Journal of Aridland Agriculture 2018, 4: 18-23
doi: 10.25081/jaa.2018.v4.3397
http://updatepublishing.com/journal/index.php/jaa/

ISSN: 2455-9377

REGULAR ARTICLE

NATURAL VARIATION IN FRUIT TRAITS OF WILD BAOBAB (*ADANSONIA DIGITATA* L.) IN BLUE NILE STATE: AWAY FORWARD FOR SPECIES DOMESTICATION AND CONSERVATION IN SUDAN

NASRELDIN ABDELRAHAMAN GURASHI*

Department of Forestry, Faculty of Natural Recourses, University of Sinnar, Sudan

ABSTRACT

The overall objective of this study was to distinguish and evaluate morphological variations in relation to locations of baobab fruits traits. The study was conducted in Blue Nile states Sudan 2015/2016. The morphological variation in fruits was evaluated bysampling fruits and assessing their characteristics. Five to twenty single trees were checking out randomly inside baobab location for the morphometric quantities (fruits) at different distances. Our first results point to there was high variety in fruit phenotypes. obovate, ovate, globose, fusiform, oblong, ellipsoid pointed, ellipsoid and spheroid emarginated fruit types were identified. Fruit shape was constant within each individual tree but was varied between trees. Results presented highly important differences (P≤0.05) in fruit traits. The study findings revealed that spheroid emarginated fruit shape from Tolaba location was highly significant in term of fruit, seed and pulp weight, 407.00±35.17 g, 187.07±23.94g and 70.18±6.23g respectively. Ovate fruit type was the most abundant (21 %), whereas spheroid emarginated and ellipsoid pointed shape was the least frequent (3%). The highly diversity found between locations is vital for domestication devotions and tree development through assortment and breeding candidate plus trees. Founded on the results documented, development of study doings on the practically unstudied baobabs in Blue Nile state, Sudan is greatly recommended.

Keywords: *Adansonia digitata*, Baobab, Domestication, Fruit traits, fruit type frequency, Blue Nile state

INTRODUCTION

The baobabs (*Adansonia digitata* L.) are well-known in the hot, hand drier provinces of tropical Africa, native to Africa, is a numerous benefits tree with curative goods, every part of it were used, uses of food from pulp of fruits, roots, leaves, and seeds are fit foods and a key foundation of liveliness [1-3]. Baobab is one of edible tree of Indigenous wild fruit trees (IFTs) stand of pronounced rank in dry land of Africa [4-7]. The genus *Adansonia* belongs to the family Bombacaceae. Previous studies [8, 9, 3] showed that there are many local type of baobab species, presence within tree species of baobab, opposing in fruit type, leaves and chemical composition of pulp. Yet, data around the environmentalism, the morphological and heritable difference within and between locations' of species and the production of their several body part is needs. Furthermore, tree progress and geneticconservation needs understanding of variation. Although one earlier report [10] showed that there are eight species of types Adansonia. The baobab remains one these species, nevertheless it has in anticipation of just been reflected the lone natives species on the African continent, life existing in most of arid and semiarid Africa, there are two species of genus Adansonia were detected, specifically *A. digitata* founded in lowland and the *A. kilima* existing in mountain or hill, it is supposed to arise on higher elevation and has a marginally changed flower morphology from *A. digitata*, between other slight modifications [11]. Data on baobabs in Blue Nile, Sudan is now necessary to progress deployment and conservation plans [12].

Earlier study [13] reported that some educations in different countries of African require emphasized this native fruit tree as a significance species for domestication and extended use. But, globally available data on baobab in East Africa, mainly in Sudan and east Africa, rests limited. A number of educations require highlighted baobab for example one of the most vital indigenous fruit trees (IFTs), with great ethno botanical importance, in Sudan [14, 15, 16, 9, 17, 18, 19, 20, 21]. To our information few recent records on tree diversity and locations arrangement is existing for baobab locations in Blue Nile, Sudan. The main aims of this study is accordingly to offer some investigative evidence on the natural variation in traits of baobab fruits characteristics, Furthermore, candidate plus trees with specific properties, on the way to a better accepting of cultivar development and protection of the baobab tree.

Received 31 December 2017; Accepted 19 March 2018

*Corresponding Author

Nasreldin Abdelrahaman Gurashi

Department of Forestry, Faculty of Natural Recourses, University of Sinnar, Sudan

Email: gurashi78@yahoo.com

Table 1: Locations descriptions of study area of *Adansonia digitata* L

Locations	Elevations (m)	Soil	Latitude (N°)	Longitude (E°)	main rainfall (mm)
Taloba	474	Stony hill side	11 °49'	34 °23'	700
Sheneisha	465	Silty clay	11°57´58.0	34°22´09.5	700
El Gerri	538	Stony hill side	11°49´00.1	34°36´31.3	700
Agadi	522	Stony hill side	11°57´25.8	34°06´23.4	654

Climatic data was obtained from Agromet team [22]. Soil information was found as of the Harmonized World Soil Database [23]

MATERIALS AND METHODS

Study areas

The study was conducted in the four zones of Blue Nile state, locates between latitudes 10° and 13° North and longitude 33° and 36° east, and occupies a total area of 38500 km². The zones studied are: Taloba, Elgerri, Shenisha and Agadi (table 1). The climate of the Blue Nile State is the semi-humid zone. The temperature varies from 14-40°C during the rainy season and increasing to 46°C in the dry season (April-June). The relative humidity was 20% during dry season and increasing to 80% in the wet season.

Sampling

Four baobab populations with 7-20 individuals per population have been sampledrandomly within baobab population for the morphometric measurements. From each tree, six dry fruits and fresh leaves without any damage were selected from different positions of tree crown and kept in labeled plastic bags. This corresponds to a total of 390 fruits sampled in the study site for assessing and analyzing morphometric data for baobab populations.

For each fruit capsule length and diameters at the widest part were measured in cm by a measuring tape and then the average was calculated. Capsules shape ratio was calculated by dividing capsule length by capsule diameter. Total weights were measured using a Dial Scale to determine the pulp productivity. The capsule shell was opened and separated from shell content (pulp plus seeds) and weighted. Fruits pulp and seeds were separated by dissolving the dry powdery pulp in water for five minutes and then the seeds were weighted and the pulp weight was calculated by subtraction (pulp+seed-seeds weight), according to the method described by De Smedt*et al.* (2011).

Statistical analysis

Analysis of variance was carried out using SPSS statistical software version 16 to determine the significance invariations among treatments applied. Duncan Multiple RangeTest was used to separate between means.

RESULTS

Our investigative outcomes signposted high phenotypic variant (fig. 1). Ther are eight fruit types Ovate, obovate, oblong, fusiform, globose ellipsoid spheroid emarginated and ellipsoid pointed fruit types were identified. Fruit features for the eight different trees are précised in fig. 1. Fruit shape various among trees however was constant inside each separable tree.

The study results in table 2 and 3 discovered that there were important variances (P≤ 0.05) between studied location in fruit length, width and fruit weight. Spheroid emarginated fruit shape recorded the highest measures (weight of fruit, pulp, seeds and width (fig. 2) were found to be highly significant in Taloba. Whereas fruits weights from obovate fruit shape in Elgerri were found to be significantly low. The results in the two same tables illustrated that pulp weight was lower in Agadi and Elgerri from obovate fruit shape (table 3).

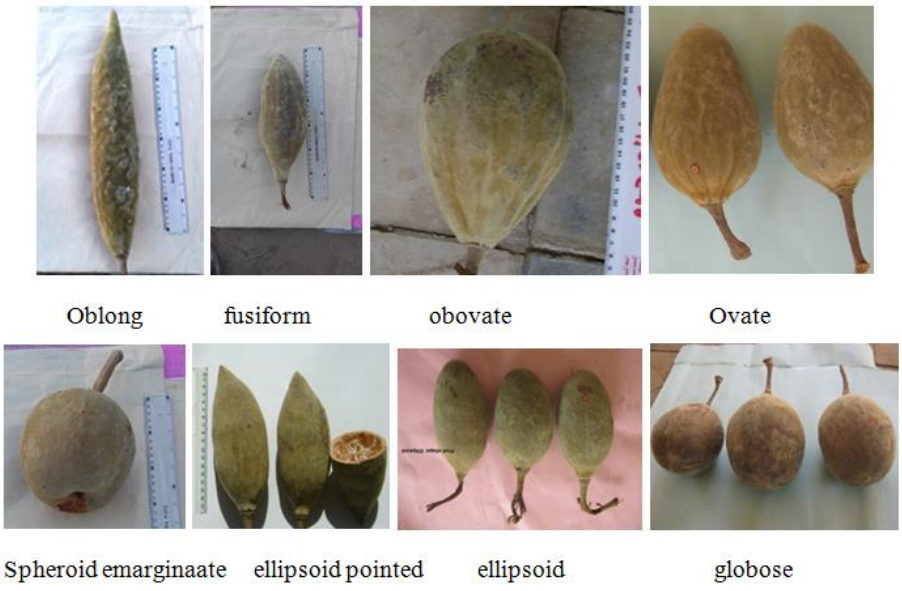

Fig. 1: Variety in fruit type of (*A. digitata* L.) from Blue Nile states, Sudan

Fig. 2: Fruit characteristics seed and pulp

Table 2: Fruit traits of *Adansonia digitata,* from Blue Nile States

Fruit shape	Location	weight of fruit (g)	Length of fruit(cm)	width of fruit (cm)
Ellipsoid	Taloba	217.9±86.48 b	16.57±2.25 c	8.59±1.18 d
	Elgerri	192.12±28.18 b	17.45±1.90 bc	8.55±0.54 d
	Agadi	136.45±10.26 bc	14.56±0.82 c	7.71±0.27 e
Ovate	Taloba	271.23±34.22 ab	16.50±1.20 c	9.86±0.64 b
	Shenisha	156.75±42.37 bc	13.65±1.97 c	8.43±0.98 d
	Elgerri	197.61±53.38 b	16.26±1.43 c	8.95±1.26 c
	Agadi	270.48±28.71 ab	16.56±1.26 c	9.85±0.73 b
Obovate	Agadi	112.56±24.02 c	12.45±0.85 d	7.67±0.53 e
	Elgerri	110.05±28.93 d	12.31±1.51 d	7.31±0.55 f
Oblong	Taloba	236.61±70.85 ab	28.30±4.53 a	7.16±0.75 f
	Elgerri	210.95±26.81 b	23.16±1.85 ab	7.80±0.42 e
	Agadi	232.28±59.64 ab	24.15±2.01 ab	7.46±0.69 f
	Shenisha	220.00±31.66 ab	26.46±0.82 a	7.95±0.32 d
Fusiform	Elgerri	196.11±36.37 b	23.39±2.67 ab	7.83±0.82 e
	Taloba	219.13±40.50 ab	20.73±2.00 b	8.50±0.29 d
Globose	Taloba	318.09±105.54 ab	14.27±2.27 c	11.39±1.52 a
Spheroid Emarginate	Taloba	407.00±35.17 a	14.06±0.77 c	12.56±0.95 a
Ellipsoid pointed	Taloba	154.08±22.65 bc	16.66±1.16 c	7.33±0.50 f

Means±SD, tracked by the similar letter in a column is not considerably different at p≤0.05 (Tu

Table 3: Fruit characteristics (weight of seed and pulp) of *Adansonia digitata,* from Blue Nile States

Fruit shape	Locations	Weight of seed (g)	Weight of pulp (g)
Ellipsoid	Taloba	97.24±50.15 ab	26.55±12.3 4c
	Elgerri	75.00±16.14 c	29.66±5.98 c
	Agadi	53.61±5.29 cd	20.65±5.05 e
Ovate	Taloba	141.48±18.78 a	29.98±4.82 c
	Shenisha	42.37±13.09 de	36.55±8.81 b
	Elgerri	91.05±39.63 b	35.43±12.22 b
	Agadi	143.87±21.46 a	26.88±1.47 c
Obovate	Agadi	28.49±9.19 de	18.05±3.49 f
	Elgerri	26.38±9.92 f	18.58±4.25 f
Oblong	Taloba	100.50±47.12 ab	32.83±8.25 c
	Elgerri	81.75±31.29 c	34.85±8.57 b
	Agadi	125.31±44.10 ab	22.92±6.85 d
	Shenisha	55.58±6.98 cd	41.80±6.13 b
Fusiform	Elgerri	92.41±20.73 ab	26.47±10.81 c
	Taloba	71.56±13.23 c	34.36±7.34 b
Globose	Taloba	146.04±45.59 a	50.35±21.23 b
Spheroid Emarginate	Taloba	187.07±23.94 a	70.18±6.23 a
Ellipsoid pointed	Taloba	64.41±9.77 cd	20.33±4.61 e

Means±SD, tracked by the similar letter in a column is not considerably different at p≤0.05

The study results appearance significant differences in all fruit physical characteristics (table 4). Overall weight of fruit is ranged as of 111.72 g in the obovate toward 407 g in the spheroid emarginated fruits. Highest fruit length and fruit width were stately with 25.37 and 12.56 cm in the oblong and speroid emarginate fruits, respectively.

The means of creamy pulp of fruit various among the different fruit types. Spheroid emarginated fruit shape scored the highest measures (weight of pulp and seeds) were found to be highly significant ($P \leq 0.05$). The same table illustrated pulp weight was lower from obovate fruit shape table (4).

Frequency of fruit shapes

The study have been clearly that fruit type ovate existed the most abundant (22%), followed by the ellipsoide and oblong type (12%). whereas obovate, fusiform, globose, speroid emarginated and ellipsoid pointed types were the least frequent (fig. 3). fruit shapes founding phenotypic traits stands the mostimportant principal step in representation and evaluating changeability aimed at plant species exchange and protection.

Table 4: Fruit shapes traits of blue Nile states, Sudan

Fruit type	Width of Fruit(cm)	Length of Fruit (cm)	Weight of Fruit (g)	Weight of Seed (g)	Weight of Pulp (g)
Ellipsoid	8.13±1.04 c	16.20±2.03 c	210.25±75.71 b	92.89±45.80 b	26.42±9.38 b
Ovate	9.06±1.15 b	15.59±1.95 c	206.86±62.27 b	91.89±47.64 b	33.75±9.92 b
Obovate	7.55±0.55 d	12.41±1.07 e	111.72±24.92 d	27.78±9.20 c	18.23±3.64 d
Oblong	7.58±0.74 d	25.37±3.71 a	225.92±53.29 b	99.99±45.02 b	29.54±9.47 b
Fusiform	7.94±0.87 c	21.75±2.39 b	181.14±42.79 b	76.92±20.22 b	25.80±9.23 b
Globose	10.27±2.44 b	12.53±3.17 e	250.15±123.15 b	108.94±58.06 b	39.33±21.81 b
Spheroid Emarginate	12.56±0.95 a	14.06±0.77 c	407.00±35.17 a	187.07±23.94 a	70.18±6.23 a
Ellipsoid pointed	7.33±0.50 d	16.66±1.16 c	154.08±22.65 c	64.41±9.77 b	20.33±4.61 c

Means±SD, tracked by the similar letter in a column is not considerably different at p≤0.05

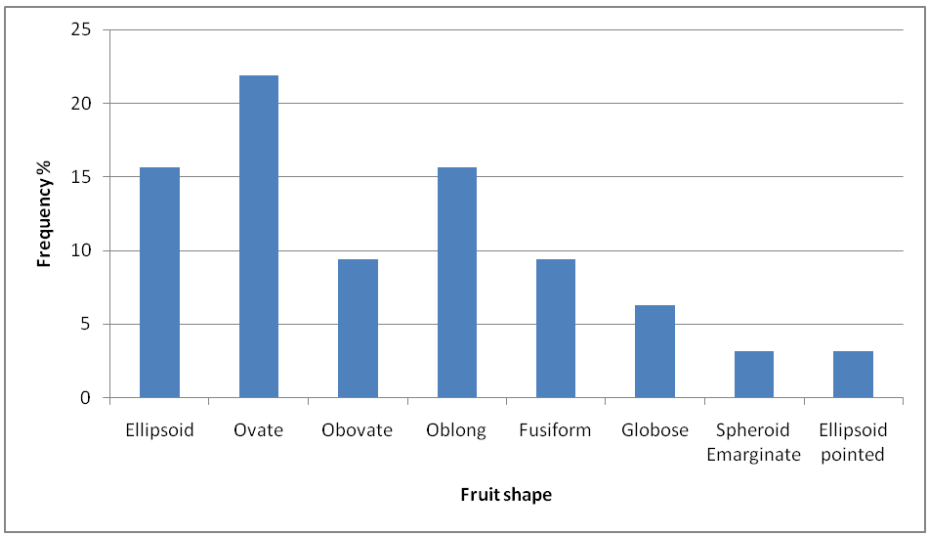

Fig. 3: Occurrence sharing of fruit shapes inside *Adansonia digitata* tree location at Blue Nile state

DISCUSSION

In the current study, a notable morphological changeability in fruit shapes was noted between baobab trees. For all fruit traits, means of trees presenting the highest values were a number of times higher than means of trees revealing low values for the particular traits. These elements were fruit width (1.71 cm), fruits length (2.04 cm), weight of fruit (3.64g), weight of seeds (6.69g) and weight of pulp (3.84g)

The detected variant proposes important chances for selection and has vital ideas for cultivation and conservation of the species. Variation between single tree in fruit characters was also created in a pair of other baobab studies [24-26]. Fruit shape was constant within individual baobab trees. This conforms to the outcomes of a previous report [27], that detected in Benin low morphological changeability within-tree in fruits shape of baobabs and proposed a high heritability of this characters. Another study [28] found maximum fruit length and width were 29 cm and 13 cm in the fusiform and globose fruits, respectively in kordofan state, whereas in the present study we founded a low within-tree morphological variability in fruits shape of baobabs in Blue

Nile fruit length and width were 12.53 to 10.27 cm and 21.75 to 7.94 cm in the fusiform and globose respectively, and proposed a high heritability of these characters. According to one previous report [29], in Africa the overall baobab fruit size was found to be ranged with (7.5–54 cm length, 7.5–20 cm wide). While compared with current studies in other countries, fruits from Blue Nile Sudan width 7.33-12.56 cm and length 12.41-25.37 cm were found to be lower than those of Benin [30], Malawi [31, 32], Mali [31] and Senegal [33]. But, fruit weight of up to 496 g noted in Niger [34] crossed the records from Blue Nile Sudan (218.39g). The most valuable part was fruit pulp of the baobab, the average percentage of fruit pulp per fruit in the Blue Nile Sudan fruits was 12.56–17.24% lower than fruit pulp in Benin (16–20 %) recorded [35, 31] about (14–28 %), (18–25 %) in Malawi and Mali respectively. The high pulp weight of spheroid emarginated fruits recommends that fruitshape may possibly be a supportable implement in choosing with high pulp weight in field environments in Sudan.

Studies [30, 31] considered the sources of morphological variant in different climatic areas and proposed that environment and genetics may performance a title role in morphology of baobab fruit.

Additional investigation is required to check desirable traits of fruits production remain to produce comparable fruit characters once developed in a changed environment.

CONCLUSION

A pronounced variety in fruit traits existed in the four studied locations from Blue Nile state, Sudan, indicating valued cultivation and great potential for domestication, which requests to be additional studies, in the view that those characters may effective by genetic control facters. These variations are very significant to report and to link that with the quality of the fruit pulp in further studies. Therefore, influence of cultivation on fruit bulk and quality should be studied.

The study delivers information on the morphological variant of baobab fruits from four locations in Blue Nile state Nevertheless; further field studies are required in other states of Sudan (eg. South of Blue Nile state, south Kordofan and Darfour) to characterize more plant materials. Future research should also focus on numerous traits, for example kernel production, nutritious value, color, and taste, which were not included in this study.

ACKNOWLEDGEMENT

Thanks to referees and the editor for their valuable notes on the manuscript.

REFERENCES

1. Teklehaimanot Z. The Role of Indigenous Fruit Trees in Sustainable Dryland Agriculture in Eastern Africa. In: Akinnifesi, FK, Leaky RRB, Ajayi OC, Silesh G, Tchoundjeu Z, Matakala P, Kwesiga FR (eds.) Indigenous Fruit Trees in the Tropics Domestication, Utilization and Commercialization. Columns Design Ltd, Reading, UK. 2008.
2. FAO. Traditional food plants. FAO food and nutrition paper 42, FAO, Italy. 1988.
3. Sidibe´ M, Williams JT. Baobab, *Adansonia digitata* L. International Centre for Underutilized Crops, UK. 2002.
4. Bennett B. Natural products: the new engine for African trade growth. Technical report. Regional trade facilitation program/Natural Resources Institute, Tajikistan. 2006.
5. Jamnadass RH, Dawson IK, Franzel S, Leakey RRB, Mitho¨ferD, Akinnifesi FK, Tchoundjeu Z Improving livelihoods and nutrition in sub-Saharan Africa through the promotion of indigenous and exotic fruit production in smallholders' agroforestry systems: a review. Int Forest Rev. 2011. 13:338–354
6. Leakey RRB. The domestication of indigenous trees as the basis of sustainable land use in Africa. In: Lemons J, Victor R, Schaffer D (eds) Conserving biodiversity in arid regions: best practices in developing nations. Kluwer Academic Publishers, USA. 2003.
7. Leakey RRB. Living with the trees of life: towards the transformation of tropical agriculture. CABI International, UK. 2012.
8. Assogbadjo AE, Sinsin B, Codjia JTC, Van Damme P. Ecological diversity and pulp, seed and kernel production of the baobab (*Adansonia digitata*) in Benin. Belg J Bot. 2005a. 138:47–56
9. Gebauer J, El-Siddig K, Ebert G. Baobab (*Adansonia digitata* L.): a review on a multipurpose tree with promising future in the Sudan. Eur J Hort Sci. 2002. 67:155 160.
10. Wickens GE, Lowe P. The baobabs: pachycauls of Africa, Madagascar and Australia. Springer, UK. 2008.
11. Pettigrew FRSJD, Bell KL, Bhagwandin A, Grinan E, Jillani N,Meyer J, Wabuyele E, Vickers CE. Morphology, ploidy and molecular phylogenetics reveal a new diploidspecies from Africa in the baobab genus Adansonia (Malvaceae: Bombacoideae). Taxon. 2012. 61:1240–1250.
12. Cuni Sanchez A. The status of baobab tree populations in southern Malawi: implications for further exploitation. For Tree Livelihood. 2011b. 20:1–16.
13. Gebauer J, Adam YO, Sanchez AC, Darr D, Eltahir ME, Fadl KE, Fernsebner G, Frei M, Habte TY, Hammer K, Hunsche M. Africa's wooden elephant: the baobab tree (*Adansonia digitata* L.) in Sudan and Kenya: a review. Genetic resources and crop evolution. 2016 Mar 1;63(3):377-99.
14. Gurashi NA, Kordofani MAY. Morphological variation in fruit shapes of *Adansonia digitata* L. from Blue Nile and North Kordofan States, Sudan. J Forest Prod Ind.2014. 3:106–111.
15. Gurashi NA, Kordofani MA. Variations in Leaf morphology of Baobab (*Adansonia digitata* L) in Sudan. Agriculture and Forestry Journal. 2017 30;1(2):89-98.
16. Bella MM, El Tahir BA, Elshiekh A, El-Din Warreg E. Report of Sudan. In: Matig OE, Gaoue` OG, Dossou B (eds) Programme de ressourcesge´ne´tiques forestie`res en Afriqueau sud du Sahara. IPGRI, Italy. 2002.
17. El Tahir BA. Status of indigenous fruits in Sudan. In: Chikamai B, Eyog-Matig O, Mbogga M (eds) Review and appraisal on the status of indigenous fruits in Eastern Africa. A report prepared for IPGRI-SAFORGEN in the framework of AFREA/FORNESSA. 2004.
18. El Tahir B. A, Gebauer J. Non-timber forest products: opportunities and constraints for poverty reduction in the Nuba Mountains, South Kordofan, Sudan. A full paper online publication of the Conference on International Agricultural Research for Development. 2004. 1-10.
19. Gebauer J, Osman OA. Obstbauim Sudan—unter Beru¨cksichtigung von Wildobst [Fruit production in

Sudan, including wild fruits]. Erwerbsobstbau. 2004. 46:110–116.
20. Adam YO, Eisa MA, Ahmed DM. Role of *Adansonia digitata* L. fruits in development and forest conservation in Rashad Locality, Nuba Mountains, Sudan. Univ Khartoum J AgricSci. 2012. 20:314–328.
21. Adam YO, Pretzsch J, Pettenella D. Contribution of non timber forest products livelihood strategies to rural development in dry lands of Sudan: potentials and failures. AgricSyst. 2013. 117:90–97**.**
22. FAO. Harmonized World Soil Database (version 5.0). FAO, Rome, Italy and IIASA, Laxenburg, Austria. 2013.
23. FAO. Harmonized World Soil Database (version 1.0). FAO, Rome, Italy and IIASA, Laxenburg, Austria. 2008.
24. De Smedt S, Alaerts K, Kouyate´ AM, Van Damme P, Potters G,Samson R. Phenotypic variation of baobab (*Adansonia digitata* L.) fruit traits in Mali. Agroforest Syst. 2011. 82:87–97.
25. Munthali CRY, Chirwa PW, Akinnifesi FK. Phenotypic variation in fruit and seed morphology of *Adansonia digitata* L. (baobab) in five selected wild populations inMalawi. Agroforest Syst. 2012. 85:279–290.
26. Assogbadjo AE, Gle`le` Kakaı¨ R, Chadare FJ, Thomson L, KyndtT, Sinsin B, van Damme P. Folk classification, perception and preferences of baobab products in West Africa: consequences for species conservation and improvement. Econ Bot. 2008. 62:74–84.
27. Assogbadjo AE, Gle`le` Kakaı¨ R, Edon S, Kyndt B, Sinsin B. Natural variation in fruit characteristics, seed germination and seedling growth of *Adansonia digitata* L. in Benin. New Forest. 2011. 41:113–125.
28. Gebauer J. and Luedeling E. A note on baobab (*Adansonia digitata* L.) in Kordofan, Sudan. 2013. DOI 10.1007/s10722-013-9964-5. 60:1587–1596.
29. Wickens GE. 1982. The baobab—Africa's upside-down tree. Kew Bull 37:173-209.
30. Assogbadjo AE, Sinsin B, van Damme P. Caracte`res morphologiques et production des capsules de baobab (*Adansonia digitata* L.) au Be´nin. Fruits. 2005b. 60:327–340
31. Cuni Sanchez A. The baobab tree in Malawi. Fruits.2011a. 66:405–416
32. Munthali CRY, Chirwa PW, Akinnifesi FK. Phenotypic variationin fruit and seed morphology of *Adansonia digitata* L. (baobab) in five selected wild populations in Malawi. Agroforest Syst. 2012. 85:279–290
33. Soloviev P, Niang TD, Gaye A, Totte A. Variabilite´ descaracte`res physico-chimiques des fruits de trois espe`ces ligneuses de cueillette, re´colte´s au Se´ne´gal: *Adansonia digitata*, *Balanites aegyptiaca* et *Tamarindus indica*. Fruits. 2004. 59:109–119
34. Parkouda C, Sanou H, Tougiani A, Korbo A, Nielsen DS, Tano-Debrah K, Ræbild A, Diawara B, Jensen JS. Variability of Baobab (*Adansonia digitata* L.) fruits' physical characteristics and nutrient content in the West AfricanSahel. Agroforest Syst. 2012. 85:455–463.
35. Assogbadjo AE, Kyndt T, Sinsin B, Gheysen G, Van Damme P. Patterns of genetic and morphometric diversity in baobab *(Adansonia digitata*) populations across different climatic zones of Benin (West Africa). Ann Bot. 2006. 97:819–830.