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Agromorphological Characterization of *Hibiscus sabdariffa* L. Collection from Burkina Faso

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Abstract

Hibiscus sabdariffa L. or roselle is an important vegetable crop in several African countries. It is rich in vitamins and minerals and is widely used in the diet of local populations in Africa, especially in Burkina Faso. However, up to now, there is no in-depth study describing roselle genetic diversity that has been carried out to assess ecotypes cultivated in Burkina Faso. Thus, this study aims to contribute to providing more insights into *Hibiscus sabdariffa* genetic variability in Burkina Faso through an agromorphological characterization. For this purpose, a trial was carried out using a Randomized Complete Block Design (RCBD) with three replications. 48 accessions

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collected from farmers were assessed. Agromorphological data collection involved 12 qualitative and 18 quantitative traits. The qualitative traits analysis showed high variability in leaf, stem, and flower color and shape. Analysis of variance (ANOVA), hierarchical cluster analysis (HCA), and principal component analysis (PCA) were performed using quantitative data. The results indicated significant differences among all genotypes for all the traits measured. The first three axes of the PCA explain 69.62% of the genetic variability. Furthermore, the results showed a high agromophological variability which is structured in three (03) groups. This variability will contribute to the enhancement and genetic improvement of *Hibiscus sabdariffa.*

Keywords: *Hibiscus sabdariffa*, *Malvaceae*, agromorphological characterization, Burkina Faso

Introduction

Hibiscus sabdariffa L. commonly known as roselle or Guinea sorrel is a relatively drought tolerant plant that grows well in mostly all types of soils. This adaptation could justify its distribution along tropical and subtropical areas (Edmonds, 1991). Roselle belongs to *Malvaceae* family, genus *Hibiscus* and section *Fucaria* (Morton, 1987). *Hibiscus sabdariffa* is an important leafy vegetable in the dry regions of West and Central Africa. The plant is potentially rich in minerals, vitamin C and especially anthocyanin (Cisse *et al*., 2009; Da-Costa-Rocha *et al*., 2014) which have antioxidant properties that is due to its strong scavenging effect on reactive oxygen and free radicals acting against cellular aging (Hirunpanich *et al*., 2005). Its chemical structure is comparable to the one of hydroxy-chloroquine and acetylsalicylic acid, all antiviral compounds, so it could be used in the treatment of Covid-19 (Parga-Lozano *et al*., 2021; Mahmoudi *et al*., 2021).

In Burkina Faso, roselle leaves, young shoots, flowers, and seeds are commonly used in human consumption (Konkobo-Yameogo *et al*., 2002; Bengaly *et al*., 2006; Hama-Ba *et al*., 2017). It has an important economic impact due to the dried calyxes exported from African countries (Senegal, Burkina Faso, Mali, Côte d'Ivoire, and Sudan) to Europe and the United States of America (Cisse *et al*., 2009). Industrially, the plant's fibers are mixed with jute fibers to manufacture ropes and bags (Ahmed and Salaheldeen, 2010).

Genetic diversity studies on *Hibiscus sabdariffa* carried out in Niger (Bakasso *et al*., 2013), India (Sharma *et al*., 2016), and Ghana (Tetteh *et al*., 2019) have proven to be significant. However, in Burkina Faso, the genetic diversity of the specie is not referenced. According to Pernes (1983), the conservation and improvement of any plant material require suitable knowledge of its genetic pattern. One of the important steps in conserving diversity studies is collecting

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and assessing local ecotypes or cultivars held by farmers. This current study aims to contribute to the knowledge of the genetic variability of *Hibiscus sabdariffa* L. cultivated on the western side of Burkina Faso. It is specifically to (i) identify the differential characters of accessions, (ii) determine the relationships between the studied characters, (iii) and establish the level and structure of the diversity of the accessions collected.

1. Materials and methods

1.1 Plant material and collection site

The plant material involved 48 accessions of *Hibiscus sabdariffa* collected in eight (08) provinces located in two different climatic zones of Burkina Faso, Soudano-Sahelian, and Soudanian zones (table 1). Sudano-Sahelian zone completely covered the central part of the country with a rainfall of around 600 and 900 mm per year, with temperatures between 20 and 30°C. Four (04) provinces were concerned in this zone: Balé, Mouhoun, Kossi, and Banwa. The second zone is the Sudanian zone with also four (04) provinces (Ioba, Houet, Poni and Bougouriba). Annual rainfall can reach 1100mn of water with an annual average of temperatures between 20 and 25°C. (figure 1).

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Table 1. *Hibiscus sabdariffa* L accessions code with geographical origins

Climatic zones	Provinces	Number of accessions	Code of accessions
Sudano-sahelian	Balé	11	BOR1, BOR2, BOR3, BOR4, BOR5, BOR6, BOR7, BOR8, BOR9, BOR10, BOR12
	Mouhoun	2	DED2, DED3
	Kossi	7	NOU1, NOU2, NOU3, NOU4, NOU5, NOU6, NOU7
	Banwa	9	SOL1, SOL2, SOL3, SOL4, SOL5, SOL6, SOL7, SOL8, SOL9
Sudanian	Houet	11	BOB1 BOB2 BOB3 BOB4 BOB5 BOB6 BOB7 BOB8 BOB9, BOB11 BOB12
	Ioba	4	DAN1, DAN2, DAN3, DAN4
	Bougouriba	2	DIE1, DIE2
	Poni	2	GAO1, GAO2

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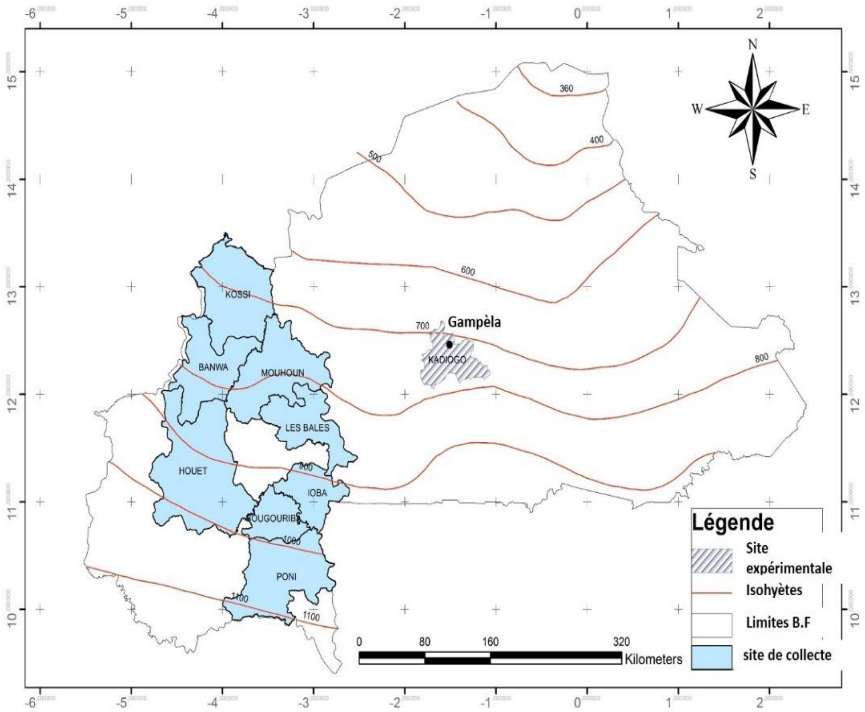

Figure 1. Collection and experimental site of *Hibiscus sabdariffa* accessions

1.2 Study site and experimental design

Agromorphological characterization was carried out in 2019 during the rainy season, from July to January on the experimental station of the Institute of Rural Development (IRD) located in Gampela (12° 24' 29" north latitude: and 1° 21' 8.6 " west longitude). The climate of the site belongs to the Sudano-Sahelian type, characterized by annual rainfall between 600 and 900 mm (Thiombiano and Kampmann, 2010). 852.7 mm of water was recorded during the assessment.

The experimental design was a completely randomized block design with three (03) replications. Each block was divided into two (02) sub-blocks and the spacing was one meter. There were 25 rows in each sub-block of five (5) meters in length and each row was assigned to a randomly drawn accession. Plant-to-plant spacing in the row was 60cm and one meter between rows.

1.3 Data Collection

Eighteen (18) quantitative and twelve (12) qualitative traits were studied. These morphological traits were recorded according to the National Bureau of Plant Genetic Resources (Mahajan *et al*., 2000), and based on previous studies on the plant (Anjah *et al.*, 2012, Satyanarayana *et al*., 2017, Sharma *et al*., 2016).

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1.3.1 Qualitative traits

Qualitative traits were observed in the field on the whole row throughout the plant cycle. These are mainly leaf color (LCO); leaf shape and pubescence (LSH and LPU), stem color and pubescence (STC and SPU), petal color (PCO), calyx shape, color, and pubescence (CSH, CCO and CPU). Seed shape (SES), seed color (SEC), and seed pubescence (SEP) were assessed using a LEICA EZ4HD magnifying glass.

1.3.2 Quantitative traits

Quantitative traits such as the number of days when 50% of seedlings in the row have emerged (NDE); the number of days between sowing and 50% of flower bud formation in the row (NDB); the number of days from sowing to time when 50% of the plants per row start to flower (NDF), and the number of days from sowing to time when 50% of the plants in the row start to maturity (NDM) were measured on the entire row.

The other morphological quantitative traits were recorded on four randomly selected plants per row at different stages of the plant's development cycle.

At 60 days after sowing the quantitative traits collected are:

- ✓ Plant height (PLH): measured from the ground to the last leaf of the main stem.
- ✓ Stem diameter (STD): measured at the collar level with a caliper.
- ✓ Number of primary branches (NPB): assessed by counting on the main stem.
- ✓ Petiole length (PEL), limb width (LIW), and limb length (LIL) were measured on 3 leaves per plant using a double decimeter.
- ✓ Fresh leaf weight per plant (FLW): the estimation of fresh leaf weight (leaf biomass) per plant was done by weighing after harvesting all leaves using an electronic scale.

According to Hien (2012), 60 days after sowing is the time when the growth of *Hibiscus sabdariffa* starts to stabilize. In addition, this period is part of the time interval during which the leaves of this species can be harvested for consumption.

At plant maturity, the quantitative traits measured were:

- ✓ Calyx length (CAL), calyx diameter (CAD) has been measured on three fruits per plant using a double decimeter and a caliper.
- ✓ Number of capsules per plant (NCP), determined by counting the number of capsules produced per plant.
- ✓ Fresh and dry calyx weights (FCW, DCW), seed weight per plant (SWP), and 100 seeds weight (100SW) were measured using an electronic scale after harvesting.

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1.4 Statistical analysis

Excel was used to calculate the frequencies of qualitative traits to assess the level of phenotypic variability. Analysis of Variance (ANOVA) was performed using GenStat v4.10.3 to determine traits that discriminate accessions and to assess accessions effects and their interaction. Multivariate analyses such as principal component analysis (PCA) and cluster analysis (dendrogram) based on the Euclidean distance between individuals at the 5% threshold were done using XLSTAT Version 2016.02. Principal component analysis was conducted to assess the correlations between quantitative variables, and clustering analysis was run to establish the structuration of variability among accessions.

2. Results

2.1. Agromorphological variation related to the qualitative traits of *Hibiscus sabdariffa*

The analysis of the qualitative traits (table 2) showed an important variability within the studied collection of *Hibiscus sabdariffa*. This variability is mainly observed with leaf and calyx shape, leaf, stem, petal, and calyx color. According to the leaf shape, all genotypes display simple leaves, but the color and shape of limbs vary from one genotype to another one. The majority (52.08%) of accessions have palmate and deeply divided leaves (Figures 2d, 2e, and 2f). 33.33% of accessions have palmate and fully divided leaves (figure 2g). Accessions with oval leaves (8.33%) have also been observed (figure 2a). A minority of accessions have palmate and weakly divided leaves (figure 2b), and very broad palmate and weakly divided leaves (figure 2c). The color of leaves, veins, and petioles depends on the stem color which varied from green to crimson.

Table 2. Distribution of frequency for qualitative traits of *Hibiscus sabdariffa* L.

Traits	Modalities	Percentages
Leaf color (LCO)	Uniformly green	14.58
	Green with purplish veins	22.92
	Green with red veins	18.75
	Dark green with red veins	25
	Green- purplish with red veins	2.08
	Variable	12.5
Leaf pubescence (LPU)	Glabrous	94
	Pubescent	6
Leaf shape (LSH)	Oval	8.33
	Palmate and weakly divided leaves	4.17
	Very broad palmate and weakly divided leaves	2.08
	Palmate and deeply divided leaves	52.08
	Palmate and fully divided leaves	33.33
Stem color (STC)	Green	14.58

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	Green with red spot at the knot	4.17
	Purplish green	33.33
	Red	8,33
	Dark red	22.92
	Crimson	10.42
	Variable	6.25
Stem pubescence (SPU)	Glabrous	89.58
	Pubescent with S	10.42
Sepals color (SCO)	Light green	12.5
	White- greenish	2.08
	Green with red spots	20.83
	Light green with red stripe	8.33
	Pink	2.08
	Red	8.33
	Dark red	22.92
	Crimson	10.42
	Variable	12.5
Petals color (PCO)	Yellow	14.58
	Yellow with red throat	22.92
	Light purple with red throat	25
	Pink with red throat	37.5
Calyx shape (CSH) and Calyx pubescence (CPU)	Long and glabrous	68.75
	Long and pubescent	6.25
	Short and glabrous	6.25
	Short and pubescent	18.75
Seed shape (SES)	Kidney form	52.08
	Angular	47.92
Seed color (SEC)°	Brown	39.58
	Grey	52.08
	Variable	8.33
Seed pubescence (SEP)	Hairy	6.25
	pubescent	41.67
	Weakly pubescent	37.5
	Glabrous	14.58

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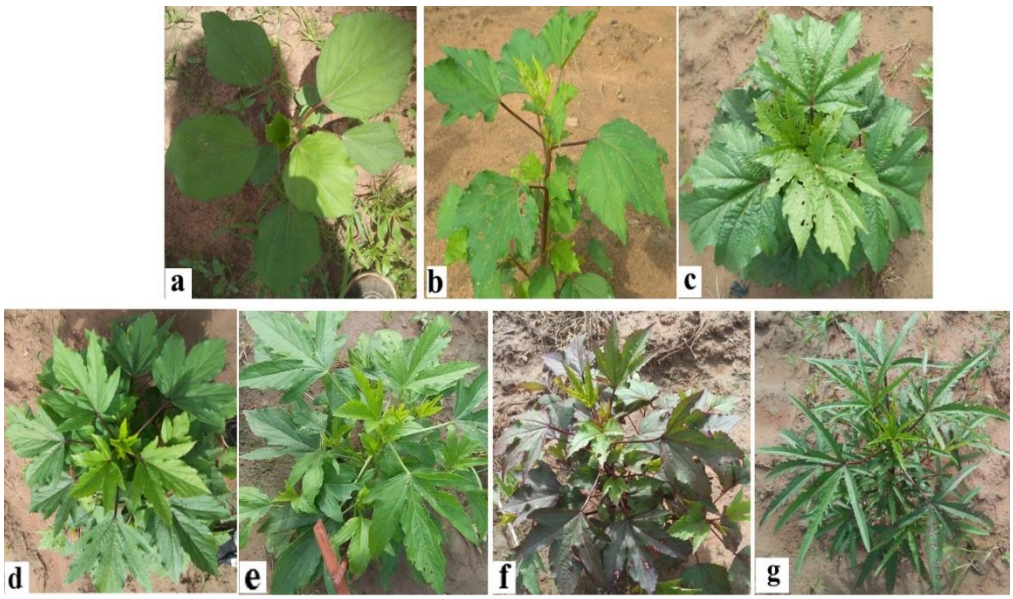

Figure 2. Different form and color of *Hibiscus sabdariffa* leaves

***Legend**: a) plant with oval and green leaves, b) plant with palmate and weakly divided green leaves , c) plant with very broad palmate and weakly divided green leaves, d) plant with palmate and deeply divided green leaves, e) plant with Palmate and deeply divided light green leaves, f) plant with Palmate and deeply divided Green- purplish leaves, g) plant with Palmate and fully divided green leaves*

The result showed an important genetic variability in calyx shape and color being light green to very dark red (figure 3). The petals (figure 4) are yellow (14.58%), yellow with red throat (22.92%), light pink with red throat (25%) or pink with red throat (37.5 %).

Presence of pubescence of varying density have been observed on leaves, stem, calyx and seed.

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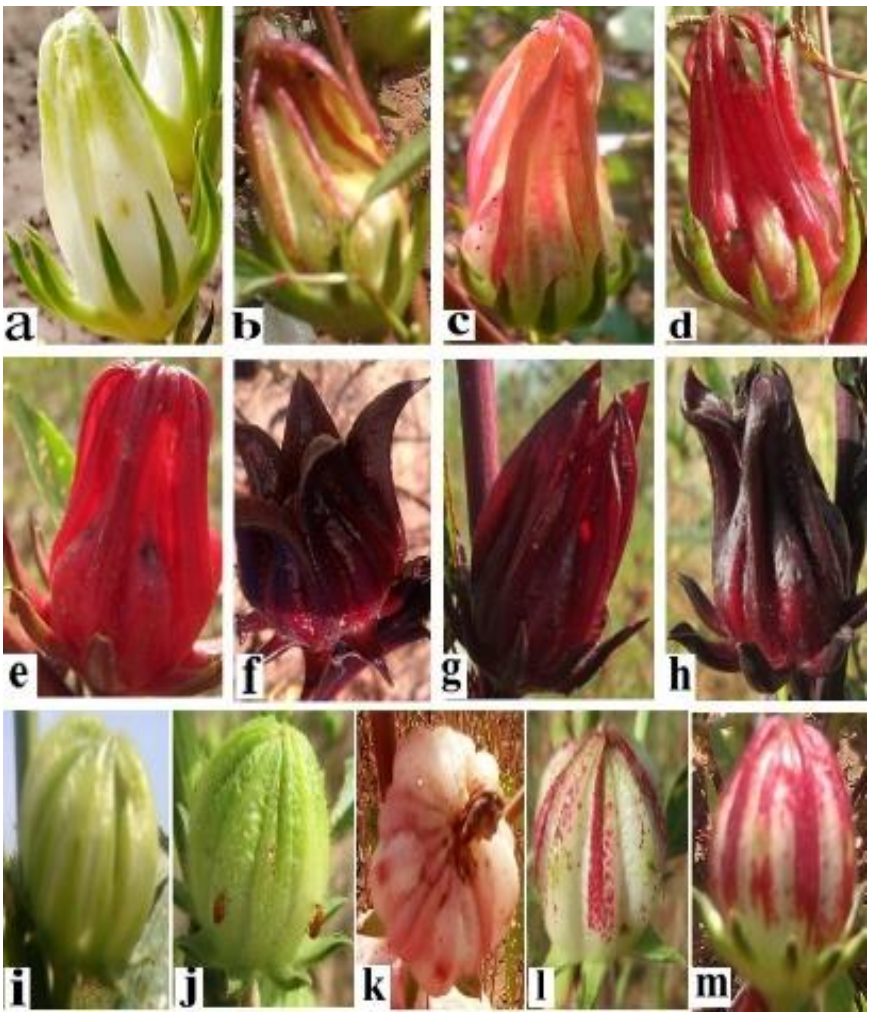

Figure 3. Different colors, forms and pubescence o*f Hibiscus sabdariffa* calyxes
***Legend**: **long calyx**: a)light green and glabrous; b)red-green and glabrous; c) light green-pink and glabrous; d) red-green and glabrous; e) red and glabrous; f) red with spines; g) red with weak pubescence; h) purple and glabrous;*
***Short calyx**: i) light green and glabrous; j) light green with spines, k) light pink and glabrous; l) light green-pink with spines; (m) light green-red and glabrous*

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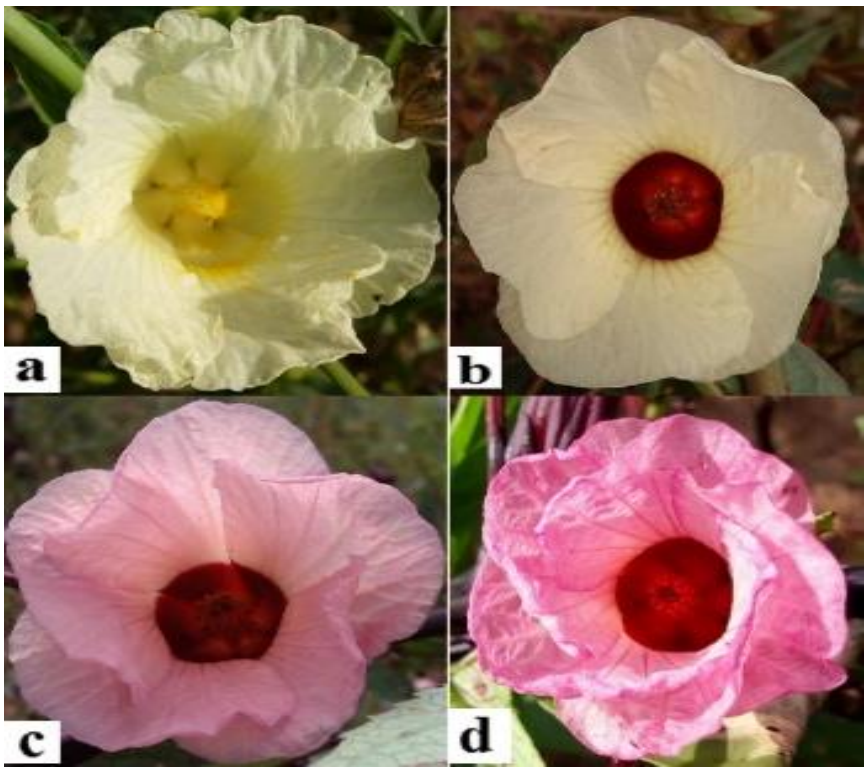

Figure 4. Different colors o*f Hibiscus sabdariffa* corolla
Legend: *a) yellow, b) yellow with red throat, c) light purple with red throat, d) pink with red throat*

2.2 Genetic variability revealed by quantitative traits

2.2.1. Analysis of variance

Analysis of variance (ANOVA) revealed significant differences among the forty-height genotypes for all quantitative traits studied (table 3). This significant difference suggests a large genetic variability in the collection of *Hibiscus sabdariffa.*

The number of days 50 % emerged varied from two (02) to four (04) days. Sixty days after sowing, the average plant height was about 1.37m with an average leaf production of 0.542 kg per plant. Flowering occurs 70 to 117 days after sowing, and about twenty days after flower bud formation. Flower buds ripen on average 30 days after flowering. The average yield of dry calyxes was 26 g per plant and the average weight of 100 seeds was 2.67 g. The coefficients of variation also showed significant variability for the traits studied and varied from 3.03% to 70.07%.

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Table 3. Analysis of variance of the collection of *Hibiscus sabdariffa* L.

Variables	Min.	Mean	Max.	CV (%)	R^2 (%)	F	P-value
PEL (cm)	8	11.84	17.23	9.17 ± 1.09	65.6	11.61**	**< 0.0001**
LIF(cm)	10.83	16.05	23.67	7.74 ± 1.24	76.8	18.43**	**< 0.0001**
LIW (cm)	6.17	11.27	21.33	8.55 ± 0.96	84.9	32.16**	**< 0.0001**
CAL(cm)	1.83	4.75	9.17	10.37 ± 0.49	88.6	50.64**	**< 0.0001**
CAD (cm)	1.93	2.884	4.06	8.59 ± 0.25	65	10.15**	**< 0.0001**
FLW (g)	129.8	541.9	1324	34.68 ± 187.9	43.9	4.02**	**< 0.0001**
PLH (cm)	70	137.4	200	12.84 ± 17.65	64	9.28**	**< 0.0001**
STD (cm)	1.4	2.552	4	16.8 ± 0.43	42.9	3.90**	**< 0.0001**
NPB (nbr)	11	24.68	41	18.15 ± 4.48	52.2	5.91**	**< 0.0001**
NCP (nbr)	6	53.56	339	61.35 ± 32.86	46.4	4.30**	**< 0.0001**
FCW (g)	24.1	158.6	1002	66.59 ± 105.6	44.3	3.53**	**< 0.0001**
DCW (g)	4.5	26.2	106.6	54.72 ± 14.33	50.9	4.54**	**< 0.0001**
100SW (g)	1.7	2.67	4.2	4.36 ± 0.12	97.6	183.08**	**< 0.0001**
SWP (g)	3.7	31.99	260.2	70.07 ± 22.41	41	3.09**	**< 0.0001**
NDE (nbr)	2	3.306	4	11.76 ± 0.39	79.1	21.37**	**< 0.0001**
NDB (nbr)	59	73.57	95	3.64 ± 2.68	92.2	62.24**	**< 0.0001**
NDF (nbr)	70	92.05	117	3.08 ± 2.84	93.4	79.98**	**< 0.0001**
NDM (nbr)	92	121.2	152	3.38 ± 4.10	91	53.87**	**< 0.0001**

Legend: *PEL: petiole length; LIF: leaf length, LIW: leaf width; CAL: calyx length; CAD: calyx diameter; FLW: fresh leaf weight per plant or fresh leaf biomass per plant; PLH: Plant height ; STD: stem diameter; NPB: number of primary branches; NCP: number of capsules (fruits) per plant, FCW: fresh calyx weight; DCW: Dry calyx weight; 100SW: hundred seeds weight; SWP: seeds Weight per plant; NDE: Number of days at 50% emergence; NDB, number of days at 50% flower bud formation; NDF: Number of days at 50% flowering; NDM: Number of days at 50% maturity; **: Significant difference at 1% level; F: Fisher's F, CV: coefficient of variation ± standard error, R^2: coefficient of determination.*

2.2.2. Principal component analysis

Principal component analysis was conducted using quantitative traits. The first three (03) components F1, F2, and F3 explained 69.62% of the total variability.

F1 axis with 31.41% of the total variability had significantly positive correlation with leaf biomass (r = 0.65), plant height (r = 0.70), main stem diameter (r = 0.74), number of primary branches (r = 0.78), number of capsules per plant (r = 0.88), fresh calyx weight (r = 0.67), dry calyx weight (r = 0.71) and seed weight per plant (r=0.86). Axis 1 is therefore the yield axis or productivity axis. The second factor (F2) accounted for 22.30% of the total variability. The traits of a number of days to 50% flower bud formation

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(r=0.78), number of days at 50% flowering (r=0.77), and the number of days to maturity (r=0.77) are positively correlated with this factor. On the other hand, the variable hundred seed weight (r = -0.72) is negatively correlated with factor F2. The second factor defined the cycle of the genotypes studied. The third factor (F3) with 15.98% of the total variability associate's petiole length (r = 0.80), leaf length (r=0.61), leaf width (r=0.69), calyx diameter (r = 0.78). Axis 3 can be considered as the factor of leaf development (figure 5).

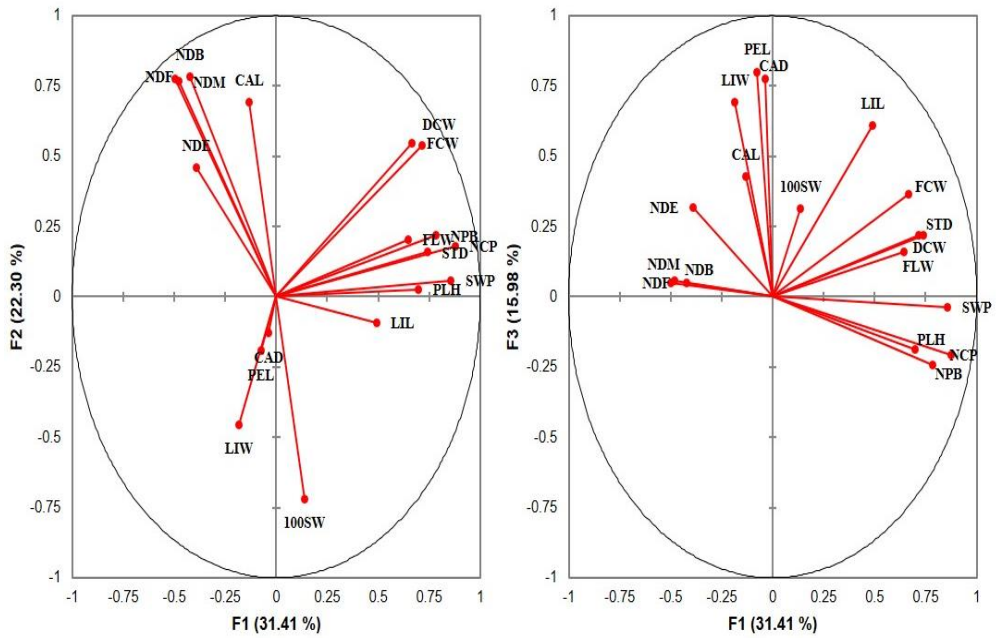

Figure 5. Principal component analysis of *Hibiscus sabdariffa* L quantitative traits

2.2.3. Cluster analysis

Hierarchical cluster analysis (figure 6) based on six quantitative traits grouped 48 accessions of *Hibiscus sabdariffa* into three clusters formed by accessions from diverse geographical origins except accessions of cluster III formed by five (05) accessions (10.47% of the collection) that provided to Banwa province (table 4). Cluster I formed by 21 accessions (43.75% of the collection) and cluster II consisted of 22 accessions (45.83% of the collection). In addition, the Fisher's statistic values, and coefficient of determination (R^2) (table 5) showed that the traits such as: plant height (PLH), calyx length (CAL), hundred seeds weight (100SW), number of days at 50% emergence (NDE), number of days at 50% flower bud formation (NDB), number of days at 50% flowering (NDF), Number of days at 50% maturity (NDM); discriminate the groups with relatively high F and R^2 values. Thus, cluster I is composed of accessions with low height (128.4 cm) and a relatively long cycle (132 days to reach 50% maturity). These accessions developed boll with long calyxes (5.5

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cm) which had the lowest hundred seed weight (100SW= 2.3 g). Cluster III is consisted of accessions all from the same locality and had the same color (uniformly green). These was tall morphotypes (146.9cm) that are early matured (96 days to reach 50% maturity) and produced boll with short calyxes and had high hundred seed weight (PCG= 3.4 g). Cluster II contained accessions with a medium cycle (116 days to reach 50% of maturity). This group contained both morphotypes with well-developed long calyxes and morphotypes with short calyxes.

Table 4. Accessions of *Hibiscus sabdariffa* grouping into three clusters according to hierarchical cluster analysis

Cluster	**I**	**II**	**III**
Accession names	NOU2, BOB8, BOR7, SOL9, DIE1, BOB3, BOB7, NOU7, BOR1, NOU3, BOR2, BOB11, BOB4, NOU1, DAN4, BOB6, DAN1, DAN2, DIE2, DAN3, BOB1	BOR9, BOR10, DED3, BOR4, SOL7, BOB5, BOB2, BOR5, BOR12, BOB12, BOR8, DED2, GAO1, NOU4, BOR3, NOU5, NOU6,SOL6, GAO2, SOL2, BOR6, BOB9	SOL4, SOL1, SOL5, SOL3, SOL8

Table 5. Evaluation of the average performance of the three groups by the Newman Keuls test

Variables	**Group 1**	**Group 2**	**Group 3**	**R^2**	**F**
PEL (cm)	11.54**a**	12.21**a**	11.44**a**	0.054	1.27^{ns}
LIL(cm)	15.51**a**	16.20**a**	17.66**a**	0.088	2.18^{ns}
LIW(cm)	11.15**a**	10.9**a**	13.3**a**	0.108	2.73^{ns}
CAL(cm)	**5.45c**	**4.53b**	**2.75a**	**0.341**	$\mathbf{11.66^{***}}$
CAD (cm)	2.93**a**	2.78**a**	3.13**a**	0.115	2.73^{ns}
FLW(g)	505.34**a**	565.63**a**	590.56**a**	0.047	1.11^{ns}
PLH (cm)	**128.41a**	**143.90b**	**146.93ab**	**0.138**	$\mathbf{3.60^{*}}$
STD (cm)	2.48**a**	2.58**a**	2.72**a**	0.049	1.17^{ns}
NPB (nbr)	23.76**a**	25.16**a**	26.43**a**	0.042	0.99^{ns}
NCP (nbr)	44.24**a**	60.08**a**	64.03**a**	0.084	2.05^{ns}
FCW (g)	160.32**a**	168.46**a**	108.01**a**	0.041	0.97^{ns}
DCW (g)	26.55**a**	27.57**a**	18.66**a**	0.057	0.865^{ns}
100SW (g)	**2.32a**	**2.85b**	**3.35b**	**0.275**	**8.53*** **
SWP (g)	25.26**a**	36.67**a**	39.65**a**	0.120	3.068^{ns}
NDE (nbr)	**3.50b**	**3.40b**	**2.05a**	**0.358**	$\mathbf{12.54^{***}}$
NDB (nbr)	**81.20c**	**69.24b**	**60.51a**	**0.714**	$\mathbf{56.12^{***}}$
NDF (nbr)	**101.20c**	**87.32b**	**74.41a**	**0.761**	$\mathbf{71.77^{***}}$
NDM (nbr)	**131.97c**	**116.49b**	**196.29a**	**0.858**	$\mathbf{136.3^{***}}$

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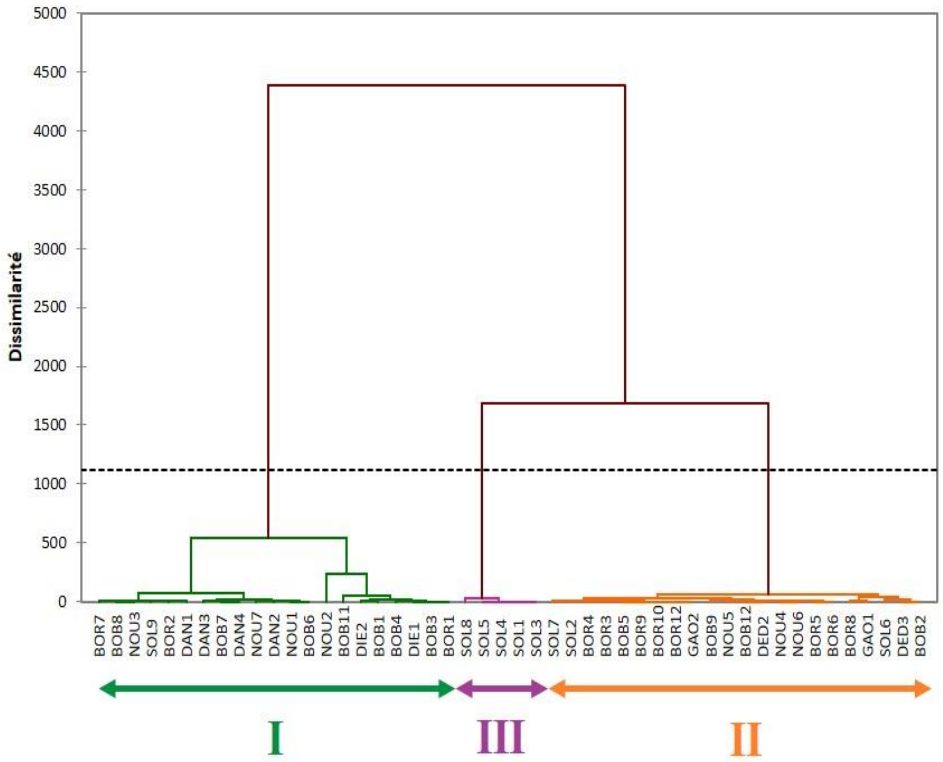

Figure 6. Dendrogram of 48 accessions of *Hibiscus sabdariffa* L.

3. Discussion

Agromorphological characterization revealed a wide morphological variability within *Hibiscus sabdariffa* accessions collected in western Burkina Faso. Color variation was observed on organs such as leaves, stems, and flowers. This diversity is linked to the plant's mode of reproduction (autogamy), which favorize homogeneity between plants in a population but can contribute to increasing diversity between ecotypes (Bakasso, 2010). The red, pink, and violet colors observed on leaves, stems, sepals, and petals result from the synthesis of anthocyanins by the species (Mazza & Miniati, 1994; Pale *et al.*, 2004) and constitute a factor of drought tolerance for the plant (Bricage, 1984). Moreover, the different calyx shapes observed show the great genetic variability of the plant. An important genetic variability in *Hibiscus sabdariffa* germplasm was also reported by Bakasso (2010), Sharma *et al.* (2016), and Ankrah *et al.* (2018) respectively in Niger, India, and Ghana.

In addition to the variability of the qualitative traits, there is a variation between accessions for all quantitative traits studied as denoted through analysis of variance.

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The high values of coefficients of variation of traits such as fresh leaf weight per plant, number of bolls per plant, fresh calyx weight, dry calyx weight, and seed weight per plant show a wide dispersion of these variables around the mean. According to Aljane and Ferchichi (2007), a high value of the coefficient of variation (>30%) reflects the heterogeneity of the material studied. The mixing of several morphotypes within the same accession and the spontaneous ginning at maturity of some accessions, which leads to seed loss, can also explain these results. Furthermore, the high values of the coefficient of determination (R^2>60) for leaf length and width, calyx length and width, plant height, hundred-seed weight, and plant cycle show that the expression of these traits could be under genetic control. Thus, a good knowledge of the genetic parameters is necessary for the choice of optimal selection criteria (Merour *et al*., 2008).

Accessions collected have a 50% flowering date comprised between 70 and 117 days. Our results differ from those of Bakasso (2010) and Satyanarayana *et al.* (2017) who found respectively a cycle of 65 to 97 days to 50% flowering for genotypes grown in Niger and 153 to 163 days to 50% flowering for genotypes grown in India. According to Islam *et al.* (2008), the flowering date of *Hibiscus sabdariffa* depends not only on environmental conditions and genotypes but also on the sowing date because *Hibiscus sabdariffa* is sensitive to day's duration as well as it is a short-day plant and blooms when the day length shortened (Mansour, 1975; Hacket and Carolene, 1982).

The grouping of accessions into three groups was done independently of the provenance of the samples but according to the length of the calyx and the cycle, this result could be linked to the management of seed by farmers through exchanges that take place among and between communities (Kiébré *et al*., 2015; Ouangraoua *et al*., 2021). In addition, calyx size is a parameter used by farmers in Burkina Faso and Niger to identify the morphotypes of *Hibiscus sabdariffa* (Bakasso, 2010; Ouangraoua et al., 2021). According to the same authors, farmers distinguish two morphotypes based on the shape of the calyx. These are genotypes with a long, highly developed calyx and a genotype with a short calyx that adheres directly to the capsule. The high diversity observed in *Hibiscus sabdariffa* L. provides a broad genetic base for the possible selection and development of suitable varieties that farmers and consumers need.

Conclusion

Agromorphological characterization of *Hibiscus sabdariffa* revealed significant variability within accessions studied. According to the identification of more discriminant traits, we denoted that, traits such as color and shape of the leaves, stem, flowers, and seeds, plant height, calyx length,

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hundred seed weight, and days to 50% flowering could be used as descriptors of *Hibiscus sabdariffa*. Concerning the determination of the relationships between the studied characteristics, it appeared some significant correlations between leaf weight per plant, number of primary branches, number of capsules per plant, fresh and dry calyx weight, seed weight per plant, and the cycle of the plant. The structuration of the variability highlighted three distinct agromorphological groups based on quantitative data. These results can contribute to the genetic improvement of the plant. Further analysis such as the use of microsatellites and sequencing for SNP selection could help to better understand the genetic diversity of Hibiscus sabdariffa in Burkina Faso.

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