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Agromorphological characterization of jute (*Corchorus olitorius* L.) landraces in Central region of Benin Republic.

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Abstract

Corchorus olitorius L. is a traditional leafy vegetable that contributes to food security and poverty reduction in Benin. Various stresses as well as absence of improved seeds lead to low yield and threaten its diversity. In order to develop a genetic improvement program for this vegetable, an evaluation of the genetic diversity of jute cultivars is necessary. 36 jute accessions collected through 16 villages in central Benin were transplanted into a complete random block design and 27 agro-morphological traits were selected to study variability within the constituted collection. The results from the qualitative character analysis indicate a grouping of accessions into 5 with identification of 35 morphological units. Assessment of the coefficient of variation and analysis of variance show high degree of variability within the accessions for the set of traits evaluated. Significant correlations were also obtained between different pairs of traits discriminating the three groups from the CAH. The first group is long cycle accessions. The second group contains early accessions with good performance for leaf-related characters. Finally, the third group shows good performance in terms of fruit yield. These different groups of accessions can be used as part of a varietal breeding and improvement program.

Keywords: *Corchorus olitorius*, diversity, qualitative traits, quantitative traits, vegetable,

Introduction

Corchorus spp. is one of the most nutritious traditional leafy vegetables used in many households in Africa (Nyadanu et al., 2014; Ngomuo et al., 2017). Formerly and traditionally classified with the Tiliaceae family (Kiebre et al. 2016), the genus *Corchorus* is recently classified in the Sparrmanniaceae family (Heywood et al. 2007; Benor et al. 2010). It includes about 50 to 60 species distributed in tropical, subtropical and warm temperate regions of the world (Benor et al. 2012).

In West Africa, there are six species of *Corchorus*, of which *Corchoruso litorius* is the most cultivated (Oyekale et al., 2017). Its main use on the African continent is vegetable consumption (Dansi et al. 2008, Benor et al. 2010). These leaves (either fresh or dried) are cooked into a thick viscous soup or added to stew or soup and are rich sources of vitamins and minerals (Branda et al., 2004). It is known to add taste and flavour as well as substantial amounts of protein, fiber, minerals (such as calcium and iron) and vitamins (A, C, E) to the diet (Steyn et al., 2001; Dansi et al., 2008). Leaves decoction is used for treating iron deficiency, folic acid deficiency, as well as treatment of anemia and as blood purifier, while the leaf twigs are used against heart troubles (Krivanek et al., 2007). According to several authors, *Corchorus* species are medicinal plants widely used in the treatment of various diseases and have broad antibacterial properties (Zakaria et al., 2006; Fagbohoun and Ibrahim, 2011; Soro et al., 2012).*C. olitorius* is rich in phytochemicals and having potential antioxidant; and may be used efficiently in traditional medicine (Adjatin et al., 2019).

In Benin, *C. olitorius* is a plant grown in all agro-ecological areas and, is one of the most consumed vegetables across all sociolinguistic groups (Dansi et al., 2008; Adjatin et al. 2017). Unfortunately, in central Benin its production is subject to several biotic and abiotic constraints including low productivity and lack of quality seeds (Adjatin et al., 2017). It therefore is necessary to develop jute varieties resistant to these various biotic and abiotic stresses to increase the production and productivity of this vegetable in central Benin. However, establishment of a varietal improvement program requires an exhaustive understanding of the genetic diversity of existing local jute varieties. Indeed, with a local designation varying from one sociolinguistic group to another, *C. olitorius* is known for its great intra-specific diversity (Akoègninou et al., 2006; Benor et al., 2012). The complexity of popular plant taxonomy generally leads to the existence of duplicates (synonym problems) within germplasm that need to be clarified (Adoukonou-Sagbadja et al 2006; Dansi et al. 2013).Characterization of genetic diversity through the use of phenotypic traits is an initial step for crop improvement (Ngomuo et al. 2016). In this context, several studies in Nigeria (Denton and Nwangburuka, 2012), Senegal (Mbaye et al., 2001) and Pakistan (Islam et al., 2002) showed strong morphological diversity in *C. olitorius*. Therefore, the main objective of this study is to assess agro-morphological diversity of *C. olitorius* accessions in central Benin for germplasm conservation and probable uses in effective varietal breeding and improvement programs. More specifically, it involved:

- Assess the diversity of jute accessions in central Benin by using agro-morphological characters to highlight different potential groups
- Establish equivalence between local names by identifying possible duplicates
- Evaluate the performance and characteristics of the different jute accessions and be able to use them in possible varietal creation programs in Benin and elsewhere.

Materials and Methods

Plant material

The plant material consists of thirty-six jute accessions collected in different villages and ethnic areas of the Department of Collines in central Benin during a prospecting (Table 1).

Design and experimental site

Seeds extracted from the 36 local varieties fruit were dried in the sun for 7 days and sown in nurseries. In a complete random block design with 3 replications, each sample was transplanted at stage 5 or 6 leaves (about 21 days after nursery), on a board of dimensions 1 m x 0,5 m with a spacing of 0,20 m x 0.30 m. A distance of 0.5 m was kept between two successive boards allowing the installation of the trial on a total area of 72 m^2 at the experimental farm of the Faculty of Science and Technology (FAST) Dassa-Zoumé based in Central Benin. Organic manure was applied at the time of ploughing to fertilize the soil.

Data collection and analysis

A total of 27 traits (Table 2 and 3), including 11 qualitative and 16 quantitative traits from AVRDC jute descriptors (2008) and also from various authors (Gosh et al., 2013); were used to evaluate the 36 accessions collected in the department of Collines. The list, measurement methods and score levels of each trait are summarized in Tables 2 and 3. The quantitative traits were subjected to descriptive statistics with R software. Study of the relationships between the traits was completed using the correlation matrix. A Principal Component Analysis (PCA) was conducted using XLSTAT 2018 software and individuals' coordinate were used to group accessions by Hierarchical Ascending Classification (HAC). The results were presented in tables and figures.

Table 1: List of *C. olitorius* accessions studied and their origin.

N°	Local names	Accessions / codes	Villages	Sector	District
1	Aladjlele	AKL1	Aklamkpa	Aklamkpa	Glazoué
2	Yabada	ARI1	arigbokoto	Dassa 2	Dassa-zoumé
3	yoyo édjo	ARI2	arigbokoto	Dassa 2	Dassa-zoumé
4	Aladjlele	ARI3	arigbokoto	Dassa 2	Dassa-zoumé
5	yoyo olessekpikpa	ARI4	arigbokoto	Dassa 2	Dassa-zoumé
6	yoyo oyinbô	ATC1	atchakpa	Ofè	Savè
7	yoyo weyeweye	ATC2	atchakpa	Ofè	Savè
8	yoyo 1	AYE1	ayédero	Dassa 2	Dassa-zoumé
9	ninnouwi 1	AYE2	ayédero	Dassa 2	Dassa-zoumé
10	ninnouwi 2	AYE4	ayédero	Dassa 2	Dassa-zoumé
11	ninnouwi 3	AYE5	ayédero	Dassa 2	Dassa-zoumé
12	yoyo 3	AYE6	ayédero	Dassa 2	Dassa-zoumé
13	ninnouwi 4	AYE3	ayédero	Dassa 2	Dassa-zoumé
14	ninnouwi	BEL1	belle-vie	Kpingni	Dassa-zoumé
15	ayoyooletiweyeweye	BOB1	bobè	Bobè	Bantè
16	ayoyooletiweyeweye	BOB2	bobè	Bobè	Bantè
17	ninnouwi	DOI1	doïssa	Kpataba	Savalou
18	alazlélé	DOI2	doïssa	Kpataba	Savalou
19	yoyo 2	ESS1	essebre	Dassa 1	Dassa-zoumé
20	yoyo edjo	ESS2	essebre	Dassa 1	Dassa-zoumé
21	yabada	GAM1	gamba	Akoffodjoulé	Dassa-zoumé
22	yabada	KAB1	kabolé	Zaffé	Glazoué
23	aladjlele	KPI1	kpingnin	kpingnin	Dassa-zoumé
24	ninnouwi	KPI2	kpingnin	kpingnin	Dassa-zoumé
25	ninnouwi	KPI3	kpingnin	kpingnin	Dassa-zoumé
26	yoyo doundoun	LOU1	loule	Dassa 2	Dassa-zoumé
27	ayoyoékô	MAY1	mayamon	Gouka	Bantè
28	faamou	MAY2	mayamon	Gouka	Bantè
29	ninnouwi	OKE1	okéowo	Okpara	Savè
30	ninnouwidôdô	OKE2	okéowo	Okpara	Savè
31	ninnouwidôdô	OKE5	okéowo	Okpara	Savè
32	oganninnouwi 1	OKE3	okéowo	Okpara	Savè
33	oganninnouwi 2	OKE4	okéowo	Okpara	Savè
34	tchigan 1	OUI1	ouissi	Paouignan	Dassa-zoumé
35	tchigan 2	OUI2	ouissi	Paouignan	Dassa-zoumé
36	aladjlele	OUW1	Zogbagahou	Ouèssè	Ouèssèwogoudo

Table 2: Qualitative traits used for Morphological evaluation and scoring levels.

Trait	Code	Score and measurement technic
Early plant vigor	EPlVig	Poor (0), Good (1), Very good (2)
Leaf lamina color	LeLaCol	Green (0), Tip green (1)
Stem color	StemCol	Green (0), Red (1)
Stipule color	StipCol	Green (0), Tip red (1)
Branching habit	BranHab	Weak (0), Intermediate (1), Strong (2), Very strong (3)
Leaf shape	Lshap	Ovate lanceolate (0), Elliptical (1), Lanceolate (2), Ovate (3), Cordate (4)
Leaf marge	Lmarg	Smooth (0), Lobed (1)
Late stem color	LaStcol	Yellow (0), Green (1), Yellowish green (2), Red (3)
Biotic stress susceptibility	BioStrSus	Very low (0), Low (1), Intermediate (2), High (3)
Dry fruit color	DryFrCol	Grewish brown (0), Blackish brown (1), Brown clear (2), Brown (3), Roux (4), Brownish black (5)
Seed color	SeedCol	Redish black (0), Brownish black (1), Black (2), Roux (3)

Table 3: Quantitative data used for Morphological evaluation and their measurement.

Trait	**Code**	**Measurement technic**
Flowering initiation	FLI	Count of the number of day between germination and the initiation of the flowering
Days to 50 % flowering	DFL50%	Number of days from sowing/transplanting until 50% of plants have at least one opened flower
Leaf lenght	LEL	Distance between the leaf tip and base measured on the third fully opened leaf from the tip.
Leaf width	LEW	Measured on the widest part of the leaf
Petiole lenght	PEL	Measured in Cm
Plant height	PLH	Measured from ground to the top of the plant
Number of nodes per plant	NNP	Count of the number of nodes on 1m
Stem diameter	STD	Recorded after cutting the stem and on three different plants
1000 seeds weight	SEW 1000	100 seeds weighted multiplied by 10 (The fruits are taken from different plants)
Number of leaf per plant	NLP	All the leaves removed and counted
Number of ramification	NRA	Count of the number of ramification
Fresh leaf weight	FLW	Fresh leaves removed after cutting the plant and weighted
Fruit lenght	FRL	Average fruit length of 10 ripe fruits of the second harvest
Fruit width	FRW	Width of the broadest portion of the fruit measured on three fruits
Number of fruit per plant	NFP	Average number of dried fruits of three plants
Total plant weight	TPW	Plants took out the soil and weighted

Results and Discussion

Distribution of phenotypic characters

Morphological variability observed through the qualitative traits collected is highlighted in Figure 1. Thus, parameters such as the leaves shape, stem color, early plant vigor, seeds color, susceptibility to biotic stress, fruit dry color, branching habit, leaf lamina color, stipules color and the appearance of the leaves marge were used, among other things, to describe the different varieties of *C. olitorius* collected in the department of Collines, in the center of Benin. For almost all varieties, green coloration is observed with the leaf lamina (94.44%), stems (97.22%) and stipules (97.22%). While a dark green or red color was observed in the other varieties for the same traits. This result is similar to that obtained by Ngomuo et al. (2017), which is justified by a predominant green color of these traits in the evaluated collection.

A good vigor of early plant was obtained with 63.89% of accessions against 11.11% of accessions with low plant vigor. As regards the marge and shape of leaves, 63.88% of accessions have smooth leaves while 44.44% of the varieties showed ovate leaves. Denton and Nwangburuka (2012) observed a large morphological and physiological variation in *C. olitorius* leaves grown by farmers in Nigeria. The variability observed in leaf shape was particularly used to constitute the different groups of local *C. olitorius* cultivars. In a morphological diversity study of subspecies of the genus *Corchorus*, Ngomuo et al. (2017) also reported a significant proportion of ovate-leaved varieties (38.3%). Similar to Ngomuo et al. (2017), color variability was obtained by considering dried fruits and seeds. For example, three essential colors such as brown (33.33%), brownish black (27.78%) and blackish brown (25%) are obtained following the evaluation of dried fruits, while reddish black (47.22%) was the majority in terms of seeds. Forty seven point six seven percent (47.67%) of accessions are susceptible to biotic stress; the others being more tolerant (30.11%) or very susceptible (22.22%).

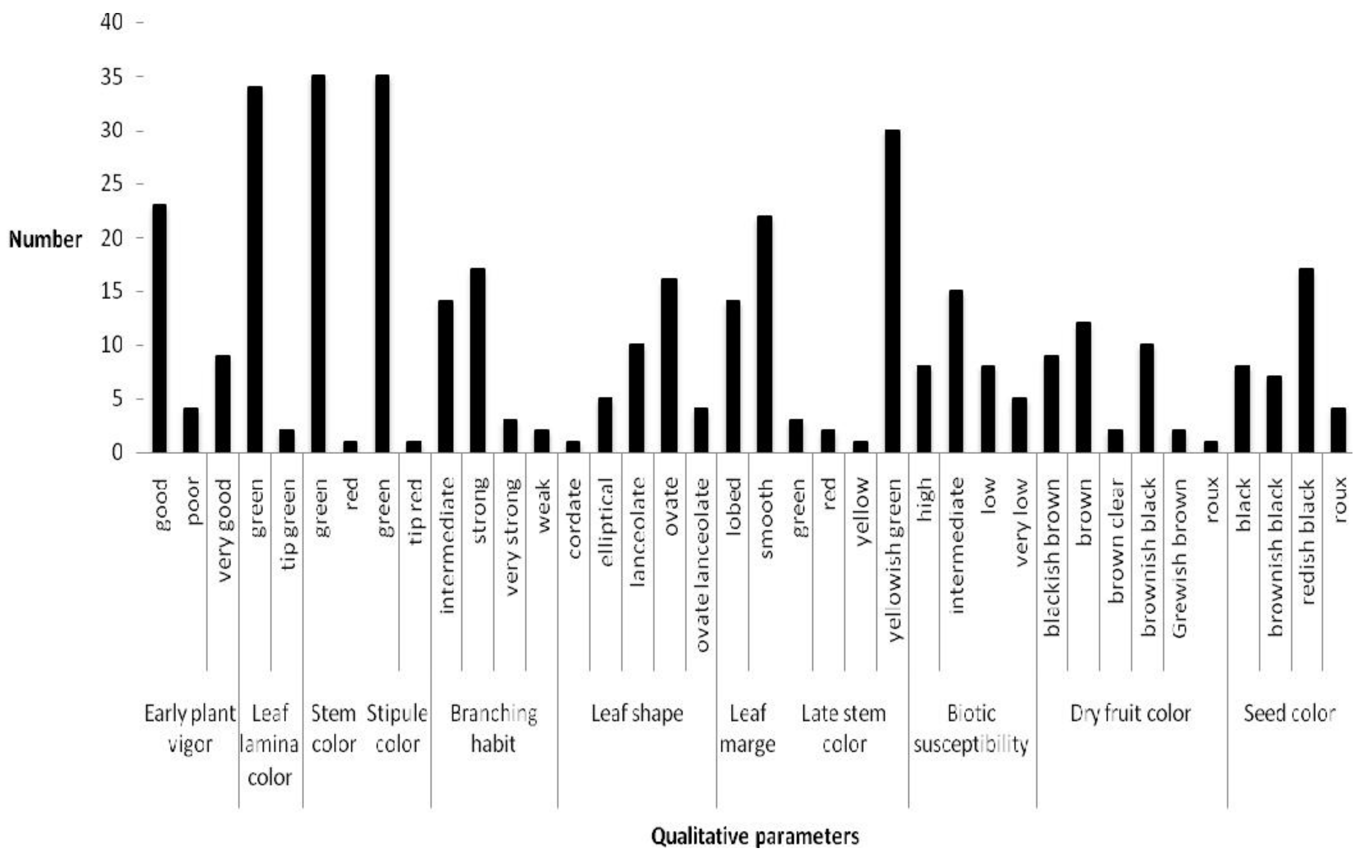

Fig. 1: Variability of qualitative traits assessed

Analysis of morphological diversity

Based on the index of dissimilarity of qualitative traits, a total of five groups with different number of accessions were constituted, of which the lowest (1) and largest (16) number are observed in groups 5 and 3. Groups 1, 2 and 4 are completed with 9, 8 and 2 accessions with distinct characteristics (Figure 2).

- Thus, Group 1 containing AYE1, KPI2, OUI2, BOB2, OUI1, ATC2, AYE5, DOI1 and BOB1 is essentially characterized by a strong branching habit of the plants.
- In Group 2, accessions GAM1, ARI3, KPI1, KAB1, ARI2, OUW1, AKL1 and ARI1 are either lanceolate or ovate in shape with lobed marge, yellowish green coloring of stems, a brown or brownish black color of the dry fruits with a mainly black color of the seeds.
-

- High variability in the color of the dry fruits, with reddish black of seeds color characterizes the accessions of group 3 consisting of OKE1, KPI3, AYE2, ATC1, DOI2, AYE4, MAY2, MAY1, AYE3, LOU1, OKE3, OKE5, ESS2, BEL1, OKE2 and AYE6.
- Group 4 differs from the other groups by a green leaf color and clusters ESS1 and OKE4 accessions.
- The single accession ARI4 of group 5 is characterized by a red stem color.

According to Adeyinka and Akintade (2015), variation in stem colors, leaf shape and stipules are the most informative phenotypic variables for the assessment of *C. olitorius* genotypes. Similar findings were also reported by Bénor et al. (2012) who reported that leaf-related characters are the most discriminating of *C. olitorius* (Bénor et al. 2012). However, the analysis of the different index of dissimilarity allows identification of 35 different morphotypes. This latter let to identify OKE2 and AYE6 in the same morphological unit and can therefore be considered as duplicates subject to exhaustive analyses.

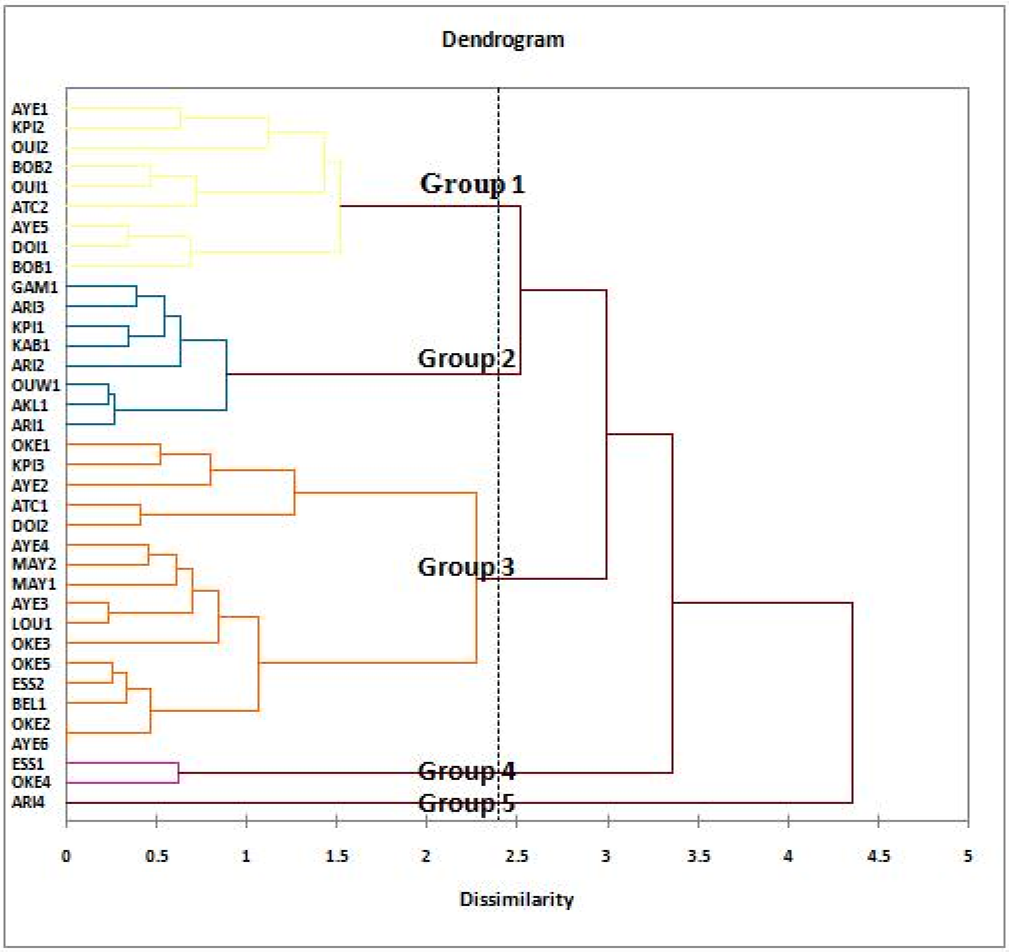

Fig. 2: Grouping of accessions according to their morphology

Variability of quantitative characteristics

Descriptive statistics and analysis of variance

The results of the descriptive analysis (mean, minimum, maximum, coefficient of variation and standard deviation) were used to assess variation within each of the 16 measured traits (Table 4). Average number of fruits per plant (NFP), average number of number of ramification per plant (NRA), 1000 seeds weight (SEW 1000), average fruit length (FRL), average leaf length (LEL), leaf width (LEW), average number of leaves per plant (NLP), average fruit width (FRW) and flowering initiation (FLI), i.e. the number of days between planting and beginning of flowering in 50% of plants of the same variety, are according to Adjatin et al. (2017), the most significant variables for producers and sellers. Large variations were observed between these traits following the evaluation of the recorded coefficients of variation. The latter can therefore be used in selection for the production of leafy vegetables. Specifically, average number of fruits per plant ranged from 3.67 to 511 and the number of ramification ranged from 11.33 to 42.33. The weight of 1000 seeds and the length of the fruit ranged from 0.4 to 2 g and 4.03 to 9.43 cm, respectively, with a fruit width varying between 0.33 and 0.67 cm. The length and width of the leaves ranged from 5.77 to 13.6 cm, and then from 2.23 to 11.73 cm. The number of leaves per plant ranged from 383 to 1235. All accessions evaluated show a flowering initiation ranging from 39 to 77. Nwangburka and Denton (2012) also reported that some trait linked to plant growth including plant ramification and stem shape are most important for leaf production (characterize the consumable portion) by the producers. Also, the high coefficient of variation of each trait supported by the results of analysis of variance justifies the use of these traits during a selection for accessions breeding program.

Table 4: Descriptive statistics and analysis of variance of quantitative characters

Trait	Minimum	Maximum	Mean	St Dev.	CV	F
FLI	39.000	77.000	54.694	10.622	19.420	***
DFL50%	41.000	89.000	61.694	11.160	18.089	***
LEL	5.767	13.600	9.156	1.990	21.733	***
LEW	2.233	11.733	5.522	2.486	45.019	***
PEL	2.267	7.067	3.898	1.157	29.679	***
PLH	21.300	163.333	100.616	33.689	33.483	***
NNP	19.000	53.667	35.731	7.496	20.979	***
STD	0.567	1.967	0.968	0.230	23.750	***
SEW 1000	0.400	2.000	0.879	0.416	47.248	***
NLP	383.000	1235.000	629.722	190.743	30.290	***
NRA	11.333	42.333	27.435	7.085	25.824	***
FLW	51.300	157.360	90.311	22.391	24.794	***
FRL	4.033	9.433	5.210	0.959	18.412	***
FRW	0.333	0.667	0.501	0.078	15.494	***
NFP	3.667	511.000	184.944	169.534	91.668	***
TPW	56.800	402.500	212.764	74.693	35.106	***

FLI : Flowering initiation, DFL50% : Days to 50 % flowering, LEL : Leaf length, LEW : Leaf width, PEL: Petiole length, PLH : Plant height, NNP: Number of nodes per plant, STD : Stem diameter, SEW 1000: 1000 seeds weight, NLP: Number of leaf per plant, NRA : Number of ramification, FLW: Fresh leaf weight, FRL : Fruit length, FRW : Fruit width, NFP : Number of fruit per plant, TPW : Total plant weight, St Dev.: Standard deviation, F: Fisher's test, ***: Highly significant.

Relationship between measured traits

Pearson correlation matrix highlights many significant correlations both negative and positive at 5% threshold by considering all 16 quantitative traits (Table 5). Thus, negative significant correlations were obtained between flowering initiation (FLI), average number of leaves per plant (NLP) and total plant weight (TPW)) and then between the number of days to 50% flowering (DFL50%), the mean number of leaves per plant (NLP) and the total plant weight (TPW) for values between r= 0.38 and r= -0.34. In fact, given the flowering date, the longer the flowering time, accessions produce less leaves resulting in a low total weight of the plant. Unlike to results of Olanrewaju et al. (2012), Kiebre et al. (2016) and Ranjit et al. (2013), analysis of these negative correlations shows that late accessions result in a low weight of the whole plant. Several positively significant correlations were also obtained with the highest correlation between flowering initiation (FLI) and the number of days to 50% flowering (DFL50%) (r = 0.974) and the lowest

Table 5: Correlations between the quantitative traits of jute Mallow cultivars in center Benin.

Traits	FLI	DFL50%	LEL	LEW	PEL	PLH	NNP	STD	SEW 1000	NLP	NRA	FLW	FRL	FRW	NFP	TPW
FLI	**1**															
DFL50%	**0.9740**	**1**														
LEL	0.1147	0.0947	**1**													
LEW	-0.0101	0.0430	0.2090	**1**												
PEL	0.0405	0.0418	**0.4211**	**0.5883**	**1**											
PLH	-0.2054	-0.1647	0.2320	**0.6493**	0.2590	**1**										
NNP	0.1353	0.1996	-0.0061	**0.4874**	0.1972	**0.5856**	**1**									
STD	-0.2958	-0.2548	0.0733	**0.3302**	0.0610	**0.4448**	**0.5500**	**1**								
SEW 1000	0.2312	0.2241	-0.0857	0.2208	0.1389	0.0633	-0.0700	-0.0218	**1**							
NLP	**-0.3471**	**-0.3432**	-0.1189	-0.3006	-0.1556	-0.0253	-0.1903	0.0820	0.0137	**1**						
NRA	0.1367	0.1729	0.0305	**0.3637**	0.1764	**0.5982**	**0.9162**	**0.5199**	0.0023	-0.0489	**1**					
FLW	-0.1308	-0.0861	0.2970	0.3156	**0.4567**	0.2973	**0.3827**	0.3154	0.2153	0.2358	**0.4268**	**1**				
FRL	0.1097	0.0984	0.3092	-0.0212	0.1996	0.1972	0.1883	0.1100	0.0950	0.3171	0.1833	**0.4391**	**1**			
FRW	0.2956	**0.3699**	-0.0745	**0.3335**	0.0683	0.0085	0.1855	0.1833	**0.3370**	-0.1688	0.1637	0.0565	-0.0474	**1**		
NFP	-0.1200	-0.1703	-0.0682	0.2957	0.1038	0.2493	0.1521	**0.3615**	**0.4475**	0.1692	0.2167	0.2255	0.1140	0.2848	**1**	
TPW	**-0.3788**	**-0.3632**	0.1867	0.1816	**0.3698**	**0.3672**	0.2226	0.2174	0.2228	**0.4705**	**0.3301**	**0.6718**	0.2887	-0.0455	**0.3679**	**1**

FLI: Flowering initiation, DFL50% : Days to 50% Flowering, LEL: Leaf length, LEW: Leaf width, PEL: Petiole length, PLH: Plant height, NNP: Number of nodes per plant, STD: Stem diameter, SEW 1000: 1000 seeds weight, NLP: Number of leaf per plant, NRA: Number of ramification, FLW: Fresh leaf weight, FRL: Fruit length, FRW: Fruit width, NFP: Number of fruit per plant, TPW: Total plant weight. Values in bold are different from 0 to an alpha significance level = 0.05

between total plant weight (TPW) and average number of ramification per plant (NRA) (r = 0.330). Leaf width (LEW) also showed a strong correlation with petiole length (PEL) (r = 0.588) and plant height (PLH) (r = 0.649), while number of ramification (NRA) indicates a very strong correlation with plant height (PLH) (r = 0.598), number of nodes per plant (NNP) (r = 0.916) and stem diameter (STD) (r = 0.519). Similarly, plant height (PLH) and fresh leaf weight (FLW) are strongly and significantly correlated, respectively, with the number of nodes per plant (NNP) (r= 0.586) and the total plant weight (TPW) (r= 0.672). Plant vegetative architecture is important for leaf production, according to some authors (Adeyinka and Akintade 2015). On the other hand, the positive and significant correlations obtained are similar to those obtained by Kiebre et al. (2016) and justify that as the size of accessions increases, more the ramification appear and more nodes per plant increase. This implies an increase in the weight and width of the leaves ensuring good profitability for producers (Kiebre et al., 2016). Some authors also reported a significant difference by considering traits such as height of mature plants, number of leaves per plant, weight of fresh leaves and weight of whole plant (Nwangburka & Denton, 2012). All these correlations would contribute to orient selection towards varieties with significant vegetative development and are also an indispensable tool for breeders in the choice of traits to be included in selection and breeding.

Principal Component Analysis

Estimation of the variability represented by each axis of the main component analysis is given by Table 6. Three main axes with Eigen value more than 1 were used to explain 56.44% of the variance present in traits. They were therefore used to describe the total variability of accessions. The first axis describes 26.99% of the variation and is defined on the positive side by LEW, PLH, NNP, NRA, FLW, NFP and TPW. This axis characterizes accessions with good performance for each of these characters. The second axis describing 17.91% of the variation is defined on the positive side by FLI, DFL50% and FRW then on the negative side by NLP. The late accessions with a low NLP and a strong FRW characterize this axis. Finally, the third axis describes 11.53% of the variation. This component is defined on the positive side by LEL, PEL, SEW1000, FRL and then on the negative side by STD. This last axis is characterized by accessions with high agronomic yield, and having a small stem diameter.

Table 6: Own values and percentages of change expressed for the first three axes of the Main Component Analysis

	Axe 1	**Axe 2**	**Axe 3**
Eigen value	4.319	2.867	1.845
Variability (%)	26.991	17.918	11.531
% cumulated	26.991	44.909	56.440
FLI	-0.063	**0.523**	0.205
DFL50%	-0.041	**0.535**	0.176
LEL	0.138	0.051	**0.284**
LEW	**0.330**	0.167	-0.106
PEL	0.254	0.079	**0.262**
PLH	**0.363**	-0.021	-0.206
NNP	**0.355**	0.183	-0.309
STD	0.303	-0.088	**-0.304**
SEW 1000	0.110	0.133	**0.344**
NLP	0.035	**-0.380**	0.240
NRA	**0.362**	0.140	-0.239
FLW	**0.344**	-0.097	0.287
FRL	0.179	-0.037	**0.383**
FRW	0.109	**0.294**	0.020
NFP	**0.229**	-0.069	0.078
TPW	**0.307**	-0.282	0.260

FLI: Flowering initiation, DFL50% : Days to 50% Flowering, LEL: Leaf length, LEW: Leaf width, PEL: Petiole length, PLH: Plant height, NNP: Number of nodes per plant, STD: Stem diameter, SEW 1000: 1000 seeds weight, NLP: Number of leaf per plant, NRA: Number of ramification, FLW: Fresh leaf weight, FRL: Fruit length, FRW: Fruit width, NFP: Number of fruit per plant, TPW: Total plant weight

Diversity and classification of accessions

Hierarchical Ascending Classification (CAH) based on weighted averages using the dissimilarity index allows representation of accessions into three main groups (Figure 3):

- Consisting of 17 accessions including OKE1, OKE5, AYE1, ESS2, KPI1and KAB1, group 1 is characterized by late accessions with a long average length of leaves (LEL) and petiole (PEL).

- Group 2 consists of 6 accessions such as: OUI2, ARI4, AYE2, AYE3, AYE4 and MAY1. They are early accessions characterized mainly by high number of leaves per plant (NLP), high fresh leaf weight (FLW), a long fruit length (FRL) and a high total plant weight (TPW). Accessions present in this group will therefore be able to be used not only for the production and marketing of leaves but also involved in a program as donors for the improvement of other varieties leaf yield.

- Finally, Group 3 consisting of 13 accessions, of which OUI1, GAM1, DOI1, MAY2, LOU1 and DOI2 are accessions with essentially better fruit yield with a high weight of 1000 seeds (SEW-1000) and dry fruit (FRW),and high number of fruit per plant (NFP). This group also shows strong mean values for traits such as number of ramification (NRA), stem diameter (STD), and plant height (PLH).

Quantitative analysis facilitates the selection of diverse parents for common beans breeding programs (Loko et al., 2018). Therefore, accessions of groups 2 and 3 can therefore be integrated into an improvement program for the development of new varieties with high production potential for leaves and fruit. Further studies in north and south Benin are recommended to collect and characterize all landraces cultivated in Benin.

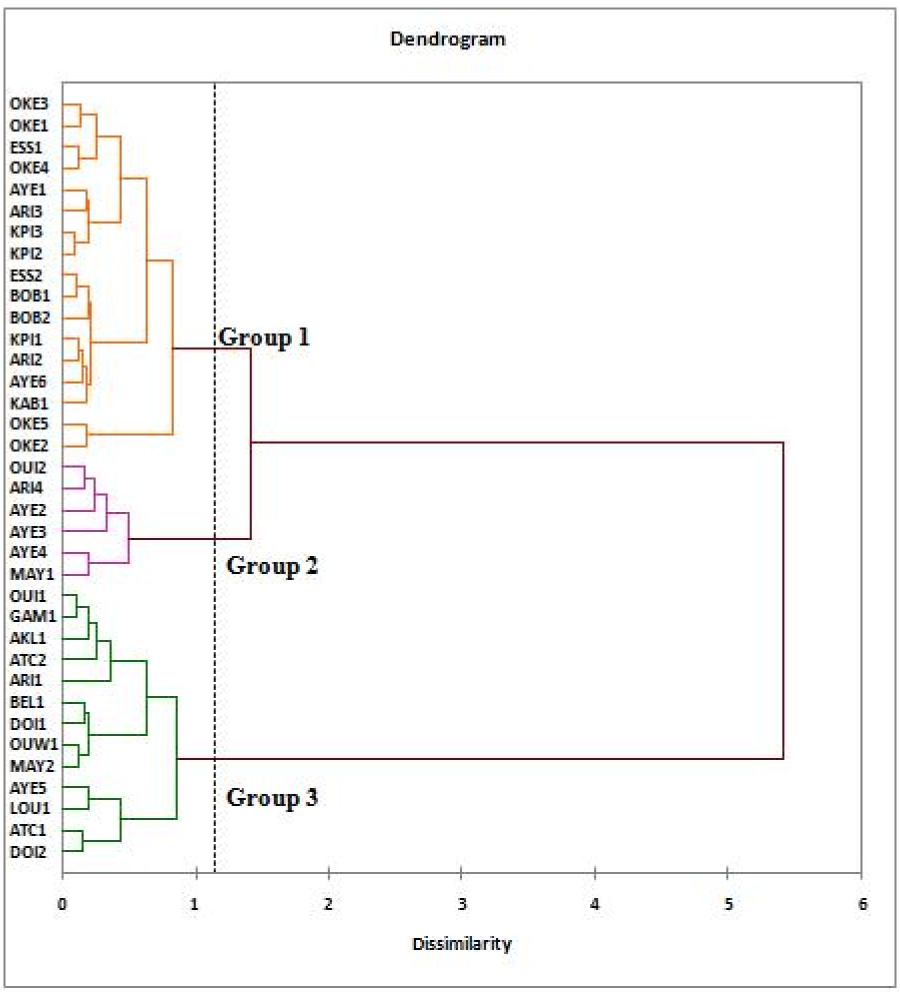

Fig. 3: Classification of 36 accessions of *Corchorus olitorius* from the collection

Conclusion

This study revealed an important agro-morphological diversity within includes accessions. The variability observed within the accessions studied according to the different qualitative and quantitative traits and the identification of discriminating characteristics constitute a database for the rational use of this resource in *C. olitorius* breeding and selection programs. In addition to the large variation observed following the descriptive analysis of the traits, the hierarchical ascending classification presented a structuring of accessions into three distinct groups to discriminate the late accessions group from the high performance accessions group in terms of leaf yield by plant and by accessions with high fruit yield. This grouping is a major first component in the use of this genetic resource and will allow to develop *C. olitorius* improvement programs according to specific objectives. However, in order to better understand the overall genetic diversity of accessions evaluated, it would be important to confirm these results through the use of molecular markers.

Conflict of interests

The authors have not declared any conflict of interests.

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