



Comparative Taxonomic Studies of Two Irvingia Species (*Irvingia gabonensis* Baill and *Irvingia wombolu* Vermeesen) in Nigeria

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ABSTRACT

In Nigeria, two varieties of *Irvingia* species (*I. gabonensis* and *I. wombolu*) are similarly identical and their importance to economy development cannot be under-estimated. Various characters have been used in describing and delimiting species in Irvingiaceae family, but not much attention has been drawn to the separation of *Irvingia gabonensis* from *Irvingia wombolu* since their similarities have been reported to be causing confusion. Morphological and leaf epidermal characters have been significantly important in taxonomic classification and delimitation. Therefore, it is imperative to attempt a search for morphological and epidermal characters that may be of taxonomic importance in separating the two species. The main objective for this study was to study the leaf epidermis and morphology of *I. gabonensis* and *I. wombolu* in Nigeria for their useful and stable taxonomic characters that can assist in identifying and distinguishing the two species from each other, even in their fragmentary state. Fresh and dried plant materials of *I. gabonensis* and *I. wombolu* were collected in different locations and Nigeria herbaria, identified and authenticated. Qualitative morphological characters of the two species were examined using binocular glass and reference literature books. Leaf epidermal preparation was conducted following standard procedure. The result showed uniform morphological characters in both species except in fruit taste that distinguish them. Characters such as epidermal cells shapes which varied from irregular in adaxial surfaces to polygonal in abaxial surfaces of *I. gabonensis* and its variations from polygonal in adaxial surfaces to irregular in abaxial surfaces of *I. wombolu* distinguished the two taxa. Anticlinal cell wall patterns (slightly curved and straight to curve) also contributed to the delimitations of the two species. It is therefore concluded that *I. gabonensis* is different from *I. wombolu* on the bases of characters such as morphology and anatomy of the species.

Keywords: Irvingiaceae, characters, Nigeria, epidermal, morphology

Introduction

Irvingia Hook. F. is an African genus and tree from Southeast Asian in the family irvingiaceae. It is flowering plants, commonly called wild mango, bush mango, dika nut or ogbono, egili (Igala), Oghi (Etsako) and African mango (Onwuka 1983). *Irvingia* tree generally grows to about 2.4m to 20m in height and girth range from 1m to 2m. The ellipsoidal fruit is mango-like, measuring between 4 and 7 cm long. The pericarp is

differentiated into exocarp (the peel) and mesocarp (the fleshy pulp) and the endocarp (the hardstone) enclosing the kernel (Harris, 1996; Etebu, 2013). They are economically important fruit tree species in Africa, valued for its oil rich seed and hardy green wood that resist termite (Kengni *et al.* , 2011).

Three species of *Irvingia* exist in Nigeria, namely; *Irvingia gabonensis*, *I. smithii* and *I. grandifolia* (Keay, 1964). In Nigeria, two varieties of the species were identified by



Okarfor (1975); *I. gabonensis* var. *gabonensis* (having sweet edible pulp) and *I. wombolu* var. *excels* (with bitter fruit). In revising the Irvingiaceae family taxonomy, Harris (1996) later renamed the bitter variety as *I. wombolu* Vermoesen and the sweet variety as *I. gabonensis* Aubry-Lecomte ex O'Rorke. The two species were later recognized in West Africa for their food and commercial value (Ladipo *et al.*, 1996). The habit of the two species look alike although they are generally distinguished by the relative small size of the fruit of *I. wombolu* (Chinelo, 2016). Their exploitation was recorded in at least twenty countries in Africa; Senegal, Guinea (Conakry), Guinea –Bissau, Sierra Leone, Liberia, Ivory Coast, Ghana, Togo, Benin, Nigeria, Cameroon, Equatorial Guinea, Gabon, Republic of the Congo, Democratic Republic of Congo, Angola, Uganda, South Sudan, Central African Republic and Sao Tome (Harris 1996; Lesley and Brown 2004; Kengni *et al.* , 2011).

Ethnomedicinal uses of the two species cannot be underrated. Every part of the species (root, leaves and bark) are very good in curing one ailment or the other. Ainge and brown (2001) and Burkil (2004) reported the bark for curing diarrhoea when combined with palm oil. The antibiotic property of the bark help heals scabby skin, and the boiled bark reduces tooth pain. The powdered kernel act as astringent and are also applied to burns (George *et al.*, 2007). The leave extract is used as febrifuge.

Morphologically, both species (*I. gabonensis* and *I. wombolu*) are identical and very difficult to identify, even on the field. There have been controversial issues among the scientists and taxonomists in the area of identification. Take for instance; Edouard *et al.* (2017) reported the fruit pulp of *I.*

gabonensis to taste sweet and edible but that of *I. wombolu* which is closely related species as bitter and inedible. Apart from this identification, Ezeabara and Eze (2016), reported the phytochemical and nutrient constituents are identical in morphological characters of *I. gabonensis* and *I. wombolu* when compared with the phytochemicals. Misidentification of plant species have wrecked serious havoc in the area of traditional medicine and cost loss of lives (Brinckmann (2011): Howard *et al.* 2012). Although there have been earlier works on the different species of Irvingia but there is lack of adequate information that distinguish the two species from each other. Therefore, the objective of this work is to use both morphological and anatomical characteristics to distinguish and separate the two species from each other.

Materials and Methods

Plant Collections

Fresh plant materials of *I. gabonensis* and *I. wombolu* were collected from Osun, Oyo, Ekiti, Anambra and Edo states, Nigeria. The plants collected were identified and authenticated in Forestry Herbarium Ibadan while previous specimens collections deposited in Forestry Herbarium Ibadan were also used to produce the qualitative morphological characteristics of the two species by using binocular glass and reference literature books such as Tree of Nigeria by Keay (1989) and Flora of West Tropical Africa by Hutchinson and Dalziel (1954).

Preparation of Leaf Epidermal

Epidermal preparation was obtained using the techniques of Ayodele and Olowokudejo (2006) and Aworinde *et al.* (2009). Fresh and dried herbarium specimens were used for the



preparation. About 5 mm²-1 cm² leaf portions were obtained from the standard median portion of the leaves. The leaf fragments were soaked in concentrated HNO₃ for a period of about 5 hrs. They were later transferred into water into a Petri dish with a pair of forceps to strip off thin slices of epidermis of the leaf. Epidermises (both upper and lower) were gently and completely isolated from the mesophyll with a pair of fine tip forceps and dissecting needles. The epidermises were cleaned with a camel hair brush and placed in distilled water for rinsing for 2 minutes before transferring into 50% alcohol for 1 or 2 minutes so as to harden the surfaces. The

epidermises were then stained in 1% aqueous solution of safranino for 5 minutes in which the excess stain was cleaned using a dropping. After the dehydration, the membranes were stained in aqueous fast green in 3 seconds and then cleaned in xylene within 15 minutes.

The membranes were then dipped in clove oil for 15 min and again cleaned in xylene for another 15 minutes and then mounted on clean slides. The slide was labeled accurately and studied under the light microscope while photographs of the micro-morphological features were taken at X400 with installed digital camera optics.



RESULTS

Table 1: Qualitative morphological characters of *Irvingia gabonensis* and *Irvingia wombolu*

Species	Leaf base	Leaf apex	Leaf shape	Leaf margin	Leaf surface	Leaf arrangement	Flowers	Fruits surface	Fruit taste	Fruit colour
<i>I.gabonensis</i>	cuneate, slightly rounded	Acuminate	elliptic to slightly obovate	Entire	glabrous	alternate	yellowish to green white	glabrous	sweet	yellowish
<i>I.wombolu</i>	slightly rounded	Acuminate	elliptic to obovate	Entire	glabrous	alternate	grey white	glabrous	bitter	yellowish

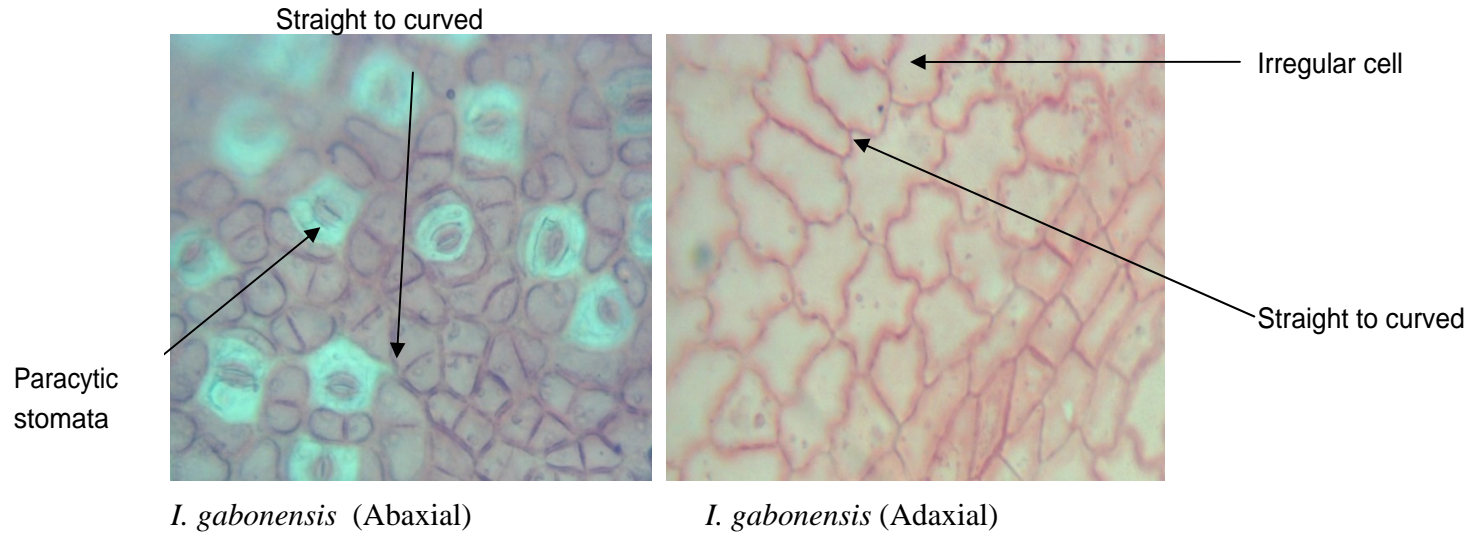


Plate 1: Photomicrograph of *I. gabonensis* showing abaxial and adaxial surfaces x 400

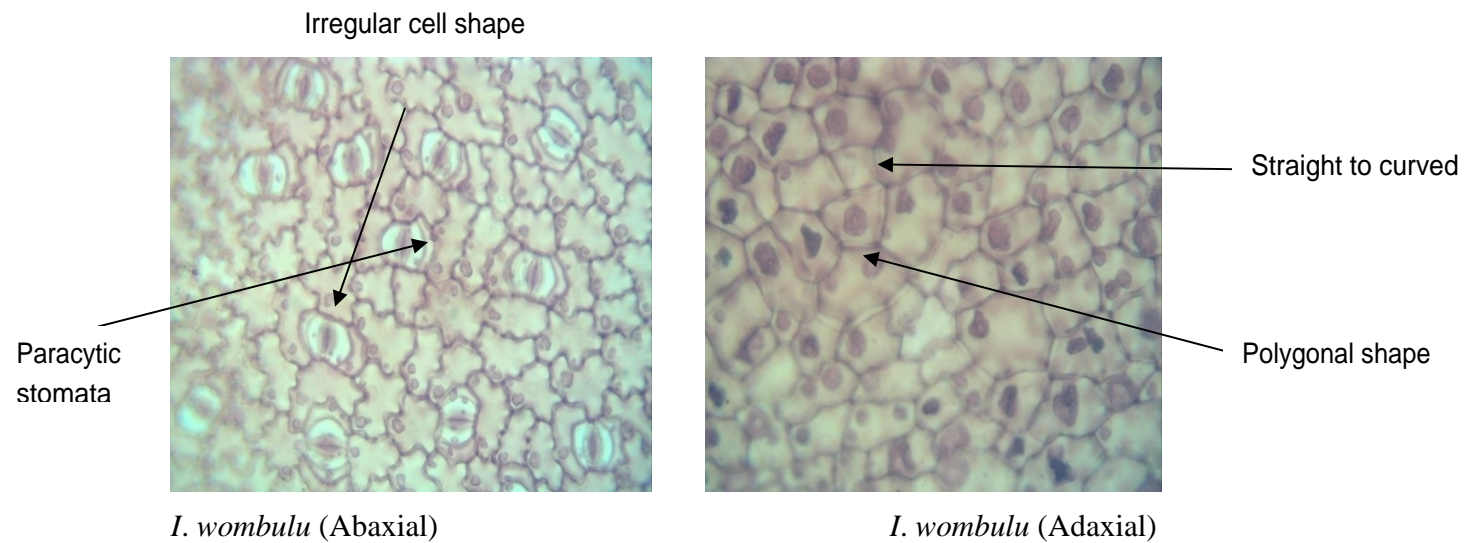


Plate 2: Photomicrographs of *I. wombolu* showing abaxial and adaxial surfaces x400

Table 2: Qualitative anatomical features of selected Irvingia species

Species	Epidermal cell Shape		Anticlinal cell wall	
	Adaxial	Abaxial	Adaxial	Abaxial



<i>I. gabonensis</i>	Irregular	Polygonal	Straight to curved and undulate	Straight to curved
<i>I. wombolu</i>	Polygonal	Irregular	Straight to curved	Undulate

Table 3: Stomata features of the selected *Irvingia* species

Species	Stomatal Type		Trichomes	
	Adaxial	Abaxial	Adaxial	Abaxial
<i>I. gabonensis</i>	Ab	Paracytic stomata	Ab	Ab
<i>I. wombolu</i>	Ab	Paracytic stomata	Ab	Ab

Ab – Absent

Results and Discussion

Macro-morphological characters of the two species (*I. gabonensis* and *I. wombolu*) were shown in Table 1. All macromorphological characters (leaf base, shape, margin, surface, arrangement, apex, flower colour, fruit surface) presented were uniform except in fruit taste that showed significant difference. This implies fruit taste as a character that distinguishes the two species from each other. This agrees with Edouard *et al.* (2017) who clearly indicated the taste of the fruit of each species as bitter (*I. wombolu*) and sweet (*I. gabonensis*). Moreso, these tastes can only show when they are ripe. This might show that identification of these species morphologically may not be possible except

they reach fruiting stage. The taste of the fruit pulp is important criterion that easily separate the two species, nevertheless, Harris (1996) and Vihotogbe *et al.*, (2013) reported that using morphological characters to separate the two species are not satisfied taxonomically. This is because the difference in fruit pulp taste is regarded as weak character and could be merely known at varietal level only (Okarfor, 1975). However, Vihotogbe and Sosef (2019) remarked that the two African bush mango trees are shown to be different species based on ecological preference and the niche difference showed a significant taxonomical opinion that bitter and sweet fruited species are two different taxa.



The epidermal features of the studied species of *Irvingia* showed some diagnostic characteristics that could be used for taxonomic decision. The study of epidermal surfaces of *I. gabonensis* and *I. wombolu* was shown in plate 1, plate 2 and table 2. Leaf epidermal cells in adaxial surface are irregular and polygonal in abaxial surfaces of *I. gabonensis* while it was polygonal in adaxial surfaces and more irregular in abaxial surfaces of *I. wombolu*. Anticlinal wall patterns are slightly curved to straight in adaxial and abaxial surfaces of *I. gabonensis* while it was straight to curve in adaxial surfaces and undulate in abaxial surfaces of *I. wombolu*. This implies that epidermal cell shape and anticlinal wall pattern distinguished the two species and these are diagnostic enough in taxonomical world. In both species (*Irvingia gabonensis* and *I. wombolu*), stomata observed were paracytic in which the subsidiary cells were two and are parallel to the guard cell wall long axis (Plate 1 and 2).

The result for stomata distribution and types showed that two species (*I. gabonensis* and *I. wombolu*) were observed to be hypostomatic, that is having stomata only at the lower epidermis (Abaxial) (Table 3). This report is also similar to Samaul *et al.*, (2020) that the shape and wall of the epidermal cell varied significantly on the adaxial surface with possession of hypostomatic and paracytic stomata types. Tahir and Rajpat (2009) showed that the type and stomata distribution are taxonomically important characters and could be valuable, reliable characterizing and distinguishing some medicinal species. However in this study, the stomata distributions of the two species were not separated. Moreover, absence of trichome characterized the species as the same genus.

Conclusion

The taxonomic significant of morphological and anatomical characters reported in this study established the separation of the two species (*I. gabonensis* and *I. wombolu*) and also assessed taxonomic level that suitable for their classification. Morphologically, only the fruit taste separated the species from each other and anatomically, features such as epidermal cells shapes and anticlinal cell wall separated the two species (*I. gabonensis* and *I. wombolu*). The hypostomatic and paracytic stomata of the two species indicated their generic constant that vindicated them to be in the same genus. Therefore, maximum work on the variation within *Irvingia* species is required most especially in the biological fields such as palynology, molecular and cytology to assess more characters in defining the two species for better classification.

References

- Abdulrahman, A.A. (2013). Cooling effects and humidification potentials in relation to features in some shade plants. *International Journal of Applied Science and Technology* vol. 3 (8). 144p.
- Ainge, L and Brown, N. (2001). *Irvingia gabonensis* and *Irvingia wombolu*. A state of knowledge report undertaken for the Central African Regional Program for the Environment by Oxford forestry institute department of plant sciences university of oxford, UK. 27pp.
- Aworinde D.O., Nwoye D.U., Jayeola, A.A., Olagoke, A.O & Ogundele, A.A (2009): Taxonomic Significance of Foliar Epidermis in Some Members of Euphorbiaceae Family in Nigeria. *Research Journal of Botany*, 4: 17-28.
- Ayodele, A.E and Olowokudejo, J.D. (2006): Taxonomy significant of leave epidermal



- characters. *South African Journal of Botany* 72(3):442-459.
- Brown, N (2004). Bush Mango *Irvingia gabonensis* and *Irvingia wombolu*. The key Non-Timber Forest Products of Central Africa.: State of Knowledge 15.
- Brinckmann J. (2011). Reproducible Efficacy and Safety Depend on Reproducible Quality: Matching the various Quality Standards that have been established for Botanical ingredients with their intended use in cosmetics, Dietary supplements , Foods and Medicines . HerbalGram The J Am Botanical Council. 91; 40-55
- Burkil, H.M.(2004). The useful plant of West Tropical Africa. Vol 4. Royal Botanical Gardens, Kew 969p
- Chinelo, A.E. and Ezeani, D. S. (2016): Comparative study of phytochemical and nutrient contents of various parts of *Irvingia gabonensis* Baill and *Irvingia wombolu* Vermoesen. *International journal of pharmacy and chemistry*, 2(2): 10-14.
- Edouard Kengni, Carl M.F Mbofung, Zac Tchoundjeu and FelicitebM. Tchouanquep. (2017). Sensory evaluation of Tropical Bush Mango (*Irvingia gabonensis*) Fruits. *Pakistan Journal of Nutrition*. 16: 562-570.
- Etebu, (2013): Metagenomic analysis of fungal community associated with *Irvingia* species (African mango) fruit wastes. *International Journal of Applied Microbiology and Biotechnology Research* Vol. 6 (2018) 78-86.
- Ezeabara, C.A. and Ezeani, D.S (2016). Comparative study of phytochemical and nutritent contents of various parts of *Irvingia gabonensis* (Aubry-Lecomte ex O' Rorke) Baill. and *Irvingia wombolu* Vermoesen . *Scientia Agriculturae*, 14 (3): 284-288.
- Samaul, M. D; Adegboyega, A and Judith,O.N. (2020). Epidermal studies of the leaves and phytochemical analysis of the seeds of *Irvingia gabonensis* and *Irvingia wombolu* in Anyigba Nigeria. *International Journal of innovations in Biological and chemical sciences*, vol. 13. 59-70
- George, I, Ndukwe, I & Yimin Z. (2007). Pharmacological activity of 2,3,8-tri-O-methyl ellagic acid isolated from the stem bark of *Irvingia gabonensis*. *African Journal of Biotechnology*, Vol .6 (16), 1910-1912 pp.
- Harris, D. J (1996). A revision of the irvingiaceae in Africa. *Bulletin du . Jardin . Botanique National de Belgique*. 65: 143 - 196.
- Howard, C., Socratous, E., Williams, S., Graham, E. and Mark, F.R (2012) . PlantID-DNA- based identification of multiple medicinal plants in complex mixtures. *Chinese Medicine* 7 (1), 1-9
- Hutchinson, J and Dalziel, J..M. (1954). *Flora of West Tropical Africa*. Vol 1, Part 1, 2nd Edition.
- Keay, R.W., Onochie C.F & Stanfield D.P (1964). *Nigeria Trees*. National Press Ltd, Forestry Research Institute of Nigeria, Ibadan, 47
- Keay, R.W.J (1989): *Trees of Nigeria*. A Revised Version of 'Nigeria Trees' (Keay *et al*, 1964) Clarendon Press. Oxford, UK
- Kengni , E., Kengue, J., Ebenezer, E.B.K & Tabuna , H .(2011): *Irvingia gabonensis*, *I. wombolu* : Bush mango. Conservation and Sustainable use of Genetic Resources of Priority Food tree Species in Sub- Saharan Africa, SAFORGEN, Biodiversity International, INIA and CITA.
- Lesley, L and Brown, N. (2004). Bush Mango (*I. gabonensis* and *I. wombolu*). In: Clark LE, Sunderland TCH (eds) Key non



- timber forest products of Central Africa; State of the knowledge. SD Publication series, USAID, 15-35PP
- Ladipo, D.O., Fondoun, J.M. & Gana, N. (1996). Domestication of the bush mango (*Irvingia* spp); Some exploitable intra-specific variation in West and Central Africa. In; Domestication and Commercialization of non-timber forest products for agroforestry
- Okarfor, J.C. (1975). Varietal delimitation in *I. gabonensis* (Irvingiaceae). Bulletin du Jardin Botanique National de Bedgigue 1995; 45 (1-2): 211-221.
- Onwuka ,N. D. (1983) Solvent extraction and characterization of from breadfruit (AB) , the African mango (AM) and the oil bean seed (OB). Progress in Food Engineering. 175- 179.
- Okafor J.C. (1974). Varietal delimitation in *Irvingia gabonensis* (Irvingiaceae). Nigeria J Forestry 4; 80-87.
- Tahir, S.S. and Rajpat, M.T.M. (2009). S.E.M Structure and Taxonomic significance of foliar stomata in *Sibbardia* L. species (Rosaceae) *Pakistan Journal of Botany* 41:2137-2143.
- Vihotogbe, R; Berg, R.G and Sosef, M.S.M. (2013). Morphological characterization of African bush mango trees (*Irvingia* species). *Genetic Resour. Crop Evol*, 60. 1597-1614pp.
- Vihotogbe, R and Sosef, M.S.M. (2019). Ecological nich information supports taxonomic delimitation of *Irvingia gabonensis* and *I. wombolu* (Irvingiaceae). *South African Journal of Botany*, vol. 127. 35-46.