Collection of genetic resources of selected traditional African vegetables in agroecological zones of Benin

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Abstract

Traditional African vegetables contribute to the reduction of food and nutrition insecurity and the strengthening of human health in urban and rural communities in Africa. They occupy a prominent place in people's livelihoods as food, medicine and source of income. However, this diversity needs to be conserved, made available to users, valorized and improved to avoid any loss of variability within and among these species so as to save them for future generations. In this perspective, the Laboratory of Genetics, Biotechnology and Seed Science in agreement with the World Vegetable Center organized a germplasm collection of traditional African vegetable crops and wild relatives in 24 municipalities districts covering all the eight agro ecological zones of Benin. Passport data were recorded for each collected accession. This activity generated a total of 1412 accessions for 18 species that are currently stored at the gene bank unit of the laboratory. *Abelmoschus esculentus, Amaranthus cruentus, Corchorus olitorius, Solanum macrocarpon* and *Lagenaria siceraria* were the top five species collected. Around 76% of seeds providers used previous harvest seeds. Moreover, the collected species are all used by local communities for multiple purposes; the use as food being common to all of the species. Others utilizations include for instance, income generation, medicines, forage, arts, rituals and firewood. This collection provides insights into the existing variability within the selected traditional African vegetables and opens the doors for more investigations and improvement of the targeted species.

Keywords: Underutilized crops, germplasm, variability, utilizations, improvement.

INTRODUCTION

In tropical countries, there is a wide variety of plant species that can significantly contribute to food security and human health (Cullis and Kunert, 2017). Among them, Traditional African Vegetables (TAVs) are of great importance to many Sub-Saharan African communities because they are easily grown and are an affordable source of nutrients. Moreover, they provide a good income for smallholder farmers (Yang and Keding, 2009), play an important role in the diversification of farm systems and generate more climate-resilient food production (Van Zonneveld et al., 2020a).

Despite their importance, TAVs have been underutilized by farmers and neglected by research and development programs. That situation has led to a loss of traditional knowledge about these species, as well as the loss of local landraces and populations (Keller et al., 2005; Pilling et al., 2020). It is therefore imperative to adequately collect and conserve the diversity within the gene pools, including the wild relatives so that these resources can be used in the broadening of the genetic base in crop improvement programmes. Recent study from van Zonneveld et al. (2020b) examined the geographical diversity and conservation status of TAVs in Sub-Saharan Africa. The authors have shown that vegetable genetic resources from West Tropical Africa and South Cameroon are least represented in ex situ collections. Moreover, Benin and Cameroon in particular are listed to be priority countries for germplasm collecting, because of the high levels of vegetable diversity observed in them.

In the framework of ensuring the conservation of the available genetic diversity of these vegetables in Benin, the Laboratory of Genetics, Biotechnology and Seed Science (GBioS) of the

Faculty of Agricultural Sciences (FSA) of the University of Abomey-Calavi (UAC) and the World Vegetable Center have initiated a germplasm collection to all the eight agroecological zones in Benin from July to September 2020. This paper reports the results of a survey conducted throughout the country in order to improve the ex situ collections of TAVs.

MATERIALS AND METHODS

The Republic of Benin is located in West Africa and between the latitudes 6°10' N and 12°25' N and longitudes 0°45' E and 3°55' E (Adam and Boko, 1993). The germplasm collection was carried out from July 14th to 29th, 2020 by eight research assistants of GBioS, each person covering three districts, making a total of 24 districts (Figure 1). For a good coverage of the country and an efficient collection of diversity, the selected districts are located in all agro-ecological zones. These districts were selected as potential areas to collect based on the results from Achigan-Dako et al. (2010). A collecting form was crafted and uploaded on smartphone using KoboCollect Application and a Prior Informed Consent (PIC) was edited and printed for signature by all participating farmers. This form provided passport data on the accessions and this included the accession code, location collected, origin and use by the seed provider, the local name of the landrace and wherever possible the name and contact of the supplier. The respondents were selected using the snowball sampling methods. The catalogue of Traditional Vegetables in Benin (Achigan-Dako et al., 2010) was used to have the local names and pictures of the species so that producers and seed providers could quickly recognize the target species. The collectors went through 217 villages and interviewed more than 470 farmers. On the seed envelopes, the collectors recorded the accession code, the scientific name, the local name of the landrace, the location where it was collected and any other useful information about the accession. The accession code was a combination of three elements: 1-2-3. The first part "1" represents the initials of the scientific name of the species; the second part "2" is the first three letters of the district in which the accession was collected and the third part "3" stands for the chronological sample number for the accession.

RESULTS AND DISCUSSION

Species richness

The germplasm collection resulted in 1412 accessions from 18 species including: *Solanum macrocarpon, Solanum americanum, Solanum nigrum, Solanum aethiopicum, Solanum scabrum, Amaranthus spinosus, Amaranthus cruentus, Amaranthus viridis, Momordica charantia, Cucurbita maxima, Cucumis melo, Lagenaria sicenaria, Citrullus lanatus, Corchorus olitorius, Abelmoschus esculentus, Abelmoschus callei, Abelmoschus manihot* and *Gynandropsis gynandra* (Figure 2). The greatest number of accessions (Figure 3) was collected for *Abelmoschus esculentus* (216), followed by *Amaranthus cruentus* (155), *Corchorus olitorius* (152) and *Solanum macrocarpon* (140). These four species are among the six considered of high potential for food and nutrition (van Zonneveld et al., 2020b). Moreover, *Solanum macrocarpon, Corchorus olitorius* and *Amaranthus cruentus* were considered as the leafy vegetables of top high national priority (Dansi et al., 2008). On the other hand, few accessions were collected for *Solanum nigrum* (2), *Solanum americanum* (14), and *Solanum scabrum* (15). Almost all the collected species were recorded by Dansi et al. (2008) except *Abelmoschus callei, Abelmoschus manihot, Amaranthus viridis* and *Cucumis melo*.

Geography and gender considerations

A higher number of accessions were collected from the agroecological zones of the central cotton zone (321) and the West Atacora zone (227) both located in the northern part of the country while the depression zone (60) and the area of fisheries (105) recorded the lowest number of collected accessions and were in the southern part. This could indicate an abundance

of target species in the North than in the South, due to the extent of cultivable areas in the North. Figure 4 indicates the number of accessions collected for each species per agroecological zones. All the species were collected in the eight agroecological zones except *Solanum nigrum, Abelmoschus manihot, Solanum scabrum, Solanum americanum, Solanum aethiopicum, Cucumis melo, Citrullus lanatus* and *Cucurbita maxima*.

Regarding gender consideration, most of the respondents and seed providers were men. However, in the northern part of the country, there were more women seed providers than men. An opposite trend was observed in the southern and central part of Benin, as illustrated in Figure 5.

Seed source

More than 76% of the respondents and seed providers used seeds from their previous harvest, as shown in Figure 6. Moreover, some seeds were found wild or in the neighbourhood of the respondents while some were purchased at market or from some informal local seed producers or offered mostly by projects (PADMA for instance) or neighbours.

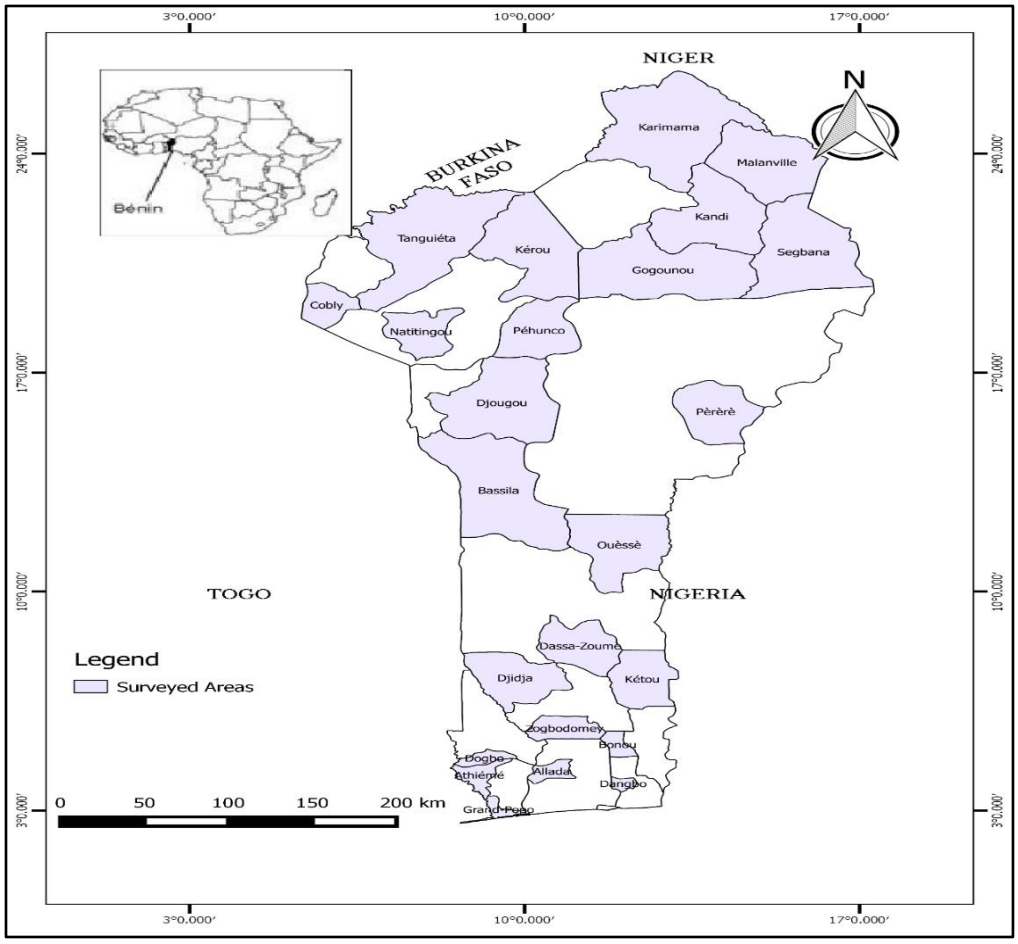

Figure 1: Map of collecting area of traditional African vegetables

Figure 2: Images of eight traditional African vegetables. a – d: the most-collected TAVs. a. Okra (*Abelmoschus esculentus*); b. African eggplant (*Solanum macrocarpon*); c. jute mallow (*Corchorus olitorius*); d. amaranth (*Amaranthus cruentus*); e. okra (*Abelmoschus manihot*); f. bitter gourd (*Momordica charantia*); g. bottle gourd (*Lagenaria siceraria*); h. African nightshade (*Solanum scabrum*). Photos: GBioS

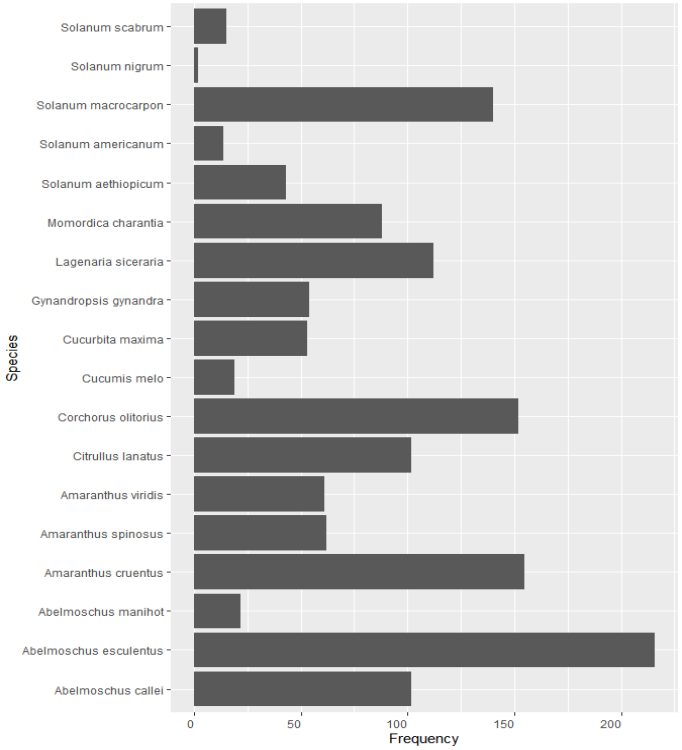

Figure 3: Number of accessions collected per species

Figure 4: Number of accessions collected per species per agroecological zone

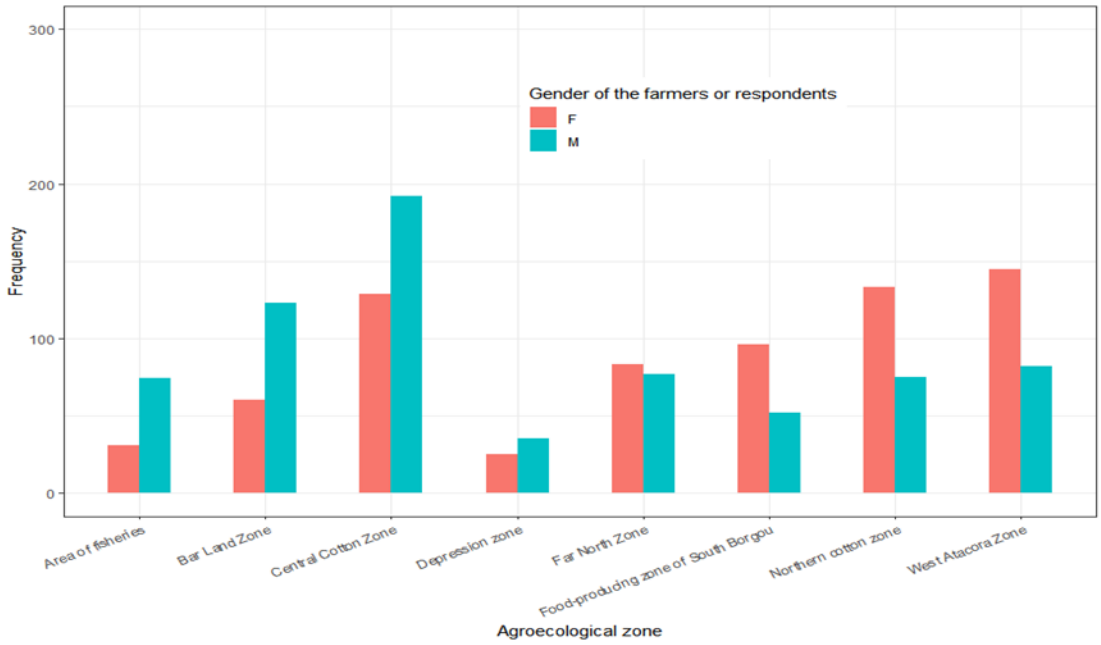

Figure 5: Gender of respondents per agroecological zone

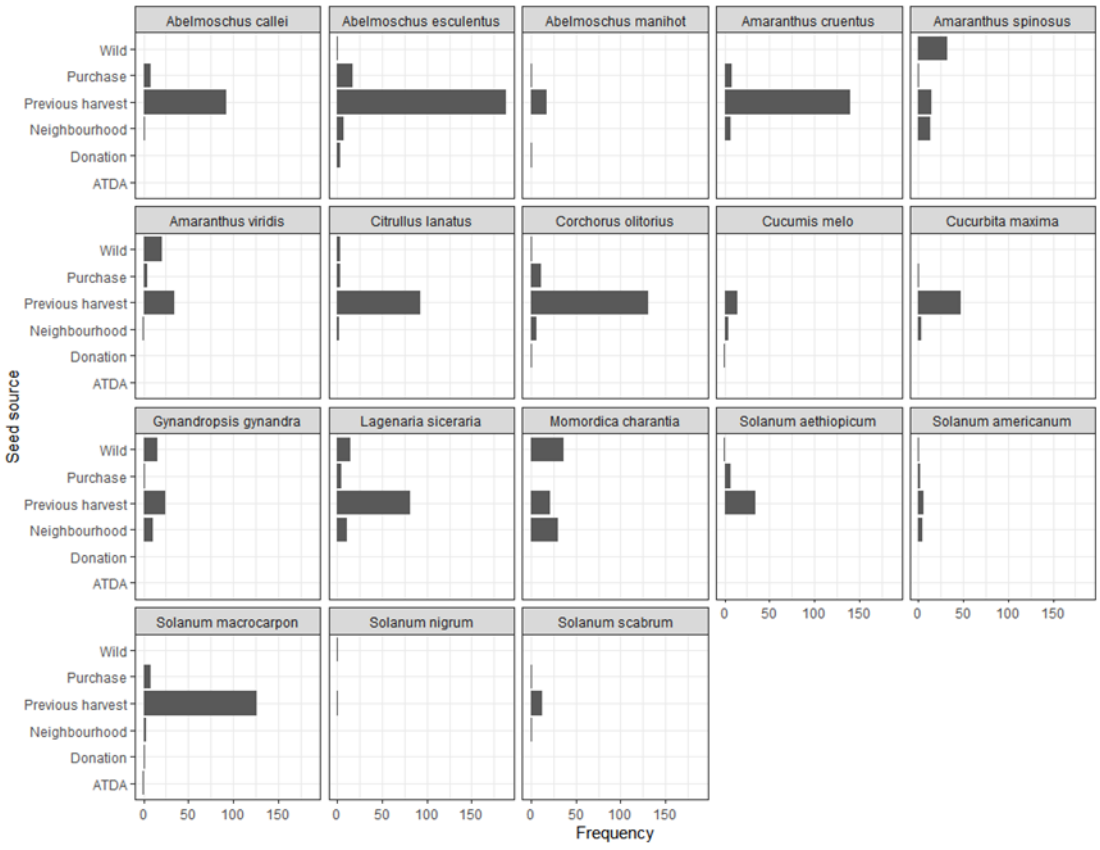

Figure 6: Seed source per species

Utilizations of species

Seventeen species other the eighteen are used for multi-purposes by local communities. The utilizations as food are the most common, followed by the uses for sale, for medicinal purposes, for forage, for arts, for rituals and finally for firewood. All the collected species are mentioned to be used for food as well as for sales purposes with higher scores for *Abelmoschus esculentus*, *Amaranthus cruentus*, *Corchorus olitorius* and *Solanum macrocarpon* (Figure 7). These four species were among the most widely traded vegetables for the whole of the country as reported by Achigan-Dako et al. (2010). Although all eaten, some sister species are not prepared the same way by growers. For those of the genus *Abelmoschus*, for example, the preparation of *Abelmoschus manihot* differs from that of the others; it is not cut with a knife but rather crumbled by hand before putting it on the fire. Some species are also used for their medicinal properties and mainly include *Momordica charantia*, *Lagenaria siceraria*, *Abelmoschus esculentus*, *Amaranthus spinosus*, *Solanum americanum* and *Gynandropsis gynandra*. Regular consumption of *Momordica charantia* leaves can cure, for example, measles and vomiting (Dansi et al., 2008). Despite the medicinal properties reported on *Abelmoschus manihot* (Todarwal et al., 2011), few people surveyed used it as a medicine. Moreover, the species is reported to be used in okra improvement for its resistance against yellow vein mosaic virus (YVMV), white flies, *Fusarium* wilt, *Alternaria* blight, powdery mildew as well as for abiotic stresses (Pandey et al., 2016; Sharma and Arora, 1993). *Lagenaria siceraria* is also said to be used for rituals, income and arts. Besides, some respondents reported the use of *Amaranthus spinosus* and *Amaranthus viridis* as forage.

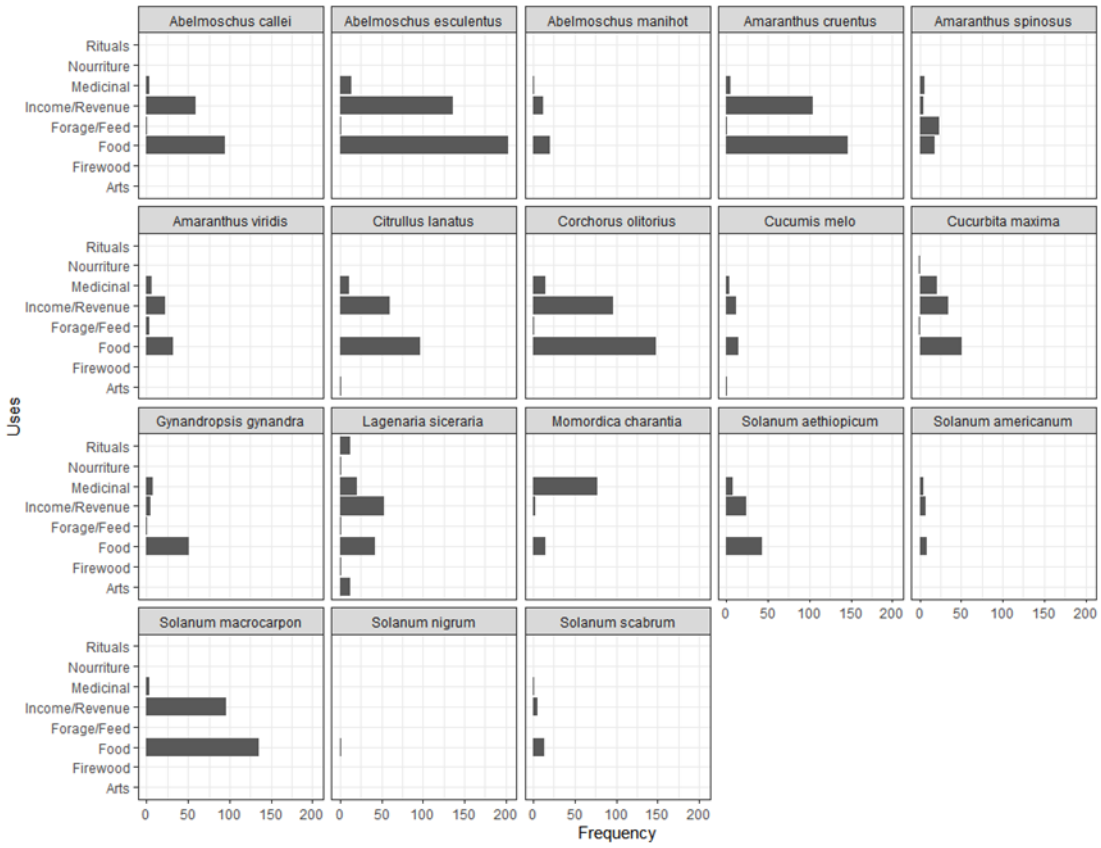

Figure 7: Uses of collected accessions per species

Perpectives

From this collection, studies should be initialized to provide insights on the variability within the collected TAVs though morphological characterisation and agronomic evaluation of accessions within polymorphic species for breeding purposes. Deep ethnobotanical studies must

be conducted to document the drivers of management of those TAVs across Different Socio-linguistic Groups. The domestication process and development of appropriate agronomic practices for some TAVs must be planned. Moreover, nutritional aspect and nutraceutical properties of the collected species must not be overlooked. Investigations should also be carried out on the existence of intermediate forms within sister species, resulting from natural interspecific hybridization, for instance between *Abelmoschus esculentus* and *Abelmoschus callei*.

CONCLUSION

This study intend to collect germplasm of TAVs in agroecological zones of Benin. It yielded the collection of 1412 accessions from 18 species with the most accessions collected for some high national priority species. The collected species were all used by local communities for many purposes. Pertinent investigations must be conducted to ensure the conservation and improvement of these collected TAVs.

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