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Agromorphological Diversity of 27 Cassava Cultivars (*Manihot esculenta* Crantz) In Bengamisa Region, Tshopo in DR Congo

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Abstract: *In the Democratic Republic of Congo (DRC), cassava occupies a particularly important place in the diet of rural households that produce it. 27 local cassava cultivars collected in 08 agricultural production basins in the Bengamisa region were evaluated agro-morphologically. The objective was to analyze the phenotypic diversity of local cassava cultivars and their structuring based on 20 variables selected from cassava descriptors. The collected local cassava cultivars were evaluated in a randomized complete block design with 27 treatments and four replications in Bengamisa. Descriptive analysis of qualitative characters revealed polymorphism between local cassava cultivars. Principal Component Analysis (PCA) showed that the 20 morphological descriptors considered were the most relevant (CP ≥30%) to explain the morphological variability between local cassava cultivars. The ascending hierarchical classification (CAH) made it possible to obtain 4 morphogroups that are relatively undifferentiated compared to the extent of the morphological space between the different agricultural production areas. Discriminant factor analysis (DFA) was carried out using the 3 quantitative production variables (number of tuberous roots per plant; weight of tuberous roots per plant; and plant height at harvest) studied in 4 groups defined by the hierarchical ascending classification and allowed through the Wilks Lambda test to reveal that the 3 descriptors or variables have a very highly significant contribution (p-0.000). These groups offer a great possibility of choosing parents for the creation of improved varieties of cassava with high yield potential and adapted to different agricultural production basins in the Bengamisa region; Tshopo; DR CONGO*
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Keywords: *local cultivars, Manihot esculenta, geomorphological diversity, Bengamisa*

I. Introduction

Plants with tropical roots and tubers (cassava, sweet potato, yams and aroids) occupy an essential place in food agriculture in many regions of the world, particularly in humid tropical zones where most of the world's population is located. It is an important source of locally grown starchy products and plays an essential role in the food security of poor countries by replacing imported cereals (Anonymous, 2006).

In the Democratic Republic of Congo (DRC), cassava occupies a particularly important place in the diet of rural households that produce it. Tuberous roots lend themselves to a variety of culinary uses (foufou, Shikwangue, Gari,) (Nweke et al., 2002). The leaves are consumed as a vegetable commonly called "lay", rich in proteins, vitamins and iron, the almost permanent availability of which in the field makes it the most consumed

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vegetable in humid tropical areas (Achidi et al., 2005).

Faced with predictions of the impacts of climate change on agriculture, which will notably affect productivity, it is imperative to find effective adaptation strategies in the short and medium term to meet the ever-increasing food demand of a global population. growing.

The promotion of local cassava cultivars in food is one of these strategies for preserving agrodiversity, and thereby adapting agricultural systems to climate change (Marjolaine, 2015).

In the world of tomorrow, with more frequent droughts and where farmers will be required to exploit less and less fertile soils, the use of local cassava cultivars that are resilient to climate change; tolerant or resistant to adverse conditions is necessary. These local cultivars exist within the diversity of cassava grown today in rural areas (Abbott,2005).

In the Bengamisa region, cassava is grown with rice (Oryza sativa L.), plantain (Musa spp.), corn (Zea mays L.), sweet potato (Ipomoea batatas L.), taro (Colocasia esculenta), and the macabo (Xanthosoma sagittifolia (L.) Schott) the seven basic food crops of populations which contribute to food security (Bolakonga, 2017).

Following the intensification of IITA's activities and the introduction of high-yielding varieties, a gradual abandonment of local cassava cultivars in favour of high-yielding varieties is observed, thus leading to the erosion of local cassava genetic resources. this culture. However, the preservation of these local cassava cultivars constitutes an important issue for the development of sustainable agriculture and in the program to improve resilient cassava cultivation in the Democratic Republic of Congo (Lomboko et al., 2023).

In the current context, one of the strategies likely to combat genetic erosion consists of the collection, geomorphological characterization and determination of the phenotypic variability of existing local cassava cultivars. This allows us not only to know the existing cultivars but also to guide the methods of conservation of diversified germplasm and the management of these useful genetic resources in varietal improvement programs (Nébié et al., 2013).

Numerous procedures allow the quantification and analysis of existing genetic diversity; evaluation techniques are using morphological markers. The analysis of morphological descriptors makes it possible to reveal diversity as it is perceived and selected by local farmers, the main actors in the management of varietal diversity (Sawadogo et al., 2010).

It is the most practical approach for phenotypic differentiation provided it is associated with a statistical tool which estimates the variation linked to the experimental environment (Nébié et al., 2013; N'Zué et al., 2014; Agré et al., (2015). In the different production areas of the Bengamisa region, the collection of local cassava cultivars has become a necessity due to its importance attested not only by the extent of the cultivated areas but also by the diversity of its use as well. both in human and animal food and losses suffered by existing banks in the country. These losses are mainly due to poor conservation conditions and the lack of suitable conservation equipment.

The general objective of this study is to use the first-time morphological descriptors to study the agromorphological diversity of cassava cultivated in the different production basins of the Bengamisa region, for efficient exploitation of these genetic resources. Specifically, the aim was to analyze the geomorphological variability of 27 local cultivars exploited in the different production basins of the Bengamisa region and to establish the genetic structuring within this collection.

II. Research Methods

2.1 Study site

The study took place from 2022 to 2023 in the concession of the Higher Institute of Agronomic Studies of Bengamisa in the Bengamisa region, Banalia Territory, Tshopo Province in the Democratic Republic of Congo and lasted nine months. The geographical coordinates of the site taken by GPS are 00°58'50.2'' N north latitude and 25° 14' 15.9''E east longitude. Our site rises to an average altitude of 437 m.

The climate of the site is type Af of the Koppen classification, a hot and humid climate with an aridity index of 47. Monthly average insolation varies between 30 to 55%. This region experiences regular heavy rainfall with a short two-month dry season between mid-December and mid-February. The average annual precipitation depth varies between 1,600 mm and 1,700 mm

The soil of the site in the Bengamisa region is heavy clay, but we also find clay-sandy, clay-sandy, sandy-clayey soils and soils with humus horizons. As for the acidity of the soil, this is between pH 4.5 and 5.5 (Van Wambeke, 1958).

The dominant vegetation on the site was composed of *Chromoleana odorata, Panicum maximum, Purera javanica, Mimosa sp., Andropogon Gowanus; imperata sp and Loudetia arundinacea.*

2.2 Plant material

The plant material used consisted of 27 local cassava cultivars from ten production basins in the Bengamisa region (table) and placed in a collection. These local cassava cultivars were referenced by vernacular names and codes.

2.3 Technical equipment

The tape measure allowed us to measure the height of the first branch and that of the base at harvest, the caliper determined the diameter of the stem, and the Fukuda descriptor allowed us to describe the local cassava cultivars; a Canon EOS 5D Mark IV digital camera for taking photos and notebooks as well as notepads for jotting down data.

2.4 Methodology

a. Prospecting and collection of local cassava cultivars

Considering the subdivision data of the production basins in the Bengamisa region presented in Table 7.1 (Prodat, 2015), we travelled the entire region to cover all the basins and the different cultivars were collected. Collection operations were based on declarations from farmers. From farmers' fields, we took cuttings corresponding to local cassava cultivars showing phenotypic differences. Fifty cuttings of approximately 100 cm were taken for the local cultivars identified, then cut at an angle using a disinfected machete.

They were then collected, and packaged in coded and labelled plastic bags. Two-digit numbers, the first of which indicates the collection production basin and the last designating the order in which the collection was carried out, were assigned to the accessions. Collection fields are located at least 1 km from major roads. Each sample was followed by an interview with the farmer who provided the samples. This interview consisted of collecting the local names of cultivars and their meanings in the nomenclature of farming environments.

Sampling covered 25 plants per accession. The collection was carried out in August 2022. The sampling points were more than 1 km from the road. A collection site consists of an agricultural production basin.

b. Installation of the experimental field

1. Experimental setup and culture conditions

The experimental design adopted was that of randomized complete blocks with 27 treatments and four repetitions. The treatments were local cassava cultivars, the distance between the blocks was 4 m, and the elementary plot measured 25 m long by 1 m (a line represented a plot) wide, i.e. an area of 25 m² comprising a total of 25 plants per plot. The plots were represented by rows of 25 randomized plants; the total area: 3840 m²; the surface area of each block: 675 m² (25 m x 27 m); distance between blocks: 4 m; aisles: 2.5 m; Spacing: 1 x 1 m Each elementary plot has been labelled (Block and cultivar name).

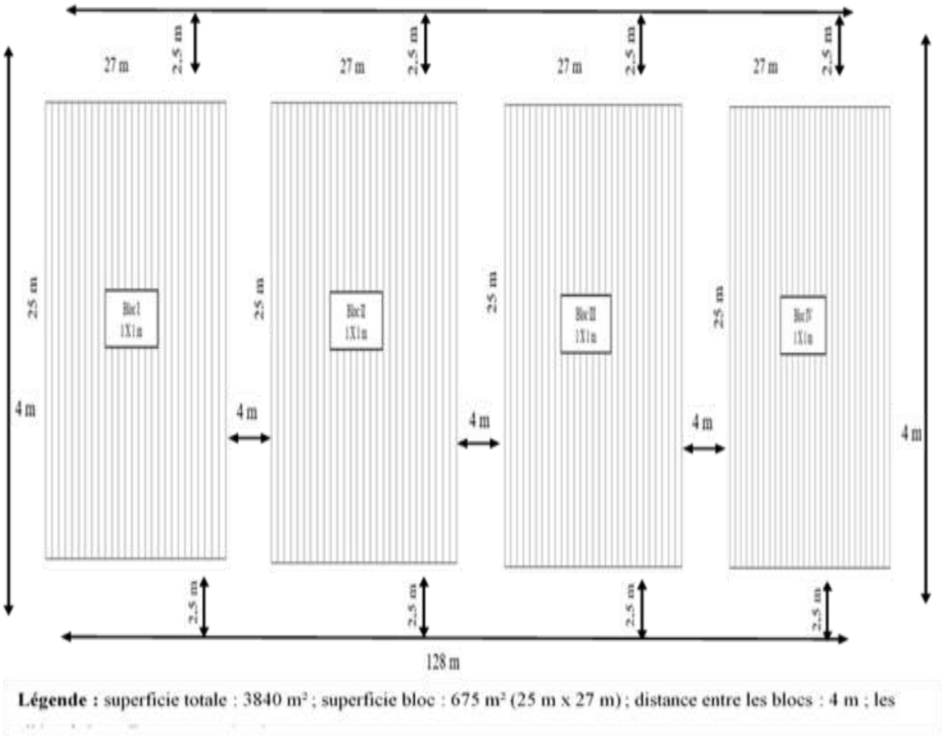


Figure 1. *Experimental setup of our test*

Legend: total area: 3840 m²; block surface area: 675 m² (25 m x 27 m); distance between blocks: 4 m; aisles: 2.5 m; Spacings: 1 x 1 m.

Crop work consisted of opening works consisting of clearing, incineration, skidding, ploughing and staking, while crop care consisted of weeding. The cuttings which were used for our experiment are those of local cassava cultivars collected in the ten production basins of the Bengamisa region; the middle parts were selected from 6-month-old plants. These cuttings have been conditioned so as not to crush the nodes which can pose a problem when regrowing. Planting consisted of placing two cuttings with 4 nodes and 20 cm long per hole in a horizontal position at 1x1m spacing.

2. Data collection

Agromorphological characters were observed at four different periods. The collection of qualitative data was done at 3, 6, and 9 months after planting (MAP) (Table 1 and 2) and at harvest using 27 descriptors proposed by Fukuda (2010), the modalities of which vary from 0 to 9. The variant most frequently seen on multiple feet is noted. The observation of qualitative variables was made on 15 feet of the elementary plot for each of the accessions.

The quantitative variables were measured on five plants randomly chosen per plot for each accession. Six months after planting, the dominant number of leaf lobes was determined by manual counting. At harvest 12 months after planting, the number of branching levels was determined visually by manual counting, the height of the plant was measured using a graduated ruler, the height at the first branching (length between the ground and the first branch) was measured using a graduated ruler and the diameter of the stem was measured using a calliper. This was done to evaluate the coverage rate and the vigour of the plants.

For production variables; the number of tuberous roots per plant was counted plot by plot, by cultivar after harvest. The descriptors which were used are twenty-seven in number including the qualitative variables and quantitative variables, carried out on the plants which were retained in the elementary plot for each of the cultivars.

3. Qualitative characteristics observed during the experiment

Traits and stage of evaluation, Code, Phenotypic classes (**Table 1**)

Characters and stage of development	**Code**	**Classes phénotypiques**
Apical leaf color (3MAP)	CAPE	Light green, (5) Dark green; (7) Purple green; (9) Purple
Apical leaf pubescence (3MAP)	PAPE	(0) Absent ; (1) Présent
Leaf retention (6MAP)	REFE	(1) Very poor retention; (2) Poor retention; (3) Average retention; (4) Good retention
Central lobe shape (6MAP)	FFAD	(1) Ovoid; (2) Elliptical-lanceolate; (3) Oboval-lanceolate; (5) Lanceolate (6) Linear; (-7) Others
Petiole color (6MAP)	COPE	(1) Green-yellow; (2) Green; (3) Green-red; (5) Red-green; (7) Red; (9) Purple
Colour of adult leaves (6MAP)	CLAD	(1) Light green; (5) Dark green; (7) Green-purple; (9), Purple
Dominant number of leaf lobes (6MAP)	NDLO	(3) Three lobes; (5) Five lobes; (7) Seven lobes; (9) Nine lobes; (11) Eleven lobes
Leaf vein color (6MAP)	CNFE	(3) Green; (5) Green-red; (7) Red
Orientation of petioles (6MAP)	ORPE	(1) Bottom; (3) Horizontal; (5) Top; (7) Irregular
Ability to Flower (6MAP)	FLOR	(0) Absent; (1) Present
Prominences of petiolar scars (9MAP)	PCPE	(3) Less important; (5) Important
Colour of stem cortex (9MAP)	CCTIG	CCTIG (1) Orange; (2) Light green; (3) Green
Stem skin color (9MAP)	CETIG	(1) Cream; (2) Light brown; (3) Dark brown; (4) Orange
Stem Color (9MAP)	CTIG	(1) Orange; (2) Light brown, (3) Dark brown; (4) Yellow; (5) golden; (6) Money; (7) White; (8) Red
Internode length (9MAP)	LEN	(3) Short; (5) Medium; (7) Long
Stem shape (9MAP)	FRTIG	(1) Straight; (2) Zigzag

Colour of branches at the top (9MAP)	CLARA	(3) Green; (5) Green-purple; (7) Purple (9MAP)
Length of stipules (9MAP)	LSTIP	(3) Long; (5) Short
Margin of stipules (9MAP)	MSTIP	(1) Integer; (2) Truncated
Fruit (At harvest)	FRU	(0) Absent; (1) Present
Seed (At harvest)	GRA	(0) Absent; (1) Present
Type of branching (At harvest)	TYRAM	(1) Upright; (2) Dichotomous (3) Trichotomous; (4) Tetrachotomy
Plant habit (At harvest)	PORT	(1) Compact; (2) Open; (3) As a parasol; (4) Cylindrical
Peduncle type (At harvest)	LPED	(0) Sessile; (3) Pedunculate; (5) Mixed
Shape of tuberculosis (At harvest)	FRTU	(1) Conical; (2) Cylindrical-conical; (3) Cylindrical; (5) Irregular
Colour of the tuber root outbreak (At harvest)	CEPIR	(1) Cream, (3) Yellow, (5) Light brown (7) Dark brown
Colour of the cortex of tuberous roots (At harvest)	CCRAT	(1) White or cream; (2) Yellow; (3) Pink; (4) Purple
Texture of the tuber outbreak (At harvest)	TREAT	(3) Smooth; (5) Intermediate (7) Rough
Colour of the pulp of the tuberous roots (At harvest)	CPRAT	(1) White; (2) Cream; (3) Yellow; (5) Pink

Source: Fukuda et *al.* 2010.

Table 2. Quantitative characteristics measured at harvest

Character Codes: Number of branching levels per foot NNRAM, HPL Plant Height
Height at first HRAM1 connection, Number of tuberous roots per plant NTP, Weight of tuberous roots per foot PTP

2.5 Data analysis

The analysis of the morphological data was essentially descriptive. These were entered into an Excel table in the form of an “accessions x morphological characters” matrix. The matrix obtained after coding made it possible to carry out a principal component analysis (PCA). The variables contributing most to the formation of the axes were defined as active variables and the rest as additional variables.

Ascending hierarchical classification (CHA) by Cluster then made it possible to classify the accessions into homogeneous groups according to the Ward method using a Euclidean distance similarity index. Analysis of variance was used after checking validity and the Tukey test was used to compare the means. And finally, we did the discriminant factor analysis. STATISTICS software version 2006 was used for statistical analyses

III. Results and Discussion

3.1 Morphological variability of 27 local cultivars of Manihot esculenta in the different Bengamisa production basins.

The twenty-seven local cassava cultivars studied showed significant variation. This demonstrates the existence of substantial phenotypic variability within the accessions analyzed. For qualitative characters, this variation is observed both at the level of the leaves, the stem and the tuberous roots.

The twenty morphological descriptors used in this study made it possible to make a preliminary assessment of the geomorphological variability of 27 local cassava cultivars collected in the different production basins of the Bengamisa region.

The first six factorial axes having an eigenvalue greater than one were used to study the interindividual variability resulting from the combination of the 27 morphological descriptors retained. the six cumulative axes allow a representation of 69.67% of the overall variability. The study of the composition of these first six axes (Table 3) shows that 20 descriptors contribute relatively significantly (partial contribution to the axis ≥ 20%) to at least one of the 6 axes. These 20 descriptors are therefore the most relevant for explaining variability.

Axis1, with Color of adult leaves (6MAP); Orientation of petioles 6MAP); Type of branching (At harvest); Color of the tuber roots outbreak (At harvest); Texture of the outbreak of tuberous roots (At harvest); Color of the pulp of tuberous roots (At harvest) represents 17.31% of the total variability; axis 2, Dominant number of leaf lobes (6MAP); Color of the tuber roots outbreak (At harvest); Color of the cortex of tuberous roots (At harvest) 15.85%; axis3, Color of the stem (9MAP) Color of the outbreak of the tuberous roots (At harvest) Texture of the outbreak of the tuberous roots (At harvest) Color of the pulp of the tuberous roots (At harvest) 12 .85%; axis 4, Type of peduncle (At harvest) 9%; axis 5, Type of branching (At harvest) Color of the pulp of tuberous roots (At harvest) 7.94% and axis 6, Color of apical leaves (3MAP) 6.25%.

3.2 Structuring of morphological variability and identification of duplicates of 27 local cultivars of Manihot esculenta in the different production basins of Bengamisa

The ascending hierarchical classification of 27 cultivars of data from principal component analysis was carried out. At an Euclidean distance of 0.20 units applied to the dendrogram obtained with the Ward aggregation method. The dendrogram established allowed the structuring of the collection into four morpho groups, group 1 is made up of 3 cultivars; ALT, MBE, and MZA. Group 2 is made up of 7 cultivars; MKE, MBG, KLA, MDI, NGE, NGA, and ZKA. Group 3 is made up of 11 DLE, MZI, ADS, ADE, APA, LZA, MTK, AKE, DRT, KBE, and M PT., and group 4 is finally made up of 6 cultivars. MDL, ANS, ATA, BSB, AKL, BKL. The Dendrogram illustrates the variability between cassava cultivars.

Group 1 brings together 3 cultivars (Alongata, Mwasizomba and Mobembe) and is made up of cultivars with the following characteristics: the shape of the lanceolate central lobe; the orientation of the petioles at the top, the colour of the branches at the top green, colour of the pulp of the tuberous root pink and the dominant number of leaf lobes seven while group 2 contains 7 cultivars (Mapkele, Mbongo, Kelenga, Mondangi, Ngonge, Zakando, Ngela) having the shape of a central lobe which is elliptical; the colour of the petiole purple, the length of the stipule long; the shape of the plant in a parasol and the colour of the epidermis of the light brown tuberous roots. Furthermore, group 3 brings together 11 cultivars (Dale, Mozungu, Adjakuladose, Adjele, Apolina, Linzaza, Motoboki, Agbokombi, Dirigeant, Kobe, Mopute) having the colour of the petioles red; the colour of the light green adult leaves, the colour of the golden stem as well as the colour of the branches with a purple-green top. Group 4 brings together 6 cultivars (Modjala, amenamolisa, Atua, Bibisombe, Akokoli, and Bapkele) having the green leaf vein colour, the colour of the branches at the green top, the type of trichotomous branching and the texture of the epidermis of the tuberous roots dark brown.

3.3 Variation in the quantitative characteristics of 27 local cultivars of Manihot esculenta in the different production basins of Bengamisa.

The values of agricultural production variables of 27 cassava cultivars analyzed are recorded in the table... Significant differences are observed between the values of important agricultural production variables such as the height of the plant at harvest, the number of tuberous roots per foot; the weight of the tuberous roots per foot,

For the number of tuberous roots per plant; 8 cassava cultivars had a large number of tuberous roots per plant compared to other cultivars: Alongata; Apolina; Tanzania; Mondangi; Mombembe; Mopute; Motomboki Mozungu. and it varied from 24 to 32 tuberous roots per plant. The numerical differences observed between the number of tuberous roots were highly significant at P-0.000. Alongata (28.3±3.07); Apolina (26.6±2.13); linzanza (22.55±1.87); Mondangi (25.05±2.89); Mombembe (23.95±2.76); Mopute (21.85±2.03); Motomboki (23.2±2.46 and Mozungu (22.9±1.99).

For the weight of tuberous roots per foot, 5 cultivars had more weight of tuberous roots per foot varying from 8 to 11 kilograms per foot: Apolina; Kobe; Linzanza; Mozungu and Muasi Zomba, while the other cultivars presented weights which varied from 2 to 7 kilograms per plant. The numerical differences observed between the number of tuberous roots were highly significant at P-0.000. Apolina (9.88±0.59), Kobe (10.64±0.42), Linzanza (7.38±0.27), Mozungu (7.66±0.37) and Muasi Zomba (8.67 ±2.65), while the other cultivars presented mean and standard deviation of 1.62±0.16 and 6.85±0.31) in kilogram per plant.

Finally, for the height of the plant at harvest, only one Makpele cultivar had a height greater than the other cultivars, i.e. 3.50 m; Makpele (3.10±0.29) in meter; the remainder of the cultivars are in the interval between 1.40±0.08 and 2.97±0.21).

Discriminant Factor Analysis for quantitative production variables for the 27 cassava cultivars

The discriminant factor analysis (AFD) was carried out from the 3 quantitative production variables studied from 4 groups defined by the hierarchical ascending classification and allowed, through the Wilks Lambda test, to reveal that the 3 descriptors or variables have a very highly significant contribution (p-0.000). Both functions discriminate cultivars with significance; the first function (y1) contributes 51.98% and the second (y2) 27.40%.

Correlation between discriminant functions and quantitative production variables

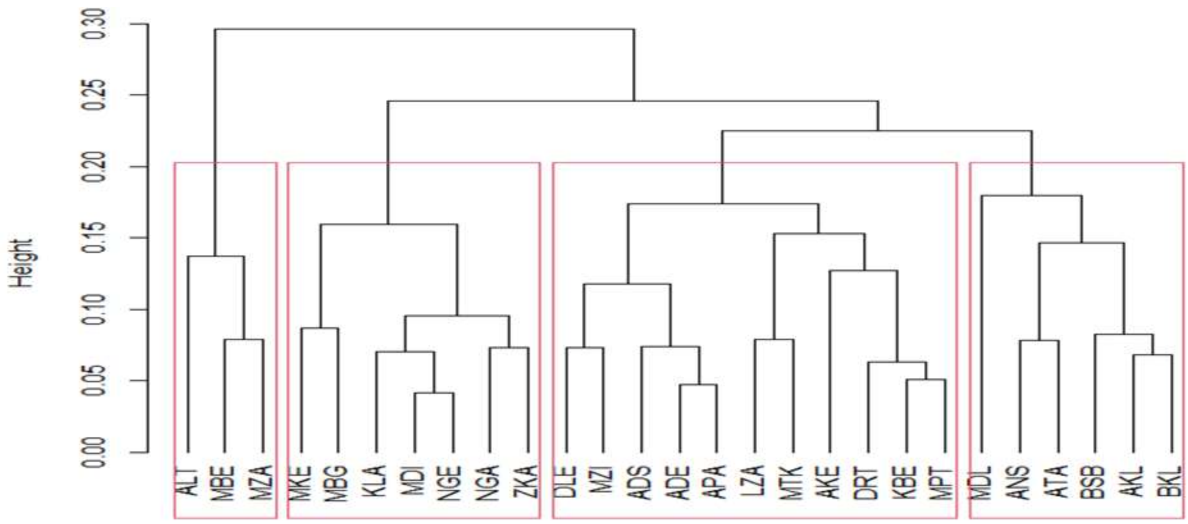
It is observed that there is a correlation between the original variables and the discriminant functions, to express the variability, the first function, i.e. y1, is characterized positively by the weight of the tuberous roots per foot and in the second function, i.e. y2, so positive height of the foot at harvest. The original variables correlate with the discriminant functions.

Eigenvalue matrices and percentages of variations expressed by the axes of the principal component analysis of the 27 local cassava cultivars

	Factorial axes (percentages of explanation of overall variability)							
°	Qualitative morphological descriptors	**Codes**	**CPI**	**CPII**	**CPIII**	**CPIV**	**CPV**	**CPVI**
1.	Apical leaf color (3MAP)	**CAPE**	-5.962	-6.295	2.212	1.708	1.503	7.807*

2.	Central lobe shape (6MAP)	**FFAD**	5.172	-4.184	6.071	1.009	2.839	5.617
3.	Petiole color (6MAP)	**COPE**	-8.574*	1.847	1.174	5.333	4.271	4.654
4.	Adult leaf color (6MAP)	**CLADD**	-7.442	9.052*	4.133	1.019	1.069	3.728
5.	Dominant number of leaf lobes (6MAP)	**NDLO**	-1.504	-1.321	5.659	2.973	5.299	3.519
6.	Leaf vein color (6MAP)	**CNFE**	-8.444*	-2.101	1.169	2.886	1.480	1.348
7.	Orientation of petioles 6MAP)	**ORPE**	5.018	-4.723	4.331	2.262	2.508	2.614
8.	Petiolar scar prominences (9MAP)	**PCPE**	-6.805*	-2.605	9.380*	1.611	2.304	3.273
9.	Stem Color (9MAP)	**CTIG**	3.479	-1.642	5.125	1.515	1.210	4.792
10.	Internode length (9MAP)	**LEN**	-3.246	-5.623	4.733	4.015	2.817	3.527
11.	Colour of the branches at the top (9MAP)	**CLARA**	-5.838	-2.032	3.406	4.393	3.372	4.329
12.	Length of stipules (9MAP)	**LSTIG**	7.088*	2.495	5.977	3.666	7.578*	3.782
13.	Type of branching (At harvest)	**TYRAM**	-1.292	4.259	3.246	2.995	4.305	4.108
14.	Plant habit (At harvest)	**PORT**	-3.930	3.592	2.362	6.525*	4.322	3.087
15.	Stalk type (At harvest)	**LPED**	-2.377	5.053	2.902	1.229	2.082	3.556
16.	Shape of tuberous roots (At harvest)	**FRTU**	-7.307*	8.040*	8.992*	4.014	5.118	1.539
17.	Colour of tuber root outbreak (At harvest)	**CEPIR**	-3.076	7.145*	5.663	1.944	2.157	2.379
18.	Colour of the cortex of tuberous roots (At harvest)	**CCRAT**	7.643*	5.075	6.800*	1.175	2.198	2.513
19.	Texture of the tuber outbreak (At harvest)	**TREAT**	7.852*	4.940	6.504*	2.221	8.952*	1.317
20.	Colour of the pulp of the tuberous roots (At harvest)	**CPRAT**	-1.891	1.261	1.966	8.415*	2.860	2.256

Ascending hierarchical classification. (C.H.A)



Result of the Discriminant Factor Analysis for the quantitative production variables for the 27 cassava cultivars

Discriminant functions	Eigenvalue	Relative frequency	Wilks' lambda	Chi-square	Significance (p)
Y1	12,14	51,98	0.001	3321.6	0.000***
Y2	6,40	27,40	0.023	1971.7	0.000***

Correlation between discriminant functions and quantitative production variables

Original variables	Discriminant functions	
	Y1	Y2
Number of tuberous roots per foot	0.11	-0.25
Weight of tuberous roots per foot	1.36	0.68
Height of the feet at harvest	-1.84	3.83

Values of agricultural production variables of 27 cassava cultivars analyzed

Tables 2. Values of agricultural production variables of 27 cassava cultivars analyzed

Variable	Cultivars	Number of roots per plant	Weight of roots per plant (kg)	Height of plants at harvest (m)
1.	Adjakuladose	15,70 ± 2,88	3,14 ± 0,65	1,73 ± 0,24
2.	Andjele	12,6 ± 1,87	5,01±0,69	2,08±0,22
3.	Agbokombi	12,55 ± 1,70	4,54 ±0,38	2,70±0,14
4.	Akokoli	14,15 ± 2,08	4,69±0,26	2,53±0,12
5.	Alongata	28,3±3,07	5,35±0,47	2,25±0,19
6.	Amenamolisa	13,8±2,09	5,67±0,52	2,65±0,23

7.	Apolina	26,6±2,13	9,88±0,59	1,34±0,08
8.	Atua	13,25±2,14	5,05±0,25	2,73±0,20
9.	Bakpele	13,5±2,09	4,80±0,24	2,31±0,15
10.	Bibisombe	13,25±2,369	6,85±0,31	2,17±0,20
11.	Dale	12,1±1,44	6,29±0,42	2,22±0,12
12.	Dirigeant	12,25±1,19	3,72±0,20	2,00±0,32
13.	Kelenga	13,19±1,72	4,60±0,47	1,95±0,24
14.	Kobe	13,45±2,39	10,64±0,42	2,56±0,16
15.	Linzanza	22,55±1,87	7,38±0,27	2,97±0,21
16.	Makpele	12,8±2,04	4,83±0,44	3,10±0,29
17.	Mbongo	10,85±2,10	2,85±0,45	1,47±0,05
18.	Mondangi	25,05±2,89	6,53±0,32	2,56±0,14
19.	Mombembe	23,95±2,76	5,11±0,40	2,07±0,25
20.	Mondjala	15,15±3,75	4,41±0,39	2,00±0,09
21.	Mopute	21,85±2,03	5,94±0,57	2,02±0,13
22.	Motomboki	23,2±2,46	1,62±0,16	2,17±0,14
23.	Mozungu	22,9±1,99	7,66±0,37	1,49±0,20
24.	Muasi Zomba	12,6±1,84	8,67±2,65	1,40±0,08
25.	Ngela	8,1±1,11	2,45±0,35	2,61±0,14
26.	Ngonge	13,10±2,18	2,78±0,24	2,46±0,12
27.	Zakando	11,9±1,51	4,90±0,20	2,28±0,18

IV. Discussion

4.1 Agromorphological variability of 27 local cassava cultivars in the different production basins of the Bengamisa region.

As for the variability of the qualitative agro morphological characters of cassava cultivars in the production basins of the Bengamisa region, twenty descriptors out of 27 used in this study made it possible to make a preliminary evaluation of the structuring of the diversity of 27 local cultivars of cassava found in the different production basins of the Bengamisa region.

The first six cumulative factorial axes allowed the representation of 69.67% of the overall variability of cassava with a partial contribution of 19 descriptors. Similar results were obtained by Okogbenin et al. (2001) in their study on the genetic characterization of a collection of cassava established in Colombia. Kumba (2012) also found similar results in the study of the genetic variability of a cassava collection in Ghana. In the Amazon too, (Brazil and Guyana), Emperaire et al. (2003), obtained 66% for the first six axes combined with a partial contribution of 9 descriptors out of 20.

The partial contributions obtained by Emperaire et al. (2003) about the 6 factorial axes concern: the narrowness of the central lobe, the petiole colour, the prominence, the stem diameter, the maximum order of branching, the angle of first branching, the roughness of the tuber epidermis, tuber epidermis colour, cortical parenchyma surface colour. On the other hand, in our case, the eigenvalues (partial contributions) are linked to 17 descriptors. Only the colour of the petiole, the prominence of the leaf scars and the colour of the epidermis of the tuberous roots are the common descriptors in terms of partial contribution between our study and that carried out by Emperaire et al. (2003). This would constitute an important part of these two descriptors in the overall diversity of cassava cultivated in the Amazon (Brazil and the Guyanas) and in the different production basins of the Bengamisa region.

The range of variation observed at 33.16% on the first two factorial axes explains that the potential morphological diversity is comparable between the groups and that there is relatively little differentiation in the extent of the morphological space between the cultivars collected. Mezette et al. (2016) in a similar analysis demonstrated that there is no significant morphological difference depending on the space occupied by cultivars from a given location. Emperaire et al. (2003) showed a variation of 32% on the first two factorial axes and that there is no significant difference in the morphological space occupied by each set of varieties from a given location.

The low variability of local cultivars in the different production areas of the Bengamisa region could be explained on the one hand by the cultivation practice based on the use of the same cultivars in the same field and on the other hand, continual exchanges of plant material with interesting agronomic characteristics between growers from different basins.

This difference in terms of partial contributions to the factorial axes proves that the share of descriptors in the morphological diversity of cassava in Amazonia is greater than the diversity of cassava in the different production basins of the Bengamisa region. However, we note that there is a difference in the number and quality of descriptors involved in the two types of studies, which can however influence the nature of the results.

These results compared to other researchers confirm our second hypothesis on the phenotypic variability of the 27 cassava cultivars collected.

4.2 Variability based on quantitative production descriptors of 27 local cassava cultivars

Eight cassava cultivars had a large number of tuberous roots per plant compared to the other cultivars: Alongata; Apolina; Tanzania; Mondangi; Mombembe; Mopute; Motomboki and Mozungu. And varying from 24 to 32 tuberous roots per plant.

Agricultural yield is one of the main objectives of cassava producers in varietal selection. On the entire collection concerned by this study; For the weight of tuberous roots per foot, 5 cultivars had more weight of tuberous roots per foot varying from 8 to 11 kilograms per foot: Apolina; Kobe; Linzanza; Mozungu and Muasi Zomba, while the other cultivars presented weights which varied from 2 to 7 kilograms per plant.

Finally, for the height of the plant at harvest, only one Makpele cultivar had a height greater than the cultivars, i.e. 3.50 m in kilograms per plant. Ephrem et al (2014) In their study on the geomorphological diversity of cassava cultivated by Central African farmers, out of 179 accessions collected in three agro-climatic zones of the country, five accessions had high tuberous root weights compared to the other accessions collected.

4.3 Identification of duplicates in the collection

Four morpho groups have been structured and are differentiated by; the shape of the central lobe, the colour of the branches at the top, the colour of the petiole, the habit of the plant, the colour of the skin of the tuberous roots, the colour of the petioles, the colour of the adult leaves, the colour of the leaf vein, the type of branching. Similar results were obtained by N'zué et al. (2014) by characterizing 159 accessions of cassava from the South-West of Côte d'Ivoire, they were structured into three groups which are differentiated by the height of the plant, the number of tubers per plant and the weight of tuber per plant. foot. From all of the above, we say that our third hypothesis is confirmed.

V. Conclusion

The study of the geomorphological diversity of 27 local cassava cultivars and their structuring based on 20 descriptors showed significant variability. This diversity has been structured into 4 groups characterized by. The central lobe shape; the orientation of the petioles; the color of the branches at the top; the color of the pulp of the tuberous root; the dominant number of leaf lobes; the color of the petiole, the length of the stipule; the plant's habit; the color of the skin of the tuberous roots. The colour of the petioles; adult leaf colour, stem colour; leaf vein colour, type of branching; and the texture of the epidermis of the tuberous roots.

This genetic variability observed between 27 local cassava cultivars is important for varietal selection work. It is important to associate molecular techniques such as microsatellites with morphological characters which will make it possible to better characterize accessions within groups.

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