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NOTES ON NEGLECTED AND UNDERUTILIZED CROPS

Black benniseed (*Sesamum radiatum* Schum. et Thonn.) cultivated as leafy vegetable in Benin

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Abstract *Sesamum radiatum* is a nutraceutical traditional leafy vegetable highly consumed in Benin. In spite of its importance for food security, nutrition and income generation, very little is known about in the scientific community and it falls into the group of so-called neglected and underutilised species. In order to document the diversity and the various traditional cultural practices associated with the production of this species and assess its "bringing into cultivation" levels across zones, a survey was conducted in 10 villages randomly selected from different agroecological and ethnic zones of both northern and central Benin. Data were collected in the different sites through application of Participatory Research Appraisal tools and techniques and analysed using both simple descriptive statistics and multivariate analysis. The study revealed a rich folk nomenclature essentially centred on the slimy texture of the sauce. No apparent intraspecific diversity was reported within *S. radiatum* at village level but the agromorphological characterisation of 18 accessions collected from different regions of the country revealed the existence of clear and well-structured intraspecific diversity exploitable in breeding for the development of new varieties with the potential to attract premium prices in local markets. In most of the households surveyed *S. radiatum* was found at the steps 1–4 in the "bringing into cultivation process". The production of *S. radiatum* is still traditional and biologic (no fertilisers, no pesticides). The cultural practices used vary with the producers and are grouped into four categories. Further agricultural experiments are needed to identify appropriate cultural practices for the large production of this species for food, nutrition and income generation. Strengthening the existing germplasm of this species with additional collection from more agroecological zones is proposed for thorough genetic characterisation.

Keywords Benin · Cultural practices · Diversity · Morphological characterisation · *Sesamum radiatum* · Vegetable

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Introduction

Africa has a large reservoir of bio-diversity of edible vegetable species that play important roles in food security and balanced nutrition on one hand and on the other as an income for farmers in both rural and urban areas (Schippers 2004; Dansi et al. 2008). In Kenya alone 220 species were recorded (Maundu et al. 1999). Recent studies conducted in Benin led to more than 180 species of traditional leafy vegetable (TLVs) among which included *Sesamum radiatum* Schum. et Thonn. (Dansi et al. 2008).

Sesamum radiatum is a perennial or annual herb found in the tropical areas of Africa and belongs to the Pedaliaceae family (Stevels 1990). It occurs in the wild in West and Central Africa. It is cultivated on a small scale since its "bringing into cultivation" is very recent (Vodouhè et al. 2011). *S. radiatum* has both nutritional and medicinal properties and belongs to the so-called traditional African nutraceutical vegetables. Its leaves, seeds and oil serve as food especially in rural areas of many African countries including Benin (Dansi et al. 2008; Adéoti et al. 2009) and Nigeria (Akpan-Iwo et al. 2006; Ogunlesi et al. 2010). The seeds have been reported to have a crude protein content of 22.9% (Oshodi et al. 1999). The leaves are also used for treating various sicknesses including stomach ailments, catarrh, eye pains, bruises and erupted skins (Ogunlesi et al. 2010; Bedigian 2003a, b; 2004b). Leave extracts were found to have significant myorelaxant effect in guinea-pig thus supporting the traditional use of the fresh leaves for treating cardio-vascular diseases in Cote d'Ivoire (Konan et al. 2006, 2008). In Western Nigeria the leaves are also used to correct male sterility by enhancing sperm count and the scientific proof has been recently provided (Shittu et al. 2007, Ogunlesi et al. 2010).

In Benin, *Sesamum radiatum* is largely consumed in the North and in the Central part of the country (Adéoti et al. 2009). According to the local communities, domestication (i.e. bringing into cultivation) of *S. radiatum* in Benin started about 60 years ago (Adéoti et al. 2009; Vodouhè et al. 2011) but has hardly progressed significantly because it has not received adequate research attention (Vodouhè et al. 2011). For so long now its production has remained traditional, with little or low input technology.

To promote research into the production, genetic development and utilization of this neglected crop for the benefit of both producers and consumers, it is necessary to document the traditional knowledge pertaining to its production and diversity. In this paper are summarised the results of the ethnobotanical investigations and the intra-species morphological diversity assessment recently carried out in Benin.

Methodology

The study area

The study was conducted in the Republic of Benin in West African sub-region between latitudes 6°10′N and 12°25′N and longitudes 0°45′E and 3°55′E (Adam and Boko 1993). It covers a total land area of 112,622 km^2 with a population estimated at about 7 million inhabitants (Akoègninou et al. 2006). The country is partitioned into 12 departments inhabited by 29 ethnic groups (Adam and Boko 1993). The south and the centre are relatively humid agroecological zones with bi-modal rainy seasons and mean annual rainfall varying from 1,100 to 1,400 mm/year (Adam and Boko 1993). The north is situated in arid and semi arid agro-ecological zones characterized by unpredictable and irregular rainfall oscillating between 800 and 950 mm/year with only one rainy season. Mean annual temperatures range from 26 to 28 °C and may exceptionally reach 35–40 °C in the far northern localities (Akoègninou et al. 2006). The country has over 2,807 plant species (Akoègninou et al. 2006). Vegetation types are semi-deciduous forest (South), woodland and savannah woodland (East Central and Northeast), dry semi deciduous forest (West Central and South Northwest), tree and shrub savannahs (far North) (Akoègninou et al. 2006).

Site selection and survey

Ten (10) villages were randomly selected from different agroecological and ethnic zones of northern and central Benin among those earlier identified by Dansi et al. (2008) in which *Sesamum radiatum* was found under cultivation. The list of the villages, their administrative locations and the ethnic groups inhabiting them are presented in Table 1. Data were collected using participatory research appraisal (PRA) tools and techniques such as direct observation, focus group discussions, individual interviews and field (home gardens or

Table 1 List of the villages surveyed, their administrative locations and ethnic groups

Villages	Districts	Ethnic groups
Alafiarou	N'Dali	Bariba
Dani	Savè	Lopka, Otamari
Dourobé	N'Dali	Bariba
Gobé	Savè	Adja, Idaïtcha, Pila–Pila
Kilibo	Ouèssè	Tchabè
Karobouarou	Parakou	Bariba
Ouogui	Savè	Otamari, Tchabè, Wama
Pam–Pam	Natitingou	Otamari, Wama, Yom
Papatia	Kouandé	Bariba
Perpoyakou	Natitingou	Wama

cultivated fields) visits using a questionnaire according to Dansi et al. (2008). In each site and prior to the survey, the particulars of the area (agro-ecological zone, name of location, name of sub-location, name of village, ethnic group) were collected after detailed presentation of the research objectives to the farmers. Through discussion, the following key information related to the traditional cultural practices was recorded. These were: seed collection, conservation and germination (nursery handling and management); date of planting and planting density; use of pesticides and fertilisers (type, dose and frequency of application); harvest (number and period) and the cropping system (sole cropping, mixed cropping). The level of "bringing into cultivation" attained by the species in each village was determined using the seven steps scale described by Vodouhè et al. (2011) as follow:

- Step 0: Species entirely wild and collected only when needed;
- Step 1: Wild species maintained in the fields when found during land preparation;
- Step 2: Farmers start paying more attention to the preserved plants for their survival and their normal growth. A sort of ownership on the plants starts;
- Step 3: The reproductive biology of the species is understood and multiplication and cultivation of the species in the home gardens or in selected parts of cultivated fields are undertaken;
- Step 4: The species is produced (in sole cropping) and harvested using traditional practices;
- Step 5: To improve the quality of the product, farmers adopt specific criteria to select plants that better satisfied people needs;
- Step 6: Development of appropriate pests and disease protection and food processing methods; Income generation becomes a key objective of the production;

Surveys data were analysed using descriptive statistics (frequencies, percentages, means, etc.) to generate summaries and tables at different levels (ethnic areas and zones). Cultural practices used by individual farmers from different regions were categorised using UPGMA cluster analysis following Dansi et al. (2008) and with NTSYS-pc 2.2 software package (Rohlf 2000).

Morphological characterization

A collection of eighteen (18) accessions of local ecotypes collected in the wild and in the cultivated fields and maintained at the experimental farm of the University of Abomey Calavi (Table 2) were studied. Seeds were first sown in polythene bags and after germination, the seedlings were transplanted at the four-leaf stage into 3 × 2 m plots in a completely

Table 2 List of the accessions used in the morphological study and their collecting sites

Accession numbers	Status	Collecting sites	
		Villages	Districts
1SrN	Cultivated	Béké	Pehunco
2SrN	Cultivated	Borondi	Djougou
3SrN	Cultivated	Cotiakou	Tanguieta
4SrN	Cultivated	Korontière	Boucoumbé
5SrS	Wild	Agonli-houégbo	Zangnanadou
6SrS	Wild	Atawignan	Adja-ouèrè
7SrS	Wild	Doutou	Houéyogbé
8SrS	Wild	Foli	Zakpota
9SrN	Cultivated	Koussoukouingou	Natintingou
10SrN	Cultivated	Naougou	Cobly
11SrN	Cultivated	Sèmèrè	Ouaké
12SrS	Wild	Atikpéta	Lokossa
13SrS	Wild	Konkondji	Savalou
14SrS	Wild	Houèdo	Abomey-calavi
15SrS	Wild	Minifi	Dassa-zoumè
16SrS	Wild	Sokponta	Glazoué
17SrN	Cultivated	Tchakalakou	Toucountouna
18SrN	Cultivated	Toubougnidi	Matéri

randomised design with four replications, at a spacing of 50 cm between rows and 30 cm within rows following IPGRI (2001). The field, primarily 5 years fallow was organic manure-fed. Fifteen (15) quantitative parameters of floral and vegetative development, leaf and seed production were studied. These were: Days to flowering (DFL), total biomass (TBO), Plant height (PH), Noose diameter (ND), Number of ramification (NR), Leaf length (LL), Leaf width (LW), Petiole length (PL), Days to fruiting (DF), Number of fruits per plant (NFP), Fruit length (FL), Fruit width (FW), Number of seeds per fruit (NSF), thousand seeds weight (TSW) and Seed germination rate (SGR). These parameters were measured and data collected from 12 weeks after sowing on five healthy individual plants randomly selected from each of the accessions per repetition following IPGRI (2001). Morphological groups were separated using UPGMA cluster analysis (Rohlf 2000) following Mih et al. (2008) with the same software package as indicated above.

Results and discussion

Systematic and botanical description

Sesamum radiatum Schum. et Thonn. [family PEDALIACEAE], Beskr. Guin. Pl. 282 (1827); F.T.A. 4, 2: 557 (1906); Chev. Bot. 489; Backer in Fl. Males., ser. 1, 4: 218; Berhaut Fl. Sén. 67., Heine in F.W.T.A., ed 2, 2: 391 (1963). Hakki in Fl. Anal. Togo: 384 (1984).

Syn.: *Sesamopteris radiata* (Schumacher et Thonn.) DC. Prodr. 9: 251 (excl. syn. Endl.). (1845)., Sesamum occidentale Regel et Heer, *Sesamum foetidum* Afz. ex Engl. in Bot. Jahrb. vol. 19, 156. 1894.

Short description (see also Burkill 1997; Akoègninou et al. 2006, Hanelt 2001): Erect annual herb (Figs. 1,2) up to 120(−150) cm tall; stem simple or branched, glandular pubescent. Leaves opposite or alternate in upper part of plant, simple; stipules absent; petiole up to 2.5 cm long in lower leaves, short in upper leaves; blade lanceolate to ovate or elliptical, 3–10(−12) cm × 1.5–5(–7) cm, cuneate to obtuse at base, acute at apex, coarsely serrate in lower leaves, usually entire in upper leaves, pubescent and densely mealy glandular below. Flowers solitary in leaf axils, bisexual, zygomorphic, 5-merous, with 2 bracts at base, each bract with an axillary, sessile gland; pedicel (2–)3–4(−5) mm long; calyx with narrowly triangular lobes up to 7 mm long, connate at base; corolla obliquely campanulate, 2.5–5 cm long, pubescent, pink to purplish, sometimes white, lower lobe slightly longer than other lobes; stamens 4, inserted near base of corolla tube and included; ovary superior, 2-celled but each cell divided by a false septum almost to apex, style long and slender, with 2-lobed stigma. Fruit: an oblong-quadrangular capsule 2–3.5 cm long, slightly compressed laterally, pubescent, with a very short beak at apex, often with 2 lateral short protuberances, loculicidally dehiscent, many-seeded. Seeds obovate in outline, compressed laterally, 2.5–3.5 mm × 1.5–2 mm, testa with radial sculptures, black or brown. Seedling with epigeal germination; hypocotyl 1–2 cm long; cotyledons broadly elliptical, up to 1 cm long, entire leafy.

Folk nomenclature

At community level, traditional leafy vegetables are identified by specific vernacular names (Dansi et al. 2009). Across the various villages and ethnic groups surveyed, 38 vernacular names were recorded among which 14 were already reported by Dansi et al. (2009). The meanings of these names are compiled in Table 3. According to this table, five key criteria (origin, status of the plant, growth habit, colour of the sauce, texture of the sauce) are used in naming *S. radiatum* across villages. Among these, the slimy texture of the sauce is the most important (Table 3). The meanings of the vernacular names also revealed the existence of some scenario (unexplained names, synonym, homonym, semantic, same name across ethnic zones) specific to folk nomenclature reported by Mekbib (2007) on sorghum and by Dansi et al. (2009) on leafy vegetables. According to many authors (Hiepko 2006; de Haan et al. 2007) the understanding of folk nomenclature of a species helps in assessing its importance and distribution and consequently in developing appropriate in situ conservation strategies.

Geographical distribution, ecology and use

S. radiatum is found almost everywhere in Benin and most importantly in the savannah regions in the North. In both wild and cultivated state, *S. radiatum* occurs on poor soils and in gravelly, sandy and even rocky areas. It is in certain zones considered as a weed to other crops in formerly cultivated fields. It tolerates heat and

Fig. 1 *Sesamum radiatum* in a field collection at the experimental farm of the University of Abomey-Calavi

Fig. 2 Close view of *Sesamum radiatum* plants in a home garden in northern Benin

drought well and continues to grow and flower during the dry season. These observations are in agreement with those of Hanelt (2001), Akoègninou et al. (2006) and Adéoti et al. (2009) who reported that the species is adapted to a wide range of habitats.

In all the villages surveyed, *Sesamum radiatum* is almost exclusively used as leafy vegetable and cooked leaves have a slimy texture. Young shoots are sometimes but rarely finely cut for use in sauces eaten with porridge. *Sesamum radiatum* is a leafy vegetable well adapted to arid and semi-arid zones where it grows fresh leaves for use during a greater part of the dry season. It can also be stored in the dried form for use all the year round. According to the interviewees, this leafy vegetable can be collected at the time of abundance, and dried in the sun soon after harvesting without prior blanching. After drying they are crushed into powder and stored in bags or plastic containers or gourds for regular use during the long dry seasons. About 30% of the interviewees reported that *Sesamum radiatum* has, in addition to its nutritional importance, some medicinal properties. Its cold leaf infusion is drunk to ease childbirth, treat metrorrhagia and diarrhoea while its macerated fresh leafy stems are applied externally to treat sprains and scorpion stings. Similar results were reported by Bedigian (2003b, 2004b).

Agromorphological diversity

None of the farmers interviewed reported intraspecific morphological diversity with *Sesamum radiatum* at village level. However morphological characterisation carried out on 18 accessions gathered from different villages belonging to different agroecological zones showed significant intraspecific diversity which led to

Table 3 List of the vernacular names recorded and their meanings

Vernacular name	Ethnic group	Meaning of the vernacular name
Agbô	Mahi	Slimy vegetable
Agbôè	Aïzô	Slimy vegetable
Agbon	Adja	Slimy vegetable
Agbôté	Idatcha	Erect slimy vegetable
Akanmanku	Fon	–
Anansara foïto	Dendi	Slimy sauce of Europeans
Dossé	Tchabè	–
Dossi	Bariba, Boko, Tchabè	–
Dossiguia	Bariba	–
Dossila	Boko	Black vegetable
Dossiyô	Peulh	–
Féïyôtô	Dendi	Slimy vegetable
Goolowo	Tchabè	–
Gousséninfounin	Ani	Slimy vegetable prepared with potash
Hangalamboati	Natimba	–
Kouangou	Gourmantché	–
Koumalo odoussè	Foodo	Slimy cultivated vegetable
Koumalo oyélissè	Foodo	Erect slimy vegetable
Koumankoun akô	Fè	Male slimy vegetable
Kounanhangou	Gangamba	Slimy vegetable of the Kabiè ethnic group
Koussèlomsô	Gnindé	Black slimy vegetable
Koussèlomsôgou	Gnindé	Black slimy vegetable
Lakouta	Dendi	–
N'zoti koudouté	Kotokoli	Cultivated slimy vegetable
Ningbô	Mahi	–
Nonbotaman	Wama	Slimy and cultivated vegetable
Nonmanwon	Yom	–
Nôrman	Dendi, Yom, Wama	–
Okoukou	Holi	Slimy vegetable
Sôka wourou	Lamba	Slimy vegetable like sesame
Tankantohoun	Berba	Slimy vegetable of Wama ethnic group
Tébonon	Bariba	–
Tissêdôonté	M'bermin	–
Titamanwadouanti	Ditamari	Slimy vegetable of Ditamari people
Toohoun	Berba	–
Touhounnoum	Lokpa	Slimy vegetable of elephant
Touwadouanti	Ditamari	Slimy vegetable of elephant
Touxoonôm	Lokpa	–

the structuring of the accessions into four agromorphological groups named G1, G2, G3 and G4 with clearly different performances (Tables 4, 5). Group 1 is early maturing and is characterised by a great number of fruits per plant while Group 4 produces fruits of relatively bigger size containing several seeds of also relatively bigger sizes. Plants of Group 2 are vigorous (large sized leaves, many ramifications, relatively big noose diameter), produce important biomass and are late maturing in terms of flowering and fruiting. Group 3 is characterised by a high plant height. With leafy vegetable in general and as reported by Chattopadhyay et al. (1996) and Mih et al. (2008), the desired characteristics for both producers and consumers include high production of total biomass, late flowering and very good fruit with several seeds. To this regard, data obtained in this study will be highly useful in developing new varieties of *S. radiatum* by series of crossing between the different groups. Accessions from the groups G2 and G4 exhibiting the best desirable performances are those collected from the home gardens in the north where the species is mostly cultivated and consumed. This may be the results of many years of morphological selection undertaken by farmers with the aim of getting plants with the potential to attract premium prices in local markets. As reported by Vodouhè et al. (2011), getting better performing varieties has always been one key objective of plant domestication for food purposes. To further investigate the genetic basis of the phenotypic diversity revealed among *S. radiatum* accessions, the use of molecular markers such as AFLPs (Rajkumar et al. 2011; Adéoti et al. 2011) will be necessary.

"Bringing into cultivation" levels of the species and their variation across villages and ethnic areas

Plant domestication is normally defined as the evolutionary process whereby a population of plants

Table 4 Distribution of the different accessions of *S. radiatum* in the different agromorphological groups

Agromorphological group	NA	Accession numbers	Morphological description
G1	7	5SrS, 6SrS, 7SrS, 8SrS, 14SrS, 15SrS, 16SrS	Medium-sized and moderately branched plant with slim and relatively short leaves with short petiole; early maturing and very fructiferous plant with fruits of medium length
G2	4	2SrN, 3SrN, 10SrN, 11SrN	Medium-sized and highly branched plant with relatively broad and long leaves with long petiole; late maturing and little fructiferous plant with fruits of medium length
G3	3	1SrN, 12SrS, 13SrS	Relatively tall and moderately branched plant with broad and long leaves with long petioles; plant of intermediate cycle, moderately fructiferous with fruits of medium length
G4	4	4SrN, 9SrN, 17SrN, 18SrN	Short and moderately branched plant with broad and long leaves with long petioles; Plant of intermediate cycle, very fructiferous with long fruits

Sr Sesamum radiatum, S south, *N* north, *NA* number of accessions

Table 5 Performances (mean values) of the four agromorphological groups identified within accessions of *Sesamum radiatum* in Benin

Characters	Code	Mean value of each class			
		G1	G2	G3	G4
Plant height (cm)	PH	105.71	105.75	121.60*	97.40
Leaf width (cm)	LW	2.30	3.23*	3.05	3.10
Leaf length (cm)	LL	4.2	6.5*	6.1	6.0
Petiole length (cm)	PL	1.1	1.6*	1.5	1.6
Noose diameter (mm)	ND	16.91	18.20*	17.73	16.00
Number of ramification	NR	21.80	25.50*	19.93	21.40
Number of fruits per plant	NFP	280.57*	137.75	199.00	278.50
Thousand seeds weight (g)	TSW	2.48	2.77	2.67	3.99*
Total biomass (g)	TOB	105.75	256.63*	196.87	205.18
Number of seeds per fruit	NSF	71.43	88.00	72.00	92.00*
Fruit length (cm)	FL	2.74	2.85	2.83	3.30*
Seed germination rate (%)	SGR	0.22	0.38*	0.25	0.35
Fruit width (cm)	FW	0.73	0.85*	0.70	0.80
Days to flowering	DFL	21.29*	56.75*	46.33	48.00
Days to fruiting	DF	28.86*	66.75*	56.00	57.00

*Best performance

becomes accustomed to human provision and control (Pourkheirandish and Komatsuda 2007). It is generally considered to be the end-point of a continuum that starts with exploitation of wild plants, continues through cultivation of plants selected from the wild but not yet genetically different from wild plants and ends with the adaptation to the agro ecology through conscious or unconscious human morphological selection, and hence genetic differences distinguishing the domesticated species from its wild progenitor (Harlan 1992; Parker et al. 2010; Sakuma et al. 2011). In this regard, there is a common suite of traits—known as the "domestication syndrome"—that distinguishes most crops from their progenitors (Hammer 1984; Harlan 1992). Compared to their progenitors, food crops typically have larger fruits or grains, more robust plants overall, a decrease in bitter substances in edible structures, loss of natural seed dispersal so that seeds remain attached to the plant for easy harvest by humans, etc. (Harlan 1992; Bedigian 2003a, b). Therefore, it is essential to distinguish between domestication and its initial phase which can be called "bringing into cultivation". Following Vodouhè et al. (2011), bringing into cultivation of leafy vegetable can be seen as a long process leading to the development of the best cultural practices or technological packages

necessary to master mass production in order to move from a proto-culture (wild species maintained in the fields for use when found during land preparation) to traditional home garden cultivation and later on to production in market gardens for food and economic purposes.

In Benin domestication of *Sesamum radiatum* is still at this phase of "bringing into cultivation" and the levels attained vary among the surveyed villages and ethnic groups (Table 6). With the ethnic groups Lokpa, Otamari, Pila–Pila and Wama of the northwest, *Sesamum radiatum* was found at levels 3 or 4 which means that it is cultivated (in mixed or sole cropping) in the home gardens or in selected parts of cultivated fields. In the Bariba villages (northeast) surveyed, the species was at level 1 meaning that it is gathered wild and only maintained in the fields during land preparation when found. With the Tchabè in central Benin, two levels (1 and 4) were observed. Level 1 was the most popular and level 4 was noted only in households located near the immigrants Otamari and Wama. Therefore, the breakthrough noted with the Tchabè could be due to the influence of the immigrant Otamari and Wama who generally move with their vegetables species and their associated knowledge that they easily share with their neighbours (Adam and Boko 1993; Dansi et al. 2009; Adéoti et al. 2009).

Cultural practices and their variation among producers

In the study zone, *S. radiatum* was found under cultivation at different sites. These include near the homestead (home gardens, cattle enclosures; 90% of farmers) and fertile portions of the cropland (10% of farmers). Planting material is exclusively seeds extracted from dry fruits. As domestication of *S. radiatum* is recent and still ongoing, seed systems are still not well organised. Apart from rare interviewees (4%) no producers carry out germination test before sowing (Table 7). Sowing is mainly by broadcasting (91% of farmers) and is, in the fields, concentrated in small patches where the debris from clearing was burnt. Nursery was also used but was however found to be a rare or uncommon practice as it is practiced by only 4% of producers. Two cropping systems (sole cropping, mixed cropping) were used. The commonest cropping systems were found to be mixed cropping (90% of users) with either vegetable or non vegetable crops (Table 7). No use of fertilisers and pesticides was recorded. Recorded options and percentage of users for planting method, planting period, planting density, number of days to the 1st harvest, cutting height and harvest frequency are also summarised in Table 7. *S. radiatum* easily produces seeds under farming conditions (Bedigian 2004a). Seeds harvested and sun-dried are packaged in materials of variable nature (Table 7) according to the households and stored in homesteads in granaries. Most of the farmers (59%) interviewed conserved seeds in bottles. In terms of storage period, the majority of the farmers reported that these conservation systems may keep the viability of seeds for more than 9 months. However, it will be important to carry out some germination tests at different storage times of seeds conserved in these containers to verify this statement and identify the best conservation conditions to be recommended. In all the households surveyed, production of *S. radiatum* is most exclusively a female enterprise. Women oversee the whole process from planting to harvesting, allocate

Table 6 Variation of the "bringing into cultivation" levels of *S. radiatum* across ethnic areas and villages in Benin

Ethnic areas	Villages	Levels of domestication			
		1	2	3	4
Adja	Gobé		x		
Bariba	Alafiarou, Dourobé, Karobouarou, Papatia	x			
Idaïtcha	Gobé		x	x	
Lokpa	Dani			x	
Otamari	Dani, Ouogui, Pam–Pam			x	x
Pila–Pila/Yom	Gobé, Pam–Pam				x
Tchabè	Kilibo, Ouogui	x			x
Wama	Ouogui, Pam–Pam, Perpoyakou			x	x

Table 7 Diversity of the traditional farming practices applied to *Sesamum radiatum* in Benin

Cultural practices	Type of practices	% of Users	Categories of producers			
			P1	P2	P3	P4
Preparation of nursery	No nursery	96	x		x	x
	Nursery	04		x		
Sowing method	Broadcasting	91				x
	Bulk seedlings	09	x	x	x	
Planting method	Random planting	10	x			x
	Planting in rows	90		x	x	
Planting period	Dry season	14				x
	Rainy season	86	x	x	x	x
Plant spacing	10–35 cm	69		x	x	
	>35 cm	31	x			
Mulching	No mulching	96	x		x	x
	Mulching	04		x		
Cropping system	Sole cropping	90		x	x	x
	Mixed cropping	10	x			
First harvest	25–30 days	93			x	x
	>30 days	07		x		
Harvest frequency	8–15 days	88			x	x
	>15 days	12		x		
Cutting height	5–9 cm	02	x		x	
	10–15 cm	87	x	x	x	x
	>15 cm	11	x			
Seed storage systems	Polythene bag	07				x
	Bottle	59		x	x	x
	Can	11	x			x
	Gourd	08	x			x
	Piece of cloth	08		x		
	Boxes	07			x	x
Germination test	No test	96	x			
	Test	04				x

duties to other members of the family and are also responsible for seed storage, preservation and exchange. This seeds custodian role of women in the traditional farming was already reported by several authors (Howard-Borjas and Cuijpers 2002; Dansi et al. 2008, Bedigian 2004b). The multivariate analysis carried out using the different practices as variables revealed the existence in the study area of four different groups of producers (P1, P2, P3, P4) corresponding to four different packages of cultural practices (Table 7). P2 and P4 assemble farmers applying the most advanced technological package (level 4 of bringing into cultivation) characterised by preparation of nursery, bulk seedling, planting in row and sole cropping. The other two groups are those using less advanced production technological packages (level 3 of bringing into cultivation).

Conclusion

The production of *S. radiatum* in Benin is still traditional and biologic. Its first phase of the domestication process (i.e. bringing into cultivation) as found across surveyed areas and with various households is still ongoing and should be supported with appropriate agricultural experiments. This agricultural research intervention will help to define the technological packages necessary for optimal exploitation of the rich potential of this species. Raising public awareness on the value and importance of *Sesamum radiatum* for food, nutrition and health will contribute to promoting this species and generate substantial resources for producers. It will be also necessary to enhance the existing germplasm through additional collection from different agroecological zones and conduct agromorphological and genetic characterisation in order to establish the scientific basis for their improvement.

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