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Morpho-agronomic characterization and nutritional composition of nine sweet potato (Ipomoea batatas L.) cultivars in Kisangani, Democratic Republic of Congo

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ABSTRACT

This study carried out the Morphological, Agronomic and Nutritional Characterization of Nine Cultivars of Sweet Potato (*Ipomoea batatas* L.) Grown in Kisangani, Democratic Republic of Congo

. The experimental design was that of randomized blocks, comprising 9 treatments of sweet potato cultivars (Carrot, Damu, Elengi, Mugande, Muganderva, Monde, Mambokolo, Kandolo and Kilomo) and 4 replications. The treatments were installed on ridges of 2.5 m length and 0.5 m width. It was obtained, the cultivars with tuber of pink color (Mambokolo, Kilomoya, Elengi and Monde); light green (Kandolo, Damu); white of diamond (Mugande); chocolate with coverage of the ground by the biomass is total for the cultivars Elengi, Mungade and chocolate (Mugande) and beige (Carrot). The shapes of the leaves, round (Mambokolo); obovate (Kandolo, Elengi); elliptic (Damu, Kilomoya); oval (Mugande) and irregular (Carrot, Muganderva and Monde). As for the unit weight of the tubers, the cultivars Mambokolo (3.35kg) and Elengi (3.5kg) performed well at 5 months of cultivation and the nutritional parameters showed that the cultivars Elengi, Kandolo and Carrot are richer in crude protein respectively 4.56; 1.43 and 0.75%.

I. Introduction

Sweet potato is a dicotyledonous species of the family Convolvulaceae, tribe Ipomoeae, probably originating from tropical America. It is a perennial herbaceous plant that is widely cultivated in all tropical and subtropical regions, where it is grown mainly for its edible, starchy tubers (Janssens, 2001).

Potato" also refers metonymically to the tubers produced by this plant. The sweet potato is an unknown cultigen in the wild. With an annual production of 113000 tons harvested one more than 9000 hectares (Anses, 2017). Sweet potato is the 7th agricultural production worldwide, after wheat, rice, corn, potato, barley and cassava. China is the leading producing country with 72000 tons or 64% of the production ; where its consumption is reputed to be beneficial to kidney, spleen and stomach (FAO, 1991).

The chemical composition of the sweet potato makes it a high energy food. It has a good nutritional value. The analysis showed that for 100 g of tuber the potato offers: 1.69 g of protein; 12.2 g of carbohydrate of which: 6.11 g of sugar 6.14 g of starch 2.9 g of dietary fiber of which: 0.042 g of saturated fatty acids 0.002 g of mono unsaturated fatty acids 0.077g of poly saturated fatty acids. 78g of water (Anses, 2017).

In addition, the sweet potato has several health benefits for its contribution in beta-carotene, which is a plant pigment precursor of the vitamin expressed by a significant coloring, vitamin C in the flesh, vitamin B6 in the skin, macro and trace elements; its glycemic index is medium; its antioxidant content is very appreciable, thus contributing to reduce the risk of cardiovascular diseases. The skin is a reservoir of antioxidants, much more than the flesh. To preserve its nutritional principles, it is necessary to keep the skin and opt for a steam cooking. The organoleptic qualities and nutritional principles of the potato are the essential criteria for the characterization and introduction of new varieties (Anses, 2017).

The tubers are consumed mainly in developing countries, where they are a staple food especially in Papua New Guinea, Solomon Islands and some East African countries such as Burundi, Uganda, Rwanda and they can be used for pig rearing (Kana et al., 2015).

In the Democratic Republic of Congo, sweet potato is also consumed as porridge, fried or grilled and its leaves as vegetables by several households (Bonkena et al., 2018).

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Regardless of the importance of the crop, its diversity still remains poorly known, however the use of available cultivars requires a good knowledge of morpho-agronomic characteristics of nutritional value and adequate culinary criteria (FAO, 1991 ; Osci-Opare, 1991 ; Bovell-Benjamin, 2007 ; Sanoussi et al., 2016 ; Mahouton et al., 2019).

In view of the above, the present study proposed to carry out the morpho-agronomic characterization and nutritional analysis of 9 cultivars of sweet potato (Ipomoea batatas L.) in Kisangani.

II. Materials and Methods

2.1. Environment

This study was conducted in Kisangani, in the IFA-Yangambi compound, located on Avenue Abbé Munyororo n° 750, Plateau Médical district. The geographical coordinates of the site taken by GPS were as follows North latitude : 00° 30' 46,1'' ; East longitude : 025° 09' 54,5" and Altitude : 399 m.

The climate of the city of Kisangani is of type Af according to the classification of Köppen. It is a hot and humid equatorial climate, with an average annual temperature of 24°C and a humidity of 80 to 90%. Annual rainfall reaches 1885 mm in height and insolation is 1972 hours (Alongo, 2015).

2.2 Materials

This study used biological materials which are the nine local sweet potato cultivars harvested in the six communes of the city of Kisangani, namely Carrot, Damu, Elengi, Kandolo, Kilomoya, Mambokolo, Monde, Mugande, Muganderva listed in Figure 1.

2.3 Methods

2.3.1. Experimental Design

For this study, the experimental set-up was that of complete randomized blocks, comprising 9 treatments which are the 9 sweet potato cultivars and 4 blocks.

The treatments were placed on ridges measuring 2.5 m in length, 0.5 m in width and 0.30 m in height. The distance between ridges was 0.5 m and 1 m between blocks. The density per ridge was 20 cuttings planted at a spacing of 0.25 m x 0.25 m. It should be noted that the morphological characterization was done using the International Sweet Potato Community (CIP) descriptor (FAO, 1991 ; Huaman, 1991).

2.3.2. Nutritional analysis of cultivar tubers

The nutritional analysis of tubers carried out in the IFA Yangambi laboratory followed the following procedure: lipid soxhlet extraction and muffle furnace calcination of minerals; reflux heating of fiber; carotene spectrometry; mineralization, distillation and titration of nitrogen by the Kjedhal method.

2.4. Statistical methods

The quantitative data of this study were tabulated and processed with SPSS 20.0 software; the Analysis of Variance with only one classification criterion (ANOVA 1 SE) was adopted, the Snedecor and Tukey F-tests at the 5% probability level in order to detect the significant difference and to group the cultivars.

III. Results

3.1. Stem Characteristics

Stem traits were observed and the results are listed in Table 1.

Based on these results, cultivar coverage was in the range of 50-90% ; internode length ranged from 3.02 cm to 8.61 cm. These cultivars were secondary and dominant in color.

3.2. Leaf Characteristics

The leaf characteristics were the subject of this study and the results are recorded in Table 2.

In this experiment, the sweet potato cultivars studied produced leaves of various shapes, i.e. central lobe, length and color, depending on the genetic background of each cultivar and environmental factors.

3.3 Morpho-agronomic characteristics of tubers

The morpho-agronomic characteristics of the tubers are shown in Table 3.

It was observed that skin color, shape, diameter, number of tubers per stem and weight of tubers per stem changed in specific ways.

3.4. Tuber yield in tons per hectare

The plot yield data extrapolated in tons per hectare and the results are presented in Figure 2.

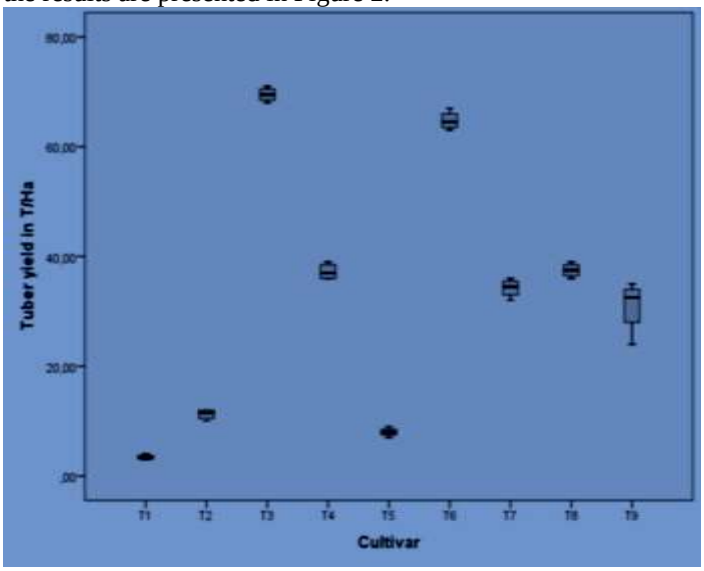

Figure 2. Tuber yield in tons per hectare.

The results show that the cultivars Elengi and Mambokolo were statistically almost equal in their ability to supply tubers, despite the numerical superiority of the cultivar Elengi (69.5 tons per hectare compared to 64.7 tons on average for the cultivar Mambokolo). The cultivars Kandolo, Mugande and Muganderva yielded an average of no more than 38 tons per hectare ; while the yields of the cultivars Carrot, Damu and Kilomoya ranged from 3 to 12 tons per hectare.

This situation shows that the cultivars Mugande and Mambokolo are early and usefully harvestable after 5 months of cultivation ; in contrast, the cultivars Carrot, Kandolo, Damu, Kilimoya, Elengi, Muganderva, and Monde are late in the agroecological conditions of Kisangani.

3.5. Nutritional composition

The values of the nutritional composition obtained after the laboratory analyses are given in Table 4.

The analysis of chemical parameters showed that the moisture of nine sweet potato cultivars characterized varied between 17.93 and 23.34% ; with the highest rate recorded in the variety Mungaderva (23.34%). It is known that for a good conservation of sweet potato, it must have a moisture of 13%.

According to the average ash content in this study condition (2.42%) ; the cultivars with high ash content are Monde (3.66%) ; Kilomoya and Mungade (3.16%) ; Mambokolo (3%) ; Carrot, Elengi and Damu (2.66%). However, those with low content are Kandolo (2.16%) and Mungaderva (1.66%) in this analysis.

The protein content places the cultivar Elengi in the lead (4.56%) ; Kandolo, in second place with 1.43% followed by

Carrot (0.75%) ; Kilomoya (0.060%) ; Mungade (0.031%) ; Mambokolo (0.012%) ; Mungaderva and Monde (0.060%) ; Damu (0.006%).

Calcium, magnesium and iron contents were almost similar for all cultivars tested under the Kisangani experimental conditions.

IV. Discussion

The purpose of this study was to characterize and analyze nine sweet potato cultivars under the conditions of Kisangani, Democratic Republic of Congo.

4.1 Stem characteristics

It was observed that the varieties Mambokolo, Carrot, Kandolo, Damu, Kilomoya and Monde have average soil cover (50 to 74%) ; on the other hand, Elengi, Mugande and Muganderva have high soil cover (75 to 90%), due to their high biomass. It should be noted that the concept of soil cover is an important characteristic because it allows the soil to remain always moist, for the benefit of the transformation of nutrients, in a form that can be assimilated by the plant (Ignasou, 2016).

Regarding the distance between the nodes, the cultivar Elengi has very wide internodes (8.61cm), it is followed by Mugande (8.060cm). The cultivars Damu, Muganderva and Carrot show similarities in internode length, measuring 5.11 and 5.10 cm respectively. The cultivars Mambokolo and Kilomoya have vines with very tight internodes (3.02 and 3.22cm), which allows them to form many stolons, with the possibility of feeding the plant well with nutrients (Ignasou, 2016).

Finally, according to the sweet potato descriptor, the cultivars Mambokolo, Monde, Mugande, Carrot, Kandolo, Damu had short internodes (values between 3 and 5 cm), while the cultivars Kilomoya, Muganderva had internodes of intermediate length.

Color analysis showed that the cultivars Mambokolo and Carrot are colored dark gray, while Mugande and Muganderva have a dark green color on their stems. In contrast, the cultivars Damu and Monde have purple stems. The light green color is found in the cultivars Kandolo, Kilomoya and Elengi.

It should be noted that the cultivars Mugande and Muganderva are able to develop photosynthesis at the level of the stem, because of the green color characteristic of the presence of chlorophyll. As for the secondary color of the stem, only two cultivars present this characteristic, it is about the cultivar Carrot which has as secondary color dark green, and Kandolo light green.

4.2 Leaf characteristics

The shape of the leaves showed that the cultivars Kandolo, Elengi, Mugande, Muganderva and Monde have the same type of leaves (round). On the other hand, the cultivar Mambokolo has slightly divided leaves. The cultivar Carrot has triangular leaves, while the cultivar Damu has lobes on the leaves.

Results related to the shape of the central lobe reveal that the central lobe of the cultivar Mambokolo is triangular, while the cultivars Carrot, Damu and Muganderva have central lobes with teeth. Cultivars Kandolo and Monde are unifoliate. The cultivar Kilomoya has a lanceolate central lobe, while the cultivar Elengi is linear; the central lobe of Mugande is simply broad. In addition, it was observed that the petiole length of the cultivars Carrot and Kandolo was short (10 and 20 cm). On the other hand, the cultivars Mambokolo, Damu, Kilomoya, Elengi, Mugande, Muganderva and Monde have petioles of intermediate length (21-30 cm) as noted by Huaman (1991).

Regarding flower color, the cultivars Mambokolo, Carrot, Kilomoya, Damu, and Mugande produced white flowers with purple color. On the other hand, cultivars Kandolo, Elengi, Muganderva and Monde did not produce any flowers at 5 months.

4.3 Morpho-agronomic characteristics of the tubers

The skin of the cultivars Mambokolo, Kilomoya, Elengi and Monde is pink, while that of Muganderva is chocolate. The Carrot cultivar has a beige skin, while that of Mugande is colored in diamond white. The cultivars Kandolo and Damu have skins colored in light green.

As for the shape of the tubers, the cultivar Mambokolo produced round circular tubers; the cultivars Damu and Kilomoya produced elliptical tubers; the cultivar Mugande produced oval tubers; the cultivars Kandolo and Elengi produced obovate tubers; and the cultivars Carrot, Muganderva and Monde produced irregularly shaped tubers.

Comparing the cultivars in terms of tuber diameter, it was observed that the cultivar Mambokolo gave on average tubers with a size of 7.2 cm. The cultivar Kandolo presented an average of 5.6 cm in diameter and the cultivar Monde in turn provided tubers of 5.6 cm in diameter, a size close to that of cultivar Kandolo.

These results showed that the cultivars Mambokolo, Kandolo and Monde can be harvested at 5 months of age in view of the size of the tubers provided at that age.

As for the average weight of tubers per stem, the cultivar Elengi gave the tuber with the highest weight than the other cultivars (3.5 kg), followed by the cultivar Mambokolo (3.35 kg) ; the cultivars Monde, Muganderva, Mugande and Kandolo weighed 1.67, 1.69 and 1.9 kg respectively. In view of these results, it should be noted that the Monde, Muganderva, Mugande and Kandolo cultivars are not very productive after 5 months of cultivation ; therefore, they can only be harvested after 5 months of cultivation.

4.4 Nutritional composition

As for the average weight of the tubers, the cultivar Elengi gave tubers with a higher weight than the other cultivars (3.5 kg), followed by the cultivar Mambokolo (3.35 kg) ; the cultivars Monde, Muganderva, Mugande and Kandolo weighed 1.67, 1.69 and 1.9 kg respectively. In view of these results, it should be noted that the Monde, Muganderva, Mugande and Kandolo cultivars are not very productive after 5 months of cultivation ; therefore, they can only be harvested after 5 months of cultivation.

The dry matter of the tubers of the tested cultivars was in the range of 1.66 - 3.66%, a value lower than 3 and 6.57%, values obtained in the analysis of 10 sweet potato cultivars in Burkina-Faso by Ignassou (2014).

It was observed that the protein contents of nine sweet potato cultivars grown in Kisangani were lower than 0.8 - 2.2%) those obtained in Madagascar by Ranaivoarivony (2011) ; following the example of the cultivars Elengi (4.56%) and Kandolo (1.43%) which deviated from the range of these values.

As a result, the Elengi cultivar should be usefully recommended for household feeding, given its high protein content compared to other cultivars. Analysis of relative values showed that iron content ranged from 0.28 to 0.58%, values well above (0.00681-0.04474%) those found by Ignassou (2014).

From the examination of the Magnesium content, it is noticed that the cultivar Mungaderva has a high content

(0.06%), followed by the cultivar Damu (0.053%), then the other cultivars, in this case Kilomoya (0.047%), Kandolo (0.04%), Monde (0.034%), Carrot and Elengi (0.28%), Mungade (0.021%), and finally the cultivar Mambokolo 0.015%.

V. Conclusion

The present study aimed at revealing the agro-morphological characters and biochemical properties of nine sweet potato (Ipomoea batatas L.) cultivars in Kisangani, Democratic Republic of Congo.

To this end, field studies and laboratory analyses suggest the following:

- The tuber cultivars with pink color (Mambokolo, Kilomoya, Elengi and Monde) ; light green (Kandolo, Damu) ; Diamond white (Mugande) ; chocolate soil coverage by biomass is total for the cultivars Elengi, Mungade and chocolate (Muganderva) and beige (Carrot) ;
- The shapes of the leaves round (Mambokolo) ; obovale (Kandolo, Elengi) ; Elliptic (Damu, Kilomoya) ; oval (Mugande) and irregular (Carrot, Muganderva and Monde) ;
- As for the unit weight of the tubers, the cultivars Mambokolo (3.35kg) and Elengi (3.5kg) performed well at 5 months of cultivation and the nutritional parameters showed that the cultivars Elengi, Kandolo and Carrot are richer in protein than the other cultivars.

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Table 1. Stem characteristics

N°	Cultivar	Ground cover (%)	Nodes (cm)	Predominant color of the stem	Secondary color of the stem
1	Carot	Medium (50-74)	5.100	Dark screams	Dark green
2	Damu	Medium (50-74)	5.110	Purple	Purple
3	Elengi	Strong (75-90)	8.610	Light green	Green
4	Kandolo	Medium (50-74)	5.280	Light green	Light green
5	Kilomoya	Medium (50-74)	13.220	Light green	Lime green
6	Mambokolo	Medium (50-74)	3.020	Dark Cree	Dark Cree
7	Monde	Medium (50-74)	3.460	Purple	Purple
8	Mugande	Strong (75-90)	4.130	Dark green	Green
9	Muganderva	Strong (75-90)	8.060	Dark green	Green

Table 2. Leaf characteristics

N°	Cultivar	Leaf shape	Central lobe	Length of petiole	Flower color
1	Carot	Triangular	Toothed	Intermediate	white with purple
2	Damu	With lobe	Dentate	Short	white with purple
3	Elengi	Round	Linear	Short	Absence of flower
4	Kandolo	Round	Single leaf	Intermediate	No flower
5	Kilomoya	Lanceolate	Lanceolate	Short	white with purple
6	Mambokolo	A little divided	Triangular	Short	white with purple
7	Monde	Round	Single leaf	Short	No flower
8	Mugande	Round	Broad	Short	Absence of flower
9	Muganderva	Round	Dentate	Short	Absence of flower

Table 3. Morpho-agronomic characteristics of tubers

N°	Cultivar	Skin color	Shape	Diameter (cm)	Average number	Weight (kg)
1	Carot	Beige	Irregular	1.900	4.000	0.150
2	Damu	Light green	Elliptical	3.000	7.000	0.500
3	Elengi	Pink	Obovale	4.100	8.000	3.500
4	Kandolo	Light green	Obovale	5.600	9.000	1.900
5	Kilomoya	Pink	Elliptical	2.400	5.000	0.400
6	Mambokolo	Pink	Round	7.200	9,500	3.350
7	Monde	Pink	Irregular	5.100	4.000	1.700
8	Mugande	Diamond white	Oval	4.000	5.000	1.900
9	Muganderva	Chocolate	Irregular	4.100	5.000	1.650

Table 4. Nutritional composition

Parameters Cultivars	Humidity (%)	Raw ash (%)	Crude protein (%)	Calcium (%)	Mg (%)	Fer (%)
Carot	18.220	2.660	0.750	0.074	0.028	0.300
Damu	20.650	2.660	0.006	0.080	0.053	0.280
Elengi	20.490	2.660	4.560	0.104	0.028	0.450
Kandolo	22.430	2.160	1.430	0.040	0.040	0.370
Kilomoya	18.160	3.160	0.060	0.064	0.047	0.500
Mambokolo	20.910	3.000	0.012	0.012	0.015	0.410
Monde	23.080	3.660	0.007	0.070	0.034	0.330
Mugande	17.930	3.160	0.031	0.114	0.021	0.500
Muganderva	23.340	1.660	0.007	0.054	0.060	0.580

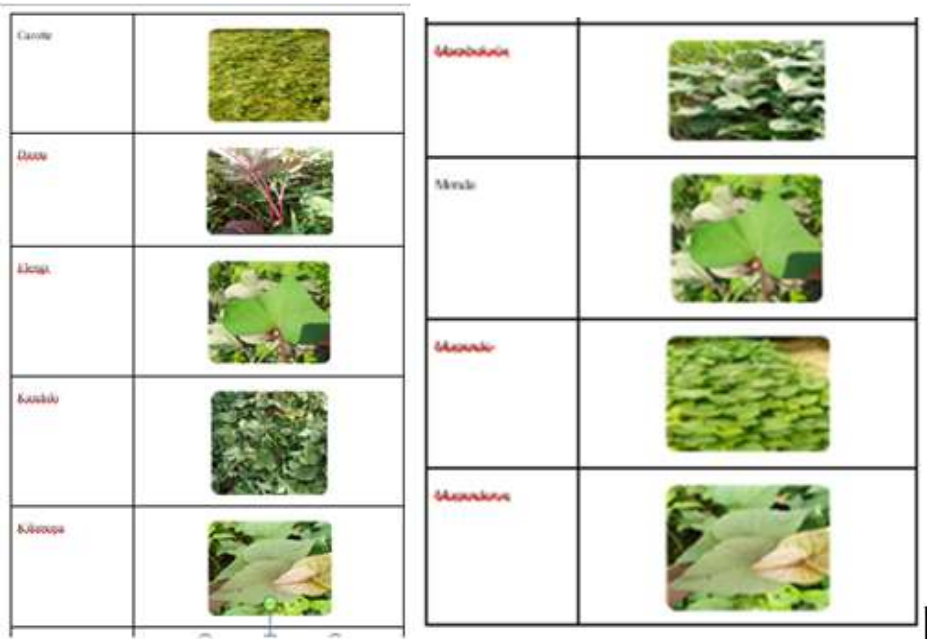

Figure 1. Test sweet potato cultivars.

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