DENSITY AND PHENOTYPIC VARIATIONS OF *Vitellaria paradoxa Gaernt C. F.* IN NIGERIAN GUINEA SAVANNAH

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ABSTRACT

The variation in density and among phenotypes of Vitellaria paradoxa (Shea tree) was studied in two ecozones (southern guinea savannah and northern guinea savannah) in the Nigerian guinea savannah. The total density of Shea trees in all sampled sites ranges from 5-42, 8-54 and 35-60 in cultivated, fallow and forest land respectively. In both the northern and southern guinea savannah, large trees (>211cm GBH) of shea were present only in cultivated land. Larger trees were found mostly in southern guinea savannah as shea trees are highly protected because of its high product value (oil). The study showed that there was a variation between the populations, related to the traits measured on the trunk and leaf. Six shapes of the tree (Spherical, Broadly pyramidal, Pyramidal, Oblong, Semi- spherical and Elliptical), different leaf base (round, shortly attenuate, oblique, cuneate), leaf shape (oblong, narrowly elliptical, broadly elliptical, elliptical), leaf margin (entire, undulate, round) and leaf apex (retuse, obtuse, acute, acuminate) were identified. Four bark colours (ash-grey, dark grey, white and black) were also identified. The leaf forms of the entire shea trees sampled were generally oblong. The petiole length, leaf length and leaf width ranged between 16.9-28.6, 10.3-21 and 4.4-8.1 respectively.

Key words: *Vitellaria paradoxa, phenotypic variation, Nigerian Guinea Savannah*

Introduction

Vitellaria paradoxa is an important tree species in Sub-Sahara parkland and it provides a range of forest products and plays vital roles in the rural economy (Okafor, 1908; Kio et al., 1989). It is typically a Savannah woodland tree species. Its natural habitat stretches over Africa. The geographical distribution of *Vitellaria paradoxa ranges* within the 600mm to 1500mm rainfall isohyets from Senegal in the west to Uganda in the east. Shea forms the dominant tree species of agroforestry parklands in Sudanian-Savannah where it is associated with other species such as *Parkiabiglobosa, Acacia senegalis and Terminaliaavicenniodes* (Boffa 1999; Hall et al 1996). In Nigeria the shea tree occurs mainly on dry open land. It also occurs in the wild. It thrives well within the Guinea and Sudan savannah areas as well as the lower Sahel

region of the country. The interest in shea is linked to its multiple physical and chemical properties. Some studies have been carried out in Nigeria on the processing of shea butter. Very few studies have been carried out on the morphological characteristics of shea trees in Nigeria, in order to identifying the different shea varieties that exist in the country. Studies carried out in some West African countries have shown the existence of a high intra-specific variation (Chevalier 1984; Ruyssen 1957) among shea trees. A phenotypic variation among variation of shea trees and a correlation between its different physical properties have been reported in Ghana (Lovett and Haq 2004), Mali (Sanou et al., 2005) and in Cote d' Ivoire (Diarrasoubaet al., 2007). A preliminary step in the identification of the various genotypes of the shea trees that may exist in Nigeria is to identify the phenotypes. Little of such studies have been carried out in the country. There is thus need for studies on the phenotypic variation of populations of shea trees to serve as a preliminary step for subsequent genetic study of the species.

Materials and Methods

The study was carried on shea tree populations from two agro-climatic zones of Nigeria: Southern Guinea savannah (Niger state) and Northern Guinea savannah (Kebbi state), identified as the major shea butter zones in Nigeria (Keay, 1989). Sampling sites were chosen according to Palmberg (1985). In Southern Guinea savanna, six locations (Tasha-alura, KawoKontagora, TshenItche, Badeggi, Kochiba, and Tungankawo) were selected, while in the Northern Guinea savanna four locations (Bin, Tendagari, Tungan-Takangar and Mararabe) were selected. The locations within zones were at least 50km apart to avoid selection of closely related individual. Within location, five shea trees separated by a distance of 25-50m were considered. In every location the number of shea trees in one hectare was recorded. So also were the number of main branches and sub branches per tree. The survey was conducted in cultivated, forest and fallow lands in each location. Fifty five shea trees were sampled.

Fourteen traits (5 qualitative and 9 quantitative) were analysed for each shea tree sampled.

Qualitative traits

The qualitative parameters measured were; the shapes of the tree, shape of the leaf, bark shape, bark colour and texture of the bark. These qualitative traits were identified with reference to description given by IPGRI, INIA (2006).

Quantitative traits

The quantitative traits were subdivided into two groups; traits related to the tree and traits related to the leaves. The circumference of the trunk of each tree sampled was measured at a distance of about 1m from the ground using a flexible measuring tape. Also measured were the crown diameters, trunk height. Five leaves per tree were randomly harvested from the periphery of the tree branches to avoid border effect.

Three traits were measured on the leaves; length of the petiole, length of the leaf and width of the leaf, all expressed in centimetres. Barks diameters were taken using a verniercalliper.

Results

From the sites studied, phenotypes for shape of tree and leaves were observed in variable proportions (Table 1). 36.36% of the trees sampled had spherical shape. It was observed that the frequency of the different phenotypes varied from one site to another. 27.27% of the trees were broadly pyramidal, while 20.00% of the trees were elliptical. Great variation was observed for the shape of trees and leaves. The mean densities of *Vitellaria paradoxa* was 25, 44 and 54 for cultivated, fallow and forest respectively in the northern province, while it was 42, 109 and 200 in the southern province as shown in table 2.

Comparism of means between the two ecological zones showed that shea populations

were different. Analysis carried out on the measured variables related to the sampled shea trees showed variation between samples means as shown in Table 3.

Table 4 illustrates the girth distribution according to land uses. In both the northern and southern guinea savannah, large trees (>211cm GBH) of shea were present only in cultivated land. Larger trees were found mostly in southern guinea savannah of Niger state as shea trees are highly protected because of its high product value (oil). The distribution in the forest in all areas sampled was completely different from the cultivated and fallow land, as most of the individuals were found in lower classes.

The circumference of the trunk tends to be higher in the Southern Guinea than Northern Guinea savannah. In the entire shea trees sampled in the agro ecozones, the leaf form was generally oblong (66.44%). Other leaf forms identified were narrowly elliptical (21.69%), broadly elliptical (8.47%) and elliptical (3.38%). Different forms of leaf apex, leaf base and leaf margin were identified. The petiole length, leaf length and leaf width ranged between 16.56-22.88, 12.76-17.32 and 5.33-7.74 respectively as shown in Table 5.

Discussion

The study of phenotypic variation is a necessary step for characterizing shea butter. This study assisted in the evaluation of the genetic diversity of shea in the Guinea savannah provinces of Nigeria. Six phenotypes (Spherical, Broadly pyramidal, Pyramidal, Oblong, Semi- spherical and Elliptical) were observed for the shape of the trees. The existence of these shapes seems to have been influenced by the type of vegetation in which the trees grow. Indeed, the competition generated by the proximity of the other trees as well as the action of humans (for agriculture) on the environment modifies the shape of trees (Diarrassoubaet al 2006). Similar observations were reported in Côte d'Ivoire (Delome 1947). On the basis of the morphology of the leaf, five forms were identified (Oblong, narrowly elliptical, broadly elliptical and elliptical). These characteristics were very discriminative and can therefore be used to structure and classify the types of shea trees in the Nigerian Guinea savannah. These traits are easily observable on a large scale. The distinction of shea population using these characteristic is easy. All the qualitative variables considered in the study were observed at all the sampling sites. Though these parameters varied significantly among sites, the qualitative parameters seemed little influenced by environmental factors. The variations of the proportions of the different parameters between the sites could be attributable to anthropogenic activities given the fact that the species grow mostly in areas close to human settlements (Lovett and Haq, 2000).

Statistical analyses carried out on the measured variables related to the shea trunk and leaves showed a very high variation between sampling sites. The analysis equally revealed that each individual could be used to a certain degree to describe the types of shea trees that exist in the studied areas. This suggests that variation existed among the shea trees for the different traits irrespective of land use pattern and location (Lovett and Haq, 2004). This finding corroborated the work of Louis (1981) that tree crops differ from one another as a result of differences in their genetic potential, efficiency of pollination and resistance to pests and diseases. This range of variability exhibited by the shea trees for various metrical characters may be attributed to the diverse parent trees. The morphological variables have already been used for the characterization of other savannah species.

Larger trees were present in cultivated land compared to fallow and forest. Field observation revealed that the main selection stage occurs when fallow/ forest land is cleared, as most immature individuals are removed and

only certain large trees are maintained on cultivated land (Lovett &Haq, 2000). Over time, this has led to significant changes in the Vitellariaparadoxa structure as compared to that expected in the natural environment. A much larger proportion of mature productive trees (dhb>150cm) are therefore present in the cultivated land than in unmanaged woodland (fallow and forest).

Larger but fewer trees were found in the northern guinea province (on cultivated land) as a result of the intensive farming in the area. Little or no species present were found where there were tractor ploughing, which reduces regeneration and damages mature tree root systems. The huge difference in distribution between cultivated and other land uses, at the same site may be explained by the abundance of regeneration and the high level of competition for light and nutrients between shea and other tree species in both fallow and forest (Bokaryet al., 2004).

The petiole length, leaf width and leaf length in the Southern guinea were longer and significantly different from the leaves in the Northern guinea. This finding corroborate the findings of Odebiyiet al. (2000) that the leaves produced by shea trees in the woodland savannah were significantly longer than those produced in the northern guinea savannah. This was attributed to differences in genetic variability of the parent trees, competition for nutrient with other trees present as well as environmental factors, which led to differences in leaf production as well as other traits measured.

Conclusion

This investigation brought out some morphological descriptors of shea trees in the Nigerian Guinea savannah. Some phenotypes were distinguished based on observations made. Qualitative characters like the shape of the leaves were discriminative. Morphological varieties were distinguished on the basis of the shapes and sizes of the tree and leaves. The shea tree population was highest in the southern guinea savannah compared to northern guinea savannah. The density of shea trees and saplings were highest in forest land, compared to cultivated and fallow land.

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Table 1: Phenotypes observed and their frequencies(%).

Qualitative character	Phenotypes	Percentage %
Crown shape	Spherical	36.36
	Broadly pyramidal	27.27
	Pyramidal	1.82
	Oblong	7.27
	Semi-spherical	7.27
	Elliptical	20.00
Leaf shape	Oblong	66.44
	Narrowly Elliptical	21.69
	Broadly Elliptical	8.47
	Elliptica	3.38
Leaf Apex	Retuse	51.53
	Obtuse	23.28
	Acute	14.89
	Accuminate	10.30
Leaf Base	Round	59.4
	Shortly Attenuate	3.6
	Oblique	20.9
	Cuneate	16.1
Leaf Margin	Entire	22.9
	Undulate	61.3
	Round	15.9

Table 2: Area of parcels, densities (shea trees and saplings) and mean girth, between trees of *Vitellari a paradoxa* in Northern and Southern Guinea Savannah in Nigeria

	Northern Guinea Savannah				Southern Guinea Savannah			
Land Uses	Girth (cm)	Density (ha^{-1})	Saplings	Area (m^2)	Girth (cm)	Density ($ha^{-1)}$	Saplings	Area (m^2)
Cultivated	164	25	6	4.5	198	42	13	4.5
Fallow	154	44	10	6.4	162	109	32	6.5
Forest	62	54	38	8.8	116	200	80	8.9

Table 3: Means and Standard Error of phenotypes

	Height (m)		Girth (m)		CD (m)		Main branch		Sub-branch	
Locations	Mean	S.E	Mean	S.E	Mean	S.E	Mean	S.E	Mean	S.E
Bin	2.6	0.321	2.85	1.877	7.33	2.418	2.33	0.333	14.00	4.042
Tendaga	2.7	0.271	1.64	0.125	8.32	0.865	2.00	0.005	8.20	0.939
Tungan Takangari	2.52	0.196	1.44	0.112	10.36	1.399	2.40	0.509	9.20	1.386
Mararabe	1.74	0.231	1.30	0.179	8.52	0.742	2.00	0.001	9.40	3.233
Mararabe	1.56	0.093	0.62	0.048	5.02	0.705	2.00	0.001	7.20	0.969
Tashaalura	1.98	0.468	1.08	0.115	9.06	0.886	2.40	0.242	9.00	1.095
Tashaalura	2.04	0.188	1.24	0.258	10.40	1.524	2.20	0.199	9.80	1.157
Matani	2.62	0.459	1.16	0.191	8.36	0.725	1.80	0.199	9.00	0.447
Kawo Kontangora	5.38	0.687	1.32	0.115	8.60	1.260	2.20	0.199	11.40	1.909
TshenItche	1.54	0.208	1.48	0.279	11.48	1.060	2.20	0.199	12.00	1.480
Badeggi	2.42	0.368	1.99	0.111	12.86	0.964	2.20	0,199	14.60	1.536

Table 4: Girth of *Vitellaria paradoxa* in cultivated, fallow and forest lands in Nigeria Guinea Savannah

Girth size class	Cultivated	Fallow	Forest
51-66	0	0	0
67-82	3	2	5
83-98	0	1	1
99-114	2	1	7
115-130	3	3	2
131-146	1	2	1
147-162	1	2	2
163-178	0	4	0
179-194	1	0	0
195-210	4	2	0
211-226	1	0	0
227-242	1	0	0

Table 5: Lamina morphology of *Vitellaria paradoxa* in the Nigerian Guinea savannah

	Petiole length (cm)		Width (cm)		Leaf length (cm)	
Locations	Mean	S.E.	Mean	S.E	Mean	S.E
Bin	16.56	1.20	5.33	0.16	12.76	0.35
Tendagari	19.98	0.55	5.36	0.18	15.12	0.44
Tungan-Takangari	18.22	0.32	5.50	0.27	13.88	0.27
Mararabe	18.32	0.33	5.58	0.18	13.78	0.25
Mararabe	19.20	0.47	5.48	0.15	13.76	0.32
Tasha-alura	22.88	0.54	7.74	0.17	17.32	0.48
Tasha-alura	20.08	0.56	5.85	0.18	14.04	0.48
Matani	21.88	0.82	5.73	0.19	16.52	0.82
Kawo Kontangora	23.36	0.65	6.32	0.24	17.16	0.52
Tshen Itche	21.28	0.66	5.22	0.22	14.54	0.43
Badeggi	20.60	0.40	5.82	0.14	15.96	0.32
LSD (0.05)	2.17	-	0.40	-	1.47	-
CV (%)	14.15	-	16.33	-	13.36	-