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Morphological and Physicochemical Characterization of Safous from Brazzaville

[1]Feueltgaldah Christian Bopoundza, [1,2]Bob Wilfrid Loumouamou, [1]Celestine Ngounga Kiminou, [1,2]Anicet Frédéric Binaki, [1]Eliane Thérèse Biassala, [1]David Mampouya and [1,2]Thomas Silou
[1]*Equipe Pluridisciplinaire de Recherche en Alimentation et Nutrition: Pôle d'Excellence Régional en Alimentation et Nutrition B.P. 389, Faculté des Sciences, Brazzaville, Congo*
[2]*Ecole Supérieure de Technologie des Cataractes, B.P. 389 Brazzaville, Congo*

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Corresponding Author:
Feueltgaldah Christian Bopoundza
Equipe Pluridisciplinaire de Recherche en Alimentation et Nutrition: Pôle d'Excellence Régional en Alimentation et Nutrition B.P: 389, Faculté des Sciences, Brazzaville, Congo

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Abstract: The aim of this work is to enhance the safou tree "orchard" of Brazzaville by carrying out the morphological and physicochemical characterization of the fruits collected from 50 trees in the 5 districts, at the rate of 10 trees per district. The characterization of the fruits made it possible to identify the types of size, class and category of safous the most found and the most cultivated in this large orchard. This study showed us that the Safous of Brazzaville form a very homogeneous group of fruits and resemble those already found in the literature. Descriptive studies on morphology indicate that it is the fruit with the sphericity index (width/length) of around 0.5 that is most commonly found in the sub-region. The safous of Brazzaville are similar to each other and, ultimately, resemble the type of safous the most sold in the sub-region. The oil extracted from the pulp has the following major fatty acid profiles: C16: 0 C18: 1 C18: 2 C18: 0 C18: 3 followed by C16: 0 C18: 2 C18: 1 C18: 0 C18: 3 with average palmitic acid contents <50%. Oleic and linoleic acids have almost similar contents with values, respectively equal to 26.8 (±5.4) and 21.5(±4.3)%.

INTRODUCTION

In developing countries, urban and peri-urban agriculture occupies an increasingly important position due to accelerated urbanization and due to the lack of roads, difficulties in transporting agricultural products to cities. It thus, contributes to food security and the fight against poverty in urban populations. Market gardening and small livestock farming which require very significant development work are very visible and represent the most important part of this activity. Fruit arboriculture is much less apparent due to its scattering on the one hand (1-3 trees at most per housing plot) and its coexistence with ornamental arboriculture on the other hand.

The safou tree (*Dacryodes edulis*, H.J. Lam), a tree endemic to the Gulf of Guinea, contributes to the richness of urban and peri-urban orchards in Central African countries; on the one hand by the nutritional value of its fruit and on the other hand by its intense maximum production which it reaches between 10 and 15 years after planting, along with other fruit trees.

A study carried out in the municipality of Limété in Kinshasa, in the Democratic Republic of Congo by Makumbelo *et al*.[1], reveals the importance of the 6 major fruit trees namely: mango tree (*Mangifera indica*), avocado tree (*Persea americamna*), oil palm tree (*Elaeïs guineensis*), papaya tree (*Carica papaya*), banana tree (*Musa paradisiaca*), safou tree (*Dacryodes edulis*). The total production of these 6 species, obtained by extrapolation to the entire municipality after a survey of 201 plots is nearly 3,000 tonnes of fruit. It constitutes an average daily availability in grams of fruit per person in the municipality varying from around 6 g, for *Dacryodes edulis*, to 50 g, for *Elaeïs guineensis*, passing through 7 g, for *Mangifera indica*. As part of the safou tree enhancement program developed at EPRAN for more than two decades, we were interested in *Dacryodes edulis* and in particular in the Brazzaville safoutier “orchard”.

The safou tree is a perennial tree which when grown from seedlings, reaches its cruising production at 10-15 years. It can live >50 years but its production begins to decrease from the twentieth year; this relatively long lifespan makes it an interesting tree in atmospheric carbon sequestration, hence, its environmental interest.

During cruising, the safou tree produces around one hundred kilograms of fruit per tree, however, yields in the order of 200-300 kg per tree have been reported in Nigeria[2]. Planting trees at an interval of 10×10 m leads to 100 plants per hectare and therefore to fruit production varying between 10 and 20 tonnes per hectare for unimproved individuals. Which is already a remarkable performance.

Cultivation by layering, in full development in almost all of the Central African countries producing safou, should significantly improve this production[3-5]. Economically, the sale of safous constitutes an important source of income for rural populations; for the example of Cameroon where it provides a turnover of nearly 300 million CFA francs per year to the producing populations[6].

The safou measures on average 3-12 cm in length and 2-6 cm in width. The fruit pulp which is consumed after heat softening has interesting nutritional characteristics: 50-70% in lipids, 10-25% in proteins; 2-6% in minerals and 1-2% in unsaponifiables. Its richness in oil (40-70% of the dry matter) gives it the qualification of oleiferous fruit. It consists of palmitic (35-65%), oleic (16-36%), linoleic (4-32%), stearic (<4%) and linolenic (<2%) acids. Linoleic and linolenic acids are essential fatty acids[5]. With an average of 50% oil content, consuming 100 g of dry matter of the safou pulp provides approximately 15 g of oleic acid and 10 g of linoleic acid.

Safou is a perishable foodstuff; it is difficult to keep, on average for three days in the open air and at room temperature[7-9]. Its natural softening causes post-harvest losses of up to 50% of production in Congo and over 50% in Nigeria[5, 10] and therefore becomes unsuitable for marketing and home consumption. Poor harvesting, transport and storage conditions accelerate softening[7]. Thus, by eliminating the transport link and shortening the time between picking and marketing or consumption, urban orchards significantly reduce post-harvest losses which are of the order of 50% for the entire sector. The result is an increase in the incomes of actors in the sector with the main consequence of reducing poverty.

Moreover, the enhancement of this bio resource, in particular the selection of trees with greater economic and nutritional value, requires a better knowledge of the biodiversity of the species. Little is known about the varietal delimitation of this species. Some authors have already proposed a classification of the safou tree based on the morphological and chemical criteria of the fruits[7-, 11-16]. But, these results are very mixed. Other authors, on the other hand, stress the difficulty of using the morphological traits of fruits as a classification criterion because of the continuous nature of these traits[13, 17, 18].

Thus, during this work, with the aim of leading to the characterization of safous in the Congo Basin, we are interested in the morphological and physical study of the fruits of the safou tree orchard of Brazzaville in comparison with the studies of Boko (Congo Brazzaville)[19], Franceville (Gabon)[16], Kinshasa and Bas Congo (Congo Kinshasa)[20] in order to bring out their technological and nutritional interests.

MATERIALS AND METHODS

The present work was carried out in the Physical Chemistry Laboratory of the Faculty of Sciences and Techniques of the Marien Ngouabi University of Brazzaville, in Congo and in the endogenous technology laboratory of the Superior School of technology of Cataractes of Brazzaville in the Congo.

Samples: In the urban area of Brazzaville, fifty trees located in Makélékélé, Bacongo, Ouénzé, Talangaï and Mfilou were studied. On the strength of the natural calibration of fruits from the same tree established previously[14, 21], we chose 10 fruits, regularly distributed over the tree, to constitute each sample[22].

Morphological and physical sizes: The sizes taken into account in the assessment of morphology are the length and width of the fruit, on the one hand and the thickness of the pulp, on the other hand as defined previously[5]. Measurements are made using a caliper, to the nearest millimeter.

Fruit and pulp masses: Using a scale, the whole fruit is weighed to the nearest decigram and we get the mass of the fruit m_0. Then the fruit is cut open lengthwise with a knife. We remove the seed, then we weigh. This gives the mass of the pulp m_1.

Water content: The pulp is studied dried at 103°C to the constant mass m_2; the water content is given by the formula: % water = $[(m_1-m_2)/m_1]$ 100.

Determination of fatty acid composition: The analyzes were carried out on an HP 5890 type chromatography fitted with an apolar column (HP 5M, 30 m long, 0.25 mm internal diameter and 0.2 μm thick) and an FID detector according to the following experimental conditions: Carrier gas, helium at constant flow: 1 mL mm^{-1}; Oven temperature: programmed from 50-280°C with a gradient of 5°C/min; Injector temperature: 250°C; Detector temperature: 280°C; Quantity injected 1 μL.

Statistical processing: The means and standard deviations were used to describe the data, the Principal Component Analysis (PCA) and the ascending hierarchical classification (CAH) for the data analysis with the software XLSTAT 2006.2 which is a macro command Microsoft Excel 10.1.

RESULTS AND DISCUSSION

Morphological and physical characteristics: The morphological (length, width and thickness) and physical (fruit and pulp masses) sizes were determined for the safous harvested from 50 trees, at the rate of 10 fruits per tree. The means per tree, along with their standard deviations are given in Table 1.

We made sure from a preliminary work, that the conclusions drawn on the average of the 500 fruits, collected from 50 trees, were completely identical to those deduced from the examination of the average sizes of ten fruits from each tree (Table 2).

Descriptive studies on the morphology of safou indicate that it is the fruit with the sphericity index (width/length) of around 0.5 that is most commonly found in the sub-region. For example, out of the 10 forms of fruits identified by Kengué in Cameroon, 9 are of the ellipsoidal type. In a large-scale work carried out in Nigeria, Ladipo *et al*.[15] demonstrated the predominance of fruits with an average size of 6×3 cm, they are indeed fruits with a sphericity index of 0.5.

Brazzaville safous belong to caliber II according to the classification proposed by Silou *et al*.[21] that is, to the variety edulis according to Okafor[11] as shown schematically in Fig. 1.

The ellipsoidal type fruits are the most common among the safous from trees planted and sold in the sub-region. The Brazzaville safous are part of this general trend in the sub-region with an almost constant width/length ratio of around 0.5.

From a morphological point of view, the Brazzaville safous all belong to caliber II previously defined by

Table 1: Morphological and physical characteristics of the fruits of the 50 trees studied

Tree	Length (cm)	Width (cm)	Width/Length	Thickness(cm)	Mass of fruit(g)	Mass of pulp(g)
MAK1	5.00(±0.27)*	2.90(±0.18)	0.6	0.30(±0.04)	41.97(±5.21)	27.47(±3.23)
MAK2	6.00(±0.36)	3.20(±0.30)	0.5	0.30(±0.10)	50.90(±8.41)	33.34(±4.06)
MAK3	5.70(0.25)	3.40(0.16)	0.6	0.50(0.04)	35.66(3.40)	21.96(2.74)
MAK4	5.80(0.24)	3.60(0.14)	0.6	0.70(0.04)	43.45(3.37)	31.58(2.67)
MAK5	6.90(0.40)	4.20(0.28)	0.6	0.70(0.03)	64.66(11.85)	44.29(8.84)
MAK6	5.10(0.57)	3.30(0.15)	0.6	0.50(0.07)	32.27(5.20)	19.54(4.75)
MAK7	6.60(0.34)	3.70(0.15)	0.6	0.60(0.06)	46.34(5.81)	31.45(4.09)
MAK8	4.00(0.43)	3.80(0.17)	1.0	0.50(0.05)	23.65(4.72)	20.32(3.81)
MAK9	5.00(0.35)	3.40(0.26)	0.7	0.40(0.05)	29.80(6.62)	18.61(3.21)
MAK10	5.70(0.34)	3.60(0.14)	0.6	0.50(0.05)	36.09(4.82)	24.33(3.40)
BAC1	6.20(0.76)	3.70(0.33)	0.6	0.60(0.05)	43.12(9.47)	28.40(6.37)
BAC2	6.50(0.66)	3.50(0.24)	0.5	0.60(0.08)	38.86(6.95)	30.03(6.03)
BAC3	7.50(0.26)	4.00(0.16)	0.5	0.70(0.04)	62.19(5.69)	45.70(3.81)
BAC4	6.30(0.24)	2.70(0.14)	0.4	0.50(0.06)	27.25(2.87)	17.75(1.91)
BAC5	6.80(0.46)	3.50(0.12)	0.5	0.60(0.05)	46.47(4.86)	32.14(3.91)
BAC6	6.30(0.90)	3.90(0.37)	0.6	0.60(0.06)	42.98(10.64)	32.50(9.09)
BAC7	5.30(0.28)	3.60(0.17)	0.7	0.50(0.09)	33.00(4.66)	23.08(3.88)
BAC8	6.90(0.37)	3.60(0.14)	0.5	0.60(0.05)	44.03(4.90)	27.88(2.81)
BAC9	6.60(0.58)	3.30(0.27)	0.5	0.50(0.09)	37.53(9.37)	23.13(5.95)
BAC10	6.50(0.25)	3.10(0.12)	0.5	0.50(0.04)	32.03(2.84)	20.35(1.79)
OUE1	6.10(0.24)	3.50(0.07)	0.6	0.70(0.05)	39.12(2.28)	27.65(2.14)
OUE2	5.50(0.97)	4.20(0.16)	0.8	0.70(0.12)	44.38(8.59)	34.86(8.28)
OUE3	5.30(0.53)	3.60(0.33)	0.7	0.60(0.06)	35.21(9.49)	20.19(5.64)
OUE4	7.50(0.28)	4.20(0.15)	0.6	0.80(0.05)	57.25(5.36)	44.90(3.84)
OUE5	4.00(0.53)	2.70(0.20)	0.7	0.40(0.00)	14.86(3.93)	8.84(2.30)

Table 1: Continue

Tree	Length (cm)	Width (cm)	Width/Length	Thickness(cm)	Mass of fruit(g)	Mass of pulp(g)
OUE6	7.20(0.42)	3.60(0.16)	0.5	0.50(0.03)	44.35(4.72)	29.84(4.21)
OUE7	7.20(0.58)	4.20(0.31)	0.6	0.80(0.06)	59.56(10.80)	40.60(9.15)
OUE8	5.50(0.69)	3.50(0.35)	0.6	0.60(0.10)	32.47(12.07)	28.88(8.98)
OUE9	5.30(0.21)	3.40(0.16)	0.6	0.60(0.05)	33.69(4.41)	23.19(3.55)
OUE10	6.00(0.58)	3.80(0.18)	0.6	0.60(0.07)	43.43(7.19)	29.22(6.00)
TAL1	6.30(0.39)	3.60(0.17)	0.6	0.60(0.05)	41.21(5.81)	25.76(3.40)
TAL2	6.30(0.22)	3.60(0.18)	0.6	0.60(0.05)	30.49(3.54)	30.49(3.54)
TAL3	7.10(0.31)	3.30(0.17)	0.5	0.50(0.05)	37.78(5.12)	26.29(3.80)
TAL4	6.00(0.31)	3.50(0.07)	0.6	0.70(0.06)	42.09(4.28)	30.29(3.34)
TAL5	5.20(0.76)	4.10(0.14)	0.8	0.70(0.05)	48.69(8.97)	31.77(6.76)
TAL6	6.10(0.23)	3.60(0.16)	0.6	0.60(0.06)	43.53(4.26)	28.86(2.51)
TAL7	5.20(0.36)	2.90(0.19)	0.6	0.50(0.03)	19.32(4.39)	15.29(3.14)
TAL8	4.80(0.31)	3.10(0.35)	0.6	0.50(0.06)	24.81(4.92)	15.15(2.83)
TAL9	5.70(0.88)	3.50(0.21)	0.6	0.70(0.11)	39.28(9.62)	36.30(9.05)
TAL10	7.30(0.29)	4.50(0.34)	0.6	0.90(0.10)	71.82(7.60)	22.03(3.08)
MFL1	6.20(0.24)	3.40(0.19)	0.5	0.60(0.05)	45.56(4.46)	28.07(3.04)
MFL2	8.10(0.37)	4.40(0.31)	0.5	0.90(0.08)	75.55(9.52)	60.72(8.55)
MFL3	8.40(0.33)	4.00(0.21)	0.5	0.70(0.04)	60.28(6.42)	45.49(6.35)
MFL4	8.10(0.36)	4.80(0.38)	0.6	0.80(0.09)	77.20(10.02)	63.72(10.63)
MFL5	6.30(0.37)	3.80(0.22)	0.6	0.80(0.05)	45.45(6.02)	33.43(5.05)
MFL6	6.40(0.18)	3.80(0.11)	0.6	0.70(0.05)	50.18(3.39)	36.25(2.75)
MFL7	7.10(0.36)	4.80(0.22)	0.7	0.80(2.67)	70.37(29.35)	52.98(29.39)
MFL8	5.80(0.27)	3.50(0.13)	0.6	0.60(0.04)	38.88(4.20)	23.87(2.96)
MFL9	6.60(0.26)	3.90(0.19)	0.6	0.70(0.09)	53.43(4.74)	40.45(4.14)
MFL10	6.00(0.37)	3.20(0.10)	0.5	0.50(0.06)	32.88(3.36)	21.04(2.54)
Average	6.20	3.60		0.60	43.31	30.21
SD	0.96	0.46		0.13	13.76	10.99

* Average (standard deviation); MAK = Makélékélé; BAC = Bacongo; OUE = Ouenzé; TAL = Talangaï; MFL = Mfilou

Table 2: Comparative statistics for 500 individual fruits and for the averages of the 50 trees

Parameters	Average of 500 individual fruits	Average of averages of 50 trees
Length (cm)	6.2(1.0)	6.2(1.0)
Width (cm)	3.6(0.5)	3.6(0.5)
Thickness (cm)	0.6(0.1)	0.6(0.1)
Mass of fruit (g)	43.3(15.0)	43.3(13.6)
Mass of pulp (g)	30.3(11.2)	30.2(10.9)

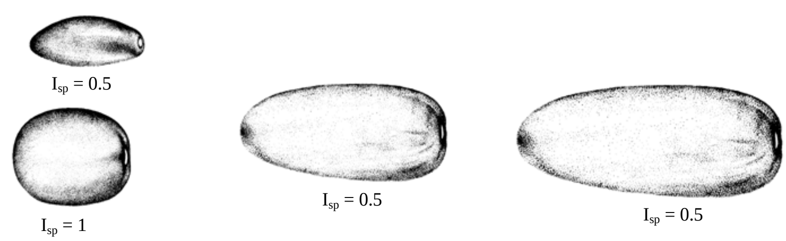

Fig. 1: Classification of common fruits in the Congo Basin[23]; Caliber I[21]; Length<5 cm; Caliber II[21]; 5 cm<length<8 cm; Caliber III[21] Length>8 cm; "variety parvicarpa"[21] Length<5 cm; "variety edulis"[11] Length>5 cm

Silou *et al*.[21] and correspond to "the edulis variety" of Okafor[11] with on average, a length of 6.2(1.0) cm, a width of 3.6(0.5), a thickness of 0.6(0.1) cm and a mass of 43.3(13.6) g.

A quick examination of the variation of these quantities, after an increasing sorting of the values, reveals a continuous growth for the length and the width (Fig. 2) as well as for the mass (Fig. 3). This has led some authors to predict the impossibility of grouping into a morphological class[17, 18].

Figure 4 shows that for the width, for example, almost all the trees have fruits whose dimensions are between 3 and 4 cm with an aggregation of the values around 3.5 cm for an amplitude of variation ranging 2.5-5 cm. The variation is more marked for the length, one notes however an aggregation of the values around 6 cm. A middle class of the most abundant fruits can be defined around 6 cm in length and 3.5 cm in width. It would only remain to retain an amplitude for each class in order to be able to characterize them. We thus, find the fruits of caliber II mentioned above.

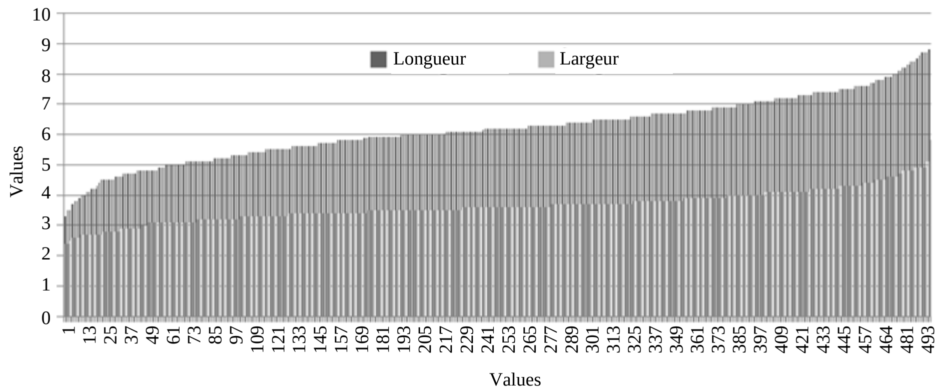

Fig. 2: Variation of the length and the width by increasing values of 500 studied fruits

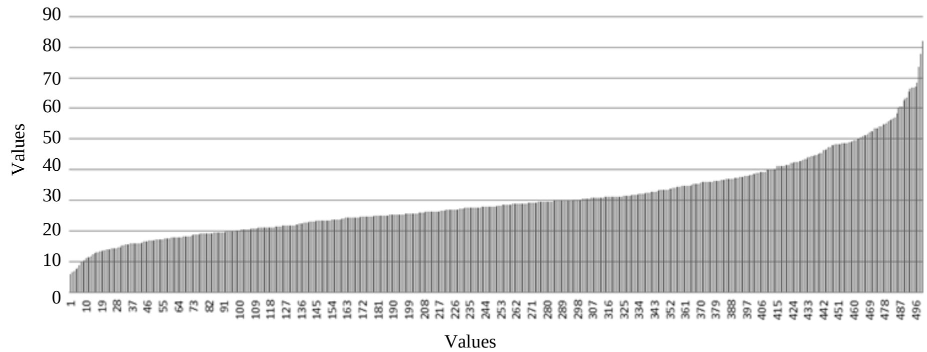

Fig. 3: Variation of mass by increasing values of 500 studied fruits

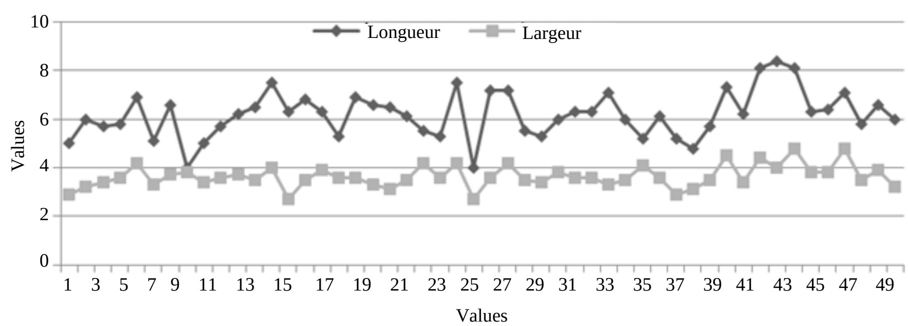

Fig. 4: Variation in fruit length and width of 50 trees of Brazzaville

The study of the amplitudes of variation of morphological quantities[23] (Table 3) indicates that. The lengths vary from 3.3-11.1 cm and the widths from 2.0-5.9 cm with amplitudes of 7.8 and 3.9 cm, respectively.

Based on these data, assuming 3 identical classes, we can set 2.6 cm for the length and 1.3 cm for the width as the amplitude of each class. With averages of 6.2 cm for the length and 3.6 cm for the width (Table 2) for the Brazzaville safous, we end up with a class varying approximately:

Table 3: Variation in morphological and physical sizes of safous from 677 trees from 3 countries of the Congo Basin[23]

Statistical	Length (cm)	Width (cm)	Mass (g)
Observation number	677.0	677.0	677.0
Minimum	3.3	2.0	11.0
Maximum	11.1	5.9	96.8
Amplitude	7.8	3.9	85.8
Average	6.1	3.4	40.3
Variance (n)	1.1	0.3	200.9
Standard deviation (n)	1.0	0.5	14.2
Coefficient of variation (%)	16.9	15.2	35.1

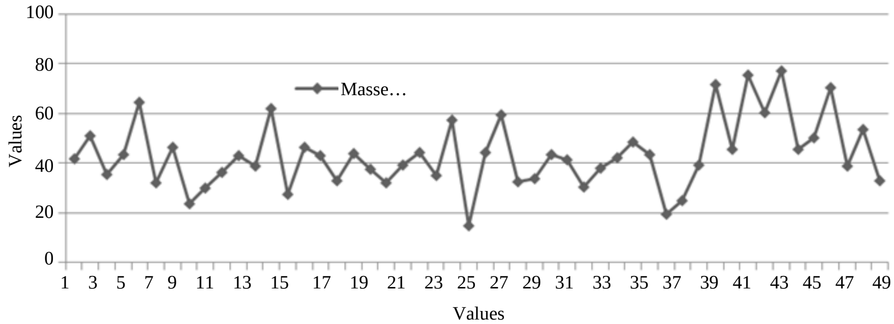

Fig. 5: Variation in the mass of fruits of 50 trees of Brazzaville

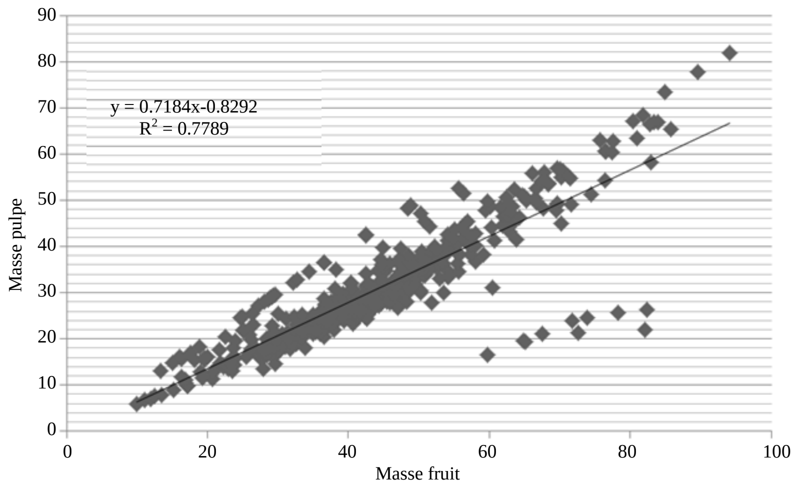

Fig. 6: Correlation between the mass of the pulp and the mass of the fruit

- From 5-8 cm for the length
- The 2.5-4.5 cm for the width

This class is bordered by class I (Length <5 cm; width <2.5 cm) and class III (length>8 cm; width>4.5 cm). We find here results similar to those obtained by Silou *et al*.[21] for Boko safous (Fig. 4). But, here again, we see an aggregation of values around 40 g.

If we take into account the mass to characterize the fruits of Brazzaville, 35 trees would be of class II, 6 of class I and 9 of class III (Fig. 5). The overwhelming majority of safous tree of Brazzaville are Class II relative to their masses. The raw material in the conservation and processing of safou is the pulp. It is interesting to predict the quantity of pulp available in a determined tonnage of fruit. The correlation research led to identify a good linear correlation ($R^2 = 0.778$) between the mass of the pulp and the mass of the whole fruit (Fig. 6) represented by the relation:

$$\text{Pulp mass} = 0.718\ (\text{fruit mass}) - 0.829$$

This relation makes it possible to evaluate the quantity of pulps knowing that of whole fruits. As the studies are carried out in 5 different districts, it is interesting for us to see whether there is any discrimination linked to the places of harvest.

The CAH on 4 variables (length, width, thickness and mass of the fruit) (Fig. 7) does not show any grouping by place of harvest. This is confirmed by the representation of individuals on the first principal plane F1F2 in principal component analysis (Fig. 8).

Water and oil content: In accordance with the results available in the literature, Kama-Niamayoua[19], Ondo[16], Mayele[20] and Silou[23], the water content varies from 25.57-81.84% and the oil content from 35.70-63.60%.

With a water content of over 50%, safou is a highly perishable product. Differences, however, minimal are observed between countries and therefore, between the ecosystems studied in these countries. The average values of the fifty trees in the urban orchard of Brazzaville (Congo) studied are totally in agreement with the results obtained previously[23] (Table 4).

The safous of the plateaux (Congo, DRC) have high values of water content, of the order of 70% while we have lower values for safous from the humid forest (59%

Table 4: Water and oil content of safou pulp from the Congo Basin

Parameters	No. of trees studied	Water content (%)	Oil content (%)
Congo	50	64.2 (±9.8)	52.2 (±6.7)
Cameroun[23]	7	54.4 (±11.4)	58.5 (±2.1)
Congo[23]	20	69.1(±4.8)	60.97 (±6.48)
RDC[23]	7	69.5 (±2.7)	50.8 (±10.5)
Gabon 1[23]	10	58.6 (±7.6)	49.0 (±5.4)
Gabon 2[23]	120	60.07 (±5.21)	56.70 (±5.58)

Table 5: Different fatty acid profiles observed on 50 trees in Brazzaville

Profile	Order of fatty acids	MAK	BAC	OUE	TAL	MFL	Total (%)
I	C16 :0 C18 :1 C18 :2 C18 :0 C18 :3	6	10	6	5	6	32(±65.31)
II	C16 :0 C18 :2 C18 :1 C18 :0 C18 :3	4	0	3	5	4	32(±32.65)
III	C16 :0 C18 :2 C18 :1 C18 :3 C18 :0	0	0	1	0	0	1(±2.04)

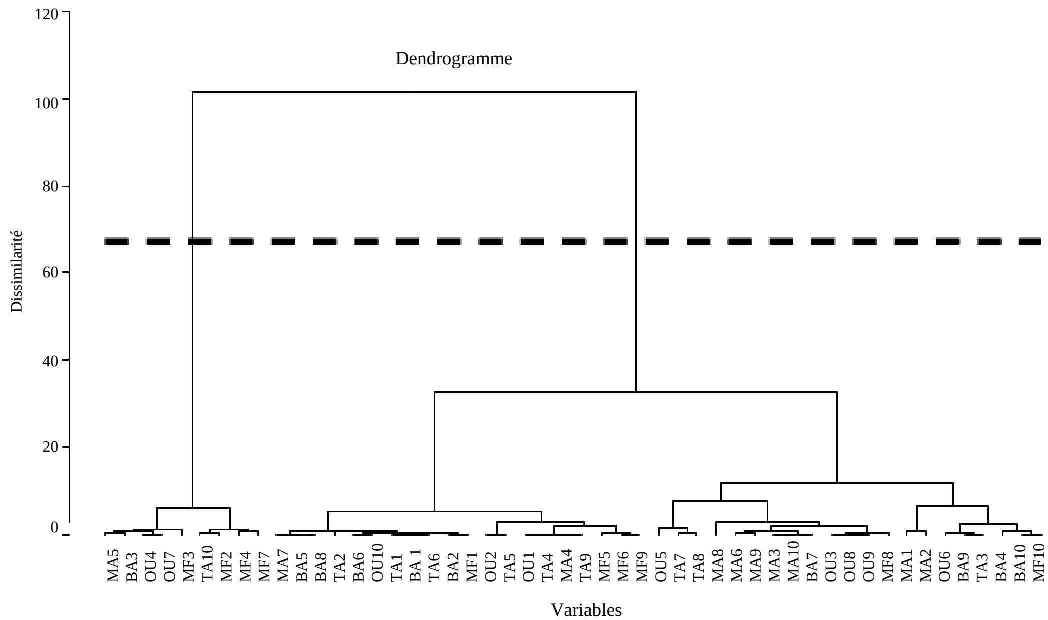

Fig. 7: Hierarchical ascending classification of 50 trees of Brazzaville for 4 variables

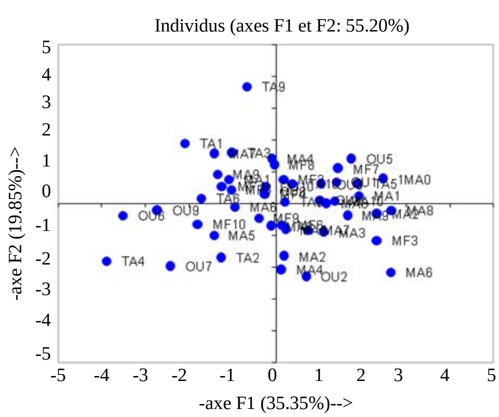

Fig. 8: Representation of individuals on the foreground F1F2 in principal component analysis

for Gabon and 54% for Cameroon). In all cases, the averages remain high throughout the Congo Basin. The average value of the oil content of the 50 trees studied is of the order of 52.2(±6.7)%. This high content is similar to that of all the samples from the sub-region studied previously, even if it is a little lower than the average for the localities already studied in Congo (61%).

Fatty acid composition: The fatty acid profile of safou oil studied previously demonstrated in the subregion is found here with C16: 0 as the major constituent, followed by C18: 1 and C18: 2; Together these three fatty acids represent over 90% of total FA, followed by C18: 0 and C18: 3. The C16: 0 content varies little, compared to that of C18: 1 and C18: 2, for the major constituents; that of C18: 3 is relatively constant compared to that of C18: 0. Of all the trees studied, 65% present the major Fatty acid profile commonly encountered (C16: 0 C18: 1 C18: 2 C18: 3); this profile is fully found in the entire Bacongo sample (Table 5).

However, two other profiles were encountered. Profile II, (C16: 0 C18: 2 C18: 1 C18: 0 C18: 3) appears at a high frequency (33%), it seems to compete with profile I in the four other districts of Brazzaville. Profile III, (C16: 0 C18: 2 C18: 1 C18: 3 C18: 0 with a frequency of 2.04% was only observed on a single tree. Nevertheless, this profile III was has already been identified on safous oils from Congo Brazzaville[22] and Gabon[16].

CONCLUSION

This study showed us that the safous of Brazzaville form a very homogeneous group of fruits and resemble the type of safous most commonly encountered in the sub-region. From a morphological point of view, they belong to caliber II previously defined by Silou *et al*.[21] and Okafor[11]'s "edulis variety" with average measurements of 6.2(1.0) cm for length and 3.6(0.5) cm for width.

Descriptive studies on morphology indicate that these fruits have a sphericity index (width/length) of around 0.5. They resemble the fruits identified by Kengué in Cameroon and the fruits studied by Ladipo *et al*.[15] in Nigeria. Fruits of the ellipsoidal type are therefore the most common among safous from trees planted and sold in the sub-region. The Brazzaville safous follow this general trend with an almost constant width/length ratio of around 0.5.

Using the characterization of the fruit mass defined by Ondo[9], they belong to class II, with an average value of 43.3 (13.6) g. Regarding the composition of fatty acid, the contents of C18: 1 and C18: 2 are very variable compared to those of C16: 0, C18: 1 and C18: 3. These variations define three major fatty acid profiles already reported in the literature including: C16: 0 C18: 1 C18: 2 C18: 0 C18: 3 (65%) commonly encountered, C16: 0 C18: 2 C18 : 1 C18: 0 C18: 3 with a frequency of 33% and C16: 0 C18: 2 C18: 1 C18: 3 C18: 0 found on a single tree (2%).

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