Journal of Applied Pharmaceutical Science Vol. 3 (07), pp. 052-060, July, 2013
Available online at http://www.japsonline.com
DOI: 10.7324/JAPS.2013.3710
ISSN 2231-3354

Population pattern and phenological behaviours for selected medicinal plants in Nigeria; implications for *ex-situ* conservation

[1]Oni, P.I., [2]Jimoh, S.O and [2]Adebisi, L.A
[1]Department of Biological Sciences, Bells University of Technology, P.M.B 1015, Ota, Nigeria.
[2]Department of Forest Resources Management, University of Ibadan, Nigeria.

ARTICLE INFO

Article history:
Received on: 05/05/2013
Revised on: 29/05/2013
Accepted on: 25/06/2013
Available online: 30/07/2013

Key words:
Medicinal plants, population, phenology, conservation, sustainability

ABSTRACT

Recent developments indicated increasing gene-pool depletion for most medicinal plants in Nigeria despite their pharmaceuticals and therapeutic potentials. Initial socio-economic study involving three countries (Nigeria, Ghana and Republic of Benin) identified ten most frequently used medicinal plants. This list was superimposed on a vegetation map of Nigeria for the production of a distribution map ahead of an eco-geographic survey for population and phenological studies. Sample sites were defined in east-west directions under different vegetation and land use types. Sample sizes of 50m x 50m quadrant were selected across the vegetation and land use types. Altogether 55 samples quadrats were recorded across the zones; Lowland rainforest (20), Derived savanna (16), Sudan savanna (13) and Guinea savannah (6). A total of 196 individuals were recorded across the four ecological zones, rainforest 66 (33.67%) and least in Sudan savanna 13 individuals (6.63%). On land use basis, plantation forest recorded the highest in the lowland rainforest zone and least in sacred groove with similar trend in Derived savanna. In Guinea savanna, farm lands had the highest number of individuals while forest plantation accounted for the highest in Sudan savanna. Flowering duration varied greatly, ranging from (8.42 ±0.83) days to (45.25 ±5.77) days. Fruiting patterns ranged between (14.44± 4.28 to 145.87± 8.76) days. The need for adequate phenological information ahead of *ex-situ* conservation programme is desirable. Low stocking density observed across the range and land use types is implicated for holistic conservation strategies and sustainability.

INTRODUCTION

There is currently a global attention on the conservation and sustainability of the rich biodiversity of the tropical rainforest. This is perhaps due to the vast resources derivable from the forest as well as threats to ecosystems resulting from various forms of human-induced degradation and natural factors (FAO, 2007). The potential of the Nigerian flora as a veritable source for pharmaceuticals and other therapeutic materials have been greatly emphasized (Gbile and Adesina, 1986, Oni, 2010). Within the natural forests in Nigeria, abound several valuable non-timber resources of edible and highly nutritive plants whose various parts (fruits, leaves, stems, twigs, barks and roots) are of high medicinal values (Sofowora, 1993; Owonubi and Otegbeye, 2004). Mgeni (1991) opined that with the unique diversity of plants and animal life, tropical rain forest represents biologically renewable resources of food, medicine and fuel if well managed.

* *Corresponding Author*
Department of Biological Sciences, Bells University of Technology, P.M.B. 1015, Ota, Nigeria. Mail id: petidowu2000@yahoo.co.uk
Phone: 08067538686 / 08096395930

However many of these valuable plant species are fast disappearing due to increasing conversion of natural forest to mono species plantation, commercial agriculture and urbanization (Adekunle, 2005). A major challenge in natural forest resources in Nigeria is the continuous decline in stock over the years (FAO, 1997; Ajakaiye, 2001, Ayodele, 2005,). It has been indicated that many of the old folks who possessed knowledge and information on the use and conservation of most of these medicinal plants are gradually dying without adequate documentation of their knowledge (Obute and Osuji, 2002, Oni *et al*; 2012). Medicinal plants will continue to play significant roles in both rural and peri-urban health care services as evident in the current number of herbal practitioners in Nigeria (WHO, 2001). Apart from their potential in pharmacological research and drug development they also serve as direct therapeutic agents or as sources of templates for the synthesis of drugs (Oni, 2010). Despite all advances made in orthodox medicine, traditional medicine has continued to gain renewed interest in health care services of Nigerians. This may be attributed to increase awareness in the potential and curative ability of these alternative medicines as well as the various short comings

indicated for several synthetic drugs (Ugbogu and Odewo, 2004). According to Gbile and Adesina (1986) herbs usually serve as the repository materials and have been acknowledged to be generally safe with minimum side effects. The dwindling economic fortune and high cost of orthodox medicines have also forced many to exploit various plant species for their medi-care (Oni, 2010). Information abounds on several aspects of medicinal plants including; ethnobotany, economic importance, distribution as well as their potency (Abbiw, 1990, Ugbogu and Odewo; 2004, Oni, 2010), however information on their ecological status in form of eco-geographic survey to monitor their population changes, flowering and fruiting behaviours continue to remain a major area of research gap. In the development of appropriate *ex-situ* conservation programme in Nigeria for these species there is the need to increase the level of available information on their population and threat status, flowering and fruiting behaviours. In most tropical tree species, flowering and fruiting behaviors vary significantly across their various agro-ecological zones According to Hall *et al*. (1996) and Oni (1997) flowering and fruiting behaviors in *Vitellaria paradoxa* and *Parkia biglobosa* which are typical medicinal plants, onset of flowering and fruiting increase in a south-north direction. Sound decisions in sustainable *in-situ* and *ex-situ* conservation and management programme for indigenous medicinal plants will require detailed knowledge of not only their taxonomy, natural regeneration pattern but also their current population pattern and their reproductive biology (Oni 2001, Gockowski, 2011). Over the years, it is evident that substantial medicinal plants collections come from the wild without corresponding efforts at enrichment plantings or deliberate efforts to protect the remaining the germplasm because most collectors believe that there will always be enough in their natural habitat. However recent field observations indicate depletion in their gene-pool (Oni, 2004, 2010). Various threats ranging from over-exploitation, environmental degradation, desertification and lack of sustainable management plan had been noticed. Therefore developing a sustainable *in-situ* and *ex-situ* conservation programme for these groups of plants requires information not only on their current natural populations across their range in Nigeria but also their flowering and fruiting (phenology) behaviors. The present paper provides additional information in this regard for selected medicinal plants in Nigeria.

MATERIALS AND METHODS

At the onset of the study, preliminary socio-economic survey was carried out among the collaborating countries; Nigeria, Ghana and Republic of Benin to identify frequently used medicinal plants among the three countries in the health care services the people.

After the survey, all medicinal plant species mentioned were synthesized and later prioritized to arrive at a list of ten commonly used medicinal plants on a country basis. The three lists emanating from the three countries were later synchronized and harmonized based on the degree of mentioning and relative importance in at least two of the three countries.

At the end, the ten most common medicinal plants across the three countries were later arrived at and adopted for use among the three countries. This final list of the ten medicinal plants was subsequently used to develop a protocol of study in Nigeria and in the other two countries. The list of the ten medicinal plants investigated is as shown in Table 1.

On the basis of the medicinal plant species distributions in Nigeria, the list was superimposed on the vegetation map of Nigeria cutting across four main vegetation zones (Lowland Rainforest, Derived savanna, Guinea savanna and Sudan savanna) (Figure 1).

As a way of providing insights into their distinct differences in biophysical characteristics among the vegetation zones, a summary of their main bio-physical characteristics and climatic variables is indicated in Table 2.

Table. 1: The selected medicinal plants investigated for population pattern and phenological behaviours in Nigeria.

SNo	Taxa for selected medicinal plants	Families	Habit
1	*Alstonea bonnie* De Willd	Apocynaceae	Tree
2	*Khaya senegalensis* (Desr) A. Juss	Meliaceae	Tree
3	*Kigelia africana* (Lam.)Benth.	Bignoniaceae	Shrub
4	*Morinda lucida* Benth.	Rubiaceae	Shrub
5	*Pycnathus angolensis* (Welw.)Warb.	Myristicaceae	Tree
6	*Rauvolfia vomitoria* Afzel.	Apocynaceae	Shrub
7	*Securidaca longpenducculata* Fresen.	Polygalaceae	Herb
8	*Tamarindus indica* L.	Fabaceae	Tree
9	*Vitellaria paradoxa* C.F Gaertn.	Sapotaceae	Tree
10	*Zanthoxylum xanthoxyloides* (Lam.)Zep & Timler	Rutaceae	Tree

Source: Eco-geographic survey of medicinal plants in Nigeria (2009).

Table. 2: The bio-physical characteristics of the selected study sites in relation to their agro-ecological zones in Nigeria.

Agro-ecological zones	Study sites	Latitude (°N)	Longitude (°E)	Altitude (m)	Annual Rainfall (mm)	Rainfall pattern
Lowland Rain forest	Benin	6 19’	5 41’	120	1440	Bi-modal
	Ekpoma	7 23’	3 56’	120	1450	
	Ibadan	6 20’	5 40’	264	1340	
	Ido/Eruwa axis	7 26	3’ 54	264	1340	
Derived savannh	Eruwa	7. 35’	3. 25	264	1340	Bi-modal
	Olokemeji	7 .35’	3.25	200	1222	
	Igana-Okeho axis	7 50’	3 55’	102	1040	
	Saki axis	8.41’	3 23’	106	1040	
Guinea savannah	Ibilo	7 50’	6 07’	52	1180	Mono-modal
	Okene-Kabba axis	7 49’	6 44’	41	1184	
	Lokoja axis	7 44’	8 35	114	1280	
	Makurdi axis	7 26’	6 04’	120	1180	
Sudan savannah	Kano	12 05’	8 35’	172	886	Mono-modal
	Taraba	08 38’	11 08’	168	920	Mono-modal

Source: Meteorological reports, 2008

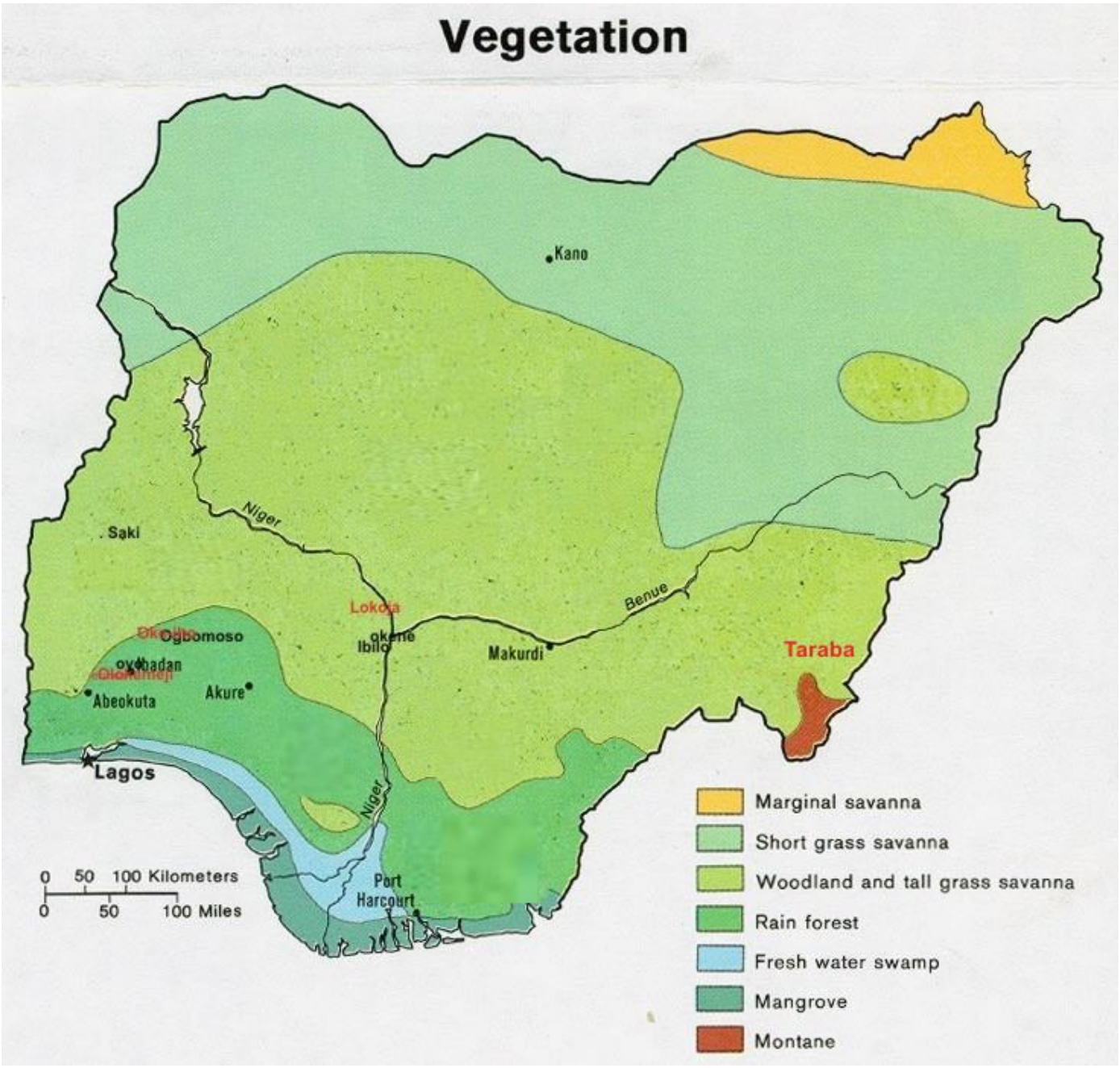

Fig. 1: Map of Nigeria showing the sampling sites across the four different vegetation zones.

Sampling procedure

Based on the results of the socio-economic study, the various locations where the utilization information were obtained for the ten different medicinal plants were defined with respect to their geographical locations and super-imposed on the vegetation map of Nigeria. On the basis of their locations and coordinates, a distribution map for the ten selected medicinal plants across the four major vegetation zones of Nigeria (Lowland Rainforest zone, Derived savanna, Guinea savanna and Sudan savanna) were developed. This was followed by eco-geographic reconnaissance survey to assess the general medicinal plants distribution in each location. Based on the output of the eco-geographic, sampling sites were selected in a (West–East and South-North directions) in each vegetation ensuring even spread. For a sampling site to be selected in each vegetation zone, it must contain at least two or more members of the medicinal plants under investigation. For the selection of the land use types, the medicinal plants must be present in at least 50% of the total land area under investigation for a particular land use type.

In each sampling site and under each land use type, 50 x 50m quadrats were laid and total assessment of different medicinal plants mother trees were carried out. Within each quadrant, the numbers of individual trees of different medicinal plant species were physically counted. Black marker was used to mark each tree

as it was counted to ensure that they were not missed, or counted twice. The number of quadrats taken in each location varied greatly depending on the medicinal plants distribution and population.

The same quadrats size was taken across the vegetation zones and land use type except in sacred grooves where in many cases the total area under protection were sometimes less than the size of the quadrant. In all the sacred grooves total enumeration of the different medicinal plants distribution were carried out. The following sample sites were encountered (Natural forest, Forest plantation, peri-urban forest, Disturbed natural forest, Fallow lands, Protected area, Free areas, National parks, Savanna parklands and Scared grooves.

RESULTS AND DISCUSSION

Distribution of the different medicinal plants in relation to forest and land use types in the four agro-ecological zones in Nigeria

All together of 55 quadrats were taken across the different land use types for the ten different medicinal plants species investigated in the four agro-ecological zones of Nigeria (Table 3). The general distributions of the different medicinal plants on sampling sites basis indicated that different forest types and land use types were encountered however the commonest was the natural forest followed by Forest plantation. The number of quadrats also varied across the different locations. The number of quadrats varied with the different forests and land use types across the four ecozones. The Lowland rainforest ecozone recorded the highest number of quadrats (20), followed by the Derived savanna (16), Sudan savanna (13) and least in the Guinea savannah ecozone (6). In all the ecozones high diversity for the different land use types were observed however forest plantation was the most commonly encountered in the Guinea and Sudan savanna range compared with the lowland rainforest and derived savannah.

On land use type basis more medicinal plants were found in the natural forest followed by forest plantation and least in the scared grooves. In all the locations and sampling sites there was rarely no evidence of direct plantings except in the scared grooves but rather majority could be regarded as volunteers. However there was evidence of deliberate protection in several locations especially in the savanna parklands, forest plantations and farm lands perhaps due to their perceived ethno-botanical importance. This was in agreement with the findings of Ibe and Nwufo (2005). El-Amin (1990) indicated that almost all trees that play one role or the other in the smallholder house-holds farmers are deliberately protected. On an ecological basis, the decreasing number of quadrats tends to be a reflection of the pattern of natural vegetation as influenced by mean annual rainfall which decreases in a south-north direction as it also affected the general plant species diversity, richness and the total population of the different medicinal plants species. The lowest number of quadrats observed in the sacred grooves land use type probably indicates that many of the medicinal plants were not typical or popular in sacred grooves. According to Castrol (1987) most plants often found in sacred grooves were preserved for rituals and festivities or with mystical significance and most of the plants in the present investigation did not belong to that group. Adekunle (2005) reported on commonly found trees in sacred grooves and shrines including; *Adansonia digitata*, *Ceiba pentrandra*, *Milicia excelsa* and *Okoubaka aubreville*, none of which was part of the list investigated in this study. The medicinal plants distribution showed that the ten different medicinal plants had a total frequency of 196 individuals across the four ecological zones with the highest frequency encountered in the rainforest ecozone, 66 (33.67%) individuals and the least in the Sudan savanna 13 (6.63%) individuals (Table 4). The distribution of the selected medicinal plants species presented an interesting ecological niche with most of them being found in areas where they have become well ecologically adapted as most of them typical of the rainforest zone had highest number of occurrence in that region while the typical savanna parklands species were less represented in the rainforest zone and more represented in the savanna ecozones (Table 4).

The general trend observed for the medicinal plants distribution was also influenced by the mean annual rainfall for each ecozone (NEST, 1999). The rainforest zone and the Derived savanna zones with (2,800mm-1280mm) mean annual rainfall had the highest number of medicinal plants accounting over 60% for the entire plants population while the Guinea and Sudan savanna with reduced rainfall (886 mm -1285mm) were represented by fewer members and accounted for about 35% of the total number of medicinal plants encountered (Table 4).

Rauvolfia vomitoria typical of the rainforest zone had the highest population (35 individuals) across the four agro-ecological zones with a relative density of 17.67% and was recorded in all the ecozones though more abundant in the rainforest and derived savannah ecozones. Oni (2010) also reported similar finding for this species in a study of medicinal plants diversity in Idena, Ijebu-ode in South Western Nigeria. The least encountered was *P. angolenses* occurring only in two of the ecological zones (2 individuals and relative density of 2.04%) while *Z. xanthozyloidess* (7 individuals, R.D = 3.57%) was encountered in three out of the four ecological zones. These two species even within their main range were observed to be under various threats including seasonal fires, roots excavation and poor natural regeneration. Similar threats were also observed for *P. angolenses*, *A. boonei*. FAO (1986) also included these species on the list of endangered and threatened trees and shrubs in Nigeria. The typical savanna ecology species; *K. senegalensis*, *V. paraodoxa* and *T. indica* were however recorded in large number in the savanna ecozones. On an ecosystem basis and land use types basis the rainforest zone showed a fairly uniform medicinal plants distribution with the highest number observed in forest plantation (16 individuals; 24.24%) followed by natural forest 14 individuals (21.12%) while the least was encountered in sacred grooves, 2 individuals (3.03%) Table 5. Similar trends were also observed at farm land use types (10 individuals, 15.15%) respectively (Table 5).

The presence of many of these medicinal plants around the farm lands fallow/peri-urban was perhaps as result of deliberate protection based on the perceived roles of these plants in their health care services. Oni (2010) observed similar level of protection for medicinal plants in a fallow plot along Idena in south western Nigeria. According to Gisjbers *et al*. (1995) in savannah parklands, only trees that play important roles in the economic activities and services of the people are selectively protected.

The distribution of the selected medicinal plants in the derived savanna zone is such that farm lands had the highest number followed by the peri-urban on land use type basis and the least was observed in the sacred groove. The relative density of medicinal plants observed in the peri-urban and selectively protected were fairly similar (Table 6). *M. lucida* and *R. vomitoria w*ere the only two medicinal plants that had representation in all the land use types including the sacred grooves while *P. angolenses* and *Z. xanthoxyloides* had restricted distribution and were observed in only 2 two of the land use types. Only *M. lucida* and *R. vomitoria* were found in the sacred grove and this was perhaps due to their unrestricted distribution irrespective of land use types and broad ecological adaptation common to the two species. Oni (2010) also observed similar consistency for medicinal plants diversity in Idena in South Western Nigeria. These two medicinal plants are among the most common naturally occurring species often referred to as volunteers.

The distribution of the medicinal plants in Guinea savanna indicated highest number of individuals 13(23.63%) in the farm land use type while no medicinal plant was recorded in the sacred grove. Similar number of medicinal plants population were observed in natural forest and savannah parklands (12 individuals; R.D, 21.18%) Table 7.

Medicinal plants population tend to be fairly well distributed across the various land use types and except for *P. angolenses* which was absent also in all the land use types. The absence of *P. angolenses* in the Guinea savanna further demonstrated its restricted ecological niche to the rainforest ecozone while its presence in the derived savanna was perhaps due to secondary invasion. *V. paradoxa* unlike *P. angolenses* showed consistency in all the land use types except in the scared grove and the highest population observed in the farm lands and savannah parklands further demonstrates its consistency and association with parklands. Hall *et al*. (1996) opined that *V. paradoxa* along with *Parkia biglobosa* were often found as dominant species of West African parklands.

The distribution of selected medicinal plants in the Sudan savanna indicated a general low population status for the different medicinal plants across the various land use types. The poor distribution and low population was perhaps a reflection of the diminishing total mean annual rainfall in that region. The best population representations for the medicinal plants were found in the farm lands and forest reserve.

The highest number of the individual was found in both forest plantation and farm land use types with 4 individuals (30.74%) respectively while the scared grove, farm fallow and savannah parklands were poorly represented (Table 8).

The low population could be attributed to both natural and human induced factors such as fuel wood exploitation. FAO(1995) and Adekunle (2005) noted about 0.53kg of fuel wood are consumed daily per household in developing countries including Nigeria. Both the natural forest and farm lands had 2 individuals each (15.38%) while no medicinal plants was encountered in the sacred groove. Novacek and Clenland (2001) noted that large scale extinction of genetic diversity is underway and many organisms may go to extinction before they are discovered. Except for *V. paradoxa* and *K. senegalensis* which are typical savanna species, all the other medicinal plants had restricted distribution in all the land use types in the zone.

Flowering behaviors among the selected medicinal plants in Nigeria

Flowering behaviors varied greatly among the selected medicinal plants with many of them going into flowering late in the dry season to early rains. It was also observed that flowering tend to vary with altitude in a south–north direction. In many of the medicinal plants, new leaves (flushing) tend to be associated with onset of flowering in many of the locations where data were collected. Same medicinal plant species were observed to vary in onset of flowering by about 2-4weeks interval as one moves in a south-north of the species range. Hall *et al*. (1996) and Oni (2001) observed similar trends in *V. paradoxa* and *P. biglobosa* respectively in Nigeria. Most of the typical rainforest and Derived savanna species including *R. vomitoria*, *M. lucida* and *K. africana* were all observed to be in flowers both in the late dry season (Jan-March) and towards end of the rains (September-October) respectively.

Many of the typical savanna medicinal plants in this study namely *V. paradoxa*, *K. senegalensis* and *T. indica* were observed in flowers in the early dry season in Nigeria (November-January). These findings were in agreement with the work of Burkill (1985), on *M.lucida*, Maydell (1986) on *A. boonei*, *K.africana* while Hall *et al*. (1996) observed similar behviours on *V. paradoxa*. *S. longipenduculata* a typical derived savannah medicinal plant species was observed to have two flowering periods (February-April) and also in (June –July). Centre Nationale De Semences Forestieres (CNSF, 2003) observed similar flowering behaviours for the species in Guinea, Cote Ivoire and Burkina Faso.

Flowering in *P. angolenses* was rather very inconsistent and could not be accurately determined because of its short flowering period however evidence of flowering was observed late October–November during the period observations. Table 9 below summarized the mean flowering and fruiting durations for the ten selected medicinal plants.

Table. 3: Distribution of sampling sites and number of quadrats in each agro-ecological zone under different land use systems and land use types.

Agro-ecological zones	Sites location and land area	Land use type	No of Quadrats
Rainforest	Porthacourt (50x50m)	Natural forest	3
	Ibadan (50m x50 m)	Peri-urban	2
	Ido/Ologuneru road	Natural forest	3
	(50m x50m)	Farm land	2
	University of Ibadan Botanical Garden (50m X 50m)	Protected area	2
	Natural forest (50m X 50m)	Free area	1
	Benin (50m X 50m)	Natural forest	2
	(50 X 50m)	National Park	2
	(30m X 20m)	Sacred grooves	3
			20
Derived savannah	Eruwa/Olokemeji (50 m X 50m)	Forest reserve	3
	Saki axis (50m X 50m)	Farm lands	2
	(50m X 50m)	Natural forest	1
	Ogbomoso (50m X 50m)	Peri-urban	1
	(50m X 50m)	Selectively protected area	2
	(50 X 50m)	Natural forest	1
	(50m X 50m)	Plantation forest	2
	Oyo (50m X 50m)	Peri-urban forest	1
	(50m X 50m)	Natural forest	2
	(50m X 50m)	Plantation forest	1
			16
Guinea savannah	Okenne -Kabba axis (50m X25m)	Disturbed forest	2
	Lokoja axis (50 X50m)	Farm land	1
	Makurdi axis (50 X 50m)	Secondary forest	3
			6
Sudan savannah	Kano (50m X 50m)	Natural forest	2
		Farm land	2
		Forest plantation	2
	Taraba (50m X 25m)	Forest plantation	2
	(50m X 50m)	Farm-fallow	2
	(20m X 15m)	Sacred groove	1
	(50m X 50m)	Savanna parklands	2
			13
Cumulative Total			**55**

Table. 4: Distribution of the selected medicinal plants in the various agro-ecological zones of Nigeria.

Medicinal plant type	Agro-ecological zones				Total	Relative Density (%)
	Lowland Rainforest	Derived savannah	Guinea savannah	Sudan savannah		
1 *Alstonia bonnie*	7	3	2	-	12	6.12
2 *Kigelia Africana*	5	4	4	4	13	6.63
3 *Khaya senegalensis*	4	7	14	1	29	14.79
4 *Morinda lucida*	18	11	3	-	33	16.83
5*Pycnathus angolensis*	3	1	-	-	4	2.04
6 Rauvolfia vomitoria	16	14	5	3	35	17.85
7 *Tamarindus indica*	2	3	5	-	13	6.63
8 Securidaca longipedunculata	5	8	4	5	17	8.67
9 *Vitellaria paradoxa*	4	8	16	-	33	16.83
10 *Zanthoxylum xanthozyloides*	2	3	2	-	7	3.57
Total	**66 (33.67%)**	**62(31.63%)**	**55(28.06%)**	**13(6.63%)**	**196 (100%)**	**100%**

Table. 5: Distribution of selected medicinal plants based on land use types in the rainforest agro-ecological zones.

Plant species types	Rainforest agro-ecological zone					
	Natural forest	Protected area	Sacred groove	Forest plantation	National park	Farm lands
1 *Astonia bonnie*	-	2		-	1	1 2
2 *Kigelia Africana*	2	1	-	-	2	-
3 *Khaya senegalensis*	-	-	-	2	1	1
4 *Morinda lucida*	4	3	1	3	4	2
5*Pycnathus angolensis*	1	1	-	-	-	1
6 Rauvolfia vomitoria	3	4	1	3	2	3
7 *Tamarindus indica*	-	-	-	-	1	1
8 *S. longipedunculata*	3	-	-	3	1	-
9 *Vitellaria paradoxa*	1	-	-	1	1	-
10 Z, xanthoxyloides	-	-	-	-	-	1
Total	**14(21.12%)**	**11(16.67%)**	**2(3.03%)**	**16(24.24%)**	**13(1969%)**	**10(15.15%)**

Table. 6: Distribution of selected medicinal plants based on land use systems in the Derived savannah agro-ecological zones.

Plant species types	Derived savannah agro-ecological zone					
	Natural forest	Peri- urban	Sacredgroove	Selectively protected	Plantation forest	Farm lands
1 *Alstonia bonnie*	1	1	-	-	1	-
2 *Kigelia Africana*	1	-	-	-	2	1
3 *Khaya senegalensis*	1	1	-	2	2	1
4 *Morinda lucida*	2	2	1	2	2	2
5*Pycnathus angolensis*	-	1	-	-	-	-
6 Rauvolfia vomitoria	3	2	2	1	3	3
7 *Tamarindus indica*	-	-	-	1	2	-
8 *S.longipedunculata*	1	1	-	2	2	2
9 *Vitellaria paradoxa*	1	2	-	-	3	2
10 *Z, xanthoxyloides*	-	-	-	2	-	1
Total	**10(16.13%)**	**10(16.13%)**	**3(4.84%)**	**10(16.13%)**	**17(27.42%)**	**12(19.35%)**

Table. 7: Distribution of selected medicinal plants based on land use systems in the Guinea savannah agro-ecological zones.

Plant species types	Guinea savannah agro-ecological zone					
	Natural forest	Disturbed forest	Sacred grooves	Forest plantation	Savannah parklands	Farm lands
1 *Alstonea bonnie*	1	-	-	-	-	1
2 *Kigelia Africana*	1	1	-	-	1	1
3 *Khaya senegalensis*	3	3	-	4	2	2
4 *Morinda lucida*	1	1	-	1	-	-
5*Pycnathus angolensis*	-	-	-	-	-	-
6 *Rauvolfia vomitoria*	2	1	-	-	1	1
7 *Tamarindus indica*	-	-	-	1	3	1
8 *S. longipedunculata*	-	-	-	1	1	2
9 *Vitellaria paradoxa*	3	2	-	2	4	5
10 *Z, xanthozyloides*	1	-	-	1	-	-
Total	**12(21.18%)**	**8(32.72%)**	**0 (0.00%)**	**10(`18.18%)**	**12(21.18%)**	**13(23.63%)**

Table. 8: Distribution of selected medicinal plants in land use systems in the Sudan savanna agro-ecological zone.

Plant species types	Sudan savannah agro-ecological zone					
	Natural forest	Farm fallow	Sacred groove	Forest plantation	Savannah park lands	Farm lands
1 *Alstonea bonnie*	-	-	-	-	-	-
2 *Kigelia Africana*	-	-	-	-	-	-
3 *Khaya senegalensis*	1	-	-	1	1	1
4 *Morinda lucida*	1	-	-	-	-	-
5*Pycnathus angolensis*	-	-	-	-	-	
6 Rauvolfia vomitoria	-	-	-	-	-	-
7 *Tamarindus indica*	-	-	-	1	-	2
8 S. longipedunculata	-	-	-	-	-	-
9 *Vitellaria paradoxa*	-	1	-	2	1	1
10 *Z, xanthozyloides*	-	-	-	-	-	-
Total	**2(15.38%)**	**1(7.69%)**	**0(0.00%)**	**4(30.74%)**	**2(15.28%)**	**4(30.74%)**

Table. 9: Duration of flowering to fruit set among the ten different medicinal plants in Nigeria.

S/No	Species	Mean no of days to flowering ± sd	Mean Fruit set period ± sd
1	*Alstonea bonnie*	9.45±1.35	15 22 ± 3.15
2	*Kigelia Africana*	12.7 ±2.30	43.56 ±2.26
3	*Khaya senegalensis*	8.42 ± 0.83	34. 39 ±4.01
4	*Morinda lucida*	17.25 ±3.67	27.58 ± 3.26
5	*Pycnathus angolensis*	11.34 ± 2.35	14.44 ± 4.28
6	*Rauvolfia vomitoria*	15.68 ± 3.45	25.36 ± 3.22
7	*Tamarindus indica*	14.25 ± 2.33	31.45 ± 3.27
8	*S. longipedunculata*	8.35 ± 1.21	15.95 ± 3.05
9	*Vitellaria paradoxa*	45.68 ± 5.77	145.87 ±8.67
10	*Z, xanthoxyloides*	16.68 ± 3.52	18.52 ± 2.43

Fruiting behaviors among the selected medicinal plants in Nigeria

Trends observed for the fruiting behaviors among the selected medicinal plants tend to be similar to flowering pattern across the four agro-ecological zones. Duration of flowering to fruit set differs greatly for the individual medicinal plants from the study (Table 9). Flowering period ranged between (8.35±1.21) days in *S. longipedunculata* to (45.68 ± 5.77) days in *V.paradoxa*. Mean duration to fruiting in the selected medicinal plants also differed significantly and ranged between (14.44 ± 4.28) days in *P. angolenses* to (145.87 ±8.67) days *in V. paradoxa* (Table 9). The varying duration observed tend to be influenced by varying climatic factors as well as differences in inherent factors. *K. africana* was observed in fruits in (Feb-March) in 'Ibillo' a site belonging to the derived savanna ecozone while *S. longipendunculata* was also observed in fruits in Eruwa in late March also belonging to the derived savanna zone of the species. Similarly both *R. vomitoria* and *Morinda lucida* were observed fruiting in March-April at the outskirt of Ibadan belonging to the rainforest ecozone.

CONCLUSION

The natural distribution of the selected medicinal plants in Nigeria represents abundant reservoir of renewable resources with various potentials both for improved rural-urban health care services, source of raw materials for the pharmaceutical industries as well as foreign exchange earnings for the country. Despite these potentials and opportunities, limited information exits on their ecological status in terms of population dynamics, threats, natural regeneration as well as information on frequency of flowering and fruiting behaviors and intensity. In most cases conscious efforts at their conservation (*in-situ* or *ex-situ)* remain low despite increasing genetic depletion. Evidently various over-exploitation activities had been observed in the present study (debarking, roots excavation and pollarding) and habitat loss as well as a breakdown in cultural practices that ensured conservation. Increasing use of plant-based medicine are quite noticeable which had resulted in pressure on medicinal plants collections without corresponding domestication efforts in form of botanical/ herbal gardens or plantation establishment.

Current findings indicated that the stocking density for almost all the medicinal plants studied were very low across the various vegetation zones and land use types. For instance six out of the ten medicinal plants had less than twenty individuals across the four ecological zones. Even where many individuals were found across the ecological zones the overall populations were relatively low from conservation point of view. Sacred grove has been known to act as traditional conservation spot however this was not effectively reflected in the present study perhaps because most the medicinal plants investigated were not known to be of spiritual importance. Forest plantation, natural reserves, communal forest, farm lands and farm fallows/parklands constituted major areas of *in-situ* conservation in this study and this is indicative of future professional management for these species. Enrichment plantings strategy is implicated for the current population within the various land use types. However management practices that incorporate protection against seasonal fires and sustainable harvesting are recommended. Ecological management of the different medicinal plants will however require eco-zones considerations in relation to climatic factors as well as ecological niche for the different medicinal plants.

However for long term conservation, the need to increase the level of awareness among the enlightened herbal practitioners to embark on more active cultivation of these plants in form of mini plots, gardens/parks or commercial farms are implicated. At this point it is imperative that relevant research organizations and stakeholders with mandates on medicinal plants (Forestry Research Institute of Nigeria (FRIN) and National Institute for Horticultural Research (NIHORT) National Conservation Foundation (NCF) as well as NACGRAB would require strengthened to enable them carry out massive germpalsm collections, domestication and various improvement conservation programme so as to serve as seeds/seedlings sources for individuals interested in conscious cultivation programme. *In-situ* conservation may also be complemented by various arms of government through seedlings supply to communities where utilization is highest. Increased enlightenment programme to enhance sustainable management of the remaining population in the wild will also be vital in this process. Therefore holistic conservation programme (*in-situ* and *ex-situ*) that ensures sustainable use of medicinal plants in form of best practices that will preserve the resource base and potentials of the different medicinal plants should be encouraged. In the area of production and domestication, there is need to address the problem of improved silvcultural practices as a strategy to ensure continuous supply of the medicinal plants seedlings to various categories of users especially farmers that are willing to establish plots or for enrichment planting. Problems of precious flowering and fruiting among some medicinal plants will also require attention while there is also the need to address accessibility to information on the flowering and fruiting behaviors to aid efficient fruits and propagules collections both for germplasm conservation and improvement program.

REFERENCES

Abbiw, D. 1990. *Useful plants of Ghana*. Intermediate Technology and the Royal Botanical Gardens, Kew.

Adekunle, V.A.J**.** 2005. Trends in Forestry Reservation and Biodiversity Conservation in Nigeria Environmental Sustainability and Conservation in Nigeria, Book of Readings. Ed. (Enos Okoko, Adekunle, V and Adeduntan, S). 82-90

Ajakaiye, D.O. Socio-economic issues in National Development: Forestry perspective. (In Popoola; Abu, J.E. and Oni, P.I (eds). For. Nat. Dev. 2001; 236-244

Ayodele, A.E. The medicinally important leafy vegetables of South Eastern Nigeria. Ethnobotanical leaflets, 2005; 2: 11-16

Burkill, H.M. 1985. *The Useful Plants of West Tropical Africa* Vol.4. Second edition. Royal Botanical Gardens, Kew

Centre Nationale De-Semences Forestieres (CNSF) Seed leaflet: 2003; 1-12

El-Amin, H.M. 1990. *Trees and shrubs of the Sudan.* Ithaca Press, UK Eseter . 484pp

Food and Agricultural Organization of United Nations Data-book on endangered Trees and Shrubs species and other provenances FAO, (FAO Forestry Paper) 1986; 77, Rome

FAO. 1995. Conservation of Forest Genetic Resources in Tropical Rainforest Management, *Principles and Concepts* (FAO Forestry Paper). 107.

FAO. 1999. State of the World's Forests 3rd Ed. FAO; Rome.

FAO. 2007. State of World's Forest. FAO, Rome. 21-22

Gbile, Z.O and Adesina, S.K Nigerian flora and its pharmaceutical potentials. *Journalof Ethnopharmacology*. 1986; 19: 1-16.

Gijsbers, H. J.M; Kessler, J. and Knevel Dynamics and natural regeneration of woody species in farmed parklands in the Sahel region (Province of Passore, Burkina Faso). *Forest Ecology and Management*, 1994; 64: 1-12

Hall, J.B. Tomlinson, H.F.; Oni, P.I., Aebisher, D. P. & Marlene-Buchy. 1997. *Parkia biglobosa* (Jacq.) Benth. *A Monograph*. School of Agricultural and Forest Sciences. Gwynedd LL57, 2UW, Bangor United Kingdom. 134pp

Ibe, A.E and Nwufo, M.I. Identification, collection and domestication of medical plants in South eastern Nigeria. *Afr. Dev*. 2005; 30: 66-77

Mgeni, A. S. M. 1991. A more efficient estate: Natural forest or plantation. In Pyatt. N and T. Williams (eds). Tropical Forestry: Third world priorities versus Western concern. 43-58.

Maydell, H. J. Trees and Shrubs of the Sahel; Their characteristics and uses. Rossdorf: 1986; TZ Verlags-geslls-Chaft.

NEST. 1991. Nigerian Threatened Environment: Nigeria Environment Study/Action Team Ibadan. 288.

Novacek, M.J. and Clenland, E.E. The current biodiversity event:scenario for mitigation and recovery. *Proceedings of the National Academy of Sciences of the United States of America*, 2001; 98: 5466-5470

Obute, G.C and Osuji, L.C. Environmental awareness and dividends: A scientific discourse, *Afr. J. Interdisciplinary Stud*. 2002; 3**:** 90-94

Oni, P.I. 1997. *Parkia biglobosa* (Jacq.) Benth in Nigeria: A resource assessment (Ph.D Dissertation). School of Agricultural and Forest Sciences, University of Wales, Bangor. United Kingdom. 220.

Oni, P.I. Breeding systems in *Parkia biglobosa* (Jacq.) Benth; an indigenous fruit resource utilization in Nigeria. *Journal of Tropical Resources*, 2001; 17: 1-9

Oni, P.I. Initial evaluation of *Parkia biglobosa* (Jacq.) Benth provenances from West Africa countries. Regional Conference on Plant *Genetic Resources and Food security in West and Central Afric*a held at IITA (26^{th} -30^{th}, April, 2004): 2004; 108-115

Oni, P.I**.** Ethno-botanical survey of a fallow plot for medicinal plants diversity in Idena, Ijebu Ode. South Western Nigeria. *Journal of Medicinal Plants Research*, 2010; **3**: (10) 45-52

Oni, P.I.; Jimoh, S.O and Adebisi, L.A. Management and conservation of indigenous medicinal plants in Nigeria using phenological information. Proceedings of the *International Conference on Sustainable Environmental and Protection* March 20-22, 2012; 189-195

Owonubi, J.J, Otegbeye, G. O. Disappearing forests: A review of the challenges for conservation of genetic resources and environmental management *J. For. Res. Manage*. 2004; 1 (1& 2): 1- 11.

Sofowora, E. A. 1993. Traditional medicine and pharmacopoeia: contribution to ethnobotanical and floristic studies in Western Nigeria. Organization of African Unity/Scientific, Technical and Research Commission. 420.

Ugbogu, O. A, Odewo, P. Some medicinal plants in the traditional medicare of Nigeria *J. For. Res. Manag.* 2004; 1. (1& 2): 29-34

WHO. 2001. Legal status of Traditional Medicine and Complimentary /Alternative medicine: A worldwide Review WHO, Geneva.

How to cite this article:

Oni, P.I., Jimoh, S.O and Adebisi, L.A., Population pattern and phenological behaviours for selected medicinal plants in Nigeria; implications for *ex-situ* conservation . J App Pharm Sci, 2013; 3 (07): 052-060.