

## Morphological Relationship among Three *Chrysophyllum* Species and their Taxonomic Implication

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### Abstract

Morphological studies of *Chrysophyllum albidum*, *C. cainito* and *C. subnudum* were investigated to confirm their inter-specific relationship. Results show that they are trees; the barks of *C. albidum* and *C. subnudum* are pale-grayish brown while that of *C. cainito* is scaly and brown. Leaves are elliptic in *C. albidum*; elliptic to obovate in *C. cainito* and lanceolate in *C. subnudum*. Sepal colour for *C. albidum* is greenish-yellow, *C. cainito* is purplish-white, while *C. subnudum* is white. Fruits are berries. Fruit colour varies per species when ripe, for *C. albidum*, it is yellow; for *C. cainito*, purple-pink and for *C. subnudum* dark green. Morphology of the three *Chrysophyllum* species investigated matched with that already described by some authors and showed intraspecific relationship among them.

**Keywords:** Morphological studies; *Chrysophyllum albidum*; Taxonomic implication

### Introduction

The genus *Chrysophyllum* belongs to the family *Sapotaceae*. *Sapotaceae* is a family of flowering plant belonging to order *Ericales*. The family comprises trees and shrubs with about 70 genera and 800 species with milky latex [1]. Distribution is pantropical, mainly in low land and lower montane rain forest [2]. The trees are usually long and straight but often low branching, deeply fluted, sometimes with small buttresses at the base [3]. Members are often characterized by the presence of reddish-brown hairs on the abaxial leaf surfaces. The leaves are simple alternate or rarely opposite, usually entire and coriaceous. Stipules are sometimes present but normally fall off extremely early and are in practical terms only seen in a few species.

Flowers are regular and usually bisexual and actinomorphic, only in a few species are they unisexual, they nearly always occur in cluster in the leaf-axile or on the older twigs behind the leaves or very rarely on the main trunk itself. The morphological characters of plants are easily observable and obtainable, thus are used most frequently in taxonomic studies [4]. Morphological characters can be grouped into two: Vegetative characters and floral or reproductive characters. They make up the greater part of the facies of most species which allows us to recognize them visually. Some of the vegetative characters that contribute to plant taxonomy and in deducing phylogeny includes: growth habit, underground parts, stems, leaves, petioles and stipules etc. Leaf characters such as arrangement, type, form, duration and venation are widely used in both classification and identification. The inflorescence, flowers and structures associated to them, form the traditional basis for taxonomic and descriptive work on plants. In *Anthyllis*, species are distinguished based on calyx types, species are distinguished on the basis of *staminodes* in *Scrophularia*, anther in *Eucalyptus*; Davis and Heywood [2] gave concise detail of the floral characters and their impact on taxonomy. Several authors have emphasized the usefulness of inflorescences in characterizing plant species [5].

Many authors have used morphology as the basis for classification and identification. Kahraman and Dogan used leaf morphological characters to separate two closely related species of *Salvia* in Turkey. Floral features have been found useful in delimiting species in the

genus *Salvia* [5,6] and also two subspecies of *Astrantia maxima* [7]. Morphological data can be extremely valuable in exploring evolutionary hypotheses for any given group. In general, morphological studies tend to be less costly, allow for greater taxonomic sampling, can be scored for many characters without damage to the specimens, and are the only method for analyzing extinct taxa known only from the fossil record.

Due to close morphological resemblance of *C. albidum* and *C. subnudum*, some authors have placed *C. subnudum* as variety of *C. albidum*, hence, necessitating this study to agree or disagree with the placement. The objective of the study is to carry out a comprehensive systematic survey of the three taxa of *Chrysophyllum* selected for this study to confirm their inter-specific relationship using morphological features.

### Materials and Methods

#### Specimen collection

Specimens of the three *Chrysophyllum* species (namely *C. cainito*, *C. albidum* and *C. subnudum*) were collected from three villages in Aboh Mbaise Local Government Area of Imo State. The villages are Ngali Obibi, Umuayara and Oboama Enyeogugu. *C. cainito* were collected from Oboama Enyeogugu while *C. albidum* and *C. subnudum* were collected from both Ngali Obibi and Umuayara.

#### Specimen identification

The specimens were identified by a taxonomist, Professor S.E. Okeke and were confirmed at the Forest Herbarium (FHI), Ibadan, Oyo State. Voucher specimens are deposited in Imo State University Herbarium (IMSUH) Owerri.

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## Morphological studies

Various morphological characters of the three species were examined and recorded. For leaves; the leaf base, leaf apex, venation, shape, arrangement, etc were observed and recorded. Leaves length and width, and petiole length were measured using meter rule. For the stems; the stem type, colour, nature of surface and rate of producing exoduce when cut were observed and recorded. Also, the stem girth and height were measured.

Floral parts were also examined and recorded. These parts include the calyx, corolla, androecium and gynoecium. Colour of the flower, position of their ovaries, were observed and recorded. Furthermore, fruit characteristics were observed and recorded. Their colour before and after ripening, fruit size at maturity, arrangement of the seeds when transversely sectioned were all recorded. Finally, the number of seeds per fruit per species was counted and recorded. The results of the morphological studies are presented in Table 1. Photographs of some of the morphological features such as stems, leaves, and fruits were taken using digital camera.

## Results and Discussion

The results accruing from morphological studies of *C. albidum*, *C. cainito* and *C. subnudum* are as presented below:

### Habit

The three species are evergreen trees.

	Characters	<i>C. albidum</i>	<i>C. cainito</i>	<i>C. subnudum</i>
<b>Inflorescence</b>	Pedical length (cm)	0.5-1	0.4-1	0.5-1
	Floral symmetry	Actinomorphic	Actinomorphic	Actinomorphic
	Arrangement	Cluster	Cluster	Cluster
	Type	Cymose	Cymose	Cymose
	Free/Fused	Free	Free	Free
	Sex	Bisexual	Bisexual	Bisexual
Flowering period	May-June	May-June	April-June	
<b>Calyx</b>	Number of sepal	6	5-6	6
	Colour	Greenish yellow	Yellow white	White
	Free/Fused	Free	Free	Free
<b>Corolla</b>	Number of petal	6	5	5-6
	Colour	Light greenish	Purplish white	Whitish
	Free/Fused	Free	Free	Free
<b>Androecium</b>	Anther shape	Bilobed	Lobed	Bilobed
	Filament number	10-12	5	10-15
<b>Gynoecium</b>	Ovary position	Superior	Superior	Superior
	Style	1	1	1
	Stigma	Lobed	Lobed	Rounded lobed
<b>Fruit</b>	Shape	Ovoid-subglobose	Rounded-Oval	Globose
	Colour when unripe	Green	Light green	Green
	Colour when riped	Yellow	Purple or pink	Green
	Type	Berry	Berry	Berry
	Seed arrangement	Star shaped	Star shaped	Star shaped
	Number of seed	3-5	5-8	4-5
Fruity period	July-August	June-July	May-July	
Seed colour	Brown	Brown	Brown	

Table 1: Floral morphology of the three species of *Chrysophyllum*.

Characters	<i>C. albidum</i>	<i>C. cainito</i>	<i>C. subnudum</i>
<b>Stem</b>			
Habit	Evergreen tree	Evergreen tree	Evergreen tree
Stem type	Dichotomously branching	Dichotomously branching	Dichotomously branching
Height (m)	32-36	28-30	34-36
Girth (m)	1.8-2.5	1.2-1.9	1.2-2.3
Colour	Pale greyish –brown	Brown	Pale greyish-brown
Bark	Rough	Scale bark	Rough
Tree shape	Dense	Dense	Dense
Root type	Tap	Tap	Tap
<b>Leaf</b>			
Texture	Leathery	Leathery smooth	Leathery smooth
Type	Simple	Simple	Simple
Arrangement	Alternate	Alternate	Alternate
Venation	Reticulate	Reticulate	Reticulate
Shape	Elliptic	Elliptic-Obovate	Lanceolate-narrowly elliptic
Margin	Entire	Entire	Entire
Apex	Obtuse	Mucronate	Obtuse
Base	Cuneate	Rounded	Cuneate
Attachment	Petiolate	Petiolate	Petiolate
Blade length (cm)	17.6-25.8 (21.7)	9.1-13.6 (11.35)	20.4-21.9(21.15)
Blade width (cm)	4.9-7.7 (6.3)	4.9-8.1 (6.5)	5.7-8.6(7.15)
Petiol length (cm)	1.5-3.0 (2.25)	1.3-1.7 (1.5)	1.8-2.9(2.35)

Table 2: Vegetative characters of three species of *Chrysophyllum*.

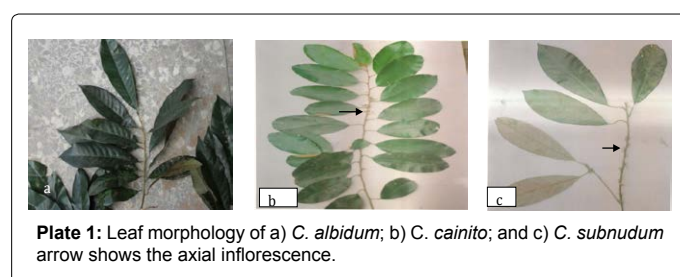


Plate 1: Leaf morphology of a) *C. albidum*; b) *C. cainito*; and c) *C. subnudum* arrow shows the axial inflorescence.

### Stem

The stems of the taxa are erect, and dichotomously branched. *C. albidum* has a height between 28-30 m with girth 1.2-1.9 m while *C. subnudum* has height of 34-36 m and girth of 1.2-2.3 m (Table 2). Bark is rough and pale grayish-brown for *C. albidum* and *C. subnudum* but scaly and brown for *C. cainito*.

### Leaves

The leaves are alternate, simple, petiolate and entire in the three species studied (Plate 1). Leaf texture showed that *C. cainito* and *C. subnudum* are leathery smooth while *C. albidum* is only leathery. Shapes of the leaves vary within species studied with *C. albidum* having elliptic leaf shape; *C. cainito* elliptic to obovate and *C. subnudum* has lanceolate-narrowly elliptic leaves shapes (Plate 1). *C. albidum* and *C. subnudum* have mucronate apex and rounded base. Petiole length varies in the three taxa investigated; *C. albidum* measured between 1.5-3.0 cm; *C. cainito* measured 1.3-1.7 cm long while *C. subnudum* has 1.8-2.9 cm long petiole (Table 2). The venation is reticulate in the three species studied. Size of the leaf blades varies in the three taxa, with *C. albidum* measuring 17.6-25.8 cm × 4.9-7.7 cm; *C. cainito* measures between 9.1-13.6 cm × 4.9-7.7 cm; and *C. subnudum* measures between 20.4-21.9 cm × 5.7-8.6 cm (Table 2).

## Inflorescences

The inflorescences are numerous, simple cymose, free and usually in dense clusters on the axile of the leaves or on older branches of the stem in the taxa studied (Plate 1).

## Flowers

The flowers are pedicellate, actinomorphic and bisexual in the three species investigated. Flowering period for *C. albidum* and *C. cainito* is between May and June while *C. subnudum* flowers between April and June. Length of pedicel for both *C. albidum* and *C. subnudum* range between 0.5 cm to 1.0 cm, while *C. cainito* ranges between 0.4-1.0 cm (Table 1).

## Calyx

Calyx is polysepalous in the three species studied. The sepals are six (6) in *C. albidum* and *C. subnudum* but varies between 5 to 6 in *C. cainito* (Table 1). The colour of sepals varies per species in the three taxa; *C. albidum* has greenish-yellow sepals. *C. cainito* has whitish-yellow while *C. subnudum* has white sepals.

## Corolla

There are 6 petals in *C. albidum*; 5 petals in *C. cainito* and ranges between 5-6 petals in *C. subnudum* (Table 1). The petals are free (Polypetalous) in the three taxa studied. Petal colour for *C. albidum* is light greenish; for *C. cainito* purplish-white while it is white for *C. subnudum*.

## Androecium

The anthers are bilobed in both *C. albidum* and *C. subnudum* but lobed in *C. cainito*. The number of filament varies per species; for *C. albidum* it ranges between 10-12; *C. subnudum* has 10-15 filaments while *C. cainito* has the least number of filament, 5.

## Gynoecium

The ovaries are superior in the three taxa examined. The stigma is lobed in both *C. albidum* and *C. cainito* but rounded-lobed in *C. subnudum*. Also, 1-style per specie studied.

## Fruits

The fruits are in berries in the three species studied. Fruit shape varies per specie with *C. albidum* ovoid to subglobose; *C. cainito* rounded to oval and *C. subnudum* globose in shapes (Plate 2a-2c). Before ripening, the fruits of *C. albidum* and *C. subnudum* are dark green in coloration; while *C. cainito* are light green. When ripe, *C. albidum* fruit colour is yellow; *C. cainito* fruit colour is purple or pink while *C. subnudum* retains its dark green colour (Plate 2a-2c).

The three taxa almost fruits at the same time; with *C. albidum* fruiting between July and August; *C. subnudum* fruits earlier May-July while *C. cainito* fruits between June and July. Transverse section of the fruits showed that the seeds are arranged in star-like shape in the three taxa (Plate 2d and 2e). Colour of pulp is milky in *C. cainito* and *C. subnudum* but yellow in *C. albidum*.

## Seeds

The seeds are flat, brownish with helium in the three species studied. *C. cainito* has 5-8 seeds, while *C. albidum* and *C. subnudum* has a maximum of 5 seeds each.

## Latex

The three taxa investigated produced white gumming latex.

## Root

Root system in the three taxa studied are tap roots.

## Discussion

The result of the morphological features of the three taxa studied showed some specific characteristics that can be used for taxonomic decisions. The three species studied are evergreen trees and dichotomously branched. *C. albidum* has a minimum height of 32 m x 1.8 m; *C. cainito* has a minimum height of 28 m x 1.2 m; and *C. subnudum* has minimum height of 34 m x 1.2 m. Hence, *C. albidum* and *C. subnudum* are of the same size. This agrees with the findings of some authors like [2,3] that recognized members of the family to comprise of trees, shrubs and herbs. The bark of both *C. albidum* and *C. subnudum* are pale grayish-brown and rough while *C. cainito* has scaly and brown bark which distinguished it from the other two. The three taxa produce white gummy latex from all the vegetative parts of the plant and the fruit. *C. cainito* exudes more latex. This feature was observed by giving cuts on the bark of the trees, plucking off the leaves, and breaking the fruits. This feature could be of diagnostic importance at the specific level.

The leaves have reticulate venation, attach to the stalk by means of petiole. Petiole length for *C. albidum* ranged from 1.5-3.0 cm; *C. cainito* ranged from 1.3-1.7 cm and that of *C. subnudum* ranged from 1.8-2.9 cm. The leaf margin is entire in the three taxa studied, but there is an observable variation in the leaf shape, *C. cainito* leaf shape varies from elliptic-obovate, and lanceolate – narrowly elliptic for *C. subnudum* while *C. albidum* is only elliptic in shape. Gbile, Keay observed and record the same leaf shape to be elliptic in the genus *Chrysophyllum* [3,8]. The variation observed in *C. cainito* and *C. subnudum* may be of taxonomic importance. *C. cainito* has mucronate leaf apex and rounded based and could be distinguished from the other two taxa that have obtuse apex and cuneate base respectively. This is in line with the works of Okeke and Nwachukwu, Nwachukwu and Mbagwu, who used leaf morphological features in determining taxonomic relationships among *Maesobotrya* and *Indigofera* species respectively [9,10]. Floral features of the three taxa showed strong intraspecific relationship among them. The flowers are small, actinomorphic, cluster at the axils of leaves, bisexual and cyme. The sepals differ in the three taxa *C. albidum* has greenish-yellow sepal; *C. cainito* has yellowish white sepal and *C. subnudum* has whitish sepal. The difference in sepal colour could be of taxonomic value in delimitating these taxa at species level.

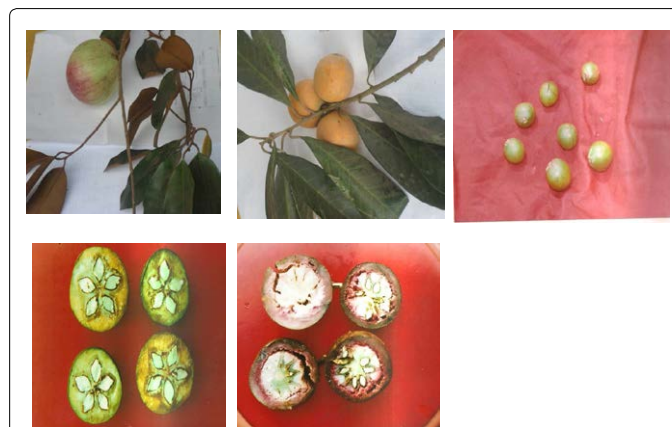


Plate 2: Fruits of a) *C. albidum*; b) *C. cainito*; c) *C. subnudum*; d) T/s of *C. subnudum* fruit e) T/s of *C. cainito* fruit.

Also, the colour of the corolla can be used to distinguish between the three taxa. The colour of corolla in *C. albidum* is light green; in *C. cainito* corolla is purplish white while in *C. subnudum* it is white. Anther is bilobed in *C. albidum* and *C. subnudum* but lobed in *C. cainito*. The difference in anther shape can be of taxonomic value at genus and species levels. The ovary is superior, one celled style in all the taxa. Stigma was observed to be rounded lobed in *C. subnudum* but lobed in the other two taxa. Fruit shape, colour when ripe and unripe, have proven to be of taxonomic value. In *C. albidum*, the fruit shape is ovoid – subglobose, green when unripe and yellow when ripe. In *C. cainito*, the fruit shape is rounded – oval, light green when unripe and purple or pink when ripe; for *C. subnudum* fruit is globose, green when ripe or unripe. Fruits of these taxa are in berries. This is in accord with all the authors that worked previously on the genus. Seeds are arranged in star form when transversely sectioned [11-13]. The variations in the vegetative and floral morphology, as seen in flowers, fruits, seeds, leaves and other parts of the *chrysophyllum* species investigated, have proven to be useful in determining the intraspecific relationship between the taxa studied.

### Conclusion

Based on the findings of this study, morphology of the three *Chrysophyllum* species investigated matched with that already described by some authors. Although there were differences in the leaf morphology of *C. cainito*, and *C. subnudum* it is of taxonomic importance.

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