



Agromorphological diversity of local cassava (*Manihot esculenta* Crantz) accessions cultivated in the South of Côte d'Ivoire

THIEMELE Deless Edmond Fulgence^{1*}; SILUE Souleymane¹; NOBA Akotchale Giresse Théodule¹

¹Department of Genetics and Biochemistry, Genetics Research Unit, Peleforo GON COULIBALY University of Korhogo, Po Box 1328 Korhogo, Côte d'Ivoire.

ARTICLE INFO

Article No.: 042924053

Type: Research

Full Text: [PDF](#), [PHP](#), [HTML](#), [EPUB](#), [MP3](#)

Accepted: 03/05/2024

Published: 30/06/2024

*Corresponding Author

THIEMELE Deless Edmond

Fulgence

E-mail: delessthiemele@gmail.com

Keywords: Agromorphological diversity, Cassava accession, Genetic erosion, Côte d'Ivoire.

ABSTRACT

Cassava (*Manihot esculenta* Crantz) is an important food source in Côte d'Ivoire and it contributes to food security. Nonetheless, its production is facing many constraints including the abandonment of landraces. With a view to preserving genetic diversity for crop improvement, 47 cassava accessions were collected in the Southern region of Côte d'Ivoire and evaluated agromorphologically on the basis of eight quantitative traits. Based on ANOVA (Analysis of Variance), high variability was shown within the accessions for the traits evaluated. The principal component analysis (PCA) applied to the 47 accessions confirmed this variability of 75.04% revealed by the first three axis. The ascending hierarchical clustering (AHC) placed the accessions into 3 groups based on the height of the plant, the length of the petiole and the number of tuberous roots per plant. Group 1 includes accessions with large plants (HPL = 305.57cm), average number of roots per plant (NTP = 6.31) and long petiole (LPE = 24.84cm). Group 2 is composed of small-sized accessions (HPL = 260 cm) with a low number of roots per plant (NTP = 4.17) and short petioles (17.07 cm). Group 3 contains accessions of intermediate size (HPL = 294 cm) with a high number of roots per plant (NTP= 7.68) and petioles of medium length (LPE = 18.45 cm). The Agromorphological variability observed in the study offers a great possibility of choosing elite accessions for the breeding of improved varieties of cassava with high potential yield and adapted to different agroclimatic zones of Côte d'Ivoire. Also, this study showed that some accessions with the same names are phenotypically different. The conservation of these accessions in collections will make it possible to fight against the erosion of these genetic resources.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) from the *Euphorbiaceae* family is an important tuber crop cultivated in many countries around the world and more particularly in West Africa (N'Zué *et al.*, 2014; Agré *et al.*, 2015). It draws its importance firstly from its tuberous roots which are rich in starches and its leaves which are rich in protein. It remains an undeniable asset for a region that is less and less self-sufficient in terms of food (Gnonloufin *et al.*, 2011). It also draws its importance from its great ease of cultivation and its various energy products. Ethanol obtained by starch fermentation could completely replace gasoline (N'Zué *et al.*, 2014; Agré *et al.*, 2015; Adjebang-Danguah *et al.*, 2016).

In Côte d'Ivoire, cassava represents the second food crop after yam with an annual production of around 6.3 million tonnes (Faostat, 2022). This crop is well integrated into all cropping systems. The Ivorian people have made it a staple food and there is a great varietal diversity favoring different types of local dishes (attiéké, bédékouman, placali, etc.). In production areas, cassava accessions are designated by vernacular names linked to the phenotype or the name of the place of origin or of a person who introduced it into a locality. This method of designation often gives rise to confusion, since the same accession can have different names depending on the production area. Also, cultural practices linked to the use of cuttings infected by viruses from year to year promote the progressive loss of varietal diversity of cassava (Amoakon *et al.*, 2023).

As well, the abandonment of certain traditional or local accessions by farmers due to factors such as their low yield, their long production cycle and their susceptibility to diseases (viruses, anthracnose, root rot) and pests (mites, mealybugs, nematodes), contribute largely to the loss of cassava genetic resources. In addition, the loss of soil fertility, the action of bush fires, the difficulty of supplying healthy planting material among others cause the decline in national yield. This constitutes a major threat to food security, particularly for small farmers practicing subsistence agriculture (Segnou, 2002). These farmers, contribute to the spread of viral-infected material through the exchange of infected cuttings, leading to a constant reduction in yields (Singa *et al.*, 2008). The result is a gradual abandonment of local accessions in favor of improved ones, leading to the erosion of local cassava genetic resources. However, the preservation of these local accessions constitutes an important issue for sustainable agricultural development in Sub-Saharan Africa. In the current context of climate change, one of the strategies likely to combat this erosion involves the collection, analysis and organization of the existing diversity in production

areas. This allows not only knowledge of the existing cultivars, but also to guide the methods of conservation and management of these genetic resources in varietal improvement programs.

The study of the diversity of accessions from the South of Côte d'Ivoire will allow us to better understand the genetic diversity of these local accessions and the agronomic potential in order to better exploit them in a varietal improvement program to increase national production. Many studies of characterization have been carried out on the genetic resources of cassava from Côte d'Ivoire (N'Zué 2007; N'Zué 2014; Djaha *et al.*, 2017; Doubi *et al.*, 2021; Kouakou *et al.*, 2022; Kouakou *et al.*, 2023), however, cassava accessions newly collected in farmers' fields in the regions of South of Côte d'Ivoire had not yet been characterized in terms of morphological and agronomic traits.

Thus, the general objective of the present study was to study the agromorphological diversity of cassava accessions cultivated in the South of Côte d'Ivoire for their efficient exploitation. Specifically, the aim was to (i) characterize the accessions on an agromorphological level and (ii) establish the structure of the agromorphological variability for rational conservation and management purposes.

MATERIALS AND METHODS

Site of study

The study was conducted in Toumodi region of Côte d'Ivoire on the experimental site of Swiss Center for Scientific Research (SCSR, Côte d'Ivoire). The experimental site is located at 6°25'0" N et 5°4'60" W and the area of the study is a transition zone, located between forest and savanna. The climate is equatorial, with a big rainy season starting from March to July and a short one starting from August to October. The average annual rainfall is 1200 mm of rain spread over 5 to 6 months. The soil is ferralitic and rich in humus.

Plant Material

The plant material consists of 47 local accessions of cassava collected in the south of Côte d'Ivoire from farmers in the areas of Abidjan, Bonoua, Grang-Lahou, Aboisso and Dabou. These accessions were referenced by their vernacular names given by the farmers. The number of accessions collected in the regions are summarised in the table 1.

Table 1: List of local accessions used for the study.

N°	Name of the accessions	Origin	N°	Name of the accessions	Origin
1	AKAMA	Abidjan	30	BOIS VERT	Dabou
2	PARASOL	Abidjan	31	ESSAPKELE	Dabou
3	ELEPHANT	Abidjan	32	6 MOIS	Dabou
4	CAMEROUN	Abidjan	33	BOCOU 1	Dabou
5	OKOMA	Abidjan	34	YACE	Bonoua
6	YACE FOUTOU	Abidjan	35	BONOUA	Bonoua
7	SANDRA	Abidjan	36	ACCRA BANKYE	Bonoua
8	BONOUA ROUGE	Abidjan	37	6 MOIS	Bonoua
9	SICAVA	Abidjan	38	NANTALE	Bonoua
10	BOUAGA	Abidjan	39	DENIKACHA	Bonoua
11	NOUVELLE VARIETE CNRA	Abidjan	40	BEDINA	Bonoua
12	ANCIENNE VARITE CNRA	Abidjan	41	BAHIRE	Bonoua
13	MEDE	Abidjan	42	6 MOIS	Aboisso
14	YACE ATTIEKE	Abidjan	43	TAMBOU	Aboisso
15	TOGO	Abidjan	44	SINZI	Aboisso
16	WANGO	Abidjan	45	BAHIRE	Aboisso
17	MAMANWA	Abidjan	46	BONOUA	Aboisso
18	BONOUA VERT	Abidjan	47	NONKLO MOKLO	Aboisso
19	INCONNUE	Abidjan			
20	SOGORO	Abidjan			
21	TAPIOCA	Abidjan			
22	BAHIRE	Abidjan			
23	DABOU/ESSAPKELE	Grand-Lahou			
24	YAVO	Grand-Lahou			
25	AKAMA	Grand-Lahou			
26	TIMITI	Grand-Lahou			
27	YACE	Grand-Lahou			
28	BOCOU 1	Grand-Lahou			
29	SAMAKE	Dabou			

Experimental design

The field experiment was arranged in randomized complete block design with three replications (or blocks). Each block was divided into 47 elementary plots and each elementary plot corresponds to an accession and has 5 rows of 6 plants, for a total of 30 plants per elementary plot. The planting density was 10,000 plants/ha, with a spacing of 1 m (rows) x 1 m (plants) and 1.5 m between plots and 2 m between blocks. Stem cuttings (20-30 cm or 4-6 comprising nodes) were horizontally planted on ploughed soil at a depth of less than 10 cm. A supply of NPK fertilizer (15-15-15) was applied at a dose of 200 Kg/ha two months after planting. Five weedings were carried out as needed during the vegetative phase.

Data collection

Eight (8) quantitative traits were selected in standard descriptors for cassava (Fukuda *et al.*, 2010) to characterize agromorphological diversity (Table 2). The quantitative traits were measured on ten plants. In order to avoid border effects, these plants were chosen in the central part of each elementary plot.

Table 2: List of agro-morphological descriptors used for the characterisation of 47 cassava accessions

Characters	Codes	Unit	Description and measurement
Number of branchings	NNRAM		It corresponds to the number of branching observed on the main stem
Plant height	HPL		It corresponds to the distance from the ground to the top of the canopy
Height of the first branching	HRAM1	cm	It corresponds to the height from ground to first primary branch.
Petiole length	LPE	cm	It corresponds to the distance between the point of insertion of the petiole on the stem and the base of the leaf
Length of the central lobe	LLOC	cm	It is the distance between the point of insertion of the lobes and the upper tip of the central lobe.
Diameter at the colet of the principal stem	DC	cm	It corresponds to the diameter of the most developed stem at the colet
Number of storage roots per plant	NTP		Total number of consumable roots of each plant
Fresh weight of accumulated roots per plant	PTP	kg	Total root weight of each plant weighed with an electronic scale. Measured at harvest

Data analysis

The collected data were processed using XLSTAT-Pro software version 2019. The quantitative variables were first subjected to descriptive statistical analyses, including correlations, followed by an analysis of variance (ANOVA) to identify significant characteristics, with a significance level of 5%. When the ANOVA was significant ($p < 0.05$), a Student Newman Keul (SNK) test was performed to differentiate the means. Principal component analysis (PCA) was then used to identify the relationships between the different characteristics studied. The groups obtained from the ascending hierarchical classification (AHC) were then characterised using a new analysis of variance. Finally, the structure of the agromorphological variation was visualised using Hierarchical Correspondence Analysis (HCA) with Ward's method, enabling the results to be represented in the form of a dendrogram.

RESULTS

Agromorphological variability of cassava accessions

Descriptive analysis of the measured traits revealed significant differences between accessions. Most of the variables had a high coefficient of variation (CV), ranging from 23.35% to 105.64%, thus showing the variability of these traits within the cassava collection (Table 3).

The results of the analysis of variance (ANOVA) showed a significant difference ($p < 0.001$) between

accessions on the basis of the 8 characters assessed (Table 3). Descriptive analysis coupled with ANOVA showed that the length of central lobe (LLOC) varied from 9.10 cm to 24.10 cm. The BENEDIA (Bonoua) accession had the smallest length of the central lobe (9.10 cm) while the YACE FOUTOU (Azaguié) accession had the largest value (24.10 cm). The petiole length (LPE) varied from 10.30 cm to 47.10 cm with WANGO (Abidjan) accession having the smallest value (10.30 cm) and the accession YACE FOUTOU (Abidjan) having the largest (47.10 cm). The colet diameter of the stem (DC) varied from 1.36 to 3.34 cm between TIMITI accession (Grand-Lahou) with 1.36 cm and YACE FOUTOU accession (Abidjan) with 3.34 cm. The number of branching (NNRAM) varied from 0.30 to 4.1. The accession AKAMA (Grand-lahou) had the smallest value (0.30) and the BAHIRE accession (Aboisso) had the greatest value (4.1). The plant height also varied from 122 to 446 cm between MAMANWA (Abidjan) with 122 cm and YACE FOUTOU (Abidjan) with 446 cm. The height of the first branch (HRAM1) varied from 0.30 to 225.40 cm between AKAMA accession (Abidjan) with 0.30 cm and BOCOU 1 accession (Dabou) with 225.40 cm. The weight of the roots per plant (PTP) ranged from 0.24 to 11.40 kg. TAMBOU accession from Aboisso had the smallest value (0.24 kg) and SOROGO (Abidjan) accession had the greatest one (11.40 kg). The number of the roots per plant (NTP) ranged from 1 to 13 between TAMBOU (Aboisso) accession with 1 and ANCIENNE VARIETE CNRA (Abidjan) and TOGO (Abidjan) with 13 roots per plant.

Table 3: Descriptive statistics and results of the analysis of variance (ANOVA) of 47 cassava cultivars for the quantitative traits

Variables	Minimum	Maximum	Means	Standard Deviation	CV (%)	F
LLOC (cm)	9.100	24.100	14.673	3.427	23.355	14.67**
LPE (cm)	10.300	47.100	19.632	6.032	30.725	19.63**
DC (cm)	1.360	3.340	2.156	0.450	20.871	2.15**
NNRAM	0.300	4.100	1.331	0.870	65.364	1.33**
HPL (cm)	122.000	446.000	280.153	71.108	25.381	280.15**
HARAM1 (cm)	0.300	225.400	72.869	76.982	105.644	72.86**
PTP (kg)	0.240	11.400	3.171	1.971	62.157	3.17**
NTP	1.000	13.000	6.214	2.521	40.561	6.21**

LLOC: Length of the central lobe; LPE: Petiole length; DC: Diameter at the collet of the principal stem; NNRAM: Number of branchings; HPL: Plant height; HRAM1: Height of the first branching; PTP: Fresh weight of accumulated roots per plant; NTP: Number of storage roots/plant. **: Significant at 1 % level of probability.

Correlations between measured quantitative characteristics

The correlation coefficients obtained between the characters varied from -0.443 to 0.629 at the 5% threshold. Table 4 highlights many significant correlations between traits. Thus, the petiole length (LPE) is positively correlated with the length of the central lobe ($r = 0.629$). The length

central lobe was itself negatively correlated with the height of the first branching ($r = -0.443$). The height of the first branching is also positively correlated with the number of branching ($r = 0.425$). Plant height is positively correlated with the diameter at the collet of the principal stem ($r = 0.405$). Finally, the number of storage roots per plant is positively correlated with the weight of accumulated roots per plant ($r = 0.48$).

Table 4: Correlation coefficients between the 8 variables measured

Variables	LLOC	LPE	DC	NNRAM	HPL	HARAM1	PTP	NTP
LLOC								
LPE	0.629							
DC	0.361	0.338						
NNRAM	-0.206	-0.138	0.072					
HPL	0.345	0.334	0.405	-0.120				
HARAM1	-0.443	-0.292	0.009	0.425	0.014			
PTP	-0.002	0.262	0.275	0.114	0.241	0.216		
NTP	0.023	0.187	0.155	-0.018	0.305	0.131	0.480	

Values in bold are correlations significant at the 5% threshold.

LLOC: Length of the central lobe ; LPE : Petiole length; DC : Diameter at the collet of the principal stem; NNRAM : Number of branchings; HPL : Plant height; HRAM1 : Height of the first branching; PTP : Fresh weight of accumulated roots per plant ; NTP : Number of storage roots/plant. **: Significant at 1 % level of probability

Structuring the diversity of accessions

Principal Component Analysis (PCA)

The first Principal Component (PC) axis with an eigen value of 2.93 accounted for 36.65% of the variation. The traits that contributed most of the variation were length of the central lobe (LLOC), length of the petiole (LPE), Diameter of the colet (DC) and plant height (HPL). The second PC also

contributed 25.50% of the total variation and contained the number of branchings (NNRAM), the height of the first branching (HRAM1), the weight of accumulated roots per plant (PTP) and the number of storage roots per plant (NTP). The third PC with 12.89% contribution was associated with the number of branchings (NNRAM) (Table 5).

Table 5: Eigenvalues, correlations between traits and the first three-component axis

	Axis 1	Axis 2	Axis 3
Eigen value	2.932	2.040	1.031
Variance. Percent (%)	36.649	25.50	12.892
Cumulative. Variance percent (%)	36.649	62.149	75.041
Length of the central lobe (LLOC)	0,828**	-0,282	0,233
Petiole length (LPE)	0,850**	-0,061	0,182
Diameter at the colet of the principal stem (DC)	0,639**	0,376	0,485
Number of branchings (NNRAM)	-0,466	0,572*	0,544*
Plant height (HPL)	0,682**	0,317	-0,054
Height of the first branching (HRAM 1)	-0,473	0,701**	0,195
Fresh weight of accumulated roots per plant (PTP)	0,286	0,720**	-0,284
Number of storage roots per plant (NTP)	0,359	0,615**	-0,539

Values in bold are correlations significant at the 1 and 5% threshold: ** : Significant at 1 % level of probability and, *: Significant at 5 % level of probability.

Ascending Hierarchical Clustering (AHC)

Ascending hierarchical clustering led to the dendrogram presenting three clusters or groups of accessions (Figure 1). The group 1 contained 15 accessions and included the tallest accessions (HPL = 305.57cm), with an average number of roots per plant (NTP = 6.31) and long petiole (LPE = 24.84cm). The group 2 gathered 23 accessions of small size (HPL = 260 cm) with a low number of roots per plant (NTP = 4.17) and short petioles (17.07 cm). The group 3 grouped 9 accessions of intermediate size (HPL = 294 cm) with a high number of roots per plant (NTP= 7.68) and petioles of medium length (LPE = 18.45 cm) (Table 6). The ANOVA carried out between these three groups is summarized in Table 7. The analysis of this table clearly

revealed highly significant ($P < 0.001$) differences among these groups and confirms the classification of the 47 accessions into distinct groups.

The results also showed that several accessions having the same vernacular names and supposedly identical are phenotypically different because they belong to different genetic groups. Thus, the AKAMA accession collected in Abidjan (Group 1) is different from that collected in Grand Lahou (Group 3). The same observation is made with YACE accessions. Indeed, YACE accession from Bonoua (Group 1) was different to YACE from Grand Lahou (Group 3). Also, 6 MOIS from Bonoua (Group 2) was different to 6 MOIS from Dabou (Group 3).

Table 6: Distribution of different cassava accessions in each group

Groups	1	2	3
Numbers of accessions	15	23	9
	YACE FOUTOU (Azaguie)	6 MOIS (Bonoua)	TIMITI (Grand Lahou)
	AKAMA Abidjan (Bimbresso)	TOGO Abidjan (Ayama)	YACE (Grand Lahou)
	BOIS VERT (Dabou)	SAMAKE (Dabou)	BONOUA VERT (Azaguie)
	OKOMA	BOCOU 1 (Grand Lahou)	TAMBOU (Aboisso)
	YACE (Bonoua)	6 MOIS (Aboisso)	AKAMA (Grand Lahou)
	ELEPHANT Abidjan (Bimbresso)	SOGORO (Azaguie)	NONKLO MOKLO (Aboisso)
	SICAVA Abidjan (Bimbresso)	BONOUA (Bonoua)	6 MOIS (Dabou)
	CAMEROUN Abidjan (Bimbresso)	BAHIRE (Bonoua)	BONOUA (Aboisso)
	MÈDÈ Abidjan (Ayama)	ANCIENNE VARIETE CNRA Abidjan (Bimbresso)	MAMANWA Abidjan (Ayama)
	BOUAGA Abidjan (Ayama)	BAHIRE (Aboisso)	
	YAVO (Grand Lahou)	SANDRA Abidjan (Ayama)	
	SINZI (Aboisso)	BAHIRE Abidjan (Brofodoumé)	
	DABOU/ESSAPKELE (Grand Lahou)	INCONNUE Abidjan (Ayama)	
	ESSAPKELE (Dabou)	TAPIOCA Abidjan (Brofodoumé)	
	NOUVELLE VARIETE CNRA Abidjan (Bimbresso)	NANTALE (Bonoua)	
		ACCRA BANKYE (Bonoua)	
		PARASOL Abidjan (Bimbresso)	
		DENIKACHA (Bonoua)	
		YACE ATTIEKE (Azaguie)	
		BEDINA (Bonoua)	
		WANGO Abidjan (Bimbresso)	
		BOCOU 1 (Dabou)	
		BONOUA ROUGE (Azaguie)	

Table 7: Characteristics of the groups resulting from the Ascending Hierarchical Classification

Variables	Group 1	Group 2	Group 3
Numbers of accessions	15	23	9
LPE	24.84 ± 7.69a	17.07 ± 3.91c	18.45 ± 4.93b
HPL	305.57 ± 78.76a	260.28 ± 33.21c	294 ± 76.93b
DC	2.24 ± 0.41a	2.25 ± 0.42a	2.07 ± 0.42b
PTP	2.95 ± 1.78b	2.82 ± 1.69b	3.24 ± 2.53a
NTP	6.31 ± 2.42b	4.71 ± 1.89c	7.68 ± 3a
P	< 0.001	< 0.001	< 0.001

LLOC: Length of the central lobe; LPE: Petiole length; DC: Diameter at the collet of the principal stem; NNRAM: Number of branchings; HPL: Plant height; HRAM1: Height of the first branching; PTP: Fresh weight of accumulated roots per plant; NTP: Number of storage roots/plant.

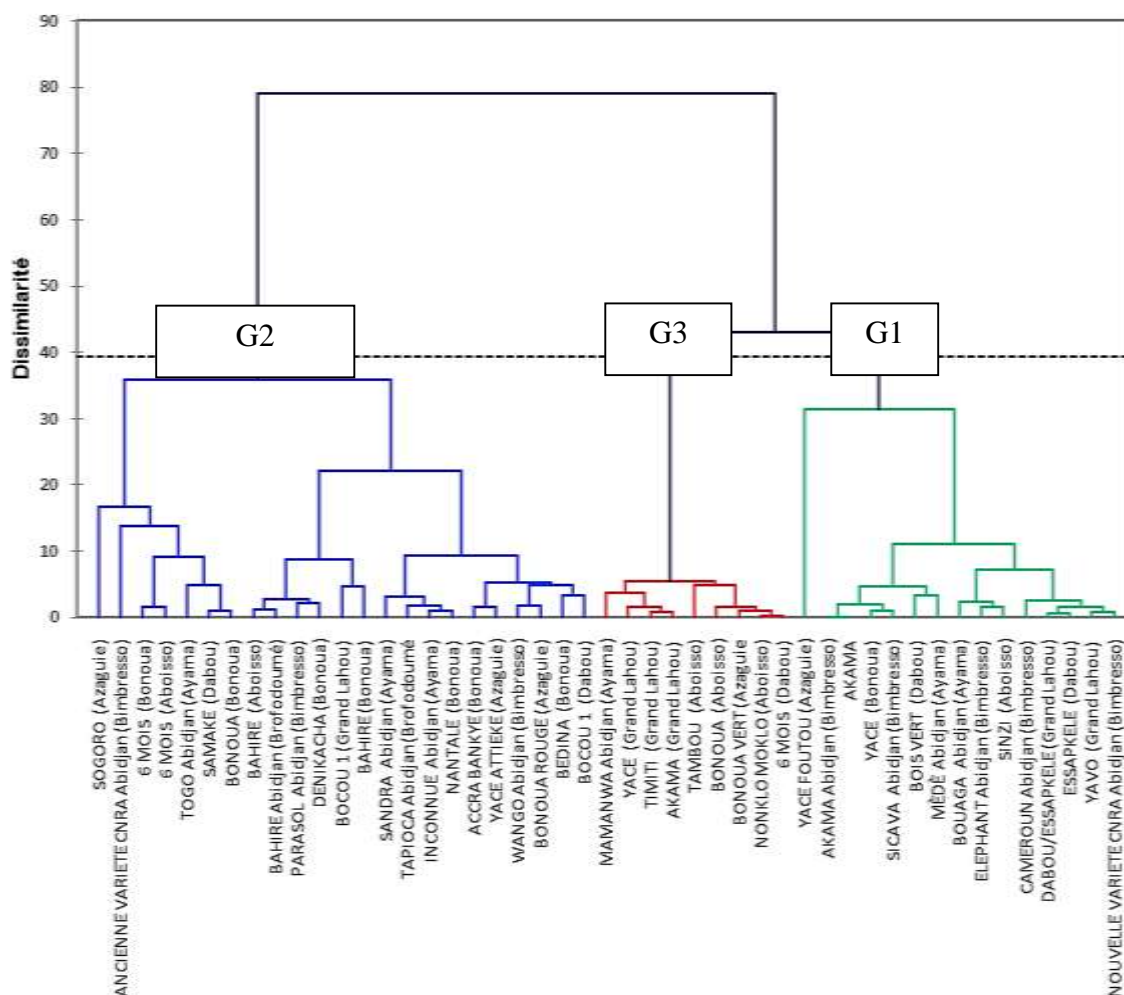


Figure 1: Cluster dendrogram depicting the genetic relationship between 30 cassava accessions based on the Ward's method

DISCUSSION

Plant breeding based on classical methods uses morphological traits of plants growing in the field as basis for identification (Fukuda *et al.*, 2010; Robooni *et al.*, 2014). It has been effectively used as a powerful tool in the classification of cultivars and the study of their taxonomic status (Elisabeth, 2011). Also, collection characterization based on agromorphological traits is the preliminary phase for molecular studies to be much more precise. Agromorphological characterization are still used successfully in numerous characterization and agronomic evaluation studies, thus allowing easier and faster differentiation of phenotypes especially in cassava (N'Zué *et al.*, 2014, Setiawan and Sebayang, 2022; Diaguna *et al.*, 2022; Kouakou *et al.*, 2023). This study permitted to evaluate the level of cassava variability newly collected in farmers' fields in the regions of South of Côte d'Ivoire by using morphological and agronomic traits.

The analysis carried out showed a significant variation within the studied accessions, thus allowing a preliminary assessment of the structuring of the diversity of cassava collected in the South of Côte d'Ivoire.

Multivariate analysis are statistical methods used in diversity analyses. In this study, multivariate analysis was used to elucidate the nature and degree of divergence of the cassava accessions. The PCA, applied to the 47 accessions on the basis of characters, results in the existence of a total variability of 75.04% within the cassava collection. This variability is greater than that observed by Ephrem *et al.* (2014) in Central African Republic and Kouakou *et al.* (2023) in Côte d'Ivoire based on agromorphological characterization. Indeed, these authors respectively obtained a variability of 55% for the first six cumulative axes and 57.45% for the first four cumulative axes having eigenvalues greater than 1. This high variability within the cassava accessions in the area of Southern Côte d'Ivoire could be explained by regular introductions of cassava varieties from neighboring countries of Côte d'Ivoire such as Ghana, Togo and Nigeria, by cultivation practice based on use of several accessions in the same field and the continuous exchanges of plant material between farmers from different localities (Missihoun *et al.*, 2012; Ferguson *et al.*, 2019; Kouame *et al.*, 2023).

Ascending Hierarchical Clustering (AHC) performed in this study revealed three groups or three morphological clusters. Similar results on cassava were obtained by N'Zué *et al.* (2014), Djaha *et al.* (2017), and Kouakou *et al.* (2022, 2023) who obtained three clusters by assessing respectively the morphological diversity of 159, 44 and 200 cassava accessions from Côte d'Ivoire. These results therefore indicated that cultivated cassava in Côte d'Ivoire could be grouped into three distinct genetic clusters. Three distinct genetic clusters were obtained again by Yusuf *et al.* (2016) by assessing the morphological diversity of 22 cassava accessions from several regions in Riau province, Indonesia. Swathy *et al.* (2023) obtained similar results in India.

Within these three groups, we found accessions collected in different areas under the same names but phenotypically different. Indeed, within villages,

exchanges of plant material are frequent between producers and most often different accessions have the same vernacular name or that several names could be given to a single cultivar on the farm as reported by Elias *et al.* (2001). This situation is the basis of several duplicates among the cassava accessions as detected by N'Zué *et al.* (2014) in collection from three zones in Côte d'Ivoire.

The variables that discriminated the three clusters were the height of the plant, the number of roots per plant and the length of the petiole. Our results are similar to those of Agre *et al.* (2015) who through the same quantitative parameters revealed a large variability within 116 cassava genotypes from Benin. Djaha *et al.* (2017) also showed that in their study on 44 cassava accessions, a total variability based on the height of the first branch, plant height, number of lobes and petiole length. These results show the relevance of the choice of the different parameters in our study.

CONCLUSION

The study of the diversity of 47 cassava accessions based on 8 descriptors showed significant variability. This diversity was structured into 3 groups characterized by the height of the plant, the length of the petiole and the number of roots per plant. Thus, the collection of accessions from the South of Côte d'Ivoire has different groups of cassava. A group of plants with height (305.57 cm), with an average number of roots per plant (6.31) and a long petiole (24.84 cm). A groups of cassava accessions with a low number of roots per plant (4.17) and small size (260 cm) with small petiole (17.07 cm) and a group of intermediate sized (294 cm) with a high number of roots per plant (7.68) with medium-sized petioles (18.45 cm). This description highlights the heterogeneity that exists within the cultivars held by farmers. The significant diversity highlighted offers great potential for the varietal improvement of cassava. This diversity could be used for food as well as for the development of varieties with multiple uses. The results of this study also showed that some accessions with the same vernacular names are genetically different. The study of the genetic diversity of cassava accessions from South of Côte d'Ivoire, through molecular markers, would deepen our knowledge of this genetic pool. However, it would be important to extend the prospecting area throughout the country in order to discover other accessions of cassava with characters of interest which could be valued in a varietal selection program. Also, complementary studies like molecular characterization are necessary.

REFERENCES

- Agre, A., Dansi, A., Rabbi, I. Battachargee, R. Dansi, M. and Melaku, G. (2015). Agromorphological characterization of elite cassava (*Manihot esculenta* Crantz) cultivars collected in Benin. International Journal of Current Research in Biosciences and Plant Biology 2(2): 1-14.

- Amoakon, W.J.L., Yoboué, A.A.N., Pita, J.S., Mutuku, J.M., N'Zué, B., Combala, M., Otron, D.H., Koné, M., Kouassi, N. and Sié, R. (2023). Occurrence of cassava mosaic begomoviruses in national cassava germplasm preserved in two agro-ecological zones of Ivory Coast. *Plant Pathology* 72: 1011–1021.
- Diaguna, R., Santosa, S.E., Hartono, Pramuhadi, A.G., Nuryartono, N., Yusfiandayani, R. and Prartono, T. (2022). Morphological and Physiological Characterization of Cassava Genotypes on Dry Land of Ultisol Soil in Indonesia. *International Journal of Agronomy*: 1-11.
- Djaha, K.E., Abo, K., Bonny, B.S., Kone, T., Amouakon, W.J.L., Kone, D. and Kone. M. (2017). Caractérisation agromorphologique de 44 accessions de manioc (*Manihot esculenta* Crantz) cultivés en Côte d'Ivoire. *International Journal of Biological and Chemical Sciences* 11(1): 174-184.
- Doubi, S., Djaha, E., Angui, V.D., Fouha, N., Hala, Baudoin, J-P. and Zoro. A. (2021). In-situ morphological characterization of cassava landraces (*Manihot esculenta* Crantz) from Côte d'Ivoire. *International Journal of Advanced Research* 9: 01-13.
- Elias, M., Doyle, M., Panaud, O., Anstett, M. and Thierry, R. (2001). Traditional management of cassava morphological and genetic diversity by the Makushi Amerindians (Guyana, South America): Perspectives for on-farm conservation of crop genetic resources. *Euphytica* 120: 143-57.
- Ephrem, K.K., Sémihinva, A., Woegan, Y.A., Duval, M.F. Dourma, M., Zinga, I., Yandia, P., Longue, D. and Semballa. S. (2014). Diversité agromorphologique de *Manihot esculenta* Crantz cultivée dans trois zones agroclimatiques en République Centrafricaine. *European Scientific Journal* 10: 365-380.
- Faostat (2022). Production en Côte d'Ivoire. https://www.fao.org/faostat/fr/#rankings/commodities_by_country.
- Ferguson, M.E., Shah, T., Kulakow, P. and Ceballos, H. (2019). A global overview of cassava genetic diversity. *Plos ONE* 14(11): e0224763 FIRCA. La filière manioc 5 - 8 pp.
- Fukuda, W.G., Guevara, C., Kawuki, R. and Ferguson, M.E. (2010). Selected Morphological and Agronomic Descriptors for the Characterisation of Cassava. (IIITA Éd.: Ibadan, Nigeria 19.
- Gnonlonfin, G.J.B., Koudande, O.D., Sanni, A. and Brimer. L. (2011). Farmers' perceptions on characteristics of casava (*Manihot esculenta* Crantz) varieties used for chips production in rural areas in Benin, West Africa. *International Journal of Biological and Chemical Sciences* 5(3): 870-879.
- Kouakou, D.A., Koffi, K.K., Bonny, S.B., Koffi, G.K. and Zoro Bi A.I. (2022). Assessment of Genetic Diversity in Côte d'Ivoire Cassava (*Manihot esculenta* Crantz) Using SSR Markers. *Philippine Journal of Science* 151 (3): 1067-1075.
- Kouakou, D.A., Koffi, K.K., Angui, C.M.V., Komenan, A.O. and Zoro Bi, A.I. (2023). Agro morphological variability of cassava varieties cultivated in five regions of Côte d'Ivoire based on quantitative traits. *Journal of Applied Biosciences* 181 :18962– 18973.
- Kouame, K.J.M.B., Kouakou, K.S. and Aka, B. (2023). Dynamique temporelle de l'adoption de la culture du manioc en Côte d'Ivoire. *Revue Espace Géographique et Société Marocaine* 71: 203-218.
- Missihoun, A.A, Agbangla, C., Adoukonou-agbadja, H., Ahanhazo, C. and Vodouhè. R. (2012). Gestion traditionnelle et statut des ressources génétiques dusorgho (*Sorghum bicolor* L. Moench) au Nord-Ouest du Bénin. *International Journal of Biological and Chemical Sciences* 6(3): 1003- 1018.
- N'Zué B. (2007). Caractérisation morphologique, sélection variétale et amélioration du taux de multiplication végétative chez le manioc (*Manihot esculenta* Crantz (Euphorbiaceae). Thèse de doctorat, spécialité : génétique, option amélioration des productions végétales, soutenue en 2007 à l'Université de Cocody, 141 p.
- N'Zué, B., Okana, M., Kouakou, A., Dibi, K., Zouhour, G. and Essis. B. (2014). Morphological characterization of cassava (*Manihot esculenta* Crantz) accessions collected in the centre-west, South-west and west of Côte d'Ivoire. *Greener Journal of Agricultural Sciences* 4(6): 220-231.
- Segnou (2002). Développement végétatif et potentiel de rendement chez le manioc. *Tropicultura*, 20(4): 161-164.
- Robooni, T., Paul S., Rob, M., Robert, K. (2014). Combining ability analysis of storage root yield and related traits in cassava at the seedling evaluation stage of breeding. *J. Crop Improv.* 28(4), 530-546.
- Setiawan, A., and Sebayang, N.U.W. (2022). Identification of Cassava (*Manihot esculenta* Crantz.) Morphophysiological Traits in the Toba Regency. *Earth and Environmental Science*, 1188: 012031.
- Singa, I., Nguimalet, C.R., Lakouetene, D.P., Konaté, G., Komba, E.K. and Semballa, S. (2008). Les effets de la mosaïque africaine du manioc en République centrafricaine. *Geo-Eco-Trop*, 32: 47-60.
- Swathy, S., Arya, K., Sheela, M.N., Revathi, B.S., Prakash Krishnan, B.S., Senthilkumar, K.M. (2023). Genetic diversity analysis of Indian Cassava (*Manihot esculenta* Crantz) accessions using morphological and molecular markers. *South African Journal of Botany*, 161: 347-357.
- Yusuf, N., Novita, L., and Indriyani, D. (2016). Characteristics of 22 cassava (*Manihot esculenta* Crantz) Genotypes from riau province, Indonesia, 48 (2): 110-119.