

Classification of Safou (*Dacryodes edulis*) fruit size and shape on mass and outer dimensions

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Abstract: Fruit size and shape are important quality parameters for product appreciation by consumers. However, aspect ratio (width over length) was used to perform the choice of ratios for fruits shape determination and mass for fruit category. This study was carried to quantitative classify Safou size and shape in bush butter (*Dacryodes edulis* (G. Don) H.J. Lam) fruits using fruit mass, as well as outer length and width measurements (aspect ratio). Results obtained showed that mass and aspect ratio can be used to classify Safou fruit size (small, medium and large) and shape (ellipsoidal, Obovate and spheroidal), respectively. Medium-sized fruits were the most represented. Irrespective of the fruit size, the ellipsoidal shape was most frequent and spheroidal shape was mostly found amongst small fruits and not amongst large fruits.

Keywords: Aspect ratio, *Dacryodes edulis*, Mass, Outer dimensions, Shape

I. Introduction

The Safou tree (*Dacryodes edulis* (G. Don) H.J. Lam), a tropical and subtropical tree belonging to the Burseraceae family, is an important native resource of the Gulf of Guinea. Indeed, consumer-preferences accelerated its spread from the Congo Basin to other parts of the world. Its pulp, the only edible part of the fruit, is rich in lipids, proteins, carbohydrates, minerals, vitamins and fibres [1-3].

Morphological characteristics of its fruits, studied on large scale samples from Cameroon, Gabon and Nigeria, present a broad variability [4-6]. Similar studies in Nigeria and later in the Congo [7-8], led to the classification of Safou fruits with respect to their masses into three main categories (small, medium and large). The values produced were < 20 g, 20 - 40 g and > 40 g, and < 30 g, 30 - 70 g and > 70 g for Nigeria and Congo, respectively. Other related study described three shapes for Safou fruits from Gabon [9] while others define, similar to other fruits, Safou size and shape as the most important consumer-preferred quality parameters [10-11]. The importance of such studies lies in the fact that they could contribute to the characterization of the fruit and further serve as guides to consumers and the food industry. In fact, physical characteristics of agricultural materials and their relationships are necessary for the design of some postharvest processing systems. Among these properties, the dimensions, mass, volume and projected area are the most important in the design of any grading system [12-14].

The aim of this study was to compare the size and shape of Safou fruits, based on mass and outer dimensions, in a bid to developing some objective and reproducible indicators for the characterization of the fruits that could be incorporated in strategies for industrial production of the fruit.

II. Materials And Methods

2.1 Sampling of bush butter

Ninety four (94) Safou trees (bush butter) were identified in farmers' fields across the different localities of Franceville city in Southeast Gabon. Mature fruits were then harvested from the four cardinal directions of each tree, above and under shade, placed in perforated sacks and transported to the laboratory. There, all damaged fruits were discarded and twenty fruits were maintained from each tree for eventual characterization.

2.2 Morphological and physical measurements

The mass of each fruit was determined using a precision balance ($e = 0.1$ mg) and its dimensional measurements (length and width) taken using a pair of callipers (precision ≈ 0.1 mm). The aspect ratio was computed as the ratio of the width (shorter dimension) to the length (longer dimension). The Safou fruits were separated by mass in accordance with established methods [8] that classify them into three main categories : small, average and large.

2.3 Shape detection

A technique was adopted for the determination of the fruits' shape, based on an analysis of its outer dimensions. The aspect ratio was computed using equation 1 described elsewhere [5]. The parameters D1, D2 and D3 represent elliptical, obovate and spheroidal-shaped fruits, respectively while 'R' was the aspect ratio ((1), (2) and (3)). Descriptive and other statistical data analyses were conducted using Microsoft Excel software and its variate, the Xlstat 2011 was used.

III. Results And Discussion

Morphological and physical characteristics of *D. edulis* collected from Franceville showed that the average fruit length, fruit width and fruit mass were 6 cm, 3.3 cm, and 3,803 g, respectively (Table 1). However, considerable morphological differences were observed among the trees and for each of these parameters as the coefficients of variation ranged from a minimum 12% for fruit width 35% for fruit mass. The width/length ratio (W/L) ranged from 0.29 to 0.92, with a mean of 0.57. These values are similar to previously obtained figures for Gabon and the Congo [15] and were equally in agreement with previous results obtained in areas renowned for bush butter production [5, 6, 16].

The masses of the small-sized Safou fruits (less than 30 g), medium-sized fruits (30 - 45 g) and large-sized fruits (more the 85 g) varied considerably as could be seen in Figure 2. Medium-sized fruits constituted the most important Safou class, representing almost half (43%) of sampled trees in the study. These results are in conformity with those obtained in a previous survey on 227 Safou trees in Gabon [6]. Analysis of Safou fruit mass and outer dimensions (length and width) showed that the fruits could be categorised in three shapes and three sizes, giving a total of nine "size x shape" combinations (Fig. 1). The frequency of medium Safous was highest (48%) amongst the three sizes, while those of the large and small fruits were least (24 - 28%) as shown in Table 3. With regards to their shapes and on the whole, the frequency of ellipsoidal-shaped Safous was highest (51%). The large-sized category did not have fruits of spheroidal shape, whereas small and medium-sized fruits had equal proportions of spheroidal-shaped fruits. These observations conform to those presented by stakeholders in the Safou commodity chain, confirming thereby the recently recorded "fruit shape x fruit dimension" interaction [17] where small calibre fruits had shapes that contrasted with those of the other calibres.

IV. Indentations and EQUATIONS

Equation 1, Elliptical: $D_1 = |R-0.52|$ (1)
 Equation 2, Obovate: $D_2 = |R-0.60|$ (2);
 Equation 2, Spheroidal: $D_3 = |R-0.68|$ (3).

V. Figures and Tables

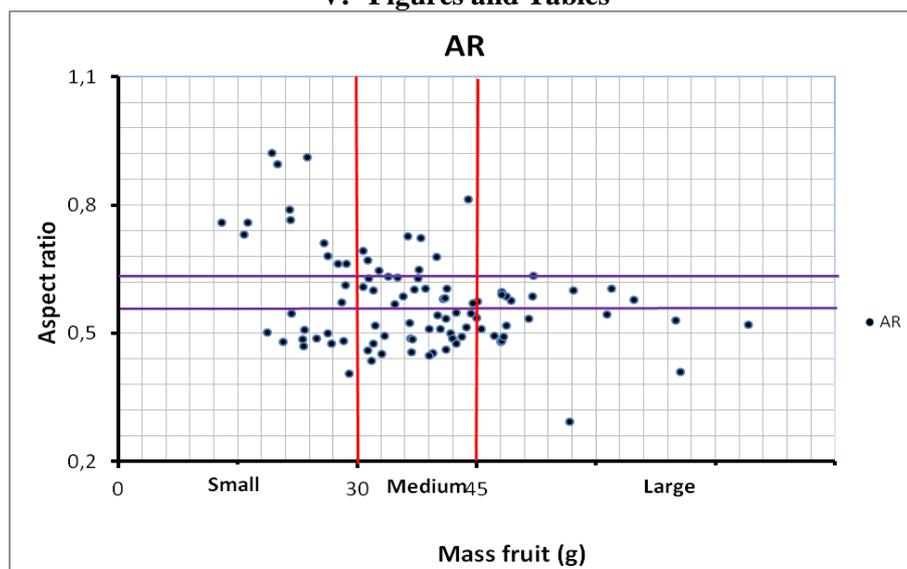


Figure 1. Aspect ratio versus mass representation

Fig. 1. Aspect ratio versus mass representation

AR: Aspect ratio

Classes Large, Medium and Small correspond to repartition obtained by using fruit mass

Table 1. Statistic description of all Safou fruits n = 1,880

	Length (cm)	Width (cm)	Mass (g)	Aspect ratio
Arithmetic mean	6.01	3.34	38.29	0.57
Variance	1.41	0.15	182.02	0.01
Median	6.12	3.32	37.42	0.56
Standard deviation	1.19	0.39	13.49	0.11
Coefficient of variation	19.7	11.70	35.10	18.9
Minimum	3.35	2.50	12.94	0.29
Maximum	11.10	4.46	89.49	0.92

Table 1. Statistic description of the 1880 fruits collected from 94 Safou trees
With n = 20 fruits from each tree

Table 2. Classification of Safou trees according to fruit mass

Size	Mass range (g)	Population	Frequency (%)
Small	< 30	25	26.6
Medium	30 - 45	46	48.9
Large	> 45	23	24.4

Table 2. Safou trees reparations according fruit mass
Classes Large, Medium and Small correspond to repartition obtained by using fruit mass

Table 3. Classification of selected Safou fruits from Franceville Gabon with respect to mass, shape and aspect ratio

Size	Mass range (g)	Shape	Aspect ratio range	Frequency (%)
Small	<30	Ellipsoidal	0.41-0.55	11.7
		Obovate	0.57-0.61	2.1
		Spheroidal	0.66-0.92	12.8
				26.6
Medium	30-45	Ellipsoidal	0.43-0.55	25.5
		Obovate	0.57-0.63	14.9
		Spheroidal	0.65-0.81	8.5
				48.9
Large	>45	Ellipsoidal	0.29-0.54	13.8
		Obovate	0.57-0.63	10.6
		Spheroidal	-	0
				24.4

Table 3. Size, mass range, aspect ratio range and frequency of the randomly of the 94 selected Safou fruits collected in Franceville Gabon

VI. Conclusion

Fruit mass and outer dimensions (length and width) as well as their ratios appear quite suitable as parameters for the characterisation and morphological classification of Safou fruits as they lead to the generation of objective and reproducible results, with the ellipsoidal and medium-sized fruits being the most represented. Such results which could therefore be incorporated in strategies for industrial production of Safou, could equally be adapted and applied to other products.

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