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Indigenous Cucurbits of Côte d'Ivoire: a Review of their Genetic Resources

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Abstract

In the framework of a collaborative research project involving the Agronomic University of Gembloux (FUSAGx, Belgium) and the University of Abobo-Adjamé (UAA, Côte d'Ivoire), we surveyed the inter- and intraspecies diversity of cucurbit species consumed in sauce in Côte d'Ivoire. The investigations resulted in the collection of 176 accessions composed of 13 cultivars belonging to five species and five genera. These species are Citrullus lanatus, Cucumeropsis mannii, Cucumis melo, Cucurbita pepo and Lagenaria siceraria. The most common species are, in decreasing order, C. lanatus and C. mannii. However on the urban markets, C. lanatus and L. siceraria are the most abundant. We found a moderate diversity within species (2-4 cultivars per species), probably due to the farmers' selection process that favors a very few plant types. Elsewhere, data obtained from these investigations showed that the species studied have a good market potential. Thus, their promotion can contribute to the economic well-being of farmers, since these species are appreciated at both city and village levels, due to their cultural and culinary importance.

***Key words**: Cucurbitaceae, biodiversity, Côte d'Ivoire, edible seeds, genetic resources, traditional crops.*

Résumé

Cucurbites Indigènes de Côte d'Ivoire : revue de leurs Ressources Génétiques

Dans le cadre d'un projet de coopération impliquant la Faculté Universitaire des Sciences Agronomiques de Gembloux (FUSAGx, Belgique) et l'Université d'Abobo-Adjamé (UAA, Côte d'Ivoire), nous avons passé en revue, la diversité inter et intraspécifique des cucurbites consommées en sauce en Côte d'Ivoire. Les investigations ont abouti à la collecte de 176 accessions composées de 13 cultivars répartis en 5 genres et 5 espèces. Ces espèces sont *Citrullus lanatus*, *Cucumeropsis mannii*, *Cucumis melo*, *Cucurbita pepo* et *Lagenaria siceraria*. Les plus répandues de ces espèces sont, dans l'ordre décroissant, *C. lanatus* et *C. mannii*. Cependant, sur les marchés urbains, *C. lanatus* et *L. siceraria* sont les plus abondantes. Nous avons noté une faible diversité à l'intérieur des espèces (2-4 cultivars naturels), probablement due au processus de sélection des cultivateurs qui favorise un très petit nombre de types de plantes. Les données obtenues de ces investigations montrent aussi que les espèces étudiées ont une bonne valeur marchande. Leur promotion peut contribuer au bien-être économique des cultivateurs car ces espèces sont bien appréciées aussi bien au niveau rural que urbain, du fait de leur importance culturelle et culinaire.

Mots clés : Cucurbitaceae, biodiversité, Côte d'Ivoire, graines comestibles, ressources génétiques, cultures traditionnelles.

1. Introduction

The conservation and characterisation of indigenous genetic resources are crucial to fulfil the needs of breeders for both present and future generations (Frankel, 1974; Brown & Briggs, 1991; Eyzaguirre, 1995). The chance for fulfilling future demand of genetic resources is better when a high level of genetic diversity is conserved and made available (Given, 1987; Anonymous, 1991; Given, 1994). This challenge should not be missed, particularly for the neglected and underutilised crops such as indigenous cucurbits. Their numerous agronomic and economic potentials make them materials for which improved production and uses can result in food security and income generation for peasants (Chweya & Eyzaguirre, 1999; IPGRI, 2002). Indeed, many neglected and underutilised crops (also called orphan crops) are reported to be rich in nutrients, well adapted to extremely divergent agro-ecosystems and various cropping systems characterised by minimal inputs.

To address these issues, a collaborative project involving Agronomic University of Gembloux (Belgium) and University of Abobo-Adjamé (Côte d'Ivoire) has been implemented using the main edible-seeded cucurbit species cultivated or growing naturally in Côte d'Ivoire as plant materials. The studied cucurbits are prized for their oily seeds consumed as soup thickener, preferentially during popular fetes and prestigious ceremonies (van Epenhuijsen, 1974; Akobundu *et al.*, 1982; Badifu, 2001; Zoro Bi *et al.*, 2003). We report herein preliminary results obtained from investigations on inter- and intraspecies diversity of the target plant materials, as well as the involved current cropping systems. The main constraints to their sustained production are also presented.

2. Materials and methods

2.1. Study sites and plant materials

This study was carried out from 2000 to 2004 in Côte d'Ivoire, which is located between latitudes 4°30 N-10°30 N and longitudes 2°30 W-8°30 W. Investigations were made in three zones (south, centre and east), selected in three agro-ecosystems, also differing by the food habits of local populations.

In the southern zone, rainfalls are abundant (annual mean > 2000 mm) and average annual temperature is 28°C. Vegetation is mainly represented by the tropical rain forest, with mangrove on the coastal side. Two departments (Alépé and San Pedro) and 10 villages were selected in this zone for field observations.

The eastern zone includes three departments (Abengourou, Daoukro and Bongouanou) and 10 villages. This zone is characterised by the transitional woodland savanna, with several blocks of semi-deciduous forests. Rainfalls vary from 875 to 1910 mm with an annual mean of 1250 mm. The annual average temperature is 27°C.

The central zone is also composed of three departments: Beoumi, Sakassou and Zuénoula. A total of 20 villages were visited in this zone. Annual rainfalls vary from 800 to 1400 mm with an annual mean of 1200 mm, and the annual mean temperature is 27°C. The vegetation is a woodland savanna showing some extended range of herbaceous areas.

Plant materials are the indigenous edible-seeded cucurbits cultivated by rural people or growing naturally. To extract the seeds, the fruits are split using a piece of wood or a machete. The split fruits are placed on the ground with the inner part downward, and covered with banana leaves or a plastic awning until the solid flesh starts to decay. The seeds are then extracted, washed, dried, shelled, and winnowed to obtain the kernels. Then the kernels are slightly toasted and ground for use as thickener of a traditional soup called *egussi* soup in Nigeria or Benin and *pistachio* soup in Côte d'Ivoire. Edible oil can also be extracted from the seeds (van Epenhuijsen, 1974; Badifu, 2001).

2.2. Data collection and analysis

In each zone, a participatory rural appraisal-based method was used to gather local community knowledge of traditionally cultivated cucurbit species, namely their vernacular names, diversity, relative cultural and social importance, and uses. The indicated approach is mainly based on interviews, the use of multiple choice question

forms, and on-farm observations. To check if morphological variations observed within a species were not due to environmental conditions prevailing in the original zones, representative samples of each accession were grown at our experimental station for two to four seasons, with two replicates and 20-50 seeds per plot of 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) that was completed by the Newman-Keuls test if necessary (Zar, 1996). Statistical analyses were performed using the StatsDirect™ statistical package for windows, release 2.4 (StatsDirect, 2005).

To assess the relative abundance of the studied species in each zone, we estimated their frequency distribution (%Sp_i) as follow:

$$\%Sp_i = \frac{n_{SPi}}{\sum n_{Spi}}$$

where n_{Spi} is the number of accessions of the species Sp in the i^{th} zone.

3. Results and discussion

3.1. Species diversity, abundance and distribution

A total of 176 accessions composed of five species in five genera were collected throughout the three zones: *Citrullus lanatus* (Thumb.) Matsum. & Nakai. (90 accessions), *Cucumeropsis mannii* Naudin (43 accessions), *Cucumis melo* L. (25 accessions) *Cucurbita pepo* L. (5 accessions), and *Lagenaria siceraria* (Molina) Standl. (13 accessions). The accession numbers of each species collected in each zone are presented in table 1 and their frequency distributions are indicated in Fig 1.

Table 1 : Accessions of indigenous cucurbit species collected during 2000-2004 from three regions of Côte d'Ivoire

Species	Number of accessions (%)			Total (%)
	Southern region	Eastern region	Central region	
Citrullus lanatus var. *citroides*	4 (26)	22 (25.88)	64 (84.21)	90 (51)
Cucumeropsis mannii	6 (40)	28 (32.94)	9 (11.84)	43 (24.43)
Cucumis melo var. *agrestis*	3 (20)	21 (24.70)	1 (1.32)	25 (14.20)
Cucurbita pepo	1 (7)	4 (4.70)	0 (0)	5 (2.84)
Lagenaria siceraria	1 (7)	10 (11.76)	2 (2.63)	13 (7.39)
Total (%)	15 (8.5)	85 (48.30)	76 (43.18)	176 (100)

As indicated in table 1 and figure 1, *C. lanatus* is the most abundant (about 50% of the accessions) and one of the most common (collected in the three sampled zones) edible-seeded cucurbit species cultivated in Côte d'Ivoire. These observations were expected on the basis of previous investigations made by Ndabalishye (1995).

The results also highlighted that *C. mannii* is the second most frequent (about 24% of the accessions) and widely distributed species (Table 1 and Fig. 1).

The distribution of *C. melo* was almost limited to the eastern zone where 21 out of the 25 accessions were collected. Only one and three accessions originated from central and southern zones, respectively. Note that the only one accession collected in the central zone was obtained from a woman who is from the eastern zone. It is also worth noting that the 3 accessions of *C. melo* collected in the southern zone belong to the same botanical variety. All these results suggested the occurrence of localised preference, in addition to possible ecological requirements of *C. melo*. The restricted geographical distribution of plant species, due to ecological adaptation or local domestication has been widely reported (Hamrick & Allard, 1972; Rick *et al.*, 1974; Karron, 1987; Maroof *et al.*, 1990).

C. pepo has been identified as the least widespread edible-seeded cucurbit cultivated in Côte d'Ivoire (5 accessions). The results showed that less attention is paid to oleaginous *C. pepo* by rural peoples. Such a trend could be explained by the fact that its seeds are less appreciated. In addition, this species grows vigorously so that it is not appropriate to be integrated to the multi-cropping systems predominantly practiced in the target zones.

With 13 accessions, *L. siceraria* is one of the less frequent species inventoried in this study, the main production zone being the east of Côte d'Ivoire (Table 1). Nevertheless, investigations carried out in Abidjan markets showed that this species is the second in abundance. These results suggested that production of *L. siceraria* is localised, as it was observed with *C. melo*.

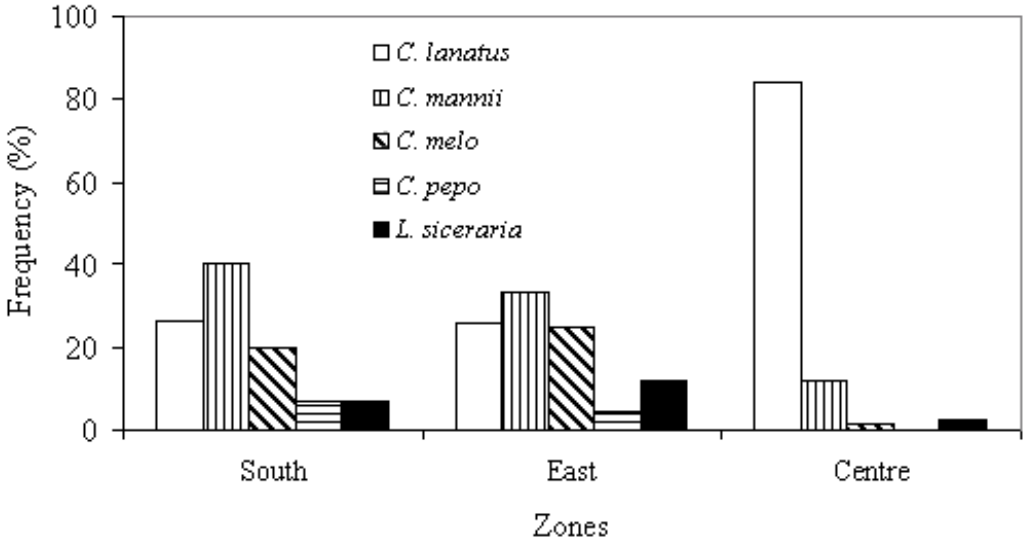

Figure 1: Frequency distribution by zone of the indigenous cucurbit species accessions collected during 2000-2004 in three regions of Côte d'Ivoire

3.2. Plant description and intraspecies diversity

Intraspecies diversity based on fruit and seed traits was observed in the five species.

C. lanatus—All the accessions from this species belong to the variety *citroides*. This species is the monoecious, yellow flowered, and creeping annual vine, presenting leaves deeply divided into 5-7 more or less subdivided lobes. Locally called *wlêwlê*, the species is the most common edible-seeded cucurbit species cultivated in Côte d'Ivoire. The fruits are round or oval (Fig. 2), uniformly light green or mottled light and dark green and contain a white bitter flesh embedding about 200 seeds. The mature dried seeds are yellowish (Fig. 2). Various fruit and seed shapes and colors are reported in *C. lanatus* (Gusmini, 2003). Two cultigroups were reported for this species. The first cultigroup, containing three cultivars (defined on the basis of seed size) has smooth seeds that are tapered to the point of attachment. Fruits of the second cultigroup, represented by one cultivar, are round and narrow or wide stripped. The seeds are ovoid and flattened, with a thick and rough margin. Statistical analyses highlighted significant differences between cultigroups for seed weight and seed size (Table 2). The same differences were also observed within varieties of the first cultigroup. Note that a type which presents slightly colored-flesh fruit, with brown and non-edible seeds are often observed on rubbish sites or on unbuilt plots in cities. This form could be a weedy type probably derived from the edible-fleshed *C. lanatus* var. *lanatus* that is widely consumed in towns. Our hypothesis is supported by the fact that some watermelon accessions held by the U.S. Department of Agriculture (USDA) contain the edible seed phenotype, designated by breeders as *egussi* seed type (Gusmini, 2003). Results from many studies devoted to genes controlling *C. lanatus* seed traits and their segregation patterns (Gusmini *et al.*, 2004) are also in accordance with our observations.

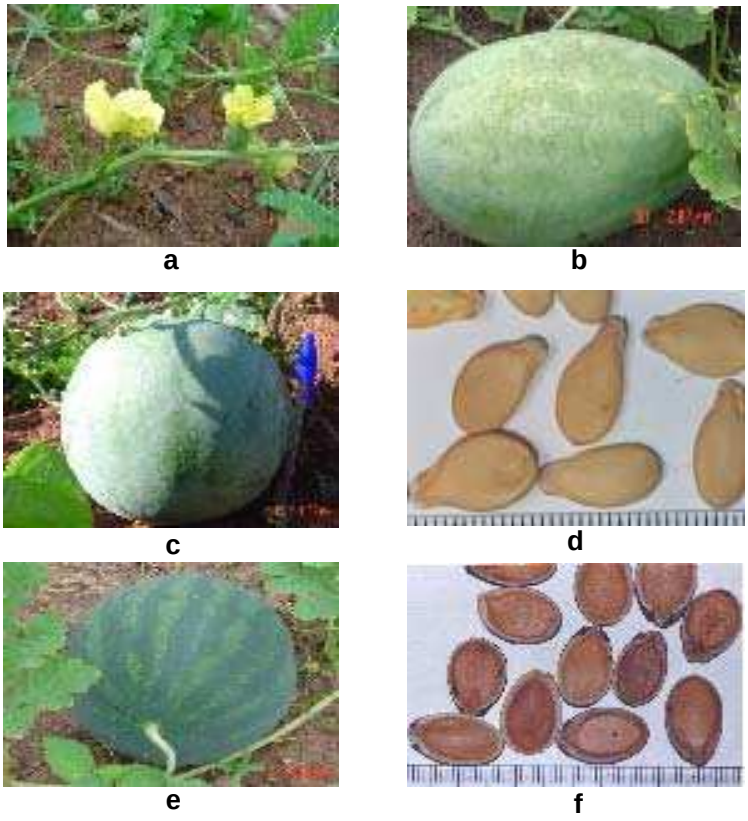

Figure 2 : Flowered stem and variability in fruits and seeds of Citrullus lanatus var. citroides (Thumb.) Matsum. & Nakai. a: flowered stem; b: oval and light green fruit; c: round and light green fruit; d: seed from oval and round light green fruits; e: round and wide striped green fruit; f: seeds from round and wide striped green fruit

With regard to the mating system, it is worth noting that the andromonoecy, a recessive trait that is reported to be common in *C. lanatus* var *citroides* (Gusmini, 2003) was not observed in the collected species.

Table 2 : Mean values (±SD) for seed size and 100-seeds weight of cultivars of edible-seeded cucurbits from Côte d'Ivoire

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

NB: Means within a column followed by different superscripts were significantly different (P ≤ 0.01), based on Student t or Newman-Keuls tests; n = sample size; r = number of replicates.

C. mannii—This species is a monoecious annual climbing vine, locally called *n'viêlê*. Vines can reach a height of 3-5 m. The leaves are embossed, with three notched lobes. Fruits are uniformly slight green or yellowish and blocky. Seeds are whitish, flattened, and tapered to the point of attachment (Fig. 3). According to peasants, maximizing yield of this species requires holding the vines vertically along stakes. For this reason, in the target zones, *C. mannii* is systematically intercropped with yam, since the latter also needs staking trellis. Three cultivars defined on the basis of seed size were found for this species (Fig. 3 and Table 2).

C. melo— All the accessions from this species belong to the variety *agrestis*. Two andromonoecious types, with dark green leaves, yellow flowers, and small oval fruits (3-7 cm length) were collected in the target zones. The most common type (Fig. 4) is cultivated and locally called *lomi n'gatê*. The seeds of this type are toasted, ground, and eaten as sauce thickener. The flesh of fruits is light green, lacks aroma, and has bitter taste.

The second type, less widely cultivated in the sampled zones, is often found along the roads, on rubbish sites or on unbuilt plots in villages and cities. Its mature fruits are orange (Fig. 4), possess aroma and are exclusively used as vegetable. The fruits 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 2).

Melon family is an economically important crop that includes wild types and numerous varieties, either consumed as desert fruits, vegetable or sauce ingredients, worldwide (van Epenhuijsen, 1974; Akobundu *et al.*, 1982; Chweya & Eyzaguirre, 1999; Badifu, 2001; Zoro Bi *et al.*, 2003). Varieties vary widely in fruit size, morphology and taste, as well as vegetative traits and climatic adaptation (Silberstein *et al.*, 1999; El Tahir & Taha Yousif, 2004). The most recent classification of *C. melo* L., following the basic taxonomic rank of the International Code of Botanical Nomenclature (ICBN) sub-divided this species into two sub-species: *agrestis* and *melo* (Pitrat *et al.*, 2000). The sub-species *agrestis* was divided into 5 botanical varieties, while the sub-species *melo* contained 11 varieties.

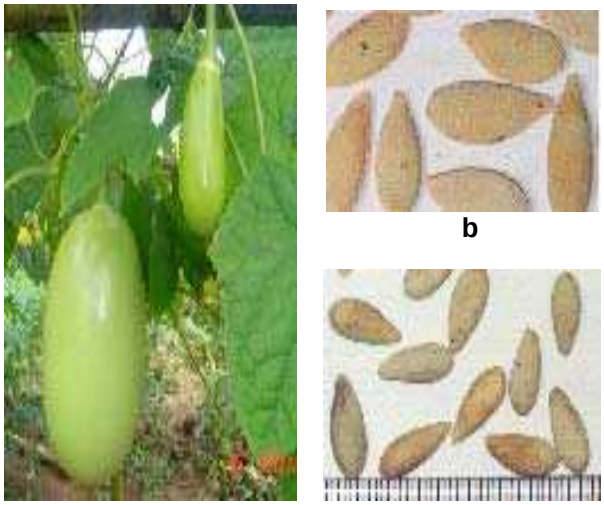

Figure 3 : Fruits and seeds of *Cucumeropsis mannii* Naudin. a: flower and fruit; b: large-sized seed; c: small-sized seed

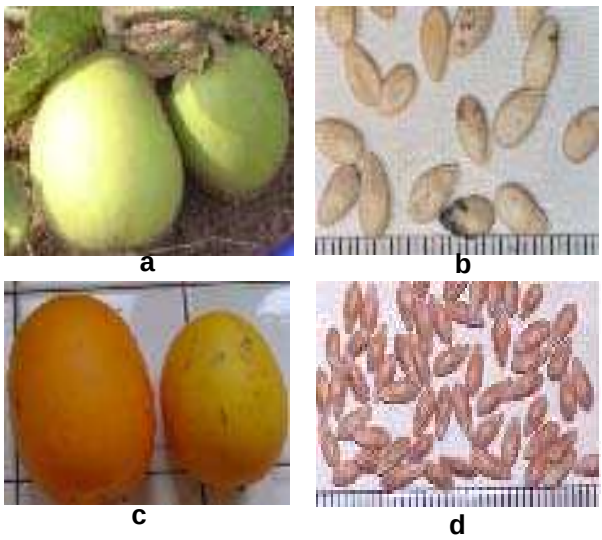

Figure 4 : Fruits and seeds of *Cucumis melo* var. *agrestis* Naudin. a: fruit of the cultivated type; b: seeds of the cultivated type; c: fruit of the uncultivated type; d: seeds of the uncultivated type.

C. pepo—Two open-pollinated cultivars, identified as *C. pepo* (Paris, 2001) and locally named *n'gando* were collected. The cultivars present yellow flowers and blocky fruits with orange flesh. This species is found in backyard gardens or on rubbish sites or on unbuilt plots in villages and cities. The main difference between the two cultivars concerns the color of the mature fruit that can be mottled light and dark green or yellow, and the seed size (Fig. 5 and Table 2).

C. pepo is among the economically most important vegetable crops worldwide and is grown in both temperate and tropical regions (Paris, 2001; Bisognin, 2002; Sanjur *et al.*, 2002). It is also one of the most variable species for fruit traits. The species includes both edible-fruited forms (pumpkins and squash) and small-fruited, often bitter, and non-edible forms known as gourds (Hart, 2004). In many cases, variability in fruit traits among cultivars is related to differences in quality needed for the culinary uses of the mature fruit and seeds. The two cultivars described in the present study have fibrous flesh so that they are solely cultivated for their seeds. Nevertheless, they expressed obvious morphological differences concerning fruit and seeds shape and size.

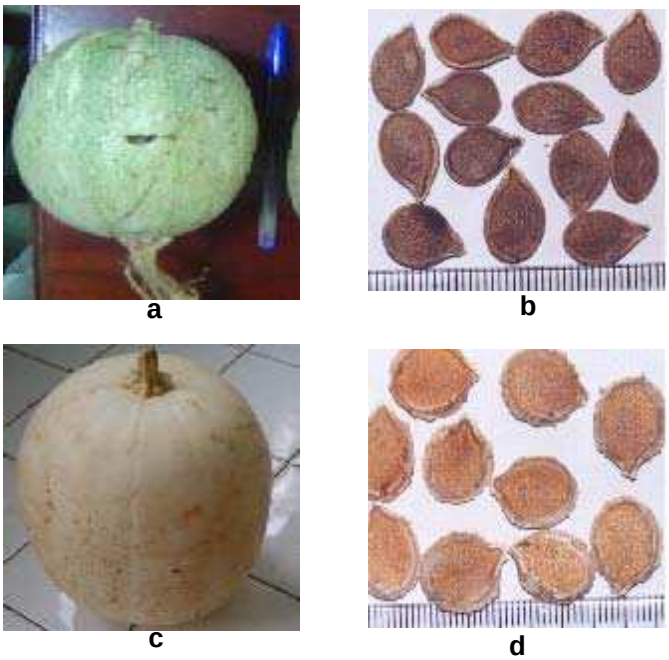

Figure 5 : Fruits and seeds of Cucubita pepo. a: fruit of yellow-fruited cultivar; b: seeds of yellow-fruited cultivar; c: fruit of green-fruited cultivar; d: seeds of the green-fruited cultivar.

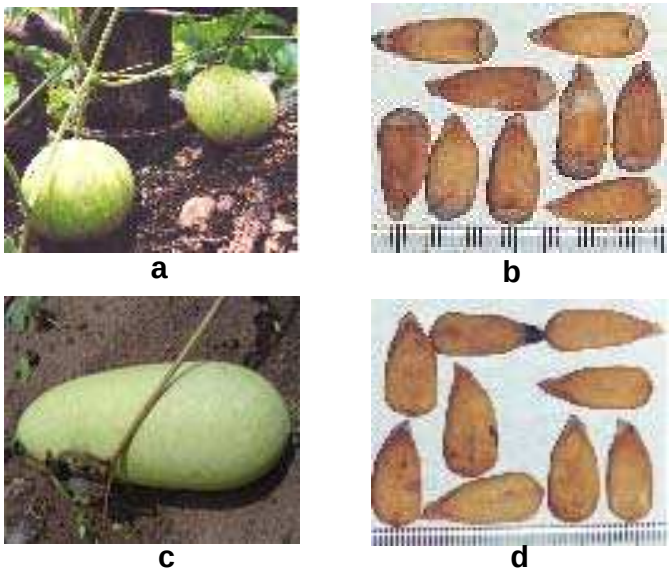

Figure 6 : Fruit and seeds of *Lagenaria siceraria*. a: stem with round fruit; b: seed of the round-fruited cultivar; c: stem with blocky fruit; d: seed of the blocky-fruited cultivar.

L. siceraria—This is a species of the monoecious white-flowered gourds locally called *bebou*. The local name comes from the manually shelling of the seeds, due to their hard coat. Two cultivars, recognisable by the fruit shape (blocky or round) were collected. Fruit and seeds shape and size are reported to be highly variable in *the genus Lagenaria* (Bisognin, 2002). In our case, seeds from the round-fruited cultivar are characterised by the presence of a cap on the distal side (Fig. 6). With regard to seed size and 100-seed weight, significant differences were observed between the two cultivars (Table 2).

4. Conclusion

This study highlighted the occurrence of five species of cucurbit incorrectly called *pistachio* in cities and cultivated at small scale for their oily seeds that represent a great importance in the sociocultural live of several people from Côte d'Ivoire. All these species except one (*C. pepo*) are cultivated in the three target zones. However, *C. lanatus* and *C. mannii* were identified as the most common species. The intraspecies diversity was limited to 2-4 varieties per species. This small number of varieties may be the result of the farmers' selection process, based on the needs and goals of the household.

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