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Full Length Research Paper

Diversity, cultural practices and domestication of *Sesamum radiatum* Thonn. ex Hornem and *Justicia tenella* (Nees) T., two neglected and underutilised traditional leafy vegetables consumed in Benin

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***Sesamum radiatum* and *Justicia tenella* are two traditional leafy vegetables highly consumed in Benin. In spite of their importance in food security, nutrition, and income generation, they still remain very little known to the scientific communities. In order to document their diversity and the various traditional cultural practices associated with their production and identity as well as their domestication 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 (means, frequencies, etc.) and multivariate analysis (ANOVA, cluster analysis). The study revealed the existence of clear intraspecific diversity within *J. tenella* contrarily to *S. radiatum* for which no apparent diversity was noted. In most of the households surveyed, *J. tenella* and *S. radiatum* were found respectively at steps 3 and 4 in the domestication process. The production of these vegetable species is still traditional and biologic (no fertilisers, no pesticides). The cultural practices used are not the same for the two species and vary between households and between ethnic groups. The multivariate analyses (Cluster analysis, PCA) conducted based on the various traditional farming practices to examine the relationship between farmers revealed respectively 4 and 5 categories of producers of *J. tenella* and *S. radiatum* corresponding to the same numbers of applied traditional technological packages. Further domestication trials were recommended to develop the best technical packages required to master mass production of the species in the future for the benefit of both producers and consumers. Agromorphological and genetic characterisation were also recommended in order to establish the scientific basis for their varietal improvement.**

Key words: *Sesamum radiatum*, *Justicia tenella,* leafy vegetables, traditional production, domestication, Benin.

INTRODUCTION

Africa is an enormous reservoir of diversity of vegetables that play an important role in food security, nutrition and income generation in both rural and urban areas (Chweya and Eyzaguirre, 1999; Shippers, 2004; Bedigian, 2004; Etèka et al., 2010). Surveys conducted in several African countries these last decades revealed a wealth of vegetable species (Batawila et al., 2007; Kimiywe, 2007). In Kenya, 220 species were recorded (Maundu et al., 1999). Recent studies conducted in Benin led to more than 180 species of traditional leafy vegetable (TLVs)

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among which *Sesamum radiatum* Thonn. ex Hornem and *Justicia tenella* (Nees) T. (Dansi et al., 2008, 2009; Adéoti et al., 2009). In Benin, these species occur and are highly consumed in the North and in the Centre of the country (Adeoti et al., 2009). According to the local communities, *S. radiatum* was locally domesticated while *J. tenella* was introduced in Benin about 60 years ago (Adeoti et al., 2009). Because they have been long time neglected by the scientific research, their production remained traditional and their domestication process (Vodouhè et al., 2011) has hardly progressed. To design a concrete research and development program for the promotion of these species for the benefit of both producers and consumers, the documentation of the traditional knowledge pertaining to their production and diversity is a prerequisite. The objectives of this study were threefold:

1) To investigate the current domestication levels of the species and assess their variation across villages and ethnic areas;
2) To document the intraspecific diversity of the species and the diverse traditional cultural practices applied to them across villages and examine their strength and weakness; and
3) To identify the priority research axis necessary for the finalisation of the domestication of the two species.

METHODOLOGY

The study area

The study was conducted in the Republic of Benin situated in West Africa between the 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 millions (Adomou, 2005). 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 two rainy seasons (Figure 1) 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 to 40°C in the far northern localities (Adomou, 2005; 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 (Centre-East and Northeast), dry semi deciduous forest (Centre-West and south northwest) and tree and shrub savannahs (far North).

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. (2008b) in which *S. radiatum* and/or *J. tenella* were found under cultivation. The list of the villages, the districts in which they are located and the ethnic groups inhabiting them are presented in Table 1. Data were collected during field works on different sites through the application of participatory research appraisal tools and techniques such as direct observation, focus group discussions, individual interviews and field visits using a questionnaire (Adoukonou-Sagbadja et al., 2006; Dansi et al., 2008a; Dansi et al., 2010). Interviews were conducted with the help of translators from each area. As TLVs is mainly women's affair, they were the potential respondents in the study but men were not excluded.

In each site, local women's organisations were involved in the study to facilitate the organisation of the meetings and the data collection. 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 first 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 on each of the species. These were: seeds collection, conservation and germination (nursery handling and management); planting period and materials (seed; cutting); space between individual plants; use of pesticides and fertilisers (type, dose and frequency of application); harvest (number and period); production system (sole cropping, associated crops); knowledge of pests and diseases and the traditional methods of their control. The level of domestication attained by the species in each village was determined following the seven steps described by Vodouhè et al. (2010) as follows:

Step 0: Species entirely wild were collected only when needed.
Step 1: Wild species are 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 satisfy people's needs.
Step 6: Development of appropriate pests and disease protection and food processing methods. Income generation become a key objective of the production.

Field visits were conducted to the farmers' home gardens or cultivated fields to see the species under production. For each species, a total of 50 producers were interviewed.

Data analysis

Data were analysed through descriptive statistics (frequencies, percentages, means, etc.) to generate summaries and tables at different levels (ethnic areas and zones). To analyse the relationships between interviewees in term of cultural practices used, producers were considered as individuals and the cultural practices as variables and scored as 1 when used or 0 if not. Using this methodology, 56 variables were created and a binary matrix was compiled. Pairwise distances between ethnic groups were computed by NTSYS-pc 2.2 (Rohlf, 2000), using Jaccard coefficient of similarity (Jaccard, 1908). Similarity matrix was used to design a dendrogram using UPGMA cluster analysis (Sneath and Sokal, 1973; Swofford and Olsen, 1990).

The ALSCAL procedure of SPSS software (SPSS, 1997) was used to build a two dimensional geometric structure based on the observed similarity or dissimilarity among investigated peoples

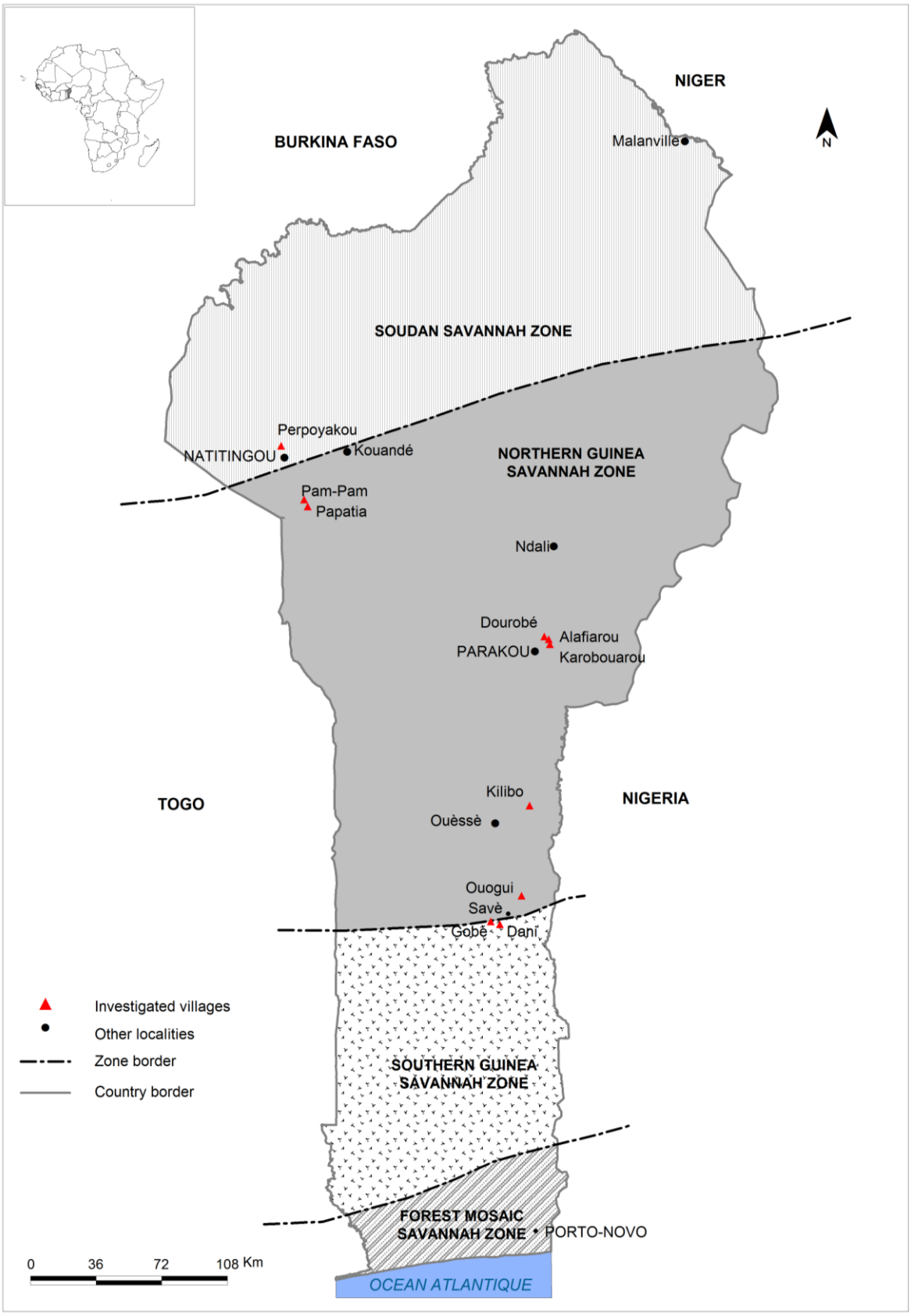

Figure 1. Geographical localisation of the villages surveyed.

Table 1. List of the villages surveyed, their administrative localisation 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

a b

Figure 2. Erected plant of *Justicia tenella* a) with green stem. b) with purple stem.

(Desbois, 2005). For five variables (planting space, harvest frequency, number of days to the first harvest, cuttings length, cutting height), mean values of the producers' groups were compared using the Kruskal-Wallis test or the Bonferronii test through analysis of variance (ANOVA) using the R Foundation for Statistical Computing software package Version 2.2.1 (R Development Core Team, 2005).

RESULTS

Diversity of the species

Within *J. tenella* farmers, the existence of varieties was reported which differ by the colour of the stem (Figure 2a and b) and the shape of the areal part (Figure 3a and b) of the plants. The morphotypes known to farmers are of four types and described as follows:

Type 1: Erected plant with green stem;
Type 2: Erected plant with purple stem and nodes intensively coloured in purple;
Type 3: Scrub-covered plant with green stem; and
Type 4: Scrub-covered plant with purple stem and nodes intensively coloured in purple.

The first type (erected plant with green stem) was found in all the villages surveyed while the three others were observed in only 3 (type 2) or 2 villages (types 3 and 4). On the scrub-covered plants, rooting is observed at the nodal points of the branches spreading on the ground. None of the farmers interviewed reported intraspecific morphological diversity on *S. radiatum*

Domestication levels of the species and their variation across villages and ethnic areas

The status (cultivated or not) of the two species investigated varies among the surveyed villages. Hence, *J. tenella* was not found under cultivation at Dani, Gobé and Ouogui while *S. radiatum* was absent in the home gardens at Alafiarou, Dourobé, Karobouarou, and Papatia, the four Bariba villages of the study sites (Table

a b

Figure 3. *Justicia tenella a)* Scrub-covered plant with green stem b) scrub-covered plant with purple stem.

Table 2. Variation of the domestication levels of *J. tenella* and *S. radiatum* across villages and ethnic areas.

Villages	Ethnic groups	Level of domestication	
		J. tenella	***S. radiatum***
Alafiarou	Bariba	3	nc
Dani	Lopka	nc	3
	Otamari	nc	3
Dourobé	Bariba	3	nc
Gobé	Adja	nc	2
	Idaïtcha	nc	2; 3
	Pila-Pila	nc	4
Kilibo	Tchabè	3	nc
Karobouarou	Bariba	3	nc
Ouogui	Otamari	nc	3
	Tchabè	nc	4
	Wama	nc	3
Pam-Pam	Otamari	3	4
	Wama	3; 4	4
	Yom	3	4
Papatia	Bariba	3	nc
Perpoyakou	Wama	3; 4	3

nc: Not cultivated.

2). In the villages where these species are cultivated, their domestication levels were variable, more often, between ethnic areas. At Perpoyakou inhabited uniquely by the Wama ethnic group, *J. tenella* was found at both

Table 3. Relative importance of the domestication levels with *Justicia tenella* and *Sesamum radiatum* in the study area.

Levels of domestication	*Justicia tenella*	*Sesamum radiatum*
Level 2	0	8
Level 3	82	26
Level 4	18	66

levels 3 and 4 following Vodouhè et al. (2011) while at Gobé, *S. radiatum* was found at levels 2, 3 and 4 with the ethnic groups Adja, Idaïtcha and Pila-pila respectively (Table 2). For the majority of the households surveyed, *J. tenella* was mostly found at the domestication level 3 and *S. radiatum* at the level 4 (Table 3).

Traditional cultural practices and their variation among producers

The different traditional agricultural practices applied to *J. tenella* and *S. radiatum* throughout the surveyed sites are summarised in Table 4. In the study zone, the species investigated were 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). Two cropping systems (sole cropping, mixed) were used. The commonest cropping systems were found to be mixed cropping (72 and 90% of users for *J. tenella* and *S. radiatum* respectively) with either vegetable or non vegetable crops (Table 4). Planting material is either exclusively seeds (*S. radiatum*) or seeds and cutting (*J. tenella*). Two cutting length (Table 4) were recorded but the one of 10 to 15 cm seems to be the most used. Planting with seeds was mainly by broadcasting (91 to 100% of farmers; Table 4) and is concentrated in small patches where the debris from clearing the fields was burned. Nursery also exists but was however found to be a rare or uncommon practice as it is practiced by only 4 and 18% of producers of *S. radiatum* and *J. tenella* respectively. It is made most often on upland fields exclusively (*S. radiatum*) and sometimes on mounds in lowlands (*J. tenella*). Recorded options and percentage of users by species for planting method, planting period, plant spacing, use of fertiliser and pesticides, number of days to the 1st harvest, cutting height and harvest frequency are also summarised in Table 4.

J. tenella and *S. radiatum* easily produce seeds under farming conditions. However, the methods that farmers use to handle seeds and which are of two types vary according to the species. Growers of *S. radiatum* harvest at maturity fruits from the desired number of individual plants and extract the seeds (100%; Table 5). A small number (12%) of farmers cultivating *J. tenella* dig up the whole plants with mature fruits and tie them to a tree in their field to favour free wind dispersion of the seeds. Seeds harvested and sun-dried are packaged in various materials and stored in homesteads in granaries. Materials used to conserve seeds (Table 5) were the same in all the villages surveyed but their degree of utilisation varied according to the species. Most of the farmers interviewed conserved seeds of *S. radiatum* in bottles while the majority of *J. tenella* growers stored seeds in either polythene bags, bottles and cans with a predominance of cans (Table 5). In terms of storage period, farmers reported that these conservation systems may keep the viability of seeds for, sometimes, more than 9 months (Table 5). Apart from rare producers (4%) of *S. radiatum* no producers do germination test before sowing (Table 5).

Classification of the producers with regard to the cultural practices used

The cluster analysis using the different practices as variables showed different groups of producers according to the species. With *J. tenella* and at 36.4% of similarity, the dendrogram constructed (Figure 4) showed 4 groups (C1, C2, C3 and C4) of farmers which also appeared well demarcated by the plan represented by the first two axis of the principal component analysis (PCA) performed to visualise the groups in a two-dimensional plan (Figure 5). C1 clusters together all the Tchabè farmers and a great number of the Bariba farmers; C2 groups the remaining Bariba farmers with two Wama and one Otamari farmers; C4 gathers almost all the Wama producers let aside by C2 except of individual FPmW17 of the village Pam-Pam solely classified in C3. In the plan defined by the two first axis of the PCA (Figure 5), Axis 1 opposes C4 to C2 and C3 and Axis 2 separates C1 from C2, C3 and C4.

On the dendrogram constructed for *S. radiatum* and at 42.8% of similarity, five groups (G1, G2, G3, G4 and G5) of producers were obtained (Figure 6). These groups were confirmed by the PCA as they all appeared well represented on the two-dimensional plan defined by the axis 1 and 2 (Figure 7). Contrary to *J. tenella*, the groups were more ethnically heterogeneous apart from G4 and G5 which were dominantly Otamari (Figure 7). The different groups of producers identified for both species and presented earlier, are each characterised by a particular technological package seen as a set of traditional

Table 4. Traditional farming practices applied to *Justicia tenella* and *Sesamum radiatum* and percentage of users.

Cultural practices	Type of practices	Percentage of users (farmers)	
		J. tenella	***S. radiatum***
Planting material	Seeds	61	100
	Cutting	39	0
Cutting length	10-15 cm	56	No cutting
	16-25 cm	44	No cutting
Nursery making	No nursery	82	96
	Nursery	18	04
Nursery site	Mounds in lowland	24	00
	Upland field	76	100
Sowing method	Broadcasting	100	91
	Bulk seedlings	0	09
Planting method	Random planting	45	0
	Planting in rows	55	100
Planting Period	Dry season	19	14
	Rainy season	81	86
Plant spacing	<10 cm	15	0
	10-35 cm	55	69
	>35 cm	30	31
Use of fertiliser	No fertiliser	100	100
	Use of fertiliser	0	0
Mulching	No mulching	100	96
	Mulching	0	4
Association with other crops	Sole cropping	72	90
	With vegetable crops	06	04
	With non vegetable crops	22	6
Application of pesticide	No pesticide	100	100
	Use of pesticide	0	0
Number of days to the 1st harvest	25-30 days	78	93
	> 30 days	22	07
Harvest frequency	7 days	6	0
	8-15 days	84	88
	> 15 days	10	12
Cutting height	5 - 9 cm	8	02
	10 - 15 cm	60	87
	> 15 cm	32	11

Tchabè; W: Wama; Y: Yom.

Table 5. Seed supply methods and storage systems.

Category of practices	Percentage of users (farmers)	
	J. tenella	*S. radiatum*
Seed supply methods		
Favoured free seed wind dispersion	12	00
Fruit collection and seeds extraction	88	*100*
Seed storage systems		
Polythene bag	19	07
Bottle	25	59
Can	44	11
Gourd	04	08
Piece of cloth	00	08
Boxes	08	07
Duration of seed storage		
≤ 8 months	49	25
≥ 9 months	51	75
Test of germination		
No test	100	96
Test	00	04

farming practices. These practices as well as the sociolinguistic groups with whom they have been encountered and their corresponding domestication levels are summarised in Table 6. The statistical analysis conducted to compare at species level the identified producers groups based on the quantitative data, revealed some differences (Table 7). Hence, the analysis of variance applied to "planting spacing, eight of cutting and length of cutting" revealed highly significant difference ($P < 0.0001$) between groups of producers of both species (*J. tenella* and *S. radiatum*) for only the first parameter (Table 7). The test of Kruskal-Wallis also revealed significant difference ($P < 0.05$) between producers groups for the numbers of days to first harvest and the cutting frequency (Table 7).

DISCUSSION

Farmers reported an intraspecific diversity within *J. tenella* and classified the species into three varieties with clearly established differences. This is clear evidence that farmers have a good knowledge of their material and therefore their indigenous knowledge should be capitalised by geneticists and breeders. Similar results were reported on many crops such as yam (Dansi et al., 1999; Dansi et al., 2000), Fonio (Adoukonou-Sagbadja et al., 2006, 2007), sorghum (Berg, 1992), rice (Price, 2006), Cassava (Emperaire, 2007) and also on traditional leafy vegetables (Dansi et al., 2008; Adeoti et al., 2010; Adeoti et al., 2011). Variables considered by the farmers in identifying varieties and species will be taken into account among other descriptors for detailed morphological characterisation and classification of the species. No intraspecific morphological diversity is reported with *S. radiatum*. This unexpected result may be an indication of low morphological diversity within the species that only a comprehensive morphological characterisation of accessions gathered from different locations and agroecological zones will help either to confirm or to invalidate.

Throughout the study zone, the status and the domestication levels of the two species investigated varies between, villages, ethnic areas and sometime households within the same village. These results are similar to those recently reported in Benin by Vodouhè et al. (2011) on a wide range of plant species among which some traditional leafy vegetables. For the majority of the households surveyed, *J. tenella* and *S. radiatum* were mostly found respectively at domestication levels 3 and 4 which correspond to fully cultivated species. The fact that *S. radiatum* was also at level 2 in some areas cast doubt on the thesis of its introduction as cultivated plant in Benin as reported by some farmers (Adeoti et al., 2010) and supports the idea of few farmers we met according to which it has been locally domesticated. As highlighted in Table 2, the higher domestication levels seem to be associated to the ethnic groups of the northwest principally the Otamari, Wama and Yom for both species and the peoples Tchabè and Pila-Pila for *S. radiatum*.

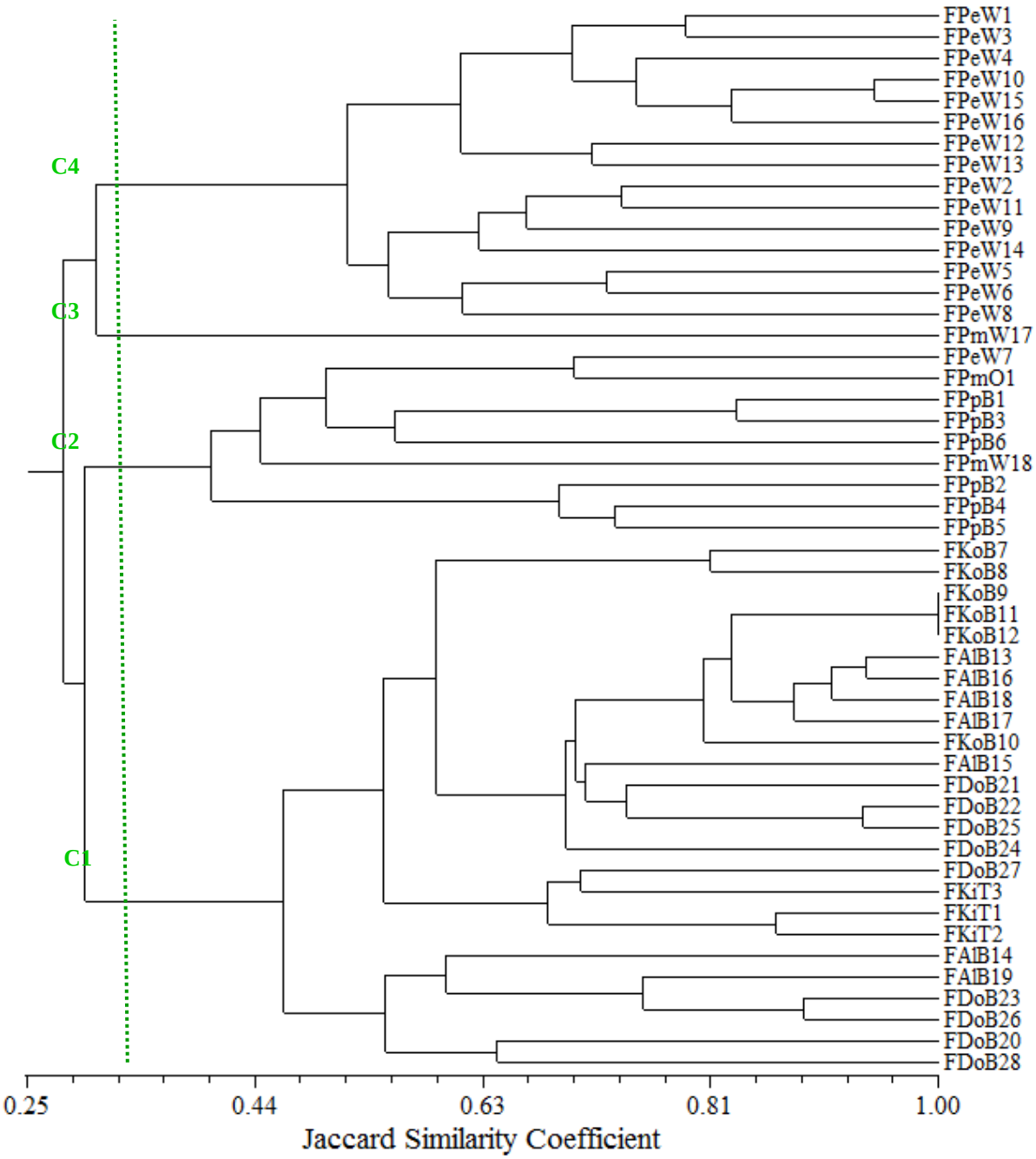

Figure 4. UPGMA dendogram based on Jaccard coefficient of similarity showing the categories of producers of *Justicia tenella* according to the indigenous farming practices used. F: Farmer; Da: Dani; Go: Gobé ; Oo: Ouoghui; Pe: Perpoyakou; Pm: Pam-Pam; A: Adja; B: Bariba; D: Idaïtcha; L: Lokpa; O: Otamari; P: Pila-Pila; T: Tchabè; W: Wama; Y: Yom.

The breakthrough noted with the Tchabè in central Benin 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; Adeoti, 2009). The traditional practices applied to both species are almost similar and do not differ from those generally used in Benin rural area for the traditional leafyvegetables in general as reported by Dansi et al. (2009). *J. tenella* and *S. radiatum* easily produce seeds

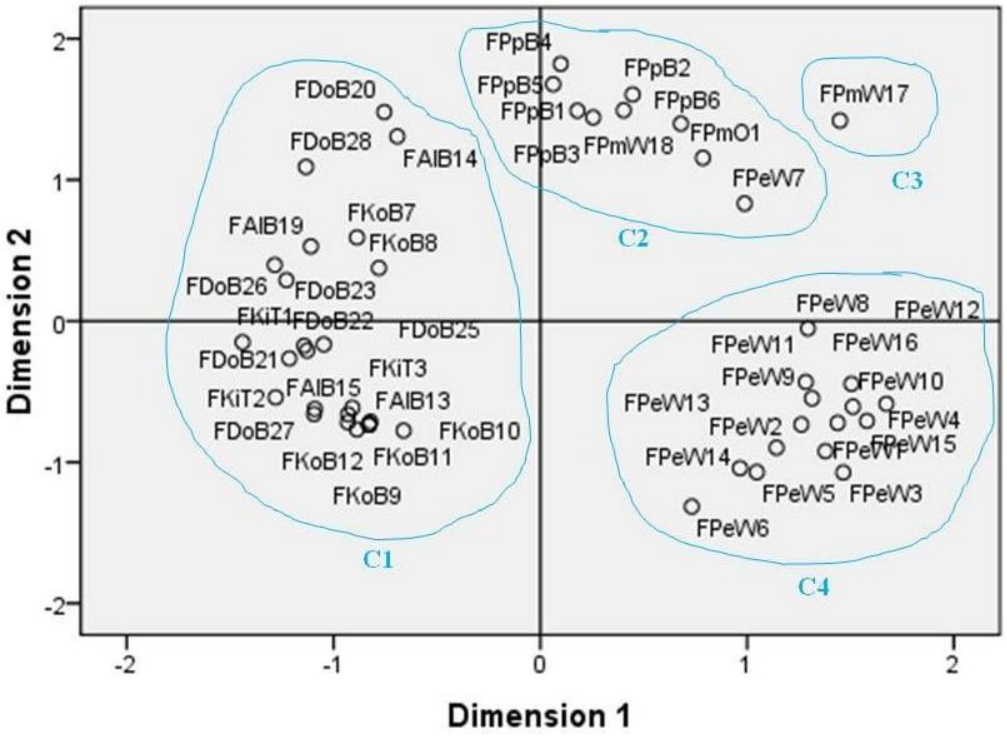

Figure 5. Grouping of producers of *J. tenella* using the ALSCAL procedure of SPSS software.

under farming conditions. However, as their domestication is still ongoing, seed systems are still not well refined. Farmers used a wide range of containers to store seeds (Kossou and Aho, 1993; Abukutsa-Onyango, 2007) and reported that they keep the viability of seeds for, sometimes, more than 9 months. Germination trials at different storage times of seeds conserved in these materials should be conducted to verify this statement and indicate the appropriate seed storage methods for the different species. The multivariate analysis carried out using the different practices as variables showed different groups of producers according to the species. C3 and C4 of *J. tenella* and G3 and G4 of *S. radiatum* assemble farmers applying the most advanced technological package (domestication level 4) characterised by seed extraction from fruits, preparation of nursery, bulk seedling, planting in row and sole cropping. The other groups are those using less advanced production technological packages.

The statistical analysis conducted to compare at species level the identified producers groups based on the quantitative data, revealed that with both species some groups of producers use wide planting spaces while some apply small spacing (Table 7). Our observations revealed that farmers who use wide planting are those who practice intercropping while the individuals applying low spacing are those producing the species in pure culture (monoculture) to satisfy the market demand. According to the farmers and as already reported by Aho and Kossou (1997), Floquet and Mongbo (1998), large spacing in intercropping system allows better development of the plants. Therefore, some trials are needed to determine the appropriate planting density for each species to help farmers in maximising their production. Similar research actions should be undertaken for the cutting frequency and the number of days to the first harvest.

Conclusion

The production of *S. radiatum* and *J. tenella* in Benin is still traditional and biologic. The cultural practices used vary between species, households and ethnic groups. Their ongoing domestication process as found across explored areas and households should be supported and speeded with intense agricultural trials. These trials will help in defining the technological packages necessary for optimal, intensive and extensive production of these species in market gardens for food nutrition, food security and economic purposes. It will also be necessary to assemble germplasm from different agroecological zones of Benin and conduct agromorphological and genetic characterisation in order to establish the scientific basis

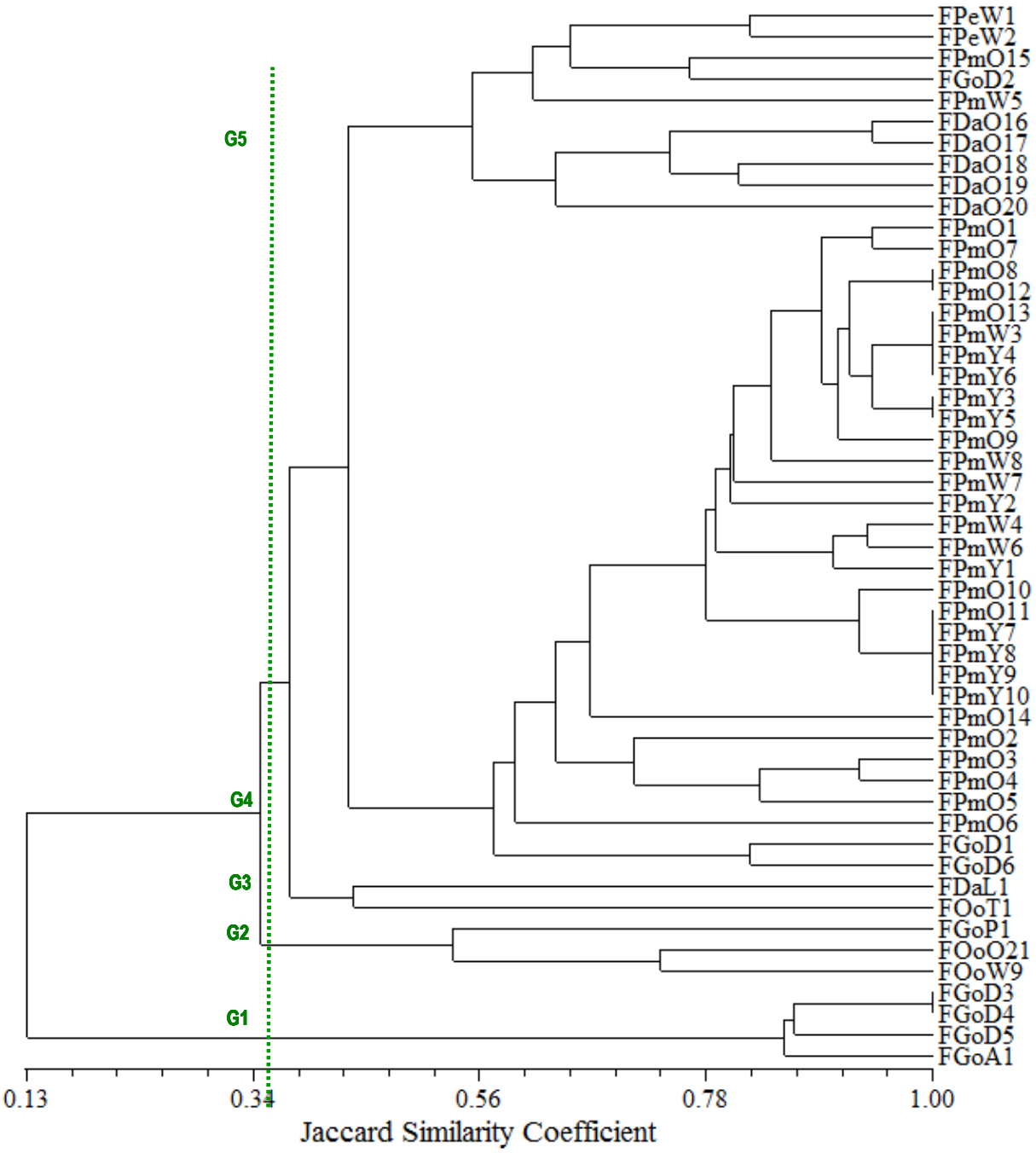

Figure 6. UPGMA dendogram based on Jaccard coefficient of similarity showing the categories of producers of *Sesamum radiatum* according to the indigenous farming practices used. F: Farmer; Da: Dani; Go: Gobé ; Oo: Ouoghui; Pe: Perpoyakou; Pm: Pam-Pam; A: Adja; B: Bariba; D: Idaïtcha; L: Lokpa; O: Otamari; P: Pila-Pila; T: Tchabè; W: Wama; Y: Yom.

for their improvement.

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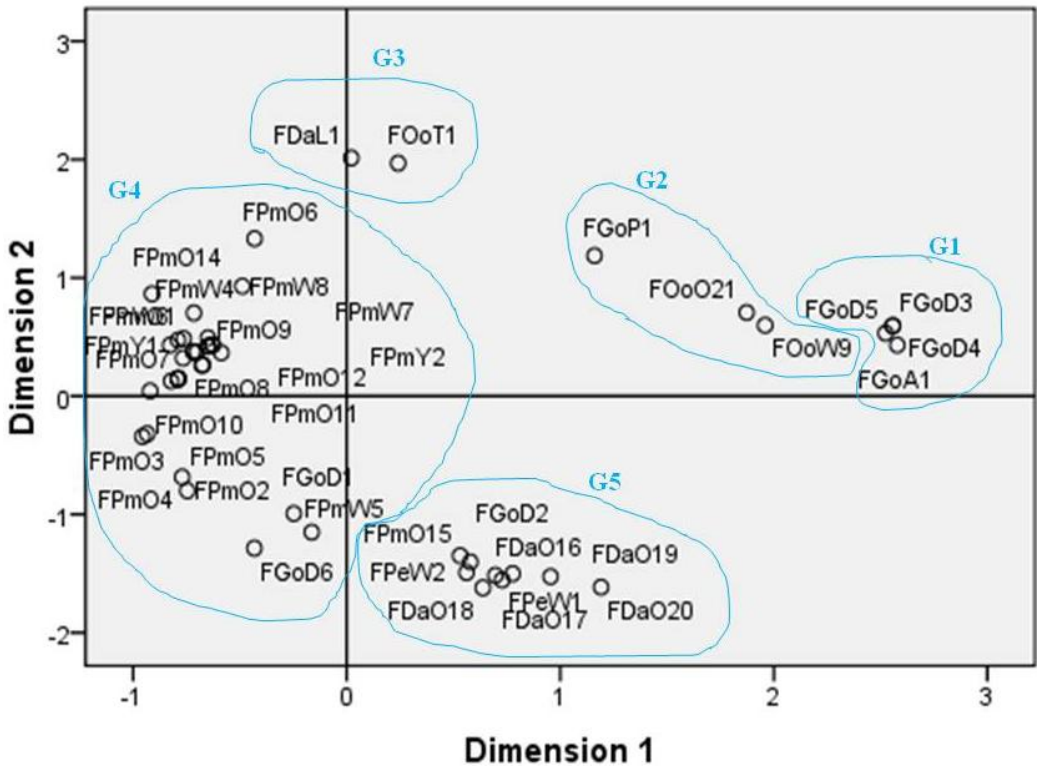

Figure 7. Grouping of *S. radiatum* producers using the ALSCAL procedure of SPSS software.

Table 6. Technological packages characterizing the categories of producers (C and G) of Justicia tenella and Sesamum radiatum, their users and corresponding domestication levels.

Cultural practices	Type of practices	*Justicia tenella*				*Sesamum radiatum*				
		C1	C2	C3	C4	G1	G2	G3	G4	G5
Seed supply methods	Favoured free seed wind dispersion		**x**							
	Extraction from seeds	**x**		**x**	**x**		**x**	**x**	**x**	**x**
Seed storage systems	Polythene bag									x
	Bottle			x	x			x	x	x
	Can	x			x		x			x
	Gourd						x			x
	Piece of cloth							x		
	Boxes									
Duration of seed storage	≤ 8 months									**x**
	≥ 9 months	x		x	x			x	x	
Planting material	Seeds	x	x	x	x		x	x	x	x
	Cutting		x							
Preparation of nursery	No nursery					x	x		x	x
	Nursery	x	x	x	x			x		

Table 6. Contd.

Nursery site	Mounds in lowland				x					
	Upland field	x	x	x				x		
Sowing method	Broadcasting	x	x							x
	Bulk seedlings			x	x		x	x	x	
Planting method	Random planting				x		x			x
	Planting in rows	x	x	x	x			x	x	
Planting period	Dry season				x					x
	Rainy season	x	x	x	x		x	x	x	x
Plant spacing	<10 cm				x					x
	10-35 cm			x				x	x	
	>35 cm	x	x				x			
Mulching	No mulching	x	x	x	x		x		x	x
	Mulching							x		
Cropping system	Sole cropping			x	x			x	x	x
	With vegetable crops		x							
	With other crops	x					x			
Number of days to the 1st harvest	25-30 days	x	x	x					x	x
	> 30 days				x			x		
Harvest frequency	7 days						x			
	8-15 days	x	x		x				x	x
	> 15 days			x				x		
Cutting length	10-15 cm		x							
	16-25 cm	x		x						
Cutting height	5 - 9 cm	x	x							
	10 - 15 cm	x			x		x	x	x	x
	> 15 cm		x	x						
Users (sociolinguistic groups)		U1	U2	U3	U4	U5	U6	U7	U8	U9
Corresponding domestication levels		**3**	**3**	**4**	**4**	**2**	**3**	**4**	**4**	**3**

U: user; U: Bariba, Tchabè ; U2: Bariba, Wama, Otamari; U3: Wama; U4: Wama; U5: Idaïtcha, Adja; U6: Wama, Otamari, Pila-Pila; U7: Tchabè, Lopka; U8: Otamari, Wama, Yom; U9: Otamari, Wama, Idaïtcha.

Table 7. Differences among producers groups of *J. tenella* (C1 to C5) and *S. radiatum* (G1 to G5) for the variable planting spacing, height of cutting, numbers of days to 1st harvest, cutting frequency and length of cutting.

Species	CL	Planting spacing (cm)	Height of cutting (cm)	Length of cutting (cm)	CF (days)	ND
J. tenella	C1	56.87±25.06[a]	15.76±5.52	18.83±2.04	15±3	31±3
	C2	36.62 ±09.08[a]	15.62 ±5.62	14.42±3.50	14±3	30±1
	C3	25.00±00.00[ab]	18.00±0.00	18.00±0.00	21±0	30±0
	C4	17.43±11.74[b]	11.87±2.96	12.00±0.00	15±1	35±5
	P	*< 0.0001*	*0.059*	*0.07*	*0.03*	*0.001*

Table 7. Contd.

S. radiatum	G1					
	G2	77.33 ±11.54[a]	15.00 ±0.00	-	-	37 ±0
	G3	27.50±3.53[b]	10.00±0.00	-	16±2	32±0
	G4	32.67±8.64[b]	13.77±2.69	-	15±1	30±1
	G5	-	13.20±3.96	-	16±2	30±1
	P	*< 0,0001*	*0.27*	-	*0.02*	*0.002*

CL: Cluster ; CF: cutting frequency; ND: number of days to 1st harvest.

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