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Endogenous Knowledge of Four Leafy Vegetables Used by Rural Populations in Benin

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*Leafy vegetables are sources of diet diversification and could contribute to food and nutritional security in African rural areas. However, in some places, little is known about if, how, and why leafy vegetables are consumed. Processing and preservation methods, food forms, and consumption determinants of four leafy vegetables (*Sesamum radiatum, Ceratotheca sesamoïdes, Acmella uliginosa *and* Justicia tenella*), known to contribute to the diet of rural populations in the Center and Northern parts of Benin, were investigated. Three hundred randomly selected households were investigated, using rapid appraisal and quantitative survey methods, descriptive statistics and correspondence analysis. Processing methods to prepare sauces varied depending on sociocultural groups. Cooking of fresh leaves predominated, while sun drying was the usual practice of preserving these leafy vegetables. Consumption frequencies were associated with sociocultural groups, food habits, and availability in living areas.*

KEYWORDS Sesamum radiatum, Ceratotheca sesamoïdes, Acmella uliginosa, Justicia tenella, *consumption frequency, processing*

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Leafy vegetables are consumed all over the world and improve the nutritional quality of diets due to their chemical composition and medicinal properties (Smith et al. 1996; Tchiegang and Kitikil 2004; Dansi et al. 2008). Indeed, leafy vegetables are important sources of vitamins (carotene, ascorbic acid, and riboflavin), proteins, and minerals such as iron, and calcium (Smith et al. 1996; Delisle et al. 1997; Vanderjagt et al. 2000; Fasakin 2004; Tchiegang and Kitikil 2004; Akubugwo et al. 2007; Avallone et al. 2007; Ndong et al. 2007; Afoloyan and Jimoh, 2009). In addition, they are sources of fiber which has beneficial effect on blood cholesterol and prevents large bowel diseases (Burkitt 1973). Leafy vegetables are an essential part of sauces served with cereal based food in Africa (FAO/WHO 1988).

In rural areas of Benin, 187 traditional leafy vegetables species (TLVs) have been identified and many are commonly used as dietary constituents in the preparation of soups and stews (Dansi et al. 2008). Most of those species are wild forest vegetables used by local communities living in various agro-ecological areas. Previous research mostly focused on botanical characteristics and socioeconomic value of forest food resources, with little interest to their endogenous processing techniques, which, indeed, are key factors of leafy vegetables nutritional values (Olson 1991; Ndoye, Ruiz-Perez, and Eyebe 1997; Codjia, Assogbadjo, and Ekué 2003; Randrianatoandro et al. 2010).

Among indigenous leafy vegetables recorded in Benin, 18 have been identified as having great importance and four of them widely occur across many districts in the north and centre of Benin, where they combine both valuable food/nutritional and therapeutic properties for local communities (Akoègninou, Van der Burg, and Van der Maesen 2006; Dansi et al. 2008). These are *Ceratotheca sesamoïdes* Endl. (False sesame; Pedaliaceae), *Sesamum radiatum* L. (Black benniseed Pedaliaceae), *Acmella uliginosa* (L.) Jansen (Toothache plant; Asteraceae) and *Justicia tenella* (Nees) T. Anderson (Acanthaceae). Until now, the available information regarding their consumption pattern, endogenous processing methods and consumption levels are fragmentary, although these are key information for their domestication, cultivation and commercial exploitation.

The present study was undertaken to identify the traditional preservation and processing methods, the food forms and consumption frequency of the previously cited four leafy vegetables used in the north and centre of Benin.

METHOD

Study Location and Sampling Technique

Surveys related to processing, preservation, foods forms and consumption pattern of studied leaves took place from March to June 2008 in five

TABLE 1 Study Areas and Sociocultural Groups Investigated for Leafy Vegetable Ethno-food Knowledge

Municipalities	Villages	Sociocultural groups
Tanguiéta	Cotiakou	Tangamba
Tanguiéta	Tiélé	Berba
Savè	Diho 1	Tchabè
Savè	Oogui	Tchabè
Savalou	Lowo	Mahi
Savalou	Zinzonkanmé	Mahi, Kotokoli
Cobly	Namoutchiaga	M'bermin
Cobly	Nouagou	M'bermin
Natitingou	Pam-pam	Wama, Pila-pila, Otamari
Natitingou	Peporiyakou	Wama, Ditamari

municipalities (table 1) located in the center (latitude 2° 36′ N and longitude 7° 45′ E) and north (latitude 1° 45′ N and longitude 10° 45′ E) of Benin. For the quantitative survey, municipalities were selected on the basis of a previous work (Dansi et al. 2008) which presented habitat of leafy vegetables in Benin. Firstly, all municipalities with the presence of at least two of the leafy vegetables in study were selected from the list. Then, five municipalities and two villages per municipality were opportunistically selected (table 1). Secondly, thirty (30) households were selected in each village through the random walk method by spinning a bottle (Gibson and Ferguson 1999) and the informed consent of each household chief was obtained. From selected households and following their informed consent, housewives were chosen to participate to the survey as they are known to have the greatest influence on the construction of the household diet. Thus, three hundred (300) housewives were selected for individual interviews.

Rapid Appraisal Investigation

Preliminary and prompted survey was conducted in the districts of Collines and Atacora in Benin as mentioned above (table 1) to gather information on the pattern of leafy vegetables, the processing and preservation techniques, the food forms and the consumption determinants of *C. sesamoïdes, S. radiatum, J. tenella* and *A. uliginosa*. In total 23 randomly selected individuals and 10 focus groups (between 19 and 28 persons) were interviewed for recognizing the plants and establishing ethno-food knowledge of edible parts. The information collected helped make up a questionnaire for quantitative survey.

Field Data Collection

Information was obtained by means of semi-structured questionnaire with the help of native interpreters in each area. This questionnaire was

administered to housewives for collecting in-depth endogenous knowledge on the pattern of leafy vegetables and factors influencing their use: (1) information on the personal characteristics of the respondents (sociocultural group, locality), (2) the vernacular names and meaning of the vegetables, (3) the leafy based foods, (4) the traditional processing methods and specific ingredients for each derived food, (5) the traditional preservation methods of the vegetables, (6) the consumption forms, and (7) factors influencing consumption. The consumption frequencies were determined from a checklist in which the respondent selected the most appropriate option from a choice of: never or rarely, consume once/week, consume 2–3 times/week, consume 4–5 times/week and consume 6–7 times/week.

Data Analyses

Recorded data were analyzed with SAS v9.1 software (SAS Institute, Inc). They were subjected to descriptive statistics using mean, mode, range and frequency distribution. Correspondence analysis was used to establish the relation between sociocultural groups and leafy vegetable-derived products, on the one hand, and sociocultural groups and consumption frequencies of each leafy vegetable, on the other. Correspondence analysis is similar to principal component analysis but it has more flexibility, since it inherently includes weights on both rows and columns of tables (Greenacre 1993, Chadare et al. 2008).

RESULTS

Food Forms

All leafy vegetables investigated were consumed in cooked form as sauces (100% of respondents). Different types of sauces were identified: (1) sauces prepared with only one vegetable and (2) sauces with a combination of leafy vegetables (table 2). One hundred percent of housewives prepared one-leafy-vegetable sauces, while 81.7% prepared sauces with at least two leafy vegetables.

C. sesamoïdes and *S. radiatum* were included with other leafy vegetables in preparation of composite-vegetable sauces. All the interviewed housewives preferred the fresh leaves of *C. sesamoïdes* and *S. radiatum* because of the slimy quality of the derived sauces. Reversely, the dried leaves of *C. sesamoïdes* and *S. radiatum* are less desired because of the less slimy texture and the bad aroma of the sauces.

A. uliginosa and *J. tenella* were also included with other leafy vegetables to obtain composite sauces. Fresh leaves of those species are usually used by all housewives. The limited agricultural production of these species limited the consumption in dried form.

TABLE 2 Components, Main Processing Operations, and Products from the Leafy Vegetables Investigated

Leafy vegetables	Parts used	Other ingredients	Processed products	Main unit operations
Ceratotheca sesamoïdes/ *Sesamum radiatum*	Young or old fresh leaves	Potash, seasoning[a]	Simple sauce 1	Washing the leaves by rubbing between the hands/slicing/mixing/ cooking
		Potash, seasoning, others leaves[b]	Composite sauce 1	Washing the leaves by rubbing between the hands/slicing/mixing/ cooking
		Potash, seasoning, dehulled or grounded beans (*Vigna unguiculata*)	Composite sauce 2 or Touwoudou 1	Beans dehulling or grounding/washing the leaves by rubbing between the hands/ slicing/mixing/cooking
		Potash, seasoning, dehulled or grounded beans (*Vigna unguiculata*), other leaves	Composite sauce 3 or Touwoudou 2	Beans dehulling or grounding/washing the leaves by rubbing between the hands/ slicing/mixing/cooking
		Tomato, seasoning, groundnut, égussi	Composite sauce 4	washing the leaves by rubbing between the hands/slicing/mixing/ cooking
	Young or old dry leaves	Potash, seasoning	Simple sauce 2	Sun drying/grinding/ sieving (optional) the leaves/mixing/cooking
		Tomato, seasoning	Composite sauce 5	Sun drying/grinding/ sieving (optional)/ mixing/cooking

Acmella uliginosa/ *Justicia tenella*	Young or old fresh leaves and young sticks	Potash (optional), tomato, Shea butter or oil seasoning	Simple sauce 3	Washing the leaves/ precooking (optional)/ mixing/cooking
		Potash (optional)/ seasoning	Simple sauce 4	Washing the leaves/ mixing/cooking
		Potash (optional), seasoning, others leaves	Composite sauce 6	Washing the leaves/ mixing/cooking
		Potash (optional), seasoning, dehulled or grounded beans (*Vigna unguiculata)*	Composite sauce 7 or Touwoundou 2	Beans dehulling or grounding/washing the leaves/mixing/cooking
		Potash (optional), seasoning, dehulled or grounded beans (*Vigna unguiculata*), other leaves	Composite sauce 8	Beans dehulling or grounding/washing the leaves/mixing/cooking
		Tomato, seasoning, groundnut, égussi	Composite sauce 9	Washing the leaves/ mixing/cooking
	Young and old dried leaves	Potash, tomato, seasoning	Simple sauce 5	Soaking the dry leaves/ mixing/cooking

[a]Spices, fermented African locus bean condiments.
[b]Slimy leaves or spinach.

Preservation and Preparation Methods of Fresh Vegetables

The fresh leaves of *C. sesamoïdes* and *S. radiatum* were used mostly in the fresh state associated with spices, fermented African locus bean (Afitin, Gnouwi, Kèyokè, Kpantou, Sonru, Iru, or Ouhou), and softening ingredients such as ash filtrate (33.3% respondents) or Kanmu (alkaline rock salt; 93.3% of respondents) to prepare sauces. The leaves can be stored in a tray for less than three days, beyond which they are sun dried for preservation. The general procedure of sauce preparation includes washing, slicing, and cooking. First, fresh leaves of *C. sesamoïdes* or *S. radiatum* were washed by rubbing between the hands, and then sliced and cooked. In some cases, after slicing, maize or sorghum flour can be used to remove sand from the leaves before cooking. Variation in the process depends on associated leaves. In the case of composite-vegetable sauce 1 (table 2), where these species are used, leaves from the cassava plant (*Manihot esculenta,* Crantz*)*, pepper (*Capsicum* sp), baobab (*Adansonia digitata*), rosselle (*Hibiscus sabdariffa*), okra (*Abelmoschus esculentus* (L.) Moench), or cowpea (*Vigna unguiculata* (L.) Walp) were cooked before adding *C. sesamoïdes* and *S. radiatum* leaves to preserve the slimy texture of the sauce. Composite sauce 2, called "Touwoudou" by Berba people, was prepared using *C. sesamoïdes* or *S. radiatum* in association with cowpea beans which could be dehulled (Berba, M'Bermin, Tangamba, Wama) or directly ground (Wama) before cooking. Then, the leaves were added to the cooked beans. Sometimes, tomato sauces and coarse flour of "egussi" (*Citrullus lanatus,* Thunb) or ground groundnut could be added.

As far as *A. uliginosa* and *J. tenella* are concerned, their leaves are mostly used in the fresh state to prepare different types of sauces (table 2). They can be packed in a polyethylene bag, after sprinkling with water, and used within one week. In this respect, the leaves and small stems were cut, washed, and pre-cooked in boiling water with or without kanmu. Then, the pre-cooked leaves and stems were pressed and used for simple sauces. In some cases, the leaves of *J. tenella* could be prepared directly in hot shea butter or groundnut oil for 5 to 10 minutes before adding seasoning. In the same order, within some sociocultural groups (M'bermin), *A. uliginosa* leaves can be mashed and directly introduced into the sauce containing seasoning, with or without oil. Similarly to sauce made from fresh leaves of *C. sesamoïdes* or *S. radiatum*, *A. uliginosa* and *J. tenella* leaves were sometimes associated with other leaves (e.g., rosselle, okra, cowpea, false sesame or black benniseed), cowpea, or spices, or fermented African locust bean, to obtain composite sauces 6, 7, 8, and 9 (table 2).

Preservation and Use of Dried Vegetables

In the dry season, dried leaves were also used to prepare the same type of sauces as those made with fresh leaves. From the beginning of the dry

season, fresh (young and/or old) leaves of *C. sesamoïdes* and *S. radiatum* were sun dried and reduced into a powder with a mortar. In some cases, leaf powder was sieved (1 mm aperture) to remove coarse particles. The resultant fine powder was added to hot water containing seasoning, and then cooked for 5 to 10 minutes to make sauces.

The use of dried *A. uliginosa* and *J. tenella* was not widespread in the survey areas (32.2% of leaves consumers, $n = 180$) compared to dried leaves of *C. sesamoïdes* and *S. radiatum* (100% consumers, $n = 180$). Pretreatment of the dried leaves prior to the preparation of sauces involved soaking in water for 15 to 20 minutes and pre-cooking in boiling water with kanmu.

Relation between Sociocultural Groups and Types of Sauce

Different sociocultural groups have developed specific sauces based on the leafy vegetables under study. Referring to the correspondence analysis (figure 1), the two first axes compiled sufficient amounts of information (82.3% of all information gathered) for interpretation. When modalities of leafy sauces and sociocultural groups are well represented on an axis (limit value is 0.4), they are considered to be associated one to another. Sociocultural groups associated with one axis indicated the correspondence with derived sauces present in this axis.

As far as axis 1 is concerned, Kotokoli, Mahi, and Tchabè sociocultural groups used *C. sesamoïdes* and *S. radiatum* leaves to make simple sauces (C1, S1), composite sauces without beans (C2), and sauces with egussi or groundnut (C5, S5). Furthermore, Tangamba, Wama, and Otamari used *A. uliginosa* to make all types of sauces identified. *S. radiatum* was used by these sociocultural groups to prepare sauces with beans (S3, S4) which are called "Touwoudou," also associated with other leaves (S2).

The sociocultural groups in axis 2 (i.e., M'bermin, Berba, and Pila-pila) added cowpea beans to *C. sesamoïdes* to obtain sauces C3 and C4. These sauces were composites from leaves and cowpea, called "Touwoundou." In contrast, Wama and Otamari used *J. tenella* to prepare sauces with or without other leaves or beans.

Relation between Sociocultural Groups and Consumption Frequency of Leafy Vegetables

Each sociocultural group attached variable importance to each leafy vegetable, expressed through consumption frequency. A correspondence analysis (figure 2) was performed to link, sociocultural groups and consumption frequency per week of *C. sesamoïdes*. The two first axes explained 92.4% of the variation and compiled a sufficient amount of information for interpretation. Consumption frequencies and sociocultural groups of Mahi,

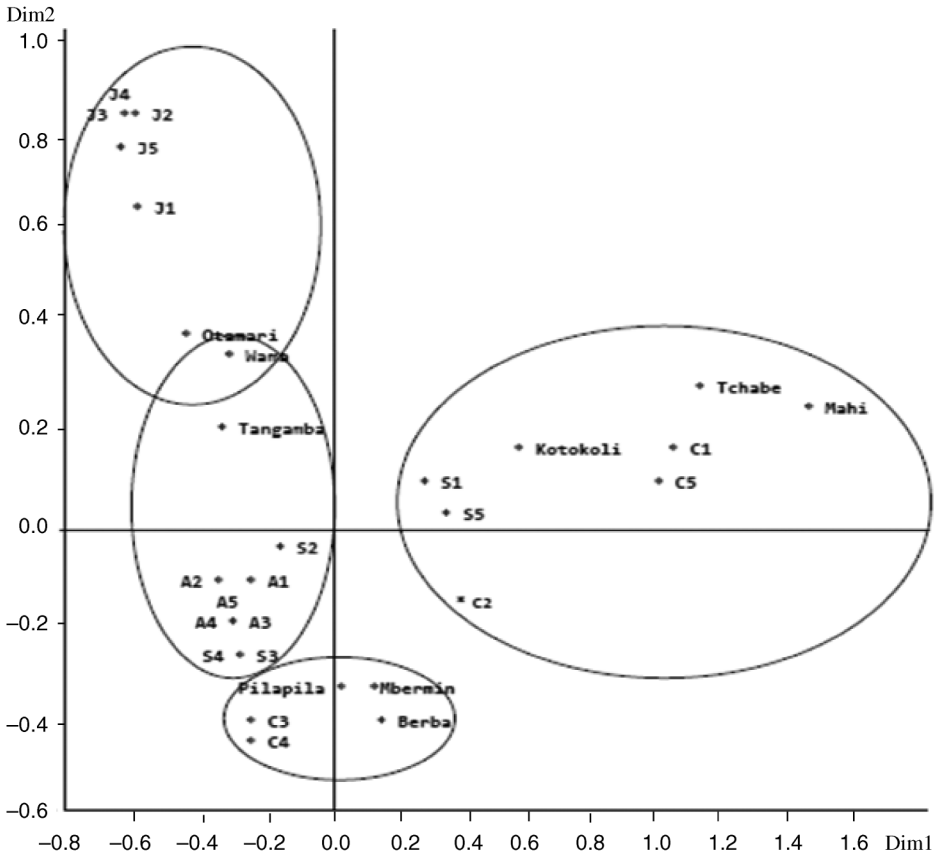

FIGURE 1 Relation between sauces from the leafy vegetables investigated and sociocultural groups. *Note.* C = *Ceratotheca sesamoïdes*; S = *Sesamum radiatum*; A = *Acmella uliginosa*; J = *Justicia tenella*; C1 = Simple sauce 1 and 2; C2 = Composite sauce 1; C3 = Composite sauce 2; C4 = Composite sauce 3; C5 = Composite sauce 4; S1 = Simple sauces 1 and 2; S2 = Composite sauce 1; S3 = Composite sauce 2; S4 = Composite sauce 3; S5 = Composite sauce 4; A1 = Simple sauces 3 and 4; A2 = Composite sauce 6; A3 = Composite sauce 7; A4 = Composite sauce 8; A5 = Composite sauce 9; J1 = Simple sauces 3 and 4; J2 = Composite sauce 6; J3 = Composite sauce 7; J4 = Composite sauce 8; J5 = Composite sauce 9.

Tchabè, Wama, Tangamba, and M'bermin were correlated with the first axis. Considering axis 1, Tchabè, Mahi, and Kotokoli were groups with high consumption frequency (2 to 7 times/ week) of *C. sesamoïdes* in opposition with Tangamba, Wama, and M'bermin groups who consumed this leafy vegetable rarely or once per week.

In the case of axis 2, the low levels (never/rarely and once) were correlated with kotokoli, Otamari, Pila-pila, and Berba groups. On this axis 2, Otamari and Pila-pila consumed rarely or never this species as well as Berba who consumed it once/week.

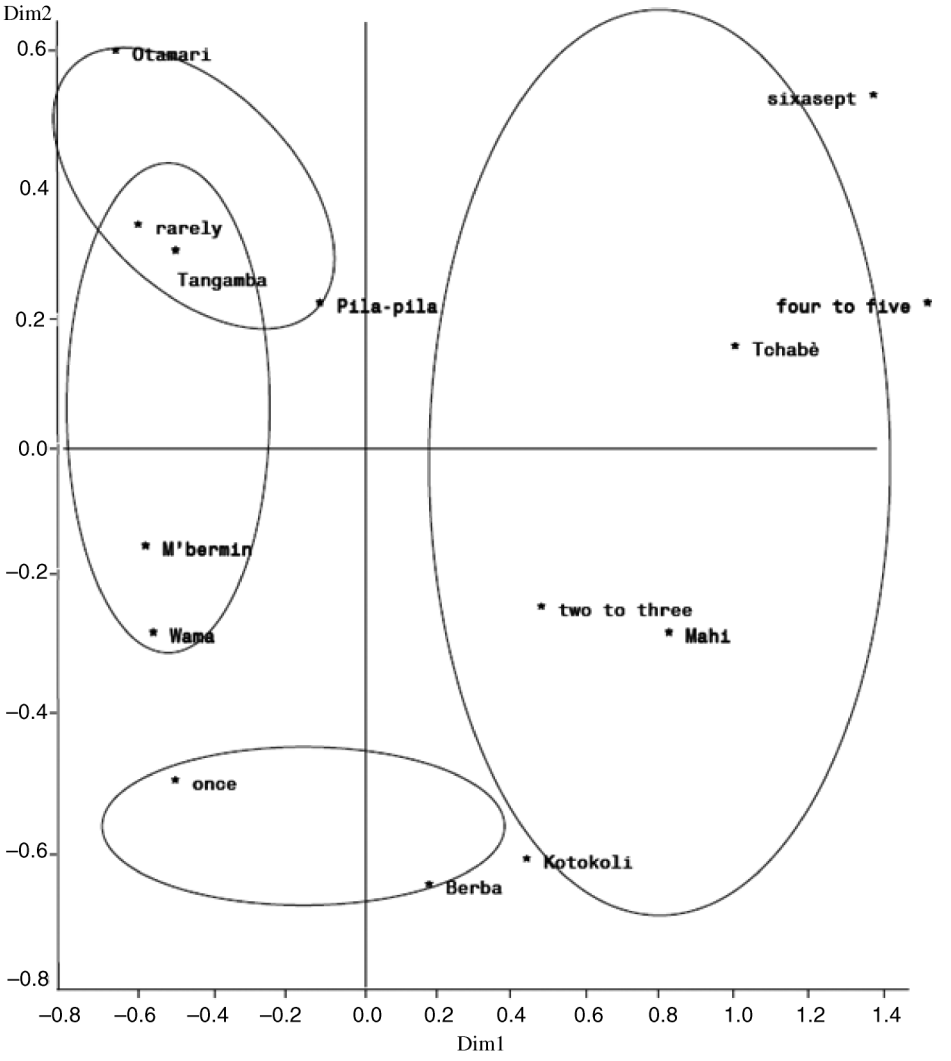

FIGURE 2 Relation between consumption frequency of *Ceratotheca sesamoïdes* and sociocultural groups.

In the case of *S. radiatum* (figures 3 and 4), a correspondence analysis between sociocultural groups and consumption frequency showed that the three first axes explained 94.9% of all information gathered. Consumption frequencies never/rarely, once and 2 to 3 times/week, and sociocultural groups of Mahi, Kotokoli, Wama, Berba, and M'bermin were correlated with axis 1, whereas once/week and 6 to 7 times/week and Tchabè, Otamari, Pila-pila, and Tangamba sociocultural groups were correlated with axis 2. Only frequency of 4 to 5 times/week and Tchabè group were correlated with axis 3. Considering axis 1 (figure 3), Mahi consumed rarely or never

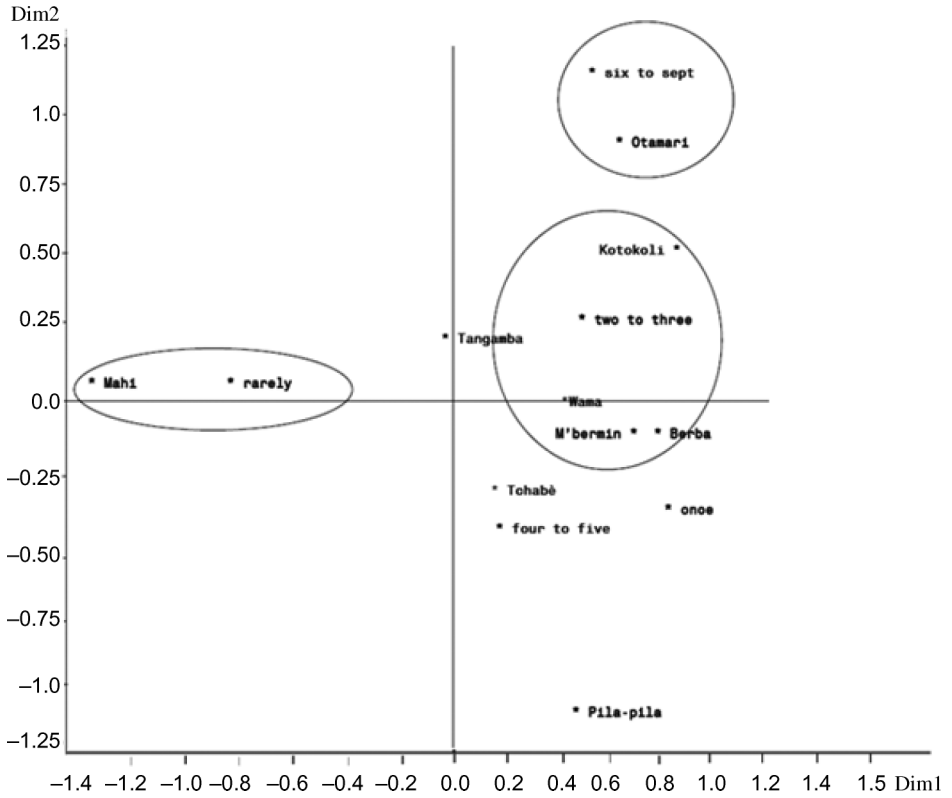

FIGURE 3 Relation between consumption frequency of *Sesamum radiatum* and sociocultural groups on axes 1 and 2.

this leafy vegetable, in opposition with Kotokoli, Berba, Wama, Tangamba, and M'bermin who consumed moderately this leaf (2 to 3 times/week). According to axis 2, most of Otamari (figure 4) had a high level of consumption of *S. radiatum* (6 to 7 times/week) in contrast with Pila-pila who had a low level of consumption (once/week). Then, Tchabè (axis 3) consumed *S. radiatum* more frequently (4 to 5 times/week).

As far as *A. uliginosa* is concerned, a correspondence analysis (figure 5) with sociocultural groups and consumption frequencies showed that the two first axes compiled 92.3% of information. Except once/week, all other frequencies and sociocultural groups of Kotokoli, Tchabè, Mahi, Wama, Berba, and Tangamba were correlated with the first axis. Once/week and Otamari, M'Bermin and Pila-pila were correlated with axis 2. Considering axis 1, Tchabè, Kotokoli, and Mahi sociocultural groups were characterized by rarity of *A. uliginosa* consumption. Wama, Berba, and Tangamba were groups of high consumption (2 to 7 times/week). Regarding axis 2, most of Otamari, Pila-pila, and M'bermin consumed *A. uliginosa* only once per week.

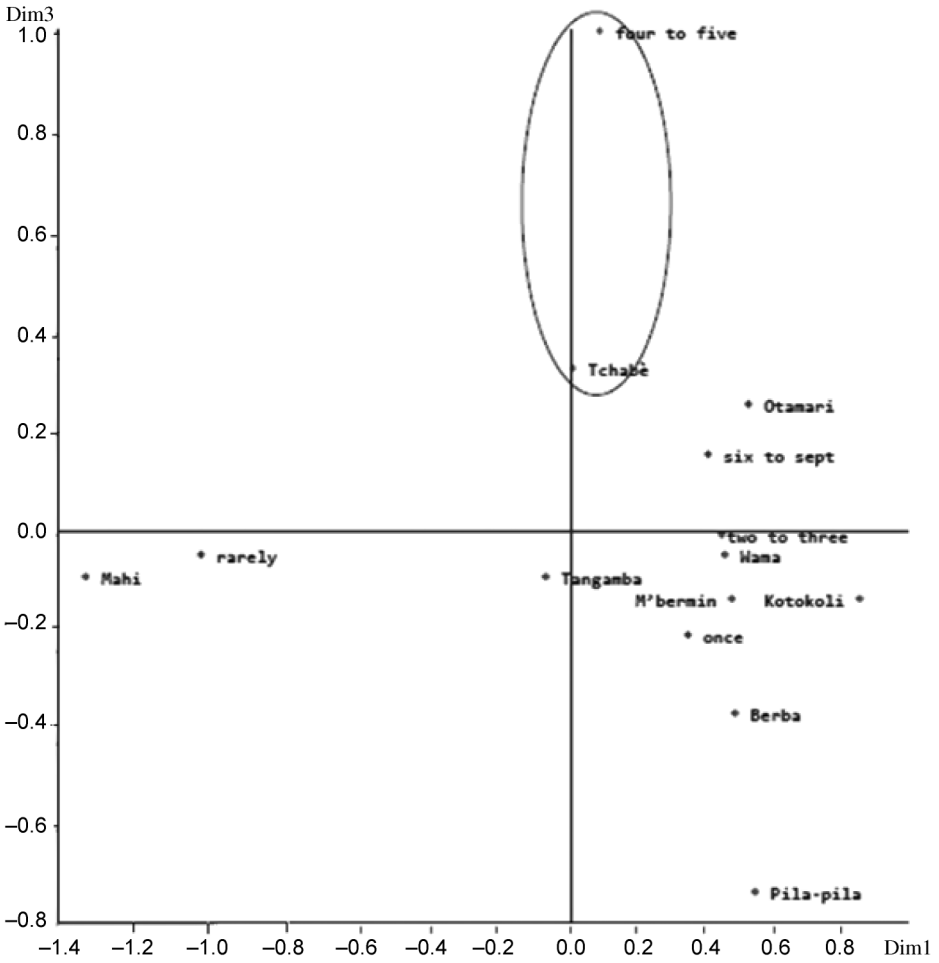

FIGURE 4 Relation between consumption frequency of *Sesamum radiatum* and sociocultural groups on axes 1 and 3.

Considering *J. tenella*, 96.1% of information was explained by the two first axes of correspondence analysis (figure 6). All sociocultural groups were correlated with axis 1. Except 4 times/week, all consumption frequencies were also correlated with axis 1. For axis 1, Mahi, Tchabè, Otamari, M'bermin, Berba, Pila-pila, and Tangamba constituted groups with a low level of consumption of *J. tenella* (never or rarely). Kotokoli consumed once a week while Wama had a moderate level of consumption of this leaf (2 to 3 times/week).

DISCUSSION

Diverse types of sauces prepared using leafy vegetables under study were identified in the investigation areas, in relation with sociocultural groups,

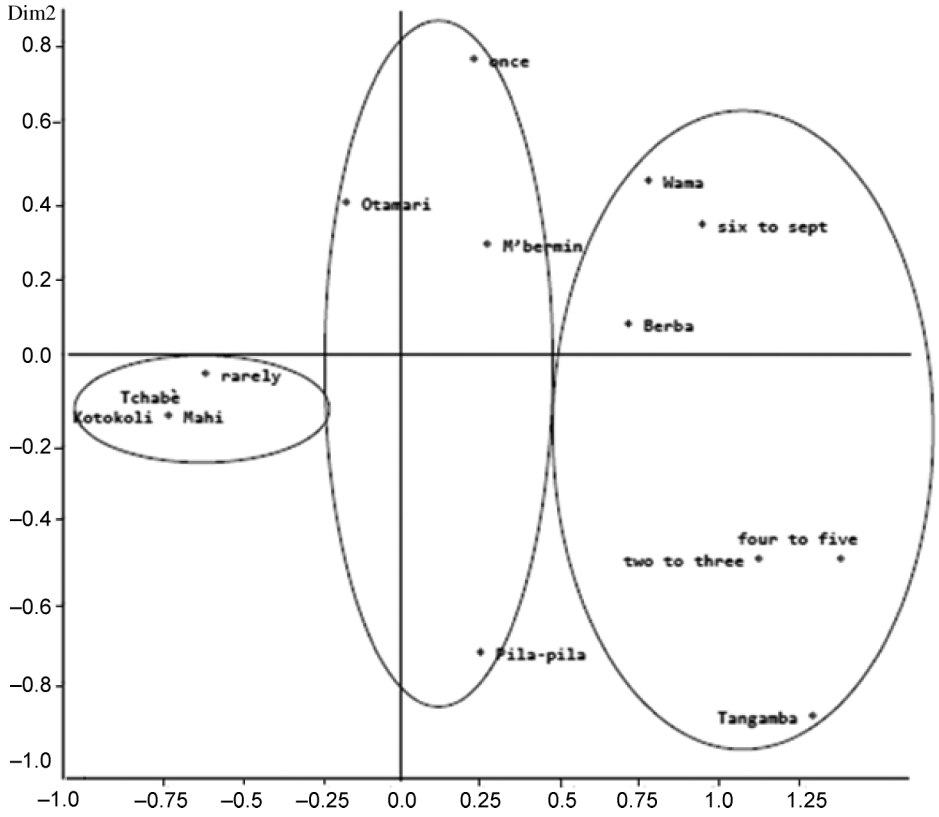

FIGURE 5 Relation between consumption frequency of *Acmella uliginosa* and sociocultural groups.

as a result of food habits, endogenous knowledge and the presence of leaf in living areas. Chadare and colleagues (2008) found that the combination of sociocultural group and its locality may be determinant for their food uses since food eating habits are usually cultural. Similar diversity of sauces based on leafy vegetables was reported by Ponka and colleagues (2006) who mentioned that the sauces prepared in Cameroun were obtained from several green leafy vegetables, leguminous seeds and cucurbit seeds (egussi). Similarly, Chadare and colleagues identified different types of sauces based on baobab leaves with or without association of other leaves or beans. They also reported that people preferred fresh leaves compared to dried ones. Recently, Randrianatoandro and colleagues (2010) mentioned that in Madagascar, dishes are generally made with vegetables, leafy vegetables, or meat which can be associated differently.

The high variability observed in consumption frequency for each leaf studied within and between municipalities confirmed the point of view of Dansi and colleagues (2008) who reported that geographical space and/or cultural identity or origin influenced consumption of traditional

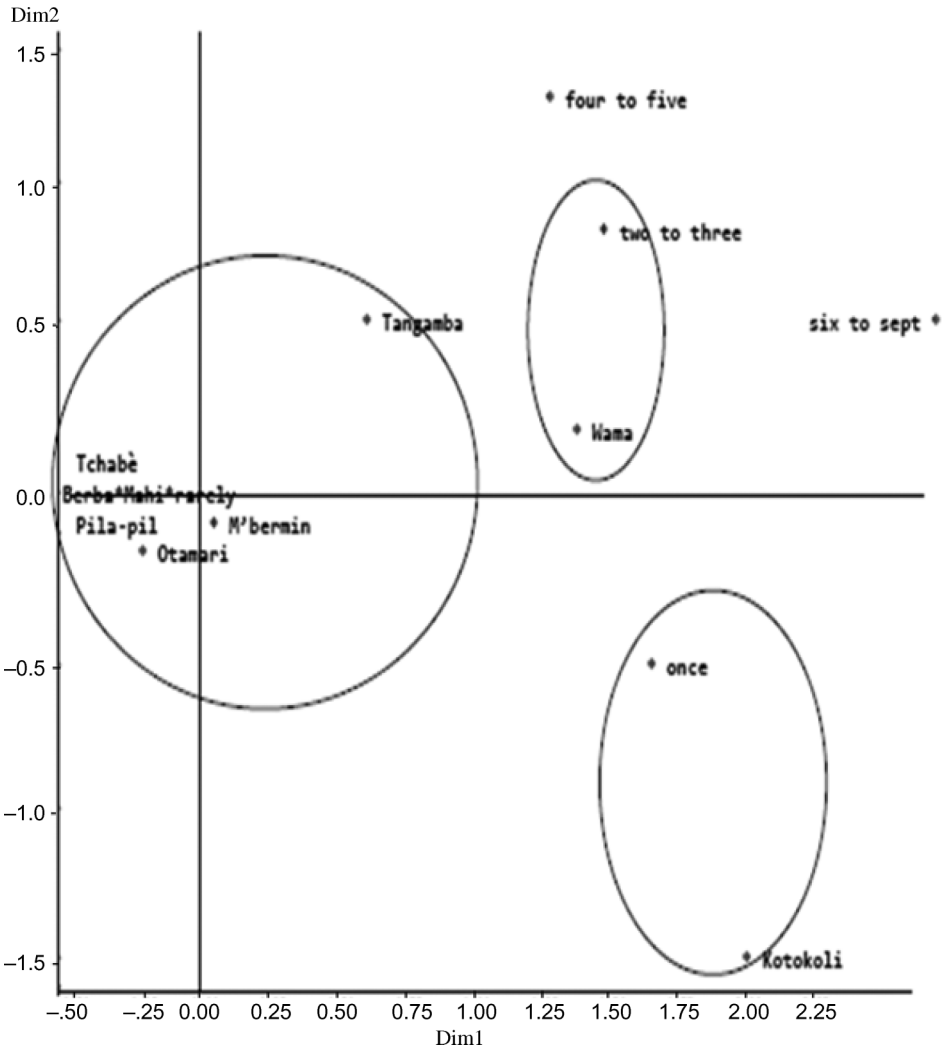

FIGURE 6 Relation between consumption frequency of *Justicia tenella* and sociocultural groups.

leafy vegetables. Hart and colleagues (2005) who studied vegetable pattern consumption of households in Nigeria showed that the consumption of vegetables was chiefly influenced by culture and season. Thus, the high frequency of consumption of *C. sesamoïdes* by Tchabè, Mahi, and Kotokoli could be explained by ethno botanical knowledge of these sociocultural groups. Indeed, 67.2% of Tchabè and 24.1% of Mahi attributed properties such as, ease of delivery of pregnant women, enhancing of male sterility, and treating burns, conjunctivitis and haemorrhoids to this leafy vegetable.

In addition, Dansi and colleagues reported that *C. sesamoïdes* gave stoutness and facilitated good growth, good dentition and bones solidification to the children when it is used frequently. According to 69.6% of respondents ($n = 300$), hunters and supernatural power owners (from Wama, Tangamba, and M'bermin sociocultural groups) are not allowed to consume *C. sesamoïdes* since the consumption of this leafy vegetable reduces their power. Similar credence was found in the northwest of Benin by Dansi and colleagues. Batawila and colleagues (2007) also found that in some sociocultural groups of Togo, consumption of *C. sesamoïdes* was prohibited to people initiated to supernatural power and hunters. The low frequency of consumption of S. *radiatum* by the Mahi group could be explained by the perception of the leaf quality as expressed by the vernacular name "Ningbo," which means "unpleasant smell feeling." Bedigian (2004) reported that *S. radiatum* was described by herbarium as antibiotic, bad, disagreeable, malodorous, nauseating, repulsive, stinking, urine-scented, and the like. These characteristics of *S. radiatum* can explain the reluctance of Mahi people to consume it.

The low frequency of consumption of *A. uliginosa* leaf by Mahi and Tchabè groups could be explained by their localization in the center of Benin where this leaf was not found and known. Dansi and colleagues (2008) reported that M'bermin and Wama were groups of high level of consumption of *A. uliginosa*. In our study, the M'bermin group (located in Cobly, northern municipality) did not have the ease to consume *A. uliginosa*. According to local people, this region is too arid (rainfall about 1,000 mm) and their soil is too poor. *A. uliginosa* is a vegetable which grows in humid areas (Grubben and Denton 2004). In Cobly, housewives don't cultivate this leafy vegetable and have to buy it at surrounding localities where the conditions are favorable for its production. Indeed, only 16.7% of respondents ($n = 30$) in Namoutchiaga village (Cobly municipality) cultivated *A. uliginosa*, while 70% bought it. There are constraints to the consumption of *A. uliginosa* for the M'bermin sociocultural group living in this village, although over 74% of M'bermin had much ethnobotanical knowledge of this leaf. *A. uliginosa* is used in this region to treat stomach ache and diarrhea. It is also used as anthelmintic, recognized as a stimulating agent of breast milk, and to ease digestion. It is also known to stimulate appetite and facilitate the elimination of blood after delivery.

J. tenella was less known by respondents than *A. uliginosa* in Savè, Savalou, Cobly, Tanguiéta, Cotiakou, and Pam-pam municipalities. This can be explained by the fact that in some localities such as Namoutchiaga (M'bermin), it was very difficult for housewives to grow *J. tenella* because of the aridity of their climate and the difficulty harvesting the seeds for another season, as the seeds are too small and scatter very quickly on the field.

It has been reported that the promotion of the consumption of green leafy vegetables in Ethiopia, Kenya, and Tanzania has reduced the prevalence of xerophthalmia observed in those countries (Wolde-Gebriel et al.

1991). It appears that leafy vegetables are sources of diet diversification and could contribute to food and nutritional security in African rural areas. Indeed, the use of some ingredients such as ash filtrate and kanmu can enhance the mineral profile of sauces prepared with these leaves. However, some research on leafy vegetables showed that some processing treatments reduced the level of minerals and vitamins in derived products (Ndawula, Kabasa, and Byaruhanga 2004; Mepha, Eboh, and Banigo 2007; Lisiewska et al. 2009). Whether this is the case with the vegetables studied in this research has yet to be investigated.

CONCLUSION

Sesamum radiatum, Ceratotheca sesamoïdes, Acmella uliginosa and Justicia tenella are variably processed and consumed by the different sociocultural groups located in the study areas. The endogenous knowledge accumulated on these leaves plays a leading role in their common uses, their preservation, and the diversification of diets in rural areas. More research is needed to determine the proximal composition, micronutrient content, and antinutritional and antioxidant components of these leafy vegetables, and to assess the influence of traditional processing methods on the nutritional values of derived sauces.

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REFERENCES

Afolayan, A. J., and F. O. Jimoh. 2009. Nutritional quality of some wild leafy vegetables in South Africa. *International Journal of Food Sciences and Nutrition* 60 (5): 424–431.

Akubugwo, I. E., N. A. Obasi, G. C. Chinyere, and A. E. Ugbogu. 2007. Nutritional and chemical value of *Amaranthus hybridus* L. leaves from Afikpo, Nigeria. *African Journal of Biotechnology* 6 (24): 2833–2839.

Akoègninou, A., W. J. Van der Burg, and L. J. G. Van der Maesen. 2006. *Flore analytique du Bénin*. Leiden: Backhuys Publishers.

Avallone, S., S. Brault, C. Mouquet, and S. Trèche. 2007. Home-processing of the dishes constituting the main sources of micronutrients in the diet of preschool children in rural Burkina Faso. *International Journal of Food Sciences and Nutrition* 58:108–115.

Batawila, K., S. Akpavi, K. Wala, M. Kanda, R. Vodouhe, and K. Akpagana. 2007. Diversité et gestion des légumes de cueillette au Togo. *African Journal of Food Agriculture Nutrition and Development* 7 (3): 1–16.

Bedigian, D. 2004. Slimy leaves and oily seeds: Distribution and use of wild relatives in Africa. *Economic Botany* 58 (suppl.): S3–S33.

Burkitt, D. P. 1973. Epidemiology of large bowel disease: The role of fibre. *Proceedings of the Nutrition Society* 32:145–149.

Chadare, F. J., J. D. Hounhouigan, A. R. Linnemann, M. J. R. Nout, and M. A. J. S. van Boekel. 2008. Indigenous knowledge and processing of *Adansonia digitata* L. food products in Benin. *Ecology of Food and Nutrition* 47:338–362.

Codjia, J. T. C., A. E. Assogbadjo, and M. R. M. Ekué. 2003. Diversité et valorisation au niveau local des ressources forestières alimentaires végétales du Bénin. *Cahiers Agriculture* 12:321–331.

Dansi, A., A. Adjatin, R. Vodounhè, K. Adéoti, H. Adoukonou-Sagbadja, V. Faladé, H. Yedomonhan, A. Akoègninou, and K. Akpagana. 2008. *Biodiversité des légumes-feuilles traditionnels consommés au Bénin*. Porto-Novo, Bénin: Bibliothèque Nationale.

Delisle, H., S. Bakari, G. Gevry, C. Picard, and G. Ferland. 1997. Teneur en provitamine A de feuilles vertes traditionnelles du Niger. *Cahiers Agricultures* 6:553–560.

FAO/WHO (Food and Agricultural Organization of the United Nations/World Health Organization). 1988. Requirements of vitamin A, iron, folate and vitamin B12. Report of a Joint FAO/WHO Expert Consultation. FAO Food and Nutrition Series No. 23, Food and Agricultural Organization of the United Nations, Rome.

Fasakin, K. 2004. Proximate composition of bungu (*Ceratotheca sesamoides* Endl.) leaves and seeds. *Biokemestri* 16 (2): 88–92.

Gibson, R. S., and E. L. Ferguson. 1999. An interactive 24-hour recall for assessing the adequacy of iron and zinc intakes in developing countries. Washington, DC: International Life Science Institute.

Greenacre, M. J. 1993. *Correspondence analysis in practice*. London: Academic Press.

Grubben, G. J. H., and O. A. Denton. 2004. *Plant resources of tropical Africa 2. Vegetables*. PROTA Foundation. Leiden, The Netherlands: Backhuys Publishers.

Hart, A. D., C. U. Azubuike, I. S. Barimalaa, and S. C. Achinewhu. 2005. Vegetable consumption pattern of households in selected areas of the old Rivers State in Nigeria. *African Journal of Food Agriculture and Nutritional Development* 5 (1): 1–19.

Lisiewska, Z., P. Gebczynski, E. Bernas, and W. Kmiecik. 2009. Retention of mineral constituents in frozen leafy vegetables prepared for consumption. *Journal of Food composition and Analysis* 22:218–223.

Mepha, H. D., L. Eboh, and D. E. B. Banigo. 2007. Effects of processing treatments on the nutritive composition and consumer acceptance of some Nigerian edible leafy vegetables. *African Journal of Food Agriculture and Nutritional Development* 7 (1): 1–18.

Ndawula, J., J. D. Kabasa, and Y. B. Byaruhanga. 2004. Alterations in fruit and vegetable β-carotene and vitamin C content caused by open-sun drying, visqueen-covered and polyethylene-covered solar-dryers. *African Health Sciences* 4 (2): 125–130.

Ndong, M., S. Wade, N. Dossou, A. T. Guiro, and R. Diagne Gning. 2007. Valeur nutritionnelle du *Moringa oleifera*, étude de la biodisponibilité du fer, effet de l'enrichissement de divers plats traditionnels sénégalais avec la poudre des feuilles. *African Journal of Food Agriculture and Nutritional Development* 7 (3): 1–17.

Ndoye, O., M. Ruiz-Perez, and A. Eyebe. 1997. The market of non-timber forest products in the humid forest zone of Cameroon. Rural Development Forestry Network, network paper 22c, 20, ODI, London.

Olson, G. 1991. Socio-economic importance of non-timber forest products in the South Pacific. Focus on Vanuatu. *Unasylva* 42 (65): 24–30.

Ponka, R., E. Fokou, M. Fotso, F. M. Tchouanguep, R. Leke, J. Souopgui, and M. A. Bih. 2006. Composition of dishes consumed in Cameroon. *International Journal of Food Science and Technology* 41:361–365.

Randrianatoandro, V. A., S. Avalonne, C. Picq, C. Ralison, and S. Trèche. 2010. Recipes and nutritional value of dishes prepared from green-leafy vegetables in an urban district of Antananarivo (Madagascar). *International Journal of Food Sciences and Nutrition* 61 (4): 404–416.

Smith, G. C., M. S. Clegg, C. L. Keen, and L. E. Grivetti. 1996. Mineral values of selected plant foods common to southern Burkina Faso and to Niamey, Niger, West Africa. *International Journal of Food Sciences and Nutrition* 47:41–53.

Tchiegang, C., and A. Kitikil. 2004. Données ethnonutritionnelles et caractéristiques physico-chimiques des légumes-feuilles consommés dans la savane de l'Adamaoua (Cameroun). *Tropicultura* 22:11–18.

Vanderjagt, D. J., C. Freiberger, H. T. N. Vu, G. Moukaila, and R. H. Glew. 2000. The trypsin inhibitor content of 61 wild edible plant foods of Niger. *Plants Foods for Human Nutrition* 55:335–346.

Wolde-Gebriel, Z., T. Demeke, and C. E. West. 1991. Xerophthalmia in Ethiopia: A nationwide ophthalmological, biochemical and anthropometric survey. *European Journal of Clinical Nutrition* 45:469–478.