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## Phenotypic Characteristics of *Parkia biglobosa* (Jacq.) Benth Fruits and Seeds Indigenous to West Africa

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### ABSTRACT

*Parkia biglobosa* produce fruits which is use as condiment in most African dishes. Its distribution across West Africa belt tends to exhibit variations. Hence, there is need to study the observable characteristics of this tree for tree improvement purpose. The fruit (pod) and the seeds morphological characteristics were assessed from the germplasm of *Parkia biglobosa* at Wasangare, Saki, Oyo State. Eight provenances of *Parkia biglobosa* represented in the germplasm include Nigeria, Mali, Senegal, Burkina Faso, Cameroun, Benin, Guinea and Ghana. Selective sampling method was adopted in the selection of the trees from provenances investigated. Variations in fruits of *Parkia biglobosa* from different provenances were assessed through optical observation, vernier caliper, electronic top bar balance. The data obtained were subjected to analysis of variance using Completely Randomized Design (CRD). The result obtained showed that the *Parkia biglobosa* pod varied in sizes from big, medium and small. Pods from Nigeria, Ghana, Burkina Faso and Cameroun provenance had big sizes, While Benin pod is the only provenance with small size, others were medium sizes. Pods from Ghana, Benin, Guinea and Mali provenances were round in shape, while pods from Nigeria and Burkina Faso were flat in shape, Guinea and Senegal pods were oval in shape. The pod from Burkina Faso has the highest pod length, pod width and pod weight as follow 22.73cm, 2.08cm and 17.48g, respectively. The fruit from Benin Republic has the least pod length, pod width and number of seed per pod which are 16.72cm, 1.76cm and 10.33, respectively. It was concluded from the result obtained from this study that there are variation in the phenotypic characteristics of *Parkia biglobosa* from different provenances Hence, the fruits of *Parkia biglobosa* from Nigeria and Burkina Faso are recommended for tree improvement and domestication purpose.

**Keywords:** *Parkia biglobosa*, Provenance, Germplasm, Domestication and improvement

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### Introduction

*Parkia biglobosa* is one of the fruit tree species whose importance is well known in Nigeria, West Africa and other part of the world. (Gbadamosi,2002). The trees are deliberately preserved and retained on the farms due to its economic values and classified into the categories of semi-wild and protected species in Nigeria. (Lamien *et al.*, 1996). *P. biglobosa* is an all important species that has socio-economic and cultural values for local people within the parkland systems. In Nigeria, *P. biglobosa* is

regarded as an important tree species which generates Non-Timber Forest Products ( Koura *et al.*, 2011 and Nyadanu *et al.*, 2017). Among the importance of the trees are ecological services which include soil fertility improvement and microclimate amelioration. *P. biglobosa* trees are source of income for many people which serves as an addition to direct domestic use of the tree products. It also gives a better family income (particularly for women) (Lamien *et al.*, 1996) and the economy of the country (Valentine *et al.*, 2012).



The depletion of the forest estate due to continuous allocation of the existing forest to urban, agricultural, recreational and other uses has drastically reduced forest environment and many of these important trees are gradually becoming extinct. (Veach *et al.*, 2017) However, nutrition and cost of living of the rural population depends mainly on these fruit trees and their products, which are undervalued (Gbadamosi, 2002). *Parkia* is ranked among the most common species of the parkland agro-forestry system (Sacande and Clethero, 2007). The demand for the tree in recent years has been on the increasing side due to the benefits that people are deriving from the tree. This is owing to the fact that recognition of contribution of *Parkia* to fulfill human basic necessity, household economics, food security and conservation of natural resources has been a factor drawing more among other factors (Joshi and Joshi, 2009).

*P. biglobosa*, an important multipurpose tree of West African Savannah land and the tree is well known to be native to West Africa soil (Akande *et al.*, 2010), also the trees is 7 to 20m tall and in some cases it can reach up to 30m (Sabiiti and Cobbina 1992). The fruit is a slightly curved, brown indehiscent pod, 30 to 40 cm long and 2 to 3 cm wide producing up to 20 seeds. The seeds when boiled and fermented is known as 'Dawadawa' in Hausa and 'Iru' in Yoruba language in Nigeria, a black strong smelling tasty seasoning, rich in lipid of about (29%), protein (35%), carbohydrate (16%) and it is a good source of fat and calcium for rural dwellers (Teklehaimanot, 2004.).

The pods are used as sponges and strings, dyes and for fishing, and also for preparing insecticide powder. Although, the growing number of studies on the domestication potential of indigenous trees have provided information about morphological and

genetic diversity, potential productivity, nutritional and medicinal properties (Assogbadjo *et al.*, 2005; Leakey *et al.*, 2007; Ekué *et al.*, 2009). However, as local environmental conditions influences variation in plants (Schlichting and Pigliucci, 1998), it is imperative that domestication programs should also consider the impact of fruit quality and quantity of the targeted species. Having known that genetical traits possessed by individual seedling of the same species differs during regeneration or plantation establishment. Such fruit qualities that are poorly explored are critical for identification of priority sites for planting, for genetic improvement and multiplication. In addition, such information may highlight the extent to which identification of better genetic traits from natural populations of different provenances of *P. biglobosa* will influence market supply of some of the fresh fruits in West African region.

## Materials and Method

### Study Area

This study was carried as a follow up on the existing germplasm plantation of *P. biglobosa* in Saki, Oyo State, Nigeria. The study location was at *P. biglobosa* germplasm trial plot located at Wasagare in Saki West Local Government Area of Oyo State. *P. biglobosa* plantation at Wazagare lies on Latitude 8.8558°N and 8.8573°N and Longitude 3.42353°E and 3.42519°E. which comprises of *P. biglobosa* trees from eight (8) provenances in eight Countries. The study also investigated *Parkia* species sourced from these eight provenances they are; Nigeria, Cameroon, Senegal, Burkina Faso, Benin Republic, Guinea, Ghana and Mali and the *P. biglobosa* germplasm was established in 1995. The ecological zone in Wasangare Saki is a derived Savannah with more grasses which dried up at the end of raining season in October and the plantation measured about 60,000 m<sup>2</sup>.

### Data Collection

Existing plantation of *Parkia biglobosa* has already been demarcated into blocks and further sub divided into plots. The compartments of blocks and plots of the plantation were used as sampling unit for each provenance. Four sample plots in each block represent the replicate for each provenance. Data for this study was collected by adopting selective sampling of *P. biglobosa* trees with the highest diameter at breast height (DBH) in the selected *Parkia* stands from each provenance.

The harvesting of the *P. biglobosa* fruit pods was carried out with aid of a harvesting tool (go –to – hell). The clustered harvested pods were totally packed in a jute bag and transported to the laboratory where they were kept. The morphological variability and characteristics of the fruit which include (Pod length, pod width, number of pod per bunch , number of pod per tree, pod weight pod colour , pod shape) and seed characteristics (number of seed per pod, seed weight per bunch, seed colour , and seed shapes) of *P. biglobosa* germplasm were investigated in this study. The colours were examined through direct

eye observation with the aid of colour checker on each of the selected seeds under observation. Seed weight of five replicate samples (each of 100 seeds) were also obtained following the International Seed Testing Association (ISTA) regulations using electronic top pan balance. The harvested pods were sun-dried and kept in black cellophane nylon and 100 pods from each provenance were randomly selected for assessment. Digital vernier calliper was used to measure the width and thickness of the pod, white thread spread on the pod and marked and later spread on the meter rule to determine the length of the pod. Thereafter, the pods were opened and the number of seeds per pod were counted and weighed.

### Experimental design and data analysis

One way analysis of variance (ANOVA) was conducted for the data obtained using Completely Randomised Design (CRD). The data obtained were expressed as mean plus or minus standard error of the means (mean  $\pm$ SEM). Duncan Multiple Range Test (DMRT) was used as a follow up test for means that were significant. The value of  $p < 0.05$  was regarded as significant for statistical comparison in all cases.

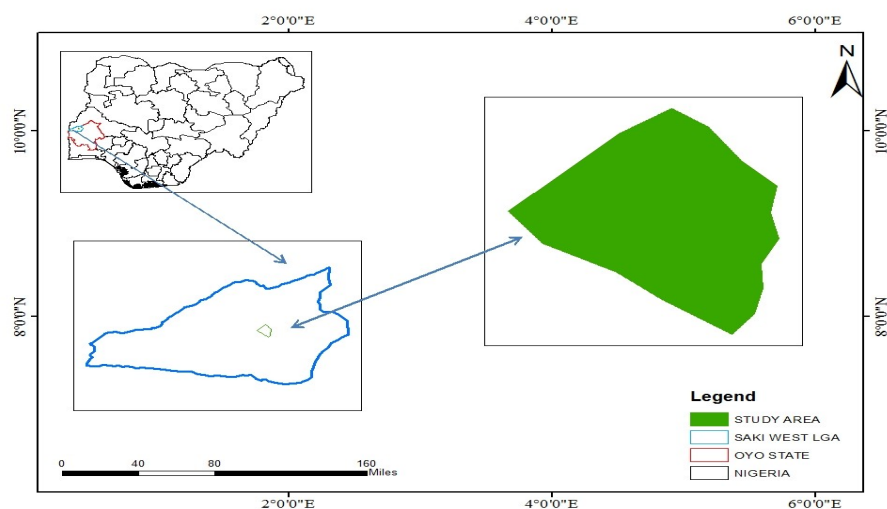


Fig 1: Map showing the study area



## Results

The assessment of the physical characteristics of fruits of *P. biglobosa* across different provenances in West Africa countries were shown in Table 1 below. The evaluation of these parameters showed significant differences and in *Parkia* fruits from one provenance to the others. The pod length of *P. biglobosa* from Burkina Faso was the longest with the length of 22.73cm, though not significantly different from *P. biglobosa* from Nigeria with 21.78cm but both however were significantly higher than pod length of *Parkia* from other six (6) provenances. It is therefore implies that there was no significant differences among the pod length *P. biglobosa* from Senegal, Guinea, Cameroun, Benin, Mali and Ghana provenances, However, *Parkia biglobosa* from Benin Republic had the least pod length of 16.72cm as shown in Table1 below.

The result of width of *Parkia* pods showed the same trend as Nigeria and Burkina Faso were not significantly different from each other but significantly different from the rest of the provenances that were assessed. Though the highest width value of 2.08cm was recorded in Burkina Faso provenance,

but the least width value of 1.76cm occurred in Benin Republic provenance. More so, the result of seeds per pod of *P. biglobosa* from Mali was significantly higher with 14.67 value than other provenances. This was followed by Guinea and Burkina Faso which was not significantly different from each other but differ significantly from the rest of the provenances. The least seed per pod of *P. biglobosa* was recorded in Benin Republic provenance. Also, there were no significant differences recorded in the weight of pod of *Parkia* from Nigeria and Burkina Faso, which differs significantly from the rest of the provenances.

This was followed by the pod weight of Cameroun 15.95g and Senegal with 14.90g. The least value of the pod weight was recorded from Ghana provenance with 11.76g. Likewise, the result of pod weight from Senegal with the value 7.9g was significantly different from other provenances. The seed weight of Nigeria (6.73g) and Burkina Faso(6.49g) were recorded respectively. The least weight of 2.76g was recorded in *P. biglobosa* from Guinea provenance as shown in table 1 below.

**Table 1: The physical characteristics of the fruit of *Parkia biglobosa***

	Pod length (cm)	Pod width (cm)	Number of seeds pod	Pod weight (g)	Seed weight (g)
Senegal	18.75 <sup>b</sup> ±1.72	1.80 <sup>b</sup> ±0.06	11.67 <sup>bc</sup> ±2.08	14.90 <sup>abc</sup> ±1.60	7.90 <sup>a</sup> ±1.16
Benin Republic	16.72 <sup>b</sup> ±0.28	1.76 <sup>b</sup> ±0.05	10.33 <sup>c</sup> ±0.57	13.11 <sup>bc</sup> ±0.67	3.21 <sup>c</sup> ±1.03
Nigeria	21.78 <sup>a</sup> ±2.14	2.04 <sup>a</sup> ±0.04	12.00 <sup>abc</sup> ±0.00	18.21 <sup>a</sup> ±1.55	6.73 <sup>ab</sup> ±0.10
Burkina Faso	22.73 <sup>a</sup> ±2.72	2.08 <sup>a</sup> ±1.15	13.67 <sup>ab</sup> ±1.16	17.48 <sup>a</sup> ±2.49	6.49 <sup>b</sup> ±0.48
Ghana	17.83 <sup>b</sup> ±0.59	1.85 <sup>b</sup> ±0.02	11.67 <sup>bc</sup> ±1.16	11.76 <sup>c</sup> ±1.96	2.77 <sup>c</sup> ±0.22
Guinea	18.54 <sup>b</sup> ±2.23	1.89 <sup>b</sup> ±0.14	13.67 <sup>ab</sup> ±2.52	13.41 <sup>bc</sup> ±2.76	2.76 <sup>c</sup> ±0.82
Cameroun	18.40 <sup>b</sup> ±0.48	1.90 <sup>b</sup> ±0.09	12.33 <sup>abc</sup> ±1.53	15.95 <sup>ab</sup> ±1.82	3.05 <sup>c</sup> ±0.48
Mali	17.49 <sup>b</sup> ±1.50	1.88 <sup>b</sup> ±0.015	14.67 <sup>a</sup> ±0.58	12.33 <sup>c</sup> ±1.53	2.85 <sup>c</sup> ±0.27

Mean followed by the same letter in the same column are not significantly different according to DMRT ( $P \leq 0.05$ )

The result obtained from the yield which were number of bunch per tree, number of pod per bunch, weight of pod per bunch and weight of bunch per tree of *P. biglobosa* from eight provenances were recorded in

Table 2. The number of bunch per tree, number of pod per bunch, weight of pod per bunch and weight of bunch per tree of *P. biglobosa* from Nigeria provenance was significantly different from the rest



provenances. However, there were no significant difference in number of pod per bunch between Nigeria provenance and

Burkina Faso. Among the remaining provenance there were variations in the parameter measured.

**Table 2: The Yield of *Parkia biglobosa* tree**

	No of bunch per tree	No of pod per bunch	Weight of pod per bunch Kg	Weight bunch per tree Kg
Senegal	35.67 <sup>d</sup> ±5.13	24.67 <sup>c</sup> ±6.35	1.30 <sup>c</sup> ±0.17	25.33 <sup>c</sup> ±1.528
Benin Republic	44.00 <sup>bc</sup> ±4.00	24.33 <sup>c</sup> ±4.04	1.30 <sup>c</sup> ±0.10	19.33 <sup>d</sup> ±3.06
Nigeria	59.00 <sup>a</sup> ±2.64	47.00 <sup>a</sup> ±2.65	2.70 <sup>a</sup> ±0.34	32.67 <sup>a</sup> ±2.08
Burkina Faso	49.67 <sup>b</sup> ±2.51	42.33 <sup>a</sup> ±3.22	0.23 <sup>ab</sup> ±0.23	33.00 <sup>a</sup> ±1.00
Ghana	45.67 <sup>bc</sup> ±5.50	34.00 <sup>b</sup> ±5.29	1.57 <sup>bc</sup> ±0.50 <sup>c</sup>	30.33 <sup>ab</sup> ±2.52
Guinea	44.33 <sup>bc</sup> ±4.61	34.00 <sup>b</sup> ±2.00	1.33 <sup>c</sup> ±0.15	27.67 <sup>bc</sup> ±4.04
Cameroun	47.00 <sup>b</sup> ±3.46	34.33 <sup>b</sup> ±5.86	1.50 <sup>c</sup> ±0.61	26.67 <sup>bc</sup> ±1.53
Mali	38.00 <sup>cd</sup> ±4.58	32.00 <sup>bc</sup> ±3.46	1.17 <sup>c</sup> ±0.21	25.33 <sup>c</sup> ±1.52

Mean followed by the same letter in the same column are not significantly different according to DMRT ( $P \leq 0.05$ )

Result of table 3 and table 4 shown below revealed pod and seed characteristics of *P. biglobosa* from eight provenances under investigation. Result showed diverse characteristics among the provenances investigated (Plate 1 and Plate 2). Results of pod size ranged from small to big sizes in *P. biglobosa* examined from different provenances. It was discovered from the result that pods of *P. biglobosa* from Benin were small, while pod collected and examined from Senegal, Guinea, and Mali had medium sizes of pod and the pods from Nigeria, Burkina Faso, Ghana and Cameroun provenances had big pod sizes.

The result also revealed that pod from Senegal and Guinea provenances had oval shape, while pod examined from Benin, Ghana, Cameroun and Mali provenances had round shapes.

But the pod from Nigeria and Burkina Faso provenances had flat shapes as shown in the table 3 below. Senegal provenance had coffee brown colour, Benin and Guinea pods provenances had chocolate brown, while Nigeria provenance pod had coconut brown colour. While Burkina Faso and Cameroun pods were deep brown and Ghana and Mali pods showed heavy brown colours (Table 3) below.



Plate 1: harvested bunches of *Parkia biglobosa*



Plate 2: *Parkia biglobosa* seeds with pulp

Table 3: Physical characteristics of pods of *Parkia biglobosa* from different provenances

Provenance	Size	Shape	Colour
Senegal	Medium	Oval	Coffee brown
Benin	Small	Round	Chocolate brown
Nigeria	Big	Flat	Coconut Brown
Burkina Faso	Big	Flat	Deep brown
Ghana	Big	Round	Heavy brown
Guinea	Medium	Oval	Chocolate brown
Cameroun	Big	Round	Deep brown
Mali	Medium	Round	Heavy brown

The physical characteristics of seeds of *P. biglobosa* from different provenances were examined to discover the sizes, shape and colour of the seeds. The result of the seeds from Senegal, Benin and Mali provenances shows that the seeds are small in sizes (Table 4). Also, it was observed that shape of the seeds of *P. biglobosa* from Senegal, Benin, Ghana and Mali were oval shape. However, Nigeria, Guinea and Cameroun had round seeds shape.

Also, from the result shown in (Table 4), Burkina Faso provenance seeds had flat shape. The colour of seeds from Senegal and Benin provenances were brown, while Nigeria and Guinea seeds had a light brown coloration. Also seeds from Burkina Faso and Ghana provenances had chocolate brown colour but seeds from Cameroun provenance had dark brown and Mali seeds provenance had deep brown colour.



**Table 4 :Physical characteristics of seeds of *Parkia biglobosa* from different provenances**

Provenance	Size	Shape	Colour
Senegal	Small	Oval	Brown
Benin	Small	Oval	Brown
Nigeria	Big	Round	Light Brown
Burkina Faso	Big	Flat	Chocolate brown
Ghana	Medium	Oval	Chocolate brown
Guinea	Medium	Round	Light brown
Cameroun	Big	Round	Dark brown
Mali	Small	Oval	deep brown

### Discussion

*P. biglobosa* fruits (pods) and seeds were examined from different provenance showed different characteristics. Variations that exist in the components of the seeds and pods of *P. biglobosa* as reported in this study was in line with the findings of Khan *et al.*, (2002) and Khan (2004) who reported that extensive intraspecific variation in seed traits is common in tropical tree species. Results observed were in line with a studies on tamarind in Burkina Faso (Diallo *et al.*,2010) and also corroborate with previous studies on other species such as *Strychnos cocculoides* Bak. and *Cordia africana* Lam. (Mkonda *et al.*, 2003; Loha *et al.*, 2006).. In a separate study of Olorunmaiye *et al.*, (2011) also reported the characteristics of fruit and seed of *P. biglobosa* examined varied in shape, colour, texture and sizes among the selected population.

However, the diversity in the physiological characteristics of the seeds and pods of *P. biglobosa* may be a pointer to the genetic traits among the provenances investigated. Moreso, there are also variation in the pod length, pod width, pod weight, number of seeds per pod and seed weight. The differences in fruits characteristics within the provenances under investigation corroborate with the findings of (Olorunmaiye *et al.*, 2011). Clinal variation patterns were also observed by Millogo (2014) in seed morphological traits, that is, length, width, thickness, weight in a sample

of 246 seed trees from 18 provenances, across four countries (Benin, Cameroon, Guinea and Ivory Coast) in the humid climate zones. It was found that longitudinal variation of length, thickness and width of seed traits, from western to eastern provenances, seeds become flatter, larger, longer, and heavier, forming two distinct groups which resulted into West African and Central African provenances. In contrast, the variation pattern in the pods and seeds characteristics of *Parkia biglobosa* in this study are unique to their specific provenances. This may be probably due to the plantation establishment under same agro ecological zone of Saki West Local Government Area of Oyo State in Nigeria. The provenances of *P. biglobosa* were able to display the genetic composition of their pods and seeds under same climatic and edaphic condition not relating to either eastern, western or central group.

This result also was affirmed by the findings of Oyerinde *et al.*, (2018) who reported that distribution of fruit pods and seeds of *P. biglobosa* weight/tree, pod weight/tree and pod number/tree of trees from Ondo State in Nigeria were the higher when compared with samples from Ekiti and Osun States also in Nigeria. The results from the study revealed that there were significant difference in pod number per tree, pod weight per tree, seed weight per tree, pod length per tree and pod breadth per tree of *P. biglobosa* across the selected States. .



It was reported by Agbolade *et al.*, (2019) that variability in pod and seed characters which includes; days of pod maturity, number of pod per peduncle, pod length, pod width, number of locules per pod, number of seeds per pod, also, seed length, seed width were observed. These were observed from weight of one hundred seeds in a study of genetic variability and diversity analysis in Pod and Seed Characters of Some Neglected and Underutilized Legumes. This supported the observation and records from this study which have earlier been reported.

It was affirmed by Agbolade and Komolafe (2016) that occurrence of variation in plant organisms is reflection of possibility of evolutionary survival and the opportunity to improve species on significant characters. Variation is a guide for selection, which is a tool for effective classification also knowledge of the within species variation is a fundamental track to effective classification and improvement.. Thus, the general assessment of the pod and seeds of *P. biglobosa* from different provenances showed variations in their physical appearance from one provenance to the other as reported in this research (Table 3 and Table 4) above.

Variation in morphological characteristics of *P. biglobosa* from different provenances could probably be as a result of the environmental, geographical and edaphic characteristic the area location of the provenance. Moreover, it is imperative to have the understanding of variation within the same species of *P. biglobosa* which were sourced from different areas if tree improvement program of the said species will be successful. Burkina Faso and Nigeria that has big seed sizes and higher seed weight could be of better choice in seed selection for tree improvement program.

The above statement was buttress by Dlamini (2011) who reported that a positive relationship between seed weight and amount of food stored in the seed storage tissue has been demonstrated in numerous plant species. A large seed normally indicates a large endosperm, or a large embryo and cotyledons. In albuminous seed, the endosperm is the reservoir of energy necessary to facilitate the germination process and in exalbuminous seeds such as those of *Fidherbia albida* (Dlamini, 1998; Dlamini, 2010). In most tree species seed size has been found to be strongly correlated with germination rate and seedling size, however, the advantage could be short lived depending on the species. The choice of seed size is relevant in breeding and domestication of *P. biglobosa*. it is imperative to intensify germplasm collection and genetic characterization towards conservation, breeding and sustainable utilization (Popoola *et al.*, 2020)

### Conclusion

The physiological characteristics of pod and seeds of *P. biglobosa* could be revealing the genetic composition inherent in them. The physiological characteristic could be bases of identification for the fruit from these provenances in West Africa. This study has been able to produce explicit information on the general features of the fruit of *P. biglobosa* according to their weight, sizes, shapes and colour. Although, there is an interaction among the species of *P. biglobosa* from different provenances, yet the physiological features of the fruits are still distinct in nature. However, this could be a precursor for selection of seeds for plant domestication based on their genetic inherited traits. The fruit of *P. biglobosa* from Nigeria and Burkina Faso could be selected for tree improvement and multiplication. This study has provided background information on further study on relationship between the fruit morphology





and genetic traits inherent in the fruits from different provenances of *P. biglobosa*.

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