NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 52 Number 1, April 2021 Pg. 17-24
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org
Creative Commons User License CC:BY

CHARACTERIZATION OF COCONUT ACCESSIONS FROM SELECTED GERMPLASM USING MORPHOLOGICAL TRAITS

[1]Odufale, O.O., [2]Oluwaranti, A.,[1]Odiowaya, G., [1]Ahanon, M.J., [1]Agho, C., [1]Okoye, M.N., [1]Ozurumba, C. J. and [1]Yusuf A.O.

[1]Plant Breeding Division, Nigerian Institute for Oil Palm Research Benin-City, Nigeria
[2]Department of Crop Production and Protection, Obafemi Awolowo University Ile-Ife
Corresponding Authors' email: odufaleoladapo@gmail.com

Abstract
Characterization is fundamental for successful plant breeding programme. Genetic diversity among the selected coconut accessions had not been studied. Hence, this study characterized and identified outstanding coconut accessions. Tall coconut accessions from four germplasm collections; Badagry (BT), South East (ST), Kwara (KT1) and Kogi (KT2) were investigated in the NIFOR substation Badagry, using morphological traits. Percentage of fruit yield components, principal component analysis (PCA) and cluster analysis of morphological traits were evaluated. Coconut water volume (161cm^3) and fresh meat weight (0.32kg) was highest in the BT accessions, while coconut water was lowest (92 cm^3) in the ST accessions. KT2 accessions had higher husk weight (0.66kg) which was significantly different from other accessions. PCA indicated that three PC axes explained 80.52% of the total variations among the accessions. The fruit traits accounted for 52.84%, while the vegetative traits accounted for 21.58%. This indicated high variability in the fruit traits than in the vegetative traits. High values of Eigen vector were posed by split nut weight (0.973), nut weight (0.972), nut circumference (0.931), fresh meat weight (0.927), water volume (0.872), shell weight (0.841), nut length (0.857), copra weight (0.812), fruit circumference (0.804) and fruit weight (0.662). Cluster analysis partitioned the accessions into four main clusters. The grouping of the accessions did not follow a particular pattern. Cluster III had members from two locations, while the other clusters had members across the locations. Cluster III had the highest fruit weight, fruit length, fruit circumference, nut weight, nut length, nut circumference, split nut weight and coconut juice than the other clusters, while clusters II which had the highest sugar level. The accessions studied had high genetic variability for selection and breeding purposes which can be exploited to produce hybrid coconut.

Keywords: Accessions, characterization, genetic diversity, morphological traits

Introduction

The coconut palm is a ubiquitous sight in tropical and subtropical regions 23°North and South of the equator (Chan and Elvitch, 2006). In Nigeria, an estimated 15,000 hectares of land is under coconut cultivation with 2million coconut stands in the country and mostly in the coastal areas of Lagos State and the Delta areas of Rivers State. Besides the cultivated area, an estimated 1.2 million hectares have been identified as suitable for coconut cultivation (Odewale *et al.,* 2012; Osemwegie *et al.*, 2016). In Africa, the crop is found mostly along the sandy shores of the Atlantic coastlines where it occurs as dense groves, in the riverine areas of the delta regions and to a less extent in the inland forest zone. More than 90% of the Nigeria's coconut belt is a continuation of the plantations or groves along the West African Coast, running from Cote d'Ivoire and southwards through Ghana, Togo and Republic of Benin to Lagos State in Nigeria, where it continues in a one-kilometer wide strip of groves inland along some 200 kilometers of coastline (Odewale *et al.,* 2012).

Evaluation and characterization of conserved material in a germplasm repository is a prerequisite for the identification of different accessions that possess important features which will be useful in crop breeding and varietal development. Diverse germplasm for important traits can then be used for the exploitation of hybrid vigour for important traits (Perrera *et al.,* 2014). In Coconut, characterizing genetic resources is a pre-requisite for crop improvement initiatives as the breeding efforts are cumbersome owing to its perennial nature. Morphological traits such as fruit component (Ekanayake *et al.,* 2010; Geethanjali, 2014), vegetative traits (Odewale *et al.*, 2014b, Ahanon *et al.,* 2016) have been used to evaluate genetic diversity in coconut from various regions. A wide morphological and physiological variation of coconut has been described at both world-wide and regional levels (Ashburner *et al.*, 1997; Zizumbo-Villarreal and Piñero, 1998).

Evaluation of morphological/phenotypic traits is direct, cost effective and easy to observe even though it may be influenced by environmental factors (Perera *et al*., 2014).

In Nigeria, there is paucity of the awareness of the importance of coconut palm thus, making it an underutilized crop. Information is scanty on the existing variability in coconut in Nigeria. Odewale *et al.* (2014a) reiterated the importance of knowledge on genetic diversity prior to development of crop species. Phenotypic traits will be effective in identifying the genetic diversity that exists among coconut accessions from coconut marginal areas in Nigeria which has not been studied, hence this study. This study was therefore conducted to characterize collected coconut accessions from marginal locations using morphological traits, identify outstanding accessions with desired fruit traits that can be used in developing improved coconut cultivars in Nigeria.

Materials and Methods

This research study was conducted at the coconut experimental station of the Nigerian Institute for Oil Palm Research (NIFOR) located in Badagry, Lagos State (Lat. 6'49°, Long. 2.96°). The coconut palm germplasm collections were of the tall variety from four coconut locations in Nigeria. They were evaluated at the NIFOR substation in Badagry. Adult palms at steady fruiting stage were used for this study. From these collections, seventy-eight palms were selected [Badagry Tall (BT) – 22, South East Tall (ST) – 17, Kwara Tall (KT1) – 20 and Kogi Tall (KT2) – 19]. Data were taken over two years; 2016 and 2018.

Data Collection

The traits observed were as described by Ekanayake (2010). Two sets of morphological traits were measured from each of the palm accessions across the collection of accessions in the germplasm; vegetative and fruit traits. For the vegetative traits; crown diameter (m), petiole length (m), leaflet length (m) and leaf spread (m) were evaluated, while the fruit traits evaluated were fruit weight (kg), fruit length (cm), fruit circumference (cm) at the equator, husk weight (kg), husk thickness (mm), nut weight (kg), nut length (cm), nut circumference (cm) at the equator, split nut weight (kg), coconut water volume (cm^3), fresh meat weight (kg) and copra weight (g/nut). For the fruit traits, five fruits were selected randomly per accession for evaluation and the average of the traits evaluated represented the accessions.

Statistical Analyses

Data collected were summarized and analyzed using one-way analysis of variance general linear models and mean separation was by Duncan's multiple range test using statistical software package SAS version 7. The software, Statistical Package for Social Sciences (SPSS) was used for evaluating descriptive statistics and Principal Component Analysis (PCA). PCA was used to reduce the data into few unrelated principal axes to obtain the contributions of the morphological; fruit and vegetative traits to the variations observed among the accessions, identify groups of accessions that have desirable traits for breeding purposes and enlightening the patterns of variation in the germplasm collections. Traits with principal components (PCs) of Eigen values ≥1.0 were selected, following Odewale *et al.* (2014a). Paleontological Statistical Software (PAST) was deployed to conduct Cluster analysis which was used to group the accessions using the traits that contributed more to the variations among the accessions. This is to obtain accessions with similar characteristics and meaningful information of genetic diversity among the accessions.

Results and Discussion

Mean of fruit yield components of the assessions collected from the the four locations evalauted at the NIFOR coconut substation Badagry

Among the accessions evaluated as shown in Table 1, the BT accessions had highest mean value for water volume (161.180cm^3) which was significantly different from other accessions, while the ST accessions had the lowest water volume (92.330cm^3), though not significantly different from those of KT1 (108.430cm^3) and KT2 (113.350cm^3). Also, the BT accessions showed highest mean value for fresh meat weight (0.318kg), which was significantly different from those of the ST (0.252kg), KT1 (0.247kg) and KT2 (0.244kg) accessions, but were not significantly different from one another. The mean value for shell weight in the BT accessions was also the highest among the accessions evaluated (0.144kg) and was significantly different from those of the ST (0.121kg) and KT1 (0.126kg), but not significantly different from those of the KT2 accessions (0.131kg). However, the KT2 accessions had the highest value for husk weight (0.656kg), which was significantly different from other three accessions. The shell weight from this study is in line with the shell weight or elite palms in Sri-Lanka germplasm study (Perera *et al.,* 2014). However, water volume and husk weight fell short of the value from same study in Sri-Lanka because the fruit weights of the Sri-Lanka varieties were bigger and larger.

Table 1: Mean of fruit yield components of the assessions collected from the four locations evalauted in 2018 at the NIFOR coconut substation Badagry

	HWT(kg)	WV(cm^3)	FMW(kg)	SW(kg)
BT	0.444^b	161.180^a	0.318^a	0.144^a
ST	0.399^b	92.330^b	0.253^b	0.121^b
KT1	0.490^b	108.430^b	0.247^b	0.126^b
KT2	0.656^a	113.350^b	0.244^b	0.131^{ab}
LSD	**±0.122**	**±34.528**	**±0.037**	**±0.016**

N.B: Means with the same letters along the columns are not significantly different at $P \leq 0.05$
HWT = Husk weight, WV = Water volume, FMW = Fresh meat weight, SW = Shell weight

Among the fruit yield traits evaluated in the BT accessions, the highest amount of coefficient of variability existed in the volume of coconut water (20.928%), and there were 16.735%, 10.652% and 10.062% coefficient of variability for husk weight, fresh meat weight and shell weight respectively among the coconut accessions in this group. The ANOVA model used was able to explain 84.0%, 78.7%, 77.6% and 82,3% variability for husk weight, coconut water volume, fresh meat weight and shell weight respectively, among the BT accessions (Table 2).

Table 2: Means of the fruit yield traits of the Badagry Tall (BT) accessions at the NIFOR substation, Badagry

Accession Number	HWT	WV	FMW	SW
1131	0.721^a	149.60^{cd}	0.315^{efgh}	0.184^{bc}
1060	0.610^{bc}	165.20^c	0.304^{efgh}	0.139^d
1061	0.503^{dce}	222.40^{ab}	0.392^{abc}	0.170^3
1056	0.288^i	85.20^f	0.279^{ghi}	0.096^g
987	0.372^{fghi}	188.60^{bc}	0.339^{def}	0.145^d
545	0.447^{defg}	95.33^{ef}	0.280^{ghi}	0.130^{de}
382	0.430^{defgh}	138.00^{cde}	0.275^{hi}	0.127^{def}
622	0.501^{dce}	270.00^a	0.411^{ab}	0.193^{ab}
505	0.371^{fghi}	143.00^{cde}	0.303^{efgh}	0.138^d
376	0.711^{ab}	270.00^a	0.4289^a	0.213^a
753	0.509^{cd}	146.60^{cde}	298^{efgh}	0.142^d
768	0.528^{cd}	140.00^{cde}	0.316^{efgh}	0.175^{bc}
386	0.335^{ghi}	270.00^a	0.395^{ab}	0.139^d
1057	0.328^{ghi}	75.00^f	0.206^j	0.110^{efg}
305	0.459^{def}	158.00^c	0.334^{defg}	0.139^d
422	0.389^{efghi}	221.67^{ab}	301^{efgh}	0.134^d
385	0.319^{hi}	180.00^{bc}	0.344^{cde}	0.140^d
373	0.294^i	75.25^f	0.232^{ij}	0.098^g
384	0.279^i	105.00^{def}	0.320^{efgh}	0.107^{fg}
280	0.294^i	178.20^{bc}	0.373^{bcd}	0.140^d
662	0.369^{fghi}	188.00^{bc}	0.284^{fghi}	0.138^d
1146	0.819^a	87.60^f	0.241^{ij}	0.150^d
R^2	0.840	0.787	0.776	0.823
CV	16.735	20.928	10.652	10.062
LSD	±0.074	±20.657	±0.026	±0.009

N.B: Means with the same letters along the columns are not significantly different at $P \leq 0.05$
HWT = Husk weight, WV = Water volume, FMW = Fresh meat weight, SW = Shell weight

The CV was highest for the coconut water volume when compared with other components of yield evaluated across the locations. This indicated a high variability of coconut water volume in the accessions even within each of the groups. The variability was highest among the KT1 accessions (33.351%) and lowest for the ST accessions (23.703%), while the BT and KT2 accessions had 20.928% and 24.517% respectively. This can be explained by the generally low volume and sparse dispersal around the mean in the volume of coconut water in the ST accessions when compared with other accessions, Tables 2-5. However, in contrast to the volume of coconut water, shell weight had the least variability across the locations (10.062, 9.566, 11.534 and 10.021 for the BT, ST, KT1 and KT2 accessions respectively). This implies that there is low variations in the shell weight within the locations, except in the KT1 accessions which differ from other locations (Table 2-5). There was low a in the fresh meat weight in both BT (10.652) and KT2 (9.897) accessions when compared with the ST (17.586) and KT1 (13.499) (Tables 2-5).

Table 3: Means of the fruit yield traits of the South East Tall (ST) accessions at the NIFOR substation, Badagry

Accession Number	HWT	WV	FMW	SW
2	0.450^{b}	84.000^{c}	0.264^{b}	0.120^{bcde}
3	0.394^{bc}	87.000^{c}	0.383^{a}	0.162^{a}
5	0.369^{cd}	47.000^{de}	0.215^{bcd}	0.118^{cdef}
7	0.258^{fgh}	140.000^{b}	0.356^{a}	0.101^{f}
8	0.313^{cdef}	52.400^{de}	0.204^{bcd}	0.112^{def}
43	0.287^{efg}	92.200^{c}	0.236^{bc}	0.113^{def}
114	0.366^{cde}	51.400^{de}	0.190^{cd}	0.112^{def}
117	0.380^{bc}	84.600^{c}	0.227^{bcd}	0.121^{bcd}
94	0.342^{cde}	47.670^{de}	0.167^{d}	0.113^{def}
148	0.228^{gh}	53.600^{de}	0.228^{bcd}	0.103^{ef}
152	0.341^{cde}	137.000^{b}	0.271^{b}	0.135^{b}
196	0.294^{defg}	76.800^{cd}	0.207^{bcd}	0.104^{def}
250	0.389^{bc}	43.000^{e}	0.219^{bcd}	0.103^{ef}
258	0.577^{a}	51.000^{de}	0.272^{b}	0.116^{cdef}
295	0.386^{bc}	43.600^{e}	0.264^{b}	0.130^{bc}
296	0.201^{h}	38.250^{e}	0.220^{bcd}	0.108_{def}
205	0.362^{cde}	98.500^{c}	0.261^{b}	0.167^{a}
R^2	0.811	0.851	0.711	0.766
CV	14.966	23.703	17.586	9.566
LSD	±0.039	±14.120	±0.032	±0.008

N.B: Means with the same letters along the columns are not significantly different at $P \leq 0.05$
HWT = Husk weight, WV = Water volume, FMW = Fresh meat weight, SW = Shell weight

Table 4: Means of the fruit yield traits of the Kwara Tall (KT1) accessions at the NIFOR substation, Badagry

Accession Number	HWT	WV	FMW	SW
2	0.254^{g}	60.400^{efg}	0.206^{ghi}	0.090^{hi}
4	0.282^{fg}	107.400^{bcde}	0.186^{i}	0.096^{hi}
5	0.391^{def}	139.500^{abcd}	0.239^{defgh}	0.127^{def}
6	0.261^{fg}	129.abcd000	0.226^{efghi}	0.121^{efg}
7	0.427^{de}	171.000^{a}	0.274^{bcde}	0.153^{ab}
8	0.430^{de}	86.800^{defg}	0.250^{cdefg}	0.106^{gh}
14	0.461^{d}	60.000^{efg}	0.195^{hi}	0.092^{hi}
15	0.712^{b}	37.500^{g}	0.182^{ji}	0.096^{hi}
21	0.738^{b}	$152,800^{abc}$	0.290^{bc}	0.135^{bcde}
28	0.725^{b}	109.200^{bcde}	0.255^{bcdef}	0.166^{a}
32	0.320^{efg}	139.800^{abcd}	0.300^{bc}	0.118^{efg}
44	0.386^{defg}	72.400^{efg}	0.240^{defgh}	130^{cde}
46	0.312^{efg}	159.400^{ab}	0.301^{b}	0.137^{bcde}
57	0.578^{c}	175.000^{a}	0.271^{bcde}	0.164^{a}
60	0.376^{defg}	68.800^{efg}	0.274^{bcde}	0.155^{ab}
97	0.658^{bc}	101.800^{cdef}	0.263^{bcdef}	0.142^{bcd}
100	0.652^{bc}	139.600^{abcd}	0.276^{bcd}	0.156^{ab}
102	0.340^{defg}	48.500^{fg}	0.216^{fghi}	0.109^{fgh}
105	0.628^{bc}	173.200^{a}	0.354^{a}	0.150^{abc}
106	0.716^{b}	36.500^{g}	0.141^{j}	0.082^{i}
R^2	0.832	0.657	0.726	0.800
CV	18.710	33.351	13.499	11.534
LSD	± 0.060	± 24.248	± 0.022	± 0.010

Table 5: Means of the fruit yield traits of the Kogi Tall (KT2) accessions at the NIFOR substation, Badagry

Accession Number	HWT	WV	FMW	SW
152	0.587[fgh]	89.200[defgh]	0.219[d]	0.114[ef]
155	0.815[bc]	116.000[cdef]	0.185[efg]	0.108[fg]
157	0.888[ab]	100.250[defg]	0.180[fg]	0.108[fg]
162	0.790[bcd]	95.600[defg]	0.234[cd]	0.132[cde]
177	0.516[gh]	173.600[b]	0.271[b]	0.132[cde]
178	0.716[cde]	116.000[cdef]	0.278[b]	0.124[def]
180	0.567[gh]	98.000[defg]	0.222[d]	0.132[cde]
195	0.613[efg]	49.200[h]	0.203[def]	0.124[def]
203	0.896[ab]	154.000[bc]	0.334[a]	0.095[g]
205	0.397[ij]	231.330[a]	0.362[a]	0.149[bc]
221	0.564[gh]	122.200[cde]	0.267[bc]	0.138[bcd]
250	0.830[bc]	85.200[efgh]	0.237[cd]	0.129[de]
254	0.827[bc]	78.800[fgh]	0.177[fg]	0.115[def]
260	0.609[efg]	128.500[cd]	0.327[a]	0.156[b]
261	0.341[j]	170.000[b]	0.292[b]	0.152[b]
263	0.477[hi]	66.800[gh]	0.167[g]	0.129[de]
278	0.348[j]	108.400[defg]	0.263[bc]	0.122[def]
154	0.988[a]	95.250[defg]	0.222[d]	0.118[def]
262	0.691[def]	75.40[fgh]	0.214[de]	0.128[de]
R^2	0.867	0.729	0.848	0.754
CV	12.598	24.517	9.897	10.021
LSD	0.056	18.465	0.016	0.009

Contributions of the morphological traits to the variations in the coconut accessions

The PCA for the morphological traits had three principal components (PC I, II, III) with Eigen values ≥ 1, and the three PCs accounted for 74.41% of the variation in the accessions considered in this study (Table 6). This showed that there was high level of diversity and in turn variability among the accessions (≥74.41). Using a restriction level of 0.40 and above in the principal component analysis for the traits, PCI showed that fruit traits contributed more to the variations among the accessions (Table 7). Fruit weight, fruit length, fruit circumference, nut weight, nut length, nut circumference, husk thickness, split nut weight, water volume, shell weight, fresh meat weight and copra weight, all lodged in component I, and were more responsible for the variations among the accessions and thus accounted for 52.84% of the total variations among the accessions. None of the vegetative traits was loaded in PCI. The vegetative traits were lodged in PCII and III. The vegetative traits were dominant contributors to the variations observed in PCII and III which contributed a total of 21.58% variations observed among the accessions which were less to the variations accounted to the fruit traits in the accessions. The vegetative traits observed were crown diameter, petiole length, leaf spread and leaflet length. Husk thickness is the only fruit trait that had low coefficient in PCI and higher coefficient in PCII and III. This emphasized its less importance as a fruit trait to be considered in fruit analysis and subsequently when making selection.

The vegetative traits, being able to explain only 21.52% variations among the accessions implied that they were unreliable as a marker in coconut selection. However, the fruits traits will be more reliable as a morphological marker capable of being used in coconut selection where the more reliable molecular marker is not available. At the upper end of the ladder of traits with the highest Eigen vector coefficient were nut weight (0.972), split nut weight (0.973) and fresh meat weight (0.927) which is the chief economic part for which coconut is being cultivated. This is a strong basis for diversity and selection for economically sustainable coconut breeding (Table 7). This result is in line with the findings of Zizumbo-Villarreal and Piñero (1998) in a study of morphological characterization of dwarf and tall coconut varieties in Mexico. They reported that there was 80% variation in the first three principal components, while Odewale *et al.* (2014a) reported 73.88% variation in the first three principal components in the characterization of hybrid coconut varieties in Nigeria. The Eigen vector loading showed that the following fruit traits contributed most to the variations among the accessions: split nut weight (0.973), nut weight (0.972), nut circumference (0.931), fresh meat weight (0.927), water volume (0.872), nut length (0.857), shell weight (0.841) and copra weight (0.812). This implies that there is wide variation among the fruits especially for these traits mentioned and can be used for selection for breeding purposes which is in consonance with Odewale *et al.* (2014a) who reported copra weight (0.844), nut weight (0.803), water volume (0.748), weight of shell (0.772), sugar content (0.856) and fresh meat weight of (0.696) as Eigen vectors for evaluated hybrid coconut palms.

Table 6: Eigen values of the correlation matrix explained by three principal component axes of coconut morphological traits

Principal Component	Eigen value	% of Variance	Cumulative %
1	8.454	52.835	52.835
2	2.070	12.936	65.771
3	1.382	8.640	74.411

Table 7: Eigen vectors of the correlation matrix explained by three principal component axes Eigen of the coconut morphological traits

	Eigen Vector loading		
	PC 1	**PC 2**	**PC 3**
Fruit weight	**.753**	**.431**	.004
Fruit Length	**.662**	.392	-.368
Fruit circumference	**.804**	.209	-.308
Nut weight	**.972**	-.040	.093
Nut Length	**.857**	-.190	.212
Nut Circumference	**.931**	-.156	.055
Husk Thickness	**.408**	**.555**	**-.580**
Split Nut Weight	**.973**	-.103	.098
Water Volume	**.872**	-.093	.104
Shell Weight	**.841**	.208	.044
Fresh Meat Weight	**.927**	-.269	.105
Copra weight	**.812**	-.219	.152
Crown diameter	.170	**.568**	**.588**
Petiole Length	-.297	**.604**	.099
Leaf Spread	-.194	**.461**	**.588**
Leaflet length	-.052	**.484**	-.023

Clustering of coconut accessions into distinct groups using vegetative and fruit morphological traits

Hierarchical cluster analysis based on Euclidean distance was used to group the accessions and this partitioned the accessions into four clusters (Fig 1). The accessions were grouped based on similar traits rather than location of collection. Accessions with outstanding fruit traits were grouped in cluster 3, while cluster 2 grouped palms with the least performance in terms of fruit traits. Cluster 4 with the highest number of palms was dominated by palms from the Badagry Tall accessions producing 40% members; the Kwara Tall, Kogi Tall and South East Tall accessions produced 30%, 16.67% and 13.33% members each respectively in this cluster group. Cluster 2 with the second largest number of accessions is dominated by the ST accessions nominating 37.04% of the members in this cluster group, followed by the KT2 accessions with 29.63% members, while KT1 and BT accessions had 25.93%and 7.41% members respectively each in the group. Cluster 3 was occupied mostly by palms from the BT accession, while cluster 1 contains palm accessions almost evenly spread across the four locations (Table 8).

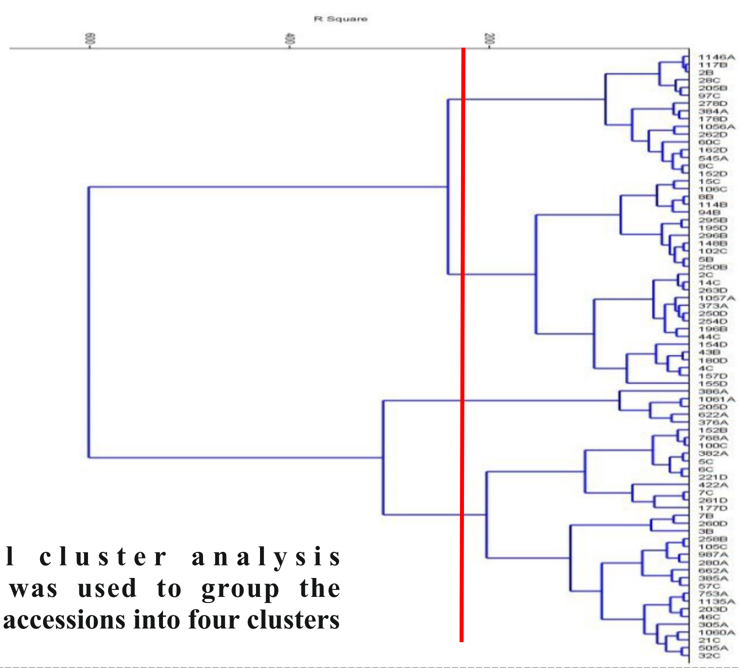

Figure 1: Hierarchical cluster analysis based on Euclidean distance was used to group the accessions and this partitioned the accessions into four clusters

Table 8: Number of accessions per cluster using morphological traits on the BT, ST, KT1and KT2accessions at the NIFOR substation, Badagry

Cluster 1	Cluster 2	Cluster 3	Cluster 4
1146BT	15KT1	386BT	152ST
117ST	106KT1	1061BT	768BT
2BT	8ST	205KT2	100KT1
28KT1	114ST	622BT	382BT
205ST	94ST	376BT	5KT1
97KT1	295ST		8KT1
278KT2	195KT2		221KT2
384BT	296ST		422BT
178KT2	148ST		7KT1
1056BT	102KT1		261KT2
262KT2	5ST		177KT2
60KT1	250ST		7ST
162KT2	2KT1		260KT2
545BT	14KT1		3ST
8KT1	263KT2		258ST
152KT2	1057BT		105KT1
	373BT		987BT
	250KT2		280BT
	254KT2		662BT
	196ST		385BT
	44KT1		57KT1
	154KT2		753BT
	43ST		1135BT
	180KT2		203KT2
	4KT1		46KT1
	157KT2		305BT
	155KT2		1060BT
			21KT1
			505KT1
			382BT
16	**27**	**5**	**30**

Suffix: BT= Badagry Tall accession, ST= South East Tall accession, KT1= Kwara Tall accession and KT2 = Kogi accession

Among the four cluster groups, cluster 3 was distinct from the other three clusters. The accessions in this cluster had the ability for high assimilate and are efficient in the translocation of assimilates to the fruit which resulted in higher mean values of the fruit traits (fruit weight, fruit circumference, nut weight, nut length, nut circumference, split nut weight, coconut water volume, shell weight, fresh meat weight and copra weight) than other cluster groups (Table 9). This made cluster III a higher yielding cluster in terms of the fruit trait qualities. This is in line with the findings of Jayasuriya and Perera (1985) on the growth, development and accumulation of dry matter in coconut. They noted that coconut palms have different potentials in accumulation and storage of photosynthates and assimilates based on their physiology and genetics which could be used in selection.

Cluster 2 contained accessions with the least fruit trait values among the accessions. The accessions in this cluster had the lowest mean value for coconut water volume relative to the other three clusters, but the coconut meat is sweeter as evident in the significantly higher sugar level relative to other clusters. These accessions had the ability to retain less water in their endosperm and increase sugar concentration in the coconut water *vis a vis* coconut meat. Cluster 2 had lower mean of fruit yield traits but had higher petiole length, leaf spread and leaflet length. These morphological traits can be selected when selection is being made for parent lines to be used in the production of improved coconut varieties in tall coconut types. But this is in contrast with the findings of Odewale *et al.* (2014b).

Table 9: Means of the morphological traits of the four clusters from the BT, SET, KT1 and KT2accessions at the NIFOR substation, Badagry

Morphological Trait	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Fruit weight	1.06^{bc}	0.89^{c}	1.54^{a}	1.17^{b}
Fruit Length	27.68^{a}	25.70^{b}	28.71^{a}	27.76^{a}
Fruit circumference	45.92^{b}	40.63^{c}	52.00^{a}	47.14^{b}
Nut weight	0.48^{c}	0.38^{d}	0.79^{a}	0.60^{b}
Nut length	17.07^{c}	16.00^{d}	19.48^{a}	18.09^{b}
Nut circumference	30.52^{c}	27.73^{d}	38.01^{a}	32.81^{b}
Husk thickness	28.55^{a}	23.10^{b}	30.19^{a}	26.93^{ab}
Split nut weight	0.39^{c}	0.32^{d}	0.57^{a}	0.45^{b}
Water volume	93.22^{c}	66.98^{d}	255.41^{a}	157.34^{b}
Sugar level	4.64^{ab}	4.90^{a}	4.26^{b}	4.36^{b}
Shell weight	0.13^{b}	0.11^{c}	0.18^{a}	0.14^{b}
Fresh meat weight	0.26^{c}	0.21^{d}	0.40^{a}	0.31^{b}
Copra weight	166.96^{b}	122.26^{c}	214.89^{a}	176.33^{b}
Crown diameter	6.64^{a}	6.20^{a}	6.15^{a}	6.54^{a}
Petiole length	1.07^{a}	1.08^{a}	0.88^{b}	1.07^{a}
Leaf spread	1.83^{ab}	1.94^{a}	1.72^{b}	1.85^{ab}
Average leaflet length	1.10^{a}	1.16^{a}	1.09^{a}	1.09^{a}

N.B: Means with the same letters in the columns are not significantly different at P≤ 0.05

Conclusion

The study established considerable genetic variability among the accessions which can be exploited for coconut parent material selection. Among the accessions, cluster III accessions were superior to other accessions in terms of the fruit weight, fresh coconut meat and water volume, while Cluster II accessions have higher sugar level and sweeter nuts than other accessions.

References

Ahanon, M.J., Adetimirin,V.O, Odewale,J.O, Odiowaya, G., Enaberue, L.O, Agho, C, Awanlemhen,B.E. and Odufale,O.O. (2016). Relationship among vegetative traits in coconut hybrid population. *Proceeding of African Regional conference on Sustainable Development,* 14,(4): 212-216.

Ashburner, G.R., Thompson,W.K. and Halloran,G.M., (1997). RAPD analysis of south Pacific coconut palm populations. *Crop Science*, 37: 992–997.

Chan, E. and Elevitch, R. C. (2006). *Cocos nucifera* (Coconut) *Arecaceae* (Palm Family). Species for Pacific Island Agroforestry. *Available online at:* www.traditionaltree.org (Visited September 2017)

Ekanayake, G. K, Perera, S. A. C. N., Dassanayake, P. N. and Everard, J. M. D. T. (2010). Varietal classification of new coconut (*Cocos nucifera* L.) forms identified from southern Sri Lanka. *Cocos* 19: 41 – 50

Geethanjali, S., Rajkumar, D. and Shoba, N. (2014). Correlation and path coefficient analysis in coconut (*Cocos nucifera*L.). *Electronic Journal of Plant Breeding*, 5(4): 702-707.

Jayasuriya, V. U., De, S. and Perera, R. K. I. S. (1985). Growth, Development and Dry Matter Accumulation in the Fruit of *Cocos nucifera L.* Var. nana form Pumil. *Cocos* 3: 16-21.

Odewale, J. O., Odiowaya, G., Agho, C., Enaberue, L. and Okoye, M. N. (2012). Relationship between canopy sizes and shapes and the productivity and yield of coconut (*Cocos nucifera L.*) Varieties in Nigeria *Greener Journal of Agricultural Sciences*, 2(8): 378-380.

Odewale, J. O., Okolo, E. C., Ataga, C. D., Okwuagwu, C. O., Odiowaya,G., Agho, C. and Yusuf, A. O. (2014a). Characterization of coconut (*Cocos nucifera* L.) selected mother palms based on fruit components in Nigeria. *Proceedings of the 38th Annual Conference of the Genetic Society of Nigeria.* Pp. 593-601.

Odewale, J. O., Ataga, C. D., Agho, C., Ahanon, M. J., Odiowaya, G. and Okoye, M. N. (2014b). Character interrelationships and path analysis for copra yield in coconut (*Cocos nucifera* L.). *Proceedings of the 38th Annual Conference of the Genetic Society of Nigeria.* Pp. 602-609.

Osemwegie, Q. E., Anyiwe, M. A. and Odewale, J. O. (2016). Econometric analysis of the economic cost of lethal yellowing disease (LYD) on Coconut (*Cocos nucifera* L.) Yield in LYD epidemic area of Nigeria: A Case Study of Nigerian Institute for Oil Palm Research (NIFOR). *American Journal of Experimental Agriculture,* 11(5): 1-10.

Perera, S. A. C. N., Dissanayaka, H. D. M. A. C., Herath H.M. N. B., Meegahakumbura, M. G. M. K. and Perera, L. (2014). Quantitative characterization of nut yield and fruit components in indigenous coconut germplasm in Sri Lanka. *International Journal of Biodiversity* Article ID 740592, 5 pages. Available at http://dx.doi.org/10.1155/2014/740592

Zizumbo-Villarreal, D. and Piñero, D. (1998). Pattern of morphological variation and diversity of cocos nucifera (Arecaceae) in Mexico. *American Journal of Botany*, 85:855-865.