



## Comparative Study on the Vegetative and Floral Morphology of Three *Ipomoea* Species from Nigeria

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### Authors' contributions

This work was carried out in collaboration among all authors. Authors KUE and CNO designed the study, performed the statistical analysis. Author CFI wrote the protocol and wrote the first draft of the manuscript. Author GCU managed the literature searches. All authors read and approved the final manuscript.

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### ABSTRACT

**Aim:** The aim of this study was to determine the different vegetative and floral morphological features of three species of *Ipomoea*; *Ipomoea aquatica*, *Ipomoea asarifolia* and *Ipomoea involucrate*.

**Area of Study, Collection and Identification of Plants:** The study was conducted in Nnamdi Azikiwe University Awka, Anambra state of Nigeria. Three species were selected from the genus *Ipomoea*, they include: *Ipomoea asarifolia*, *Ipomoea involucrate* and *Ipomoea aquatica*. All the samples were collected from different locations across Nnamdi Azikiwe University premises.

**Methodology and Statistical Analysis:** The Morphological study was done by physical observation and measurement of physiognomic features of the fresh flower, leaf and stem. Plant type and growth habit were done by physical observation. The flower of each specimen was sectioned longitudinally and transversely to observe their placentation, stamen and carpel. The

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length of the sepal, petal, stamen and carpel were measured with a meter rule (cm). Counts were taken of the number of stamen, carpel, sepal, the inflorescence type, the floral symmetry, the number of sepal and petal colour were all observed and recorded carefully. The leaf texture, leaf arrangement, leaf shape, leaf type, leaf margin, leaf venation, leaf apex, leaf base were observed also and recorded. Data collected were analyzed using confidence interval at 95%, one way analysis of variance and mean separation by Duncan Multiple Range Test (DMRT) using SPSS version 21.

**Results:** Result of the vegetative morphology of three species of *Ipomoea* revealed that the three species are trailing herbs. The leaf shape is cordate for all species. The leaf apex of *I. asarifolia* is rounded while that of *I. involucreata* and *I. aquatica* is acuminate. The leaf base for *I. asarifolia* and *I. involucreata* is cordate while that of *I. aquatica* is truncate. The leaf arrangement and leaf venation is alternate and reticulate respectively for all species studied. The result on the quantitative vegetative characters revealed that the petiole is longer in *I. asarifolia* (13.655-16.045b) and shorter in *I. involucreata* (3.805-4.815 cm). The leaf length is also higher in *I. asarifolia* (9.522-10.898 cm) and lower in *I. aquatica* (4.273-4.887 cm). The leaf width is higher in *I. asarifolia* (11.799-12.301 cm) and lower in *I. aquatica* (4.351-5.29 cm). There was a significant difference in all quantitative vegetative characters studied ( $p < 0.05$ ). Result of the floral morphology of three species of *Ipomoea* revealed that the flower type is complete in the three species. There is presence of hairs on the sepals of *I. involucreata* but absent on *I. asarifolia* and *I. aquatica*. The floral symmetry is generally actinomorphic in all three species. Result on the quantitative floral characters revealed that diameter of flower is higher in *I. aquatica* (4.04-4.72 cm) and lower in *I. involucreata* (3.08-3.38 cm). There was a significant difference in the diameter of flower and pedicle length between the three species of *Ipomoea*.

**Conclusion:** Generally, the members of this genus *Ipomoea* have morphological differences or species uniqueness for easy identification.

**Keywords:** *Aquatica*; *Asarifolia*; floral; *ipomoea*; *involucreata*; morphology; species; vegetative.

## 1. INTRODUCTION

The Convolvulaceae comprise nearly 1650 predominantly tropical species. The genus *Ipomoea*, with approximately 500-600 species, comprises the largest number of species within the Convolvulaceae [1,2,3]. This family is dominated by twining or climbing woody or herbaceous plants that often have heart-shaped leaves and funnel-shaped flowers [4]. The genus *Ipomoea* occurs in the tropics of the world although some species also reach temperate zones [5]. The species of this genus are mainly distributed throughout the South and Central America countries, and tropical African territories [3].

One of the most noticeable anatomical characteristics of the Convolvulaceae is the existence of cells, which secrete resin glycosides in the foliar and roots tissues of the plants. These glycosides constitute one important chemotaxonomic marker of this family [6] and are responsible for the purgative properties of some species of the Convolvulaceae [7].

Most *Ipomoea* occur in tropical and subtropical climates throughout the world, but representative

elements of the genus are in all known biomes [8,9]. The genus comprises about 500 species in the tropical and sub-tropical zones of the world. Thirty-eight species have been reported in West Africa and of these; thirty species are reported in Nigeria [10]. They are mostly herbaceous to woody, scrambler, climber, trailer, twinner, shrub or small tree. The presence of milky latex exudates and bicollateral vascular bundles is highly diagnostic [11]. Flowers are campanulate, generally bisexual, actinomorphic with variable petal colours ranging from purple to blue, red, pink, scarlet or white. Stamens are five situated alternately with the corolla lobes; ovary is superior with one style, stigma capitate [12]. Adeniyi et al. [2] used the style length and bracts shape characters to aid the identification and classification of commonly encountered *Ipomoea* species in south west Nigeria. Fruits are capsular, thin walled, globose or ovoid shaped and bearing 4 or rarely 6 seeds per fruit. *Ipomoea* are good flagship species and possible good environmental indicators [13]. *Ipomoea* species are generally of vital economic importance ranging from ornamental, medicinal to culinary value. *Ipomoea* species are highly variable in nature and this has led to the description of intra specific species [14].

The aim of this study was to determine the different morphological features of three species of *Ipomoea*; *Ipomoea aquatica*, *Ipomoea asarifolia* and *Ipomoea involucreta* including various botanical attributes under local conditions to get a better insight on the vegetative and floral morphology of these important economic plant species which could be very useful in the taxonomic description of these plants. This also provides more detailed information on the genus *Ipomoea*.

## 2. MATERIALS AND METHODS

### 2.1 Area of Study

The study was conducted in Nnamdi Azikiwe University, Awka, Anambra state of Nigeria.

### 2.2 Collection and Identification of Plants

Three species were selected from the genus *Ipomoea*, which include: *Ipomoea asarifolia*, *Ipomoea involucreta* and *Ipomoea aquatica*. Leave, stem, root and flowers of the plant species were collected. All the samples were collected from different locations across Nnamdi Azikiwe University premises. The area is on Longitude 6°13'0"N and Latitude 7°4'60"E, with a temperature of about 33°C/91°F. It is located in sub-locality district, Awka, Anambra state of Nigeria. The specimens collected were taxonomically identified by Dr. Mbaekwe, E.I., a plant Ecologist in the Department of Botany, Nnamdi Azikiwe University, Awka.

### 2.3 Methodology

The morphological study was done by physical observation and measurement of physiognomic features of their fresh flower, leaf and stem. Plant type and growth habit were done by physical observation. The flower of each specimen was sectioned longitudinally and transversely to observe their placentation, stamens and carpel. The length of the sepals, petals, stamens and carpel were measured with a meter rule (cm) and recorded carefully for each of the specimens. Counts were taken of the number of stamen, carpel, sepal and recorded on a datasheet. Photograph of a representative specimen of each species was taken.

In the flower part of the plants, the inflorescence type, the floral symmetry, the number of sepal and petal colour were all observed and recorded

carefully. The leaf texture, leaf arrangement, leaf shape, leaf type, leaf margin, leaf venation, leaf apex, leaf base were observed also and recorded. The leaf length, leaf width, leaf petiole, flower pedicel, length of stamen, length of style, length of petal and sepal, diameter of the funnel-like flower were all measured with a meter rule. The stem height was measured with a measuring tape (m). The stem colour, shape and stem branching were observed physically.

### 2.4 Statistical Analysis

Data collected were analyzed using confidence interval at 95%, one way analysis of variance and mean separation by Duncan Multiple Range Test (DMRT) using Statistical Package for social sciences (SPSS) version 21.

## 3. RESULTS

### 3.1 Comparative Qualitative Vegetative Morphology

Result of the vegetative morphology of three species of *Ipomoea* revealed that the three species are trailing herbs (Table 1). The leaf shape is cordate for all three species. The leaf apex of *I. asarifolia* is rounded while that of *I. involucreta* and *I. aquatica* are acuminate (Table 1). The leaf base for *I. asarifolia* and *I. involucreta* is cordate while that of *I. aquatic* is truncate. The leaf arrangement and leaf venation is alternate and reticulate respectively for all species studied. Leaf hairs are present in *I. involucreta* but absent in *I. asarifolia* and *I. aquatica* (Table 1).

### 3.2 Comparative Quantitative Vegetative Morphology

The result on the quantitative vegetative characters revealed that the petiole is longer in *I. asarifolia* (13.655-16.045 cm) and shorter in *I. involucreta* (3.805-4.815 cm). The leaf length is also higher in *I. asarifolia* (9.522-10.898 cm) and lower in *I. aquatic* (4.273-4.887 cm) (Table 2). The leaf width is higher in *I. asarifolia* (11.799-12.301 cm) and lower in *I. aquatic* (4.351-5.29 cm). The stem length is higher in *I. asarifolia* (4.834-5.506 cm) and lower in *I. aquatic* (2.823-3.638 cm) while the leaf area is higher in *I. asarifolia* (113.451-132.907 cm<sup>2</sup>) and lower *I. involucreta* (28.10 -32.783 cm<sup>2</sup>). There was a significant difference in all quantitative vegetative characters studied ( $p < 0.05$ ).

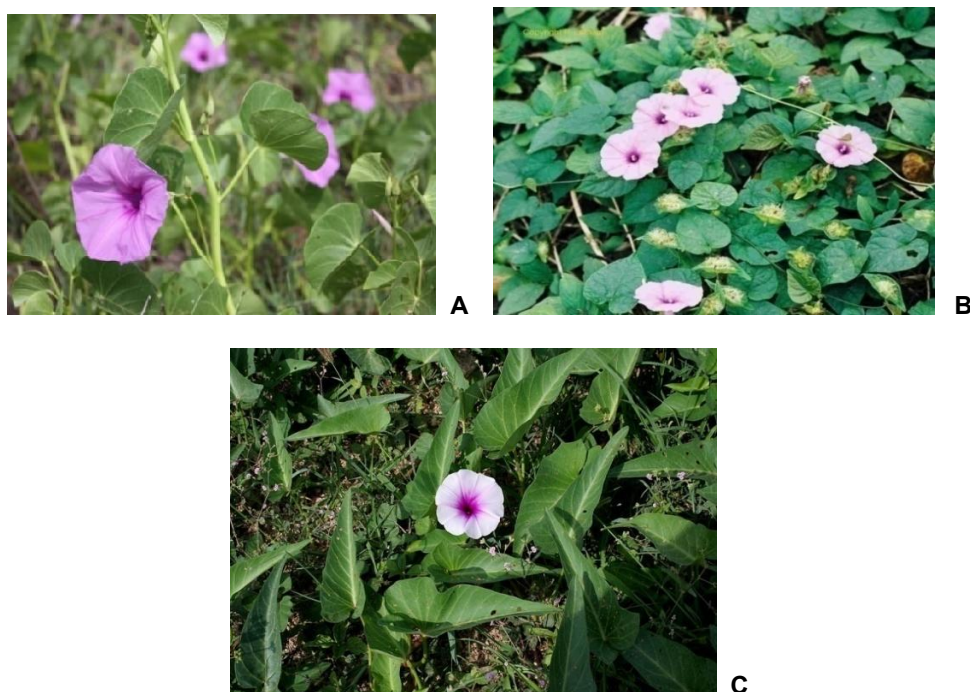


Fig. 1. The three species of *Ipomoea* under study; A. *Ipomoea asarifolia*, B. *Ipomoea involucreta* and C. *Ipomoea aquatic*

Table 1. Comparative qualitative vegetative morphology of three species of *ipomoea*

Vegetative parameters	<i>I. asarifolia</i>	<i>I. involucreta</i>	<i>I. aquatic</i>
Plant habit	Trailing herb	Trailing herb	Trailing herb
Leaf shape	Cordate	Cordate	Cordate
Leaf apex	Rounded	Acuminate	Acuminate
Leaf base	Cordate	Cordate	Truncate
Leaf margin	Entire	Entire	Entire
Leaf arrangement	Alternate	Alternate	Alternate
Venation	Reticulate	Alternate	Reticulate
Hairs	Absent	Present	Absent

Table 2. Comparative quantitative vegetative morphology of three species of *ipomoea*

Vegetative parameters	<i>I. asarifolia</i>	<i>I. involucreta</i>	<i>I. aquatic</i>
Petiole (cm)	13.655-16.045 <sup>b</sup>	3.805-4.815 <sup>a</sup>	4.273-4.887 <sup>a</sup>
Leaf length (cm)	9.522-10.898 <sup>b</sup>	6.355-6.885 <sup>a</sup>	6.482-8.178 <sup>a</sup>
Leaf width (cm)	11.799-12.301 <sup>b</sup>	4.297-4.904 <sup>a</sup>	4.351-5.29 <sup>a</sup>
Stem length (cm)	4.834-5.506 <sup>c</sup>	4.403-4.917 <sup>b</sup>	2.823-3.638 <sup>a</sup>
Leaf Area (cm <sup>2</sup> )	113.451-132.907 <sup>b</sup>	28.104-32.783 <sup>a</sup>	28.579-43.325 <sup>a</sup>

### 3.3 Comparative Qualitative Floral Morphology

Result of the floral morphology of three species of *Ipomoea* revealed that the flower type is complete in the three species (Table 3). The ovary type is also superior in all the three species. The colour of petals is whitish-pink in *I.*

*involucreta* and *I. aquatic* but purple in *I. asarifolia*. The placentation is basal in the three species. The shape of flower is funnel-shape in all the three species. There are presences of hairs on the sepals of *I. involucreta* but absent on *I. asarifolia* and *I. aquatic*. The floral symmetry is generally actinomorphic in all three species.

**Table 3. Comparative qualitative floral morphology of three species of *Ipomoea***

Flower parameters	<i>I. asarifolia</i>	<i>I. involucrate</i>	<i>I. aquatic</i>
Flower type	Complete	Complete	Complete
Type of ovary	Superior	Superior	Superior
Colour of petal	Purple	Whitish Pink	Whitish Pink
Placentation	Basal	Basal	Basal
Shape of flower	Funnel shape	Funnel Shape	Trumpet shape
Hairs in the sepals	Glabrous	Present	Glabrous
Floral symmetry	Actinomorphic	Actinomorphic	Actinomorphic

**Table 4. Comparative quantitative floral morphology of three species of *Ipomoea***

Flower parameters	<i>I. asarifolia</i>	<i>I. involucrate</i>	<i>I. aquatic</i>
Diameter of Flower(cm)	4.056 -4.224 <sup>b*</sup>	3.08-3.38 <sup>a</sup>	4.04-4.72 <sup>b</sup>
No of Stamen	5.0-5.0 <sup>a</sup>	5.0-5.0 <sup>a</sup>	5.0-5.0 <sup>a</sup>
Length of Stamen (cm)	2.11-2.77 <sup>a</sup>	2.55-2.67 <sup>a</sup>	2.36-2.46 <sup>a</sup>
No of Styles	1-1 <sup>a</sup>	1-1 <sup>a</sup>	1-1 <sup>a</sup>
Length of style(cm)	2.20-2.88 <sup>a</sup>	2.66-2.79 <sup>a</sup>	2.52-2.64 <sup>a</sup>
No of Sepals	5.0-5.0 <sup>a</sup>	5.0-5.0 <sup>a</sup>	5.0-5.0 <sup>a</sup>
Pedicle Length (cm)	3.18-3.60 <sup>b</sup>	2.66-2.80 <sup>a</sup>	4.33-4.48 <sup>c</sup>

Quantitative results are presented in lower and upper bonds of confidence intervals at 95%.

\*Rows followed by the same alphabets is not significantly different by DMRT ( $p>0.05$ )

### 3.4 Comparative Quantitative Floral Morphology

Result on the quantitative floral characters revealed that diameter of flower is higher in *I. aquatic* (4.04-4.72 cm) and lower in *I. involucrate* (3.08-3.38 cm). The number of stamen is five (5) for all the species. The length of stamen is higher in *I. involucrate* (2.55-2.67 cm) and lower in *I. asarifolia* (2.11-2.77 cm). The number of style is one (1) for the three species. The length of style is higher in *I. involucrate* (2.66-2.79 cm) and lower in *I. asarifolia* (2.20-2.88cm). The length number of sepal is 5 in the three species. The pedicle length is highest in *I. asarifolia* (4.33-4.48 cm) and lowest in *I. involucrate* (2.66-2.80cm). There was a significant difference in the diameter of flower and pedicle length between the three species of *Ipomoea*.

### 4. DISCUSSION

The comparative study of some members of *Ipomoea* namely: *Ipomoea asarifolia*, *Ipomoea involucrate* and *Ipomoea aquatic* showed the major morphological difference basically on the leaf size, leaf shape, leaf apex, leaf base, petiole length, presence of hairs in the body and floral color and morphology.

Qualitatively, the leaf shape of all the three species corresponds largely with the findings of Akobundu and Aagyakwa [16] who reported that the leaves are alternate, rounded, blunt at the apex and heart-shaped at the base.

Statistically, the result on the quantitative vegetative characters revealed that the petiole length is higher in *I. asarifolia* and lower in *I. involucrate*. The leaf length is also higher in *I. asarifolia* and lower in *I. aquatic*. The leaf width is higher in *I. asarifolia* and lower in *I. aquatic*. This broad leaf of *I. asarifolia* suggests that the plant can be used as a cover crop in farming system to reduce weed or increase the soil moisture and structure. The stem length is higher in *I. asarifolia* and lower in *I. aquatic* while the leaf area is higher in *I. asarifolia* and lower *I. involucrate*. The study also revealed that the three species studied are trailing herbs. This is in agreement with the findings of Stefanovic et al. [15] who reported that *Ipomoea asarifolia*, *I. aquatic* and *I. involucrate* are herbs trailing on the ground usually several meters long with numerous internodes. There was a significant difference in all quantitative vegetative characters studied.

The result of the floral morphology of the three species of *Ipomoea* is consistent with the findings of [2]. The result revealed that the flower type is complete in the three species. The ovary type is also superior in all the three species. The colour of petals is pink in *I. involucrate* and *I. aquatic* but purple in *I. asarifolia* and this could depict that *I. involucrate* and *I. aquatic* share a possible closer ancestor that *I. asarifolia*. The placentation is basal in the three species. The shape of flower is funnel or Trumpet in three species studied. Hairs are present in the sepals of *I. involucrate* but glabrous in *I. asarifolia* and *I.*

*aquatic*. The floral symmetry is generally actinomorphic in all three species with basal placentation. The inflorescence type is cyme in *I. involucrate* and *I. asarifolia* but axillary cyme with one to few flowers in *I. aquatic*.

The quantitative floral characters revealed that diameter of flower are higher in *I. aquatica* (4.04-4.72 cm) and lower in *I. involucrate* (3.08-3.38 cm). The number of stamen is five (5) for all the species. The length of stamen is higher in *I. involucrate* (2.55-2.67 cm) and lower in *I. asarifolia* (2.11-2.77 cm). The number of carpel is one (1) for the three species. The length of style is higher in *I. involucrate* (2.66-2.79 cm) and lower in *I. asarifolia* (2.20-2.88 cm). The number of sepal is 5 in the three species. The pedicel length is highest in *I. asarifolia* (4.33-4.48 cm) and lowest in *I. involucrate* (2.66-2.80 cm). There was a significant difference in the diameter of flower and pedicel length between the three species of *Ipomoea* which could be a factor in the delimitation of the three species into individual species despite their phylogenetic relationship. This result also corresponds largely with the findings of [2] who reported that the flowers of *Ipomoea* are campanulate, generally bisexual, actinomorphic with variable petal colours ranging from purple to blue, red, pink, scarlet or white. Stamens are five situated alternately with the corolla lobes. The ovary is superior with one style and the stigma is capitate.

## 5. CONCLUSION

The result revealed that the flower type is complete in the three species of *Ipomoea*. The significant difference in the flower diameter and pedicel length between the three species of *Ipomoea* might be a factor of delimitation of the three species into individual species despite their phylogenetic relationship. Generally, the members of this genus *Ipomoea* have morphological differences or species uniqueness for easy identification.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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