Journal of Plant Sciences
2021; 9(6): 303-308
http://www.sciencepublishinggroup.com/j/jps
doi: 10.11648/j.jps.20210906.14
ISSN: 2331-0723 (Print); ISSN: 2331-0731 (Online)

Phenotypic Variability in Germplasm Collection of African Yam (*Dioscorea* spp) in North Central Nigeria

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To cite this article:

Tanko Thomas, Olamide Ahmed Falusi, Oladipupo Abdulazeez Yusuf Daudu, Matthew Omoniyi Adebola, Abdulhakeem Abubakar. Phenotypic Variability in Germplasm Collection of African Yam (*Dioscorea* spp) in North Central Nigeria. *Journal of Plant Sciences.* Vol. 9, No. 6, 2021, pp. 303-308. doi: 10.11648/j.jps.20210906.14

Received: October 21, 2021; **Accepted**: November 13, 2021; **Published**: November 23, 2021

Abstract: Yams (*Dioscorea* spp) are staple food crops of the people in tropical and subtropical region of the world. The crop consists of approximately 600 species. These species are threatened by genetic erosion due to several factors such as pest and diseases attack, inadequate improved varieties and dearth of germplasm collection and conservation. On this premise, this research was carried out to collect and manage the available germplasm in North-Central Nigeria. Fifty accessions of yam (*Dioscore*a spp) were collected from adaptable farmers' varieties. These were evaluated according to standard descriptors of yam into four (4) species (*D. alata, D. bulbifera, D. dumetorum and D. rotundata*). The highest germplasm (21) was recorded in Niger state, which was dominated by white yam (*D. rotundata*). This was followed by Benue state with twenty (20) accessions. Others are three (3) accesssions each from FCT and Kogi State, then two (2) accessions each from Nasarawa and Kwara States. Of the 50 accessions of yam collected, 40% (20) are rare landraces and are at the brim of becoming extinct locally. Phenotypic observation revealed that tuber skin colour varies from light-brown, through dark and milk spotted to dark and dark-brown. The most dominate of these were dark-brown with 60% of the accessions, this was followed by light-brown and the least were 6% which was recorded for dark-milk spotted accessions. Similarly, tuber shape showed that cylindrical dominated with 80% of the accessions and the least was snake shape with only 4% of the accessions. These findings have given some insights on the available germplasm of yam in North-central Nigeria with promising traits. However, there is for a promising approach of characterisation of the crop species in the area for the improvement, conservation and breeding programme of yam in the future.

Keywords: Accessions, Germplasm, Landraces, Yam Tubers

1. Introduction

Yam (*Dioscorea* spp) is one of the domesticated food crops in the tropical regions of the world [1-3]. The crop belongs to the genus Dioscorea in the family Dioscoreacea. The genus contains 600 species with six of the species observed to be indigenous to Africa [4]. According to FAO [1], Nigeria is the leading world producer of yam and account for 71% of the world production [5]. Major producing areas in North-Central, Nigeria are; Benue, Niger, Federal Capital Territory (FCT) Abuja, Nasarawa, Kogi and Kwara states [2]. The most popular species grown in Nigeria are *Dioscorea rotundata* (white yam or Guinea Yam), *Dioscorea cayenesis* (Yellow Yam), *Dioscorea dumetorum* (trifoliate yam) and *Dioscorea hispida*.

Plants resources form an integral part of interdependent system that includes physical components and biological community of life [6]. One of the ways to increase food supply is to use a good variety that is environmental forbearance, tolerance and resistance to pests and diseases. Hence, plant breeders are in search for genetic materials to build new desirable varieties. These genetic materials could only be sourced in the available gene pool; in other words, the usefulness of these genetic resources depend on reservoirs of variability present in the gene pool. Thus, the larger the gene pools, the better the chances of finding the desired traits and the smaller the gene pools, the narrower the chances of using

desired trait. These resources according to FAO [1] are generally referred to as germplasm which constitutes the building block of plant breeding. They are heritage of mankind to be preserved and to be freely available for use for the benefit of the present and future generations. Plant genetic resources could also be the plant itself, seeds, tissues, cells pollen, vegetative materials or DNA. Indeed they perform a vital role in the development of new cultivars and restructuring of the existing ones [7]. Furthermore, there are two major sources of plant genetic resources that can be utilized by plant breeders; these are exotic germplasm and indigenous germplasm. The former refers to those genetic resources that exist far away from the native country, while the later are resources that are native to the country.

Nigeria has great potentials for yam production both for domestic and export market. However, the yield is relatively declining due to challenges faced in the production of the crop. These challenges range from dearth of germplasm collection and conservation of the crop, which has led to some indigenous genotype with desirable traits been abandoned by the farmers and are presently endangered and at the brim of extinction [8]. In addition, inadequate improved varieties and identification of cultivars that can strive well in Low Soil fertility in the area understudy has led to under production of the crop, [9, 10]. It is against these backgrounds that assembly, evaluation and conservation of available landraces is necessary. This will help to conserve available landraces of yam species with desirable traits, ascertain and nutritive increase genetic of the crop and provide bases for improvement programme. Thus, the research was carried out to collect and conserved indigenous yam genotypes (landraces) across North-Central Nigeria for subsequent breeding programme.

2. Materials and Method

Germplasm Collection and Evaluation

Systematic collection of accessions of African Yam accessions was carried out in collaboration with Agricultural Development Project (ADP) Extension officers in yam growing areas across North-Central state of Nigeria, between December 2018 and March 2019. This period corresponded to the harvesting time of yam. The states visited were geo-referenced and represented in a simple map using map tools and map plots software packages [11, 12] (Figure 1). The method of collection involved the use of well-structured questionnaires. Different local government areas and villages where the tubers are produce in commercial quantity were visited in each of the growing states. A total of one hundred (100) questionnaires was administered to the respondent accompany by verbal interview on; Gender, Agricultural practices, purpose of production, species cultivated and cultural practices. The samples collected were assigned accession number and transported for storage and conservation at experimental farm Tungan Mallam.

Data collected was analyzed for simple percentage using Microsoft excel software version 2020.

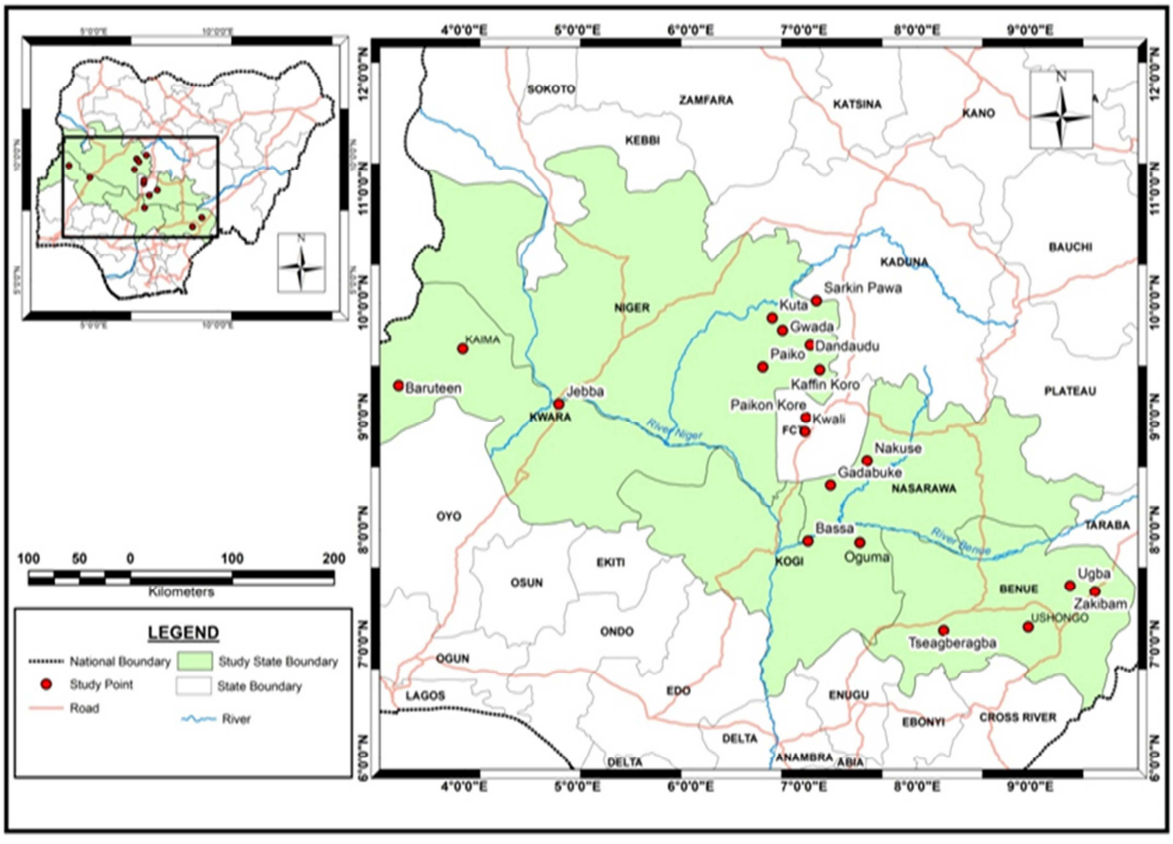

Figure 1. *Germplasm Collection of Africa yam in North Central State of Nigeria Source.*

3. Result

3.1. Demographic Information and Agricultural Practices

The result of demographic data obtained showed that highest number of yam cultivators were male with 85 individuals (85%) and 15% were female. This was an indication that majority of yam farmers were male. Similarly, sixty percent (60%) of the farmer's practices subsistence agriculture, while the least (40%) practice commercial agriculture. This shows that majority of the farmers are poor and could only cultivate small area of land either for family sustenance or sale (table 1).

Table 1. *Gender Representation and Agricultural Practices among Yam Farmers in North-Central Nigeria.*

Gender	Number of farmers	Percentage
Male	85	85%
Female	15	15%
Agricultural Practices		
Subsistence	60	60%
Commercial	40	40%

The results of the purpose of yam production and cultural practices among farmers in North-central Nigeria are presented in table 2. The highest number of farmers producing tubers of yam for food (consumption) were seventy (70) representing 70%, produced the yam for sell (commercial), and the least was 2% for medicinal purposes. This was an indication that majority of the farmers were cultivating yam tubers for food and not adequate for commercial. Similarly, the result equally revealed that most of the farmers practice rain-fed agriculture with the highest number (96%), followed by irrigation with 4 farmers.

Table 2. *Purpose of yam production and cultural practices.*

Purpose of production	Number of farmers	Percentage
Food	70	70%
Sell	28	28%
Medicine	2	2%
Total	100	100%
Cultural practices		
Rain fed	96	96%
Irrigation	4	4%
Total	100	100%

3.2. Germplasm Information on Accessions of African Yam

A total of fifty (50) accessions of African yam landraces were collected from six (6) cultivating states; twenty-one (21) local government area in Nigeria. The landraces were further classified according to farmers' indigenous knowledge (Table 3). These species include *D. alata, D. bulbifera, D. dometorum and D. rotundata*. Of the accessions, 21 accessions were obtained from Niger state, followed by 19 accessions in Benue and the least was two (2) accessions each from FCT and Kogi state. The local names of these landraces varies from tribe to tribe; for instance, white yam (*Discorea rotundata*) were known and named as "Arima, Dan'anacha, Bazhenbyi, Didiya, Giga/Biwara, Kpako, Loshi, Mana, Suba, Shindo, Taribe, Zagi, Yangbeje, Bazje, Suruwowoi, Surukokoi, Maragbagi, Kandu, Jeep/Sarki Dabo, Iko, Mumuye, Naira/Pasa-bunga, Akangi, Pepa and Shamura" in Gbari/Gbagi (Table 3). Similarly, "Ajan, Faketsa, Ugoja, Gbongu, Hembakwatse, Ishipua, Ihyara/Kongo, Noryo, Punch, Tameyo, Alakpa, Gyuwa/Akpoki, Angungul, Ayisha, Ipua, Annasuwe" in Tiv and "Sofini" in Nupe languages. In addition, water yam (*Dioscorea alata*) was known as "Shamma-khadna, Shenugyi, Shamma-bubuyi, Shamadogo pyiri" in Gbari/Gbayi tribe, "shakata" in Hausa/Gbagyi, "Anenga" in (Tiv) "Agbo-banard" in Bassange and "Ehura" in Yoruba. The aerial yam, (*Dioscorea bulbifera*) was also named "Kandu" in Nupe and Gbari. Furthermore, Trifoliate yam (*Dioscorea dumetorum*) ware equally called "Urukokoi, Suru-wowoi" in Gbari/Gbagyi. Of the 50 landraces collected 44 were white yam (*Dioscorea rotundata*), 3 accessions were *D. alata*, 2 accessions *D. dometorium* and the least species; one (1) accession of aerial yam (*Dioscorea bulbifera*) was obtained from Niger state. This shows that Niger state could be a secondary centre of diversity of African yam in North-Central Nigeria.

A total of twenty (20) Rare/scarce species such as "Mana, Shindo, Kpako, Giga/Biwara, Arima, Bazje, Bazjenbyi, Pape, Gbongu, Taribe, Zagi, Amula, Kandu, Dan'anacha, Mumuye, Ishipua, Iko, Maragbagi, Suru wowoi and suba" were retrieved through our germplasm survey; such landraces have been mostly neglected by farmers and are presently at the brim of extinction (Table 3). Hence very few can be found in farm lands (fields) and market. This effect could be due to pest and diseases that attack the tubers, unfertile land, low-income derived from these cultivar due to low productivity which led the farmers to abandoned the species. Furthermore, personal communication with the farmers indicated that some indigenous cultivars cultivated in the past were no longer in existence (extinction). In spite of this short-coming, high diversity was observed in some of these Rare/scarce species. These endangered cultivar further calls for yam germplasm conservation in North-central Nigeria to avoid extinction.

3.3. Phenotypic Information in African Yam Germplasm

In terms of phenotypic characteristics, various range of variability was examined among the accessions collected (Table 4). Tuber skin colour varies from light-brown, Dark and milk spotted; Dark and Dark-brown. The most dominate of these were dark-brown with 30 accessions, this was followed by light-brown and the least were 3 recorded in dark-milk spotted accessions (Figure 2). This shows that African yam species germ cells may contain colour cells pigment. Forking position was observed with highest number (32) recorded in neutral (Non-forked) accessions (Figure 3). This is an indication that forking species may be less in African yam genotypes. Similarly, tuber shape was equally determined with cylindrical shape dominating with 40 accessions and least snake shape with 2 accessions. This shows that African yam genotype may have more number of cylindrical shapes. (Figure 4).

Table 3. *Status of African Yam Germplasm from Cultivating State in North-Central, Nigeria.*

Accession Number	Local Name	*D. alata*	*D. bulbifera*	*D. dumetorium*	*D. rotundata*	Local Government	State	Status	Rare Species
NGr.001	Arima				1	Paikoro	Niger	Landraces	Rare
NGr.002	Dan'anacha				1	Paikoro	Niger	Landraces	Rare
NGr.006	Bazhenbyi				1	Paikoro	Niger	Landraces	Rare
NGr.008	Didiya				1	Shiroro	Niger	Landraces	Abundant
NGr.012	Giga/Biwara				1	Shiroro	Niger	Landraces	Abundant
NGr.020	Koch				1	Bosso	Niger	Landraces	Abundant
NGr.021	Kpako				1	Paikoro	Niger	Landraces	Rare
NGr.022	Loshi				1	Paikoro	Niger	Landraces	Abundant
NGr.023	Mana				1	Paikoro	Niger	Landraces	Rare
NGr.028	Suba				1	Paikoro	Niger	Landraces	Rare
NGr.029	Shindo				1	Paikoro	Niger	Landraces	Rare
NGr.036	Taribe				1	Paikoro	Niger	Landraces	Rare
NGr.038	Zagi				1	Paikoro	Niger	Landraces	Rare
NGr.037	Yangbeje				1	Paikoro	Niger	Landraces	Abundant
NGr.007	Bazje				1	Paikoro	Niger	Landraces	Rare
NGd.031	Suruwowwoi			1		Gurara	Niger	Landraces	Abundant
NGa.033	Shamma-khadna	1				Paikoro	Niger	Landraces	Rare
NGr.024	Maragbagi				1	Katch	Niger	Landraces	Rare
NGb.019	Kandu		1			Katch	Niger	Landraces	Rare
NGr.017	Jeep/sarki debo				1	Muya	Niger	Landraces	Abundant
NGr.015	Iko				1	Paikoro	Niger	Landraces	Rare
BNr.044	Ajan				1	Zakibiam	Benue	Landraces	Abundant
BNr.038	Faketsa				1	Zakibiam	Benue	Landraces	Abundant
BNr.077	Ugoja/gbari				1	Zakibiam	Benue	Landraces	Rare
BNr.059	Gbongu				1	Ushongo	Benue	Landraces	Rare
BNr.063	Hembakwatse				1	Zakibiam	Benue	Landraces	Abundant
BNr.066	Ishipua				1	Ushongo	Benue	Landraces	Rare
BNr.067	Ihyara/kongo				1	Ushongo	Benue	Landraces	Abundant
BNr.071	Noryo				1	Ushongo	Benue	Landraces	Abundant
BNr.083	Punch				1	Katsinala	Benue	Landraces	Abundant
BNr.075	Tameyo				1	Ushongo	Benue	Landraces	Abundant
BNr.050	Alakpa				1	Ushongo	Benue	Landraces	Abundant
BNr.061	Gyu'ua/Akpoki				1	Ushongo	Benue	Landraces	Abundant
BNr.055	Anzungul				1	Ushongo	Benue	Landraces	Abundant
BNr.051	Ayisha				1	Konshisha	Benue	Landraces	Abundant
BNr.065	Ipua				1	Konshisha	Benue	Landraces	Abundant
BNr.048	Annasuwe				1	Konshisha	Benue	Landraces	Abundant
BNd.030	Suru kokoi			1		Konshisha	Benue	Landraces	Abundant
BNa.054	Anenga beer	1				Konshisha	Benue	Landraces	Abundant
BNr.056	Agboyo/Akura				1	Konshisha	Benue	Landraces	Abundant
FCr.073	Mumuye				1	Gwagwalada	FCT/Abuja	Landraces	Rare
FCr.095	Naira/Pasabunga				1	Kwali	FCT/Abuja	Landraces	Rare
FCr.079	Akanji				1	Kuje	FCT/Abuja	Landraces	Abundant
KGr.043	Amula				1	Bassa	Kogi	Landraces	Abundant
KGr.003	Army				1	Dekina Ida	Kogi	Landraces	Abundant
KGr.121	Dambala				1	Ijumu	Kogi	Landraces	Abundant
NSr.027	Pepa				1	Toto	Nasarawa	Landraces	Rare
NSr.097	Shamura				1	Karu	Nasarawa	Landraces	Abundant
Kwr.133	Sofini				1	Buruti	Kwara	Landraces	Abundant
Kwr.134	Ehura	1				Kaima	Kwara	Landraces	Abundant
G total	50	3	1	2	44	21	6	50	20

Table 4. *Phenotypic Variability in African Yam Species.*

Phynotype Traits	Number of Accessions				Total
Skin colour	Light brown	Dark-milk spotted	Dark	Dark- brown	
	12	3	5	30	50
Forking position	Lower fork	Middle fork	Upper fork	Neutral fork	
	10	5	3	32	50
Tuber shape	Cylindrical	Flattered	Snake	Irregular	
	40	5	2	3	50

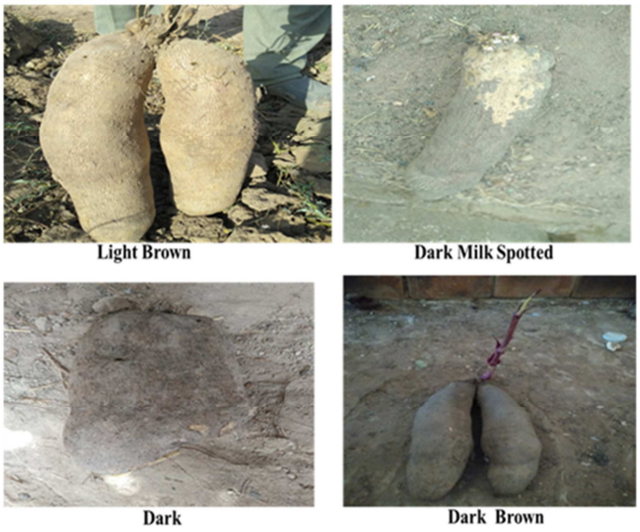

Figure 2. *Variability in skin colour.*

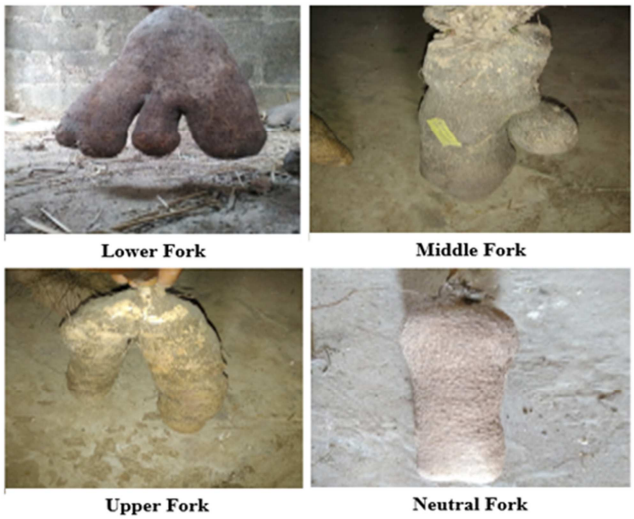

Figure 3. *Variability in Forking Position.*

Figure 4. *Variability in Tuber Shape.*

4. Discussion

On the basis of the indigenous knowledge the classification of the collected germplasm into five (5) different species is inconformity with the earlier work of Clarke [13], that reported 6 species from 23 accessions. Contrary their report that *D. alata* was the most common accessions; *D. rotundata* was found to be most abundant and widely distributed cultivars in North Central Nigeria. The high presence of most species in Niger state and Benue State confirmed the assertion that these state were the major yam cultivating state in the country, an indication the state could be secondary centre of yam diversity. In agreement with this statement World Data Atlas Nigeria Ranking Agriculture [14], reported that the top region of yam production in Nigeria are; Benue, Niger, Enugu, and Kaduna account for 50.55% of its total production in the country. Secondary centres of diversity have been reported to be the regions of high diversity, developed as a result of subsequent spread of a crop [15]. The variability in shape and skin colour is an indication of high level of diversity among the landraces. In line with this results of Mulualem *et al.* [16] reported that there is a wide range of variability of tubers among *Dioscorea* species with the tuber shape of the landraces varied from irregular to oval. However, the least and unique tuber shape obtained in the study in snake shape. The presence of fewer rare/scarce spicies in farm lands (fields) and market among the cultivating regions with some presently at the brim of extinction could be attributed to the abandoned of the species due to their poor yielding ability, lack of knowledge on their importance, preservation, vulnerability of the species to insects and diseases as well as poor adaption to the environment. Mulualem *et al.* [16], had earlier reported that variety adoption by farmers depends on agronomic characteristics, usually pertaining to productivity, resistance to pests or adverse cropping conditions environmental conditions but also to stability of production [17].

5. Conclusion

Survey and germplasm collection of African Yam in North-Central Nigeria has shown that, white yam (*Dioscorea rotundata*) is the most cultivated and abundant species and aerial yam (*Dioscorea bulbifera*) is rare species in the region. Among the cultivating state in the region, Niger state was found to possess diverse species of the yam and could be a secondary centre of diversity of African yam. However, a promising approach of characterisation of the crop species in the area is required for the improvement, conservation and future breeding programme.

Acknowledgements

The authors thank the project managers of Agricultural Development Project (ADPs) for their co-operation towards the successful collection of the germplasm in their area. The authors equally appreciate the local farmers for participating in this research by providing plant materials.

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