Evaluation of Genetic Variability and Morpho-Agronomic Characters of Sweet Potatoes (*Ipomoea batatas* (L.) Lam.) from Umudike Germplasm and Selected Landraces from Southwest, Nigeria

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ABSTRACT

This study was carried out to evaluate the genetic variability and agro-morphological variation of thirty sweet potatoes accessions and selected landraces sourced from the National Root Crops Research Institute (NRCRI), Umudike and local farmers from the six states of South West, Nigeria. The sweet potatoes were planted in the experimental field of the Department of Botany, University of Ibadan using randomize complete block design with four replicates. Planting was done on ridges of 6m long with the distance between ridges of 1m. On each ridge, 9 cuttings of 30 cm were planted at a spacing of 60 cm. Morphological data (Quantitative and Qualitative characters) were measured 90 days (vine and leaf characters) and 120 days (root characters) after planting in line with standard protocol. The means squares from the analysis of variance for the growth and yield characters indicated highly significant variability ($p<0.001$) among the sweet potatoes for the various characters studied. The mean performance of the growth and yield characters clearly indicated the agronomic superiority of some of the sweet potatoes over others. Storage root fresh yield showed strong positive correlation with storage root dry yield ($r = 0.71$), and a strong positive association with a number of storage roots per plant ($r = 0.70$). The studied accessions had great genetic variability for all the characters. There is a need for farmers and plant agronomists to harness the great variability identified in this study for improvement of sweet potatoes in Nigeria to enhance food security.

Key words: Sweet potatoes, Accessions, Landraces, Agro-morphological Variation, Umudike

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INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam) is a tropical and subtropical vine that belongs to the botanical family Convolvulaceae along with other familiar plants, such as morning glory and bindweed. It is a dicotyledonous plant which is perennial in nature but cultivated as an annual crop. Sweet potato is grown for both the leaves, which served as greens, and the tubers, for a high carbohydrate and beta-carotene source (Egbe, 2012; Ohajianya *et al.,* 2014; Alfred *et al.,* 2019).

Sweet potato is the world's seventh most important staple crop, cultivated in over 100 countries of the world, covering an estimated total area of 9.2 million Hectare (Ha), with annual global production of approximately 125 million tons. Almost 95 % of the total production is in developing countries of the world (Rees, 2002; Bhandari *et al*., 2017). For several reasons, sweet potato is particularly valuable for resource poor farmers. It can be grown with little inputs, it is relatively resistant to pests and diseases and it is quite drought tolerant (Rees, 2002; Akoroda *et al*., 2007).

China is the largest producer of sweet potato, accounting for more than 80% of the world supply. About 40% of the production is used for human consumption and industrial used, while the rest is used as animal feed. Nigeria ranked second as the largest producer of sweet potato sweet with approximately 3.49 million tons (Odebode *et al*., 2008; Padmaja, 2009; Demelie and Aragaw, 2016).

Sweet potato also serves as important source of raw materials for manufacturing of industrial products such as starch, liquid glucose, ethanol, flour in bread, brewing of alcoholic drinks and as sweetener in non-alcoholic drinks (Ohajianya *et al.,* 2014). Sweet potato is consumed without special processing; the fresh tuber is boiled, roasted, baked or fried as chips (Njuguna, 2005; Egbe, 2012; Maquia *et al*., 2013).

Assessment of genetic diversity is the process by which variation among individuals or groups of individuals or populations is analysed by a specific method or a combination of methods (Mohammadi and Prasanna, 2003; Aremu, 2007; Osawaru, 2015). These data often involve numerical measurement and in many cases, combinations of different types of variables. The analysis of genetic diversity rely on pedigree, morphological, biochemical and molecular (DNA-based) data. Genetic diversity entails variation of heritable characteristics in a population; it results from one or a combination of processes such as evolution, mutation, migration, domestication, plant breeding and selection (Osawaru *et al.,* 2015). Knowledge about genetic diversity and relationships among plants is an invaluable aid in plant breeding and classification. The variability among accessions is crucial to the maintenance, utilization and acquisition of germplasm resources (Koussao *et al*., 2014). Morphological markers are important tools in studying genetic diversity, phylogenetic and germplasm evaluation (Nair *et al.,* 2017). The knowledge of the presence and amount of genetic diversity in germplasm is fundamental to improvement for yield; assessment of variability in gene pool form the basis in plant breeding. Genetic variability in any breeding material is essential as it provides not only a basis for selection but also some vital information concerning the selection of diverse parents for use in a hybridization exercise (Saravati *et al*., 2018; Muhammad *et al*., 2019). Thus, the present study was carried out to evaluate the genetic variability and agro-morphological variation of sweet potato accessions and selected landraces from the National Root Crops Research Institute (NRCRI), Umudike and local farmers from the six states of South West, Nigeria.

MATERIALS AND METHODS

Plant materials

A total of thirty (30) sweet potato accessions were collected from six states (Oyo, Osun, Ondo, Ogun, Ekiti and Lagos), and the National Root Crop Research Institute (NRCRI), Umudike (Table 1).

Experimental Design

The experiment was laid out in a complete randomize design with four replicates. Thirty one (31) characters, comprising of 11 quantitative and 20 qualitative growth and yield traits were evaluated (Table 2).

Experimental location and planting method

An open field experiment was conducted at the nursery research farm, Department of Botany, University of Ibadan, Ibadan, Nigeria. The experimental field was cleared off bushes, plots marked out and ridges constructed. Planting was done on ridges of 6m long with distance between ridges of 1m. On each ridge, 9 cuttings of 30 cm were planted at a spacing of 60 cm. The fields were maintained by frequent weeding. Harvesting of the mature tuberous roots was done after 120 days after planting.

Morphological characterization

Morphological data were determined 90 days (vine and leaf characters) and 120 days (root characters) after planting based on the measurements of four replicates in the middle portion of the main stem according to the procedure described by Huaman (1991).

Statistical Analysis

Morphological data was subjected to multivariate analysis using SAS generalized linear model (GLM) software version 9.3. Means were separated by Duncan Multiple Range Test (DMRT) ($p \leq 0.05$). Person's correlation was used to determine the interrelationship between the agro-morphological characters.

interrelationship between the agro-morphological characters.

RESULTS

Mean Squares Variance for Eleven Quantitative Characters of 30 Sweet Potato Accessions

The analysis of variance showed highly significant variability ($p \leq 0.001$) among the sweet potato accessions for some traits such as mature leaf size, plant type, leaf petiole length, vine internode length, vine internode diameter, storage root diameter, storage root length and Storage Root Fresh Yield per Plant. However, significant variability ($p \leq 0.05$) among the accessions was observed for storage root dry yield per plant. Yet, high significance difference ($p \leq 0.01$) among the accessions was observed for individual storage root weight, while the accessions showed no significance difference ($p \geq 0.05$) for storage roots per plant (Table 3).

Growth and Yield Characters of 30 Sweet Potato Accessions

Table 4 presents the growth and yield characters of the 30 sweet potato accessions. There are variations across all accessions with respect to mature leaf size, plant type, leaf petiole length, vine internode length, vine internode diameter, storage root diameter, storage root length, storage root dry yield per plant, number of storage roots per plant, individual storage root weight and storage root fresh yield per plant.

The mature leaf size (MLS) of accession 10 (Anamo 9) is significantly higher ($p<0.05$) with mean value of 19.68 cm than other accessions. Accession 18 (UMUSP03) and accession 27 (AYT015) with mean values of 8.50 cm and 8.38 cm respectively had poor performance in respect to their mature leaf sizes. Again, accession 10 (Anamo 9) had the highest mean value of 370.63 cm for plant type (PT) and was significantly higher ($p<0.05$) than other accessions, while cm for plant type (PT) and was significantly higher ($p<0.05$) than other accessions, while accessions 26 (AYT012) and 27 (AYT015) had the least plant type. UMUSP01 (accession 19) has significantly higher ($p<0.05$) mean value of 20.00 cm than other accessions for leaf petiole length, while AYT012 (7.83 cm) performed very poorly. The vine internode length of OFSP (accession 1) with mean value of 12.00 cm was significantly higher than other accessions, while AYT015 again performed poorly in vine internode length. Accession 22 (8164) performed best (20.00 mm) in respect to vine internode diameter which was significantly higher than other accessions, while ERICA (accession 24) performed poorly in this character. The storage root diameter of THEO JOE (accession 28) has significantly higher mean value (5.70 mm) than other accessions, while AYT005 (accession 23) had the least mean value of 0.93 mm.

The storage root length of TIS87/0087 (accession 16) has significantly higher ($p<0.05$) mean value of 24.50 cm than other accessions. Anamo 4 (accession 5) and AYT005 (accession 23) with mean values 4.73 cm and 3.98 cm respectively had poor performances for this character. AYT002 (accession 17) has significantly higher ($p<0.05$) mean value of 295.50g than other accessions for storage root dry yield per plant, while AYT005 (accession 23) performed least for this character. The number of storage roots in TIS87/0087 (accession 16) was significantly higher with mean value of 7.00 than other accessions but not significantly different from THEO JOE (accession 28) with mean value of 6.25, while AYT005 (accession 23) performed poorly for this character. Anamo 13 (accession 14) with mean value of 175.38g has significantly higher ($p<0.05$) individual storage root weight, while AYT005 had the least performance for this character. Again, the storage root fresh yield per plant of Anamo 13 (accession 14) (822.50g) has significantly higher mean value than other accessions, while AYT005 (44.80 g) again performed poorly.Correlation

(44.80 g) again performed poorly.Correlation Coefficient of Growth and Yield Characters of 30 Sweet Potato Accessions

The result in Table 5 shows the correlation coefficient among 11 growth and yield characters of 30 sweet potato accessions at 95% level of significance $p \leq 0.05$. Storage root fresh yield per plant shows strong positive association between storage root dry yield per plant ($r= 0.71$), number of storage root ($r= 0.70$) and positive correlation with storage root length ($r= 0.55$). Storage root diameter had positive relationship with Storage root fresh yield per plant ($r= 0.55$), storage root length ($r= 0.55$) and number of storage root per plant ($r= 0.50$). Also, storage root length had a strong positive correlation with individual storage root weight ($r= 0. 63$). Storage root dry yield per plant had a positive relationship with number of storage roots per plant ($r= 0.55$).

Correlation Coefficient of the Qualitative Morphological Traits measured on 30 Sweet Potato Accessions

The result in Table 6 shows that the shape of central lobe accounted for a strong positive correlation with leaf lobe type ($r= 0.89$). General leaf outline had a strong positive association with shape of central lobe ($r= 0.83$), leaf lobe type ($r=0.81$) and a fair positive correlation with leaf lobe number ($r= 0.57$). Furthermore, leaf lobe number produced a strong positive correlation with leaf lobe type ($r=0.67$) and shape of central lobe ($r= 0.59$). Predominant skin colour had a strong positive association with intensity of predominant colour ($r= 0.73$) and secondary skin colour ($r=0.62$). Intensity of predominant skin colour had a strong positive correlation with secondary skin colour ($r= 0.73$). Predominant colour had a fair positive relationship with secondary flesh colour ($r= 0.55$).

Phenotypic variation in leaf, vine and root traits among the Sweet Potato Accessions

Phenotypic variation exhibited by the sweet potato accessions in leaf and vine characters is shown in Plate 1a-d. The accessions also showed variation in root characters including, root skin colour, root shape, root flesh colour, root surface defect etc. (Plate 2a-h).

Table 1: Collection site of 30 Sweet Potato Accessions and Landraces used for the study

S/No	Accession/ Local Name	Name of Donor/farmer	State/town sourced
1	OFSP	IITA	IITA/Ibadan
2	Anamo 1	Ogboade S.	Lagos/Ikorodu
3	Anamo 2	Ogboade S.	Lagos/Ikorodu
4	Anamo 3	Anwokhai M.	Lagos
5	Anamo 4	Ayodej. Y. R.	Osun/Iwo
6	Anamo 5	Isawumi T.	Oyo/Apata
7	Anamo 6	Isawumi T.	Oyo/Apata
8	Anamo 7	Adekpe S.	Oyo/Bashorun
9	Anamo 8	Akorada M.	Oyo/UI
10	Anamo 9	Adewole	Ogun/Ikenne
11	Anamo 10	Oluwasegun	Ikiti/Ise
12	Anamo 11	Akoroda M.	Oyo/UI
13	Anamo 12	Olabode M.	Ondo/ Owo
14	Anamo 13	Olabode O.	Ondo/ Akure
15	UMUSP04	NRCRI	Abia/NRCRI
16	TIS87/0087	NRCRI	Abia/NRCRI
17	AYT002	NRCRI	Abia/NRCRI
18	UMUSP03	NRCRI	Abia/NRCRI
19	UMUSP01	NRCRI	Abia/NRCRI
20	AYT004	NRCRI	Abia/NRCRI
21	LOURDES	NRCRI	Abia/NRCRI
22	8164	NRCRI	Abia/NRCRI
23	AYT005	NRCRI	Abia/NRCRI
24	ERICA	NRCRI	Abia/NRCRI
25	IRENE	NRCRI	Abia/NRCRI
26	AYT012	NRCRI	Abia/NRCRI
27	AYT015	NRCRI	Abia/NRCRI
28	THEO JOE	NRCRI	Abia/NRCRI
29	Anamo 14	Timilayo	Ogun/Ijebu Ode
30	Anamo 15	Olarenwaju S.	Ekti/Ifaki-Ekiti

Table 2: Morphological Characters Evaluated in Sweet Potato Accessions

S/No.	Morphological Descriptor	Morphological Character
1	**Leaf**	Immature leaf colour
		Mature leaf colour
		Leaf shape
		Mature leaf size
		Petiole length
		Petiole colour/pigment
		Type of leaf lobes
		Number of leaf lobes
		Shape of central lobe
		General leaf outline
2	**Vine**	Predominant vine colour
		Vine pigment
		Ground cover
		Hairiness
		Vine internode diameter
		Secondary vein colour
3	**Storage Root**	Storage root shape
		Storage root cortex thickness
		Root surface defects
		Storage root skin colour
		Predominant root skin colour
		Intensity of predominant root skin colour
		Secondary root skin colour
		Storage root relative range of dispersal
		Storage root flesh colour a. Predominant flesh colour b. Secondary flesh colour c. Distribution of secondary flesh colour

Table 3: Mean Squares Variance for Eleven Quantitative Characters of 30 Sweet Potato Accessions

Source of Variation	df	MLS	PT	LPL	VIL	VID	SRD	SRL	SRDY	NSR	ISRW	SRFY
Accession	29	30.09***	37125.07***	31.76***	17.16***	56.51***	6.19***	123.75***	14712.13*	6.77^{ns}	3851.90**	**152869.31*****
Replicate	3	6.98	4750.96	2.53	0.72	9.39	1.40	12.96	7055.74	11.70	862.62	**171437.42**
Error	87	2.70	5233.63	4.80	2.53	5.54	1.68	27.04	6943.56	7.06	1636.15	**60338.52**
Corrected Total	119											

*significant at $p \leq 0.05$; ** highly significant at $p \leq 0.01$; *** highly significant at $p \leq 0.001$

MLS= Mature leaf size; **PT**= Plant Type; **LPT**= leaf petiole length; **VIL**= vine internode length; **VID**= Vine internode Diameter; **SRD**= Storage Root Diameter; **SRL**= Storage Root Length; **SRDY**= Storage Root Dry Yield per Plant; **NSR**= Number of storage roots per plant; **ISRW**= Individual Storage Root Weight; **SRFY**= Storage Root Fresh Yield per Plant.

Table 4: Growth and Yield Characters of 30 Sweet Potato Accessions

ACCESSION	MLS (cm)	PT (cm)	LPL (cm)	VIL (cm)	VID (mm)	SRD (mm)	SRL (cm)	SRDY (g)	NSR (g)	ISRW (g)	SRFY (g)
1	16.18^{bcd}	334.75^{ab}	13.00^{cdefg}	12.00^{a}	10.50^{efghi}	1.80^{ef}	13.50^{defgh}	66.28^{cdef}	2.50^{ab}	70.78^{bcdefg}	177.60^{ef}
2	16.03^{bcde}	297.25^{abc}	12.00d^{efgh}	5.35^{defghijk}	8.75^{fghijk}	2.15^{def}	14.63^{cdefgh}	74.98^{bcdef}	3.00^{ab}	58.75^{cdefg}	171.70^{ef}
3	16.63^{bcd}	273.75^{abcd}	13.75^{bcde}	3.88^{hijk}	12.25^{bcdef}	1.90^{ef}	14.50^{cdefgh}	97.70^{bcdef}	4.00^{ab}	42.25^{efg}	204.80^{ef}
4	16.35^{bcd}	240.00^{bcdef}	9.55^{ghi}	6.70^{cdef}	9.00^{fghijk}	2.95^{bcdef}	10.10^{fghi}	119.38^{bcdef}	4.00^{ab}	73.90^{bcdefg}	346.80^{bcdef}
5	16.40^{bcd}	285.63^{abc}	14.40^{bcde}	9.50^{b}	7.25^{hijki}	1.75^{ef}	4.73^{i}	68.85^{cdef}	6.00^{ab}	52.48^{defg}	215.30^{ef}
6	16.30^{bcd}	126.20^{fghi}	12.93^{cdefg}	3.90^{ghijk}	9.50^{fghij}	1.98^{ef}	16.85^{abcdef}	73.28^{bcdef}	3.50^{ab}	85.53^{bcdefg}	252.00^{def}
7	15.63^{bcdef}	178.00^{cdefgh}	11.50^{efgh}	6.63^{cdefg}	8.50^{fghijk}	2.85^{cdef}	18.63^{abccdef}	77.64^{bcdef}	3.25^{ab}	93.55^{bcdef}	259.00^{def}
8	14.83^{cdef}	247.00^{bcde}	9.18^{hi}	3.65^{ijk}	5.25^{kl}	2.38^{cdef}	19.13^{abcde}	84.65^{bcdef}	3.25^{ab}	95.05^{bcdef}	272.00^{def}
9	13.38^{efg}	291.25^{abc}	13.50^{bcdef}	6.40^{cdefgh}	8.75^{fghijk}	3.18^{bcde}	6.40^{ghi}	98.16^{bcdef}	3.75^{ab}	74.70^{bcdefg}	361.50^{bcdef}
10	19.68^{a}	370.63^{a}	14.38^{bcde}	5.88^{defghi}	8.25^{ghijk}	3.30^{bcde}	19.10^{abcde}	94.11^{bcdef}	2.75^{ab}	123.60^{abc}	345.30^{bcdef}
11	15.90^{bcde}	323.25^{ab}	11.63^{defgh}	4.93^{efghijk}	7.75^{ghijkl}	5.10^{ab}	12.38^{defghi}	84.34^{bcdef}	2.75^{ab}	85.03^{bcdefg}	314.00^{cdef}
12	16.13^{bcde}	310.00^{ab}	15.00^{bcde}	7.63^{bcd}	8.25^{ghijk}	4.33^{abcd}	20.25^{abcd}	160.20^{bcde}	5.50^{ab}	112.00^{bcde}	597.80^{abcde}
13	16.98^{bcd}	297.75^{abc}	12.00^{defg}	4.25^{efghijk}	11.00^{defgh}	2.95^{cdef}	11.13^{efghi}	80.90^{bcdef}	3.25^{ab}	105.88^{bcdef}	290.00^{def}
14	16.88^{bcd}	278.58^{abc}	13.03^{cdefg}	5.30^{defghijk}	8.00^{ghijkl}	3.65^{abcde}	23.50^{ab}	214.23^{ab}	4.25^{ab}	175.38^{a}	822.50^{a}
15	13.35^{efg}	153.00^{efghi}	15.38^{bcd}	6.88^{cde}	14.00^{bcde}	1.50^{ef}	15.75^{abcdef}	193.63^{abcd}	4.75^{ab}	106.88^{bcdef}	712.30^{abc}
16	14.30^{defg}	340.95^{ab}	15.93^{bc}	5.65^{defghij}	15.25^{bc}	4.50^{abc}	24.50^{a}	202.63^{abc}	7.00^{a}	137.90^{ab}	731.30^{ab}
17	15.38^{bcdef}	141.25^{efghi}	15.33^{bcd}	3.63^{ijk}	14.75^{bcd}	5.13^{ab}	14.73^{bcdefg}	295.50^{a}	5.25^{ab}	90.00^{bcdefg}	459.80^{abcdef}
18	8.50^{i}	74.50^{hi}	8.75^{hi}	2.95^{jk}	6.50^{ijkl}	3.10^{bcdef}	6.25^{ghi}	80.58^{bcdef}	3.50^{ab}	63.45^{cdefg}	225.50^{def}
19	14.93^{cdef}	107.00^{ghi}	20.00^{a}	4.25^{efghijk}	13.50^{bcde}	4.48^{abc}	13.75^{defgh}	109.60^{bcdef}	6.00^{ab}	92.93^{bcdef}	588.80^{abcde}
20	14.30^{defg}	248.75^{abcde}	16.88^{ab}	4.43^{efghijk}	13.75^{bcde}	3.05^{bcdef}	17.00^{abcdef}	88.94^{bcdef}	4.25^{ab}	73.98^{bcdefg}	320.00^{bcdef}
21	15.83^{bcde}	159.00^{defghi}	11.75^{defgh}	6.38^{cdefgh}	5.00^{kl}	3.48^{bcde}	14.50^{cdefgh}	52.10^{def}	3.00^{ab}	76.08^{bcdefg}	180.50^{ef}
22	15.75^{bcde}	98.50^{hi}	16.90^{ab}	4.25^{efghijk}	20.00^{a}	4.25^{abcd}	16.13^{abcdef}	60.25^{cdef}	2.75^{ab}	75.23^{bcdefg}	196.30^{ef}
23	10.50^{hi}	150.25^{efghi}	12.13^{defgh}	4.50^{efghijk}	15.75^{b}	0.93^{f}	3.98^{i}	13.83^{f}	1.50^{b}	20.95^{g}	44.80^{f}
24	11.73^{gh}	182.03^{cdefgh}	11.50^{efgh}	4.63^{efghijk}	4.25^{l}	1.88^{ef}	9.98^{fghi}	56.13^{def}	2.50^{ab}	67.75^{bcdefg}	179.00^{ef}
25	17.08^{bcd}	120.50^{fghi}	11.65^{defgh}	4.00^{fghijk}	11.50^{cdefg}	3.38^{bcde}	18.48^{abcdef}	41.50^{ef}	3.50^{ab}	40.80^{fg}	135.50^{cf}
26	9.75^{hi}	53.65^{i}	7.83^{i}	3.28^{ijk}	5.25^{kl}	3.25^{bcde}	18.60^{abcdef}	73.38^{bcdef}	3.75^{ab}	65.30^{cdefg}	277.30^{def}
27	8.38^{i}	53.83^{i}	9.05^{hi}	2.88^{k}	6.50^{ijkl}	2.35^{cdef}	10.93^{efghi}	66.26^{cdef}	3.75^{ab}	83.93^{bcdefg}	237.30^{def}
28	13.03^{fg}	343.83^{ab}	13.48^{bcdef}	8.70^{bc}	6.00^{jkl}	5.70^{a}	22.75^{abc}	184.38^{abcde}	6.25^{a}	101.53^{bcdef}	647.30^{abcd}
29	18.00^{ab}	220.13^{bcdefg}	10.00^{fghi}	3.63^{ijk}	8.00^{ghijkl}	1.85^{ef}	5.88^{hi}	64.69^{cdef}	2.50^{ab}	54.40^{cdefg}	209.50^{ef}
30	17.63^{abc}	318.75^{ab}	16.75^{ab}	6.50^{cdefgh}	10.25^{efghi}	5.10^{ab}	19.25^{abcde}	107.02^{bcdef}	4.75^{ab}	114.78^{abcd}	443.50^{abcdef}

Means with the same Superscripts within a column are not significantly different at $p \geq 0.05$

MLS= Mature leaf size; **PT**= Plant Type; **LPT**= leaf petiole length; **VIL**= vine internode length; **VID**= Vine internode Diameter; SRD= Storage Root Diameter; **SRL**= Storage Root Length; **SRDY**= Storage Root Dry Yield per Plant; **NSR**= Number of storage roots per plant; **ISRW**= Individual Storage Root Weight; **SRFY**= Storage Root Fresh Yield per Plant.

1= **OFSP**, **2**=Anamo 1, **3**= Anamo 2, **4**= Anamo 3, **5** =Anamo 4, **6** =Anamo 5, **7** = Anamo 6, **8** =Anamo7, **9**=Anamo 8, **10** =Anamo 9, **11** =Anamo 10, **12** = Anamo 11, **13** =Anamo 12, **14** =Anamo 13 , **15** = UMUSP04, **16**= TIS87/0087, **17** =AYT002, **18** =UMUSP03, **19** =UMUSP01, **20** =AYT004, **21** =LOURDES, **22** =8164, **23**=AYT005, **24**=ERICA, **25** =IRENE , **26**=AYT012, **27** =AYT015, **28** =THEO JOE, **29** =Anamo 14, **30** =Anamo 15.

Table 5: *Correlation Coefficient of Growth and Yield Characters on the 30 Sweet Potato Accessions*

Correlation	MLS	PT	LPL	VIL	VID	SRD	SRFY	SRL	SRDY	NSR	ISRW
MLS											
PT	0.44										
LPL	0.27	0.22									
VIL	0.24	0.44	0.15								
VID	0.15	-0.06	0.51	-0.07							
SRD	0.06	0.10	0.24	0.03	0.07						
SRFY	0.06	0.16	0.22	0.11	0.08	**0.55***					
SRL	0.20	0.10	0.13	0.06	0.01	**0.55***	**0.50***				
SRDY	0.07	0.13	0.18	0.04	0.14	0.41	**0.71****	0.42			
NSR	-0.04	0.11	0.13	0.14	0.04	**0.50***	**0.70****	0.40	**0.55***		
ISRW	0.23	0.12	0.08	0.14	-0.05	0.45	0.63	**0.63****	0.45	0.25	

MLS= Mature leaf size, **PT**= Plant type, **LPL**= Leaf Petiole length, **VIL**= Vine internode Length, **VID**= Vine internode diameter, **SRD**= Storage Root Diameter, **SRFY**= Storage Root Fresh Yield per Plant, **SRL**= Storage Root Length, **SRDY**= Storage Root Dry Yield per Plant, **NSR**= Number of Storage Root per Plant, **ISRW**= Individual Storage Root Weight

Table 6: *Correlation Coefficient of the Qualitative Morphological Traits measured on 30 Sweet Potato Accessions*

Correlation	ILC	MLC	GC	GOL	LLN	SCL	LLT	PP	ALVP	VTP	PVC	SVC	SRSD	SRCT	PSC	IPSC	SSC	PFC	SFC	SRS
ILC																				
MLC	0.25																			
GC	-0.16	0.00																		
GOL	-0.01	-0.02	-0.45																	
LLN	0.14	0.18	-0.34	0.57*																
SCL	0.05	-0.02	-0.41	**0.83****	0.59*															
LLT	0.02	-0.07	-0.41	**0.81****	**0.67****	**0.89****														
PP	0.23	0.31	-0.14	0.28	0.37	0.26	0.33													
ALVP	0.01	0.46	-0.04	0.12	0.02	0.06	0.07	0.42												
VTP	0.42	-0.10	0.05	-0.04	-0.10	-0.12	-0.20	-0.15	-0.25											
PVC	0.03	0.07	-0.05	0.38	0.35	0.33	0.45	0.54	0.46	-0.29										
SVC	0.23	0.09	-0.05	0.08	-0.04	0.08	-0.02	0.02	0.14	0.20	0.11									
SRSD	0.03	0.21	0.09	-0.28	0.12	-0.20	-0.12	-0.07	0.28	0.08	0.05	0.25								
SRCT	-0.09	-0.24	0.25	-0.05	-0.30	-0.19	-0.05	0.01	0.18	0.04	0.18	0.31	0.09							
PSC	-0.17	-0.04	-0.16	0.24	0.14	0.24	0.42	0.22	0.22	-0.42	0.43	0.03	-0.06	0.18						
IPSC	-0.49	-0.23	-0.11	0.12	-0.01	0.08	0.23	-0.12	-0.04	-0.33	0.13	-0.04	0.08	0.12	**0.73****					
SSC	-0.50*	-0.14	0.03	0.02	-0.13	-0.09	0.03	-0.13	-0.04	-0.35	-0.01	-0.08	-0.06	0.38	**0.62****	**0.73****				
PFC	0.03	-0.19	-0.02	-0.15	-0.02	-0.06	0.01	0.30	0.28	-0.33	0.43	-0.01	0.13	0.04	0.25	0.07	-0.16			
SFC	-0.01	-0.09	-0.13	-0.11	0.01	-0.05	0.02	0.07	0.39	-0.25	0.26	0.05	0.29	-0.04	0.38	0.34	-0.09	0.55*		
SRS	0.43	0.30	-0.14	-0.21	0.01	-0.15	-0.12	0.23	0.36	0.01	-0.07	0.07	0.36	-0.17	-0.17	-0.20	-0.40	0.13	0.31	

Correlation coefficient at 95% level of significance ($p \leq 0.05$)

ILC= Immature leaf colour; **MLC**= Mature leaf colour; **GC**=Ground Cover; **GOL**= General outline of the leaf; **LLN**= Leaf Lobes Number; **SCL**= Shape of central lobe; **LLT**= Leaf Lobe type; **PP**= Petiole Pigmentation; **ALVP**= Abaxial Leaf vein Pigmentation; **VTP**= Vine Tip Pubescence; **PVC**= Predominant Vine Colour; **SVC**= Secondary vine Colour; **SRSD**= Storage Root Surface Defect; **SRCT**= Storage Root Cortex Thickness; **PSC**= Predominant Skin Colour; **IPSC** = Intensity of Predominant skin colour; **SSC**= Secondary Skin Colour; **PFC**= Predominant Flesh Colour; **SFC**= Secondary Flesh Colour and **SRS**= Storage Root Shape

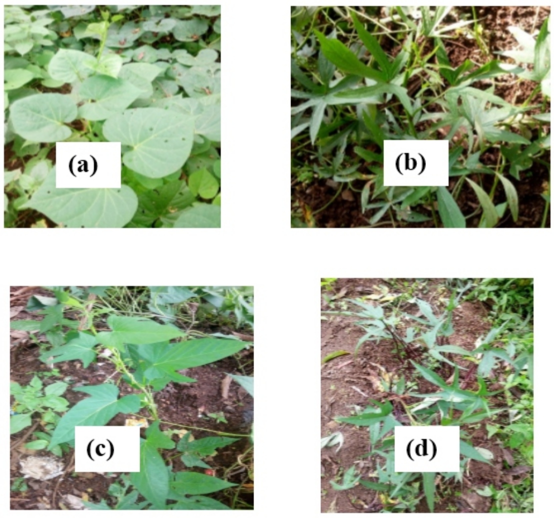

Plate 1a-d: Photographs of:

(a) Cordate (general outline of leaf), Tooth (shape of central leaf lobe) in Anoma 1 (accession 2)

(b) Almost divided (general outline of leaf), Oblanceolate (shape of central leaf lobe) in LOURDES (accession 21)

(c) Haste (general outline of leaf), Semi-elliptic (shape of central leaf lobe) in Anamo 6 (accession 7)

(d) Almost divided (general outline of leaf), and Linear (narrow) (shape of central leaf lobe) in IRENE (accession 25)

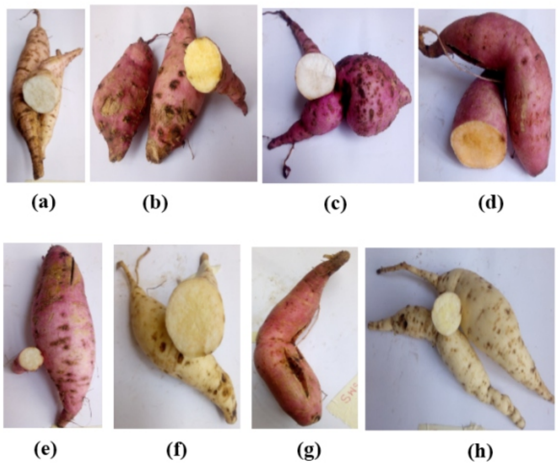

Plate 2a-h: Photographs of:

(a) Pink (Predominant skin colour), Cream (Predominant flesh colour) and oblong (shape of root) of TIS87/0087 (accession 16)

(b) Purple-red(Predominant skin colour), pale yellow (Predominant flesh colour) and alligator-like Skin (root surface defect) of UMUSP01 (accession 19)

(c) Dark-purple(Predominant skin colour), white (Predominant flesh colour) and Horizontal constrictions (root surface defect) of AYT002 (accession 17)

(d) Purple-red (Predominant skin colour) and pale yellow (Predominant flesh colour) of IRENE (accession 20)

(e) Horizontal constrictions (root surface defect) in 8164 (accession 22)

(f) Cream (Predominant skin colour), Cream (Predominant flesh colour) and Obovate (shape of root) of AYT004 (accession 20)

(g) Longitudinal grooves (root surface defect) IRENE (accession 25)

(h) Cream (Predominant skin colour), Cream (Predominant flesh colour) and Elliptic (root surface defect) of Anamo 2 (accession 3)

DISCUSSION

Highly significant variation was observed among the sweet potato accessions for all the traits evaluated. The presences of high variability among the accessions indicates that genetic improvement of the crop through selection of different agro-morphological traits could be promising. This corroborates the findings of Karuri *et al.* (2010), and Alfred *et al.* (2019), who reported the presence of highly significance variability among sweet potato accessions in Kenya and North Central Nigeria respectively.

The study distinguished sweet potato accessions based on mature leaf length, plant type, leaf petiole length, vine internode length, root skin colour and root flesh colour. The skin colour of the sweet potato in this research were white, light purple and purple which is in line with the findings of Afuape *et al.* (2011), who noted that colour of skin and flesh of sweet potato constitutes an important factor in the choice of sweet potato by farmers and consumers. Odebode *et al.* (2008), also pointed out the significance of the skin and flesh colour of sweet potato to its marketability.

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Accessions with promising yield characteristics were identified in this study. They possessed good yield traits as could be seen in their high individual storage root weight and storage root fresh yield per plant, number of storage roots, and storage root diameter. This is in accordance with the results of Mbithe, *et al*. (2016), and Mwanga *et al*. (2017), who reported good yield characters in their study of sweet potato accessions and landraces.

Characters with significant positive correlation with tuber yield show that any increase in these characters could result in an increase in yield of sweet potato and would be suitable for selection to improve the crop yield. The strong positive correlation of storage root fresh yield per plant with storage dry yield per plant and number of storage root indicated that they could be used to predict yield; and selection for these characters will helpful in improving the yield of the crop. This agrees with the findings of Bhattacharya (2001), and Gupta *et al*. (2018), who reported strong positive correlations between tuber length, tuber weight and yield.

The high significant correlation observed between predominant skin colour and intensity of predominant skin colour; between shape of central lobe and leave lobe type indicates the presence of positive relationship between the traits. This is in agreement with the report of Muhammad *et al.* (2019), who opined that improvement of one of these traits will lead to the improvement of the other traits in the same direction.

CONCLUSION

The accessions from Umudike germplasm and selected landraces from the south west Nigeria used in this study had significant genetic variability in all the growth, agronomic and yield characters. Accession 14 (ANAMO13), accession 16 (TIS87/0087), accession 28 (THEO JOE) and accession 19 (UMUSP01) had higher growth and yield traits, thus, could be considered for further breeding programme. Storage root fresh yield, storage root dry yield, storage root diameter and number of storage roots per plant show positive correlation among the accessions. These characters could be used for future breeding activity. There is need for farmers and plant agronomists to harness the great variability identified in this study for improvement of sweet potato in Nigeria to enhance food security.

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