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Research Article

STATE OF PLACE AND ENDOGENOUS KNOWLEDGE OF *SOLANUM MACROCARPON* L. GROWN IN BURKINA FASO

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A B S T R A C T

Solanum macrocarpon is a species native to Africa that is of considerable importance to the population both for their diet and their health needs. However, in Burkina Faso, it is little known and there is also little data on the extent of its cultivation, as well as its genetic diversity. The objective of this study is to contribute to a better knowledge of the diversity of *S. macrocarpon* L. cultivated in Burkina Faso based on endogenous local knowledge focused on its management. Thus, an ethnobotanical survey coupled with a collection survey were carried out using a semi-structured interview and an exhaustive collection method. This study identified the areas where *S. macrocarpon* was grown and collected 36 accessions from one hundred and two prospected market gardeners. It also revealed a gradual abandonment of culture (35.30 % of respondents) in all the areas concerned. Finally, it appears from this study that *S. macrocarpon* is an important leaf and fruit vegetable for the population of the survey area. Thus, given the above all nutritional interest generated by this species and above all in order to preserve and enhance it, more in-depth studies such as its agromorphological, physico-chemical and molecular characterization are therefore necessary.

INTRODUCTION

Plant genetic resources are the key to food security and sustainable agricultural development. However, the earth's plant diversity is seriously threatened (CGIAR, 1994; Diouf *et al.,* 2007). Traditional varieties of so-called neglected and underutilized crop species are disappearing in several tropical regions due to the introduction and large-scale cultivation of cash crops and exotic varieties (Brush, 1995; Tamini *et al*., 1995 ; Zoro Bi *et al.,* 2003). However, studies of crop diversity have clearly shown that traditional varieties, although less often productive, are genetically more diversified than improved varieties (Brown, 1982 ; Ahmadi *et al.,* 1988) and their conservation contributes to the maintenance of this genetic richness (Frankel *et al.,* 1995). Among these traditional varieties is *Solanum macrocarpon* (Gboma). Indeed, Solanum macrocarpon is one of the important indigenous vegetables grown in Africa for its leaves and fruits that are used in the preparation of sauces and many other culinary preparations. Studies on its biochemical composition show that it is rich in mineral salts, fibre, proteins and other nutrients essential for normal body growth and health (Agoreyo *et al.,* 2012; Nyadanu and Lower, 2014).

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Also, the sale of its edible parts is a source of income for many households (Adeyeye and Adanlawo, 2011). Finally, the different parts of the plant have a wide variety of medicinal uses (Oboh *et al.,* 2005; Nwodo *et al.,* 2011). Despite its proven nutritional, medicinal and economic potential, the species is still unknown and there is very little scientific data on its genetic diversity in Burkina Faso. The objective of this study is to contribute to a better knowledge of *Solanum macrocarpon* by using endogenous local knowledge focused on its management. Specifically, this involves (i) identifying local knowledge on the management of the species, (ii) identifying areas of its cultivation, (iii) identifying the preferential characteristics of producers and consumers and (iv) establishing a national collection for future research.

MATERIALS AND METHODS

Presentation of the study environment

This study was carried out in most of Burkina Faso. Located in the heart of West Africa, Burkina Faso covers an area of 274200 km². It shares its borders with Mali to the north and west, Côte d'Ivoire to the southwest, Ghana and Togo to the south, Benin to the southeast and Niger to the east. Its estimated population of about 18 million inhabitants in 2014 is 51.4 % female and 48.6 % male, with an average annual increase of about 3.1 %. The majority, 77.3 % of the population, live in rural areas (INSD, 2015). The Burkinabe

population includes about sixty ethnic groups, the main ones in terms of numerical proportion being the Mossé (48%) who occupy the central part of the country. The Peulhs (10 %) occupy the northern part, the Bobos (7 %) are found in the west, the Gourmantchés (7 %) in the east, the Gurunsi (7 %) in the southcentral part and the Lobis (7 %) in the southwest. The Mandés (6.7 %), composed of Marka and Samos, meet in the northwestern part of the country while the Senoufos (5.3 %) occupy the far western part of the country. Minor ethnic groups represent 9 % of the population (INSD, 2015). The climate is tropical with a predominantly Sahelian climate with a more humid area in the south. It is subdivided into three climatic domains according to the position of the annual rainfall isohyets (Figure 1). These are the Sahel domain (about 600 mm/year), the Sudano-Sahel domain (600 -900 mm/year) and the Sudanese domain (900 -1200 mm/year) (Thiombiano and Kampmann, 2010).

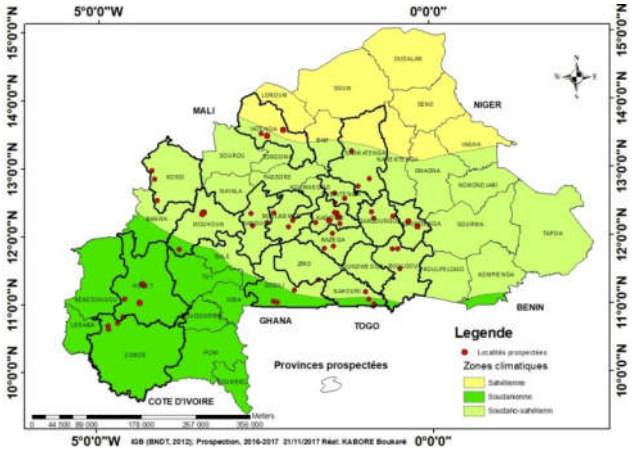


Figure 1 Map of the *S. macrocarpon* prospecting area in Burkina Faso

METHODOLOGY

Prospection-collection of accessions and ethnobotanicalsurvey

Surveys followed by an ethnobotanical survey associated with access collections were carried out between December 2016 and March 2017. The surveys were carried out in collaboration with the technical agents (head of ZAT) of the Ministry of Agriculture who are in contact with market gardeners. It made it possible to identify the provinces and villages where S. macrocarponis grown. The survey method used was that of individual and semi-structured interviews with market gardeners from the various identified sites. To this end, a questionnaire taking into account the socio-cultural and economic aspects of *S. macrocarpon* was drawn up. At the end of the interviews, accesses were collected and thenstored in envelopes containing all the information necessary to identify the sample.

Data analysis

The maps of the *S. macrocarpon* prospecting and collection area were designed using the ArpG is software. The data collected were entered, processed and analyzed using the Excel 2010 spreadsheet, which was also used to calculate frequencies and construct pie charts. It also made it possible to determine the distribution of respondents, *S. macrocarpon* producers and collected accessions by climatedomain, province and gender.

RESULTS

Socio-cultural characteristics of respondents and state of S. macrocarpon culture

Of the sixteen (16) provinces surveyed, only three (3) provinces were identified as *S. macrocarpon* growing areas, namely Nahouri, Sissili and Sanguié provinces (Figure 2). In these three provinces, the majority of the indigenous populations are of the *Gurunsi* ethnic group. Table 1 provides a breakdown of respondents by province, gender and ethnic group. In total, one hundred and two (102) market gardeners (59.81% men and 40.19% women) were surveyed and belong mainly to three ethnic groups : the Gurunsi (83.33 %), the Mossi (10.78 %) and the Bissau (5.88 %). Their age ranges from 20 to 80 years, the majority (80.40 %) of whom are under 50 years of age (age ≤ 50 years). As for the producers of *S. macrocarpon*, they all belong to the Gurunsi ethnic group. The gender distribution of these producers shows that *S. macrocarpon* is much more cultivated by women than men (55 % women compared to 45 % men). About 35.30% of producers have abandoned the cultivation of *S. mcrocarpon* in the last five years. This dropout is more pronounced for men (66.67 %) than for women (33.33 %). It also varies according to age, 89.65 % among the younger age groups (20 to 50 years) compared to 10.34 % among producers over 50 years of age. In terms of the distribution of producers by province, the highest proportion of abandonment is observed in Nahouri province.

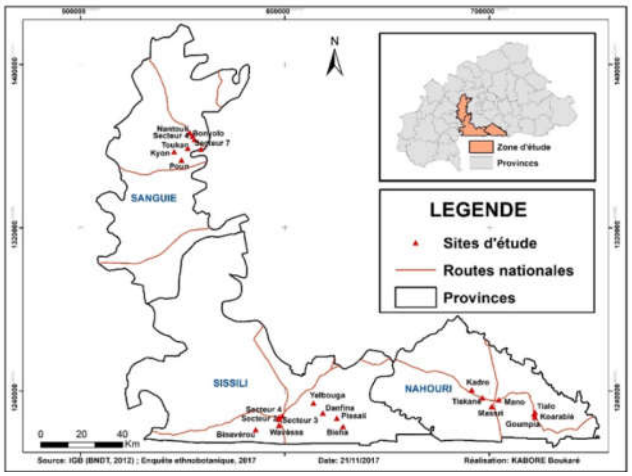


Figure 2 Survey and access collection sites for *Solanum macrocarpon*

Table 1 Distribution of respondents by province, gender and ethnic group

Province	Age (ans)			Sexe		Groupe ethnique		
	20-35	35-50	> 50	Hommes	Femmes	*Gurunsi*	*Mossi*	*Bissa*
Nahouri	11	14	5	20	10	23	3	4
Sissili	15	16	9	28	12	30	8	2
Sanguié	14	12	6	13	19	32	0	0
Total	40	42	20	61	41	85	11	6

Distribution of accessions collected according to the three collection provinces

A total of thirty-six (36) accessions of *S. macrocarpon* were identified and collected in the three provinces from producers who had seed samples available. The highest number of accessions (19) was obtained in Sissili province, while the lowest number (3 accessions) was recorded in Nahouri

province. Fourteen (14) accessions that were collected in the province of Sanguié (Table 2).

Table 2 Distribution of accessions collected by climatedomain, province and gender of producers.

Province	Number of accesses by gender of producers		Percentage (%)	Climatedomain
	Men	Women		
Sanguié	5	9	38.88	Sudano-sahelian
Sissili	11	8	52.77	Sudanese
Nahouri	2	1	8.33	Sudanese
Total	18	18	100	-

Characteristics of the accessions collected and nomenclature of Solanum macrocarpon

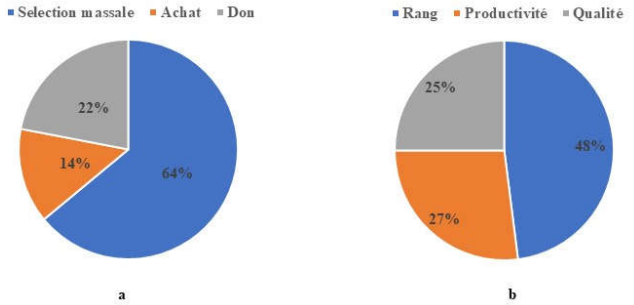
The description of the accessions collected by the producers during the investigation revealed a variability related only to the colour of the immature fruit. Thus, the accessions were divided into two (2) modalities (Figure 3). These are green fruit morphotypes representing 58.33% of the accessions collected and white fruit morphotypes representing 41.67 % of the accessions. However, these proportions vary from one area to another. Thus, all the accessions of Nahouri and Sanguié (55.56 % of the collection) have green fruits while those of Sissili have presented both colours with a predominance of white (62.5 %) over green (37.5 %). *Solanum macrocarpon* is known under three names within the *Gurunsi* ethnic group and is a function of the three dialects of that ethnic group. These are "Boro" in Lyelé (Sanguié province), "Bolo" in Nuni (Sissili province) and "Bio" in Kassena (Nahouri province). For the other ethnic groups found in the area, *Solanum macrocarpon* has the same name as *Solanum aethiopicum*, with the exception that the name of the Gurunsi ethnic group is always associated, namely "*Gurun kumba*" in Mooré and "*Gurun Bossi*" or "*Gurun Bassi*" in Bissau which means "aubergine Gurunsi".

a b

Figure 3 Fruit coloursidentified by producers: (a) green fruit and (b) white fruit

Method of obtaining and saving seeds

The surveys showed that there are three ways in which producers can acquire *S. macrocarpon* seeds (Figure 4a). These are mass selection, donation and purchase of seeds. Massal selection in personal fields is practiced by the majority of respondents, i.e. about 64 %. Seed selection criteria are the order of appearance of the fruit on the plant, plant productivity, degree of maturity and diameter of the fruit (Figure 4b). Indeed, it is the first fruits, or the largest fruits, or the plants with the highest number of fruits that are most retained. The physiologically mature fruits thus harvested are either dried directly in the sun (62.26 %) or the seeds are isolated, washed and dried in the open air in the shade (37.74 %). Dried seeds are generally packaged in plastic bags (35.71 %), cans (16.07 %), bottles (30.35 %) or cans (3.59 %). However, dried whole fruits are stored in canaries or in a safe place in the field.



a b

Figure 4 Sector graphs showing acquisition patterns (a) and seedselectioncriteria (b) for S. macrocarpon by producers

Use of S. macrocarpon

This study carried out in the provinces of Nahouri, Sanguié and Sissili reveals that about 56 % of the respondents produce *S. macrocarpon* exclusively for its leaves compared to 44 % who produce it for fruits and leaves. In Sanguié, it is produced for both leaves and fruits and only leaves in the other two provinces. According to the respondents, especially women, the leaves are nutritious, appetizing and soften sauces. Thus, tender leaves can be boiled and eaten as a salad with other vegetables (Figure 5a). The harvested leaves and fruits are used for family consumption or are marketed. However, for most market gardeners over 50 years of age, the production is exclusively for family consumption, only the surplus is sold on the market. The marketing of leaves and fruits is mainly carried out by women in the different markets of the surveyed areas (Figure 5b). Marketing by men is only observed at production sites.

Figure 5 (a) Salad made fromboiled *S. macrocarpon* leaves mixed with onion (b) Exposure of *S. macrocarpon* leaves for sale at the Leo market.

Cultivation practices of Solanum macrocarpon in the three provinces

Cultivation system

Solanum macrocarpon is grown in home fields (55.35% of producers) or in vegetable gardens (44.64%) both in the rainy and dry seasons (Figure 6). *S. macrocarpon* is grown in pure or mixed cultivation on small areas of difficult to estimate dimensions. In mixed farming, it is generally used in combination with other vegetables such as onions, sweet paws, amaranth, cabbage, lettuce (Figure 7).

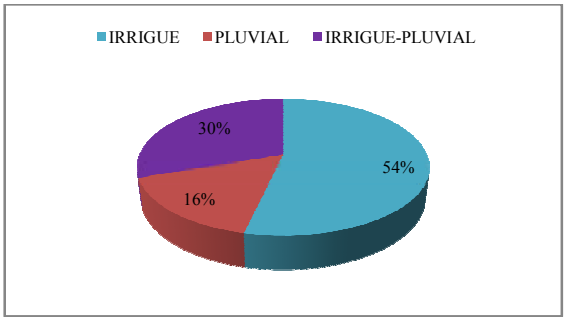


Figure 6 Sector graphs showing the growing seasons of *S. macrocarpon*

Figure 7 Cultivation of *S. macrocarpon* in association withs wee paw and amaranth in a peasantfield in Leo

Nursery and transplanting

The surveys revealed that nursery plantingis the methodmostcommonlyused by producers (100% of respondents) and nursery plantingtakes place between May and June for rainfedcrops and between September and December for dry season crops. Producers reported thattrans planting takes place between 25 and 30 days after sowing, usually in the evening on soilpreviously prepared as a board and amended with organic fertilizer. Interline and interpicker spacing are difficult to estimate, but are defined to ensure good plant development.

Field maintenance

For the majority of producers, field maintenance consists of weeding and hoeing on demand and the application of organicmanure. Thus, NPK and urea are occasionally applied during vegetative development and at the flowering stage. Ureaismainly used by market gardeners who produce for foliar biomass. To control pests and diseases of leaves (71.42% of attacks), stems (17.85% of attacks) and fruits (10.73% of attacks), 66% of producers use fungicides and pesticides compared to 34% who use ash.

Fruit and leaf harvesting

Farmers grow eggplant for its fruits and leaves. The first harvest of fruit and leaves takes place 30 to 60 days after trans planting and is carried out in stages. The fruits are harvested once or twice a week in an immature state with the stalk to extend the shelf life. After the first fruit harvest, the leaves are harvested on demand to aerate the plant and encourage the formation of new flowers.

DISCUSSION

The cultivation of *S. macrocarpon* or "aubergine Gurunsi" is confined to three provinces of Burkina Faso, which reflects the low geographical distribution of the species. Lester *et al.* (1990) showed that Burkina Faso is one of the areas where S. macrocarpon is grown. But, unlike other leafy vegetables, S. macrocarpon remains a minor plant grown only by the Gurunsi ethnic group. However, some authors (Ouédraogo, 2016 ; Kiébré, 2016) have reported that vegetables such as okra and white caya are grown throughout Burkina Faso and by several ethnic groups. The low diversification of ethnic groups observed for the cultivation of *S. macrocarpon* is said to be related to culinary habits and preferences that differ from one ethnic group to another.

The name "Gurunsi eggplant" by other ethnic groups living in the growing area indicates that the plant constitutes a socio-cultural identity for this ethnic group. Indeed, according to Baskar-Rajan, (2005); Kahane *et al* (2005), traditional knowledge and skills such as maintaining traditional cuisine is a socio-economic, but also strategic and ecological issue in the conservation of genetic diversity. *Solanum macrocarpon* is therefore a minor crop whose use in local dishes by the Gurunsi has enabled it to be maintained in the production areas. The lack of taxonomic diversity associated with low distribution suggests a significant introduction of the species in Burkina Faso. Indeed, its cultivation is reduced to a small area near Ghana where it is widespread and well exploited. *S. macrocarpon* would therefore be introduced into Burkina Faso from Ghana.

The study also revealed that the leaves and fruits of *S. macrocarpon* are highly appreciated organoleptically by consumers. According to Agoreyo *et al.* (2012) and Nyadanu and Lowor (2014), S. macrocarpon is rich in protein, fibre, calcium, iron, potassium, magnesium, phosphate and sodium. The quality of the proteins in its leaves and fruits makes it a quality food accessible to many poor families (Adeyeye and Adanlawo, 2011). The gradual abandonment of its cultivation is explained by the pressures of diseases and pests, and the low economic contribution compared to exotic varieties such as tomatoes, purple eggplant, cabbage, salad, chilli, onion, which are more resistant to pests and diseases and strongly requested by traders from neighbouring Ghana. In addition, there is a lack of adapted cultivation techniques and quality seeds. Like all traditional vegetables grown in Burkina Faso, the cultivation practices used for the production of *S. macrocarpon* are essentially traditional with rudimentary means and rarely or only a few inputs. Indeed, according to Masuka *et al* (2012), local vegetables as a whole suffer from the lack of appropriate agronomic methods. Similarly, the cultivars used by producers are the result of a mass selection whose seeds are no longer adapted due to the climatic variations observed nowadays. The seed system and seed saving methods are still archaic. The gradual abandonment of culture, which is observed by the number of accessions collected compared to the number of people and provinces surveyed, could contribute more to the reduction of the diversity or even the disappearance of the species in view of the narrowness of its cultivation area in Burkina Faso.

The predominance of women (55%) in the cultivation of the species is consistent with the results reported on other vegetable species (Dansi *et al.,* 2008 ; Kiébré Z. *et al*., 2015, Kiébré M. *et al.,* 2017) which reported that African vegetable production is largely ensured by women; especially when they are mainly for family consumption. This justifie the small areas allocated to the cultivation of *S. macrocarpon*. Indeed, the land belongs to men who can grant a portion or not to women. The latter are very often forced to settle for the small plots of land that men give them (Bamshaiye *et al.*, 2011 ; Ouoba *et al.,* 2016). According to FAO (2011), agricultural activity is important for women, but women producers have

relatively limited access to the productive resources and services needed by farms. Similarly, the social-cultural beliefs associated with the African socio-economic organization are so strong that it is the woman who is in charge of selling vegetables in markets and especially cooking (Kiébré M. *et al.*, 2017). Dansi *et al* (2008) also reported that vegetable marketing is an essentially female activity. The high proportion of older women in the culture of S. macrocarpon indicates that they are an essential link in the conservation of diversity. They focus on the cultural value of local species while young women have very little interest in them. Thus, in a context of enhancing the value of local dishes and considering the nutritional potential of the plant, the cultivation of S. macrocarpon could bring more income to women.

CONCLUSION

Solanum macrocarpon is a minor crop grown in three provinces of Burkina Faso by the Gurunsi ethnic group. The prospecting-collection made it possible to collect thirty-six (36) accessions for more in-depth studies of their diversity. Its culture is strongly devoted to women and is gradually being abandoned due to the pressure of diseases and pests. Thus, the low diversity and gradual abandonment of its exploitation would constitute serious risks of genetic erosion of the crop in Burkina Faso. In view of the various constraints, the enhancement of the crop suggests the implementation of a programme to improve the species. Thus, a characterization of the genetic diversity of the present collection is essential to consider the improvement and conservation of the species.

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