

Full Length Research Paper

Characterization of high-performance cashew (*Anacardium occidentale* L.) accessions in Burkina Faso

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The cashew tree (*Anacardium occidentale* L.) is a perennial plant in the Anacardiaceae family. It is cultivated for its fruit in general and for its nut in particular. The main objective of this study is to characterize the accessions of cashew nuts in the orchard of the Kouentou agricultural farm in western Burkina Faso. To this end, 340 fruits of 17 cashew accession were harvested from previously labelled vines, that is, 20 fruits per accession for data collection. The fruits were harvested taking into account the cardinal points. The variables to be measured were established considering the International Board for Plant Genetic Resources (IBPGR) 1986 guidelines. The results obtained from the fruit indicate several cashew apple shapes (Cylindrical, Conical, Rounded and Pyriform). Similarly, yellow, red, orange and red-yellow coloring was observed in the different apples of the 17 cashew accessions. The analysis of variance showed very highly significant difference for all the quantitative variables with the exception of sugar content, which was not significant at the 5% level. The resulting dendrogram shows a distribution of the 17 cashew accessions into four classes according to the sugar content of the apples, and the size and mass of the apples and nuts. These accessions offer hope for the varietal diversity of cashews in Burkina Faso.

Key words: Accessions, cashew nuts, characterization, Burkina Faso.

INTRODUCTION

The cashew tree (*Anacardium occidentale* L.) is a fruit tree native to northeastern Brazil (Tandjiékpon, 2005). It is still called cashew nut tree and is cultivated for its fruit, which is, composed of two parts namely the nut and the apple (Kotchofa, 2014). It is a predominantly allogamous plant. Its inflorescence is made up of both male and hermaphrodite flowers (Paiva et al., 2009). The world's largest cashew nut producers are Côte d'Ivoire, India,

Vietnam, Indonesia, Brazil, Nigeria, Tanzania and Mozambique. West Africa is the cashew nut production hub par excellence in Africa (International Nut and Dried Fruit Council [INC], 2023) with a production of 1 795 000 T, or 49% of the world's cashew nuts (Pierre, 2019). Côte d'Ivoire was the world's leading cashew nut producer (Ouattara et al., 2020). In Burkina Faso, the dynamism of this sector has led to the recent drafting of a development

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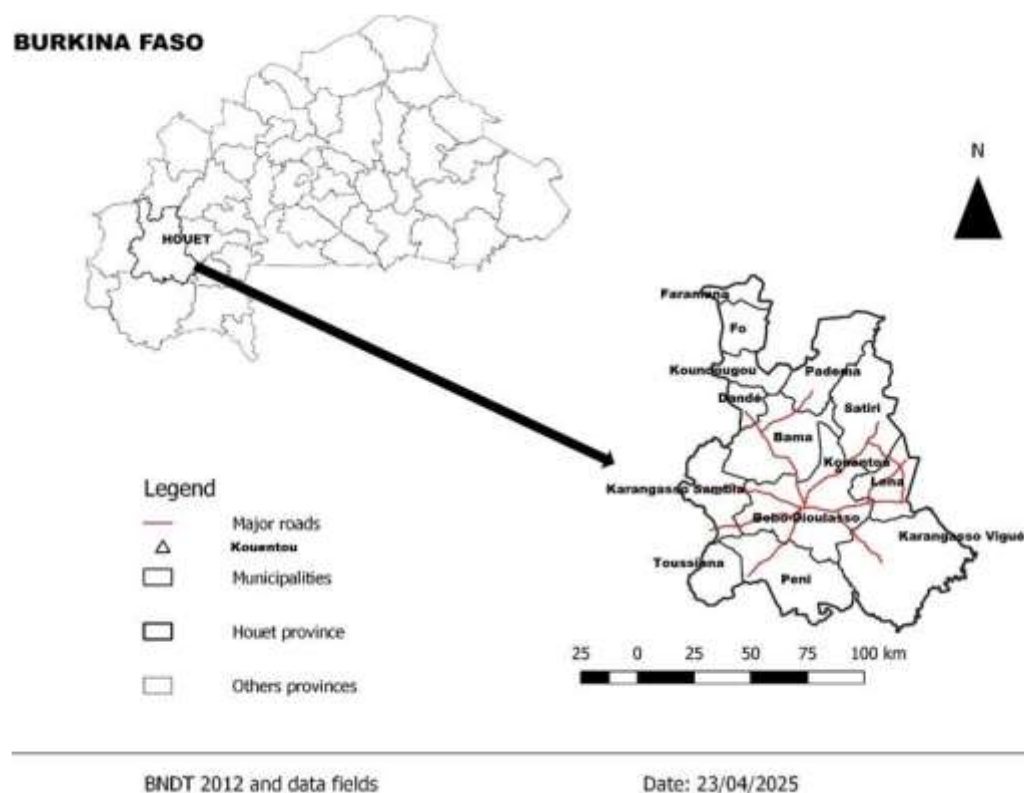


Figure 1. Geographical location of the study area.

strategy for the sector and the creation of a Burkina Cashew Council. The South-West, Cascades, Haut-Bassin and Centre-West regions alone account for more than 99% of national production (Apex, 2017). In order to further promote the cashew nut industry in Burkina Faso, agricultural research needs to be supported with quality seedlings (Tarpaga et al., 2020). However, only two cashew varieties are produced in Burkina Faso (Apex, 2017). These are the 'yellow colour' and 'red colour' varieties. The existence of two varieties selected on the basis of the colour of the apple represents a risk of genetic vulnerability (Barros et al., 2000). The solution lies in the great variability found in the nuts and apples of each variety. In some producer countries, such as Brazil, India and Thailand, the selection of high-performance accessions is essential if yields are to be increased (Soro, 2012). So, to better develop the cashew nut sector in Burkina Faso, it is necessary to select high-performance varieties to support the processing chain. It is in this context that the present study was initiated, with the aim of obtaining high-performance varieties that could revolutionized the cashew nut industry in Burkina Faso.

MATERIALS AND METHODS

Study area

The Kouentou agricultural farm is a private educational farm located

in Kouentou village. Kouentou is located 26 km from the town of Bobo Dioulasso on the Bobo Dioulasso-Dedougou Road. It is located at latitude 11°19'34" North and longitude 4°07' 24" West (Figure 1). The plant materials for the study consisted of the fruits of 17 cashew accessions from the Kouentou farm. Twenty fruits of each accession, that is, a total of 340 fruits, were collected from the identified mother trees (Table 1). The fruits cashews were harvested on the Kouentou farm in western Burkina Faso. 20 fruits of each accession were harvested at physiological maturity in February 2024 according to the International Board for Plant Genetic Resources (IBPGR) 1986 guidelines. Qualitative and quantitative data were collected on each cashew accession. The nut and apple of each fruit were detached and measurements and observations were done. All qualitative variables were determined in the same way by direct observation with the naked eye. These variables are: fruit colour and fruit shape. As for the quantitative variables, the lengths and sections of the apples and nuts were measured using a caliper. The weights of the fruit, apples and nuts were determined using a WH-B05 0.1 g precision balance.

Data collection

The variables measured during the experiment were qualitative and quantitative. These variables are listed in Table 2.

Data analysis

The Excel 2016 spreadsheet was used to calculate the frequencies of the qualitative variables. For data with quantitative variables, measurements were taken using a graduated double decimeter, caliper, spectrometer and a 0.001 g precision balance. XLSTAT

Table 1. List of accessions studied.

Accession	Origin
AK7	Kouentou
AK5	Kouentou
AK11	Kouentou
AK9	Kouentou
AK14	Kouentou
AK1	Kouentou
AK2	Kouentou
AK21	Kouentou
AK12	Kouentou
AK13	Kouentou
AK8	Kouentou
AK15	Kouentou
AK16	Kouentou
AK18	Kouentou
AK10	Kouentou
AK28	Kouentou
AK6	Kouentou

Table 2. Qualitative and quantitative data collected on the fruit.

Data	Variable	Code
Qualitative	Fruit colour	-
	Fruit shape	-
Quantitative	Apple Length	AL
	Brix	°B
	Apple Section	AS
	Total Mass	TM
	Nut Mass	NM
	Apple Mass	AM

2016 software was used for the analysis of variance (ANOVA) and the means were compared using the Fisher test at the 5% threshold.

RESULTS

Fruit quality variables discriminating the 17 cashew accessions

Figure 2 shows the fruit quality variables for the 17 cashew accessions studied. This figure shows four different colourings of cashew accessions. Firstly, the yellow colour is observed in the AK08, AK07, AK28, AK14, AK10 and AK13 accessions. Secondly, the orange colour is seen in accessions AK02, AK12 and AK21. Thirdly, the red-yellow colour is seen in accessions AK01, AK06, AK09 and AK18. Finally, the red colour is seen in accessions AK05, AK16, AK11 and AK15. As for the

different fruit shapes, there are accessions with elongated fruits (AK08, AK07, AK28, AK12, AK21, AK01, AK06, AK09, AK18 and AK16) and others with rounded fruits (AK14, AK10, AK13, AK02, AK05, AK11 and AK15).

Quantitative fruit variables discriminating the 17 cashew accessions

Analysis of the data for the quantitative fruit variables showed that there were both non-significant differences and differences that were highly significant at the 5% level according to the fisher test (LSD) (Table 3). For the variable total fruit mass (TM), the analysis of variances showed highly significant difference at the 5% level. The AK9 accession presented the highest total masses with an average of 97.62 ± 7.13 g. It is statistically equivalent to the AK8 and AK11 accessions. Accession AK13 had the

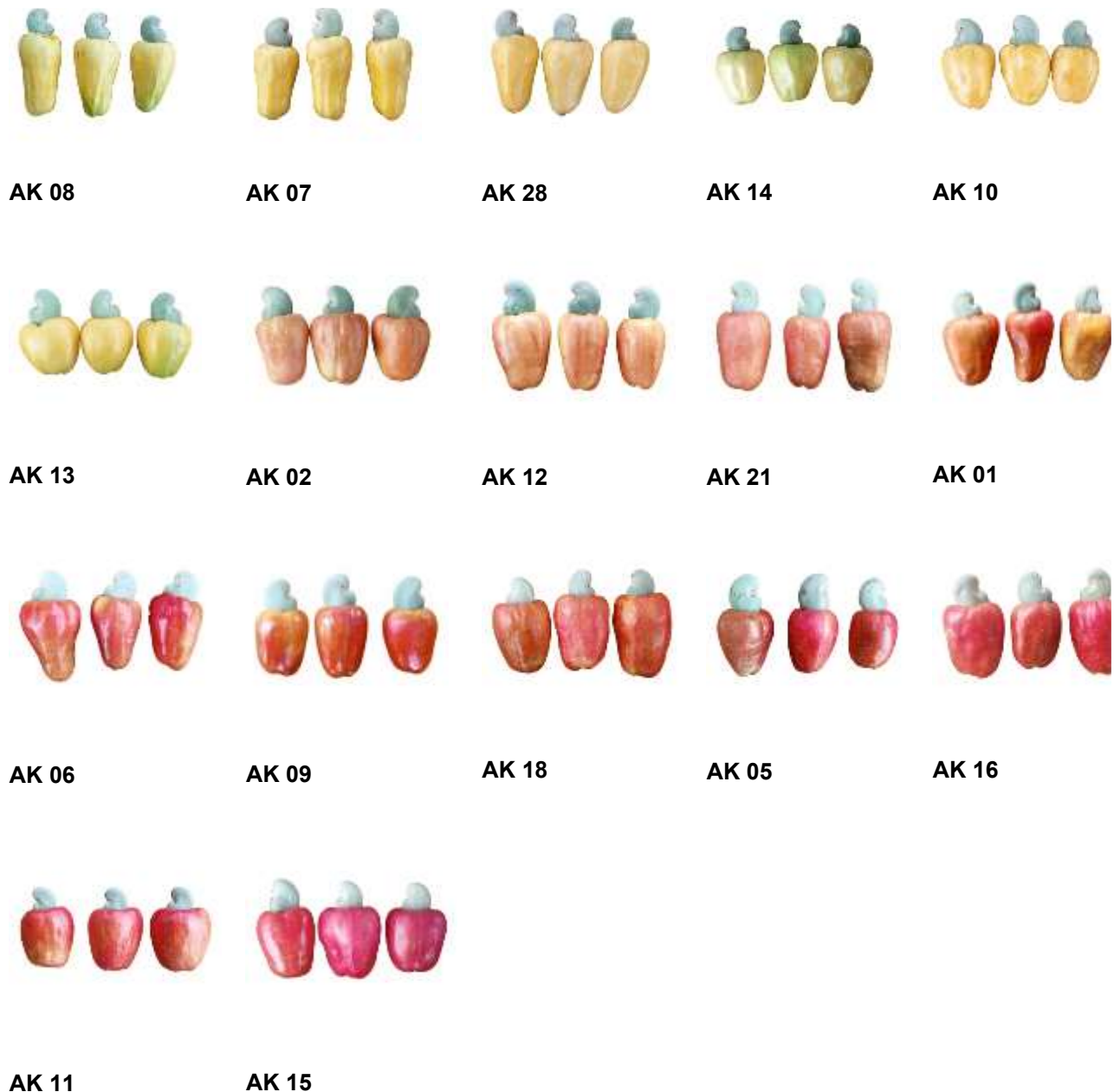


Figure 2. Qualitative variables of the different cashew accession.

lowest total fruit mass with an average of 33.91 ± 0.04 g. With regard to the apple mass variable (AM), the analysis of variances showed highly significant difference at the 5% threshold. The AK9 accession had the highest apple mass with an average of 92.60 ± 15.82 g. It is statistically equivalent to the AK11 accession. The AK13 accession had the lowest apple mass with an average of 30.66 ± 0.01 g. For the nut mass variable (NM), the analysis of variances showed very highly significant differences at the 5% threshold. The AK7 accession had the highest nut mass with an average of 10.76 ± 0.67 g. The AK28 accession had the lowest nut mass with an

average of 2.61 ± 0.46 g. For the apple length variable (AL), the analysis of variance showed very highly significant difference at the 5% threshold.

Quantitative fruit variables discriminating the 17 cashew accessions

Analysis of the data for the quantitative fruit variables showed that there were both non-significant differences and very highly significant differences at the 5% LSD (Table 3). For the variable total TM, the analysis of

Table 3. Measurements of quantitative fruits variables.

Variable	TM	AM	NM	AL	AS	°B
AK9	97.62 ^a ± 7.13	92.60 ^a ± 15.82	8.94 ^b ± 0.80	8.45 ^a ± 0.12	4.75 ^a ± 0.05	17.95 ^{abc} ± 0.68
AK11	94.35 ^a ± 11.87	86.78 ^{ab} ± 10.91	7.5 ^{cd} ± 1.09	7.35 ^{bc} ± 1.05	4.35 ^{ab} ± 0.77	16.5 ^{abcd} ± 2.54
AK8	84.94 ^{ab} ± 10.53	76.53 ^{bc} ± 9.87	8.47 ^{bc} ± 0.47	8.0 ^{ab} ± 0.61	4.03 ^{bc} ± 0.20	15.89 ^{bcd} ± 1.21
AK2	73.01 ^{bc} ± 9.49	63.79 ^{cde} ± 10.68	6.27 ^e ± 0.82	5.92 ^{defg} ± 0.15	4.05 ^{bc} ± 0.05	17.95 ^{abc} ± 2.83
AK1	73.99 ^{bc} ± 13.23	67.35 ^{cd} ± 12.46	6.31 ^{de} ± 0.63	6.82 ^{cd} ± 1.44	3.2 ^{def} ± 0.16	15.67 ^{bcd} ± 1.45
AK14	62.67 ^{cd} ± 9.43	57.07 ^{def} ± 9.88	5.50 ^{efg} ± 0.76	5.37 ^{gh} ± 0.97	3.97 ^{bc} ± 0.71	16.97 ^{abcd} ± 1.82
AK7	56.89 ^{de} ± 17.47	45.73 ^{gh} ± 16.82	10.76 ^a ± 0.67	6.4 ^{def} ± 0.92	3.12 ^{ef} ± 0.28	17.3 ^{abcd} ± 4.03
AK5	56.95 ^{de} ± 11.24	49.17 ^{fg} ± 9.07	7.48 ^{cd} ± 2.23	5.00 ^{gh} ± 0.32	3.97 ^{bc} ± 0.32	15.55 ^{bcd} ± 2.9
AK12	48.59 ^{ef} ± 7.55	44.34 ^{gh} ± 7.36	4.2 ^{hi} ± 0.61	5.8 ^{efg} ± 0.29	3.97 ^{bc} ± 0.32	18.05 ^{abc} ± 2.14
AK21	56.74 ^{de} ± 4.46	51.30 ^{efg} ± 4.83	5.42 ^{efg} ± 0.50	5.4 ^{gh} ± 0.75	3.72 ^{cd} ± 0.32	14.67 ^{cd} ± 3.84
AK15	49.81 ^{def} ± 10.18	44.09 ^{ghi} ± 9.14	5.69 ^{ef} ± 1.11	3.6 ⁱ ± 1.00	3.9 ^{bc} ± 0.46	16.85 ^{abcd} ± 4.70
AK28	41.61 ^{fg} ± 4.50	38.94 ^{ghi} ± 4.00	2.61 ^j ± 0.46	6.57 ^{cde} ± 0.41	3.02 ^{ef} ± 0.52	18.55 ^{abc} ± 2.32
AK6	48.36 ^{ef} ± 7.54	43.66 ^{ghi} ± 7.33	4.38 ^{ghi} ± 0.44	5.37 ^{gh} ± 0.27	3.57 ^{cde} ± 0.28	16.95 ^{abcd} ± 2.87
AK18	39.44 ^{fg} ± 9.47	34.77 ^{hi} ± 9.06	4.36 ^{ghi} ± 0.54	5.12 ^{gh} ± 0.70	3.25 ^{def} ± 0.66	20.47 ^a ± 7.87
AK16	38.36 ^{fg} ± 6.20	33.84 ^{hi} ± 5.87	4.43 ^{ghi} ± 0.40	4.57 ^{hi} ± 0.45	2.72 ^f ± 0.53	19.9 ^{ab} ± 1.46
AK10	40.26 ^{fg} ± 5.93	35.21 ^{hi} ± 5.64	5.00 ^{gh} ± 0.47	4.97 ^{gh} ± 0.49	3.85 ^{bc} ± 0.28	12.87 ^d ± 1.30
AK13	33.91 ^g ± 0.04	30.66 ⁱ ± 0.01	3.24 ^{ij} ± 0.02	3.95 ⁱ ± 0.28	3.55 ^{cde} ± 0.05	19.1 ^{abc} ± 0.11
F	17.606	15.137	25.793	14.226	6.144	1.465
Pr> F	0.000	0.000	0.000	0.000	0.000	0.151
Signification	THS	THS	THS	THS	THS	NS

TM: Total mass of the fruit; AM: apple mass; MN: nut Mass; AL: apple length; AS: apple section; °B: Brix; THS: very highly significant; NS: non-significant.

variances showed very highly significant difference at the 5% level. The AK9 accession presented the highest total masses with an average of 97.62±7.13 g. It is statistically equivalent to the AK8 and AK11 accessions. Accession AK13 had the lowest total fruit mass with an average of 33.91±0.04 g. With regard to the apple AM, the analysis of variances showed very highly significant difference at the 5% threshold. The AK9 accession had the highest apple mass with an average of 92.60±15.82 g. It is statistically equivalent to the AK11 accession. The AK13 accession had the lowest apple mass, with an average of 30.66±0.01 g. For the variable nut mass (NM), the analysis of variances showed very highly significant differences at the 5% threshold. The AK7 accession had the highest nut mass with an average of 10.76±0.67 g. The AK28 accession had the lowest nut mass with an average of 2.61±0.46 g. For the apple AL, the analysis of variances showed very highly significant difference at the 5% threshold. The AK9 accession had the longest apple with an average of 8.45±0.12 cm. It is statistically equivalent to the AK8 accession, which is marked with the letter 'a'. The AK15 accession had the lowest apple length with an average of 3.6±1.00 cm. For the variable apple section (AS), the analysis of variances showed very highly significant difference at the 5% threshold. The AK9 accession had the highest apple section, with a mean of 4.75±0.05 cm. It is statistically equivalent to the AK11 accession, which has the same letter 'a'. Accession

AK16 had the smallest apple cross-sections, with an average of 2.72±0.53 cm. Analysis of variances for the sugar content variable (°B) showed a non-significant difference at the 5% threshold. The AK18 accession had fruit with higher brix and an average of 20.47±7.87. The AK10 accession had fruit with lower brix and an average of 12.87±1.30.

Structuring of morphological variability in cashew fruit accessions

The dendrogram (Figure 3) derived from the Ascending Hierarchical Classification (AHC) shows the distribution of individuals into four classes. The first class (C1), represented by nine accessions including AK2, AK21, AK14, AK10, AK5, AK8, AK11, AK9 and AK1. The central object of this class is the AK2 accession. The fruits of the accessions in this class are very sweet with large, heavy apples. The second class (C2) is made up of a single accession, AK7. The fruits of this class have heavy nuts and long, very sweet apples. The third class (C3), represented by four accessions including AK6, AK28, AK15 and AK12. The central object of this class is the AK6 accession. The fruit in this class is smaller, lighter and moderately sweet. The fourth class (C4) is made up of three accessions including AK16, AK18 and AK13. The

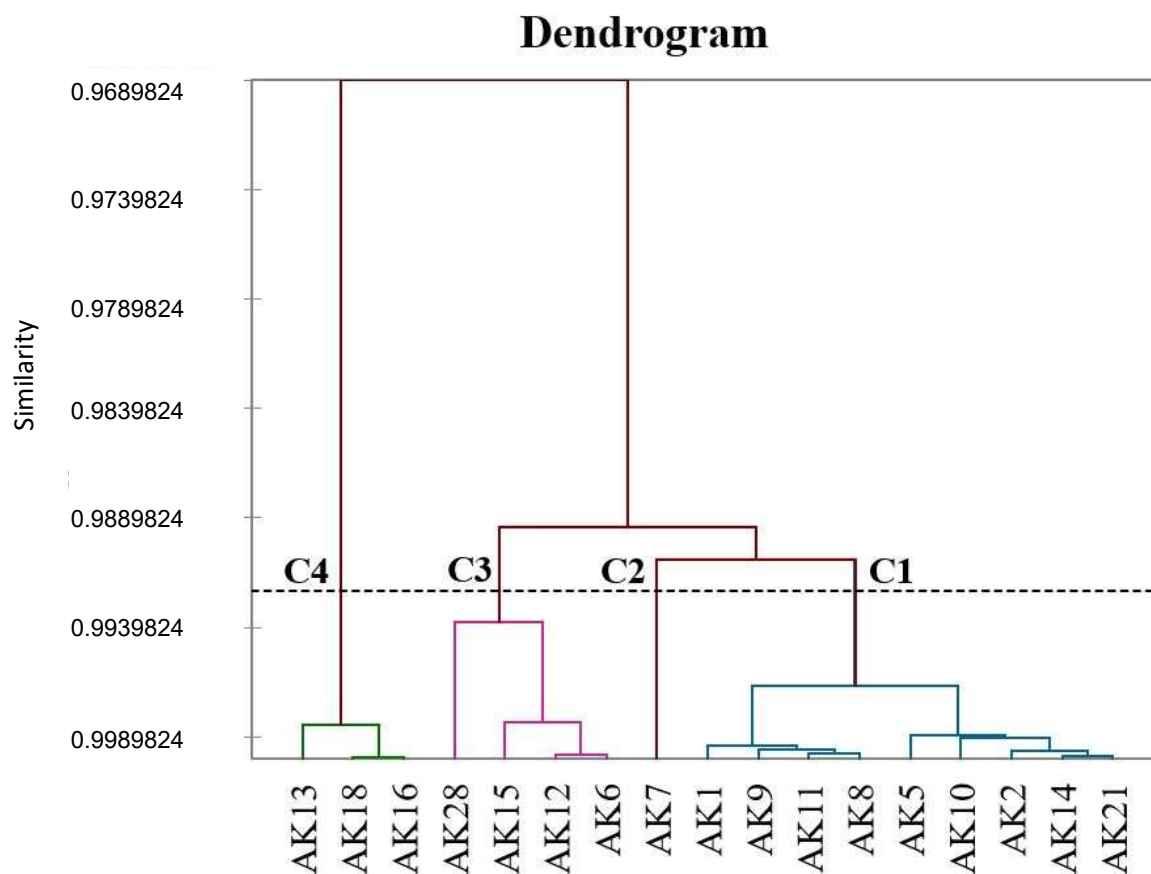


Figure 3. Dendrogram grouping accessions according to fruit morphological variables.

central object of this class is the AK16 accession. The fruits in this class are light, ranging from apples to walnuts, but are very sweet.

DISCUSSION

Four different apple colours were observed: yellow, orange, red-yellow and red. These colours reflect the great genetic variability that exists within these accessions. Previous studies have also shown the existence of these different colours in the apples observed in our study (Barros et al., 2000; Paiva et al., 2003). From orange to reddish, yellow to red, the various cashew genotypes have been characterized, indicating their adoption on the fresh fruit market. Elongated and rounded shapes were also found among the accessions studied. These results will make it possible to remedy the lack of high-performance varieties, which is an obstacle to the development of the cashew industry, which has only two varieties, one yellow and the other red (Apex, 2017). In terms of fruit quality, the AK9 accession performed better in terms of total fruit mass and apple length. This accession is recommended to apple juice processors. Paiva et al. (2003) also characterized

cashew genotypes in Brazil according to the mass of their apples and nuts. However, during their work, some orange genotypes had apples that weighed an average of 135 g. This result, based on the mass of the apple, is much higher than the average. This result for the mass of the apple is considerably higher than that of our study, which averaged 97.62 g. The lowest apple masses averaged 76.5 g with light nuts that are not appreciated on the market. In this case, these nuts are used as rootstock seeds (Barros et al., 2000). For those who transform cashew apples into wine, the AK18 accession is recommended because it is the sweetest. However, the AK10 accession is recommended for diabetics as it is less sweet. With a variation in sugar content ranging from 12.87°Brix to 20.47°Brix, these results are not in line with those found by Ndiaye et al. (2022) who admit that the sugar content of an apple varies from 14 to 14.70°Brix. Cashew varieties such as clone BRS 189 with a lower brix of 13.3 would be created and recommended specifically for fresh fruit in irrigated cultivation (Barros et al., 2002). The AK7 accession is recommended for processors and growers who only need nuts. This accession has the best performance and could make growers and processors happy once it has been adopted. The classification of the 17 cashew accessions studied

reveals the enormous differences that exist within these accessions. It could facilitate the inclusion of these accessions in the national catalogue as varieties in their own right. This would be a relief for cashew growers, since only two cashew varieties are currently produced in Burkina Faso (l'Agence pour la Promotion des Exportations (Apex), 2017). This shortage of cashew varieties is felt in the sub-region, as was the case in Côte d'Ivoire, where a distinction is made between the old-growth varieties (with generally small nuts) and the JUMBO variety (large nuts) originating from Brazil (Réseau des ONG Européennes d'Appui au Développement [RONGEAD], 2009).

Conclusion

The main objective of this study was to characterize the cashew nut accessions in the orchard of the Kouentou farm in Burkina Faso. At the end of the study, the results showed that the 17 accessions were highly variable, both in terms of colour and shape of the apples and in terms of the quantitative variables measured. Similarly, the dendrogram obtained enabled the accessions to be divided into four classes. In view of the results obtained, it is necessary to register them as varieties in the national catalogue.

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CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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