Anambra State, Nigeria in June, 2013. They include *Colocasia esculenta* var. *antiquorum* (eddoe), *Colocasia esculenta* var. *esculenta* (dasheen), "Kochuo", "Nwine" and "Ogeriobosi" with collection numbers: ACE 34, ACE 35, ACE 36, ACE 37 and ACE 38, respectively. The voucher specimens were authenticated by Prof. C. U. Okeke and C. A. Ezeabara, Plant Taxonomists, and deposited in herbarium of Department of Botany, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.

### 2.2. Morphological Study

The petiole and leaf measurements were done in October 2013; hence the plants were four months old when the measurements were done. The corm (main stem) and cormels were measured in December 2013. The meristem of the corm (main stem) were removed until they cannot be removed without force; third cormels from the base of the main stem were randomly chosen and third fully opened active leaves and petioles from the base were measured. The petiole measurement started from the ligule to the base of the leaf. The raw corms and third cormels from the base of the main stem were peeled with a knife. Observations and measurements of the plants parts were done using eye lens, thread and ruler. Photographs of the habit and plant parts were taken with digital camera (Sony DSC-W230, China).

### 2.3. Statistical Analysis

One-Way-Anova (F-Test) was used to analyze the data at $p < 0.05$. Duncan's Multiple Range Test (DMRT) was then used to separate the means and data were expressed as mean ± standard deviation of triplicate determinations.

## 3. Results

The leaf of all the varieties was thick, succulent and downward-pointing, with reticulate venation. Three strong midribs arose from the point of attachment to the petiole, the main midrib pointed towards the basal lobe, while other two smaller midribs extended to the two posterior lobes, with one midrib on each lobe. The primary lateral veins originated from the three midribs, while the veinlets emanated from these primary lateral veins. The leaf margin was entire; the leaf blade was sagittate and not shiny, the abaxial and adaxial surfaces of the leaf blade

were glabrous with the exception of abaxial surface of "ogeriobosi"; the anterior lobes were twice as large as the posterior lobes, which were round in shape; and the petiole attachment was peltate. Petiole had a wide range of colours, including pale green, dark green, yellowish green and purple (**Figures 1(a)-(j)**). The base of petiole of *C. esculenta* var. *antiquorum* was deep purple (**Figure 1(a)**) when compared with *C. esculenta* var. *esculenta* (**Figure 1(b)**). The leaf of "kochuo" has a prominent distinctive feature, which was presence of a purplish dot on the centre of the adaxial surface (**Figure 1(c)**). The petiole of "nwine" was yellowish green (**Figure 1(d)**, **Figure 1(i)** and **Table 1**), while that of "ogeriobosi" was purple in colour (**Figur 1(e)** and **Table 1**). Abaxial leaf surface of "kochuo" had a conspicuous purplish colour at the point of attachment to the leaf (**Figure 1(h)**). "Ogeriobosi" had foliaceous (leaf- like) appendages at the veins of the abaxial surface of the leaf (**Figure 1(j)**).

*C. esculenta* var. *antiquorum* and "kochuo" had large corms which were more or less orbicular (approximately circular) in shape, whereas corms of *C. esculenta* var. *esculenta*, "nwine" and "ogeriobosi" were more or less oval. "Ogeriobosi" had the largest corm as well as the largest cylindrical cormels (**Figures 2(a)-(f)**). "Nwine" possessed large corm with slender cormels (**Figure 2(c)** and **Figure 2(f)**). Cormels of *C. esculenta* var. *antiquorum* were small, numerous and round. They were relatively the smallest, whereas those of "ogeriobosi" were the biggest (**Figure 2(a)**, **Figure 2(e)**, **Figure 2(f)** and **Table 1**). The cormels of *C. esculenta* var. *esculenta* were few and more or less cylindrical shaped, while cormels of "kochuo" were numerous with vertical purplish stripes on the surface.


**Figure 1.** Photomicrographs of habit and abaxial leaf surfaces of five varieties of *Colocasia esculenta*. (a) Habit of *C. esculenta* var. *antiquorum*. (b) Habit of *C. esculenta* var. *esculenta*. (c) Habit of "kochuo". **(**d) Habit of "nwine". (e) Habit of "ogeriobosi". (f) Abaxial leaf surface of *C. esculenta* var. *antiquorum*. (g) Abaxial leaf surface of *C. esculenta* var. *esculenta*. (h) Abaxial leaf surface of 'kochuo'. (i) Abaxial leaf surface of "nwine". (j) Abaxial leaf surface of "ogeriobosi".


**Figure 2.** Photomicrographs of five varieties of *Colocasia esculenta* showing the shape, size and texture of the main stem (corm) and cormels. (a) *C. esculenta* var. *antiquorum*. (b) *C. esculenta* var. *esculenta*. (c) "kochuo". (d) "nwine". (e) "ogeriobosi". (f) [(A) *C. esculenta* var. *antiquorum*, (B) *C. esculenta* var. *esculenta*, (C) "kochuo", (D) "nwine", (E) "ogeriobosi"].

**Table 1.** Morphological characters (cm) of *Colocasia esculenta* var. *antiquorum*, *Colocasia esculenta* var. *esculenta*, "Kochuo", "Nwine" and "Ogeriobosi".

| Varieties | Petiole length | Petiole colour | Leaf length | Leaf width | Leaf colour | Corm length | Corm width | Cormel length | Peeled tuber (raw) |
|---|---|---|---|---|---|---|---|---|---|
| Antiq | 26.67 ± 2.20$^{a}$ | Pale green | 42.80 ± 5.86$^{a}$ | 36.90 ± 4.25$^{a}$ | Pale green | 4.10 ± 0.10$^{a}$ | 5.23 ± 1.28$^{a}$ | 3.70 ± 0.96$^{a}$ | Green |
| Esc | 38.07 ± 2.22$^{b}$ | Pale green | 44.80 ± 4.33$^{b}$ | 36.00 ± 2.65$^{a}$ | Deep green | 6.17 ± 0.50$^{b}$ | 4.47 ± 0.72$^{b}$ | 5.00 ± 1.35$^{b}$ | Green |
| "Kochuo" | 40.33 ± 22.35$^{c}$ | Green | 35.6 ± 7.70$^{c}$ | 34.13 ± 4.80$^{b}$ | Deep green | 4.86 ± 1.95$^{c}$ | 6.33 ± 1.27$^{c}$ | 5.45 ± 3.02$^{c}$ | Purple |
| "Nwine" | 41.4 ± 5.65$^{d}$ | Yellowish green | 41.4 ± 4.23$^{d}$ | 45.27 ± 3.66$^{c}$ | Pale green | 4.55 ± 0.87$^{d}$ | 5.67 ± 0.59$^{d}$ | 6.63 ± 1.42$^{d}$ | Pink |
| "Ogeriobosi" | 63.3 ± 3.83$^{e}$ | Purple | 49.9 ± 3.55$^{e}$ | 35.8 ± 3.64$^{d}$ | Deep green | 8.60 ± 0.35$^{e}$ | 5.53 ± 0.76$^{e}$ | 7.03 ± 0.36$^{e}$ | Milk |

Antiq = *Colocasia esculenta* var. *antiquorum*; Esc = *Colocasia esculenta* var. *esculenta*. Data are means ± standard deviation of triplicate determinations. Columns with different subscripts are significantly different at ($p < 0.05$).

There was significant difference among the petiole length of all the varieties at $p < 0.05$. Petiole length of "ogeriobosi" was the highest (63.3 ± 3.83 cm), while the least was *C. esculenta* var. *antiquorum* (26.67 ± 2.20 cm). The petiole colour of *C. esculenta* var. *antiquorum* and *C. esculenta* var. *esculenta* were the same, whereas others differed. There was significant difference among the leaf length of all the varieties at $p < 0.05$. The leaf length of "ogeriobosi" was the highest (49.9 ± 3.55 cm), while the least was "kochuo" (35.6 ± 7.70 cm). There was no significant difference between the leaf width of *C. esculenta* var. *antiquorum* (36.90 ± 4.25 cm) and *C. esculenta* var. *esculenta* (36.00 ± 2.65 cm), whereas the leaf width of "nwine" (45.27 ± 3.66 cm) was the highest. The leaves of *C. esculenta* var. *esculenta*, "kochuo" and "ogeriobosi" were deep green in colour, while those of *C. esculenta* var. *antiquorum* and "nwine" were light green. There was significant difference among the corm

lengths of all the varieties. The highest corm length was 8.60 ± 0.35 cm ("ogeriobosi"), and the least was 4.10 ± 0.10 (*C. esculenta* var. *antiquorum*). There was also significant difference among the corms width of all the varieties. "Kochuo" (6.33 ± 1.27 cm) had the greatest corm width, whereas the least was found in *C. esculenta* var. *esculenta* (4.47 ± 0.72 cm). The cormel length of "ogeriobosi" (7.03 ± 0.36 cm) was the highest, while *C. esculenta* var. antiquorum (3.70 ± 0.96 cm) was the least. The colour of the peeled raw tubers of all the varieties varied with *C. esculenta* var. *antiquorum* and *Colocasia esculenta* var. *esculenta* having the same colour (**Table 1**).

## 4. Discussion

The common leaf features of all the varieties with the exception of presence of foliaceous outgrowth at the abaxial surface of "ogeriobosi" suggested their inter-relatedness. These characters could be regarded as their field characters and probably as the generic characters of *Colocasia*; which some could be applicable in distinction of *Colocasia* from *Xanthosoma*. The appearance of *C. esculenta* and *X. sagittifolium* are sometimes confusing, as a result of their similarity. The leaves of *Xanthosoma* (Tannia) are large, approximately 20 cm in length, 15 cm in width, hastate (saggitate-ovate) in shape, with the anterior lobe twice as large as the posterior lobe, with distinct marginal vein, and round basal lobes [7]. In addition, the petiole attachment of *Xanthosoma* is at the margin of the leaf. Leaves of *X. sagittifolium* are nearly in a rosette in acaulescent plants, or in a distal crown in mature plants; blades horizontal to slight ascending, with the posterior lobes ascending, simple, upper surface dark green with light green primary secondary veins on basal lobes, lower surface light green with dark green venation; petioles light green; basal lobes of the leaf sub-rhomboid obtuse [8]. *Colocasia* can therefore, be easily distinguished from *Xanthosoma* by the point where the petiole is attached to the leaf. In *Colocasia*, the petiole attachment was peltate, whereas for *Xanthosoma*, the petiole attachment is at the margin of the leaf. Moreover, *C. esculenta* can be differentiated from *X. sagittifolium* by shape of the basal lobes, position of the leaf blades, and colour of petiole and leaf. In *Colocasia esculenta*, the basal lobe of leaf was round, leaf blade pointed downward, and leaf colour was dark green with petiole colour ranging from pale green, dark green, yellowish green and purple; while for *X. sagittifolium*, basal lobes is sub-rhomboid obtuse, blades horizontal to slight ascending, with leaf and petiole light green. It has been stated that morphological characteristics are the strongest determinants of the agronomic value and taxonomic classification of plants [9].

Generally, all the varieties of *C. esculenta* looked alike in the field until a closer look was made. Interestingly, however, there were remarkable differences in some parts of the varieties. Presence of foliaceous appendages at the veins of the abaxial surface of "ogeriobosi" leaves could be regarded as a diagnostic character; in addition, the leaf length of "ogeriobosi" (49.9 ± 3.55 cm) was the highest; and deep purple colour of the petiole was the most conspicuous morphological feature differentiating it from others. Diagnostic character for "nwine" was possession of yellowish green petiole, with highest leaf width (45.27 ± 3.66 cm), whereas that of "kochuo" was location of purplish spot in the centre of the adaxial surface of the leaves. In addition, varieties of *C. esculenta* can be delimited on the basis of their leaf, petiole as well as peeled corm and cormel colour. The leaves of *C. esculenta* var. *esculenta*, "kochuo" and "ogeriobosi" were deep green in colour, indicating a close relatedness, whereas those of *C. esculenta* var. *antiquorum* and "nwine" were pale green, also suggesting a close affinity. In addition, variation in the colour of the peeled raw corm and cormel of all the varieties with the exception of *C. esculenta* var. *antiquorum* and *C. esculenta* var. *esculenta* could be beneficial in differentiating them. The use of leaf characters in classification and identification of plants has been extensively reported. It has been documented that the leaf characters, such as arrangement, type, form, duration and venation are widely used in both classification and identification [10]. In *Ulmus* and *Betula*, the species are delimited only on the basis of leaf characters. In *Trifolium*, the species were separated on the basis of stipule morphology. *Dalbergia* species were distinguished on the basis of their leaflet, size, shape and arrangement on the rachis. The leaves are important for identification in palms, *Salix* and *Populus* [11]. Leaf character has been reported to be a critical tool in the hand of taxonomists in the classification and separation of taxa [12].

Moreover, there were some similarities between *C. esculenta* var. *antiquorum* and *C. esculenta* var. *esculenta*, which happened to be the only two taxonomically recognized varieties of *C. esculenta*. The colour of the peeled raw tubers of all the varieties varied, but *C. esculenta* var. *antiquorum* and *C. esculenta* var. *esculenta* had the same colour. There was also no significant difference in the leaf width of *C. esculenta* var. *antiquorum* (36.90 ± 4.25 cm) and *C. esculenta* var. *esculenta* (36.00 ± 2.65 cm), indicating a close affinity between them. However,

some morphological characters can be used in differentiating them. The corm and cormel length of *C. esculenta* var. *esculenta* (6.17 ± 0.50 cm; 5.00 ± 1.35 cm) were bigger than those of *C. esculenta* var. *antiquorum* (4.10 ± 0.10 cm; 3.70 ± 0.96 cm), respectively. Besides, *C. esculenta* var. *antiquorum* had large corm which was more or less orbicular (approximately, circular) in shape with numerous small round cormels, whereas the corm of *C. esculenta* var. *esculenta* was large and oval with few more or less cylindrical shaped cormels. The petiole of *C. esculenta* var. *antiquorum* was deep purple beneath, while *C. esculenta* var. *esculenta* was pale green. This suggested that the petiole colour, size, shape and number of corm and cormel of *C. esculenta* var. *antiquorum* and *C. esculenta* var. *esculenta*, therefore, were the most prominent morphological characters which distinguished them from each other. Some of these characters have extensively been used to differentiate between *C. esculenta* var. *antiquorum* and *C. esculenta* var. *esculenta* by various workers [2] [6] [13] [14].

There was also significant difference in the corm length, corm width and cormel length of all the varieties of *C. esculenta*. This indicated that these characters could be useful in distinguishing the varieties. Long slender cormel of "nwine" could be used as a ready distinctive character, as well as the largest corm and cormel size of "ogeriobosi". It has been specified that underground parts, such as roots and tubers, are of some taxonomic value in plants [10]. The tubers are helpful in the taxonomy of *Dioscorea* and Cyperaceae. Some vegetative characters that play a major role in plant taxonomy and in deducing phylogeny include growth habit, phonological characters, underground organs, stems, leaves, petiole and stipules. Three sesame species, namely *Sesamum alatum*, *S. radiatum* and *S. indicum* were differentiated on the basis of their vegetative and the pod characteristics [15]. In addition, such characteristics, because of their high taxonomic importance, could be used in constructing a taxonomic key for the purpose of easy and quick identification of the three sesame species irrespective of their growth environment.

## 5. Conclusions

This work provided information on the morphology of these five varieties of *C. esculenta* present in Anambra State, Nigeria; which was previously lacking. Secondly, the overwhelming evidence from this study suggested close relatedness between *C. esculenta* var. *antiquorum* and *C. esculenta* var. *esculenta*, and provided diagnostic characters for "kochuo", "nwine" and "ogeriobosi".

Conspicuous diagnostic characters observed in "kochuo", were presence of purplish colour at the point of attachment to the leaf of the abaxial leaf surface, as well as presence of a purplish dot on the centre of the adaxial surface of the leaf, and numerous vertical purplish stripes on the surface of the cormels. For "ogeriobosi", the prominent diagnostic features include: presence of foliaceous appendages at the veins of the abaxial surface of the leaves, as well as the purplish colour of the petiole; while yellowish green petiole colour of "nwine" was only the striking diagnostic character. The differential characters include, large corm of *C. esculenta* var. *antiquorum*, which was more or less orbicular (approximately circular) in shape with numerous small round cormels; large and oval corm of *C. esculenta* var. *esculenta* with few more or less cylindrical shaped cormels; slender cormels of "nwine"; and possession of the largest oval corm of "ogeriobosi".

Plants are generally grouped by their relationship to one another based on their similarities and differences, which is based on the characters they possess. This study, therefore, supplied additional morphological information which might be helpful in resolving the on-going controversy in the taxonomy of *Colocasia*, which would, in turn, probably lead to possible delimitation of *C. esculenta*.

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