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Endogenous Knowledge and Socio-Economic Importance of Squash (*Cucurbita sp.*) in Burkina Faso

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Abstract: Squash (*Cucurbita sp*) is one of the vegetables-fruits used in human nutrition and in traditional medicine. This study contributes to a better understanding of endogenous squash practices related to socio-demographic factors (age and gender) and socio-cultural group in Burkina Faso. To this end, 194 semi-structured personal interviews were conducted in nine regions (South-West, Central-West, Central-South, Central-East, Central, North, Boucle du Mouhoun, East, and Hauts-Bassins) of the country using the random method. The relative frequency of citation, the reported use value and the cultural importance index were used to quantify the uses and importance of the species. Totally, 27 uses were identified and registered into three categories of use, that are the most mentioned with the highest cultural importance values such as food and medicinal uses. The fruit is the part/organ of the plant more needed for food uses. Moreover it is locally marketed. Medicinal uses involve several organs/parts (fruit, leaf, stem, seed and root). Knowledge about the uses of *Cucurbita sp* varies between socio-cultural groups but not between gender and age groups. Indeed, the *Bobo* and *Toussian* socio-cultural groups, unlike the *Mossi* and *Samo*, have more knowledge about the uses of *Cucurbita sp* and prefer it for food uses. The promotion of the food uses of *Cucurbita sp* can be considered and thus serve as a starting point for its extended value improvement. However, future analyses should explore the genetic diversity of *Cucurbita sp* and focus on the agronomic, nutritional value and income generated by the plant as well as its expansion for value adding.

Keywords: Squash, *Cucurbita sp*, Ethnobotany, Use, Burkina Faso

1. Introduction

Undernourishment and malnutrition are recurrent issues in developing countries despite the fact that agriculture is the backbone of the economy of these countries. This is partly due to a political choice that focuses on the promotion of cash crops at the expense of traditional local crops often neglected, referred to as minor crops [1]. A better management of available plant genetic resources is necessary to ensure and guarantee a sustainable food security. Indeed, plant genetic resources are agricultural and food production based. Facing demographic pressures and climate change, the continuous search for elite varieties well adapted to different environments is required. Moreover, agricultural development policies integration of minor crops supplemented by major crops (cash crops) is now encouraged by several institutions including the FAO [2]. To this end, traditional varieties, because of their nutritional, energy and medicinal potential, offer some agricultural diversification and food opportunities and also some for populations. They are characterized by a high genetic diversity and are potential sources of new traits needed for varietal creation programmes

aimed at improving agricultural productivity [3]. Minor crops include various wild and grown species such as cereals, tubers and vegetables such as cucurbits, etc.

The cucurbits are a large family of 120 genera, of which the most widely grown are *Cucumis, Citrillus and Cucurbita*. The genus *Cucurbita* has 13 species of which the most grown are *C. pepo, C. maxima* and *C. moschata*. Commonly known as squash, they are grown for household food and for trade [4].

In Burkina Faso, squash is important for the local population on food, socio-economic and cultural ground. Indeed, it is grown and consumed in different ways depending on the country's regions and ethnic groups. However, do the uncertainties related to major crops (maize) lead farmers to adopt strategies to diversify their sources of income by combining minor crops with the main crops. Thus, growing squash is a potential source of supplemental income as well as it meets the family immediate food needs. But despite this, it is important to notice that squash has long not been part of the main development research programmes. Very few scientific data highlight the endogenous knowledge of squash. Therefore, strategies for conserving of this vegetable and transmitting knowledge about this species should be developed. This study can be justified by the above-mentioned elements which aim to document the endogenous practices and importance of squash for the population in order to improve its growing system in Burkina Faso.

2. Methodology

2.1. Identification of Squash Production Locality

The squash production sites were identified with the help of the services of the General Directorate of Plant Production (DGPV) of the Ministry of Agriculture. Thus, based on the information in the balance sheets of the decentralized structures at regional level, the squash production areas have been identified by the Ministry of Agriculture. Then, each regional director has enumerated the producing provinces and put us in touch with the provincial directors of agriculture. The identification of villages where squash is grown was possible thanks to the support of the heads of the technical support zones and the development councils of the village, who are in permanent touch with the farmers.

2.2. Surveys Conducted on Producers and Traders

A survey was conducted from November to December 2020 in areas where squash is grown. Some Semi-structured personal interviews were conducted on squash growers and sellers selected at random and upon agreement. Each farmer was interviewed in his own farm to enable him name and identify the different cultivars. For the traders, the interview was conducted directly at the trading place. The questionnaire sent to the informant done in his native language. The heads of the technical support zones and village development advisers, having a good command of the local languages and knowing well species, assisted us in data collection in each locality. The questionnaire administered to the respondents was geared towards (i) socio-demographic characteristics (ethnic group, age and gender), (ii) parts of the plant used, (iii) utilization categories of the parts of the plant, (iv) growing system of the plant and (v) management practices.

2.3. Data Analyses

Data processing was carried out with the statistical software R and consisted in quantitative analysis with the *ethnobotanyR* Package version 3.6.3 [5].

The ethnobotanical index, the relative frequency of citation, the total reported value use, the total reported value use per organ and cultural importance index, were calculated to assess respectively the knowledge and agreement of the respondents on those knowledge, uses and cultural importance of *Cucurbita sp*. - The Relative *Frequency of Citation (*RFC) refers to the number of times respondents in a social group mentioned a given specific use, reported to the total number of respondents in that group [6, 7]:

$$RFC = \frac{n}{N} \times 100$$

where RFC is the relative frequency of citation expressed as a percentage; n is the number of respondents who mentioned a given use of *Cucurbita sp.*

The RFC permitted to order the specific uses the specific uses of the parts/organs of *Cucurbita sp.* High values for RFC a specific use generally show an agreement on the use of for that part/organ use within the community.

The number of uses (NU) is the number of the categories for each organ of the species:

$$NUs = \sum_{u=u1}^{Unc} URu$$

The number of reported uses (UR) per species organ is the number of uses reported by all respondents and for all use categories of organ *i:*

$$URs = \sum_{u=u1}^{Unc} \sum_{i=i1}^{iN} URui$$

The total reported use value (VUR) [8] for a group is the average total number of specific uses reported for *Cucurbita sp.* in that group, expressed as specific uses per respondent.

$$VUR = \frac{\sum_{i=1}^{N} RUVi}{N}$$

where VURi is the total number of specific uses reported by respondent i in the group; N is the total number of respondents for the social group considered.

This index permitted to measure and compare respondent's knowledge between the different socio-cultural groups, age categories and sexes. The groups showing high VURs are those that generally have more knowledge about the uses of the plant. As the VUR values are counting data, they were subjected to a generalized linear Poisson model to test the effect of sociocultural group, age and gender on its variation.

The reported use value per organ (VURorg) [8] is the average number of uses reported for each organ of *Cucurbita sp.*, expressed in specific uses per respondent:

$$\text{VURorgx} = \frac{\sum_{i=1}^{N} RUVxi}{N}$$

Where VURorgx is the reported use value for part/body x; VURxi is the total number of specific uses of part/body x mentioned by respondent i in the group considered; N is the total number of respondents in the group.

This index was used to assess the number of uses known per part/organ of the plant. The parts/organs with high VURorg values are those with the highest number of uses, and therefore probably the most frequently needed by the populations. A generalized linear Poisson model was used to test the significance of differences in RUVorg values between parts/organs of the plant.

The cultural importance index (CI) [9] refers to the cultural value attributed to the plant on one hand and to the plant parts/organs by local populations on the other hand. The CI value was calculated by category of uses (ICCU) for each socio-cultural group on one hand and for each part/organ of the plant on the other hand. In the first case, the CI highlights the most important category of uses according to the socio-cultural groups, and in the second case, the most important category of uses according to the part/organ of the plant. The CI value was also calculated per part/organ (ICOrg) and for each socio-cultural group in order to highlight the most important parts/organ of the plant for each socio-cultural group.

For each socio-cultural group (respectively each party/organ), the cultural importance of any category k of uses was calculated using the formula below:

$$\text{CIcuk} = \frac{\sum_{i=1}^{N} Scuk}{N}$$

Where S_{CUki} is the score attributed by respondent i of the socio-cultural group considered to the category of uses k (CU_k) of the plant; N refers to the total number of respondents.

The cultural importance index of each part/ organ of the plant for a given socio-cultural group was calculated using the formula below:

$$CIpp/orgm = \frac{\sum_{i}^{N} \sum_{k=1}^{K} Spp/orgm - cuk}{\text{N}}$$

where $S_{PP/Orgm-CUki}$ is the score attributed by respondent i of the socio-cultural group considered to part/organ m of the plant in category k of uses (CU_k) of the plant; K refers to the total number of use categories of uses (K = 3 this study); N refers to the total number of respondents of the socio-cultural group considered.

Prior to this, data examination was carried out following the protocol described by Zuur F. Alain et al. [10]. Since they are counting data, we used a generalized linear model (GLM) with a Poisson distribution in order to consider abnormal errors and the fact that deviations increase with the averages in the counting data [11]. GLM was applied to assess the variation of UV regarding the area, category of age, ethnic group and gender. Software R was also used to draw a pie chart linking ethnobotanical uses to species of organs. This diagram allows a better visualization of the frequency of citation of each organ for the different categories of use. Software QGIS 3.18 was used to map the survey areas.

3. Results

3.1. Study Areas

The survey area covers 17 provinces in nine (09) administrative regions. These are (i) the provinces of Noumbiel, Poni, Bougouriba, and Ioba in the South-West region, (ii) the provinces of Kouritenga and Boulgou in the Central-East region, (iii) the province of Sanguié in the Central-West region, (iv) the province of Zoundwéogo in the Central-South, (v) the province of Passoré in the North, (vi) the province of Mouhoun, Kossi and Sourou in the Boucle du Mouhoun region, (vii) the province of Kadiogo in the Central region, (viii) the province of Gourma in the East region and (iv) the provinces of Houet, Kénédougou and Tuy in the Hauts-Bassins region. Totally, data collection was conducted in 74 areas located in the Sudanese (48) and Sudano-Sahelian (26) climatic zones (Figure 1).

3.2. Socio-Demographic Characteristics of Respondents

Totally, one hundred and ninety-four (194) people were surveyed and divided up according to age groups of Assogbadjo *et al* [12] as follows: The young (age ≤ 30 years); adults (30 < age < 60); the old (age ≥ 60 years). They are unequally grouped between men and women (35.05% /64.95%) and are in age ranges between 17 and 83 years. While women are generally in the majority in squash production, in the *Bobo* and *Birifor* socio-cultural groups, men represent 57.14% and 53.33% of the respondents from these ethnic groups respectively. The informants belong to the majority (*Mossi*, *Dagara, Birifor, Lobi, Samo, Bobo* and *Toussian*) and minority (*Djan, Dafi, Gourounsi, Bwamu, Sambla and Gan*) ethnic groups. Due to the low representativeness of the socio-cultural groups *Gan*, *Bwamu*, *Sambla*, *Dafi*, *Gourounssi* in the sample, which could change estimations the estimates, these socio-cultural groups have been merged into 'other socio-cultural groups' (Table 1).

3.3. Diversity of Knowledge on the Uses of Cucurbita sp

Table 2 explains the diversity of uses of *Cucurbita sp.* It is noticed that the populations of the areas surveyed know in general 27 uses of the species. There are 100% of the respondents who have asserted that the species is mainly used for human food. On the contrary, the medicinal uses of *Cucurbita sp* in the treatment of non-infectious diseases were mentioned by 15.46% of the respondents. The cultural uses of *Cucurbita sp* must also be taken for granted (7.21% of respondents).

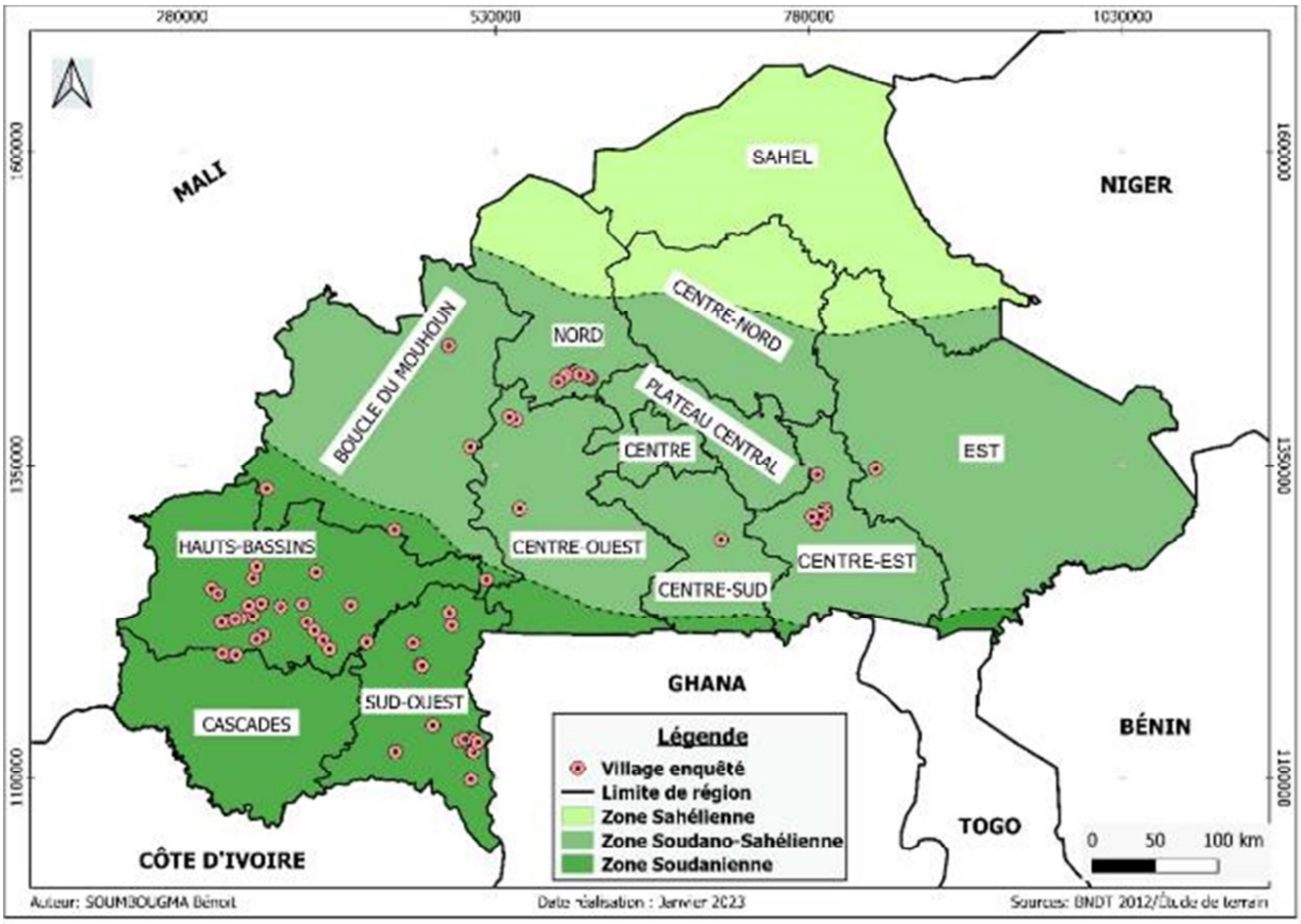

Figure 1. *Burkina Faso's climatic zones and location of survey sites.*

Table 1. *Socio-demographic characteristics of the respondents.*

Ethnic Groups																					
Age group	**Mossi**		**Dagara**		**Birifor**		**Lobi**		**Djan**		**other***		**Dioula**		**Bobo**		**Samo**		**Toussian**		**total**
	M	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	
	28.75	**71.25**	**48.28**	**51.72**	**53.33**	**46.67**	**21.43**	**78.57**	**0.00**	**100.00**	**36.36**	**63.64**	**22.22**	**77.78**	**57.14**	**42.86**	**37.50**	**62.50**	**42.86**	**57.14**	
(≤ 30 years)	13.75		24.14		6.67		7.14		0.00		18.18		44.44		28.57		25.00		42.86		18.04
(30 < Age ≤ 60	37.50		48.28		60.00		42.86		66.67		54.55		22.22		42.86		31.25		28.57		41.75
(> 60 years)	48.75		27.59		33.33		50.00		3.33		27.27		33.33		28.57		43.75		28.57		40.21
Total (%)	41.24		14.95		7.73		7.22		3.09		5.67		4.64		3.61		8.25		3.61		100.00

* *Gan*, *Bwamu*, *Sambla*, *Dafi*, *Gourounssi*; M = male; F = female

Table 2. *Specific uses of Cucurbita sp and relative frequency of citation.*

Category of use	**body**	**Specific use**	**Frequency of citation**
food	fruit	Sauce alone	68%
		Sauce in combination with other vegetables	100%
		sauce in combination with the bean	45%
		tô	32.47%
		couscous	1.5%
		Livestock fodder	14.43%
	sheets	Sauce	84.02%
		Livestock fodder	6.14%
	seeds	Appetizer	15.46%

Category of use	body	Specific use	Frequency of citation
		Oil extraction	5.15%
		Paste	34.53%
		constipation	14.45%
		Urinary pain	12.88%
	fruit	Heartache	2.57%
		children's navel	2.14%
		Stomach ache	2.14%
		constipation	34.04%
medicinal	sheets	Mosquito repellent	1.54%
		Urinary pain	12.88%
		cough	2.57%
	seed	Eye pain	2.12%
	stem	Stomach ache	2.06%
		Urinary pain	2.06%
	root	Urinary pain	2.06%
		Anti-iron rite	27.84%
Cultural	fruit	Protection against evil spirits	2.57%
		Don	2.06%

3.4. Use Value and Cultural Importance of Cucurbita sp

Totally, 27 different uses of the parts/organ were of the plant mentioned by the 194 respondents in the two climatic zones. In these localities, five parts/organs of the squash are used by local population in three categories of use and the most used are fruits and leaves (Figures 2 and 3). Food (UR = 457 and CI = 2.37) is the category of use which has registered a great number of uses followed by traditional medicine (RU = 30 and CI = 0.15). On the other hand, the socio-cultural domain is the category of use where few uses were mentioned (UR = 14 and CI = 0.07) (Table 3). The use of squash by different ethnic groups also varies. Thus, the *Bobo* ethnic group has the highest use value (RUV= 1.57), followed by the *Djan* with a use value of 1.33. The *Mossi* socio-cultural group had the lowest use value (RUV= 0.21) (Figure 4). Figure 5 shows the cultural importance of the squash categories of use according to ethnic groups. The ethnic groups that use squash more among the three categories are the *Mossi* and the *Dagara*. Among the *Birifor*, *Lobi*, *Samo* and *Toussian,* squash is only used for food. According to the frequency of quotation, the fruit is the organ more mentioned by the populations surveyed (Figure 6).

Table 3. *Description of the three categories of use of the five organs of Cucurbita sp.*

Categories of use	description	UR	CI
Food	Human and animal's food	435	2.35
Medicinal	Human traditional medicine	30	0.15
Socio-cultural	Ritual and magical uses	14	0.7

UR: number of reported uses; *CI*: index of cultural importance.

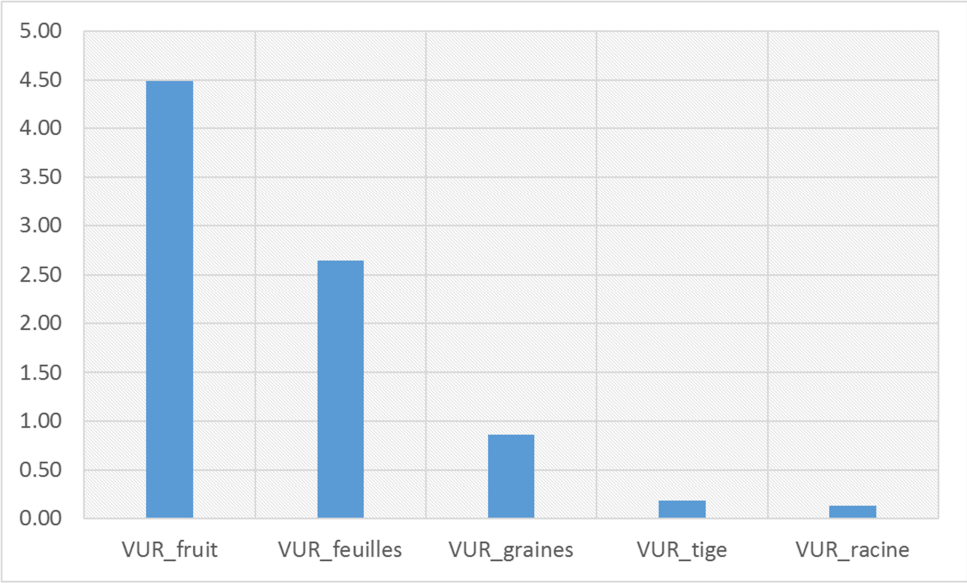

Figure 2. *Use Value of Cucurbita sp.*

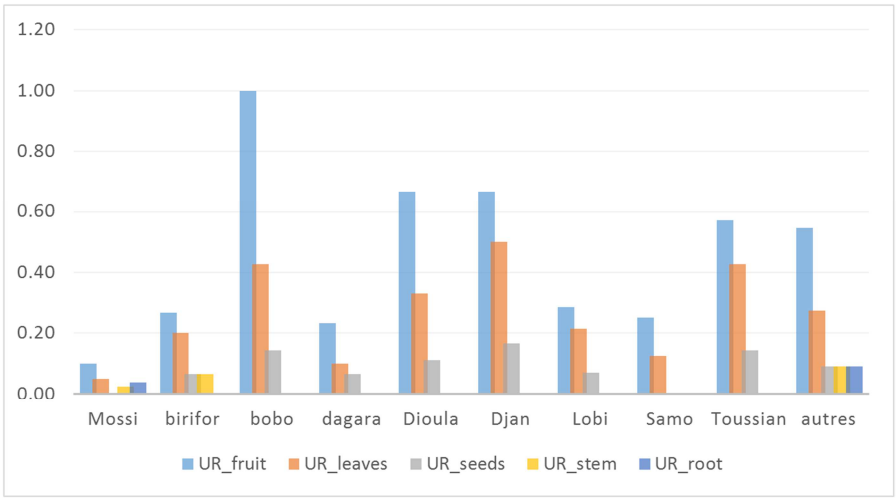

Figure 3. *Squash (Cucurbita sp) organs use value according to ethnic groups.*

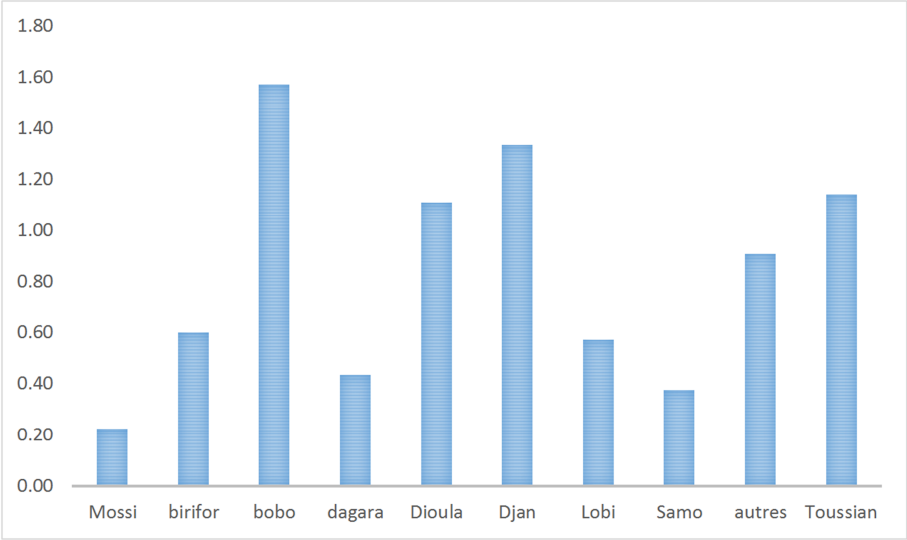

Figure 4. *Ethnic use value of squash.*

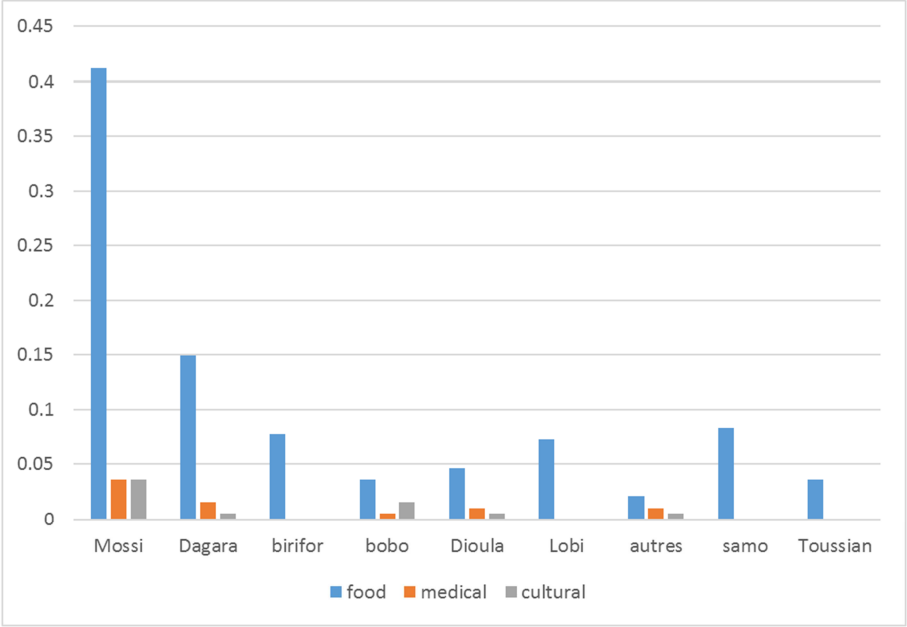

Figure 5. *Histogram describing the cultural importance of Cucurbita sp according to socio-cultural groups.*

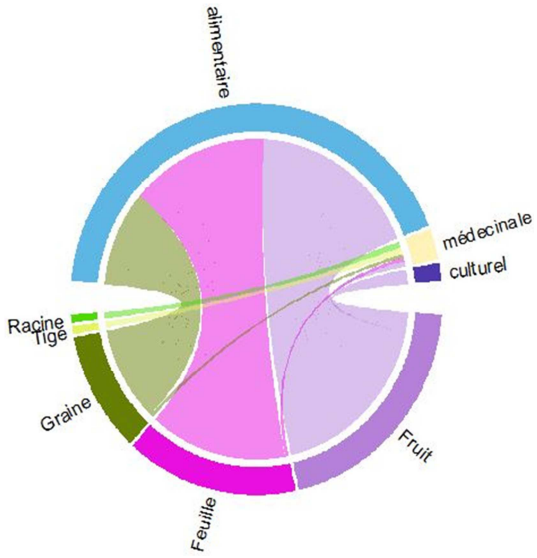

Figure 6. *Diagram illustrating the relationship between parts/bodies and category of use.*

Each organ (bottom half of the diagram) is linked to its different uses (top half of the digram). For example, fruits are used in food, traditional medicine and cultural *matters*

3.5. Factors Influencing the Use Value of Cucurbita sp

The GLM results indicated that the use value of *Cucurbita sp* for traditional medicine ($P < 0.008$) and cultural medicine ($P = 0.01$) varies significantly between locality (provinces) (Table 4). The populations of the Boulgou, Kouritenga, Passoré and Houet provinces have more knowledge about the uses in all categories of use (Figure 7). Also, there is a significant difference between men and women for the use value of *Cucurbita sp* in cultural use ($P = 0.032$) and as food ($P = 0.001$) (Table 4). In fact, men have more knowledge than women in the use of the species in the cultural domain and women knew more uses of squash in the food domain. The ethnic group of the respondents also significantly influenced the use value of squash in traditional medicine (P =0.0085) and culture (P =0.002) (Table 4). In general, the *Mossi*, *Dagara* and *Dioula* have more knowledge about the uses of gourds in these areas than the other ethnic groups (Figure 8). In relation to the interaction of socio-demographic variables, highly significant differences were observed for the interactions of locality × gender and locality × age (Table 4).

Table 4. *Influence of socio-demographic variables on the use value of Cucurbita sp.*

Category of use	Locality (L)	Gender (G)	Age category (A)	Ethnicity (E)	L×G	L×A	G×A
Food	0.359ns	0.001**	0.811ns	0.276ns	0.000***	1.1558ns	0.259ns
Traditional medicine	0.008**	1ns	0.787ns	0.00835**	0.000***	0.000***	1.00ns
Cultural	0.01*	0.032*	0.372ns	0.002**	0.000***	0.000***	0.327ns

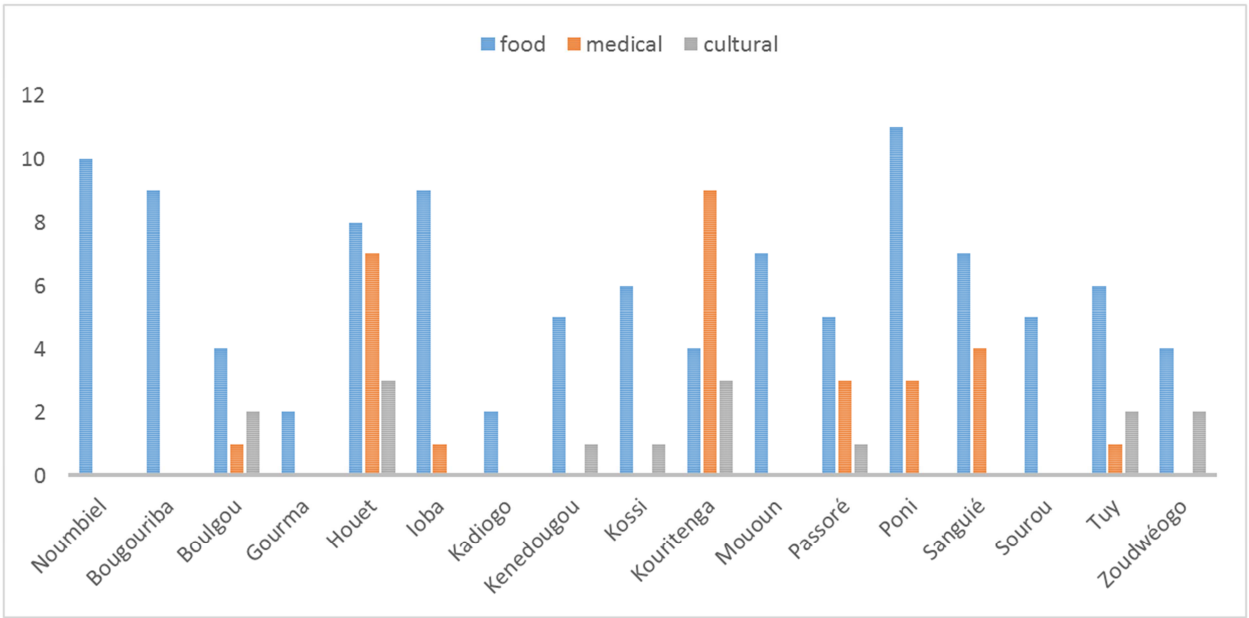

Figure 7. *Use value of Cucurbita sp according to the provinces surveyed.*

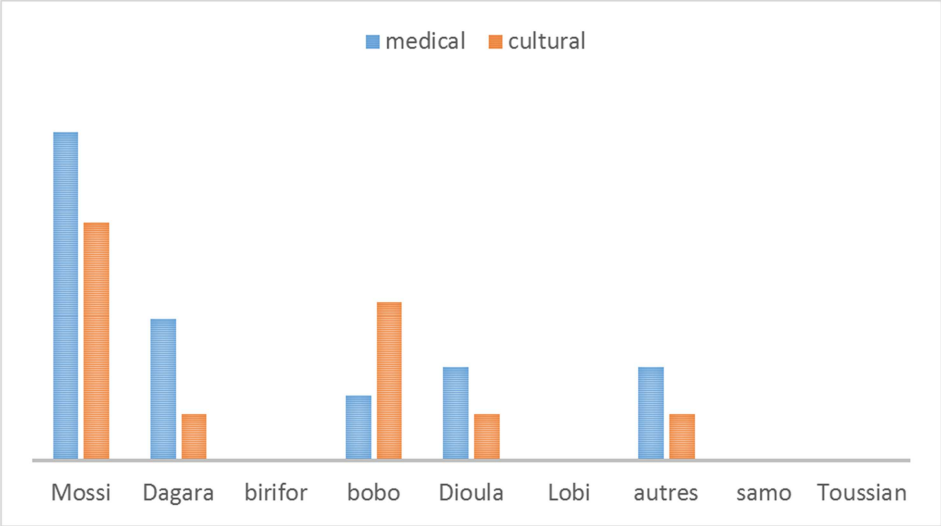

Figure 8. *Use value of Cucurbita sp in traditional and cultural medicine according to ethnic group.*

Figure 9. *Squash-maize mixed cropping in the field.*

Figure 10. *Monoculture on a hut roof.*

3.6. Growing Practices of Squash (Cucurbita sp.)

In Burkina Faso, squash is grown on small lands. The majority of respondents (84.54%) grow squash only during the rainy season and only 15.46% grow it during all seasons in the low grounds in the South West and Hauts-Bassins regions. Squash is grown in the dry season only for young plants that are uprooted and sold in local markets. For growing it during the rainy season, two farming systems were identified: the mixed cropping system, practiced by 87.76% of the farmers, and monoculture practiced by 12.37%. Sowing takes place from May (for monoculture farmers) to July (for mixed cropping system) depending on the region and the farming system. Most of the mixed cropping is concerned maize (*Zea mays*) (Figure 9), okra (*Abelmoschus esculentus*) or sorghum (*Sorghom biccolor*). Figure 10 shows the monoculture system found in the provinces of the Central East Region. The sowing-harvesting period of squash is varies a lot (2 to 6 months). The majority of the farmers surveyed harvest the mature squash between three months (34.3%) and four months (45.3%) after sowing. Five-point eight percent (5.8%), 11.7% and 2.9% of the farmers start harvesting their squash respectively at 2 months, 5 months and 6 months after sowing. Organic fertilizer is the most commonly used fertilizer by squash farmers (92.78%).

3.7. Acquisition and Conservation Method of Seeds

The method of seed acquisition identified in this study are those known and widely used by farmers in Burkina Faso (massal selection, purchase and gift). Thus, almost all the respondents (93.3%) practice mass selection on the basis of the morphological aspect of the fruit. The seed is preserved either by seed or by whole fruit. For the last case, after harvesting, the fruits are spread out on the ground in the shade of trees or huts (Figure 11). The length of time the fruit is kept varies from 5 months (38.7% of producers) to 8 months (40.9%) and sometimes even 12 months or more (20.4% of respondents). On the other hand, the seed is stored in the form of seeds for the next season. In this case, the entire carpellar lodge is pressed against the wall or spread out in a container for drying. Once dried, the seeds are kept either in bags (51.1% of the respondents), in cans (35.8%), in canaries (7.3%) or in bottles (2.2%).

Figure 11. *Fruit stored in a traditional house in the southwest (a) and the shade of a tree (b).*

4. Discussion

The natural area for distributing squash (*Cucurbita sp*.) production covers two climatic zones in Burkina Faso. The literature shows that squash cultivars have a fairly long cycle (4 to 6 months) and that hot temperatures (above 29°C) coupled with dry conditions lead to flowers and fruits bearing failure [13, 14]. The climatic conditions of these zones (Sudanian-Sahelian and Sudanian) are therefore more suitable for the development of the plant. On the contrary, the climatic aridity (annual rainfall < 600 mm) and the very short rainy season (2 to 3 months) that characterize the Sahelian zone would be unfavorable to its development.

The study also revealed that squash growing activity is not practiced in all provinces of the two climate zones, but also a low representativeness or absence of certain ethnic groups in the surveyed provinces (sometimes even the indigenous ones). This could be due to the fact that squash remains a minor crop or a prohibited food. Indeed, the respondents noted that there were prohibitions in certain localities. In the Boulgou province, for example, squash is not grown by the *Bissa* ethnic group because its consumption would lead to men's impotence; it is therefore preferable not to grow it to avoid any consumption errors. Similarly, in the *Moaga* area in general, hunters, wrestlers, fetishes worshipers or anti-knife gris-gris and guardians of ancestral traditions do not consume it. According to them, eating gourds cancels out the effects of the gris-gris and would make them vulnerable. Thus, according to the latter, a 'real man' should not consume squash.

However, there are a lot of uses of squash for the local populations of the growing areas and most organs of the species are used to satisfy the daily needs of these populations. Indeed, most of the organs are used with 27 different uses in three areas (food, medicinal and cultural). These diversity of uses of the organs of the species show the importance of these organs for these communities [15]. Also, the uses of all organs of the species in traditional medicine and those of fruit, leaves and seeds in food by the people surveyed show the medicinal and dietary importance of the species for these populations. The categories of use most often mentioned are food and medicine, and the fruit is the organ most commonly used, generally in the form of vegetable sauce. Food and medicinal uses, particularly from the fruit or even the seeds of *Cucurcbitacaes*, were often reported as the most widespread among several communities [16]. These results can be explained by the fact that the first objective of local populations is to meet their essential needs, including food needs [17], what leads them to exploit considerably the edible parts of the species. This great value of *Cucurbita sp* is an asset for food security in these areas of occurrence. *Cucurbita sp* is also used in traditional medicine for the treatment of certain diseases: malaria, coughs, heart aching, constipation, urinary pain, etc. This diversity of medicinal uses of the plant is also constitutes an asset for future exploration of several medicinal features through ethno-pharmacological analyses. Similar results have been reported on other vegetables such as *Corchorus olitorius* L. [18, 19] and *C. gynandra* [20]. The therapeutic importance of squash fruit would be linked to βcarotene. Indeed, in addition to the fact of being a source of vitamin A, β-carotene also has an antioxidant effect and could improve some immune system functions [21, 22]. Carotenoids, methanol and some types of sugars (polysaccharides) found in squash could reduce glycemia and could make insulin available in diabetic patients [23].

5. Conclusion

This ethnobotanical analysis of *Cucurbita sp* in Burkina Faso confirms the importance of integrating squash growing practices for agricultural sectors diversification and the conservation of biodiversity. Although the species is used by almost all the socio-cultural groups encountered, it remains undervalued on the local and international market despite its food and medicinal assets. The importance of the food use of the fruits, leaves and seeds of the squash indicates a potential of *Cucurbita sp* in development strategies of nutritional condition based on local resources. Similarly, its potential in traditional medicine suggests some pharmacological analyses for possible identification and extraction of its active ingredients. Thus, the various uses of squash show the socio-economic benefit meaning that it is more and more grown in some localities of the country. A characterization of these accessions using scientific methodologies could help assess the diversity of squash in Burkina Faso. This study could be a basic process for a systematic research programme on squash

production. Also, an assessment of the nutritional value of the consuming parts, the income generated by its marketing process and the identification of possible morphotypes is also fundamental for value improvement of the plant.

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