

Diversity of Cucurbit Species Cultivated in Côte d'Ivoire for Edible Seeds

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Introduction: Cucurbits are cultivated worldwide, in extremely diverse environments and are important economic crops, particularly in the Americas, Europe, and Asia. In sub-Saharan Africa, the indigenous species are prized for their oleaginous seeds consumed as soup thickener, preferentially during popular celebrations and important ceremonies (1, 2, 3). The African cultivated cucurbits are reported to be rich in nutrients (3, 4), well adapted to extremely divergent agro-ecosystems and low-input agriculture (5, 6). Despite their agronomic, cultural, and culinary importance, these plants lack attention from research and development and are thus categorized as orphan crops (4, 5). Promoting the production and use of such crops can result in securing food and increasing income for poor farmers.

To address these issues, a collaborative project between the Agronomic University of Gembloux (Belgium) and the University of Abobo-Adjamé (Côte d'Ivoire) has been implemented using the main edible-seeded cucurbit species cultivated in Côte d'Ivoire as plant models. Specifically, three topics were defined for the project: collection and genetic characterization of the *Cucurbitaceae*, agronomic evaluation of the most common species, and implementation of improved cropping systems for their cultivation. We report herein preliminary results obtained from investigations on inter- and intra-species diversity of the target plant materials.

Materials and Methods: Investigations were made in 2000-2004 throughout three zones (South, East, and Centre), based on agro-ecology and food habits of local populations. A total of 40 villages were selected (10 in South, 10 in East, and 20 in Centre), the number of villages per zone being based on the results of a preliminary survey of the target sites. In each zone, a participatory rural appraisal-based method (7) was used to gather local community knowledge of traditionally cultivated cucurbit species, namely their vernacular names, diversity, relative cultural and social importance, and uses. To check if morphological variations observed within a species were not due to environmental conditions prevailing in the original sites, representative samples of each plant introduction (PI) accession were grown at our experiment station in multiple seasons (2-4), two replicates, and 20-50 seeds per plot (25 m x 25 m). Within each species, morphological differences between cultivars were examined considering the following features: mature fruit shape and color, seed shape, seed size (estimated as height x width), and 100-seed weight. The estimates of seed size and 100-seed weight were then used to compare cultivars using Student *t*-test (for two cultivars) or one-way analysis of variance (for more than two cultivars) using the Newman-Keuls test if necessary (8). Statistical analysis was performed using StatsDirect™ 2.4 statistical package for Windows (9).

Results: A total of 176 PI accessions composed of five species in five genera were collected throughout the three zones: *Citrullus lanatus* var. *citroides* (Thumb.) Matsum. & Nakai. (90 PI accessions), *Cucumeropsis mannii* Naudin (43 PI accessions), *Cucumis melo* var. *agrestis* L. (25 PI accessions) *Cucurbita moschata* L. (5 PI accessions), and *Lagenaria siceraria* (Molina) Standl. (13 PI accessions). All are cultivated mainly by women as intercrops with staples in fields or backyard gardens. Intraspecies diversity based on fruit and seed traits was observed in the five species.

C. lanatus var. *citroides*. This species is monoecious, yellow flowered, and has creeping annual vines, with leaves deeply divided into 5-7 more or less subdivided lobes. Locally called "wléwlé", the species is the most common edible-seeded cucurbit cultivated in Côte d'Ivoire. The fruits are round or oval (Figure 1), uniformly light green or mottled light and dark green and have white bitter flesh surrounding the seeds. The mature dried seeds are yellowish in color (Figure 1). Two groups were reported for this species. The first group, including three cultivars (defined on the basis of seed size) has smooth seeds that are tapered to the point of attachment. Fruits of the second group, including one cultivar, are round and narrow or wide striped. The seeds are ovoid and flattened, with a thickened and roughened margin. Statistical analysis indicated significant differences between and within groups for seed weight (hundred-seeds) and size (Table 1). Note that a type which presents slightly colored-flesh fruit, with brown seeds are often observed on permanent rubbish piles or empty lots in urban areas. This form could be a weedy type probably derived from the edible-fleshed *C. lanatus* var. *lanatus* that is widely consumed in towns.

C. mannii. This species is a monoecious annual climbing vine, locally called "n'viélé". The leaves are embossed, with three notched lobes. Fruit are uniformly

slight green or yellowish and blocky. Seeds are whitish, flattened, and tapered to the point of attachment (Figure 2). Vertical training of the vines is believed to be important to maximize yield of this species. For this reason in the target zones, *C. mannii* is systematically intercropped with yam (*Dioscorea* spp.), since the latter also needs to be grown on trellis. Three cultivars defined on the basis of seed size were found for this species (Figure 2 and Table 1).

C. melo var. *agrestis*. Two andromonoecious types with dark green leaves, yellow flowers, and small oval fruit (3-5 cm length) were collected in the target zones. The most common type (Figure 3) is cultivated and locally called "lomi n'gatè". Seeds of this type are toasted, ground, and used as soup thickener. The flesh of fruits is light green, lacks aroma, and has bitter taste. The second type, uncultivated, is often found along roads, on permanent rubbish piles or empty lots in villages and cities. Its mature fruits are orange in color (Figure 3), are aromatic, and are exclusively used as a vegetable. Fruit are cut into slices and added to soup. In addition to mature fruit color, the other differences between the two types are related to seed size and seed weight (Table 1).

C. moschata. Two open-pollinated cultivars, identified as *C. moschata* and locally named "n'gando" were collected. These cultivars have yellow flowers and blocky fruits with orange flesh. This species is found in backyard gardens or empty lots in villages and cities. The main differences between these two cultivars are color of the mature fruit that can be mottled light and dark green, or yellow, and seed size (Figure 4 and Table 1).

L. siceraria. This is a species of the monoecious white flowered gourds locally called "bebou". The local name is related to the manually shelling of the seeds, due to their hard coat. Two cultivars, different in fruit shape (blocky or round), were

collected. Fruit and seed shape and size are reported to be highly variable in *Lagenaria* (11). In our case, seeds from the round-fruited cultivar are characterized by the presence of a cap on the distal side (Figure 5). With regard to seed size and weight, significant differences were observed between these two cultivars (Table 1).

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Table 1. Sample size (n) and mean (\pm SD) for two seed traits analyzed to test differences between cultivars of edible-seeded cucurbits from Côte d'Ivoire

Species	Cultivar / Type	Seed size (mm ²) ($n = 100$)	100-seed weight (mg) ($n = 10$)
<i>Citrullus lanatus</i>	Big seeds	120.41 \pm 16.94 ^c	11.50 \pm 0.61 ^a
	Medium seeds	58.81 \pm 9.76 ^b	5.49 \pm 0.23 ^b
	Small seeds	42.07 \pm 7.17 ^a	4.26 \pm 0.26 ^c
	Thickened margin seeds	179.06 \pm 26.11 ^d	17.45 \pm 0.60
<i>Cucumeropsis manii</i>	Big seeds	138.31 \pm 12.90 ^c	11.87 \pm 0.59 ^a
	Medium seeds	96.80 \pm 10.79 ^b	10.73 \pm 0.33 ^b
	Small seeds	49.44 \pm 7.68 ^a	4.47 \pm 0.15 ^c
<i>Cucumis melo</i> var. <i>agrestis</i>	Green-fruited	19.16 \pm 2.59 ^b	1.11 \pm 0.04 ^a
	Orange-fruited	13.24 \pm 1.48 ^a	0.58 \pm 0.11 ^b
<i>Cucurbita moschata</i>	Green-fruited	79.59 \pm 9.12 ^a	7.54 \pm 0.34 ^a
	Yellow-fruited	123.92 \pm 11.48 ^b	7.87 \pm 0.53 ^a
<i>Lagenaria siceraria</i>	Round-fruited	159.08 \pm 19.43 ^a	25.08 \pm 0.70 ^a
	Blocky-fruited	190.78 \pm 26.88 ^b	21.60 \pm 2.80 ^b

NB: For each trait and species, means within a column followed by different superscripts were significantly different ($P \leq 0.01$), based on Student t or Newman-Keuls test.

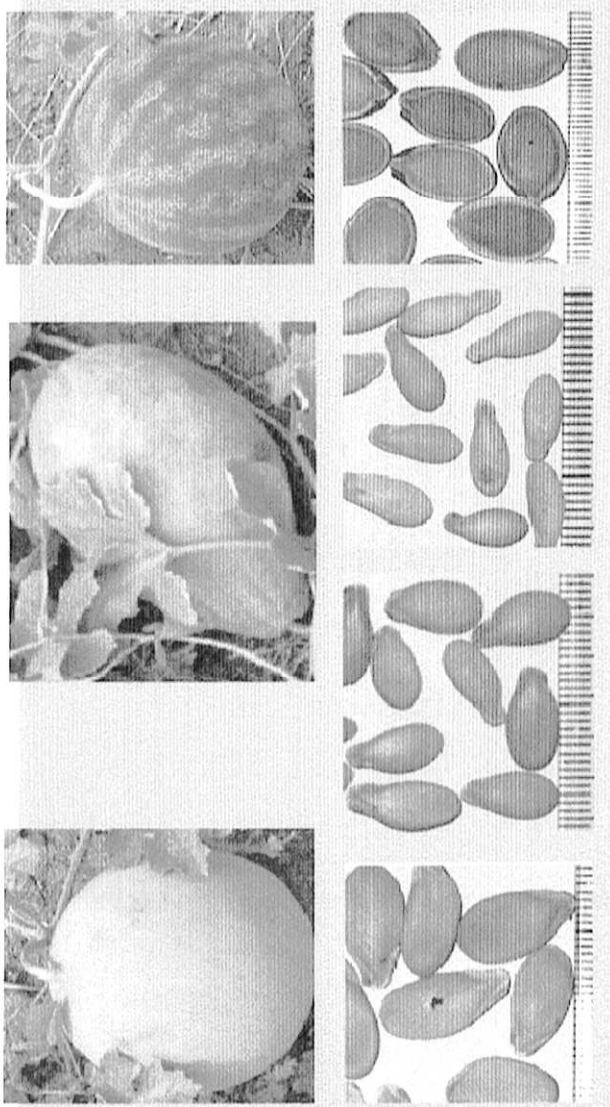


Figure 1. Fruit and seed of *Cucurbit lanatus* var. *citroides*. Left to right, top row, fruit shape and color: round and light green; oval and light green; and round and wide striped. Bottom row, seed shape, color, and size: tapered, yellowish, and large; tapered, yellowish, and medium; tapered, yellowish, and small; ovoid, flattened, yellowish, and large.

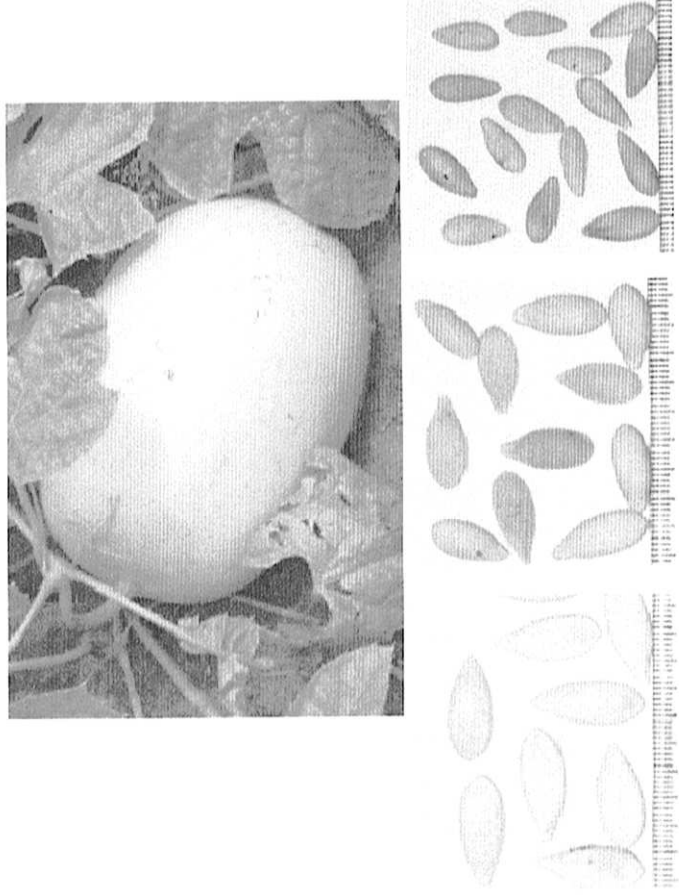


Figure 2. Fruit and seed of *Cucumeropsis mannii*. Bottom row, left to right, seed size: large, medium, and small.



Figure 3. Fruit and seed of *Cucumis melo* var. *agrestis*. Top row, left to right: cultivated type; wild type. Bottom row, left to right: seed of the cultivated type; seed of the wild type.

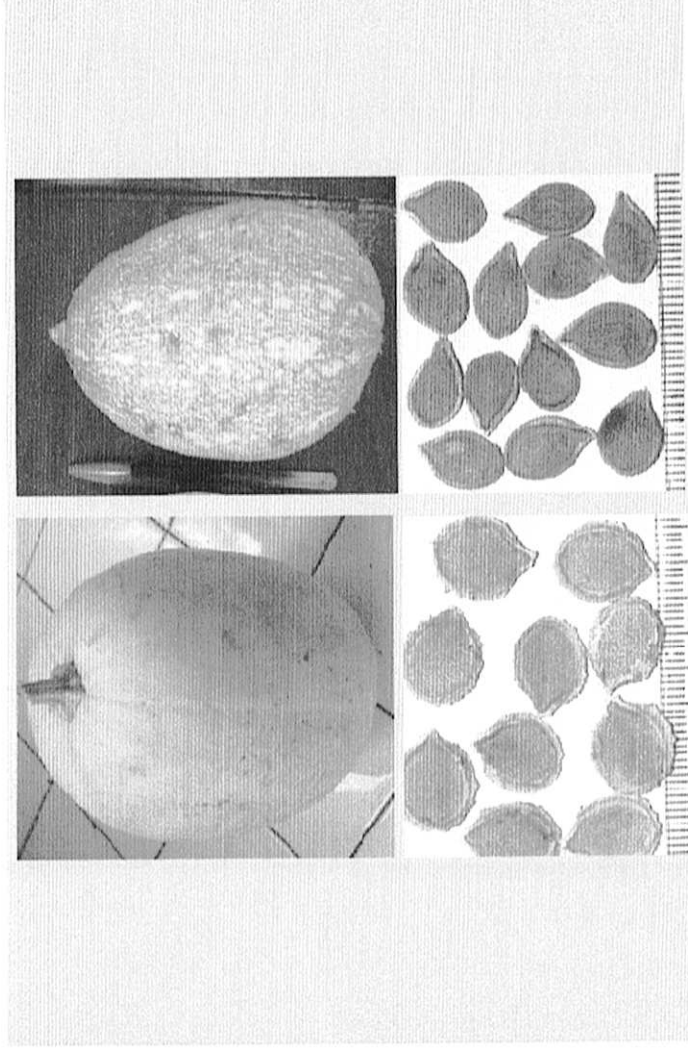


Figure 4. Fruit and seed of *Cucurbita moschata*. Top row, left to right: yellow cultivar; green cultivar. Bottom row, left to right: seed of the yellow cultivar; seed of the green cultivar.

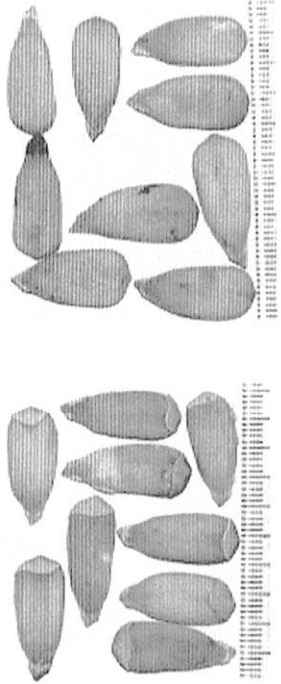
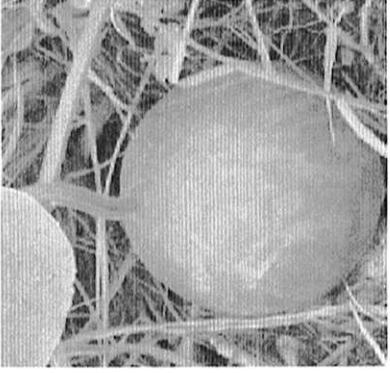


Figure 5. Fruit and seed of *Lagenaria siceraria*. Bottom row, left to right: seed of the round cultivar, seed of the blocky cultivar.