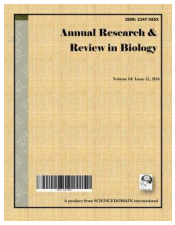

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Agro-morphological Characterization of *Corchorus olitorius* Cultivars of Benin

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Authors' contributions

This work was carried out in collaboration between all authors. Author HOA anchored the field study, gathered the initial data and performed preliminary data analysis. Author LEA designed the study, wrote the protocol and interpreted the data. Authors FQ and VE managed the literature searches and produced the initial draft. All authors read and approved the final manuscript.

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ABSTRACT

Aim: *Corchorus olitorius* is indubitably one of the most important vegetables in Benin. It is grown in most regions of the country and also in the tropical and sub-tropical regions of the world, particularly in Asia, Africa and Latin America. Therefore, the aim was to determine the phenotypic diversity of different cultivars of *C. olitorius* in Benin
Study Design: A randomized complete block design was used.
Methodology: Forty seed samples of *C. olitorius* were collected during a survey carried out in twenty-one (21) municipalities of Benin. These seeds were sown at Savè in the center of Benin. Twelve (12) quantitative traits and eleven (11) qualitative traits were recorded.
Results: The results of principal component analysis and hierarchical ascending classification applied to quantitative variables showed six (06) classes of cultivars namely: C1, C2, C3, C4, C5 and C6. The discriminating characteristics highlighted were: plant height, number of leaves per plant, number of branches per plant, leaf length, leaf width, fruit length, fruit diameter, flowering

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date, the number of days between two successive cuts and fresh leaf weight. For cultivars of classes C5 and C4, the number of days between two successive cuts was the shortest and their cycle was the longest. Fresh leaf weight and fruit number per plant were higher. As for the qualitative characters studied, only four cultivars showed variability. Three (03) leaf types were identified: lobed type, lanceolate type and simple indented type.

Conclusion: There is a great variability within Benin cultivars. Cultivars from southern Benin were more diverse than those in the north. Cultivars of the classes C5 and C4 showed the best performance (important number of leaves and branches, high yield and a big size). These two classes are of great importance to vegetable farmers and breeders. Cultivars of classes C1 and C3 are of less importance.

Keywords: Corchorus olitorius; morphotype; characterization; multivariate analysis; diversity; Benin.

1. INTRODUCTION

Leafy vegetables are known to add taste and flavour, as well as substantial amounts of protein, fiber, minerals, and vitamins to the diet [1,2]. Among the vegetables, genus *Corchorus* L. is one of the most important groups [2,3]. Nowadays, it belongs to the family of Sparmaniaceae [4]. It contains about forty species including *Corchorus olitorius* which is one of the most cultivated *Corchorus* species in the world. In Benin, it is cultivated nationwide and its local name varies according to the regions: Nenounwi, Dun, Obèyo, yoyo [5]. It is recognized for its high intra-specific diversity and a wide distribution [6]. It is found in Asia, America and Africa [7,8]. *Corchorus olitorius* leaves are well known as emollient, diuretic, tonic and purifying human body [9]. Its leaves are also used to make a sticky sauce that accompanies the first courses. *Corchorus olitorius* leaves are very rich in amino acid and essential minerals [10]. They are used as herbal pharmacopoeia against malaria or typhoid fever. In other African countries and especially in Asia, *C. olitorius* is grown for its stem fiber properties [11]. In the world, this species ranks second behind cotton as a source of fiber. Fiber of *C. olitorius* is used to make clothing, bags, ropes, packaging, etc. [11,12], its fiber is environmentally friendly because of its biodegradability. Previous research findings indicated that edible species of *Corchorus* are a very good source of proteins, vitamins (A, C, E) and are also rich in mineral nutrients like calcium and iron [13, 14]. Moreover, *C. olitorius* with its high levels of iron and folate is used for the prevention of anaemia [12].

Several studies across the world have shown that *C. olitorius* has a high morphological diversity: Nigeria [15], Senegal [16], Egypt [17], Pakistan [18] and many other countries. In Benin, it is not uncommon to see different leaf types when moving from one locality to another.

From the socio-economic viewpoint of this vegetable in our country, it is important that the research focuses on the diversity that exists within it. Therefore, the main objective of this study was to determine the agro-morphological diversity of different cultivars of *C. olitorius* in Benin.

2. MATERIALS AND METHODS

2.1 Collection of Seed Samples of *C. olitorius*

To ensure a good representation, twenty-one (21) municipalities (Fig. 1) were selected across Benin to collect seed samples of *C. olitorius*. These municipalities were selected based on their potential in gardening and their accessibility. Geographical coordinates of the various collection points are presented in Table 1.

Seed samples were collected directly from plants in the fields or in farmer's seed stock. In both cases, seeds were put separately into envelopes then labeled. Once all the samples collected, a code was given to each cultivar (Table 2).

2.2 Setting up and Monitoring of the Experiment

The experiment was set up in a garden site (8° 02 '29.23 "N and 2° 28' 51.26" E) of Savè city, Department of Collins. The site is located in the village of Ba-Otcho in the district of Plateau. The climate in the district of Savè is the transition of the sub equatorial of the south and Sudano-Guinean of the north. The annual average temperature varies between 27ºC and 28.6ºC every year. Minimum temperatures of 19ºC were recorded in December-January and maximum of 40ºC in March-April [19].

Forty (40) cultivars were sown in a two big trial plots where the seed samples collected were

randomized. After germination, the seedlings were transplanted in an interval of 0.20 m * 0.20 m on these two big trial plots (16.40 m * 2.40 m). On these two big trial plots, every cultivar had twelve (12) plants. The first trial plot was used to collect quantitative and qualitative traits and the second trial plot was used to collect yield data after cutting plants. To break dormancy, seeds were treated with hot water (90ºC) for five (05) minutes [20]. Forty (40) small trial plots (0.6 m * 0.4 m) were designed to serve as a nursery for each cultivar. The nursery was watered daily.

A basal fertilizer (50 kg / ha of NPKSB 14-23-14-5-1) was applied in order to accelerate recovery after transplantation. Transplantation was done fifteen (15) days after emergence.

Table 1. Geographical coordinates of collection sites

N°	Municipalities	Geographical coordinates		
		Sample 1	**Sample 2**	**Sample 3**
1	Bembèrèkè	10° 23’ 50,04" N 2° 43’ 32.63" E	10° 23’ 50,04" N 2° 43’ 32.63" E	10° 12’ 04.32" N 2° 38’ 32.60" E
2	Abomey-Calavi	6° 28’ 17.03" N 2° 20’ 54.20" E	-	-
3	Copargo	9° 49’ 59.91" N 1° 32’ 57.35" E	-	-
4	Dassa	7° 40’ 39.27" N 2° 13’ 29.62 E	-	-
5	Djakotomey	6° 50’ 28.73" N 1° 45’ 41.63" E	6° 54’ 22.24 N 1° 42’ 45.07 E	-
6	Djougou	9° 41’ 11.78" N 1° 39’ 47.44" E	9° 41’ 11.78" N 1° 39’ 47.44" E	9° 42’ 05.75" N 1° 40’ 18.77" E
7	Gogounou	10° 47’ 18.24" N 2° 49’ 28.74" E	10° 47’ 18.24" N 2° 49’ 28.74" E	10° 56’ 46.40 N 2° 52’ 00.78 E
8	Grand Popo	6° 17’ 9.73" N 1° 48’ 26.39" E	-	-
9	Cotonou	6° 22’ 4.67" N 2° 23’ 29.56" E	-	-
10	Klouékanmey	6° 58’ 34.95" N 1° 50’ 13.19" E	6° 57’ 33.97 N 1° 49’ 24.87 E	-
11	Lalo	6° 55’ 29.26" N 1° 53’ 16.54" E	-	-
12	Lokossa	6° 38’ 33.83" N 1° 42’ 37.55" E	-	-
13	Mallanville	11° 52’ 02.47" N 3° 22’ 45.33" E	11° 52’ 02.47" N 3° 22’ 45.33" E	11° 52’ 02.47" N 3° 22’ 45.33" E
14	N'dali	9° 53’ 57.52" N 2° 42’ 52.01" E	9° 53’ 57.52" N 2° 42’ 52.01" E	9° 53’ 57.52" N 2° 42’ 52.01" E
15	Ouidah	6° 22’ 32.53" N 2° 3’ 49.78" E	-	-
16	Pehunco	10° 13' 42.60" N 2° 00' 70.88" E	10° 13' 42.60" N 2° 00' 70.88" E	10° 13' 42.60" N 2° 00' 70.88" E
17	Pobè	6° 58' 59.67" N 2° 39' 48.98" E	-	-
18	Savalou	7° 55’ 30.94" N 1° 58’ 39.51" E	7° 53’ 45.44" N 2° 05’ 12.45" E	-
19	Savè	8° 00’ 11.96" N 2° 22’ 40.18" E	-	-
20	Sèmè-kpodji	6° 25' 20.92" N 2° 35' 56.70" E	-	-
21	Toffo	6° 50' 59.99" N 2° 04' 59.99" E	6° 50' 59.99" N 2° 4' 59.99" E	-

2.3 Data Analysis

The qualitative and quantitative data collected are presented in Table 3. To facilitate the manipulation of these variables, abbreviations were attributed to the quantitative variables. Trait selection and measurement techniques were based on [21]. Data were collected on each of the ten plants of each cultivar.

Principal Component Analysis and Discriminant Analysis were performed on quantitative data using SAS 9.2 software. PROC CLUSTER procedure was used to group the 40 cultivars based on their phenotypic relationship. A simple description by analyzing frequency or proportion of different categories of each categorical variable was performed for qualitative data.

3. RESULTS

3.1 Quantitative Variables

The Principal Component Analysis performed on the quantitative variables revealed four (04) first principal axes. These four (04) axes restored 77.82% of the total variation (Table 4). This means that those axes gathered 77.82% of information and provided enough precision for interpretations. The cultivars were classified into six distinct cluster groups using PROC CLUSTER (procedure WARD). Six (06) classes were then retained and represented in the dendrogram (Fig. 2). Class C1 with seven (07) cultivars and class C2 with three (03) cultivars consist of individuals collected from southern Benin. There are also two cultivars from N'Dali and Djougou (northern part of Benin). Class C3 is the second largest group after C5 with ten (10) cultivars. Most of these cultivars were also from the coastal zone. In this group, we found both individuals from the north and the south. Four (04) cultivars were found in the class C4. Class C5 included 13 cultivars. This class C5 represents most cultivars collected from the north and the hills. The leaves were lobed as shown in Fig. 5. Class C6 contained only three (03) cultivars with simple and indented leaves (Fig. 7). The leaves on the plants appeared greener and more shiny (reflecting the sunlight) than the other cultivars.

The different cultivars found in each class and their origins are shown in Table 5. The characteristics (mean and standard deviation) of the initial variables for each of the six (06) selected classes are presented in Table 6.

Table 2. Names of different cities and cultivars' code

N°	Towns	Cultivars code		
		Sample 1	Sample 2	Sample 3
1	Bembèrèkè	V1	V2	V3
2	Abomey-Calavi	V4	-	-
3	Copargo	V5	-	-
4	Dassa	V6	-	-
5	Djakotomey	V7	V8	V9
6	Djougou	V10	V11	V12
7	Gogounou	V13	V14	-
8	Grand-Popo	V15	V16	-
9	Cotonou	V17	-	-
10	Klouékanmey	V18	V19	-
11	Lalo	V20	V21	V22
12	Lokossa	V23	V24	-
13	Mallanville	V25	V26	-
14	N'dali	V27	V28	V29
15	Ouidah	V30	-	-
16	Ouassa-Péhunco	V31	V32	V33
17	Pobè	V34	-	-
18	Savalou	V35	V36	-
19	Savè	V37	-	
20	Sèmè-kpodji	V38	-	-
21	Toffo	V39	V40	-

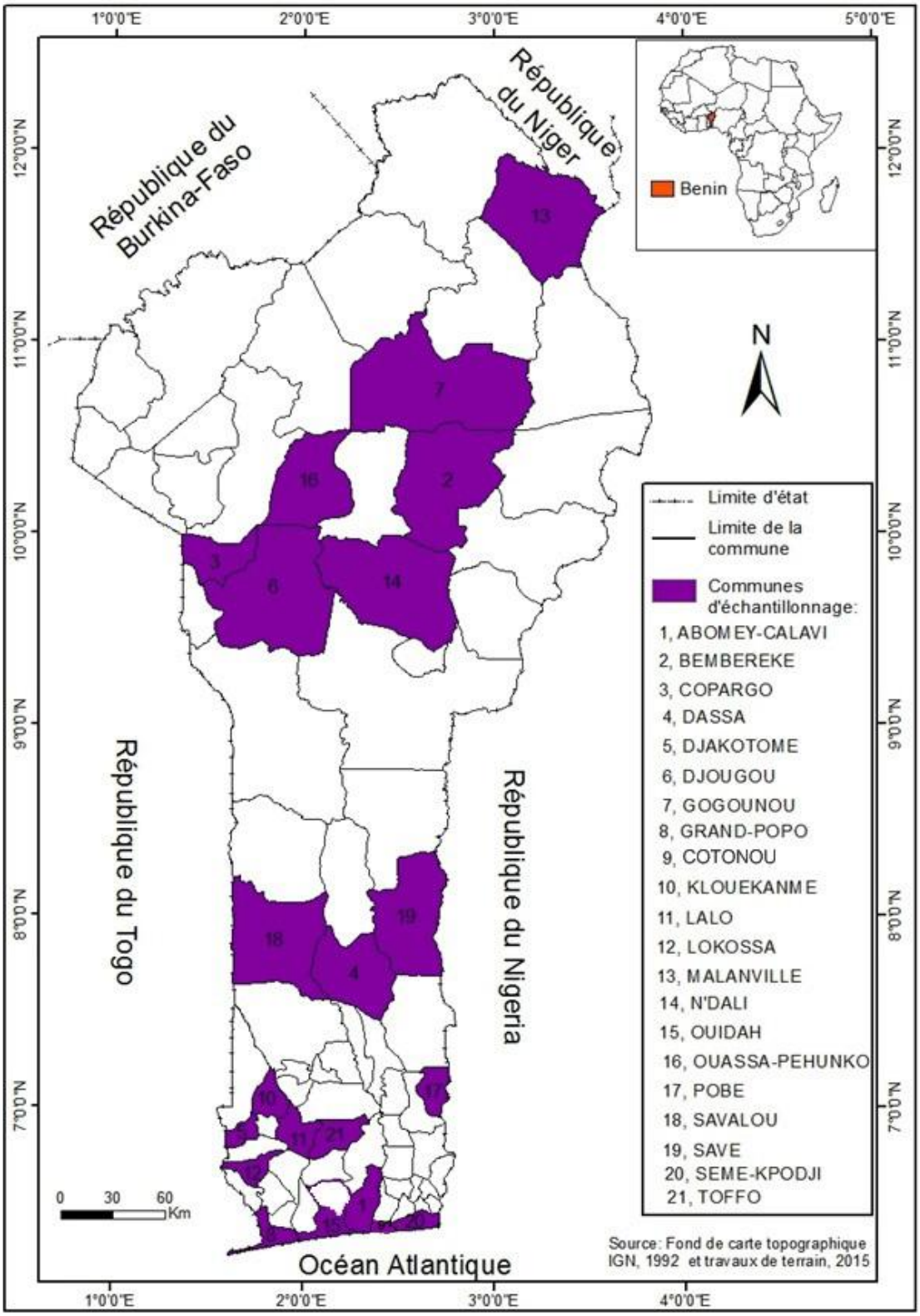

Fig. 1. Municipalities chosen for the collection of seed samples of *C. olitorius*

Table 3. Descriptors used

N°	Quantitative descriptors	Abbreviations
1	Plant height	HP
2	Number of leaf per plant	NFPP
3	Number of ramifications per plant	NRPP
4	Fresh leaf weight per plant	PFrPP
5	Leaf length	LoF
6	Leaf width	LaF
7	Fruit length	LoFr
8	Fruit width	LaFr
9	Number of fruit per plant	NFrPP
10	Flowering date	DFl
11	Physiological maturity date	DMP
12	Number of days between two successive cuts	NJDC
13	Fresh leaf weight per plant	PFePP
N°	**Qualitative descriptors**	
1	Stem color	
2	Hairiness of the stem	
3	Leaf type	
4	Leaf color	
5	Hairiness on the superior face of leaf	
6	Hairiness on the inferior face of leaf	
7	Leaf nervation	
8	Presence of stipule	
9	Dry fruit color	
10	Seed color	
11	Level of attack	

Discriminant analysis was used to differentiate characters. Plant height, number of leaves per plant, number of branches per plant, leaf length, leaf width, fruit length, fruit diameter, flowering date, and the number of days between two successive cuts were discriminating variables and significantly correlated with the first canonical axis. Only the fresh leaf weight was correlated with the second canonical axis. Fig. 2 highlights the potential of each class in relation to discriminated characters represented on the first canonical axis. Individual plants of class C5 had the most height (47.72 cm), the largest number of leaves (mean 85.16) and the largest number of branches (20.68). They are followed by cultivars of class C4 with 40.46 cm, 74.88 and 19.13 for these three characters, respectively. The number of days between two successive cuts was substantially equal to fifteen (15) days for both classes. However, the days to flowering were more important for class C4 (65.55 days) than for C5 (54.84 days). This shows that the class C5 is more important than the class C4 because the earlier the flowering the less the production of leaves.

Unlike classes C4 and C5, Class C1 included individuals with less performance. These individuals were smaller in size (21.83 cm), with little branching (14.46) and few leaves (41.70). Twenty (20) days between two successive cuts were recorded and they flowered very early (30 days).

The other classes showed average performance. However, there are some clarifications: the cultivars of the class C6 flowered late (76.53 days). However, this class had small individuals (28.16 cm) with few branches (16.63) and few leaves (52.70). The C4 class had the largest leaves (3.42 cm) unlike the Class C1 (1.99 cm).

Plants of class C1 and C3 had almost the same number of branches (14.79 as against 14.46 for C1). For other characters, there is no difference.

For traits related to the width of the leaves and fruit, only the leaves of the class C4 were wider than those of class C5 (an average of 3.42 cm against 2.95 cm) .

Fig. 3 shows the average characteristics of classes for each variable represented in the first axis. It should be noted that the cultivars of class 5 had the highest size, more branches with the largest number of leaves. It is important to mention that class C5 was mainly found in the hills. The number of days between two successive cuts was more important for cultivars of the third class. The latter performance was poor.

The fresh leaf weight was used as an indicator for productivity. Plants of class C5 had the best performance in terms of productivity with average weight of 0.62 kg/cut then followed by the class C6. This performance is due to the large size and the large number of leaves produced by these cultivars. These individuals can be recommended to producers to improve their yields.

The number of fruits per plant was used to determine the cultivar with more seeds. Table 5 shows the mean values for each class. The

classes C3, C5 and C6 had an average of 8.46 fruits ± nine (09) fruits per plant. They showed the best and significant performance for that very important character. These individuals are ideal for seed production. For other classes, the average number of fruit was 7.46 ± eight (08).

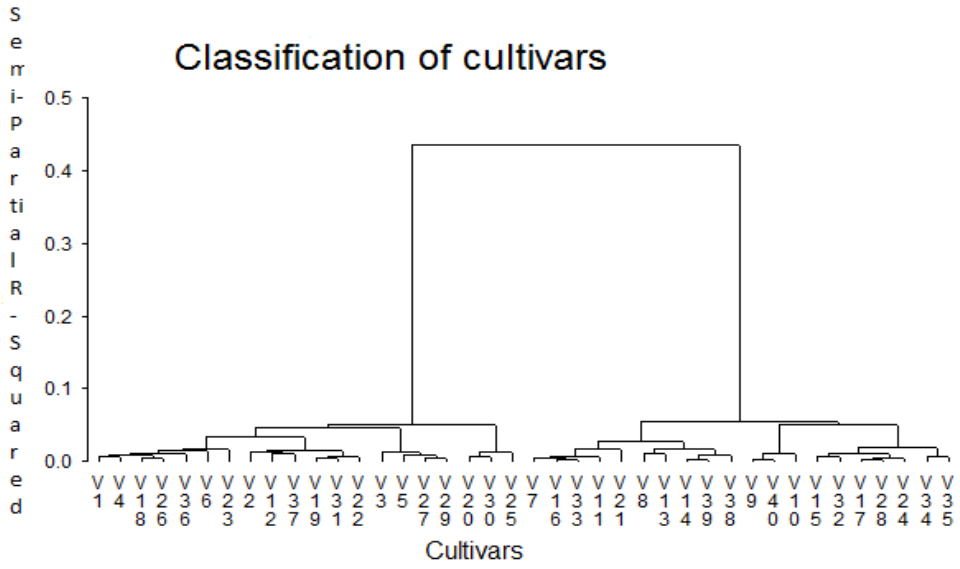

Fig. 2. Dendrogramm showing the relationship among the forty cultivars of *C. olitorius based on 13 agro-morphological traits*

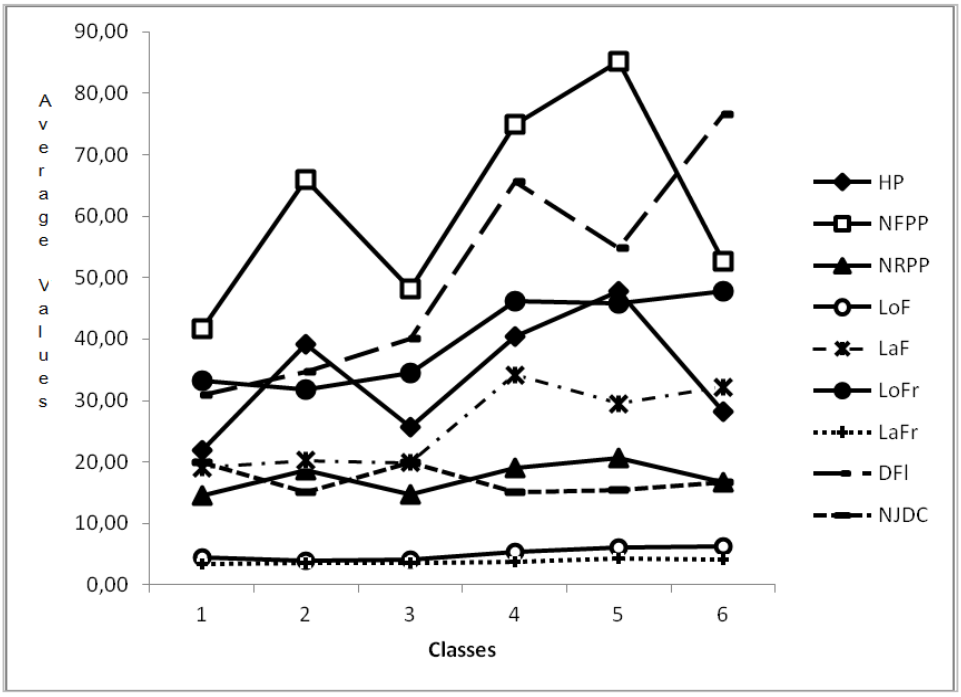

Fig. 3. Mean of class traits for discriminate variables

Note : Because of scale, the values of variables «leaf width», «fruit length» and «fruit diameter» have been multiplied by 10; The abbreviation as mentioned above (Table 3)

Table 4. Eigen values, proportions and cumulative proportions according to axis

Axis	Eigen values	Proportion	Cumulative proportions
1	6.41743518	0.4936	0.4936
2	1.67317832	0.1287	0.6223
3	1.06561652	0.082	0.7043
4	0.9609167	0.0739	0.7782
5	0.74375899	0.0572	0.8354
6	0,69040134	0.0531	0.8885
7	0.47989618	0.0369	0.9254
8	0.34846066	0.0268	0.9522
9	0.25086713	0.0193	0.9715
10	0.14763723	0.0114	0.9829
11	0.13568687	0.0104	0.9933
12	0.06265115	0.0048	0.9981
13	0.02349372	0.0018	1

Table 5. Different cultivars grouped on the basis of the classes and cities of collection

N°	Cultivars	Classes	Towns	N°	Cultivars	Classes	Towns
1	V15	C1	Grand popo	1	V7	C3	Djakotomey
2	V17	C1	Cotonou	2	V8	C3	Djakotomey
3	V24	C1	Lokossa	3	V11	C3	Djougou
4	V28	C1	N'dali	4	V13	C3	Gogounou
5	V19	C1	Klouékanmey	5	V18	C3	Klouékanmey
6	V34	C1	Pobè	6	V16	C3	Grand popo
7	V23	C1	Lokossa	7	V21	C3	Lalo
1	V9	C2	Djakotomey	8	V4	C3	Abomey-Calavi
2	V10	C2	Djougou	9	V38	C3	Sèmèkpodji
3	V40	C2	Toffo	10	V39	C3	Toffo
1	V3	C4	Bembèrèkè	1	V1	C5	Bembereke
2	V5	C4	Copargo	2	V2	C5	Bembereke
3	V27	C4	N'dali	3	V14	C5	Gogounou
4	V29	C4	N'dali	4	V6	C5	Dassa
1	V20	C6	Lalo	5	V12	C5	Djougou
2	V25	C6	Mallanville	6	V33	C3	Peounco
3	V30	C6	Ouidah	7	V32	C5	Peounco
				8	V22	C5	Lalo
				9	V35	C5	Savalou
				10	V26	C5	Mallanville
				11	V31	C5	Peounco
				12	V36	C5	Savalou
				13	V37	C5	Savè

3.2 Qualitative Variables

The results of the frequency analysis of variables are shown in Fig. 4. Apart from the type of leaves, the color of dry fruit, seed color and the level of pest attack, and other characters were the same for all cultivars (Table 7). It should be noted that three (03) leaf types were identified: the lobed type (42.5%), lanceolate type (25%), and simple indented type (32.5%) (Figs. 5a, 5b and 5c)

4. DISCUSSION

The result of this study shows that the same cultivars are found both in the south and in the north. The high presence of cultivars in the southern and northern regions could be due to the exchange of seeds between producers in these regions. Multivariate analysis was used to classify *C. olitorius* cultivars from Benin in six (06) classes. There was a variability in the collected cultivars. In Nigeria, [4] identified only two (02) classes from fourteen (14) accessions of *C. olitorius analyzed.* This difference is certainly

due to the small number of accessions they studied. Moreover, in Nigeria [14] identified four (04) classes from fifteen (15) accessions. The individuals in group 3 had simple indented leaves (Fig. 7). Leaf characteristics were quite similar to those of *Corchorus olitorius var. olitorius* described by [16]. Likewise, cultivars found in class 5 were related to *Corchorus olitorius var. incisifolius* described by [16]. It is then necessary to conduct taxonomic and molecular studies in order to determine if the individuals of these two classes (C3 and C5) are the same with those described by Mbaye.

Discriminant analysis was used to differentiate the following characters: plant height, number of leaves per plant, number of branches per plant, leaf length, leaf width, fruit length, fruit diameter, flowering date, number of days between two successive cuts and fresh leaf weight. [15] also found that the number of leaves per plant, mature plant weight, rod weight, fresh leaf weight and harvest index were discriminating characters between *C. olitorius* populations. [16] found variation in a number of vegetative characters among three Egyptian cultivars of *C. olitorious.* Several studies carried out using molecular marker techniques showed genetic variation in *C. olitorius* [22,23,6].

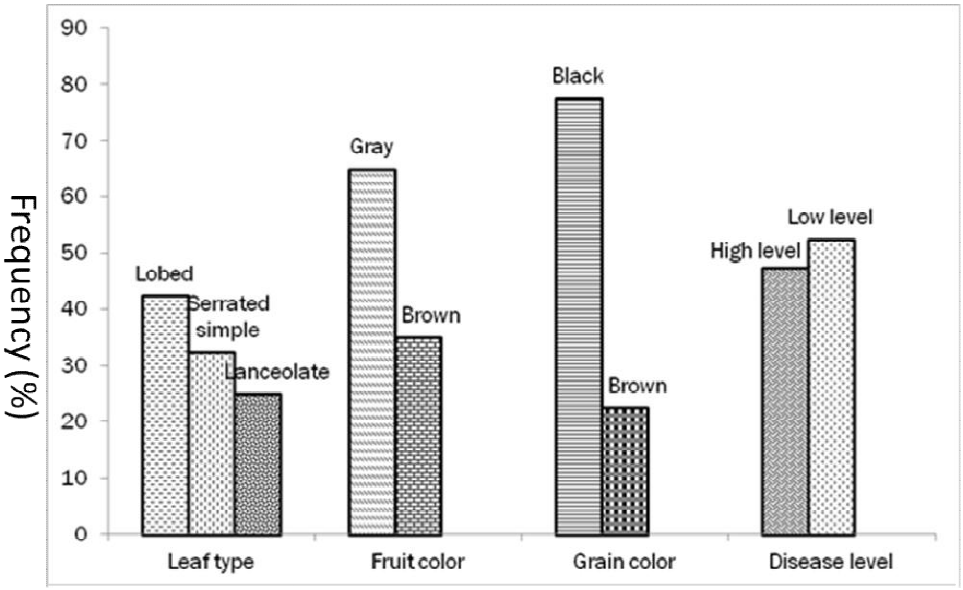

Fig. 4. Histogram of qualitative variables frequency

Note: The histogram presents only the four variables which have variability;

Table 6. Mean (±SD) of quantitative variables for each class. The results are given as mean±SD

	C1	C2	C3	C4	C5	C6
HP	21.83±5.47	39.21±10.19	25.65±6.32	40.46±9.12	47.72±7.97	28.16±9.29
NFPP	41.70±5.73	66.00±13.45	48.21±10.97	74.88±11.57	85.16±14.74	52.70±20.23
NRPP	14.46±1.20	18.63±247	14.79±1.40	19.13±2.06	20.68±1.94	16.63±2.56
LoF	4.55±0.90	3.99±0.24	4.15±0.29	5.41±0.46	6.12±0.57	6.29±0.59
LaF	1.91±0.28	2.02±0.19	1.99±0.19	3.42±0.11	2.95±0.29	3.22±0.34
LoFr	3.32±0.18	3.18±0.12	3.46±0.28	4.62±0.41	4.58±0.30	4.79±0.36
LaFr	0.35±0.01	0.36±0.03	0.36±0.02	0.37±0.02	0.42±0.03	0.42±0.01
NFrPP	7.10±0.62	7.60±0.26	8.29±0.75	7.55±0.66	8.25±0.47	8.83±0.06
PFePP	0.11±0.01	0.13±0.01	0.11±0.02	0.11±0.01	0.14±0.01	0.14±0.01
PFrPP	5.39±0.59	5.47±0.32	5.6±0.34	5.98±0.33	6.27±0.56	6.1±0.17
DFl	30.83±10.31	34.63±13.66	40.06±18.23	65.55±13.05	54.84±19.07	76.53±0.29
DMP	27.81±0.28	27.47±0.15	27.43±0.28	27.70±0.22	27.39±0.30	27.17±0.23
NJDC	19.93±0.19	15.00±0.00	20.00±0.00	15.00±0.00	15.38±1.39	16.67±2.89

5a

5b

5c

Fig. 5. The three morphological types of *Corchorus olitorius* leaves a - Lobed leaf type b - Lanceolate leaf type c - Simple indented leaf type

Table 7. Percentage distribution between the cultivars of C. *olitorius* in Benin through 11 qualitative traits

Qualitative variables	Observations	Percentage (%)	Qualitative variables	Observations	Percentage (%)
Stem color	Green	100.0%	Hairiness on the	Presence	0.0%
	Another	0.0%	superior face of leaf	Absence	100.0%
Hairiness of	Presence	0.0%	Leaf nervation	Pinnate	100.0%
the stem	Absence	100.0%		Another	0.0%
Leaf type	Lobed	42.5%	Presence of stipule	Presence	100.0%
	Serrated simple	32.5%		Absence	0.0%
	Lanceolate	25.0%	Dry fruit color	Gray	65.0%
Leaf color	Green	100.0%		Brown	35.0%
	Another	0.0%	Seed color	Black	77.5%
Hairiness on	Presence	0.0%		Brown	22.5%
the inferior face of leaf	Absence	100.0%	Level of attack	High	47.5%
				Low	52.5%

The analysis of correlations between variables and canonical components revealed that apart from the number of days between two successive cuts, the correlations were positive for all other characters including the date to flowering. This means that plant with high size has a lot of leaves and branches, big biomass, significant leaves and fruits. This positive correlation was also reported by [15]. The long cycle of this species is of great importance, especially for gardeners who can allow the plant to grow sufficiently before the cut in order to increase the economic viability.

From the present work, the class C5 is the most appropriate class for varietal improvement. It has many interesting features: large size, large number of leaves, greater aboveground biomass and the longest cycle. The number of days between two successive cuts is the shortest. Class C5 is also an indicative of seed production. Therefore, from the breeding point of view, these genotypes appear to be good candidates for jute-breeding programs focusing on the large number of leaves and seed yield. As regards the results of the frequency analysis performed on variables, there is very little variability in the population of *C. olitorius* in Benin. The leaves of all cultivars are green, hairless with pinnate venation and stipules. These observations are similar to those realized by [16]. The stems and leaves showed no hairiness. As for the type of the leaves, there were three (03) types: lanceolate, lobed and simple indented. These results are in concordance with those of [21,24].

There were two color patterns of dry fruit and seed. 65% of dry fruits were grayish while others were brown (Fig. 4). 77.5% of seeds were black while others were brown (Fig. 4). The two colors were also reported by [21].

5. CONCLUSION

The present study focused on the agro-morphological characterization of 40 cultivars of *C. olitorus* collected in Benin. The results obtained in this study showed that there is a great variability within Benin cultivars. The results of multivariate analysis on quantitative data revealed six (06) classes. Plant height, number of leaves per plant, number of branches per plant, leaf length, leaf width, fruit length, fruit diameter, flowering date, number of days between two successive cuts and fresh leaf weight were the characters that best explain the agro morphological diversity.

Cultivars from southern Benin were more diverse than those in the north. Individuals of classes C5 and C4 showed the best performance. Therefore, from the breeding point of view, these genotypes seem to be good candidates for jute-breeding programs focusing on the large number of leaves and seed yield. These two classes are of great importance to vegetable growers and breeders. Classes C1 and C3 were of less importance. Three (03) leaf types were identified: lobed type, lanceolate type and simple indented type.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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