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## Selection of sites for the *in situ* conservation of four traditional leafy vegetables consumed in Benin

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### ABSTRACT

*Acmella uliginosa*, *Ceratotheca sesamoides*, *Justicia tenella* and *Sesamum radiatum* are four traditional leafy vegetables which are widely consumed in Benin. In order to document their origin, folk nomenclature, geographical distribution and ecology and to select adequate zones for *in situ* conservation of their genetic resources, 118 villages were randomly selected and surveyed throughout the country using a participatory research approach. All the species apart from *Ceratotheca sesamoides* were reported by farmers as introduced in Benin at different periods. The folk nomenclature comprising 93 different names is based on nine key criteria of variable frequencies according to the species. The geographical distribution maps revealed that the species under study are unequally distributed. Indeed, *A. uliginosa* is found exclusively in the northwest, *J. tenella* in the northeast and partially in the centre while *S. radiatum* and *Ceratotheca sesamoides* were found almost everywhere in Benin. Results from multivariate analysis combined with geographical distribution maps of the species and the soil and climate maps of Benin, led to the selection of the Northwest and of the Northeast regions as the appropriate conservation zones for the four species. Molecular analysis was recommended as it can help in describing genetic diversity and consequently in identifying additional sites for the widely spread species *Sesamum radiatum* and *Ceratotheca sesamoides*.

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**Keywords:** Folk nomenclature, biodiversity, geographical distribution, site selection, *in situ* conservation, Benin.

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### INTRODUCTION

Traditional Leafy Vegetables (TLVs) are plants whose leaves (including immature

green pod and flowers) are socially accepted, used and consumed by the local populations (Dansi et al., 2008a). They are rich in fibres,

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vitamins and minerals such as carotene (provitamin A), ascorbic acid, riboflavin, iron, iodine, calcium, etc. (Chweya and Eyzaguirre, 1999; Odhav et al., 2007; Mensah et al., 2008). In addition to their high concentration in micronutrients, vegetables provide little dietary energy, making them valuable in energy limited diets. The fibre they content has been reported to have beneficial effects on blood cholesterol and aids in the prevention of large bowel diseases, while in diabetic subjects, they improve glucose tolerance (Odhav et al., 2007; Mensah et al., 2008). Throughout the world and in West Africa in particular, quite a large number of TLVs have long been known and reported to have health protecting properties and uses (Odhav et al., 2007; Mensah et al., 2008; Chweya and Eyzaguirre, 1999; Shippers, 2002; Abukutsa-Onyango, 2004; Francisca and Eyzaguirre, 2007; Dansi et al., 2008a, 2009a).

In Benin, TLVs occur as cultivated and semi-cultivated crops or weedy and wild plants, with ecological, social and cultural values, playing a significant role in the daily food and nutritional requirements of local people not only in rural areas, but also and increasingly in urban areas. A biodiversity inventory and documentation survey recently conducted on traditional leafy vegetables throughout the country revealed a total of 187 plant species belonging to 141 genera and 52 families (Dansi et al., 2008a, 2008b, 2009a). Out of the species inventoried, 18 having local and/or national importance were identified, among which *Acmella uliginosa* (L.) Jansen, *Ceratotheca sesamoides* Endl., *Justicia tenella* (Nees) T. Anderson and *Sesamum radiatum* L. were found to be of paramount interest. Indeed, *Acmella uliginosa* is used as a nutraceutical and believed, apart from its nutritional value, to bear special medicinal properties. It is a medicine which facilitates the elimination of blood clots in women after delivery and stimulates milk production with breast-feeding mothers (Dansi et al., 2008a). Contrary to the seasonally used leafy vegetables, *Sesamum radiatum* and *Ceratotheca sesamoides* are available all year

round. The first one is cultivated and the second one is harvested from the wild but both of these species can be collected at the time of plenty, sun dried, stored in traditional containers such as gourds and further used when needed. Moreover, these two TLVs are known, to give stoutness and facilitate good growth, dentition and bones' solidification in children when regularly consumed (Dansi et al., 2008a). *Justicia tenella*, although with no reported medicinal value, is widely cultivated in home gardens and consumed mainly in the Bariba cultural area which spreads over one third of the country.

In order to promote the production, domestication, conservation, marketing and utilization of these four species of high nutritional/medicinal importance for the local communities, a multidisciplinary and multi-institutional research project has been recently launched by the University of Abomey-Calavi (UAC). The present study was undertaken in order to:

- Document their origin and understand their folk nomenclature,
- Draw their geographical distribution maps and clearly describe their ecology,
- Select appropriate zones for the *in situ* conservation of the genetic resources of these species.

## MATERIALS AND METHODS

### Presentation of the study zone

The present study was implemented in the Republic of Benin, situated in West Africa between latitudes 6°10' and 12°25' and longitudes 0°45' and 3°55'. The profile of the country is an undulating plateau except for a few scattered hills in the centre and the north. The altitude varies from sea level to 400-650 m in the northwest, where the Atacora chain is the outstanding feature. Four major groups of soils can be distinguished, according to Adam and Boko (1993): (1) ferrallitic soils covered by semi-deciduous forest, (2) ferruginous soils covered by dry forest, woodland, and savannah, (3) vertisols in the depression of Lama covered by a particular type of semi-

deciduous forest, and (4) hydromorphic soils covered by swamp and riparian forest.

The average annual rainfall varies from 900 to 1300 mm. Its lowest values (900-950 mm) are recorded in the southwest and in the far north. The highest rainfalls (1200-1300 mm) are confined to southeast Benin along the Bassila-Djougou tract. The average annual temperature ranges from 26 to 28 °C and can exceptionally reach 35-40 °C in some northern localities such as Kandi and Malanville. As in most West-African countries, the climate is primarily determined by the annual cycle of the "Inner Tropical convergence Zone" (ITCZ). Three climates zones can broadly be distinguished (Akoègninou et al., 2006): (1) From the coast up to 7°-7°30'N, the climate is subequatorial with two rainy seasons alternating with a long dry season (December-February), and a short dry season (July-August), which rarely exceeds two months, (2) Between the latitudes 7°-7°30' and 9°, the climate becomes subhumid or subsudanian with a tendency to a pattern made of one rainy season and one dry season, (3) The northern section is characterised by a Sudanian climate with a unimodal rainfall regime. The type of this Sudanian climate encountered in the northwest is called Atacorian climate (Akoègninou et al., 2006).

Benin's southern part belongs to the Dahomey gap, which is the dry wedge that separates the West African rain forest belt into the upper Guinea and Lower Guinea /Congolian Forest Blocks (White 1993). As a result, this part of the country (from the coast up to c. 7°30'N) consists of savannah, grassland, farmland, and fallow intermingled with small islands of closed forest (semi-deciduous and swamp forests). From ca. 7°30'N to 12°25'N, the natural vegetation is essentially made of a patchwork of a woodlands and savannahs with belts of riparian forest along rivers.

#### Sites selection and survey

In order to draw a concise geographical distribution of a plant species at the country level, a great number of villages

located in different agroecological zones and spread out all over the country should be considered. For these reasons, 118 villages (Table 1) belonging to diverse ethnical and agro-ecological (humid, semi arid, arid) zones (Dansi et al., 2008a, 2009a) were randomly selected and surveyed (Figure 1). Data were collected during expeditions to different sites, through the application of Participatory Research Appraisal tools and techniques such as direct observation, group discussions, individual interviews and field visits using a questionnaire, according to Kamara et al. (1996), Defoer et al. (1997), Chweya and Eyzaguirre (1999), Adoukonou-Sagbadja et al. (2006) and Dansi et al. (2008a, 2008b, 2009a). Interviews were conducted with the help of interpreters from each area. As TLVs are mainly a women's affair; women local organisations were involved in the study in each site, in order to facilitate precise data collection. Prior to group meeting, farmers were requested in advance to bring samples of the species under study and, if any, samples of their known diverse forms. Specific information about 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. Then, farmers were asked to display the different types of the species and their variability as known in their village if any. Through discussion, key information was recorded on each one of the species under study. These are: vernacular name and meaning, origin, preferred habitat, intraspecific diversity and specific uses (known medicinal properties). Field (home gardens, cultivated fields, bushes, shallows) visits were organised in order to observe the plant species under cultivation or in their natural habitat.

#### Data analysis

Data were analysed through descriptive statistics (frequencies, percentages, means, etc.) in order to generate summaries and tables at different levels. To analyse the relationship between villages in

**Table 1:** List of the selected sites surveyed and their geographical localisation.

N°	Village names	Village code	Geographical localisation	
			Region	District
1	Agbodjèdo	S10	Sud	Allada
2	Aglamidjodji	C15	Centre	Savalou
3	Agonli-houègbo	C19	Centre	Zangnanado
4	Akaradè	W22	Northwest	Bassila
5	Akongbé	C5	Centre	Savè
6	Alédjo	W36	Northwest	Bassila
7	Aplahoué	S20	Sud	Aplahoué
8	Atawignan	S15	Sud	Adja-ouèrè
9	Azowlissè	S11	Sud	Adjohoun
10	Badékprou	E25	Northeast	Parakou
11	Badjoudè	W18	Northwest	Ouaké
12	Banon	C3	Centre	Bantè
13	Bassila	W21	Northwest	Bassila
14	Béké	W32	Northwest	Pehounko
15	Belléfoungou	W12	Northwest	Djougou
16	Bensékou	E30	Northeast	Kandi
17	Bétérou	E18	Northeast	Tchaourou
18	Birni	W33	Northwest	Copargo
19	Bodi	W20	Northwest	Bassila
20	Bodjékali	E5	Northeast	Malanville
21	Boké	E12	Northeast	Sinendé
22	Bonou	S14	Sud	Bonou
23	Borodarou	E10	Northeast	Gogounou
24	Borondy	W11	Northwest	Djougou
25	Copargo	W35	Northwest	Copargo
26	Cotiakou	W6	Northwest	Tanguiéta
27	Dassari	W25	Northwest	Materi
28	Déwa	W15	Northwest	Djougou
29	Djaloukou	C7	Centre	Savalou
30	Djougou	W14	Northwest	Djougou
31	Doutou	S26	Sud	Houéyogbé
32	Dré	S7	Sud	Houéyogbé
33	Ewè	S19	Sud	Kétou
34	Fita	C8	Centre	Dassa
35	Foli	C20	Centre	Zakpota
36	Foumbéa	W13	Northwest	Djougou
37	Galata	C14	Centre	Bantè
38	Gbassa	E3	Northeast	Banikoara
39	Gbélito	S4	Sud	Aplahoué
40	Gbèssaka	E8	Northeast	Ségbana

41	Gokanna	E20	Northeast	Tchaourou
42	Gomé-ifada	C13	Centre	Glazoué
43	Goro	E21	Northeast	Tchaourou
44	Goumarou	E11	Northeast	Gogounou
45	Goungoun	E7	Northeast	Kandi
46	Gouroubéri	E27	Northeast	Karimama
47	Guéné	E6	Northeast	Malanville
48	Houébossou	S13	Sud	Lokossa
49	Hounti	S12	Sud	Lokossa
50	Idadjo	C2	Centre	Ouèssè
51	Ifangni	S25	Sud	Ifangni
52	Illara	S21	Sud	Kétou
53	Illikimou	S22	Sud	Kétou
54	Ita akadi	S17	Sud	Sakété
55	Kalalé	E17	Northeast	Kalalé
56	Kassakpéré	E26	Northeast	Nikki
57	Kawado	W17	Northwest	Ouaké
58	Konkondji	C16	Centre	Savalou
59	Korontière	W3	Northwest	Boukoumbé
60	Kossou-Ouinra	W39	Northwest	Pehounko
61	Kouandé	W29	Northwest	Kouandé
62	Koundokpoé	S3	Sud	Comè
63	Koupagou	W1	Northwest	Natitingou
64	Koussoukoingou	W30	Northwest	Natitingou
65	Koutagou	W23	Northwest	Natitingou
66	Koutakourkou	E29	Northeast	Kandi
67	Kpankou	C18	Centre	Kétou
68	Kpanroun	S1	Sud	Abomey-calavi
69	Kparou	E13	Northeast	Tchaourou
70	Kpassabéga	W34	Northwest	Kopargo
71	Lahotan	C17	Centre	Savalou
72	Lou	E15	Northeast	Kalalé
73	Louho	S24	Sud	Porto-Novo
74	Madémahoué	S8	Sud	Come
75	Magoumi	C12	Centre	Glazoué
76	Malanville	E4	Northeast	Malanville
77	Manigri	W38	Northwest	Bassila
78	Minifi	C10	Centre	Dassa-Zoumè
79	Monkassa	E28	Northeast	Malanville
80	Montèwo	C4	Centre	Savè
81	Nafayaoti	W27	Northwest	Tanguiéta
82	Naogon	S23	Sud	covè
83	Naougou	W2	Northwest	Cobly
84	Niaro	W31	Northwest	Kouandé

85	Odo mèta	S18	Sud	Kétou
86	Okounfo	C11	Centre	Save
87	Okoutaossé	C1	Centre	Bantè
88	Ouari Maro	E19	Northeast	N'Dali
89	Ouèdèmè adja	S6	Sud	Lokossa
90	Pam-Pam	W10	Northwest	Perma
91	Paouignan	C9	Centre	Dassa-Zoumè
92	Parakou	E23	Northeast	Parakou
93	Pédarou	E14	Northeast	Parakou
94	Pénèssoulou	W37	Northwest	Djougou
95	Péporiyakou	W9	Northwest	Natitingou
96	Pèrèrè	E16	Northeast	Pèrèrè
97	Satiandiga	W24	Northwest	Tanguiéta
98	Sébou	E22	Northeast	Parakou
99	Sèdjè-Dénou	S2	Sud	Abomey-Calavi
100	Ségbana	E9	Northeast	Ségbana
101	Sègbohoulé	S9	Sud	Allada
102	Sèmèrè	W19	Northwest	Ouaké
103	Sinawongourou	E31	Northeast	Kandi
104	Sokouhoué	S5	Sud	Lokossa
105	Sokponta	C6	Centre	Glazoué
106	Sonoumon	E1	Northeast	N'Dali
107	Sooum	W4	Northwest	tanguiéta
108	Tansé	W28	Northwest	Kouandé
109	Tayakou	W7	Northwest	Tanguiéta
110	Tchakalakou	W8	Northwest	Natitingou
111	Tchaourou	E24	Northeast	Tchaourou
112	Tiélé	W5	Northwest	Tanguiéta
113	Toubougnidi	W26	Northwest	Matéri
114	Toumè	E32	Northeast	N'dali
115	Wassa	W16	Northwest	Djougou
116	Wiya	S27	Sud	Grand-Popo
117	Yakassou	E2	Northeast	N'dali
118	Zoungbomè	S16	Sud	Akpro-Misséréte

NB: W: West; C: centre; E: East; S: South

terms of species distribution, surveyed villages (Table 1) were considered as individuals and the vegetable species (*Acmella uliginosa*, *Ceratotheca sesamoides*, *Justicia tenella* and *Sesamum radiatum*) as variables and scored as 1 when present or 0 when absent. Using this methodology, a binary matrix was compiled and used to perform a Principal Coordinate Analysis (PCA) with SAS statistical package (SAS

Institute, 1996). Similarity between species in term of geographical localisation was assessed using Jaccard coefficient of similarity (Jaccard, 1908) computed by NTSYS-pc 2.2 (Rohlf 2000) and a dendrogram drawn using UPGMA cluster analysis of the same program (Sneath and Sokal 1973; Swofford and Olsen 1990). In this analysis, vegetable species were considered as individuals and the villages as

variables and scored as described above. For better understanding of the species' ecology, their geographical distribution maps constructed using MapInfo Professional 8.0 were superimposed on the Benin soils and climate maps following Adam and Boko (1993) and the frequency of the species in diverse ecological zones (number of villages in which the species is found out of the total number of the villages surveyed) were determined.

## RESULTS

### Origins of the species

Out of the four leafy vegetables studied, only the uncultivated species *Ceratotheca sesamoides* is recognised by the farmers as indigenous to the country. According to them, *Justicia tenella*, *Acmella uliginosa* and *Sesamum radiatum* were all introduced to Benin at different periods. *Justicia tenella* was introduced to the northeast of Benin about 60 years ago by the catholic European missionaries while *Acmella uliginosa* and *Sesamum radiatum* were introduced from Togo to the Northwest by Kabiè immigrants, about respectively 10 years and 50 years ago.

### Folk nomenclature

Across the various villages and ethnic groups surveyed, TLVs are identified by specific vernacular names. For the four species investigated, a total of 93 vernacular names were recorded (Table 2). While *C. sesamoides* and *S. radiatum* have the greatest recorded number of vernacular names (29 and 30 respectively), only 15 vernacular names were recorded for *J. tenella* and 19 for *A. uliginosa* (Table 2). The meanings of the vernacular names recorded are compiled in Table 2.

Our analysis revealed the use, across regions, of nine key criteria in naming the four species under study. These are: origin, status of the plant (wild, cultivated), specific habitat, growth habit (creeping or erected), shape of the leaf, taste, easiness of the cooking, type and colour of the sauce (Table 1). While five

criteria were used to name *S. radiatum* and *C. sesamoides*, only two (origin and taste) were applied to *A. uliginosa* and all apart from the growth habit go with *J. tenella*. No vernacular names in relation with origin have been used to designate *C. sesamoides*. Taste is only applied to *A. uliginosa* and *J. tenella* and it appeared, for these species, as the most used criteria. The slimy aspect of the sauce is the most important criterion used to designate *C. sesamoides* and *S. radiatum*. These two morphologically very close species are separated in their naming by two additional key criteria which are the growth habit (*C. sesamoides* is creeping while *S. radiatum* is erected) and the status (*C. sesamoides* is wild while *S. radiatum* is cultivated) of the plant (Table 3).

### Geographical distribution and ecology of the species

The geographical distribution maps of the species (Figures 1) revealed that they are unequally distributed throughout the country. Indeed, *A. uliginosa* (Figure 1) is found almost exclusively in the northwest region (Departments of Donga and Atakora). *J. tenella* occupies the north and the Nago cultural area of the centre of Benin (Figure 1). *S. radiatum* was found almost everywhere in Benin (Figure 1). Apart from the far south where it is absent (Figure 1) *Ceratotheca sesamoides* follows the same geographical distribution as *S. radiatum*.

The superimposition of the geographical distribution maps of the species with both Benin soil and climate maps combined with the frequency of occurrence of the species on each type of soil (Figure 2) or climate (Figure 3) helped to understand their respective ecology. *C. Sesamoides*, although present everywhere, mostly occurs on ferralitic and ferruginous soils (Figure 2) and in Sudanian and Atacorion climates (Figure 3). In almost all the villages surveyed, this species was reported to be closely linked to lateritic soils and some of its vernacular names (Table 2) even refer to this particular habitat. *S. radiatum* is found on all the types

**Table 2:** List of the vernacular names recorded per species and their meaning.

Species	Vernacular names	Ethnic groups	Meaning of vernacular names
<i>Ceratotheca sesamoides</i>	Abiwèrè	Tchabè	-
	Agbô	Idatcha, Mahi, Goun, Fon	Slimy vegetable
	Assôworou	lamba	Slimy vegetable of hare
	Dowoungbaana	Boko	Vegetable of rocky zones
	Féiyôtô	Dendi	Slimy vegetable
	Gandaföi	Dendi	Creeping vegetable
	Gnankassounwari	Bariba	Wild vegetable
	Goufounin	Ani	Slimy vegetable
	Idjabô	Tchabè	Slimy vegetable
	Issé	Mokolé	Slimy vegetable
	Kasankpokpo	Foodo	Slimy creeping vegetable
	Koufohangou	Gangamba	Wild slimy and creeping vegetable
	Koumonkou ilè	Fè	Slimy creeping vegetable
	Kpééwari	Bariba	Slimy creeping vegetable
	Kpééwori	Bariba	Slimy creeping vegetable
	N'zoti adènin	Kotokoli	Creeping and slimy vegetable
	Nonman	Wama	Slimy vegetable
	Nonpoéa	Wama	White slimy vegetable
	Nôr	Pila pila	-
	Siwadouanwé	Ditamari	-
	Taalè hounnoum	Lokpa	Wild Slimy vegetable
	Tanonman	Wama	Creeping and slimy vegetable
	Toohoun	Berba	Slimy vegetable
	Toopouôguè	Berba	White and slimy vegetable
	Toossibouhoun	Berba	Black and slimy vegetable
	Wôri	Bariba	Slimy vegetable
	Wôrigbéégui	Bariba	Wild vegetable
	Woriyô	Peulh	-
	Yoodo	Dendi	Slimy vegetable
	<i>Sesamum radiatum</i>	Agbôè	Aizô
Agbon		Adja	Slimy vegetable
Agbôté		Idatcha	Erect slimy vegetable
Anansara foïto		Dendi	Slimy sauce of white people
Dossé		Tchabè	-
Dossi / Dossiguia		Bariba	-
Dossiyô		Peulh	-
Dossila		Boko	Black vegetable
Féiyôtô		Dendi	Slimy vegetable
Gooloo		Tchabè	-
Gousséninfounin		Ani	Slimy vegetable prepared with potash
Koumalo odoussè		Foodo	Slimy cultivated vegetable
Koumalo oyélissè		Foodo	Erect Slimy vegetable
Koumankoun akô		Fè	Male Slimy vegetable



	Kounanhangou	Gangamba	Slimy vegetable of the people Kabiè
	Koussèlomsôgou / Koussèlomsô	Gnindé	Black slimy vegetable
	Lakouta	Dendi	-
	N'zoti koudouté	Kotokoli	Cultivated slimy vegetable
	Ningbô	Mahi	-
	Nonbotaman	Wama	Slimy and cultivated vegetable
	Nonmanwon	Yom	-
	Okoukou	Holi	Slimy vegetable
	Sôka wourou	Lamba	Slimy vegetable like sesame
	Tankantohoun	Berba	Slimy vegetable of wama ethnic group
	Tébonon	Bariba	-
	Titamanwadouanti	Ditamari	Slimy vegetable of Ditamari people
	Touhounnoum	Lokpa	Slimy vegetable of elephant
	Touwadouanti	Ditamari	Slimy vegetable of elephant
<i>Acmella uliginosa</i>	Anansaara kalowao	Lokpa	<i>Zanthoxylum xanthoxyloides</i> of white people
	Boubouô	Ditamari	Vegetable of pepper taste
	Boupèbouô	Ditamari	White people's pepper
	Bourdierikè	Berba	-
	Didakomfroubiali	Gangamba	<i>Zanthoxylum xanthoxyloides</i> of Ditamari's ethnic group
	Djidja koumalo	Foodo	Slimy vegetable of elephant
	Gaatam migaate	Peulh	-
	Kablè koulmawô	Foodo	Spice of Kabiè's ethnic group
	Kalwôou	Lamba	-
	Kpékpéraboubou	Berba	-
	Kpéssèbohaa	Yom	-
	Lôwôlôkpè	Holi	It's on the hands it takes a long time
	Otomkalouwè	Ani	Vegetable of <i>Zanthoxylum xanthoxyloides</i> ' taste
	Oulakombouonou	Yindé	-
	Sãanakupãwôgô	Pila pila	White people's <i>Zanthoxylum xanthoxyloides</i>
	Tanwou-wouroussouguia	Bariba	-
	Yèyèca	Kotokoli	Taste like pepper
	Yoritampobou	Wama	Yoruba vegetable of pepper taste
	Yowaboukpé	Bariba	Vegetable of Ditamari ethnic people
<i>Justicia tenella</i>	Agbadoudou	Kotokoli ; Foodo	Delicious vegetable
	Atchélikéma	Ani	Atchélé tree's vegetable
	Bôwénou	Bariba	-
	Dimouniountchoro	Wama	Woman eat and forget to serve her husband
	Djagudjagu	Fè, Tchabè	Eat fufu (pounded yam)
	Djègoudjègou	Idatcha	Eat fufu (pounded yam)
	Gnonwonko	Bariba	-
	Kourôkountônu	Bariba	The woman is not the man

Parbatoukpékpéya	Wama	Hard leaves
Saligaman	Saxwè	Haoussa ethnic group 's vegetable
Tchakou tchakou	Lamba	-
Tikounsooti	Ditamari	Black vegetable
Tilétoussi	Lokpa	Vegetable of termites
Tipèwadouanti	Ditamari	Slimy vegetable of white people
Tokpélé	Saxwè	-

of Benin soils and climates (Figures 2 and 3). *A. uliginosa* and *J. tenella* are all associated with the ferralitic and ferruginous soils and with the Sudanian and Atacorien climates of the northern Benin.

#### Selection of zones for *in situ* conservation

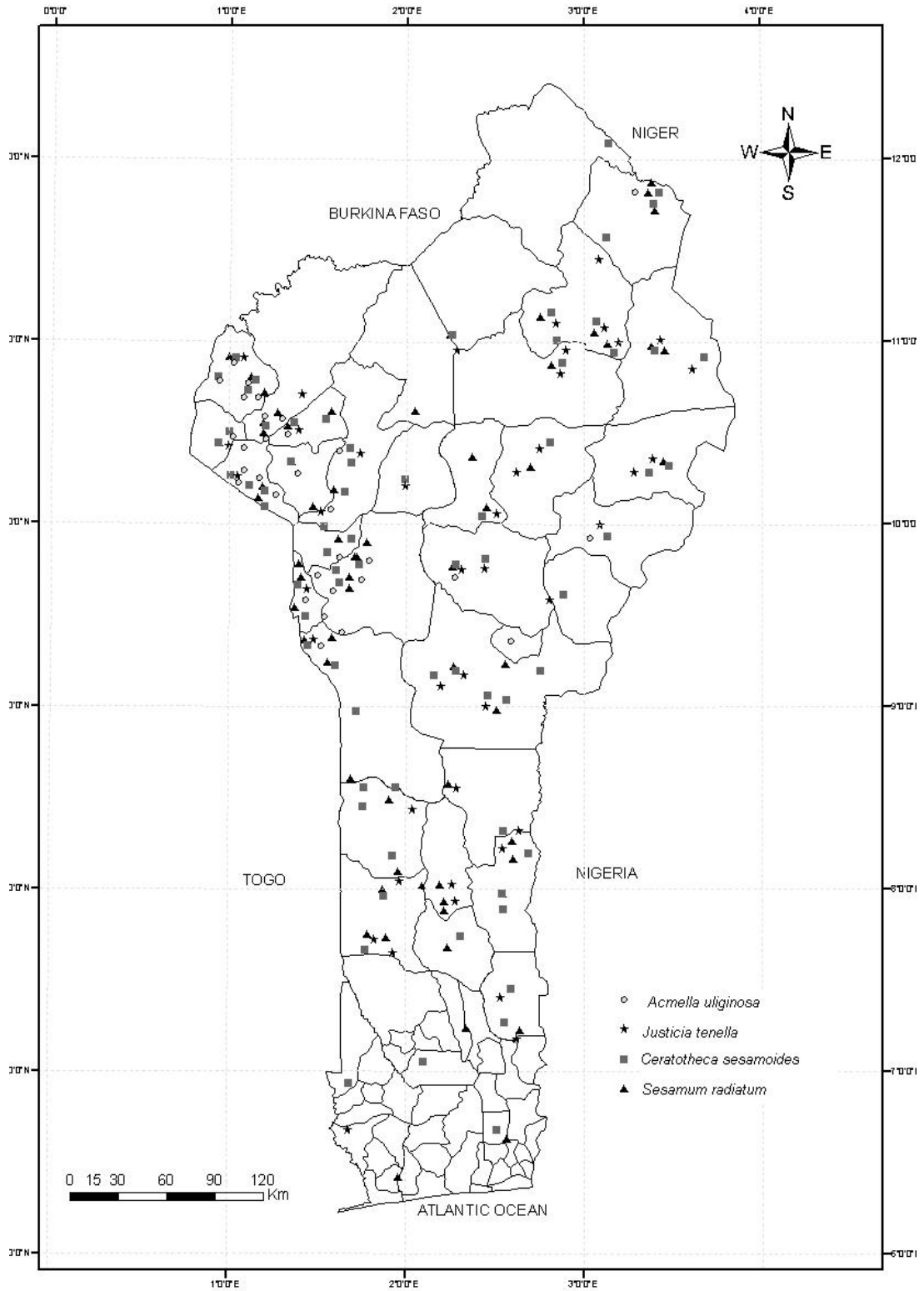
The Principal Coordinate Analysis (PCA) carried out to analyse the relationships between surveyed villages in term of species distribution led to four groups, namely G1, G2, G3 and G4 (Figure 4). G1 gathers villages (almost all of the northwest) in which, *A. uliginosa* was found. G2 is the group of *J. tenella*. This particular group assembles villages in which *J. tenella* is associated with *C. cesamoides* and *S. radiatum*. Groups 3 and 4 identify *S. radiatum* and *C. Cesamoides* respectively. At 75% of similarity on the dendrogram (Figure 5) which was designed to assess the resemblance between species in term of geographical distribution, *C. cesamoides* and *S. radiatum* were found to cluster together. Moreover, they appeared as isolated from *J. tenella* and *A. uliginosa*. Geographical distribution of the species combined with multivariate analysis led to the selection of two regions for the *in situ* conservation of the genetic resources of the species. These are the Northwest for *A. uliginosa* in association with the couple *C. cesamoides* and *S. radiatum* and the Northeast for *J. tenella* together with the same couple.

#### DISCUSSION

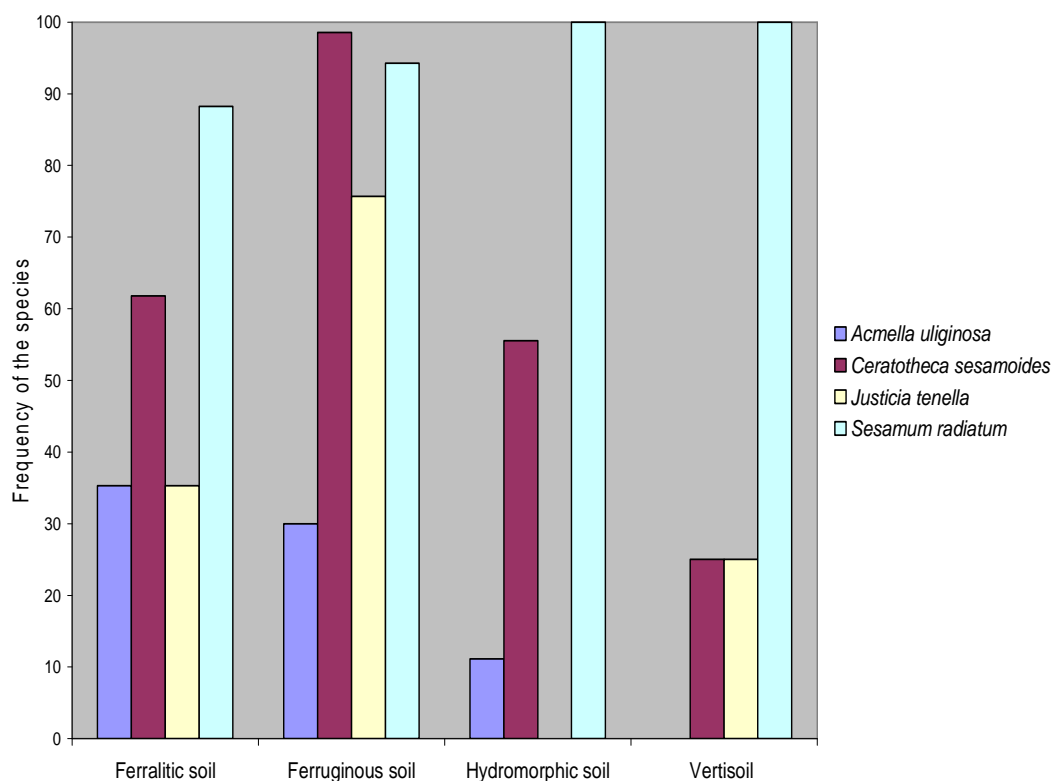
All the species under study, apart from *Ceratotheca sesamoides*, were reported as introduced in Benin. Although farmers uphold the thesis of the introduction of *Justicia tenella* in Benin, its area of origin remains unclear. The species is still not

described yet in the PROTA database (www.prota.org) and it is therefore difficult to hypothesise on its origin and history. *Acmella uliginosa* and *Sesamum radiatum* effectively exist in Togo and their local geographical localisations, as reported by Batawila et al. (2007), is in agreement with reports from Beninese farmers. The introduction of species or crop varieties from one country to another via the cross border communities is frequent. In Benin, it has been already reported for many crops including fonio (Adoukonou-Sagbadja et al., 2006; Dansi et al., 2009b), yam (Dansi et al., 1999; Dumont and Vernier, 2000; Mignouna and Dansi, 2003) and leafy vegetables (Dansi et al., 2008a).

Various vernacular names are used to designate the species. Among the 93 vernacular names recorded (Table 2), 24 were already reported by Dansi et al. (2009a). The analysis of the meanings of vernacular names compiled in Table 2 confirms the existence of various scenario which are specific to folk nomenclature (unexplained names, synonymy, homonymy, semantic, same name across ethnic area, singular and plural) as reported by Mekbib (2007) on sorghum and Dansi et al. (2009a) on TLVs. The fact that no vernacular names in relation with origin have been used to designate *C. sesamoides* was expected as *C. sesamoides* is indigenous and growth in the wild (Akoègninou et al., 2006; Dansi et al., 2009). Taste is the most used criteria in naming *A. uliginosa* and *J. tenella*. According to the farmers, *A. uliginosa* has a particular spicy taste similar to the one of the root's bark of *Zanthoxylum xanthoxyloides*. One understands why almost all the vernacular names of this species refer to the taste of *Zanthoxylum* root's bark (Pepper taste) and to its foreign origin as described above (Table 2). In the northern regions, both species are rather used as nutraceuticals for the same



**Figure 1:** Geographical distribution map of *Acmella uliginosa*, *Ceratotherca sesamoides*, *Justicia tenella* and *Sesamum radiatum* in Benin.

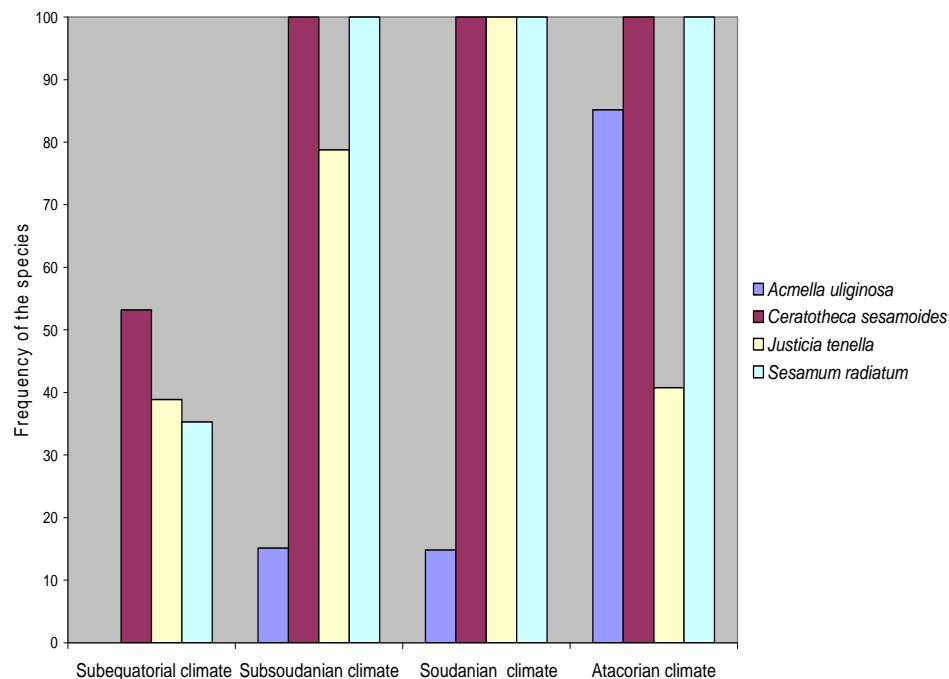


**Figure 2:** Frequency of the species on different Benin soils.

**Table 3:** Naming criteria and their importance per species.

Criteria	<i>C. sesamoides</i> (%)	<i>S. radiatum</i> (%)	<i>J. tenella</i> (%)	<i>A. uliginosa</i> (%)
Origin	-	10.52	12.5	46.66
Taste	-	-	50	53.34
Aspect of the sauce	60.86	55.26	6.25	-
Status of the plant	10.86	18.42	6.25	-
Specific habitat of the plant	02.17	-	6.25	-
Growth habit	19.56	7.89	-	-
Colour of the sauce	6.52	7.89	6.25	-
Shape of the leaf	-	-	6.25	-
Easiness of the cooking	-	-	6.25	-

**N.B.:** For a given species and criterion, value in the table represents percentage of vernacular names based on the criteria.

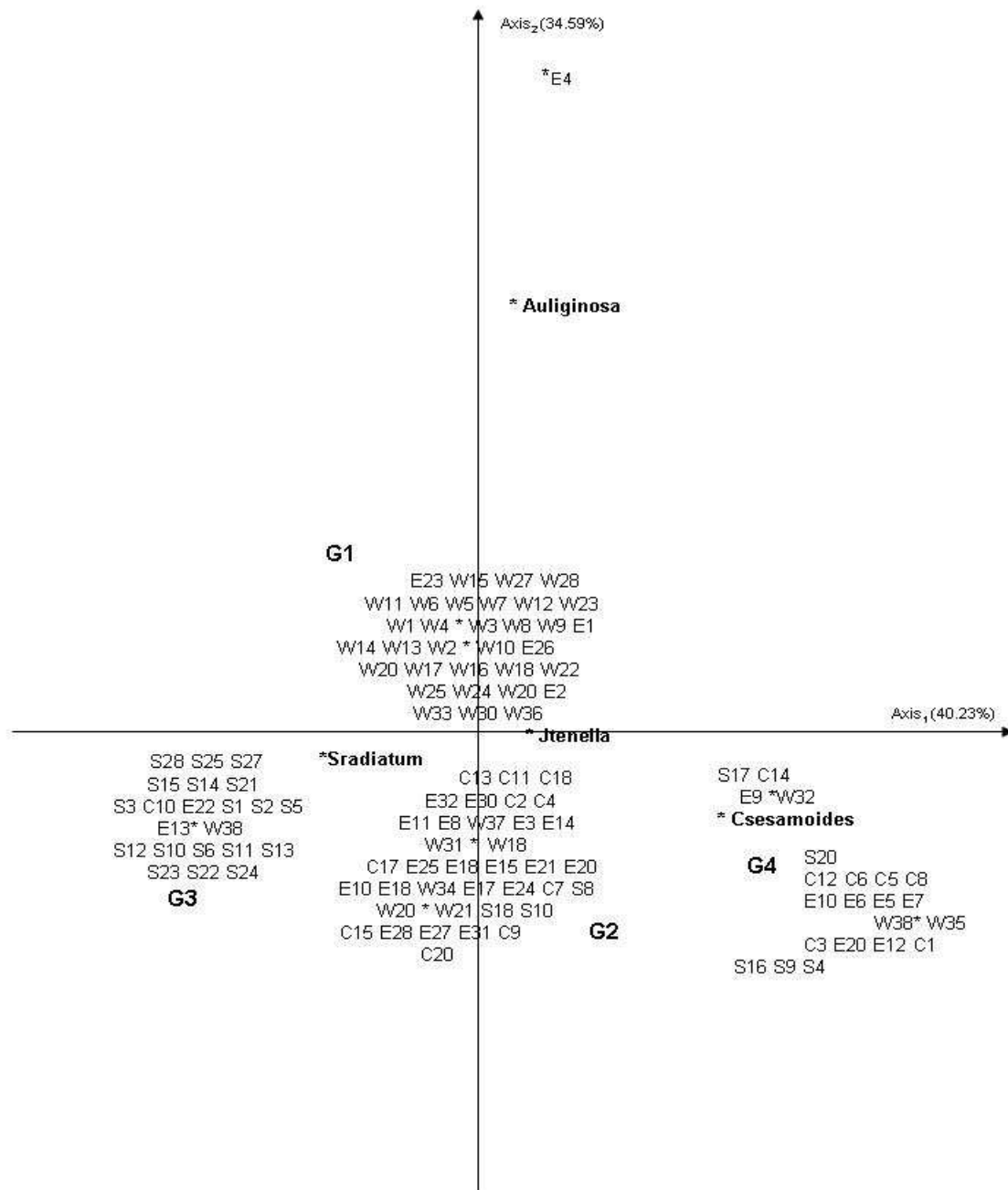


**Figure 3:** Frequency of the species on different Benin climates.

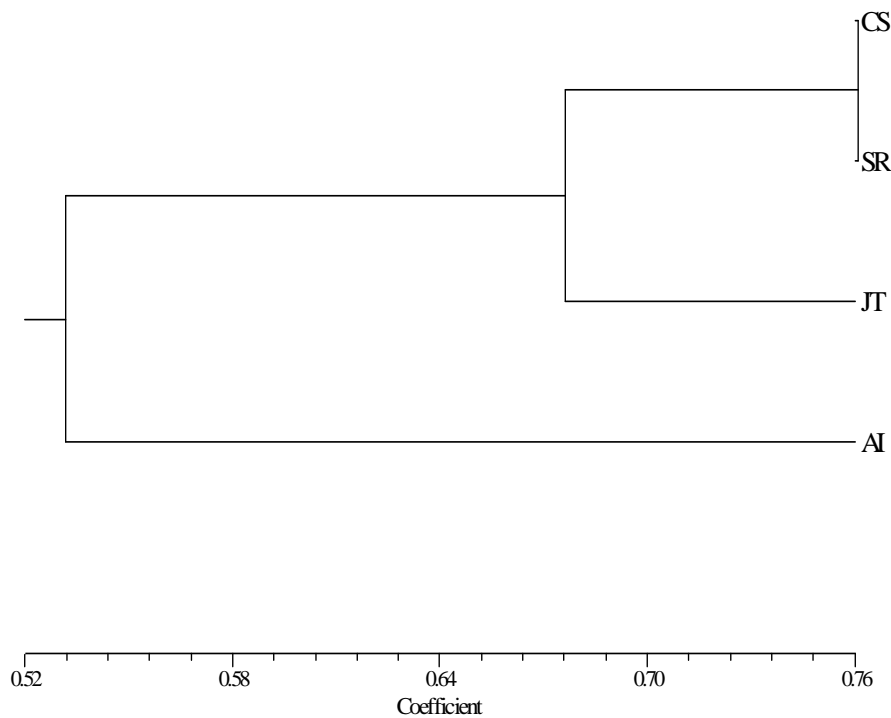
purposes (Akoègninou et al., 2006; Dansi et al., 2008a). In the case of *J. tenella* the taste really refers to the deliciousness of its sauce which most frequently brings women (as reported by interviewed men) to eat all and therefore forget to reserve a part for their husbands. Its vernacular names Dimouni-n'tchoro and Kourôkountonnou which literally mean "a woman has forgotten to give to her husband" and "a woman is not a man" in Wama and Bariba languages respectively are in agreement with the men's statement. As reported by many authors (Brush 1980; Brush et al., 1981; Alcorn 1984; Hernandez 1985; Maxted et al., 1997; Brush, 2000; Tuan et al., 2003) the understanding of folk nomenclature of these species helps in identifying their importance and distribution and consequently in developing appropriate *in situ* conservation strategies.

As revealed by the geographical distribution map, the four species under study are unequally distributed throughout the country. According to farmers, the presence of

*Acmella uliginosa* in some places in the northeast (Parakou, Malanville, Sonoumon and Kassakpèrè) is linked to the migration of some Ditamari farmers from the northwest in the search of labour opportunities. The fact that this species is sold exclusively by the Ditamari women in the local markets of these localities confirms this hypothesis. *J. tenella* which was firstly known and used by the Bariba people of the northeast has rapidly diffused toward the northwest and the centre. The historic mixture and the remarkable integration of the Nago and Bariba communities in the transition zone of Tchaourou have surely contributed to its quick adoption as a leafy vegetable by Nago people. The absence of the species in the Mahi cultural area though surrounded by Nago was surprising and needs further investigation. The results obtained in this study with regard to the ecology (soil and climate) of *C. sesamoides* and *Sesamum radiatum* are in agreement with those reported by Bedigian (2004) and Batawila et al. (2007). *A. uliginosa*



**Figure 4:** Principal Coordinate Analysis showing the dispersion of the surveyed villages with regard to the presence of the species under study. Villages grouped together are similar by the species they contain.



**Figure 5:** UPGMA dendrogram based on Jaccard coefficient of similarity showing the grouping of the species. CS (*Ceratotheca sesamoides*), SR (*Sesamum radiatum*), JT (*Justicia tenella*), AI (*Acmella uliginosa*).

is actually in progression towards the centre, the south and the northeast. It is also the case of *J. tenella* which is in progression towards the south. For these two cultivated species, it is too early to conclude on their final distribution and ecology mainly because of their continuous spread.

The results of the multivariate analysis combined with the geographical distribution of the species have led to the selection of the northwest and of the northeast for the *in situ* conservation of the genetic resources. However, as *C. cesamoides* and *S. radiatum* are not distributed only in the north, their adaptability to various agro-ecological zones could also reflect some fractionation of their respective total genetic diversity. Therefore, a further genetic diversity assessment using molecular markers is required for the

estimation of genetic diversity and the selection of adequate conservation sites for these two species as it was the case for *Dioscorea abyssinica* (Agbangla et al., 2007), *Digitalis obscura* (Nebauer et al., 1999) and *Asimina triloba* (Huang et al., 2000). Following Maxted et al. (1997), two to three sites should be chosen within selected regions as conserving diversity in many sites is not only more reassuring but highly recommended.

### Conclusion

The present study revealed that the four species under study are unequally distributed throughout the country and are preferentially linked to diverse soils and climates. Therefore, more than one zone will be required to preserve genetic resources *in*

*situ*. Based on both distribution maps and multivariate analysis, Northwest and Northeast regions were selected as appropriate conservation zones for *A. uliginosa* and *J. tenella* respectively. At the same time, these two zones will also help to conserve *S. radiatum* and *C. sesamoides* which are present almost everywhere in Benin. Because of the wide adaptability of these two closely related species to various agro-ecological zones, the existence of a well structured but hidden intra-species genetic diversity has been hypothesized. Estimating this genetic diversity using molecular markers such as AFLP will be useful in decision making with regard to the selection of additional *in situ* conservation sites.

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#### REFERENCES

- Abukutsa-Onyango MO. 2004. *Crotalaria brevidens* Benth. In *Plant Resources of Tropical Africa 2. Vegetables*, Grubben GJH, Denton OA (eds). Backhuys Publishers: Leiden, Wageningen/CTA, Netherlands; 229-231.
- Adam S, Boko M. 1993. *Le Bénin*. Les Editions du Flamboyant / EDICEF.
- Adoukonou-Sagbadja H, Dansi A, Vodouhè R, Akpagana K. 2006. Indigenous knowledge and traditional conservation of Fonio millet (*Digitaria exilis* Stapf, *Digitaria iburua* Stapf) in Togo.

*Biodiversity and Conservation*, **15**: 2379-2395.

- Agbangla C, Dansi A, Ahanhanzo C, Alavo TBC, Daïnou O, Tostain S, Scarcelli N, Pham J-L. 2007. Assessment of genetic diversity within and between populations of *Dioscorea abyssinica* Hochst. ex Kunth of northern Benin using AFLP (Amplified Fragment Length polymorphism) markers. *Annales des Sciences Agronomiques du Bénin*, **9**(1): 43-55.
- Akoègninou A, Van der Burg WJ, Van der Maesen LJG. 2006. *Flore Analytique du Bénin*. Backhuys Publishers: Netherlands.
- Alcorn JB. 1984. *Huastec Mayan Ethnobotany*. Austin, Univ. Press : Texas.
- Batawila K, Akpavi S, Wala K, Kanda M, Vodouhè R, Akpagana K., 2007. Diversité et gestion des légumes de cueillette au Togo. *AJFAND*, **7**(3): 1-16.
- Bedigian D. 2004. Slimy leaves and oily seeds: Distribution and use of wild relatives of sesame in Africa. *Economic Botany*. **58**: 3-33.
- Brush SB, Carney HJ, Haumam Z. 1981. Dynamics of Andean potato agriculture. *Economic Botany*, **35**: 70-85.
- Brush SB. 1980. Potato taxonomies in Andean agriculture. In *Indigenous Knowledge Systems and Development*, Brokensha DW, Warren DM, Werner O (eds). University Press of America: New York; 37-47.
- Brush SB. 2000. *Genes in the Field*. Lewis Publishers: United Kingdom.
- Chweya JA, Eyzaguirre P. 1999. *The Biodiversity of Traditional Leafy Vegetables*. IPGRI Publication: Italy.
- Dansi A, Adjatin A, Adoukonou-Sagbadja H, Adomou A, Faladé V, Yedomonhan H, Akpagana K, de Foucault B. 2009a. Traditional leafy vegetables in Benin: Folk nomenclature, species under threat and domestication. *Acta Botanica Gallica*, **156**(2): 183-1999.



- Dansi A, Adjatin A, Adoukonou-Sagbadja H, Faladé V, Yédomonhan H, Odou D, Dossou B. 2008a. Traditional leafy vegetables and their use in Benin Republic. *Genetic Resources and Crop Evolution*, **55**: 1239-1256.
- Dansi A, Adoukonou-Sagbadja H, Vodouhè R. 2009b. Diversity, conservation and related wild species of Fonio millet (*Digitaria* spp.) in the northwest of Benin. *Genetic Resources and Crop Evolution* (submitted).
- Dansi A, Mignouna HD, Zoundjhekpou J, Sangare A, Asiedu R, Quin FM. 1999. Morphological diversity, cultivar groups and possible descent in the cultivated yams (*Dioscorea cayenensis-Dioscorea rotundata* complex) of Benin Republic. *Genetic Resources and Crop Evolution*, **46**: 371-388.
- Dansi, A, Adjatin A, Adoukonou-Sagbadja H, Akpagana K. 2008b. Production and traditional seeds conservation of leafy vegetables in Benin rural areas. *Bulletin de la Recherche Agronomique du Benin*, **59**: 59-70.
- Defoer T, Kamara A, de Groove H. 1997. Gender and variety selection: farmers' assessment of local maize varieties in southern Mali. *African Crop Sciences Journal*, **5**(1): 65-76.
- Dumont R, Vernier PH. 2000. Domestication of yams (*Dioscorea cayenensis-rotundata*) within the Bariba ethnic group in Benin. *Outlook on Agriculture*, **29**(2): 137-142.
- Francisca IS, Eyzaguirre P. 2007. African leafy vegetables: their role in the world health organization's global fruit and vegetables initiative. *AJFAND*, **7**(3): 1-17.
- Hernandez XE. 1985. Maize and man in the greater southwest. *Economic Botany*, **39**(4): 416-430.
- Huang HW, Layne DR, Kubisiak TL. 2000. RAPD inheritance and diversity in pawpaw (*Asimina triloba*). *J. Am. Soc. Hort. Sci.*, **125**: 454-459.
- Jaccard P. 1908. Nouvelles recherches sur la distribution florale. *Bull. Soc. Vaudoise Sci. Nat.*, **44**: 223-270.
- Kamara A, Defore T, de Groove H. 1996. Selection of new varieties through participatory research: the case of corn in South Mali. *Tropicultura*, **14**(3): 100-105.
- Maxted N, Ford-Lloyd BV, Hawkes JG. 1997. *Plant Genetic Conservation: the in situ Approach*. Chapman and Hall: United Kingdom.
- Mekbib F. 2007. Infra-specific folk taxonomy in sorghum (*Sorghum bicolor* (L.) Moench) in Ethiopia: folk nomenclature, classification, and criteria. *Journal of Ethnobiology and Ethnomedicine*, **3**(8): 645-663.
- Mensah J K, Okoli R I, Ohaju-Obodo J O, Eifediyi K. 2008. Phytochemical, nutritional and medical properties of some leafy vegetables consumed by Edo people of Nigeria. *African Journal of Biotechnology*, **7**(14): 2304-2309.
- Mignouna HD, Dansi A (2003). Yam (*Dioscorea* spp.) domestication by the Nago and Fon ethnic groups in Benin. *Genet. Resour. Crop Evol*, **50**: 519-528.
- Nebauer SG, del Castillo-Agudo L, Segura J. 1999. RAPD variation within and among natural populations of outcrossing willow-leaved foxglove (*Digitalis obscura* L.). *Theor. Appl. Genet.*, **98**: 985-994.
- Odhav B, Beekrum S, Akula Us, Baijnath. H. 2007. Preliminary assessment of nutritional value of traditional leafy vegetables in KwaZulu-Natal, South Africa. *Journal of Food Composition and Analysis*, **20**(5): 361-448.
- Rohlf FJ. 2000. NTSYS-pc version 2.2: Numerical Taxonomy and Multivariate Analysis System. Exeter Software, New York.
- SAS. 1996. SAS/STAT User's guide. Release 6 12 Cary, N.C SAS Institute.

- Shippers RR. 2002. African indigenous vegetables: an overview of the cultivated species. Chatham, UK. Natural resources Institute/ACP-UE Technical Centre for Agricultural and rural Cooperation.
- Sneath PHA, Sokal RO. 1973. *Numerical Taxonomy*. Freeman: San Francisco.
- Swofford DL, Olsen GJ. 1990. Phylogeny reconstruction. In *Molecular Systematic*, Hillis DM, Moritz C (eds). Sinauer Associates, Sunderland, Mass.
- Tuan HD, Hue NN, Sthapit BR, Jarvis DI. 2003. On-farm management of agricultural biodiversity in Vietnam. Proceedings of a Symposium 6-12 December 2001, Hanoi, Vietnam. IPGRI Publication, Italy.
- White F. 1993. The AETFAT chorological classification of Africa: history, methods and applications. *Bull. Jard. Bot. Natl. Belg.*, **62**: 225-281.