

Article

# Utilization of Spider Plants (*Gynandropsis gynandra*, L. Briq) amongst Farming Households and Consumers of Northern Namibia

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**Abstract:** Spider plants (*Gynandropsis gynandra*, L. Briq.) are a semi-wild vegetable reported to have high nutritional, medicinal, insecticidal, and cultural values, yet continue to be neglected in research. The study was undertaken to investigate indigenous knowledge and utilization of the species in five regions of northern Namibia. Three tools were used; (i) focus group discussion, (ii) semi-structured interviews involving a random selection of 100 farming households and 24 consumers, and (iii) key informant interviews involving four agricultural staff and two open-market supervisors. Data were subjected to descriptive statistics, inferential, and cluster analyses. The study found that farming households and consumers placed higher nutritional, sociocultural, and medicinal values in spider plants than any other vegetable. Ranking of utilization traits, such as nutritional, sociocultural, and medicinal use, revealed three clusters of sociolinguistic groups associated with geographical region. The vegetable was sold and used in most cultural, traditional, and religious functions as a relish, as a source of honor, to bring luck, and for protection. The diverse uses and value placed on spider plants could offer an opportunity for the development of technologies for enhancing their domestication, production, and utilization. It is recommended that follow-up studies be carried to identify specific sociocultural and geographic factors affecting the use of spider plants.

**Keywords:** indigenous vegetable; ethnobotanical; nutraceutical potential; sociolinguistic groups

## 1. Introduction

Adequate knowledge on the use of high-value vegetables is key to achieving the nutritional, medicinal, and socio-economic needs of the communities. The information serves in devising strategies for promoting the cultivation, consumption, processing, storage, and commercialization of these high-value vegetable species, thus potentially contributing to improving the nutritional and health needs, living standards, and expansion of vegetable markets and employment [1–5]. The information is particularly significant for smallholder farmers of sub-Saharan Africa (SSA), whose diets are dominated by carbohydrates and often lack vitamins and minerals. These farmers face challenges in participating in high-value foods at a global level, leading to changing focus towards promoting nutraceutical and insecticidal indigenous vegetables [1,6] than the exotic vegetables.

Spider plants (*Gynandropsis gynandra*, L. Briq.) have a potentially critical role in food, nutrition, and generation of income amongst the rural households yet it continues to be neglected and underutilized. In several parts of the SSA, spider plants grow naturally in the wild and in farmers' fields during the rainy season [7,8]. Tender leaves, stems, pods, and flowers are consumed as vegetables by boiling in water or milk, with or without mixing with other vegetables [9]. Furthermore, the initial cooking water may be decanted, and fresh boiling water added to reduce the bitter taste particularly in purple stemmed accessions. The draining of water during cooking might, however, reduce the quantities of water-soluble micronutrients, such as vitamin A and C. Nevertheless, when compared with other vegetables, Silue [10] observed that spider plants best retain vitamin C after cooking.

In Benin, spider plants are used as a nutraceutical and medico-magic protection amongst different sociolinguistic groups [11]. In some areas, such as Kenya and South Africa, seed companies sell the seed of spider plants to farmers who either establish it in the field as a vegetable or plant it in association with other crops. Namibia, on the other hand, depends on South Africa for the supply of seeds but unfortunately, spider plants are not amongst the traded seeds. Studies show that spider plants grow naturally around the country, mostly in North Central and North Eastern Namibia, which consist of the regions of Kunene, Okavango East and West, Ohangwena, Omusati, Oshana, Oshikoto, and Zambezi regions [12]. The vegetable is known by several names in Namibia, ranging from spider flower to cat's whiskers in English, Ombidi in Oshikwanyama, Omboga in Oshindonga, Ombowa yozongombe or Ombowayozondu in Herero, and Gomabeb in the Damara languages [12]. No studies, however, have been reported aimed at exploring how the rural people use the species. A few related studies have been conducted on indigenous fruits [13], medicinal plant use by traditional healers [14], and medicinal properties of *Ximenia* [15]. The lack of research has perpetuated the underestimation and under-exploitation of the potential value of the vegetable, hence denying the rural households from optimizing its potential benefits. Challenges limiting the production of spider plants include lack of information on agronomic practices, limited variety development, dwindling knowledge of the species (especially amongst the younger generations), poor seed germination, and inadequate extension services [4,16,17].

Dansi et al. [18] acclaimed that ethnobotanical study aimed at evaluating, identifying, documenting, and prioritizing the interventions could have the potential to reduce production constraints and improve agronomic practices. In addition, the study could also aid in assessing the contribution of the vegetables to household income. There has been limited ethnobotanical studies, however, aimed at exploring how farming communities and consumers of different sociolinguistic groups utilize spider plants. For example, Sogbohossou et al. [4] provide some insights on how sociolinguistic groups of Benin and Togo utilize the species, but similar studies are lacking in Southern Africa. According to Martin [19], ethnobotany refers to "the interactions between people and plants," which impacts on utilization. Studies aimed at establishing the levels of utilization of *G. gynandra* suggested that smallholder farmers select the vegetable based on production traits and nutrient quality [20]. As a result of different degrees of selection, agro-morphological diversity [21] is created. In Namibia, spider plants are commonly seen being sold in open markets and used during different traditional ceremonies, such as Olufuko. However, no study has been conducted to determine the extent of use of the species amongst farming communities and consumers.

It is against this background that the study was conducted to (1) identify the uses and utilization traits of spider plants amongst the farming communities and consumers; and (2) determine the level of consensus and rank utilization traits of spider plants amongst the farming households and consumers in the five regions of northern Namibia. In this study, a farming household refers to individuals living in the same house and primarily depending on farming as a source of livelihood. Furthermore, consumers referred to individuals who paid some amount of money to acquire vegetables at the open markets. It was assumed that consumers played important roles in influencing decisions at farm level hence affecting the agro-economic system. Rohm et al. [22] suggested that the behavior of people in the utilization of food, including vegetables, is shaped by health, supply, and culture and family habits

which are inherited from generation to generation. It was, therefore, hypothesized that belonging to different user groups (farming households or consumers), sociolinguistic groups, regions, gender and age groups, and those of different education levels does not affect the utilization of spider plants.

## 2. Materials and Methods

### 2.1. Research Sites

The study was conducted in the regions of Omusati, Oshana, Ohangwena, Oshikoto, and Okavango West, and in the town councils of Outapi, Oshakati and Ongwediva in Namibia. Namibia is in the southwestern part of Africa, in between 17° and 29° South and 11° and 26° East. The study regions lay in between the coordinates of 18.2710° S and 18.4276° E for Okavango West, 17.5979° S and 16.8178° E for Ohangwena, 18.4070° S and 14.8455° E for Omusati, 18.4305° S and 15.6882° E for Oshana, and 18.4153° S 16.9123° E for Oshikoto. The study areas are characterized by hot and dry semiarid climatic conditions. Day temperatures are mostly sunny and hot (18 °C to 34 °C), while night temperatures can be as cool as 0–10 °C. Rainfall ranges from 350 mm to 700 mm, the highest being in Okavango region, and is influenced by Benguela current from the Atlantic Ocean [23]. According to the national demographic survey of 2016 [24], Okavango West, Ohangwena, Omusati, Oshana, and Oshikoto comprised 17.0, 49.5, 54.4, 44.5, and, 45.4 thousand households, respectively. The region with the highest percentage of farming households was Omusati (53%), seconded by Ohangwena (36%), then Oshikoto (33%), Okavango West (31%), and, lastly, Oshana (12%). The household sizes ranged from 5.2 for Okavango West and Ohangwena to 4.2 for the Oshana regions. The Omusati and Oshikoto regions had average household sizes of 4.6 and 4.3 respectively. Most of the households are communal farmers [24].

### 2.2. Data Collection Tools and Sampling Design

Semi-structured interviews for farming households were conducted in five regions of northern Namibia: Okavango West, Ohangwena, Omusati, Oshana, and Oshikoto. Furthermore, data for consumers was collected from open markets of the Outapi, Oshakati, and Ongwediva town councils.

Three tools were used in the study to determine the utilization levels of spider plants amongst the farming households and consumers of Northern Namibia. Farming households and consumers were interviewed using semi-structured questionnaire, while focus group discussion (FGD) was conducted with a farmer group. Finally, four specialists from the Ministry of Agriculture, Water and Forestry and supervisors of the open markets from the town councils were interviewed as key informants. The structure of data collection tools for spider plants uses was based on Cook's classification of plant uses [25], with a slight modification to accommodate the prospects of income generation through selling.

A three-stage sampling frame was used when sampling the farming households. The first stage was a purposeful selection of the regions based on a prior preliminary survey which showed the availability and use of spider plants in the regions. Secondly, constituencies were randomly selected in each of the five regions. The regions in this study refer to administrative divisions comprising several constituencies as sub-divisions. In each of the selected regions, one constituency was sampled. Finally, 100 farming households, 20 from each of the five constituencies, were randomly sampled for semi-structured interviews. Minimum sample size was determined using Cochran's formula (Equation (1)) [26] as follows:

$$n_0 = (z^2 pq) / e^2 \quad (1)$$

The calculations were based on an 8% margin of error ( $e$ ) and 95% confidence interval ( $z$ -value = 1.96). It was further estimated that at least 80% of the population was familiar with spider plants ( $p$ ). The proportion of the population not familiar with spider plants ( $q$ ) was estimated at 20%. This was based on a pilot assessment and the fact that farmers were targeted. The margin of error was set to be between 10% and 5% and this is based on the resource constraints while maintaining statistical requirements as per previous studies [27]. A sample size of 96 farming households was calculated and

adjusted upwards by 10% to account for non-responses. However, only the first 20 households per constituency were interviewed (Table 1) and the target was household heads or their partners.

**Table 1.** Number of households and consumers sampled in the constituencies and open markets, respectively.

(1) Farming Households			(2) Consumers		
Region	Constituency	Sample	Region	Open Market	Sample
Omusati	Anamulenge	20	Oshana	Oshakati	6
Oshana	Okatana	20		Ongwediva	9
Ohangwena	Ondobe and Engela	20		Outapi	2
Oshikoto	Umuntele and Okankolo	20	Omusati	Anamulenge	3
Okavango West	Kapako	20		Onimbu	4
Total		100			24

Staff based at the regional and constituency offices of the Ministry of Agriculture, Water and Forestry assisted in the mobilizing and sampling of the farming households that were interviewed at their homesteads. Study objectives were explained and consent obtained from the respondents. In addition to semi-structured interviews, one farmer group from the Ohangwena region was sampled using FGD, while four agricultural extension staff were interviewed as key informants. The Japan International Cooperation Agency (JICA) project facilitated the formation of the farmers' group, with support from the Ministry of Agriculture, Water and Forestry. The group was engaged in conservation agriculture to enhance productivity. Regional and constituency-level agricultural extension staff helped in mobilizing the members of the cooperative.

Furthermore, a total of 24 consumers were sampled from the main open markets in the Omusati and Oshana regions. These open markets are in Outapi, Anamulenge, Onimbu, Oshakati, and Ongwediva (Table 1). The consumers are referred to as individuals who came to the open market to buy the vegetables. The number of sampled consumers depended on the number of consumers who came to buy vegetables on the day set for interviews. Every other customer who came to buy vegetables at the specific bench of the retailer was sampled and consequently interviewed after obtaining their consent. The market supervisors and vegetable marketing committees at each open market assisted with mobilizing the respondents. The consumer interviews were conducted at the open markets by a team of five research assistants for the whole day. Consent for the study was obtained at different levels, which included the University of Namibia, regional offices for the Ministry of Agriculture and Forestry, town council offices, and the respondents themselves.

The key research questions revolved around (1) identifying the different uses of spider plants amongst different sociolinguistic groups; (2) exploring the level of knowledge of nutritional benefits and the perceived rank of spider plants when compared with other vegetables; and (3) the ranking of different utilization traits to identify traits of importance amongst the sociolinguistic groups. Utilization, in this paper, refers to the action of making effective and practical use of different parts of spider plants amongst the different sociolinguistic groups.

### 2.3. Data Analysis

Data from the farming households and consumers were subjected to descriptive and chi-square statistics and cluster analysis using Statistical Package for Socio Scientists (SPSS) for Windows, Version 20, NY: IBM Corp. Data for the uses of spider plants were coded using Cook's classification of plant uses [25], which was modified to accommodate responses on selling in the open markets to generate income (Table 2).

**Table 2.** Cook’s Classification of Plant Uses [25].

Use	Description
Food	Food, including beverages, for human consumption only.
Food additives	Processing agents and other additive ingredients which are used in food preparation.
Animal Food	Forage and fodder for vertebrate animals only.
Bee plants	Pollen or nectar sources for honey production.
Invertebrate food	Only plants eaten by invertebrates useful to humans, such as silkworms, lac insects and edible grubs.
Materials	Woods, fibre, cork, cane, tannins, resins, gums, waxes, oils, lipids, and their derived products.
Fuels	Wood, charcoal, petroleum substitutes, and fuel alcohols.
Social uses	Plants used for social purposes, which are not definable as food or medicine, for instance masticatories, smoking materials, narcotics, hallucinogens, and psychoactive drugs, contraceptives, and abortifacients with ritual or religious significance.
Vertebrate poisons	Plants which are poisonous to vertebrates, both accidentally and usefully eg for hunting and fishing.
Non-vertebrate poisons	Both accidental and useful poisons e.g. molluscides, herbicides, insecticides, to non-vertebrate animals, plants, bacteria, and fungi.
Medicines	For human and veterinary uses.
Environmental uses	Include intercrops and nurse crops, ornamentals, barrier hedges, shade plants, windbreaks, soil improvers, plants for revegetation and erosion control, wastewater purifiers, indicators of the presence of metals, pollution, or underground water.
Gene sources	Wild relatives of major crops which may possess traits or qualities, such as disease resistance, cold hardness etc. of value in breeding programmes.

Furthermore, fidelity levels (*FL*), Shannon–Wiener diversity indices (*H*), rapid informant rank (*RIR*), and Pearson correlations (*r*) were computed in MS Excel. The non-parametric Levene test ( $p > 0.05$ ) [28] was used to test the equality of variances for utilization traits across regions, sociolinguistic, and gender groups. *FL* was computed for the socio-linguistic groups, regions, and sex of the respondents using the following Equation (2) [29]:

$$FL(\%) = \frac{n}{N} \times 100 \quad (2)$$

where *n* is the number of respondents related to a specific use and *N* is the total number of respondents. *FL* was computed in order to determine the level of consensus amongst the farming households on the specific uses of spider plants. *FL* of greater than 5% implied that the use was significant [29]. The diversity of utilization of spider plants amongst sociolinguistic groups was estimated using Shannon–Wiener diversity indices (*H*) as follows (Equation (3)):

$$H = - \sum [(pi) \times \ln(pi)] \quad (3)$$

where *pi* is the number of responses for a specific use divided by the total number of responses for all uses within a specific sociolinguistic group.

Determination of the utilization attributes based on ranked responses was done using the modified *RIR* model proposed by Lawrence et al. and cited in Hoffman and Gallaher [29]. *RIR* was calculated based on the following formula (Equation (4)):

$$RIR_{Use} = \frac{\left( \sum \frac{T_p}{n_p} + \sum \frac{T_c}{n_c} \right)}{2} \quad (4)$$

where *RIR<sub>Use</sub>* means rapid informant rank for use, *T<sub>p</sub>* means total sum of scores for a given use by farming households, *n<sub>p</sub>* is equal to the number of farmer respondents, and finally, *T<sub>c</sub>* and *n<sub>c</sub>* stand for total scores for a given use by the consumers and number of consumers respondents respectively. After satisfying the assumptions of normality, *RIR* output was further subjected to analysis of variance using Genstat for Windows, 19th Edition (VSN International, Hemel Hempstead, UK), and means

separation using least significance difference (LSD) at a 5% level of significance. Furthermore, hierarchical clustering analysis, employing a measure of squared Euclidean distance, was performed based on six utilization variables to cluster the sociolinguistic groups. Finally, thematic analysis [30,31] was conducted to summarize qualitative data from FGDs and key informants.

### 3. Results

#### 3.1. Demographic Characteristics of the Respondents

The majority of the farming households, according to this study, were either single or had never married or divorced (49.5%), while married households and widows constituted 44.4% and 6.1%, respectively. On the other hand, most consumers were not married (75%), the married consumers were 20.8%, while the rest (4.2%) were widowed. Using average number of years in formal school as a proxy to literacy levels, Chokwe (1.0 years) had the least educated respondents, while Kwambi (8.7 years) had the highest (Table 3). The overall mean of years in school was 6.6 years.

**Table 3.** Composition of interviewed farming households, their levels of education and mean ages across the sociolinguistic groups and regions of northern Namibia.

Category		Percentage of Respondents (%)	Number of Years in Formal School	Average Age (years)
Sociolinguistic group	Chokwe	7	1.0	46.9
	Kwambi	20	8.7	50.4
	Kwangali	13	5.6	34.0
	Kwanyama	22	6.2	55.7
	Mbadja	9	8.4	44.8
	Mbalantu	11	6.2	55.7
	Ndonga	18	7.4	53.2
Regions	Okavango	20	4.0	38.5
	Ohangwena	21	6.0	56.4
	Omusati	20	7.2	50.8
	Oshana	20	8.7	51.4
	Oshikoto	19	7.7	52.5
	<b>Overall</b>	<b>100</b>	<b>6.6</b>	<b>50.0</b>

According to Table 3, the Kwangali sociolinguistic group comprised of a relatively young age group of respondents (34 years), while the Kwanyama and Mbalantu sociolinguistic groups had the oldest age group of respondents. In terms of regions, Okavango West had lowest mean age of participants, while the Ohangwena participants had the highest mean age of respondents. The ages of the consumers ranged from 16 to 67 years, with a mean of 41.5 and a standard deviation of 13.5 years.

Household sizes for the farming households ranged from 2 to 50, with an average of 11 (Table 4), while those of consumers ranged from 4 to 32, with an average of 10 and a standard deviation of 7.1. The majority of the family members in the farming households were children between 6 and 17 years (mean 3.6), seconded by females between 18 to 59 years (mean 3.1). The elderly over 60 years of age were the least in number, followed by under-five children (Table 4). On the other hand, consumers comprised of more females in the household (3.3), while adults over 60 were the least (0.2 adults per household).

**Table 4.** Average number of household members across different age categories and number of years the farming household and consumers who had been using spider plants. N = 100 for farming household; N = 24 for consumers.

Statistics	Mean	SE	SD	Min	Max
<b>a. Farming households</b>					
Age of the respondent	50.0	1.7	17.1	17.0	96.0
Household size	10.8	0.7	7.2	2.0	50.0
Adults ( $\geq 60$ years)	0.7	0.1	0.8	0	3.3
Females (18–59 years)	3.1	0.2	2.3	0	14.0
Males (18–59 years)	2.4	0.2	2.1	0	11.0
Children (6–17 years)	3.6	0.4	4.0	0	29.0
Children ( $\leq 5$ years)	1.4	0.2	1.9	0	10.0
Years using spider plant	36.9	1.8	17.2	10.0	72.0
<b>b. Consumers</b>					
Age of the respondent	41.5	2.8	13.5	16	67
Household size	10.0	1.5	7.1	4	32
Adults ( $\geq 60$ years)	0.2	0.1	0.4	0	1
Females (18–59 years)	3.3	0.5	2.6	0	10
Males (18–59 years)	2.4	0.5	2.4	0	9
Children (6–17 years)	2.7	0.5	2.4	0	9
Children ( $\leq 5$ years)	1.1	0.3	1.5	0	5
Frequency of buying spider plants	3.4	0.3	1.2	2	5

Thirty-seven percent (37%) of the participants indicated that they were household heads, 28% were spouses of the household head, with the wives dominating, while 21%, 11%, and 3% indicated that they were children, grandchildren, or either brother or sister of the household head, respectively. Most of the respondents indicated farming as the primary occupation (90%). Only 7% were engaged in business, 2% were scholars, and finally, 1% were in formal employment.

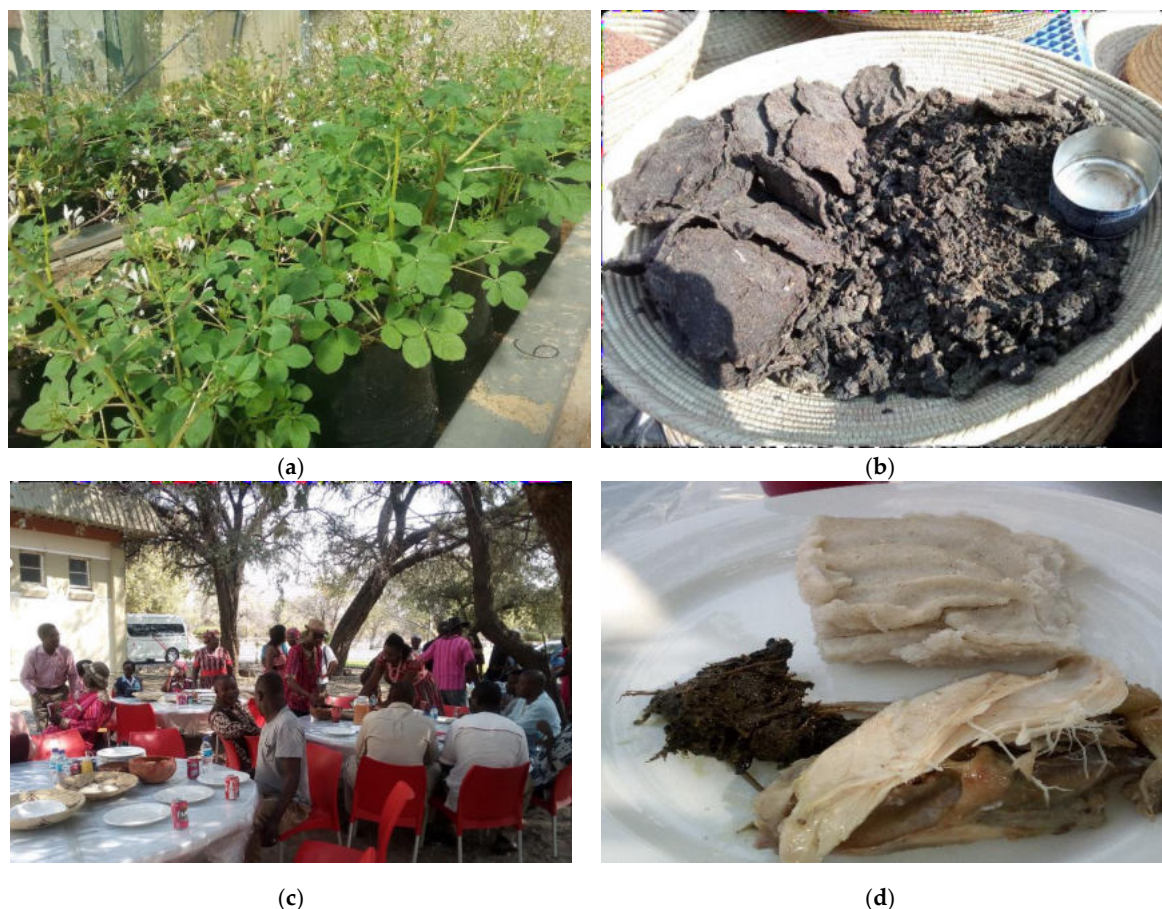
### 3.2. Utilization of Spider Plants in Northern Namibia

The different uses of spider plants amongst the sociolinguistic groups, across the five regions, and by gender are summarized in Figure 1 and Appendix A Table A4. Spider plants were found to be used in three major ways: cooking as a relish (28.8%), social uses particularly during traditional ceremonies (26.2%), and selling to generate income (20.3%).

In this study, tradition was used synonymously with social uses and implied a belief, behavior, or folk custom passed down within a sociolinguistic group which symbolizes special significance with origins in the past. The social uses of spider plants amongst the sociolinguistic groups of northern Namibia included weddings, birthdays, and kitchen parties, when opening a new house or naming a newborn, during spiritual ceremonies, such as confirmation and baptism sacraments, when welcoming an important person to the family or clan, and during cultural festivals, such as Olufuko. Furthermore, spider plants were considered a vegetable that brought luck and honor; as such, it constituted the first dish served during important events and when embarking on a long journey. The social and medicinal use of spider plants were associated with specific sociolinguistic groups in the study regions.

Sociolinguistic groups belonging to the Omusati, Oshana, Ohangwena and Oshikoto regions reported using spider plants in social events, such as traditional ceremonies (Figure 1c,d), and as medicine, in addition to other uses, while the Kwangali and Chokwe sociolinguistic groups of Okavango West region reported neither social nor medicinal uses of spider plants (Appendix A, Table A4). Using spider plants as food during meals and as a source of income through selling were the most important uses amongst sociolinguistic groups of the Okavango West region. The medicinal use of spider plants was related to the belief that it healed different ailments, such as pain in the ears, diarrhea, anemia, flu, cough, eyesight, constipation, goiter, and general loss of weight. The concoction was generally prepared by either crushing the leaves and squeezing the liquid for use, boiling in water, or use as

a pure concoction or mixture with other herbs. It was also reported that spider plants were used as animal food, particularly amongst the Kwambis. The use of spider plants as a non-vertebrate poison (pesticide) was the least amongst the survey participants.



**Figure 1.** (a) Spider plant growing in the screen house; (b) processed spider plants sold in the open markets in northern Namibia; (c) a cultural festival at Ogongo campus of the University of Namibia where spider plants were used to serve the invited traditional leaders and delegates as a sign of honor in 2019; (d) typical dish of the Ovambo ethnic group which comprises cooked spider plant (dark portion).

The response rates per specific use, according to the values of *FL*, were all significant at 5% (Table 5). The highest degree of consensus was on using spider plants as food, seconded by social use, while selling was third (Table 5). However, the Chokwe and Kwangali socio-linguistic groups did not use spider plants in social ceremonies. There was also a high *FL* on using spider plants as medicine amongst the Kwanyama socio-linguistic group of the Ohangwena region. When the *FL* were disaggregated by gender, the results showed that men did not use spider plants for medicine, nor as pesticides, while women reported significant *FL* across all uses, except using the plants as non-vertebrate poison.

Shannon–Wiener indices showed more diversity in the use of spider plants amongst the Kwanyama sociolinguistic group ( $H = 1.72$ ), followed by Ndonga ( $H = 1.63$ ), while the Chokwe sociolinguistic group ( $H = 0.67$ ) had the least diversity (Table 5).



**Table 5.** Fidelity levels (%) of the uses of spider plants and Shannon–Wiener diversity index (*H*) for diversity of utilization across the socio-linguistic groups, regions, and genders of respondents (N = number of households).

Disaggregation Category of the Respondent		Fidelity Levels (%) of Uses of Spider Plants							Shannon–Wiener Diversity Index ( <i>H</i> )
		Food Plants	Social Uses	Income Generation (Selling)	Animal Food	Medicine	Non-Vertebrate Poisons (Pesticides)	Other Uses	
Socio-linguistic group	Chokwe (N = 7)	85.7	-	57.1	-	-	-	-	0.67
	Kwambi (N = 20)	100.0	100.0	80.0	50.0	40.0	5.0	-	1.59
	Kwangali (N = 13)	61.5	-	38.5	15.4	-	-	-	1.14
	Kwanyama (N = 20)	95.0	90.0	55.0	45.0	80.0	20.0	10.0	1.72
	Mbadja (N = 9)	100.0	100.0	88.9	33.3	33.3	11.1	-	1.58
	Mbalantu (N = 11)	90.9	100.0	90.9	27.3	18.2	-	-	1.42
	Ndonga (N = 19)	100.0	89.5	73.7	47.4	31.6	5.8	-	1.63
Region	Okavango(N = 20)	70.0	5.0	45.0	10.0	-	-	-	-
	Ohangwena (N = 20)	95.0	90.0	55.0	45.0	80.0	20.0	10.0	-
	Omusati (N = 20)	95.0	100.0	90.0	30.0	25.0	5.0	-	-
	Oshana (N = 20)	100.0	100.0	80.0	50.0	40.0	5.0	-	-
	Oshikoto (N = 20)	100.0	89.5	73.7	47.4	31.6	15.8	-	-
Gender	Female (N = 90)	92.2	78.9	71.1	38.9	38.9	10.0	2.2	-
	Male (N = 9)	88.9	55.6	44.4	11.1	-	-	-	-
<b>Overall (N = 99)</b>		91.0	76.0	68.0	36.0	35.0	9.0	2.0	1.63

### 3.3. Perception of the Nutritional Value of Spider Plants and Identification of the Most Important Utilization Traits

Further investigation, aimed at establishing the reasons behind using spider plants mostly as food, showed that all respondents considered spider plants to have nutritional benefits. When asked to compare the nutritional value of spider plants with other vegetables, 78.1% responded that it superseded all other vegetables, while 20.8% stated that the nutritional value was the same as other vegetables. Only 1% considered spider plants as inferior in terms of nutritional value when compared with other vegetables.

Based on emerging responses, a further attempt was made to identify the most important utilization traits by ranking, using the modified *RIR* proposed by Lawrence et al. [29]. The ranking of the traits was consistent between the farming households and consumers (Table 6). High nutritional value was ranked as the most important utilization trait, seconded by sociocultural value, which was specifically the use of spider plant in traditional rituals and ceremonies. The utilization of the spider plants for pest control was the lowest ranking amongst the six utilization traits.

**Table 6.** Rapid informant ranks of utilization traits across farming households and consumers of northern Namibia.

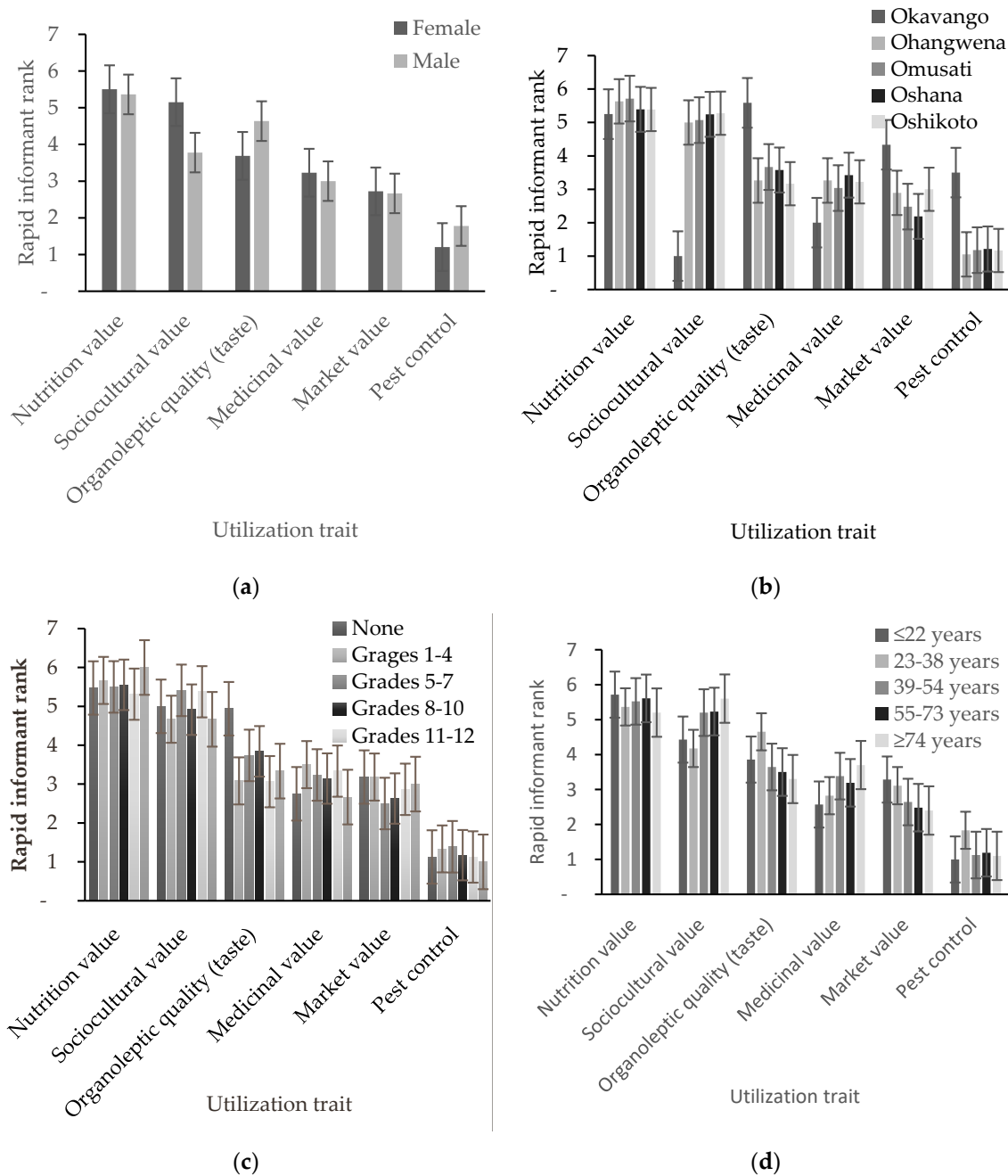
Utilization Traits	Farming Households			Consumers			Overall RIR
	Total Scores	Frequency	RIR	Total Scores	Frequency	RIR <sup>1</sup>	
Nutritional value	507	92	5.51	119	22	5.41	5.49 <sup>a</sup>
Sociocultural value	402	79	5.09	106	22	4.82	5.03 <sup>ab</sup>
Organoleptic quality (taste)	348	92	3.78	83	22	3.77	3.78 <sup>abc</sup>
Medicinal value	253	78	3.24	68	22	3.09	3.21 <sup>bc</sup>
Market value	225	81	2.78	55	22	2.50	2.72 <sup>bc</sup>
Pest control	100	80	1.25	28	22	1.27	1.25 <sup>c</sup>
Mean							3.60
<i>p</i> value							<0.001
LSD							1.51
CV							32.4%

<sup>1</sup> RIR means rapid informant rank as proposed by Lawrence et al. [26]. The larger the value of RIR, the more important the utilization trait. <sup>a, ab, abc, bc, c</sup> Figures with the same letter for overall RIR are not statistically different.

Overall rankings showed significant differences ( $p < 0.001$ ) amongst the utilization traits and maintained the same order of rankings amongst the farming households and consumers (Table 6). High nutritional value, sociocultural value, and organoleptic quality were ranked as the most important utilization traits and were not significantly different at 5% level of significance.

In contrast, differences in the ranking patterns of the utilization traits, based on gender (Figure 2a) and geographic region (Figure 2b), were observed for all traits except nutritional value, which maintained the highest rank. There was a strong correlation ( $r = 0.87$ ) on the ranking of the utilization traits of spider plants between male and female respondents, except for the sociocultural value, which showed significant differences. Female respondents considered the sociocultural value of spider plants as more important than the organoleptic quality. On the other hand, male respondents ranked organoleptic quality higher than the sociocultural value. The results also showed consistent and strong correlation ( $0.968 < r < 0.994$ ) in the ranking of the utilization traits in the Ohangwena, Omusati, Oshana and Oshikoto regions (Figure 2b and Appendix A Table A3). The ranking of the utilization traits in the four regions was consistent with the overall ranking. In contrast, the Okavango West region ranked the utilization traits differently from the other regions (Figure 2b) and showed a very weak correlation with the other regions ( $r$  ranging from 0.129 to 0.008) (Appendix A Table A3). The ranking of all utilization traits by Okavango was significantly different from the rest of the regions, except for the nutritional value of the plant. The sociocultural value of the spider plants was ranked

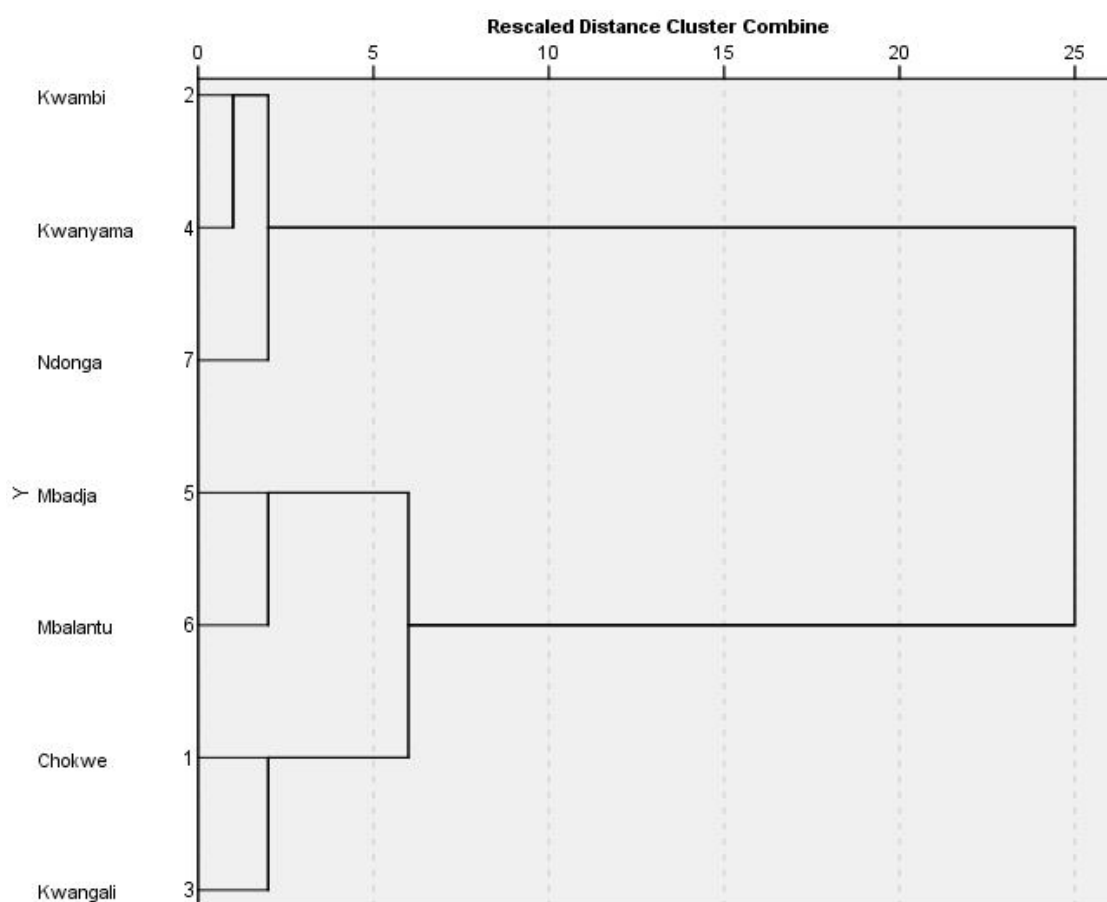
the least (Figure 2b), while the organoleptic quality was the highest-ranking utilization trait, seconded by nutritional value. The data also showed that respondents who did not have any formal education valued organoleptic quality more than those who had formal education (Figure 2c). In addition, older respondents ranked sociocultural value of the spider plant higher than the younger generations (Figure 2d).



**Figure 2.** Relationships between utilization traits and rapid informant rank across gender groups (a), regions (b), educational levels (c) and age categories (d).

Further analysis was conducted to identify the clustering patterns based on the frequencies of six utilization traits across the sociolinguistic groups. The dendrogram generated three clusters using a cut-off of five (Figure 3). Mbalantu and Mbadja were clustered together and these sociolinguistic groups were from the Omusati region. The second cluster grouped Chokwe and Kwangali sociolinguistic groups, which both happened to be from the Okavango West region. The third cluster grouped

sociolinguistic groups from Ohangwena, Oshana and Oshikoto, which were Kwanyamas, Kwambis and Ndonga respectively.



**Figure 3.** Clustering of sociolinguistic groups using average linkage between groups based on frequencies of the six utilization traits of spider plants in northern Namibia.

#### 4. Discussion

The extent of utilization of vegetable species is believed to be shaped by cultural beliefs or ethnicity [27,32], norms [33], geographical location [34,35], and availability of the species. The multiple utilization traits and perceived nutritional and medicinal benefits of spider plants amongst farming households and consumers of different sociolinguistic groups implied the cultural significance of the vegetable and the potential for domestication in northern Namibia. The medicinal and nutritional utilization traits of spider plants identified in this research were consistent with the findings of other researchers [36] who reported nutritional properties which were believed to heal eyesight, and cure marasmus and scurvy. Furthermore, researchers [2] reported the major use of spider plants as food and medicine, with 80% and 40% of the respondents, respectively. The use of the vegetable for income generation was third, with 20% of respondents, while the use for cultural reasons was the least (5% of respondents) [2]. Kolbeg [12], citing Kakujaha-Matundu [37], reported income of N\$1131.36 per season per household in Namibia, while in South Africa [38], researchers reported average income of R413 per month. Their findings, however, put less emphasis on social use, which was contrary to the finding of this study. Differences in cultural values and beliefs might explain the differences in spider plants use across sociolinguistic groups. The strong link on the use of spider plants in social ceremonies in northern Namibia was supported by the vegetable's historical perspective in other countries, such as Kenya and Uganda, where the vegetable was used to service chiefs and important people in the society [39]. In addition, a study conducted in Kenya [16] reported that the vegetable was used to

serve high profile visitors to signify respect amongst the Luo and Kisii communities, thus agreeing with the findings of this study. In Namibia, the leaves of spider plants are sometimes mixed with other species, such as *Amaranthus* spp., for consumption. Oftentimes, cooked leaves are dried into cakes locally known as “omavanda” which are flattened and either stored for consumption during the months of scarcity or for sale at the open markets [12]. These findings suggested that spider plants were important to the social and cultural systems of the sociolinguistic groups of northern Namibia; as such, its reducing trends in diversity [40] might likely lead to undesirable impacts on the cultural identity and stability of these sociolinguistic groups, as observed by other researchers [41,42]. The vegetable could, therefore, be classified as a cultural keystone species [43], according to theories and major hypotheses in ethnobotany. The differences and similarities observed across the sociolinguistic groups, however, call for an in-depth study of the specific cultural differences that might be responsible for the similarities and differences. We found, in this study, that leaves were the main component of the plant used, but we do not have evidence of the factors that might have influenced the choice of the plant part.

The three clusters related to the ranking of the uses of spider plants suggested that sociolinguistic groups close to each other were more likely to rank the utilization traits in a similar way, which could imply that the clustered groups shared similar cultural beliefs. This observation is consistent with the findings of other researchers [44–46], who found that traditional knowledge on the use of indigenous vegetables was more likely to be passed on amongst relations. In this study, sociolinguistic groups from Omusati formed the first cluster, Ohangwena, Oshana and Oshikoto formed the second cluster, while the third cluster comprised sociolinguistic groups from Okavango West. The clusters were consistent with the geographical location of the regions, whereby Omusati is in the northwest, and Ohangwena, Oshana, and Oshikoto shared boundaries in the north-central area, while Okavango is located far north-east. Researchers [35] reported differences in the importance and uses of vegetables across regions and communities and attributed the differences to cultural influence, tradition, geographical separation, and biology. For example, researchers in Benin [34] observed that geographic region was a strong determinant of the use of traditional vegetables. However, Powell and other researchers [35] identified significant variation in knowledge and use both between the geographical regions and between socio-linguistic groups within the regions. In addition, a study on the use of *Strychnos spinosa* [27] identified climatic zone and sex as general factors influencing the choice of the use categories of the species. These observations could be applied to the case of northern Namibia, where the study regions were geographically separated and had unique sociolinguistic groups which could imply cultural differences playing the role as well.

Furthermore, women were found to value sociocultural uses of spider plants more than men and this could have been influenced by differences in local knowledge distribution between the gender groups, as suggested by Pfeiffer and Butz [47]. According to researchers [48], rural women are usually unemployed and tend to combine sociocultural information as they discharge household and subsistence activities. This tends to give women an edge over men on the knowledge of sociocultural values. The positive association between age and socio-cultural use of spider plants, with the older people considering socio-cultural uses as more important than the younger generations, would suggest erosion of cultural values amongst the young generation.

Moreover, other researchers [49] reported that the differences in cultural influence, tradition, geographical separation, and biology could account for the shaping of the agro-morphological diversity of the species. Furthermore, the existence of strong culture, tradition, and gender [49,50] was reported to have an influence on the utilization of indigenous crop species. These findings underscore the importance of considering a range of factors in each geographical region, in order to identify and determine the relative contribution of each factor on the differences in utilization of traditional vegetables. In this study, however, gender did not influence the ranking of the utilization traits. The findings, therefore, called for an adequate understanding of cultural norms, tradition, and gender in influencing utilization of spider plants to shape future attempts in popularizing the vegetable. Voster, et al. [50] reported organoleptic quality as one of the factors influencing the use and preference

of vegetables across age and gender groups. In addition, the follow-up studies would also aid in determining the Cultural Food Significance Index (CFSI) [49], in relation to other vegetables and across the different sociolinguistic groups.

Finally, the study found that farmers were knowledgeable that spider plants had nutritional and medicinal attributes. This finding was consistent with other researchers [51,52], who confirmed that several underutilized crops were nutrient-dense. Nutrient density of the underutilized crops offers an opportunity to enhance access to diversified diets amongst the rural households, which remains a challenge particularly in SSA, including Namibia. The respondents perceived that the nutritional value of spider plants superseded all other indigenous vegetables, hence putting it at the advantage of being widely domesticated and adopted. Other researchers considered a diversification of the diets using indigenous vegetables, such as spider plants, as cost-effective and sustainable in alleviating malnutrition for the households living below the poverty line [53]. The nutritional and medicinal attributes [52], therefore, make the spider plant an ideal vegetable for its inclusion in healthy diets and the promotion of food and nutritional security. The research provided a good understanding of the uses and utilization traits of spider plants, including the influence of sociocultural factors. These provided insights towards sustainably, popularizing the domestication of spider plants amongst the farming communities of northern Namibia. The rolling-out of a robust and demand-led breeding program aimed at developing production technologies that would ease production changes constitutes the first step. The breeding program should capitalize on the nutritional value of the plant, organoleptic quality, and cultural customs which generate utilization habits from generation to generation, as observed by Nemeth et al. [54].

## 5. Conclusions

The spider plant is an indigenous vegetable with the potential of addressing hidden hunger and health problems due to its high nutraceutical properties. Farming households and consumers of spider plants in northern Namibia recognize its nutritional, social, and medical importance, and these are perceived to exceed other vegetables. These utilization attributes are stimulants towards initiatives aimed at promoting the domestication and utilization of spider plants. Prioritizing research in spider plants offers a great potential in addressing nutritional deficiencies and improving incomes, particularly amongst the under-resourced households in the rural areas. An understanding of how the indigenous households utilize the species and specific cultural influence towards utilization constitute the basis for designing demand driven research projects that address the needs of the players in production and utilization value chains.

**Author Contributions:** Conceptualization of the design of the research and the methodology were done by B.Y.C. He also did the investigation, data curation, analysis and drafted the original manuscript. Review of the methodology and results, supervision of the research and editing of the manuscript were done by L.S.-M.A., E.G.A.-D. and J.S., K.K. did a revision and editing of the manuscript. All authors have read and agreed to the published version of the manuscript.

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**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

**Table A1.** Demographic characteristics of consumers.

Characteristics	Minimum	Maximum	Mean	Std. Deviation
Age of respondent	16	67	41.1	13.6
Household size	4	32	10.0	7.0
Adults age 60+ years	0	1	0.2	0.4
Adult females (18 to 59 years)	0	10	3.2	2.5
Adult males (10 to 59 years)	0	9	2.9	2.5
Children (6 to 17 years)	0	9	2.7	2.4
Under-five children (below 5 years)	0	5	1.1	1.5

**Table A2.** Correlation coefficients amongst sociolinguistic groups on the ranking of utilization traits of spider plants.

Sociolinguistic Group	Chokwe	Kwambi	Kwangali	Kwanyama	Mbadja	Mbalantu	Ndonga
Chokwe	1.000						
Kwambi	−0.988	1.000					
Kwangali	0.948	−0.977	1.000				
Kwanyama	−0.919	0.960	−0.984	1.000			
Mbadja	−0.941	0.930	−0.917	0.844	1.000		
Mbalantu	−0.798	0.706	−0.609	0.515	0.769	1.000	
Ndonga	−0.919	0.960	−0.984	1.000	0.844	0.515	1.000

**Table A3.** Correlation coefficients for utilization traits of spider plants across the regions.

Region	Okavango	Ohangwena	Omusati	Oshana	Oshikoto
Okavango	1.000				
Ohangwena	0.046	1.000			
Omusati	0.008	0.985 ***	1.000		
Oshana	0.125	0.972 ***	0.987 ***	1.000	
Oshikoto	0.129	0.994 ***	0.975 ***	0.968 **	1.000

\*, \*\* and \*\*\* mean significant at 5%, 1% and 0.1% respectively.

**Table A4.** Different uses of spider plant, in percentage, disaggregated by sociolinguistic groups, regions and gender (*n* is based on multiple responses amongst the farming households).

Disaggregation Category of the Respondents		Different Uses of Spider Plant						Total %	
		Food Plants	Social Uses	Income Generation (Selling)	Animal Food	Medicine	Non-Vertebrate Poisons (Pesticides)		Other Uses
<b>Sociolin-guistic group</b>	Chokwe ( <i>n</i> = 10)	60.0	-	40.0	-	-	-	-	100
	Kwambi ( <i>n</i> = 98)	27.6	27.6	19.4	14.3	10.2	1.0	-	100
	Kwangali ( <i>n</i> = 16)	50.0	6.3	31.3.4	12.5	-	-	-	100
	Kwanyama ( <i>n</i> = 106)	26.4	25.5	13.2	12.3	17.0	3.8	1.9	100
	Mbadja ( <i>n</i> = 38)	26.3	31.6	21.1	10.5	7.9	2.6	-	100
	Mbalantu ( <i>n</i> = 53)	28.3	30.2	28.3	9.4	3.8	-	-	100
	Ndonga ( <i>n</i> = 68)	26.5	27.9	20.6	13.2	7.4	4.4	-	100
<b>Region</b>	Kavango ( <i>n</i> = 26)	53.8	3.8	34.6	7.7	-	-	-	100
	Ohangwena ( <i>n</i> = 84)	23.8	25.0	14.3	10.7	19.0	4.8	2.4	100
	Omusati ( <i>n</i> = 98)	27.6	30.6	24.5	10.2	6.1	1.0	-	100
	Oshana ( <i>n</i> = 110)	29.1	27.2	18.2	15.5	9.1	0.9	-	100
	Oshikoto ( <i>n</i> = 71)	26.8	28.1	19.7	12.7	8.5	4.2	-	100
<b>Gender</b>	Female ( <i>n</i> = 362)	27.6	26.0	20.7	12.2	10.5	2.5	0.6	100
	Male ( <i>n</i> = 27)	44.4	29.6	14.8	11.1	-	-	-	100
<b>Overall (<i>n</i> = 389)</b>		<b>28.8</b>	<b>26.2</b>	<b>20.3</b>	<b>12.1</b>	<b>9.8</b>	<b>2.3</b>	<b>0.5</b>	<b>100</b>



**Table A5.** Ranking of utilization traits of spider plants amongst the farming households and consumers in northern Namibia.

Respondents Category	Utilization Traits	Frequency Per Rank						Total Score	RIR
		1	2	3	4	5	6		
Farming households	Nutritional value	53	33	6	0	0	0	507	5.51
	Sociocultural value	28	40	7	1	0	3	402	5.09
	Organoleptic quality (taste)	11	9	41	14	14	3	348	3.78
	Medicinal value	0	6	17	45	10	0	253	3.24
	Market value	1	6	14	15	43	2	225	2.78
	Pest control		1	0	3	10	66	100	1.25
Consumers	Nutritional value	13	6	2	1	0	0	119	5.41
	Sociocultural value	6	10	3	2	1	0	106	4.82
	Organoleptic quality (taste)	2	4	6	7	3	0	83	3.77
	Medicinal value	1	0	7	6	8	0	68	3.09
	Market value	0	1	2	6	11	2	55	2.50
	Pest control		0	2	0	0	20	28	1.27

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