Journal of Ethnopharmacology 150 (2013) 682–691

Contents lists available at ScienceDirect

Journal of Ethnopharmacology

journal homepage: www.elsevier.com/locate/jep

Local knowledge, use pattern and geographical distribution of *Moringa oleifera* Lam. (Moringaceae) in Nigeria

Jacob O. Popoola, Olawole O. Obembe *

Department of Biological Sciences, School of Natural and Applied Sciences, College of Science and Technology, Covenant University, P.M.B. 1023, Canaanland Ota, Ogun State, Nigeria

ARTICLE INFO

Article history:
Received 26 June 2013
Received in revised form
31 August 2013
Accepted 12 September 2013
Available online 2 October 2013

Keywords:
Quantitative ethno-botany
Ethno-ecological knowledge variation
Use value
Use diversity
Underutilized species
Nigeria

ABSTRACT

Ethno-pharmacological relevance: All parts of *Moringa oleifera* are medicinally valuable with overlapping uses in treating myriads of ailments and diseases including body pains and weakness, fever, asthma, cough, blood pressure, arthritis, diabetes, epilepsy, wound, and skin infection. *Moringa* also has robust ability to challenge terminal diseases such as HIV/AIDs infections, chronic anemia, cancer, malaria and hemorrhage. The present study was to obtain ethnobotanical information on the use and local knowledge variation, geographical distribution, and to collect different landraces of *Moringa oleifera* from the different agro-ecological regions in Nigeria, for further studies.

Materials and methods: Ethnobotanical data were collected through face to face interviews, semi structured questionnaires and discussions with selected people who had knowledge about the plant. The fidelity level (FL %) and use value for different use categories of *Moringa oleifera* and its parts were estimated. The variation in ethnobotanical knowledge was evaluated by comparing the mean use value among ethnic, gender and age groups using sample T test. Garmi GPS was used to determine the locations (latitude and longitude) and height in different areas to assess the geographical spread of the species.

Results: Seven (7) categories of use (Food, medicine, fodder, fencing, firewood, gum and coagulant) were recorded for *Moringa oleifera*. Food and medicinal uses showed highest fidelity level while the leaves and the seeds were the plant parts most utilized for the same purposes. There were significant differences among the ethnic, gender and age groups regarding the ethno-botanical use value. The geographical distribution pattern shows that the *Moringa oleifera* is well distributed in all ecological zones of Nigeria, well adapted to the varied climatic conditions and gaining unprecedented awareness among the people.

Conclusion: Though considered an introduced species, *Moringa oleifera* has found wide acceptance, recognition and usefulness among the various ethnicities in the studied areas. The sources of introduction, domestication and ethnic differentiation influenced the distribution pattern across the geographical areas.

1. Introduction

Plants serve as a rich source of food, medicine, energy, shelter, fodder feeds and other forestry products (Ogunkunle and Oladele, 2004; Houessou et al., 2012). Different plant species have been universally utilized in the preparation of traditional medicines for the cure of several ailments and diseases and for other plant bio-products. The knowledge of such uses had always been transferred orally from generation to generation. Today, great emphasis is being placed on the consumption of food that will not only provide nutrients to the body but also helps in the prevention of diseases (Dike et al., 2012). Plants are being explored and engineered more than ever to produce recombinant pharmaceuticals, genetically modified food, industrial proteins and other secondary metabolites (Obembe et al., 2011).

Moringa oleifera is a multipurpose plant that fits properly into the above uses. It is economically useful as source of food, natural medicine, animal fodder, natural coagulants, forestry products, fertilizer, living fence, alley cropping and fueling (Fahey, 2005; Anwar et al., 2007; Pandey et al., 2012). *Moringa* is considered rich with several medicinal properties as all the parts have been reportedly engaged singly or with other plants for treating diverse illnesses and diseases (Mughal et al., 1999; Fuglie, 1999; Pamok et al., 2012). A review of medical evidence for the use of *Moringa oleifera* for nutrition, therapeutic and prophylactic properties indicated that the demand for it is on the increase in scientific research and in terms of global use (Fahey, 2005).

Abbreviations: FL, fidelity level; UVk, Ethno-botanical use value; OUV, overall ethno-botanical use value; GPS, geographical positioning system

* Corresponding author. Tel.: +234 8130928965.
E-mail address: olawole.obembe@covenantuniversity.edu.ng (O.O. Obembe).

0378-8741/$ - see front matter © 2013 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jep.2013.09.043

Each culture has different perspectives to plant use and application, thus ethnobotany and geographical distribution survey are the right steps in driving its domestication, widening its genetic diversity and expanding its economic uses. Drug discovery, design and development, cultural use of plant species, timber processing, soup making and other areas of plant products have long recognized the usefulness of ethnobotanical studies. Most studies on ethnobotanical knowledge have always concluded that there is an unequal indigenous knowledge concerning plant use among local populations with respect to differences in ecological regions, ethnicities, gender, age, professions, religion, cultural beliefs, abundance and usefulness of the species (Ayantunde et al., 2008; Omonhinmin, 2012). Knowledge about the geographical distribution of plant species is crucial for genetic diversity studies particularly for determining the various ecotypes/accessions that are best suited for each economic value and product.

In spite of its enormous properties and uses, *Moringa oleifera* is considered under-exploited, under-utilized, neglected (NRC, 2006; GFU, 2012) and even cited among the lost crops of Africa (NRC, 2006). Ethno-botanical use value and pattern, distribution pattern, reproductive biology, ecology and genetic variability studies are needed in order to evolve a better conservation strategy and genetic improvement programme (NRC, 2006; GFU, 2012). Our initial survey revealed that *Moringa oleifera* had been available in local communities of the different ecological zones in Nigeria, although the local knowledge of its use was quite weak in most ethnicities except the Hausas. There was therefore a compelling need to assess the use pattern by the locals of the different ethnic groups within Nigeria and determine the geographical distribution pattern so as to avoid the loss of relevant ethnobotanical information and initiate participatory conservation strategy for the species. The study also intended to gather relevant indigenous information on the ecotypes, collect accessions, evaluate pattern of ecological distribution to assess genetic variation, all of which are necessary to initiate a robust breeding strategy that will lead to appropriate genetic improvement as well as sustainable utilization.

2. Methods

2.1. Ethnobotany

2.1.1. Study area and socio-demographic characteristics

The study was carried out in selected areas in Nigeria, covering the major agro-ecological regions (Fig. 1). The geography lies between 5.48–13.057°N and 3.234–11.001°E within the humid, sub-humid rainforest, savannah and arid regions of Nigeria.

The selected states cut across the Southern and Northern regions of Nigeria. The tropical climate of the Southern Nigeria is characterized by two distinct conditions of wet and dry seasons of high rainfall ranging from 2000 mm to 4000 mm. The mean annual temperature is 30 °C and the vegetation is composed mostly of forest trees, shrubs and savannah trees. The Northern part, made up of savannah and arid region, exhibits moderate rainfall between 500 mm and 1000 mm annually with long period of dry seasons. The mean annual temperature is about 38 °C in the Northern part and the vegetation is characterized by grassland, shrubs and sparse trees.

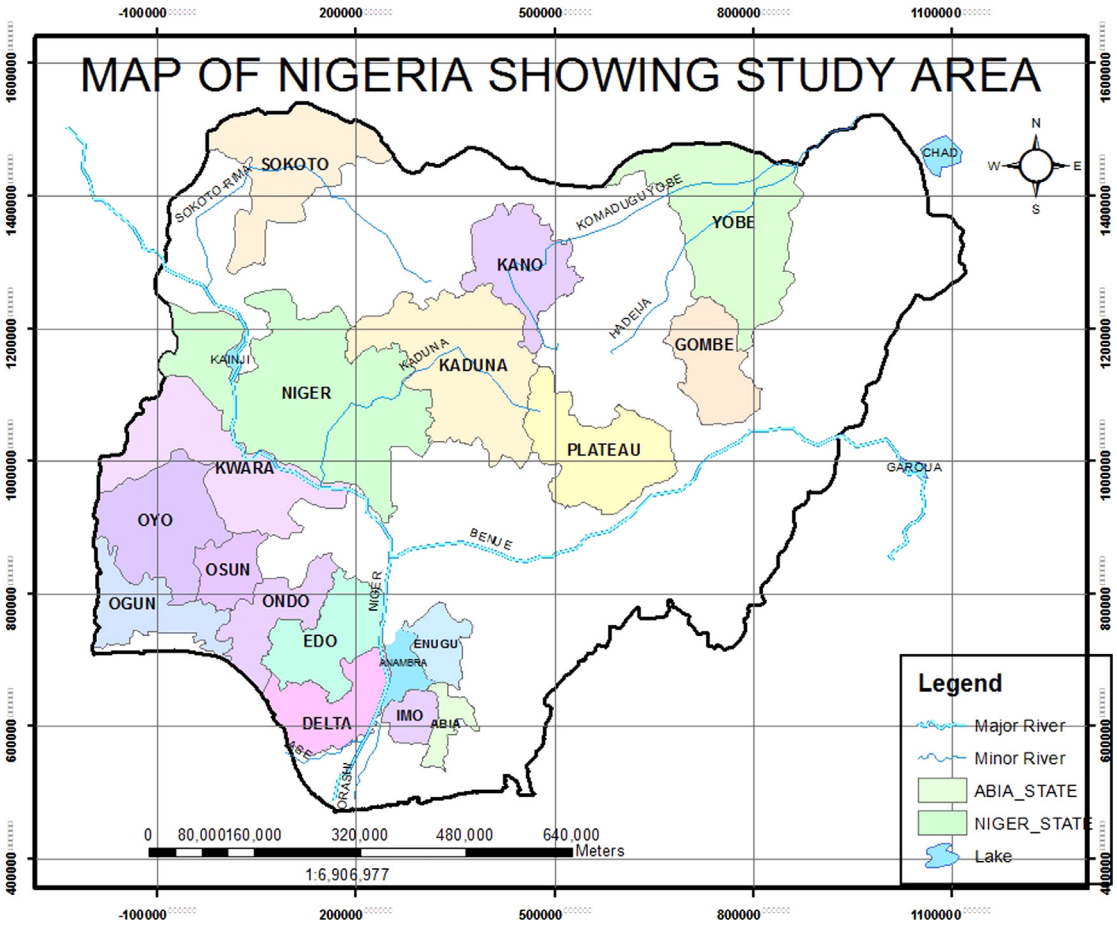

Fig. 1. Geographic location of area of study.

Eight (8) ethnic groups namely; Yoruba, Hausa, Fulani, Igbo, Edo/Deltans, Tivs, Ibariba and Sabe were recorded for this study. The Southern Nigeria was composed of the following ethnic groups; Yoruba, Igbo, Edo/Deltan and Sabe while Northern part consists of Hausa, Fulani, Tivs and Ibariba. Respondents were randomly chosen from the selected areas where *Moringa oleifera* was common and known. A total of 745 respondents were interviewed comprising 60% males and 40% females. Two hundred eighty-two of them were less than 35 years old, 260 were within 35 and 65 years of age, while 203 were 65 years and above. The socio-demography features of the sampled population are presented in Table 1.

The study was carried out from March 2011 to January 2013. Informed consent was obtained from all the respondents prior to interview, discussions and administration of questionnaires.

2.1.2. Data collection

The study was conducted using semi-structured questionnaires (Table 2), face to face interviews with the locals. Translators were employed as required in some cases. The purpose of seeking information was clearly explained to the respondents. Ethnobotanical information was obtained on the local uses, history, distribution and probable origin of the accessions.

2.1.3. Use categories

Seven (7) use categories were selected and recorded. The use level for each category (e.g. food, medicine, fodder, etc.) was determined using a coding system: 3=highly used, 2=fairly used, 1=weakly used and 0=not used. The same coding system was used for different parts of the plant used for various uses. Ethnic knowledge through frequency of use was also determined by evaluating the number of respondents with the knowledge of use to the total number of the respondents in particular ethnic, gender and age group.

Table 1
Socio-demography of the selected populations in the studied areas.

Ethnic group	Local name	Gender		Age years			Total
		Male	Female	≤ 35	> 35 < 65	≥ 65	
Yoruba	Gbogbonise/Ewe ile	124	75	51	68	80	199
Hausa	Zogalla	92	53	54	32	59	145
Fulani	Konamarade	22	39	27	25	9	61
Edo/De	Moringa	39	30	24	38	7	69
Igbo	Okochi egbu	58	27	39	29	17	85
Tiv	Zogalla/Moringa	25	18	19	18	6	43
Sabe		45	33	33	30	15	78
Ibariba	Yorwata/Yuru ara	40	25	35	20	10	65

Table 2
Questionnaires used to interview the local population about their knowledge of *Moringa oleifera* for various uses.

1.	Date of interview and location	
2.	Name of participant	
3.	Sex of participant	Male Female
4.	Age of participant	
5.	Occupation of participant	
6.	Telephone/address	
7.	Residence (Urban/Rural)	
8.	Duration of residence of the participant	
9.	What is the local name of the plant?	
10.	What do you know about the plant?	
11.	Do you know anything about the origin of the plant?	
12.	Was it planted? When? How?	
13.	For which diseases do you use the plant?	
14.	Which parts of the plant do you use? (Root, stem, flower, leaves, fruit, etc.)	
15.	How do you prepare the plant for use?	
16.	How and when do you use the plant?	

2.1.4. Data analysis

The following parameters were estimated;

- Fidelity Level (FL): The use frequency in percentage for the various use categories of the species was computed using Friedman et al. (1986).

$$FL = S/N \quad (1)$$

where S=number of respondents who gave a positive answer to the use of *Moringa oleifera* for a given category. N is the total number of respondents.

- Ethno-botanic use value (UV): The ethno-botanic use value was determined to assess the importance of *Moringa oleifera* plant parts for each ethnic group, age and gender groups. The ethno-botanic use value was calculated following the formula of Philips and Gentry (1993). Data were arranged per use category (k) and the ethno-botanic use value (UV) in each category was computed as the mean score given by all the respondents in the considered category.

$$UV_k = \frac{1}{n}\sum_{p=1}^{n} S \quad (2)$$

where S is the score ascribed to *Moringa oleifera* by the respondents with respect to the use categories, 'k' and 'n' the number of respondents. UV_k ranges from 0 to 3 (0=not used for the purpose/category, 1=weakly used, 2=fairly used and 3=highly used). The overall ethno-botanical use value of *Moringa oleifera* was also determined for each ethnic, age and gender group as follows:

$$OUV = \sum_{i=1}^{k} UV_k. \quad (3)$$

where 'k' is the number of use categories, 'UV_k' is the estimated ethno-botanic use value of *Moringa oleifera* in the use category 'k' for each ethnic, age and gender group. Ethno-botanic use mean value for all the categories was compared using ANOVA to test their levels of significant differences.

2.2. Geographical distribution

Availability, field study and observations were employed to determine the distribution pattern of *Moringa oleifera*. Garmin Etrex GPS was used to detect the locations (latitude and longitude) and height in different locations (Table 3). Relevant information concerning cultivation, origin, uses and history of different accessions were collected from the various ecological zones. Information on *Moringa oleifera* were sourced first from areas where Hausa settlers could be found in Southern Nigeria, since it is believed that *Moringa oleifera* is endemic and well known in the Northern part of Nigeria. Researchers in research institutes and Universities working on the plant were also contacted. Voucher specimens in form of leaves as herbarium specimens and seeds collected were deposited in the herbarium and seed repository of the Department of Biological Sciences, Covenant University, Ota. Accessions were carefully selected to eliminate duplicates and cultivated in an experimental field in Covenant University for further studies. Table 3 shows the accession numbers, area of collection, locations, age and origin of the accessions collected.

Table 3
Study areas, area of collection, history, sources and locations of accessions used for this study.

S/N	Acc No	State	L/G	Area of collection	Age/history	Origin/source	Latitude	Longitude	Height	Remarks/info
1	oyN001	Oyo	Saki West	Oke-oro	27 yrs	Philippines	8.66834	3.40054	469 m	Brought by Dr. Vlavflor
2	oyN002	Oyo	Saki West	Army Barracks	20 yrs	Gombe	8.64876	3.42345	390 m	Military settlement
3	oyN003	Oyo	Saki West	Aroje	6 yrs	U.S.A	8.60979	3.40975	330 m	Brought by Dr. BimpeOnifade/farm settlement
4	oyN004	Oyo	Atisbo	Sango, Ago Are	35 yrs	Kano	8.63805	3.40387	342 m	Hausa traders
5	oyN005	Oyo	Atisbo	Aba Alaga	close to 40 yrs	Togo/Coutonou	8.44567	3.33365	341 m	Sabe, Togolese, Farm settlement
6	oyN010	Oyo	Itesiwaju	Okaka	Above 58 yrs	Kano	8.45743	3.40868	307 m	Hausa traders/settlers
7	oyN011	Oyo	Oorelope	Alaguntan Village	Unknown	Kano	8.84249	3.74196	436 m	Fulani and Hausa settlers
8	kwN014	Kwara		Sobi Barrack	25 yrs	Kaduna	8.57457	4.55744	420 m	Military settlement
9	kwN015	Kwara	Ilorin South East	Ilorin	Unknown	Unknown	8.49105	4.54542	326 m	Partial endemic area
10	niN017	Niger	Mokwa	Mokwa	Unknown	Unknown	9.29189	5.05457	209 m	Endemic
11	niN018	Niger	Bida	Bida	Unknown	Unknown	9.07459	6.00567		Partial endemic area
13	osN020	Osun	Ife central	OAU	5 yrs	Indian	7.50715	4.52791	255 m	Research
14	osN021	Osun	Iwo	Iwo	18 yrs	Sokoto	7.63293	4.18416	205 m	Hausa settlers
15	osN022	Osun	Ejigbo1	Ejigbo	12 yrs	Abuja	7.90011	4.31917	245 m	Civil Servant
16	ogN026	Ogun	Odeda	Olodo	32 yrs	Sokoto	7.28813	3.65915	211 m	Hausa Settlers
17	plN030	Plateau	Jos	UniJos	Unknown	Jos	9.95093	8.88948	98 m	Omonhinmi CA/Researcher
18	yoN031	Yobe	Karasuwa	Bukarti	Unknown	Unknown	12.82285	11.0066	455 m	Endemic
19	kaN032	Kaduna	Kafanchan	Kafanchan	Unknown	Unknown	9.58365	8.51021	321 m	Endemic
20	edN035	Edo	Esan Central	Ehanlen-Ewu	Above 55 yrs	Unknown	6.73394	6.17659	326 m	Late O. Esichei/RCS
21	edN036	Edo	Esan Central	Agbede	Unknown	Unknown	6.68351	6.29051	290 m	
22	edN037	Edo	Esan Central	BenedictaMonastry	Unknown	Unknown	6.56732	6.00035	279 m	Missionary
23	edN038	Edo	Ovia North	Uniben	14 yrs	Minna	6.39651	5.61341	267 m	Missionary
24	edN039	Edo	Egor	Uselu	Unknown	Indian	6.40717	5.61392	225 m	Indian people
25	deN042	Delta	Oshimili South	Parkinson	Unknown	Kano	6.18715	6.72647	47 m	Traditional Priest used as fetish grove
26	deN043	Delta	Oshimili South	Asaba - Onitsha Road	above 30 yrs	Katsina	6.16633	6.78346	37 m	Hausa settlers
27	deN044	Delta	Ika South	Agbor	Unknown	Abuja	6.25387	6.20323	158 m	
28	anN046	Anambra	Awka	UniZik	10 yrs	North	6.24884	7.11168	109 m	Research
29	anN047	Anambra	Awka	Ifite	Above 25 yrs	Sokoto	6.24022	7.08995	144 m	
30	anN049	Anambra	Awka	Enulfite	After civil war	Unknown	6.24786	7.08769	152 m	Priest
31	anN050	Anambra	Idemili South	Oba Junction	Unknown	Kano	6.06648	6.83375	238 m	Hausa settlers
32	enN052	Enugu	Nsukka	UNN	7 yrs	Kogi	6.86473	7.39821	424 m	Research
33	enN055	Enugu	Enugu South	Ugwuomu	10 yrs	Kano	6.44541	7.53084	421 m	Research
34	abN058	Abia	Umuahia South	Mbalaka	Unknown	Unknown	5.57869	7.60987	169 m	
35	imN061	Imo	Okigwe	Okigwe	Unknown	Unknown	5.81668	7.34977	154 m	
36	imN062	Imo	Owerri	Owerri	Unknown	Unknown	5.48306	7.03443	89 m	
37	imN063	Imo	Obowo	Achingali	12 yrs	Abuja	5.60266	7.32192	160 m	
38	soN067	Sokoto	Sokoto	Shagari	Unknown	Unknown	12.86542	5.65432	254 m	Endemic
39	goN068	Gombe	Nafada	Nafada	Unknown	Unknown	11.09291	11.3334	157 m	Endemic area
40	onN070	Ondo	Akure	Owena road	17 yrs	Kaduna	7.28619	5.22675	215 m	Hausa traders
41	onN071	Ondo	Okitipupa1	Idepe	Unknown	Unknown	6.52819	4.7818	332 m	
42	onN072	Ondo	Okitipupa2	OSUSTECH	3 yrs	Ghana	6.51232	4.78234	199 m	Research
43	knN077	Kano	Bukavo	Army Barracks	Unknown	Unknown	12.03227	8.5102	98 m	

3. Results

3.1. Ethno-ecological knowledge and use categories of Moringa oleifera

Different local names were attributed to *Moringa oleifera* according to the ethnic groups (Table 1). More than one name was provided by the three major ethnic groups; Hausa, Yoruba and Igbo. The local name “Gbogbonise” in Yoruba means ‘multipurpose use’, which describes the medicinal prowess of the plant. The name “Okochi egbu” in Igbo language means ‘the tree that cannot be killed by the dry season while the local name “Zogalla”, ‘Bagaruwar maka’ in Hausa was also more associated with the multipurpose use and growth habit.

Moringa oleifera was used by the local populations for many purposes. Seven use categories namely; food, medicine, fodder, fencing, firewood, gum and coagulant for water purification were recorded. Medicinal category was the most dominant use among all the ethnic groups. The use frequency of each use category is presented in Fig. 2. Medicinal use has a 93% fidelity level, food and nutritional purposes (FL=71.1%), fodder plant (FL=60.9%), fencing (FL=53.2%), gum (FL=38.9%), coagulant (FL=38.8%), and firewood (FL=27.9%). Other uses such as timber/wood, fiber, charcoal and cooking oil were also mentioned by the respondents but it was rarely utilized as such. Almost 100% of the respondents preferred to use *Moringa oleifera* for both medicine and food.

3.2. Pattern of use of Moringa oleifera

Different plant parts of *Moringa oleifera* are being used in nutrition, phyto-medicine, and fodder for animals and wood for firewood (Fig. 3, Table 4). The leaves were the mostly used part by the respondents both for food and medicine. About 30 ailments that are being treated with the various parts of *Moringa oleifera* as well as their fidelity levels are presented in Table 4. The leaves were frequently used (FL=above 70%) to treat several ailments including malaria, typhoid fever, blood pressure, arthritis, swellings, cuts, hypertension, diabetes, as well as to elicit lactation and boost the immune system. The leaves were frequently used as vegetable, eaten singly or prepared in a special way mixed with

groundnut cake (Kwulikwuli) and other spices, and then eaten as food. This use is peculiar to the Hausa, Fulani, Sabe, Ibariba and Tiv ethnic groups. The use of the leaves as vegetable either consumed singly or in combination with other leafy plants like bitter leaves, water leaves and mixed with Egusi is gaining adoption among the Yoruba, Edo/Deltan and Tiv ethnic groups. The use as fodder is also gaining recognition as the use increases among the local population especially among the Hausa, Fulani and Yoruba ethnic groups. The roots of plantlets (tuberous root) were observed to have peppery sensation and used as intoxicating agent usually prepared as decoction either singly or combined with other plants. The roots were involved in the treatment of infertility, pile, malaria, high blood pressure, diabetics, etc. The bark of the plant was also used against many ailments including sterility, asthma, cough, pile, typhoid fever, ulcer and snake bite. The bark boiled with *Rauwolfia vomitoria* (FL=30%) was said to be very potent against chronic hypertension. The powdered form of the bark was also found to be very active against snake and scorpion poisons.

With respect to the wood and whole tree of *Moringa oleifera,* 58% of the respondents mostly women considered the wood to be good for firewood while 67% mostly men found the plant to be useful for fencing. Majority of the respondents considered the plant very poor for building purposes as the bole break with ease. The use as gum was mentioned by the respondents based on exudates observed on the barks of the plant but specific uses were not known. The use of the seeds as a coagulant (FL=38%) was most frequently mentioned among the Hausa ethnic group.

The two highest values of fidelity level of use of *Moringa oleifera* (FL=100% and FL=86.7%) were obtained in the Hausa and Ibariba ethnic groups, respectively (Table 5). The use as food, medicine, fencing, fodder and coagulant was prominent in both ethnic groups. Fidelity levels of use category (FL=80% and FL=60%) were recorded for the Fulani/Sabe and Igbo/Tiv ethnic groups, respectively, while the two least fidelity levels of 46.7% and 26.7% were recorded for the Yoruba and Edo/Deltans ethnic groups, respectively (Table 5). The use as medicine, food and fodder is common to Yoruba, Edo/Deltan and Igbo ethnic groups. All the ethnic groups use *Moringa oleifera* as animal fodder; nonetheless, the Hausa and Fulani ethnic groups use it the most for this purpose. Its use in fencing though common to Hausa, Fulani, Sabe and Ibariba ethnic groups, was also observed to lesser extents among the Igbo, Yoruba and Tiv ethnic groups. With respect to gender, 80% and 73.3% fidelity levels of use were recorded for female and male, respectively (Table 5). Fidelity level of 46.7% was recorded for *Moringa oleifera* use among the respondents of age ≤ 35 years, while for those of age $> 35 \leq 65$ years, 73.3% fidelity level of use was recorded and among the respondents older than 65 years, 100% fidelity level of *Moringa oleifera* use was recorded (Table 4). This shows that use knowledge varies with increase in age, with the old respondents having better knowledge of use across the seven use categories than any other age groups.

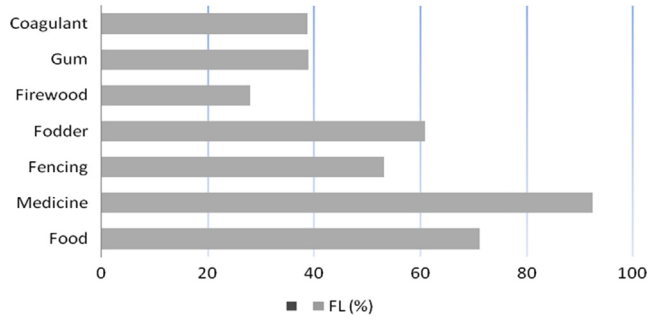

Fig. 2. Fidelity level of use categories of *Moringa oleifera* in Nigeria.

An ethnic breakdown of the results on the use pattern of *Moringa* species in Nigeria is presented in Table 6. All the ethnic groups use the leaf singly or in combination with other plants. The use of *Moringa* parts in the treatment of high blood pressure, hypertension and HIV/AIDS related diseases was observed in all the ethnic groups in Nigeria supporting the wide usage of the species (Dieye et al., 2008). Nonetheless, the combination of *Moringa* leaves with lemon grass and "Efinrin" (*Occimum gratissimum*) was common to the Yoruba and Igbo ethnic groups for the treatment of high fever, chronic hypertension, diabetes, pile and infertility. The use of fresh leaves in combination with unripe pods and *Occimum gratissimum* as infusion or cooked was peculiar only to the Igbo ethnic group as a good medication for anemic patients. Additionally, the use of the fresh leaves in combination with lemon grass and bitter leaves for the treatment of cancer was only mentioned by the Igbos. However, the use of bark and root decoction was not mentioned by the Igbo respondents encountered. Fresh or dried leaves in combination with cream or shear butter was mentioned by the Igbo and Edo/Deltan ethnic groups, which was not found in other ethnic groups. Interestingly, the Hausa and Fulani ethnic groups believe that the leaves release strength to them and therefore use it against general body weakness and malaria. The use of dry leaf, stem bark and root as food supplement powder was only common to the Ibariba ethnic group for libido enhancement in men while the Sabe people combine these parts with alcohol to enhance its potency.

Fig. 3. Some parts of *Moringa oleifera* used for different purposes. Leaves and flowers (A); matured plant showing pods (B), pods and seeds (C) and bark with gum exudates (d).

Table 4
Different plant parts used, method of preparations, form of use, purpose of use and fidelity level (FL) of uses of *Moringa oleifera* in Nigeria.

Parts used	Use category	Mode of preparation	Form of use	Purpose of use	Fidelity level (FL) %
Leaves	Medicine	Boil in water as infusion	Drink the extract	Malaria & stomach pain	76.1
				High blood pressure	96
				Stroke, rheumatism	70
				Ease labor	20
		Leaves crushed (extract) singly, eaten raw,/leaf extracts mix with "Osan Orombo" (Citrus sp)	Drink the extract	Diarrhea	50
				High blood pressure	92
				Diabetes	80
				Pain killer, epilepsy	70
				Sores & mouth wounds,	40
				Infertility	10.2
		Leaves dried and turn into powder	As medicine & condiment	*Chronic sickness (HIV infection)	10.5
		Crushed leaves	Rob on wounds	Wound healing and arthritis	74
	Food	Leaves boiled mix with "Kwulikwuli"+pepper, onion & tomato. and serve with "burukutu". Boiled leaf extract as tea usually consume early in the morning	Eat as salad, vegetable soup Tea extract	Human nutrition	96.5
	Fodder	Harvest the leaves from the tree	Serve raw as forage	Animal feed	46
Seeds	Medicine	Seeds eaten raw, crushed/grinded as decoction	Decoction	Ease stomach pain	60
				Ulcer & poor vision	34
				Joint pain	58
				Aid digestion	48
	Food	Roasted seed as groundnut Oil extract		Nutrition	18.2
	Coagulant	Grind the seed into powder	Add to poor water	Purifier	38
Bark	Medicine	Soak in water over night and allow to ferment	Drink the liquid	Hypertension	18
		Boil in water+"Asofeyeje" (*Rauwolfia vomitoria*)	Drink the extract	Chronic hypertension	30
				Diabetes	10
		Boil in water singly Soak in alcohol	Drink	High blood pressure	36
		Boil in water as infusion	Mouth wash Drink the extract/liq	Tooth-ache	78
				Diabetes/heamorrhoids	30
		Dry and grind to powder (agumu)	Add to infected parts	Potent against snake & scorpion bite	56
Young roots (tuberous root)	Medicine	Soak in water/alcohol Eat the tuberous root	Drink Having peppery sensation	Nervous disorder Hysteria, pain	26
Roots	Medicine	Soak in water/alcohol Boiled with other herb	Drink Decoction/drink	Pile, toothache Sex enhancer	50 42
Wood	Fuel wood	Gather dried wood	Domestic	Firewood	58
Whole tree	Fencing	Plant around the house	Living fence	Fencing	67

3.3. Use knowledge variation and geographical distribution of Moringa oleifera

Significant differences were observed among the ethnic groups and the use categories except for coagulant use in which there was no significant difference (Table 7). Significant differences were also noticed among the gender groups with respect to the uses of *Moringa Oleifera* as food, medicine, fencing and firewood. However, there were no significant differences with respect to fodder, gum and coagulant use categories, indicating that both men and women utilize the plant the same way. The paired-sample T test procedure was further used to compare the means of men and women with respect to all use categories. The result also revealed significant differences ($X=0.343$, $t=2.661$, $df=6$, $sig=0.037$, $P=0.05$) among the gender classes with respect to uses. However, women preferred to use the species mainly for food and firewood while men cited and used the plant for medicine and for demarcating boundaries. Similarly, significant differences (<0.05, Table 7) were observed among the age groups. There were significant differences with respect to the various use categories among the three age group with the old people ≥ 65 years having better knowledge of the various uses of the plant than the young people of age ≤ 35 years and the adult of age $> 35 \geq 65$ years. The old people considered the plant as a highly valuable medicinal plant with other specific uses such as food, gum, fodder and as coagulant for water purification.

Table 5
Fidelity levels of use among the ethnic, gender and age groups.

Parameters	Fidelity level (FL %)
Ethnic group	
Yoruba	46.7
Hausa	100
Fulani	80
Edo/Deltans	26.7
Igbo	60
Tiv	60
Sabe	80
Ibariba	86.7
Gender	
Male	73.3
Female	80
Age group	
$\leq$ 35 yrs	46.7
$\geq 35 < 65$ yrs	73.3
$\geq$ 65 years	100

Generally, the overall ethno-botanical use value of *Moringa oleifera* ranged from $OUV_{Hau=}$ 16.3 to 9.2 in OUV_{Tiv}, and for both genders ($OUV_{male}=17.5$, $OUV_{female}=15.5$). The result showed that the Hausa ethnic group had the highest overall use value $OUV=16.3$ while Tiv ethnic group had the lowest, 9.2. As for the age group, the overall ethnobotanical use value is higher among the older people compared to the young and adult, indicating that

Table 6
Ethnopharmacological use pattern of *Moringa*.

Tribes	Parts and preparation	Illness treated
Yoruba	Boiled leaves singly or with lemon grass or "Efinrin" (*Occimum gratissimum*) or dried powder Leaf tea	Malaria, hypertension, high blood pressure, HIV infections, pile, stroke, wound and peptic ulcer, lactation
	Boil bark in water + "Asofeyeje" (*Rauwolfia vomitoria*)	Chronic hypertension, diabetes, high blood pressure, chronic malaria
	Crushed seeds eaten raw like groundnut (having dual taste (bitter and sweet))	Peptic ulcer, hypertension
	Young root/rootlets eaten raw/soak in alcohol	To fight infertility, as laxative, reduce back pain and kidney problem
	Bark or leaf decoction	Toothache, gum problem, as mouthwash, tonsillitis
Igbo	Leaves boiled singly/eaten raw/powdered form or boil fresh leaves with lemon grass, bitter leaves	Malaria, ulcer, hypertension, HIV infections, cancer
	Fresh leaves + unripe pods + Efinrin (*Occimum gratissimum*)	Chronic anemia for anemic patients
	Crushed seeds as groundnut	To ease kidney and liver problems
	The use of barks and root decoction	Not mentioned
	Dry leaves mix with body or hair cream	Skin infections/diseases
Hausa/ Fulani	Boil leaves singly usually as tea/tea extract/add ginger/mixed with "Kwulikwuli" (groundnut cake)	Malaria, ease labor, aid digestion, relieve stomach pain
	Tender stem/ tendril are chewed to clean mouth	Toothache, mouthwash, wounds, gum problems and refreshes
	Leaves cooked with spices	Aid vision, reduce body pain and weakness, malaria
	Seeds are roasted or eaten raw	Hypertension, reduce liver lipid level,
Edo/Deltans	Leaves use singly: processed into powder	Peptic ulcer, high blood pressure, hypertension and other kinds of ailments
	Leaf and oil extracts from the seed mix with shear butter	Skin smoothening and against skin infections
	Decoction of bark and leaf boiled	High fever, typhoid, hypertension
	Root usage was unknown	
Tiv	Leaves boiled as infusion, soaked in alcohol or cooked as vegetable	Malaria, high blood pressure, hypertension, pile
	Tendril/young stems as chewing stick	Mouthwash, toothaches, rashes and wounds
	Bark and root uses was not mentioned	
Sabe	Leaf + bitter leaf extracts and mix with alcohol	Chronic malaria, aid sleep, fight hypertension
	Bark prepare with Alcohol and administered in the night	Against hypertension, high blood pressure and enhances sleep
	Crushed seeds eaten raw	Pile and stomach upset
Ibariba	Fresh leaves eaten raw, boiled or cooked	Malaria, body pains and weakness, pile and high blood pressure
	Bark decoction soaked in alcohol	To cure epilepsy, hysteria
	Generally, the leaves, bark and root are carefully dried and processed into powder and added to Corn pap	Headache, dropsy, pile, malaria, pains. Root powder is used to cure infertility and enhances libido
	The use of pod/seed as medicine was not mentioned except as food supplements (groundnut)	

Table 7
Overall use value of *Moringa oleifera* according to ethnic, gender and age group.

Classes	Ethnic group								P	Gender		P	Age			P
	Yor	Hau	Ful	Edo	Igb	Tiv	Sab	Iba		Male	Female		≤ 35 yrs	≥35 < 65 yrs	> 65 yrs	
Food	1.9	3	2.6	2	2.3	1.5	2.6	2.4	0.00*	2.9	2.5	0.04*	1.1	1.6	2	0.03*
Medicine	2.7	2.8	2.3	2.5	2.8	2.3	2.7	2.7	0.00*	3	2.7	0.03*	1.4	1.9	2.9	0.04*
Fencing	1.4	2.7	2	1.5	2.6	1.6	2	2.1	0.00*	2.5	2.3	0.03*	1.5	1.4	2.6	0.04*
Fodder	2.5	2.4	2.8	1.4	1.6	1.9	2.8	2.8	0.00*	2.8	2	0.11	1.7	1.6	2.5	0.02*
Firewood	1.7	2.2	1.9	0.7	0.9	1	1	1.1	0.00*	2.4	2.7	0.04*	1.9	1.3	2.5	0.03*
Gum	0.5	1.4	1.3	1.4	0.9	0.9	1.3	1.4	0.00*	2.5	2	0.07	1.1	1.6	2	0.03*
Coagulant	1.1	1.8	1.8	0.8	0.5	0	0.3	0.9	0.06	1.8	1.3	0.10	1.8	1.3	1.4	0.01*
OUV	11.8	16.3	14.7	10.3	11.6	9.2	12.7	13.4			17.9	15.5		10.5	10.7	15.9

OUV = Overall use value; P = Level of Significance;

* $P < 0.05$.

older people possessed rich and reliable information about the species.

In almost all the villages and towns visited, availability of *Moringa oleifera* was observed and field observations recorded. *Moringa oleifera* is well distributed in all the locations (Table 3). It was found in compounds, fetish groves, road sides, farms and few stands scattered in abandoned farm settlements. Data obtained also highlights origin or source and pointed out transference of *Moringa oleifera* from neighboring countries and others to Nigeria. The history gathered from all the study areas revealed that *Moringa oleifera* has been available before the incident of civil war in Nigeria. In the South East of Anambra (Ifite, Awka) and Enugu (Ogwuoma), *Moringa* was found planted as hedges serving as boundary plants and in homesteads while in Delta State (Mangrove swamp), the plant was not only planted as hedges but also as fetish grove with a traditional priest in charge. The traditional use in the grove was linked with its medicinal usage to cure diseases. The age of the introduction of the plant ranges from 3 years in Okitipupa area of Ondo state to 58 years in Okaka area of Oyo state. In Oyo State, the age of the accessions ranges from 6 years in Aroje, Saki West Local Government (introduced from the USA) to 58 years in Okaka, Itesiwaju Local Government (introduced from Kano by a Hausa settler, Late Baba Manman). For Edo State (Ehanlen Ewu) the age of the accession was above 55 years, and the plant was introduced from the Northern part of Nigeria by Late Okogbo Esichei, who had worked there as a civil servant. The age and history of accessions collected from the Northern part were mostly unknown as respondents were not specific and not sure of their history or ages because the plant had been with them all along.

4. Discussion

Moringa oleifera as a food plant with multiple medicinal uses and other non-timber forest products (NTFP) has been variously reported and cited in the scientific literature (Fahey, 2005; Anwar et al., 2007; Paliwal et al., 2011; Pandey et al., 2012). This study provides ethnobotanical as well as ethno-pharmacological information on multi-local uses, knowledge variation, geographical distribution, and possible origin of different collections of *Moringa oleifera* in Nigeria. Our findings reveal that *Moringa oleifera* is indeed valuable, edible and beneficial to man in diverse ways.

Seven categories of use were considered in this study with four (medicine, food, fodder and fencing, in that order) identified to be well known and utilized by all the ethnic groups. Five ethnic groups (Hausa, Fulani, Sabe, Ibariba and Tiv) have extensive knowledge on the multipurpose uses of *Moringa oleifera* while the remaining three ethnic groups (Yoruba, Igbo and Edo/Deltans) have fairly moderate knowledge of the use of the plant. The use as food is well known to the Hausa, Fulani, Sabe and Ibariba ethnic groups. To these groups, *Moringa* oleifera leaves are generally used as vegetables in soup preparations or cooked and mixed with groundnut cake (Kwulikwuli) and other spices, and then eaten as food. This use is being adopted in other ethnic groups like Yoruba, Igbo, Tiv and Edo/Deltans as the knowledge and awareness about the multipurpose uses of the plant increases. The use of the crushed seeds eaten raw or roasted like groundnut is also restricted to those ethnic groups with extensive knowledge. The utilization of the seeds as a good source of cooking oil is yet to be practiced among all the ethnic groups. Gum exudates observed on the barks of the plant also corroborate its potential use as industrial gum, condiment and as medicine for stomach and bladder ailments (HDRA, 2002). There has been growing awareness about the use of *Moringa oleifera* as medicine in Nigeria in recent times, and which may probably explain why it is the most widely known use as revealed by our study. Similarly, the use value and fidelity level results reveal that utilization for different purposes increases with increase in age, with the old people (> 65 years) having the highest overall knowledge use value. Therefore, the ethnobotanical or oral history gathered from respondents of age 65 years above can be relied upon. There was no suspicion of loss of relevant information about the history as far as this study is concerned.

The ethnobotanical information gathered on the use as fodder for ruminant animals are in agreement with the reported good potential as supplementary food or fodder plant adapted to the agro-ecological characteristics of the sub-Sahara Africa (Ayushy et al., 2010). Reports from ITC, Gambia, revealed that *Moringa oleifera* compared favorably with other conventional ruminant feedstock and adjudged to have high biological value, with 20–40% inclusion in groundnut hay based diet recommended for ruminant animals (ITC, 2004). Recent studies on medicinal and therapeutic properties (Pandey et al., 2012; Mbikay, 2012) also confirmed the many-sided medicinal uses having high potential to cure all kinds of ailments. A wide variety of food supplements, nutritional and medicinal properties have also been attributed to its leaves, seeds, roots, bark, flowers and pods (Anwar et al., 2007; Kumar et al., 2010; Pandey et al., 2012). The leaves and seeds are the most valuable non-timber forest products used mainly for food, medicine and fodder among all the considered ethnic groups. In fact, the nutritional and medicinal properties are now well known to all the respondents to such an extent that some of them are already considering commercial cultivation of the plant. However, differentiation between food and medicinal uses of *Moringa oleifera* parts (leaves, seeds, pods, roots, barks, flowers, tubers) was difficult among the ethnic groups. This observation has been reported in many cultures throughout the tropics since plant uses span both categories and this is integrated in the traditions and fabric of the communities (Lockett et al., 2000; Fahey, 2005).

Regarding the parts of the plant utilized differently as medicine, our findings show specificity and overlap of the different parts with robust ability to cure many ailments. This observation is

not different from previous studies on its nutritional, therapeutic, and prophylactic properties (Fahey, 2005, Anwar et al., 2007; Dieye et al., 2008; Kumar et al., 2010; Paliwal et al., 2011; Mbikay, 2012).

Despite these huge potentials and the use categories considered in this study, only four of the use categories are well known and adopted, indicating that *Moringa oleifera* is less exploited and less incorporated into the commercial agricultural production. Though, there is increase awareness and transfer of knowledge of use from one ethnic group to another, its use remains traditionally localized, and underutilized. Our findings also reveal poor management and conservation of its genetic resources in the different agro-ecological zones, which calls for the evolution of effective strategies towards improved genetic conservation.

It is remarkable to note also that our findings on ethnic usage of *Moringa* in Nigeria are comparable to its wider usage. Take for instance, in the Philippines, *Moringa* leaf is utilized to increase woman's milk production and it is sometimes prescribed for anemic patient (Estrella et al., 2000; Siddhuraju and Becker, 2003). This is also very much in practice in Nigeria especially among the Hausa, Igbo and Yoruba ethnic groups. In addition, the use of crushed seeds for relieve of stomach pains, diabetes and for lowering of lipid levels in the liver, which is common to most ethnic groups in Nigeria was earlier reported in Ghana and Indian (Anwar et al., 2007; Fahey, 2005). Even though *Moringa* is being used among the Ibariba ethnic groups as food supplement, no specific purpose was ascribed to its use in this form unlike the report from Sudan regarding its ability to provide necessary vitamins for pregnant women and nursing mothers (Price, 2000). Conversely, the combinations of *Moringa* with other plant parts like lemon grass, "Efinrin" (*Occimum gratissimum*), "Asofeyeje" (*Rauwolfia vomitoria*) and bitter leaf as utilized by the Igbo and Yoruba ethnic groups have not been previously reported anywhere else. Among the Yoruba respondents, a combination of *Moringa* leaves with lemon grass is believed to be very active against high fever. Also, when combined with "Asofeyeje" (*Rauwolfia vomitoria*), it is used to challenge chronic hypertension. Similarly, a combination with "Efinrin" (*Occimum gratissimum*) is generally accepted to be more active against malaria, pile, peptic ulcer and body weakness than when taken singly.

These ethno-medicinal claims need to be subjected to more rigorous scientific verifications for their efficacy, therapeutic effects and possible side effects in view of the growing popularity of the plant especially in the sub-Sahara Africa where traditional medicine is thriving. To the best our knowledge, just few clinical and experimental trials on humans and animals are available, suggesting the need for the state-of-the-art scientific examinations of the mode of administration and the determination of its pharmacological effects on living organisms.

4.1. Knowledge variation on use and geographical distribution of Moringa oleifera in Nigeria

The significant differences observed among the ethnic and age groups regarding the ethno-uses of *Moringa oleifera* indicate unequal distribution of indigenous knowledge, which had been previously reported for other plant species with strong cultural attachment (Ayantunde et al., 2008; Houessou et al., 2012; Omonhinmin, 2012). The significant differences observed among the gender group and differences in the overall use value among the age groups indicate a strong link between the three different classes of respondents (ethnic, gender and age) and the uses of the plant. Therefore, the ethnic origin or tradition, age and gender are important factors to take into account in plant utilization value assessment. Rich knowledge of the plant use increases with increasing age, as the old people 65 years and above had more knowledge of use than the other age categories.

Moringa oleifera is an introduced species particularly to the Southern part of Nigeria (Yoruba, Edo/Deltans and Igbo) though the information gathered suggested that it has been known for close to 60 years. The plant has been well domesticated and adapted to the different ecological regions in Nigeria. The wide range of uses and localization of names among the ethnic groups indicate the degree of acceptance and integration of *Moringa oleifera* in Nigeria and other African countries. The sources of introduction and domestication positively influenced the diversity distribution pattern across the geographical areas. The major introduction points to most of the geographical areas include; the Philippines, Togo, the US, Niger Republic, Benin Republic and Northern Nigeria. The different accessions collected from varied ecological areas lend credence to the fact that *Moringa oleifera* is probably an introduced species. Though it is considered native to Northern Nigeria, the Arab world and India are widely regarded as the origins of introduction to other part of the world (Irvine, 1961; GRIN, 2007). The wide distribution in Nigeria has probably resulted from adaptation to the different ecological conditions with wide climatic tolerance (Price, 2000; Navie and Csurhes, 2010) that favors its growth and survival. The suitability of the species to the diverse ecologies also suggest that it can potentially serve as a food plant with multiple medicinal uses, forage feed for animals and other productive uses. *Moringa oleifera* is widely naturalized in other tropical regions including Zimbabwe, Madagascar, South Africa, Burkina Faso, Cameroun, Sierra Leone, Sudan, Zaire, Togo, Ugandan, Senegal and in Asian continent supporting its wide distribution beyond the tropical areas (Hyde and Wursten, 2007; Papillo, 2007; Mbikay, 2012).

5. Conclusion

The study clearly established that indeed *Moringa oleifera* is a highly valuable plant in all the regions of Nigeria and the value attached to it by each ethnic group cannot be overemphasized. It is widely distributed in Nigeria. Though considered an introduced species, *Moringa oleifera* has found wide acceptance, recognition and usefulness among various ethnicities in Nigeria. The increase in awareness of this highly valued plant has led to its emergence as a national crop for economic growth and development. With all the acclaimed economic uses, the potentials of *Moringa oleifera* has not been fully harnessed and utilized. Presently in Nigeria, *Moringa oleifera* remains underutilized. As regards geographical distribution, often a species could be underutilized in some regions but not in others (Padulosi et al., 2006) as in the case with many plants including *Moringa oleifera*. Recent awareness in the Southern Nigeria has elicited a positive reaction towards cultivation, exploitation and utilization of the species. Geographical distribution, unequal indigenous knowledge and ethnic differentiation are strong sources of genetic diversity that can help determine diversities available in the morphology, chemical components, taste, anatomy and other characters of *Moringa oleifera* in Nigeria. These characters if properly identified and harnessed would lead to better conservation and breeding strategies that will enhance its genetic improvement and transformation.

Acknowledgment

This work has been funded by the Covenant University's Research Seed Grant awarded to O.O. Obembe. We wish to acknowledge the assistance of Dr. A.C. Omonhinmin and also appreciate Mr. Adeoluwa Akande for providing Fig. 1.

References

Anwar, F., Latif, S., Ashraf, M., Gilani, A.H., 2007. *Moringa oleifera*: a food plant with multiple medicinal uses. Phytotherapy Research 21, 17–25.

Ayantunde, A.A., Briejer, M., Hiernaux, P., Udo, H.M.J., Tabo, R., 2008. Botanical knowledge and its differentiation by age, gender and ethnicity in Southwestern Niger. Human Ecology 36, 881–889.

Ayushy, S., Meena, A.K., Ramanjeet, K., Bhavana, P., Brijendra, S., 2010. *Moringa oleifera*: a review. Journal of Pharmacy Research 3, 840–842.
Dieye, A.M., Sarr, A., Diop, S.N., Ndi-aye, M., Sy, G.Y., Diarra, M., Rajraji-Gaffary, I., Ndiaye, Sy, A., Faye, B., 2008. Medicinal plants and the treatment of diabetes in Senegal: survey with patients. Fundamental and Clinical Pharmacology 22, 211–216.
Dike, I.P., Obembe, O.O., Adebiyi, E.F., 2012. Ethnobotanical survey for potential anti – malarial plants in South-Western Nigeria. Journal of Ethnopharmacology 144, 618–626.
Estrella, M.C.P., Mantaring, J.B.V., David, G.Z., 2000. A double blind, randomized controlled trial on the use of maunggay (*Moringa oleifera*) for augmentation of the volume of breast milk among non-nursing mothers of preterm infants. Philippine Journal of Pediatrics 49, 3–6.
Fahey, J.W., 2005. *Moringa oleifera*: a review of the medical evidence for its nutritional, theurapeutic and prophylactic properties: part 1. Trees for Life Journal 1, 5.
Friedman, J., Yaniv, Z., Dafni, A., Palewitch, D., 1986. A preliminary classification of the healing potential of medicinal plants, based on a rational analysis of an ethno pharmacological field survey among Bedouins in the Negev Desert, Israel. Journal of Ethnopharmacology 16, 275–287.
Fuglie, L.J., 1999. The Miracle Tree: *Moringa oleifera*, Natural Nutrition for the Tropics. Church World Service, Dakkar, Senegal p. 68.
GFU, 2012. Global Facilitation Unit (GFU) for underutilized species. *Moringa oleifera*. ⟨www.under-utilized_species⟩. Accessed 5, Nov. 2012.
GRIN 2007. Taxon: *Moringa oleifera* Lam. Germplasm Resources Information Networks (GRIN). ⟨http://www.ars.grin.gov/cgi-bin/npgs/html/taxon. Pl?24597⟩. National Germplasm Resources Laboratory, United States of Department of Agriculture, Beltsville, Maryland, USA. Accessed 5, Nov. 2012.
HDRA 2002. *Moringa oleifera*: A Multi-purpose Tree. ⟨http://www.gardenorganic.org.uk/pdfs/international_programme/Moringa.pdf⟩. HDRA- the organic organization, Coventry, UK.
Houessou, L.G., Lougbegnon, T.O., Gbesso, F.G.H., Anagonou, L.E.S., Sinsin, B., 2012. Ethno-botanical study of the African star apple (*Chrysophyllum albidum* G. Don) in the Southern Benin (West Africa). Journal of Ethnobiology and Ethnomedicine 8, 1–10.
Hyde, M.A., Wursten, B., 2007. Flora of Zimbabwe: Species Information: *Moringa oleifera*. ⟨http://www.zimbabweflora.co.zw/speciesdata/speciesphp?species_id=124730⟩ Accessed 10 January, 2013.
ITC 2004. *Moringa* – So Much Potential. International Trypanotolerance Centre (ITC), Newsletter, January – June, 2004, Banjul, Gambia.
Irvine, F.R., 1961. Woody Plants of Ghana with Special Reference to Their Uses, Pp. Oxford University. Press, London, pp. 53–54.
Kumar, P.S., Mishra, D., Ghosh, G., Panda, G.S., 2010. Medicinal uses and pharmacological properties of *Moringa oleifera*. International Journal of Phytomedicine 2, 210–216.
Lockett, C.T., Calvert, C.C., Grivetti, L.E., 2000. Energy and micronutrient composition of dietary and medicinal wild plants consumed during drought. Study of rural Fulani, Northeastern Nigeria. International Journal of Food Sciences and Nutrition 51, 195–208.
Mbikay, M., 2012. Therapeutic potential of Moringa oleifera leaves in chronic hyperglycemia and dyslipidemia: a review. Frontier in Ethnopharmacology 3, 1–12.
Mughal, M.H.S., Srivastava, P.S., Iqbal, M., 1999. Drumstick (*Moringa pterygosperma* Gaertn.): a unique source of food and medicine. Journal of Economic and Taxonomic Botany 23, 47–61.
(National Research Council (NRC)), 2006. Lost Crops of Africa: Volume II: Vegetables, Development, Security and Cooperation. National Academy of Science, Washington, D. C, pp. 247–267.
Navie Sheldon and Steve Csurhes, 2010. Weed Risk Assessment: Horshradish tree *Moringa oleifera*. Biosecurity Queensland. Department of Employment, Economic Development and Innovation, GPO Box 46, Brisbane 4001.
Obembe, O.O., Popooola, J.O., Leelavathi, S., Reddy, S.V., 2011. Advances in plant molecular farming. Biotechnology Advances 29, 210–222.
Ogunkunle, A.T.J., Oladele, F.A., 2004. Ethnobotanical study of fuel wood and timber wood consumption and replenishment in Ogbomoso, Oyo State, Nigeria. Environmental Monitoring and Assessment 19, 223–236.
Omonhinmin, A.C., 2012. Ethnobotany of *Dacryodes edulis* (G. Don). H.J. Lam. in Southern Nigeria 1: Practices and Applications among the Yoruba speaking people. Ethnobotany Research and Application 10, 175–184.
Padulosi, S., Hodgkin, T., Williams, J.T., Haq, N., 2006. Underutilized crops; trends, challenges and opportunities in the 21st century. A paper presented Moringa and other highly nutritious plant resources, strategies, standards and markets for a better impact on nutrition in Africa, Accra, Ghana, Nov. 16–18, 2006.
Paliwal, R., Sharma, V., Pracheta, P., Sharma, S., Yadav, S., Sharma, S.H.., 2011. Antinephrotoxic effect of administration of *Moringa oleifera* lam in amelioration of dmba – induced renal carcinogenesis in swiss albino mice. Biology and Medicine 3, 27–35.
Pamok, S., Saenphet, S., Vinitketkumnuem, U., Saenphet, K., 2012. Anti proliferation effect of *Moringa oleifera* Lam. and *Psenderanthera palatiferum*(Nees) Radlk extracts on the colon cancer cell. Academic Journals. Journal of Medicinal Plants Research 6, 139–145.
Pandey, A., Pandey, R.D., Tripathi, P., Gupta, P.P., Haider, J., Bhatt, S., Singh, A.V., 2012. *Moringa oleifera* Lam. (Sahijan) – A plant with a plethora of diverse therapeutic benefits: an updated retrospection. Medicinal & Aromatic Plants 1, 101, http://dx.doi.org/10.4172/2167-0412.1000101.
Papillo, J., 2007. *Moringa oleifera*: the multi-purpose wonder tree. ⟨http://peacecorps.mtu.edu/resources/studentprojects/moringa.htm⟩ Michigan Technological University, Michigan, USA.
Philips, O., Gentry, A.H., 1993. The useful plants of Tambopata Peru. II Statistical hypothesis tests with a new quantitative technique. Economic Botany 47, 33–43.
Price, M.L., 2000. The *Moringa* Tree. Echo Technical Note. ⟨http://www.echotech.org/technical/technotes/moringabiomasa.pdf⟩ ECHO, North Ft, Myers, Florida, USA.
Siddhuraju, P, Becker, K., 2003. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agro-climatic origins of drumstick tree (Moringa oleifera Lam.). Journal of Agriculture and Food Chemistry 15, 2144–2155.