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Ethnobotanical investigation of three traditional leafy vegetables [*Alternanthera sessilis* (L.) DC. *Bidens pilosa* L. *Launaea taraxacifolia* Willd.] widely consumed in southern and central Benin

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Key words: Benin, Cultural practices, Domestication, Leafy vegetable, Morphological diversity.

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Abstract

In Africa, importance of traditional leafy vegetables (TLV) for food security of people living in both rural and urban areas is well recognized. In Benin, TLVs such as *Launea taraxacifolia*, *Bidens pilosa* and *Alternanthera sessilis* are widely consumed with high importance for both nutrition and medicinal purposes. To document indigenous knowledge and farmers' know-how related to these TLVs, an ethnobotanical investigation, using participatory approach research methods and tools, was conducted in 19 villages randomly selected across ethnic and agro-ecological zones of southern and central Benin. The geographical distribution of the three species was established and the southern area appeared suitable for *in situ* conservation programme of the three species. Respectively 11.11%, 55.56% and 90% of the respondents reported that *Launaea taraxacifolia, Bidens pilosa* and *Alternanthera sessilis* are still harvested from the wild (level 0 of domestication) while 22.22% and 16.67% of respondents reported that *L. taraxacifolia* and *B. pilosa* are being cultivated (level 4 of domestication). Women were mostly involved in harvesting and the most common harvest method was plant uprooting and plant stem cutting. The study revealed the existence of morphotypes resulting in the identification of different varieties of *L. taraxacifolia* (three varieties), *Bidens pilosa* (two varieties) and *Alternanthera sessilis* (two varieties). The frequency of consumption of each of the leafy vegetables and its consumption method varied according to the ethnic group. Regarding methods of preparation, sauce made from raw leaves was reported only for *Launaea taraxacifolia*. According to the respondents, *L. taraxacifolia* was the most valued medicinally, and is used for the prevention or healing of 21 diseases with 16 possible pharmacological functions. Further research is required on biochemical and phytochemical characterization of these species as well as effects of processing methods on their nutritional value.

Introduction

In tropical countries in general and in Sub-Saharian Africa (SSA) in particular, the interest of vegetable plants for food for rural communities is recognized (Andzouana and Mombouli 2012). Traditional leafy vegetables (TLVs) are plants whose leaves (including immature green pods and flowers) are used and consumed by the local populations (Dansi *et al.*, 2008). Moreover, traditional "African" vegetables are rich in micronutrients, antioxidants (Yang and Keding, 2009), and other health-related phytochemicals (Afari-sefa *et al.*, 2012).

Traditional Leafy vegetables (TLVs) often provide higher amounts of provitamin A, vitamin C and several important minerals than common intensively bred vegetables both on a fresh weight basis and after preparation (Afari-sefa *et al.*, 2012). According to Adjatin *et al.*, (2013a), many traditional leafy vegetables have long been known and reported to have some curative, regulative and stimulative properties besides food qualities and are used as nutraceutical plants. Throughout the tropical world and particularly in West Africa, a large number of TLVs have been reported to play important roles in food security for people living in both rural and urban areas (Ukpong and Idiong, 2013; Adjatin *et al.*, 2013b). They represent affordable quality nutrition for a large proportion of the population and offer an opportunity for improving nutritional status of many families (Olaposi and Adunni. 2010).

The importance of indigenous knowledge and traditional crops in the survival strategies of rural people has only recently been recognized by researchers (Voster *et al.*, 2007). According to Smith and Eyzaguire (2007), this indigenous knowledge of the health promoting and protecting attributes of TLVs is clearly linked to their nutritional and non-nutrient bioactive properties. However, in Africa, there is concern about the disappearance of traditional knowledge on cultivated and wild species (Diouf *et al.*, 2007). Much of this information is held by women and escapes to largely public people. However, modern agriculture using new, more homogeneous varieties with high potential performance has led to a reduction of genetic diversity (Diouf *et al.*, 2007).

Recent studies conducted in Benin revealed the existence of 187 species of TLVs among which *Launaea taraxacifolia*, *Bidens pilosa* and *Alternanthera sessilis* are widely consumed and of great importance for the Centre and South local communities (Dansi *et al.*, 2008). According to reports by Gruben and Denton (2004), *L. taraxacifolia* is well recognized as a TLV while *Bidens pilosa* and *Alternanthera sessilis* are of lesser importance as a leafy vegetable but valued highly for medicinal applications. However, these three species are simply neglected and underutilized by researchers and extension workers in Benin (Dansi *et al.*, 2012). Underutilized plants are those species which have a potential, not fully exploited for contributing to food security, health (nutritional/medicinal), income generation and environmental services and poverty alleviation (Ahmad et Javed. 2007). *Launaea taraxacifolia* and *Bidens pilosa* were reported among the 19 species considered in Benin to be priority neglected and underutilized crops for research (Dansi *et al.*, 2012). Because they have been for a long time neglected by the researchers, their production has remained traditional and their domestication (Vodouhè *et al.*, 2011) has hardly progressed. The collection of the diversity of local ecotypes and documentation of traditional knowledge related to them is important for food security.

For better facing these situations and contributing to food security and poverty alleviation as third millennium development goal by promotion and better utilization of these three genetics resources with great importance in south and central Benin, a research was conducted to:

- Document indigenous knowledge and farmers' know-how related to *Alternanthera sessilis*. *Bidens pilosa* and *Launaea taraxacifolia* leafy vegetables

across villages and ethnics groups of Centre and South of Benin;

- Map the geographical distribution and extent of the three species across the study area;
- Explore diversity, importance and domestication level of the three species.

Materials and methods

Study area

The present study was conducted in the Centre and Southern part of Benin republic. The Republic of Benin is situated in West Africa and between the latitudes 6°100 N and 12°250 N and longitudes 0°450 E and 3°550 E (Akoègninou *et al.*, 2006). The south and the Centre are relatively humid agro-ecological zones with bimodal rainy seasons and mean annual rainfall varying from 1.100 to 1.400 mm/year (Adam and Boko, 1993). Mean annual temperatures range from 26 to 28°C and (Adomou. 2005; Akoègninou *et al.*, 2006). Vegetation types are semi deciduous forest (South), woodland and savannah (centre East), dry semi deciduous forest (Centre West and South).

Site selection and survey

Nineteen villages (7 in the Centre and 12 in the south) belonging to diverse ethnical groups and humid agro-ecological zones were selected and surveyed. Surveyed villages and geographical location are listed in Table 1.

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

N°	Villages	Districts	Regions	Ethnic groups
1	Sehouè	Toffo	South West	Aïzo / Fon
2	Vèdji	Dassa-zoumè	Centre	Idaasha/ Mahi
3	Illèman	Dassa-zoumè	Centre	Idaasha / Mahi
4	Ouèdèmé	Glazoué	Centre	Idaasha / Mahi
5	Kpakpaza	Glazoué	Centre	Idaasha / Mahi
6	Naogon-aga	Covè	Centre	Mahi / Fon
7	Bognongon	Zogbodomey	South	Fon
8	Ayétédjou	Kétou	South East	Holy
9	Towé	Pobè	South East	Holy
10	Ita-djèbou	Sakété	South East	Yoruba
11	Ikpédjilé	Sakété	South East	Yoruba
12	Gbezoumè	Houéyogbé	South West	Sawhè
13	Assèdji	Athiémè	South West	Cotafon
14	Dahoue	Dogbo	South West	Adja
15	Lalo-centre	Lalo	South West	Adja
16	Gangnigon	Kétou	South East	Holy
17	Houègbo	Toffo	South West	Fon
18	Késsounou	Dangbo	South East	Goun
19	Kpodédjilé	Adjohoun	South East	Goun

Data were collected during field work at different sites through the application of participatory research appraisal tools and techniques such as direct observation, focus group discussions (20 to 25 person) and field visits using a questionnaire (Dansi *et al.*, 2010; Adjatin *et al.*, 2012). Through discussions, the following key information (the vernacular name of the species and its meaning, status (wild. cultivated), habitat, season of availability, procurement practice of each species, period of consumption, frequency of consumption (measured on an ordinal scale as follows: more than 2 times a week (very frequently), 1 - 2 times a week (frequently), 1 - 2 times a month (moderately), 1 - 2 times per six month (rarely), once a year (very rarely), modes of consumption, storage practices, intraspecific morphological diversity, cultural importance and medicinal properties) related to traditional knowledge on the three leafy vegetables, *L. taraxacifolia*. *Bidens pilosa* and *Alternanthera sessilis*, species studied were recorded. The level of domestication attained by the species in each village was determined following the seven steps described by Vodouhè *et al.*, (2011).

Data collected were analyzed through descriptive statistics (frequencies, percentages, means. etc.) in order to generate summaries and tables at different (villages, ethnic groups, households). The Kruskal Walis test was done to compare the different means obtained.

Results

Geographical distribution

Across the study area and among the three species studied, *Launaea taraxaicifolia* was found alone in 89.47 % (17/19) of villages surveyed while *A. sessilis* and *B. pilosa* were encountered in 52.63% (10/19) and 47.36% (9/19) of surveyed villages respectively (Fig. 1). Following the Benin analytic flora (Akoegninou *et al*., 2006) and report of Achigan Dako *et al*., (2009) on traditionally leafy vegetable in Benin and folk nomenclature, the whereabouts of the three leafy vegetables were recorded and their geographical distribution maps established for the whole Benin republic (Fig. 2).

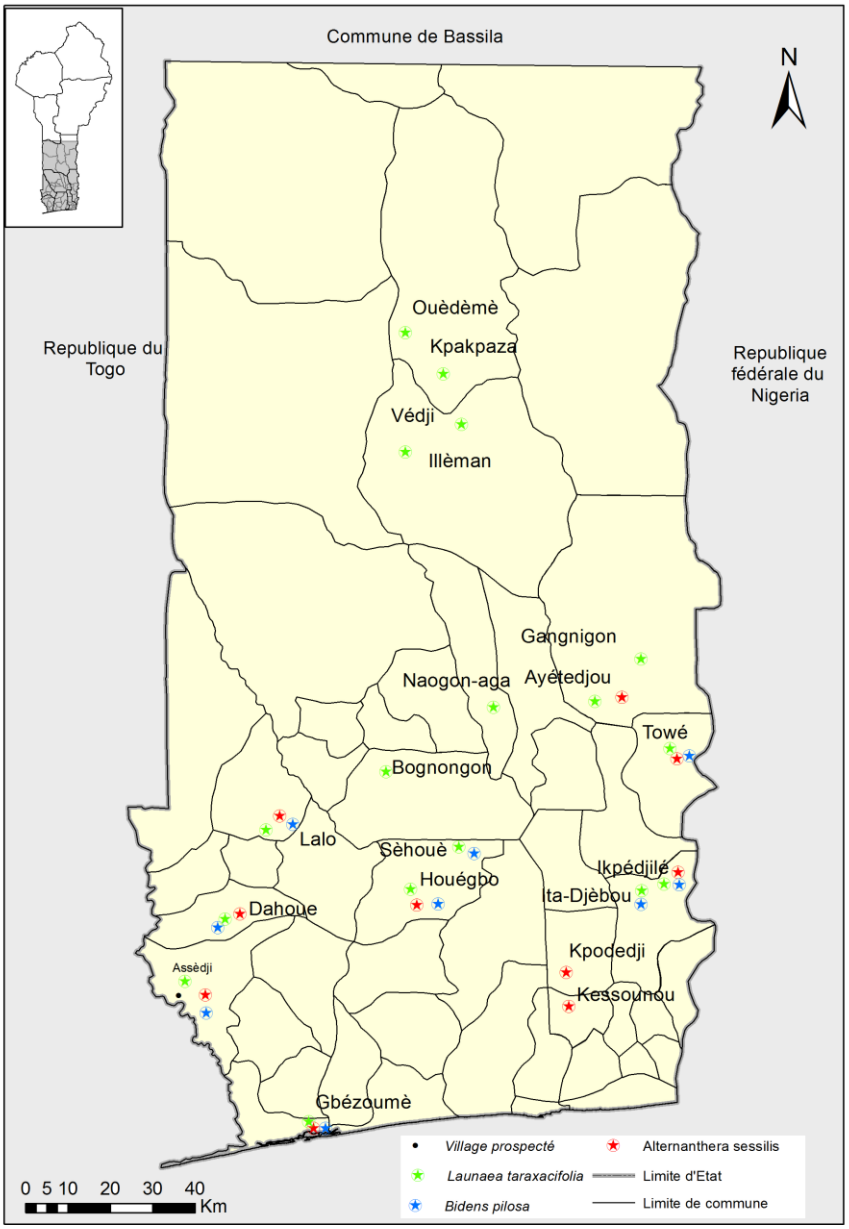

Fig. 1. Distribution of *Launaea taraxacifolia*. *Bidens pilosa* and *Alternanthera sessilis* across Central and Southern Benin villages surveyed.

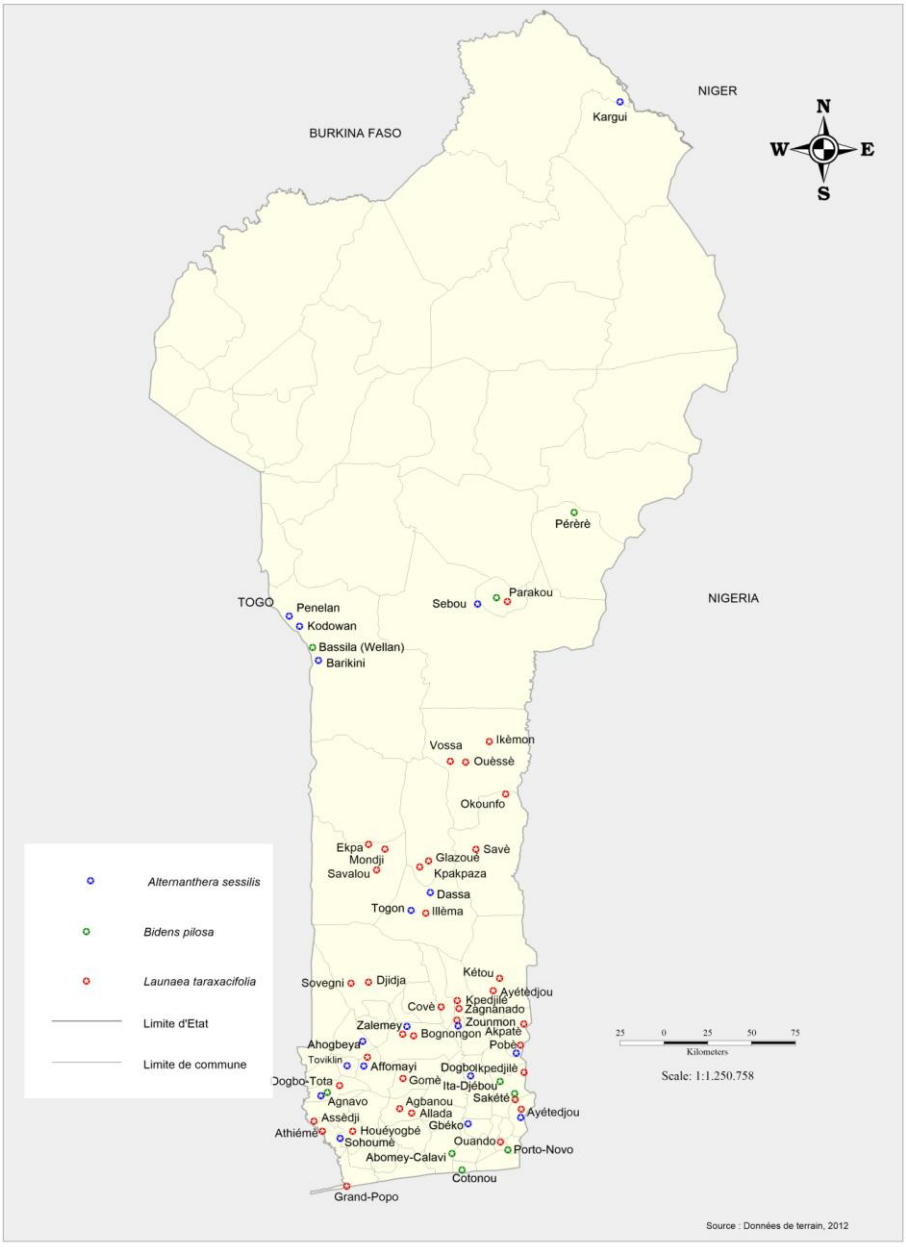

Fig. 2. Geographical distribution map of *Launaea taraxacifolia*, *Bidens pilosa* and *Alternanthera sessilis* in Benin republic.

Folk nomenclature and diversity of species

At total 27 vernacular names (10 for *L. taraxacifolia*. 9 for *A. sessilis* and 8 for *B. pilosa*) were utilized by respondents for the three leafy vegetables. The vernacular names of species and the analysis of the meanings of vernacular names is compiled in Table 2. The main criteria of denomination for *L. taraxacifolia* stemmed from their organoleptic and technological qualities while morphology traits of plants were the most used criteria to name *B. pilosa,* and habitat for *A. sessilis*. The distinguishing traits used by respondents to identify the different morphotypes of each species as well as ethnic groups of respondents are shown in Table 3.

Habitat of species and their evolution in domestication process

The perceived natural habitat of the TLVs by farmers are surveyed and shown in Fig. 4. Although *Launaea taraxacifolia* was found across in the majority of

villages surveyed and seem to be adaptable to all types of soil. *Bidens pilosa* and *Alternanthera sessilis* seem to prefer respectively clayey land (45.45 of % of responses) and lowlands (42.85 % of % of response). These observations may be explained by the large distribution of *Launaea taraxacifolia* across the national territory contrary to the other TLVs.

Table 2. Vernacular names of *L. taraxacifolia*. *B. pilosa* and *A. sessilis* and its meanings in surveyed area.

Species	Vernacular name	Ethnics groups	Significations	Criteria of denomination
Launaea taraxacifolia	Yantotoé or yantoto	Fon	Soft like meat after cooked	Organoleptic quality
	Lantoto or yantotoé	Mahi	Leaves consumed instead of meal in ancient times	Organoleptic and technologic qualities
	Odôdô or Odôdôlodôdô	Idaacha	The genuine leafy vegetable	Organoleptic and technologic qualities
	Efô gnanri	Holy/yorouba	The genuine leafy vegetable	Organoleptics quality. technological trait
	Wontou	Adja	Plant with rich biomass which tend to	Technological traits
Bidens pilosa	Gningbé/ gninman or Gnintonou	Fon/mahi/Oueme	Herbs with thorn	Morphology of plant
	Abèrè oloko	Yoruba/Nago	The sting of farmers	Morphology of plant
	Djanhounkpi	Sahouè	The plant with sting on mature flowers	Morphology of plant
Alternanthera sessilis	Houngbé	Fon	Blood provider leaves	Medicinal uses
	Idé	Holy	None heritage from ancient	-
	Gomi	Adja	Plant with high multiplication capacity due to its important number of node	Natural habitat, morphology
	Agouègbé, Agouèman	Cotafon, Sahouè	Plant originated from Agoué river, which liked humid zone	Natural habitat. origin
	Agwè-houngbè	Goun	Leafy vegetable prohibited for « Agossou » (anormal borned baby) parents	Cultural uses
	Ossoun odô. Agômayan Goudé	Yoruba	None. heritage from ancient	-

Within each of these three species and with regard to their morphological traits related to the shape, stem, colour and odour of leaves, different morphotypes were recorded. In the study area, the result showed that there are three different morphotypes and two respectively for *L. taraxacifolia*. *B. pilosa and A. sessilis* (Fig. 3).These results are in accordance with the observation of Dansi *et al.*, (2008) and those of Adjatin *et al.*, (2012), who report that with traditional leafy vegetables, intraspecific diversity is frequent.

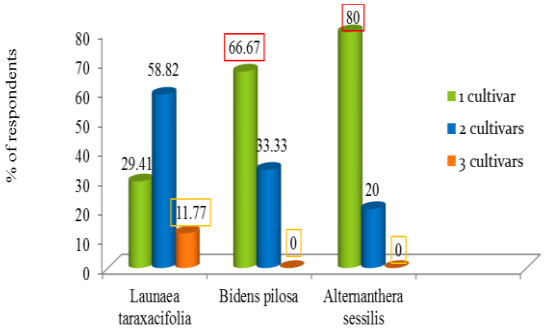

Fig. 3. Diversity of *L. taraxacifolia*. *B. pilosa* and *A. sessilis* in surveyed zone.

Table 3. Morphotypes of species studied per ethnic groups and traits used to distinguish species.

Species	Number of cultivars	Local names	Distinguishes traits
Bidens pilosa	2	Djanhounkoui Adjatô	Odour of leaves
		Djanhounkoui Yovotô	Odour, colour, height of leaves; important ramifications on stem
Launaea taraxacifolia	3	Yantotoé wéwé	Colour of leaves (light green), forms of leaves (lobes),Emptiness of stem
		Yantotoé Vôvô	Colour of leaves (green, green-redish), forms of leaves (lobes). stem
		Yantotoé wouiwoui	Colour of leaves (Dark green)
Alternanthera sessilis	2	Gomi	Height and colour of leaves
		Agwè-aguéton	Development of leaves and colour

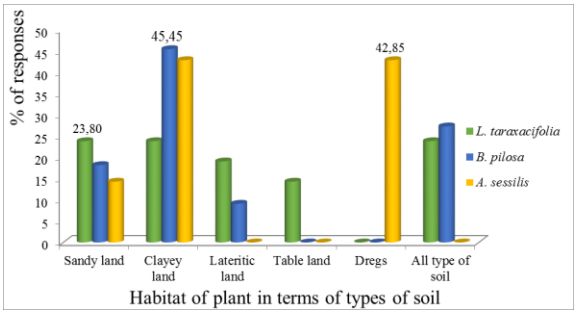

Fig. 4. Habitat of *L. taraxacifolia*, *B. pilosa* and *A. sessilis* as perceived by farmers.

Though the three species reach a certain domestication stage at the community level, their management practices varied among respondents (Table 4). For instance respectively 11.11 %; 55.56 % and 90 % of the respondents reported that *Launaea taraxacifolia*, *Bidens pilosa and Alternanthera sessilis* are still harvested from the wild (level 0 of domestication) while 22.22% and 16.67% of respondents (belong to Mahi/Holly/Nago and Adja ethnics groups respectively) reported that *L. taraxacifolia* and *Bidens pilosa* are being cultivated (level 4 of domestication).

The reasons for domestication reported by the respondents were: consumption as a vegetable during the dry season when other TLVs are scarce, scarcity of the species in the fields around the villages, high perceived organoleptic quality and medicinal value, contribution to household income through commercialization (*Launaea taraxacifolia* and *Alternanthera sessilis*).

Table 4. Variation of the domestication levels of *Launaea taraxacifolia*, *Bidens pilosa and Alternanthera sessilis*.

Species	Number of villages	Level of domestication (% of village)				
		N0	N1	N2	N3	N4
Launaea taraxacifolia	17	11.11a	61.11c	5.56	5.56	16.67a
Bidens pilosa	9	55.56b	22.22b	-	-	22.22b
Alternanthera sessilis	10	90.00c	10.00a	-	-	-

Harvesting methods and procurement practices

The harvesting methods of the three species were investigated and are shown in Table 5. Mostly women were involved in harvesting and the most common harvest method was uprooting the plant and plant stem cutting. To harvest *Launaea taraxacifolia*, uprooting (35.29% respondents) is the most practiced while plant stem cutting (25% and 40% of respondents) is the most used respectively for *Bidens pilosa* and for *Alternanthera sessilis*. Due to their status of domestication, two major procurement methods were identified for the three TLVs studied: picking from the natural habitat and purchasing from the seller. The results showed that within local communities, certain market values are linked to *L. taraxacifolia* and *A. sessilis*.

Table 5. Different methods used to harvest *L. taraxacifolia*, *B. pilosa* and *A. sessilis* in the prospected area.

species	Harvesting methods (%)					
	Plant stem cutting	Uprooting	Defoliation	Plant stem cutting and uprooting	Defoliation and uprooting	Defoliation and plant stem cutting
L. taraxacifolia	11.76	35.29	5.88	29.41	11.76	5.88
B. pilosa	33.33	11.11	11.11	22.22	0.00	22.22
A. sessilis	40.00	30.00	10.00	10.00	10.00	0.00

Consumption and post-harvest storage

The frequency and method of consumption of these three leafy vegetables varied according to the ethnic group. Regarding methods of cooking, sauce made from fresh triturate leaves (17.07 percentage of responses) as well as consumption of raw leaves as salad were reported only for *Launaea taraxacifolia* while the step of pre-cooking leaves is otherwise necessary for the other leafy vegetables studied (Table 6).

Table 6. Consumption methods of *L. taraxacifolia*, *B. pilosa* and *A. sessilis* in Centre and Southern Benin.

Consumption methods (%)	Pre-cooked and add to sauces or non-cooked ingredients	Triturate and add to sauce or non-cooked ingredients	Raw as salad
Launaea taraxacifolia	68.28	17.07	14.63
Bidens pilosa	100.00	0.00	0.00
Alternanthera sessilis	100.00	0.00	0.00

The frequency of each leafy vegetable was surveyed and reported in Fig. 4. According to ethnic groups the frequency of consumption of each of three leafy vegetable studied varied significantly. Among the *L. taraxacilia* consumers, the people belong to Idasha and Mahi (23.52 %) as the most frequent consumers while the Adja, Cotafon and Sahouè people are the most frequent consumers of *Bidens pilosa*. For the majority of respondents (82.35%, 88.88% and 80%) for *L. taraxacifolia*, *Bidens pilosa* and *A. sessilis*, there are no properly defined post-harvest storage practices for conservation of the three TLVs studied.

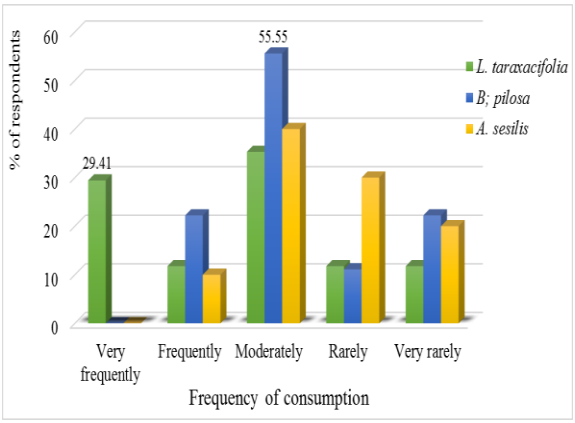

Fig. 5. Frequency of consumption of *L. taraxacifolia, B. pilosa* and *A. sessilis* in surveyed area.

Cultural importance and medicinal value of the species

100 % of respondents reported that there is no need of special rituals before consuming the three species studied and they can be consumed freely at all the times. However *L. taraxacifolia* and *A. sessilis* are prohibited for Hêviosso, Tron and Djaguidi divinity disciples and for « Agossou » (abnormal born baby) parents respectively.

The respondents also reported that these leafy vegetables possessed in addition to their culinary value several medicinal properties, *L. taraxacifolia* being the most valued medicinally, and is used for the prevention or healing of 21 diseases with 16 possible pharmacological functions among which, anti-venomous properties are the most reported (21.05% of responses) (Table 7). Among its medicinal properties, analgesic, fever-reducing, fungicidal, blood pressure regulating as well anti-diabetic functions are also well recognized. For the three species, antibiotics and laxative uses are common while, in addition, aphrodisiac properties seem reported only for *Bidens pilosa* and anti-colic for *Alternanthera sessilis*.

Table 7. Medicinal and possible disease curing properties associated with leafy vegetables of *Launaea taraxacifolia*. *Bidens pilosa* and *Alternanthera sessilis*.

Medicinal properties (% of responses)	Reported diseases cured	*Launaea taraxacifolia*	*Bidens pilosa*	*Alternanthera sessilis*
Antibiotic	Wound, sore throat, abscess	5.26	33.33	10
Anti-venimous	Scorpio/ snake bite	21.05	-	-
Anti-poisonous	poison	5.26	-	-
Anti-anemic	Anemia	2.63	-	10
Anti-inflammatory	Cramp, Navel cicatrizing (baby)	2.63	-	10
Antalgic	Head, eyes and ear aches	10.53	-	-
Fungicide	Tetter, tinea, Mycosis	13.16	-	10
Febrifuge	Fever	7.90	-	-
Sedative	Convulsive attack	5.26	-	-
Parasiticide	Guinea worm	2.63	-	-
Blood pressure regulator	Blood pressure	7.90	-	-
Anti-diabetic	Diabetes	2.63	-	-
Anti-coughing	Cough	2.63	-	-
Anti-colic	Stomach disorders	-	-	10
Anti-dizzy	Dizzy	5.26	-	-
Galactogen	Breast milk production default	2.63	-	-
Laxative	Indigestion, constipation	2.64	33.33	50
Aphrodisiac	Aphrodisiac	-	33.33	-

Discussion

By observation of distribution maps and geographical localization of species, Southern Benin would be the best area for *in situ* conservation of these plant genetic resources. These observations are different to the finding of Adjatin *et al.*, (2012) and those of Adéoti *et al.*, (2009) which all proposed Central Benin for *in situ* conservation of six important species (*Crassocephalum rubens* and *Crassocephalum crepidoides*, *Acmella uliginosa*. *Ceratotheca sesamoides*. *Justicia tenella* and *Sesanum radiatum*) of traditional leafy vegetables in Benin. However this situation may be explained by the fact that the South and Central Benin are relatively humid agro-ecological zones (Adam et Boko, 1993), while in the same agro-ecological zone each species requires special edapho-climatic conditions (soil and climate) to be grow well.

Across both villages and ethnic groups surveyed in the study area, variations were recorded among vernacular names. It exist different ethnic groups which uses a common vernacular for a same species. However such observed variations of vernacular names are common and were already reported in many crops including cassava (Dansi *et al.*, 2010), sorghum (Mekbib, 2007), cowpea (Gbaguidi *et al.*, 2013), pepper (Orobiyi *et al.*, 2013) and traditional leafy vegetables (Adjatin *et al.*, 2012). The status (cultivated or not) of domestication of the three TLVs species investigated varies among the surveyed villages as reported by Avohou *et al.*, (2012) for *J. tenella* and *S. radiatum*. The observed level of domestication of each species through the study area may be linked to its importance (economic).

The most common harvesting methods of TLVs were uprooting and plant stem cutting according to respondents in this study. These practices could contributed significantly to species loss, especially uprooting. It is important to train people in defoliation methods during harvest which avoids genetic erosion.

According to Gruben and Denton (2004), 50% of sub-Saharan African leafy vegetables are harvesting from the wild. In this study for each of the three species, more than 50% of respondent reported that leaves were procured by picking from the wild. Harvesting and procurement methods are an important factor in conservation and management of genetic resources.

The consumption of raw leafy vegetables highlighted here for only *Launea taraxacifolia* may be link to probable non toxicity of the specie for human consumption like as reported for Crassocephalum spp

TLVs eaten as raw green salads in some areas in Nigeria (Gruben and Denton. 2004) and in Benin (Adjatin *et al*., 2012). As reported by Gil *et al*., (1999) and by Adjatin *et al*., (2013b), these cooking methods which also preserve the aroma of the vegetable sauce could be recommended since blanching reduces the nutrient content, especially vitamin C. Undoubtedly, the frequency of consumption of each TLV is linked to ethnic groups of consumers.

The medicinal values reported for *L. taraxacifolia* are in accordance with the observations of Arawande *et al*., (2013) who revealed that leaf extract mixed with breast milk of a nursing mother is administered medically to cure partial blindness resulting from snake bites.. According to Yang *et al*., (2006), bioactive compounds isolated from *B. pilosa* reportedly possess antibiotic and antimalarial properties, and inhibit prostaglandin synthesis. The plant is known in folk medicines, and is a popular ingredient in herbal tea for anti-inflammatory, antiseptic, liver protective, Blood pressure-lowering and hypoglycemic (Deba *et al*., 2007). Since there is good agreement between local knowledge and these research reports on the medicinal properties of these three vegetables, their promotion is justified.

Conclusion

The three species studied here are still mostly wild in Benin and their production is still traditional. Southern Benin may be suitable to carry out *in situ* conservation of these species. Among each of the TLVs plants studied, the existence of morphotypes was reported and could be useful for breeding purposes. The domestication process across surveyed areas is still ongoing and should be encouraged for intensive and optimal production. The people surveyed have a good knowledge of the species' medicinal value and they could be promoted more. Further research is required on the biochemical and phytochemical characterization of the genetic diversity of these species as well as the effects of processing methods on their nutritional value. There is also need to create awareness among local communities of the importance of good harvesting practices for promotion and conservation the existing diversity.

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