



Food and Agriculture  
Organization of the  
United Nations



The International Treaty  
ON PLANT GENETIC RESOURCES  
FOR FOOD AND AGRICULTURE

# Key descriptors for *Irvingia* spp. (bush mango)



INTERNATIONAL YEAR OF  
FRUITS AND VEGETABLES

2021



Key descriptors for  
***Irvingia* spp.**  
(bush mango)

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World Agroforestry (ICRAF) is a centre of science and development excellence that harnesses the benefits of trees for people and the environment.

Leveraging the world's largest repository of agroforestry science and information, we develop knowledge practices, from farmers' fields to the global sphere, to ensure food security and environmental sustainability.

ICRAF is the only institution that does globally significant agroforestry research in and for all of the developing tropics. Knowledge produced by ICRAF enables governments, development agencies and farmers to utilize the power of trees to make farming and livelihoods more environmentally, socially and economically sustainable at scales.

We are guided by the broad development challenges pursued by CGIAR, a global research partnership for a food-secure future, which include poverty reduction, increasing food and nutritional security and improved natural resource systems and environmental services. ICRAF's work also addresses many of the issues being tackled by the Sustainable Development Goals (SDGs), specifically those that aim to eradicate hunger, reduce poverty, provide affordable and clean energy, protect life on land, and combat climate change.

ICRAF's Vision is an equitable world where all people have viable livelihoods supported by healthy and productive landscapes.

The Centre's mission is to harness the multiple benefits trees provide for agriculture, livelihoods, resilience, and the future of our planet, from farmers' fields through to continental scales.

The objectives of the FAO International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) are the conservation and sustainable use of all plant genetic resources for food and agriculture (PGRFA) and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity (CBD), for sustainable agriculture and food security.

The ITPGRFA text stresses the importance of in situ conservation and the need to collect and make publicly available related information. Particularly Article 5d which states that Contracting Parties shall "*Promote in situ conservation of wild crop relatives and wild plants for food production, including in protected areas, by supporting, inter alia, the efforts of indigenous and local communities*".

Since 2015, the ITPGRFA has intensified its support to national institutions on the documentation and exchange of PGRFA data in the context of its Article 17 and the development of the Global Information System on PGRFA.

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## PREFACE

The 'Key descriptors for *Irvingia* spp. (bush mango)' consists of an initial minimum set of characterization and evaluation descriptors for this species. This strategic set aims at facilitating access to and utilization of these African indigenous fruit trees. It does not exclude the addition of other descriptors later.

This work has been done jointly with the World Agroforestry (ICRAF) and the FAO International Treaty on Plant Genetic Resources for Food and Agriculture. The list was based on a preliminary List developed by World Agroforestry. In addition, internet searches were carried out looking for the most updated information on relevant characteristics and traits. The original List was subsequently integrated with evaluation traits. Special attention was given to the inclusion of descriptors relevant to nutritional components and biotic stresses of particular importance in the context of emerging adverse weather events which are expected to intensify under current and future climate challenges. Those included in this Key set have been chosen because of their global impact since they have wide geographic occurrence and cause significant economic damage.

The key set of access and utilization descriptors was defined through an online survey, in which 20 experts from 14 different organizations/universities from eight countries participated. Survey results were subsequently validated in consultation with a Core Advisory Group (see 'Contributors') led by Alain Tsobeng from ICRAF.

The strategic set of data standards is designed to facilitate access to and utilization of plant genetic resources for food and agriculture information. Together with passport information (Alercia *et al.* 2015, 2018), descriptors are critical to the effective sharing of characterization and evaluation data and to the efficient use of plant genetic resources for food and agriculture.

## INTRODUCTION

*Irvingia* species, commonly known as bush mango, as well as in their local names namely, dikka, dikanut, dikabread tree, odika, ogbono, or iba-tree, are multipurpose fruit trees growing in Africa and Asia. They belong to the family Irvingiaceae.

The genus is composed of seven species, native to different regions. *Irvingia wombolu* and *Irvingia grandifolia* are native to Central Africa. *Irvingia gabonensis*, *Irvingia robur*, *Irvingia smithii* and *Irvingia tenuinucleata* are native to West and Central Africa, and *Irvingia malayana* is native to South-East Asia.

The *Irvingia* trees commonly grow in rainforests and humid zones in dry ground, except for *Irvingia smithii*, which always grows beside water on riverbanks in savannah regions, seasonally flooded and riverine forest, and of *Irvingia malayana*, which occurs also in deciduous dipterocarp forest and dry evergreen forest.

*Irvingia* trees have multiple uses. They bear edible mango-like fruits and are valued for their fat- and protein-rich nuts, in addition to Vitamin C,  $\beta$ -carotene and fibre contents. The bark and kernel have medicinal uses. Bush mango products are increasingly used in America and Europe as a weight-loss aid and as health supplement. Bush mungo oil is used in the cosmetics industry.

*Irvingia* trees have a great importance for livelihoods and income as bush mango provides income for all actors along the market chain from harvesters to consumers. Therefore, supporting studies of genetic and morphological diversity for conservation of genetic resources and domestication of *Irvingia* spp. are key priorities.

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## KEY SET OF CHARACTERIZATION AND EVALUATION DESCRIPTORS FOR *IRVINGIA* SPP. (BUSH MANGO)

This is an initial, minimum set of Characterization and Evaluation descriptors for bush mango that are useful in assisting researchers to utilize accessions more easily. This is not intended to be an exhaustive descriptor list, but rather a key list of descriptors and traits that are relevant to describing, categorizing, and especially utilizing germplasm of indigenous fruit trees.

- Ideally, observations should be made on trees of the same age, unless otherwise stated, growing as much as possible in the same environment.
- For fruit descriptors, record the average measurement, or predominant shape, or colour of 24 ripe fruits randomly selected.

### CHARACTERIZATION

#### 1. Tree growth habit

- 1 Erect
- 2 Semi erect
- 3 Drooping

#### 2. Tree height [m]

From ground level to the top of the tree.

#### 3. Crown shape

- 1 Roundish
- 2 Ellipsoid
- 3 Semi-circular
- 4 Pyramidal
- 99 Other (specify in the Notes descriptor)

#### 4. Crown diameter [m]

Measured as the mean diameter using two directions [East-West, South-North].

#### 5. Trunk diameter [cm]

Record diameter at breast height.

#### 6. Dry-season leaf retention

- 0 No
- 1 Yes

**7. Ripe fruit exocarp (skin) colour**

Observed on ripe fruits.

- 1 Green
- 2 Yellow
- 3 Orange
- 4 Brownish
- 5 Reddish

**8. Fruit shell thickness [mm]**

Measured at the centre of the fruit.

**9. Fresh fruit mesocarp (flesh) colour**

- 1 Green
- 2 Yellow
- 3 Orange

**10. Presence/ absence of brown pigments in the fresh mesocarp**

- 0 Absent
- 1 Present

**11. Fruit shape**

Record the predominant shape of fruits.

- 1 Oblong-cylindrical
- 2 Oblong-irregular
- 3 Ellipsoid
- 4 Globose
- 5 Oval
- 99 Other (specify in the Notes descriptor)

**12. Fruit apex shape**

- 1 Acute
- 2 Obtuse
- 3 Round
- 4 Depressed

**13. Fruit diameter [cm]**

Record the average diameter of 24 fruits randomly selected at the widest point.

**14. Fruit length [cm]**

Measured from the base to the tip of the fruit. Record the average length of 24 fruits randomly selected.

**15. Fruit weight [g FW]**

Record the average weight of 24 mature fruits randomly selected.

**16. Flesh weight [g FW]**

Record the average weight of 24 mature fruits randomly selected.

**17. Flesh taste**

- 0 Tasteless
- 1 Very sweet
- 2 Sweet
- 3 Bitter
- 4 Very bitter

**18. Flesh texture**

- 1 Soft
- 2 Juicy
- 3 Fibrous

**19. Kernel width [mm]****20. Kernel weight [g]**

Record the average weight of 24 kernels randomly selected.

**21. Seed length [cm]**

Measured at the longest point. Record the average seed length of 10 seeds.

**22. Seed width [cm]**

Measured at the widest point. Record the average seed width of 10 seeds.

**23. Seed cracking**

- 3 Easy
- 7 Hard

**24. Kernel drawability potential**

The sliminess of the moistened kernels when ground up.

- 3 Poor
- 7 Good

## EVALUATION

**25. Number of fruits per tree (Yield) [kg/ha]**

Record the number of only mature fruits on tree in view of estimating the yield.

**26. Regular bearer**

- 0 None (Never fruited)
- 1 Annual (fruited each year)
- 2 Biennial (fruited every two years)

**27. Fruiting seasonality**

- 3 Early
- 5 Moderate
- 7 Late

### Fruit nutritional content

**28. Seed fibre content [%]**

**29.  $\beta$ -carotene content [mg 100/g]**

**30. Flesh protein content [%]**

**31. Flesh calcium content [mg 100/g]**

**32. Flesh Ascorbic acid content [mg 100/g]**

**33. Fatty acids content [%]**

**34. NOTES**

Specify any additional information here.



## BIBLIOGRAPHY

- Adebayo-Tayo, B.C., Onilude, A.A., Ogunjobi, A.A., Gbolagade, J.S. & Oladapo, M.O. 2006. Detection of fungi and aflatoxin in shelved bush mango seeds stored for sale in Uyo, Nigeria. *African Journal of Biotechnology*, 5(19): 1729–1732.
- Arogba, S.S., & Omede, A. 2012. Comparative Antioxidant Activity of Processed Mango (*Mangifera indica*) and Bush Mango (*Irvingia gabonensis*) Kernels. *Nigerian Food Journal (NIFOJ)*, 30(2): 17 – 21.
- Akusu, O.M. & Kiin-Kabari, D.B. 2003. Effect of storage period on selected functional, chemical stability and sensory properties of bush mango (*Irvingia gabonensis*) seed flour. *African Journal of Food Science Technology*, 4: 136–140.
- Alawode, A.O., Eselem-Bungu, P.S., Amiamdamhen, S.O., Meincken, M. & Tyhoda, L. 2020. Evaluation of *Irvingia* kernels extract as biobased wood adhesive. *Journal of Wood Science*, 66(12). (also available at <https://doi.org/10.1186/s10086-020-01860-9>).
- Alercia, A. 2011. Bioversity International. Key characterization and evaluation descriptors: Methodologies for the assessment of 22 crops. Bioversity Technical Bulletin Series. Bioversity International, Rome, Italy. 602 p., available at: [https://www.bioversityinternational.org/fileadmin/user\\_upload/online\\_library/publications/pdfs/1440.pdf](https://www.bioversityinternational.org/fileadmin/user_upload/online_library/publications/pdfs/1440.pdf).
- Alercia, A., Diulgheroff, S. & Mackay, M. 2015. Source/contributor: FAO (Food and Agriculture Organization of the United Nations), Bioversity International. In: FAO/Bioversity MultiCrop Passport Descriptors (MCPD V.2.1). (also available at <https://cgspace.cgiar.org/handle/10568/69166>).
- Alercia, A., López, F.M., Sackville Hamilton, N.R. & Marsella, M., 2018. Digital Object Identifiers for food crops - Descriptors and guidelines of the Global Information System. Rome, FAO. (also available at: <http://www.fao.org/3/I8840EN/i8840en.pdf>).
- Alercia, A., López, F., Marsella, M., & Cerutti, A.L. 2021. Descriptors for Crop Wild Relatives conserved *in situ* (CWRI v.1). Rome, FAO on behalf of the International Treaty on Plant Genetic Resources for Food and Agriculture. 26 Pp. (also available at <https://doi.org/10.4060/cb3256en>).
- Anegbeh, P.O. 2000. Phenotypic variations in *Irvingia gabonensis* in farmers' fields: Case study in Southeast Nigeria. Paper presented at DFID-ODI-ICRAF-ITE Data Analysis Workshop on Domestication of Indigenous Trees in West and Central Africa for Income Generation, 6 - 8 March 2000. ICRAF, Yaounde, Cameroun.
- Anegbeh, P.O., Usoro, C., Ukafor, V., Tchoundjeu, Z., Leakey, R.R.B. & Schreckenberger, K. 2003. Domestication of *Irvingia gabonensis*: 3. Phenotypic variation of fruits and kernels in a Nigerian village. *Agroforestry Systems*, 58(3): 213–218.
- Asaah, E.K., Tchoundjeu, Z. & Atangana, A.R. 2003. Cultivation and conservation status of *Irvingia wombolu* in humid lowland forest of Cameroon. *Journal of Food, Agriculture and Environment*, 1: 251–256.
- Atangana, A.R., Tchoundjeu, Z., Foldout, J.M., Asaah, E., Dumb, M. & Leakey, R.R.B. 2001. Domestication of *Irvingia gabonensis*: 1. phenotypic variation in fruit and kernels in two populations from Cameroon. *Agroforestry Systems*, 53: 55–64.

- Atangana, A., Ukafor, V., Anegbeh, P., Asaah, E., Tchoundjeu, Z., Fondoun, J.M., Ndoumbe, M. & Leakey, R.R.B. 2002. Domestication of *Irvingia gabonensis*: 2. The selection of multiple traits for potential cultivars from Cameroon and Nigeria. *Agroforestry Systems*, 55: 221–229. (also available at <https://doi.org/10.1023/A:1020584823505>).
- Ayivor, J.E., Debra, S.K., Nuviadenu, C. & Forson, A. 2011. Evaluation of Elemental Contents of Wild Mango (*Irvingia gabonensis*) Fruit in Ghana. *Advance Journal of Food Science and Technology*, 3(5): 381–384.
- Ayuka, E.T., Dagumba, B., Franzel, S., Kengue, J., Mollet, M., Tiki-Manga, T. & Zenkeng, P. 1999. Uses, management and economic potential of *Irvingia gabonensis* in the humid lowlands of Cameroon. *Forest Ecology and Management*, 113(1): 1–9.
- Babalola, F.D. & Agbeja, B.O. 2009. Marketing of *Irvingia* spp. (Bush mango) in Southwest Nigeria: prospects and challenges. *Research Journal of Agriculture and Biological Sciences*, 5(6): 944–953.
- Bamidele, O.P., Ojedokun, O.S. & Fasogbon, B.M. 2015. Physico-chemical properties of instant ogbono (*Irvingia gabonensis*) mix powder. *Food Science and Nutrition*, 3: 313–318.
- Bello, E.I., Fade-Aluko, A.O., Anjorin, S.A. & Mogaji, T.S. 2011. Characterization and evaluation of African bush mango Nut (Dika nut) (*Irvingia gabonensis*) oil biodiesel as alternative fuel for diesel engines. *Journal of Petroleum Technology and alternative Fuels*, 2(9): 176–180.
- Boateng, S.K., Yeboah, E. & Amponsah, J.Y. 2007. Collection of edible wild fruits in the forest areas of Volta region of Ghana. *Journal of Plant Sciences*, 2: 243–246. (also available at <https://docsdrive.com/pdfs/academicjournals/jps/2007/243-246.pdf>).
- Chah, J.M., Ani, N.A., Irohibe, J.I. & Agwu, A.E. Exploitation of Bush Mango (*Irvingia wimbolu* and *Irvingia gabonensis*) Among Rural Household in Enugu State, Nigeria. *Journal of Agricultural Extension*, 18(2).
- Djikpo, V.A.R. 2016. Perception locale, démographie et répartition spatiale des manguiers sauvages africains (*Irvingia* spp: Irvingiaceae) dans la région forestière de la volta (Togo). MSc Thesis, Faculty of Agronomic Sciences, University of Abomey-Calavi, Benin Republic.
- Dolor, D. 2011. Effect of propagation media on the germination and seedling performance of *Irvingia wimbolu* (Vermoesen). *American Journal of Botany*, 1(2): 51–56.
- Eka, O.U. 1980. Proximate Composition of seeds of bush mango tree and some properties of dika fat. *Nigerian Journal of Nutritional Sciences*, 1: 33–36.
- Ekpe, O.O, Umoh, I.B & Eka, O.U. 2007. Effect of a typical rural processing method on the proximate composition and amino acid profile of bush mango seeds (*Irvingia gabonensis*). *African Journal of Food, Agriculture, Nutrition and Development*, 7(1): 1–12.
- Ezeabara, C.A. & Somtochukwu, E.D. 2016. Comparative Study of Phytochemical and Nutrient Contents of Various Parts of *Irvingia gabonensis* (Aubry-Lecomte ex O' Rorke) Baill. and *Irvingia wimbolu* Vermoesen. *International Journal of Pharmacy and Chemistry*, 2(2): 10–14.
- Fadare, D.A. & Ajaiyeoba, E.O. 2008. Phytochemical and antimicrobial activities of the wild mango *Irvingia gabonensis* extracts and fractions. *African Journal of Medicine and Medical Sciences*, 37(2): 119–124.
- Harris, D.J. 1996. A revision of the Irvingiaceae in Africa. *Bulletin du Jardin Botanique National de Belgique*, 65: 143–196.

- Ingram, V., Ewane, M., Ndumbe, L.N. & Awono, A. 2017. Challenges to governing sustainable forest food: *Irvingia* spp. from southern Cameroon. *Forest Policy and Economics*, 84: 29–37.
- Kang, B.T., Akinnifesi, F.K. & Ladipo, D.O. 1994. Performance of selected woody agroforestry species grown on an Alfisol and an Ultisol in the humid lowland of West Africa, and their effects on soil properties. *Journal of Tropical Forest Science*, 7: 303–312.
- Kengni, E., Kengue, J., Ebenezer, E.B.K. & Tabuna, H. 2011. *Irvingia gabonensis*, *Irvingia wombolu*, bush mango. *Conservation and Sustainable Use of Genetic Resources of Priority Food Tree Species in sub-Saharan Africa*. Bioersivity International.
- 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 R.R.B. Leakey, A.B. Temu, M. Melnyk & P. Vantomme, eds. *Domestication and commercialization of non-timber forest products for agroforestry*. Non-Timber Forest Products Paper 9, pp. 193–206. Rome, FAO.
- Ladipo, D.O. 2000. Harvesting of *Irvingia gabonensis* and *Irvingia wombolu* in Nigerian forests: Potentials for the development of sustainable systems. Paper presented at the seminar harvesting of non-wood forest products, Menemen-Izmir, Turkey. (also available at <https://www.fao.org/3/y4496e/Y4496E32.htm>).
- Leakey, R.R.B., Temu, A.B., Melnyk, M. & Vantomme, P., eds. 1996. *Domestication and commercialization of non-timber forest products in agroforestry systems*. Proceedings of an international conference held in Nairobi, Kenya, 19 - 23 February 1996. Rome, FAO.
- Leakey, R.R.B., Fondoun, J.M., Atangana, A. & Tchoundjeu, Z. 2000. Quantitative descriptors of variation in the fruits and seeds of *Irvingia gabonensis*. *Agroforestry Systems*, 50(1): 47–58.
- Leakey, R.R.B., Tchoundjeu, Z., Smith, R.I., Munro, R.C., Fondoun, J.M., Kengue, J., Anegebeh, P.O., Atangana, A.R., Waruhiu, A.N., Asaah, E., Usoro, C. & Ukafor, V. 2004. Evidence that subsistence farmers have domesticated indigenous fruits (*Dacryodes edulis* and *Irvingia gabonensis*) in Cameroon and Nigeria. *Agroforestry Systems*, 60: 101–111.
- Leakey, R.R.B., Greenwell, P., Hall, M.N., Atangana, A.R., Usoro, C., Anegebeh, P.O., Fondoun, J.M. & Tchoundjeu, Z. 2005. Domestication of *Irvingia gabonensis*: 4. Tree-to-tree variation in food-thickening properties and in fat and protein contents of dika nut. *Food Chemistry*, 90: 365–378.
- Lesley, A., & Nick, B. 2001. *Irvingia gabonensis* & *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, United Kingdom.
- Lowe, A., Russell, J.R., Powell, W. & Dawson, I.K. 1998. Identification and characterisation of nuclear, cleaved amplified polymorphic sequence (CAPS) loci in *Irvingia gabonensis* and *I. wombolu*, indigenous fruit trees of west and central Africa. *Molecular Ecology*, 7: 1786–1788.
- Lowe, A.J., Gillies, A.C.M., Wilson, J. & Dawson, I.K. 2001. Conservation genetics of bush mango from central/west Africa: implications from random amplified polymorphic DNA analysis. *Molecular Ecology*, 9(7): 831–841.
- Ndamitso, M.M., Mathew J.T., Shaba, E.Y.I., Salihu, A.B. & Ogunmiloro, O.J. 2012. Comparative nutritional compositions of *Irvingia gabonensis* (wild bush mango) seeds and *Abelmoschus esculentus* (Okra) pods. *Nigerian Journal of Chemical Research*, 17: 50–58. (also available at <https://www.ajol.info/index.php/njcr/article/view/107968>).

- Noh, F.M. & Ahmad, Z. 2016. Evaluation of Density for Malaysian Hardwood Timber Treated by Heat: The Case of Pauh Kijang (*Irvingia* spp.) and Kapur (*Dryobalanops* spp.). In M. Yusoff, N. Hamid, M. Arshad, A. Arshad, A. Ridzuan & H. Awang, eds. InCIEC 2015, pp. 759–767. Springer, Singapore. (also available at [https://link.springer.com/chapter/10.1007%2F978-981-10-0155-0\\_64](https://link.springer.com/chapter/10.1007%2F978-981-10-0155-0_64)).
- Nya, P.J., Omokaro, D.N. & Nkang, A.E. 2000. Comparative studies of seed morphology, moisture content and seed germination of two varieties of *Irvingia gabonensis*. *Journal of Applied Sciences*, 6: 375–378.
- Nya, P.J., Omokaro, D.N. & Nkang, A.E. 2009. Effect of pretreatments on seed viability during fruit development of two varieties of *Irvingia gabonensis*. *Global Journal of Pure and Applied Sciences*, 12(2): 141–148.
- Nzekwe, U., Onyekwelu, S.S.C. & Umeh, V.C. 2002. Improving the germination of *Irvingia gabonensis* var *excelsa* seeds. *Nigerian Journal of Horticultural Science*, 7: 58–61.
- Oben, J.E. 2011. Chapter 32 – Seed extract of West African Bush Mango (*Irvingia gabonensis*) and its Use in Health. In V.R. Preedy, R. Ross Watson & V.B. Patel, eds. *Nuts and Seeds in Health and Disease Prevention*, pp. 271–278. Academic Press, USA.
- Ogunsina, B.S., Bhatnagar, A.S., Indira, T.N. & Radha, C. 2012. The proximate composition of African bush mango (*Irvingia gabonensis*) kernels and characteristics of its oil. *Ife Journal of Science*, 14(1): 117–183.
- Okafor, J.C. 1975. Varietal delimitation in *Irvingia gabonensis* (Irvingiaceae). *Bulletin du Jardin Botanique National de Belgique*, 45: 211–221.
- Okolo, H.C. 2000. Industrial potential of various *Irvingia gabonensis* products, such as oil, ogbono and juice. In D. Boland & D. O. Ladipo, eds. *Irvingia: Uses, potential and domestication*. ICRAF, Nairobi, Kenya.
- Omokhua, G.E., Ukoima, H.N. & Aiyeloja, A.A. 2012. Fruits and seeds production of *Irvingia gabonensis* (O' Rorke) and its economic importance in Edo Central, Nigeria. *Journal of Agriculture and Social Research*, 12(1): 149–155.
- Onimawo, I.A., Oteno, F., Orokpo, G. & Akubor, P.I. 2003. Physicochemical and nutrient evaluation of African bush mango (*Irvingia gabonensis*) seeds and pulp. *Plants Foods for Human Nutrition*, 58: 1–6.
- Sahoré, D.A., Gnopo, N.A. & Tetchi, A.F. 2012. Study of physicochemical properties of some traditional vegetables in Ivory Coast: seeds of *Beilschmiedia mannii* (Lauraceae), seeds of *Irvingia gabonensis* (Irvingiaceae) and *Volvariella volvacea*. *Food and Nutrition Sciences*, 3: 14–17.
- Shiembo, P.N., Newton, A.C. & Leakey, R.R.B. 1996. Vegetation propagation of *Irvingia gabonensis*, a West African fruit tree. *Forest Ecology and Management*, 87: 185–192.
- Singh, A.K. 2007. Bush Mango (*Irvingia gabonensis*): New Potential multipurpose fruit tree for India. *Journal of Plant Genetic Resources*, 20(1): 32–37.
- Sossa, T. 2005. Caractérisation morphologique et productivité fruitière de *Irvingia gabonensis* (Aubry-Lecomte) dans les zones agroécologiques au sud-est Benin. MSc Thesis, Faculty of Agronomic Sciences, University of Abomey-Calavi, Benin Republic.
- Sunday, Y.G., Vitalis, I.O. & Monday, O.A. 1994. Chemical composition and functional properties of raw, heat-treated and partially proteolysed wild mango (*Irvingia gabonensis*) seed flour. *Food Chemistry*, 49(3): 237–243.

- Tchoundjeu, Z., Duguma, B., Foudoun, J.M. & Kengue, J. 1998. Strategy for the domestication of indigenous fruit trees of West Africa: Case of *Irvingia gabonensis* in southern Cameroun. *Cameroun Journal of Biological and Biochemical Sciences*, 4: 21–28.
- Tchoundjeu, Z. & Atangana, A. 2007. *Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill. In H.A.M. van der Vossen & G.S. Mkamilo, eds. PROTA 14, *Vegetable oils/ Oléagineux*, pp. 95–99. PROTA Foundation/Backhuys Publishers/CTA, Wageningen.
- Tchoundjeu, Z., Atangana, A.R. & Degrande, A. 2005. Indigenous methods in preserving bush mango kernels in Cameroon. *American Journal of Applied Sciences*, 2: 1337–1342.
- Ude, G.N., Dimkpa, C.O., Aneghbeh, P.O., Shaibu, A.A., Tenkouano, A., Pillay, M. & Tchoundjeu, Z. 2006. Analysis of genetic diversity in accessions of *Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill. *African Journal of Biotechnology*, 5: 219–223.
- Ujor, G.C. 1995. Reproductive biology of *Irvingia gabonensis* (O'Rorke) Bail. in southern Nigeria: phenology, floral biology and varietal characteristics. PhD Thesis, University of Ibadan, Nigeria.
- Vihotogbé, R., Houessou, L.G., Ponette, Q., Codjia, J.T.C. & Le Boulengé, E. 2008. Ethnobotany and endogenous conservation of *Irvingia gabonensis* (Aubry-Lecomte) Baill. in traditional agroforestry systems in Benin. *Indilinga*, 6: 196–209.
- Vihotogbé, R., van den Berg, R.G., Bongers, F., Sinsin, B. & Sosef, M.S.M. 2012a. Phenological diversity and discrimination within African bush mango trees (*Irvingia*: Irvingiaceae) in the Dahomey Gap (West Africa). In R. Vihotogbé, ed. Characterization of African bush mango trees with emphasis on the differences between sweet and bitter trees in the Dahomey Gap (West Africa), pp 83–117. PhD Thesis, Wageningen University.
- Vihotogbé, R., van den Berg, R.G., Bongers, F., Sinsin, B. & Sosef, M.S.M. 2012b. Backgrounds of the domestication process of African bush mango trees (Irvingiaceae) in the Dahomey Gap (West Africa). In R. Vihotogbé, ed. Characterization of African bush mango trees with emphasis on the differences between sweet and bitter trees in the Dahomey Gap (West Africa), pp 43–81. PhD Thesis, Wageningen University.
- Vihotogbé, R., Van Den Berg, R. & Sosef, M.S.M. 2013. Morphological characterization of African bush mango trees (*Irvingia* species) in West Africa. *Genetic Resources and Crop Evolution*, 60(4): 1597–1614. (also available at <https://link.springer.com/article/10.1007%2Fs10722-013-9969-0>).
- Vihotogbé, R., Glelè Kakai, R., van Andel, T., van den Berg, R.G., Sinsin, B. & Sosef, M.S.M. 2014. Impacts of the diversity of traditional uses and potential economic value on food tree species conservation status: case study of African bush mango trees (Irvingiaceae) in the Dahomey Gap (West Africa). *Plant Ecology and Evolution*, 147(1): 109–125.
- Vihotogbé, R., Houessou, L.G., Assogbadjo, A.E. & Sinsin, B. 2014. Germination of seeds from earlier fruits of bitter and sweet African bush mango trees. *African Crop Science Journal*, 22(4): 291–301.
- Vihotogbé, R., van den Berg, R.G., Sinsin, B., Bongers, F. & Sosef, M.S.M. 2014. Does phenology distinguish bitter and sweet African bush mango trees (*Irvingia* spp., Irvingiaceae)? *Trees*, 28: 1777–1791.
- Vihotogbé, R., Idohou, R., Gebauer, J., Sinsin, B. & Peterson, T.A. 2019. Estimation of cultivable areas for *Irvingia gabonensis* and *I. wombolu* (Irvingiaceae) in Dahomey-Gap (West Africa). *Agroforestry Systems*, 93: 937–946.

- Vihotogbé, R., Raes, N., van den Berg, R.G. & Sosef, M.S.M. 2019. Ecological niche information supports taxonomic delimitation of *Irvingia gabonensis* and *I. wombolu* (Irvingiaceae). *South African Journal of Botany*, 127: 35–42.
- Yamoneka, J., Malumba, P., Blecker, C., Gindo, M., Richard, G., Fauconnier, G., Lognay, G. & Dasthine, S. 2015. Physicochemical properties and thermal behaviour of African wild mango (*Irvingia gabonensis*) seed fat. *LWT – Food Science and Technology*, 64(29): 989–996.







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