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Analysis of the value chain of Guinea sorrel (*Hibiscus sabdariffa* L.) in the urban community of Maradi, Niger

KAKA KIARI Boukar Kéllou[1]*, MAMADOU CHETIMA Maina Boukar[1], MAHAMADOU BACHIR Hamet Mahamane[1], MOUSSA Massaoudou[2], ATTA Sanoussi[3], BAKASSO Yacoubou[4], MAHAMANE Ali[4]

[1] University of Diffa, BP78 Diffa, Niger;
[2] Dan Dicko Dankoulodo University of Maradi, Niger,
[3] AGRHYMET-CRA-AOS/CILSS Regional Center, Training and Research Department, BP11011 Niamey, Niger;
[4] Abdou Moumouni University of Niamey, Faculty of Science and Technology, BP 10662 Niamey, Niger.
*E-mail correspondent: *boukar787@gmail.com*

Abstract

In Niger, sorrel plays an important role in the food and nutritional security of populations. The objective of this study is to put value in the value chain of Guinea Sorrel. The choice of individuals to be surveyed was made randomly at different levels of the value chain. At the producer level, a sample of 26 individuals was retained, 20 individuals for processors and 19 individuals for consumers. For traders, a sample of 21 individuals was retained. In total, 86 individuals were interviewed. The main links are production, marketing, processing and consumption. The price per kg of leaves is 100 FCFA; 300 FCFA for the calyxes and 500 FCFA for the seeds. The investigation shows that the leaves are transformed into salad, the calyxes into bissap juice and the seeds into soumbala. The sorrel processing activity in the town of Maradi is profitable, with an average weekly net gain of around 712.50 F CFA, or around 2,850 F CFA per month for the leaves; 2,192.50 F CFA, or approximately 8,770 F CFA per month for the chalices; 1,600 F CFA, or around 6,400 FCFA per month for seeds. In addition to human consumption, the stems, leaves, hulls, and seeds are used as animal fodder. To revitalize the sorrel sector, better organization of the market and players is necessary.

Keywords: *Hibiscus sabdariffa*, food security, sorrel value chain, Maradi, Niger

Introduction

Guinea sorrel (*Hibiscus sabdariffa* L.) is an important crop due to its leaves, calyxes and seeds which play a considerable socio-economic role for the Nigerien population (Kaka-Kiari, 2020, Abdou *et al.,* 2020; Kaka-Kiari *et al.,* 2023). It is exploited for its food and medicinal properties (Diallo, 2007; Bakasso, 2010; Kaka-Kiari *et al.,* 2022b; Kaka-Kiari *et al.,* 2021). In terms of food, the leaves are used to prepare sauces and can be eaten cooked in the form of salad (Kaka-Kiari *et al.,* 2019a). They are also pounded, cooked and served with the rice dish as a spice (Bakasso *et al.,* 2013; Kaka-Kiari, 2020). The calyxes are used to make refreshing drinks called "bissap" (Bako *et al.,* 2010; Atta *et al.,* 2013; Aziato *et al.,* 2020). Today, bissap is one of the most popular drinks served at ceremonies in West Africa (Kaka-Kiari *et al.,* 2019b). The seeds are used to make soumbala, which is widely consumed by the rural Sahelian population (Parkouda *et al.,* 2008; Bakasso, 2010). It is used in the preparation of dishes to enhance the taste of sauces accompanying cereal-based dishes such as rice, millet, sorghum, corn, etc. (Bengali *et al.,* 2006; Aliou , 2009; Abdou *et al.,* 2020). In addition to human consumption, the stems, leaves, hulls and seeds are used as animal fodder (Kaka-Kiari *et al.,* 2023). Nutritionally, sorrel leaves and calyxes are rich in minerals, proteins and ash (Atta *et al.,* 2010a; Atta *et al.,* 2013; Kaka-Kiari, 2020). The seeds are also rich in protein, fat, oil, ash and carbohydrates (Halimatul *et al.,* 2007; Mera *et al.,* 2009; Atta *et al.,* 2010b; Kaka-Kiari, 2020).

In Niger, sorrel can contribute to improving household income because the local unit of measurement (around 500 g) of calyx can cost more than 1000 FCFA at certain times of the year, which is by far more expensive than millet, the country's main food crop (Bakasso, 2010). The sorrel processing activity can generate an income of 24,000 to 30,000 or even 40,000 CFA francs per month (Kaka-Kiari *et al.,* 2023). It thus provides substantial income to modest and poor households to meet daily needs. In addition, this culture mobilizes multiple actors both upstream and downstream of the value chain. To revitalize the sorrel sector, better organization of the market and players is necessary. The present study therefore aims to promote the value chain of Guinea sorrel in the city of Maradi in order to identify and highlight the main actors in the chain.

Materials and Methods

Study zone

The investigation took place in the urban community of Maradi. It covers an area of 86 km^2 limited to the north by the commune of Tibiri, to the west by the communes of Safo and Sarkin Yamma, to the east and south by the commune of Djiratawa (CCNi, 2009). The Maradi region is located in south-central Niger, between 13° and 15°25' north latitude and 6°15' and 8°33' east longitude. It extends over 41,796 km^2 and is limited by the region of Zinder to the east, those of Tahoua to the west and Agadez to the north. It also shares a border of approximately 150 km with the Federal Republic of Nigeria to the south. The Maradi region is located 645 km^2 from Niamey, the country's capital. It has two very distinct types of climate. Firstly, there is the Sahelian climate in the North characterized by average annual precipitation of between 200 and 300 mm; and the Sahelo-Sudanian climate in the South, characterized by average annual precipitation of between 500 and 600 mm.

Sampling

The general approach adopted during this study is based on the value chain approach. The choice of individuals to be investigated was made randomly at different levels of the value chain. At the producer level, a sample of 26 individuals was retained, 20 individuals for processors and 19 individuals for consumers. For traders, a sample of 21 individuals was retained. In total, 86 individuals were interviewed. The main links are production, marketing, processing and consumption.

Field investigation

The survey took place in October 2022 in the urban community of Maradi. It was semi-open and declarative. The survey aims to highlight the socio-economic and organizational aspects of the value chain through questioning the different links. It consisted of the administration of individual questionnaires to producers, traders, processors and consumers.

Data Entry, Processing and Analysis

After data collection, Excel and Statistical Package for Social Science (SPSS) software were used for data entry and analysis. In the case of this study, these are descriptive statistics (frequency, mean, standard deviation, etc.). The results are presented in the form of tables and graphs.

Results

Production

Producer profile

The results of the analysis of the profile of producers show that almost 85% are men (Figure 1). The distribution by age group indicates that 62% are aged between 25 and 46 years and 37% are over 46 years old (Figure 2). The average age is 43.38±9.91 years. It appears from the analysis of the survey results that the producers have a long experience in growing the variety studied, the majority of producers have more than 5 years of experience and those with less than 5 years of experience do not represent only 27% of the sample surveyed (Figure 3). The average duration of the producers surveyed in this activity is 9.73±6.77 years. Producers as a whole are illiterate (75%) (Figure 4).

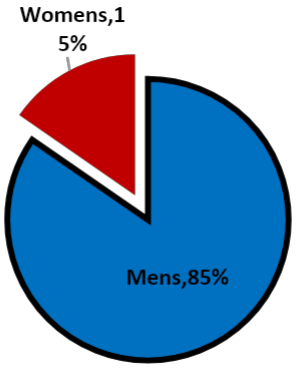

Figure 1: Distribution by gender of producers

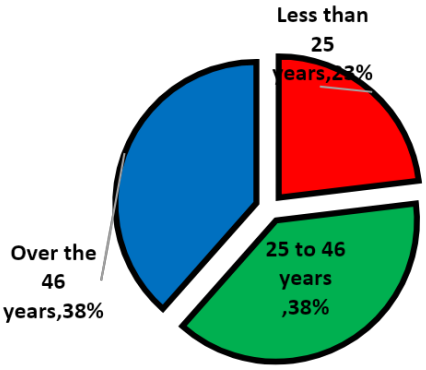

Figure 2: Age class of producers

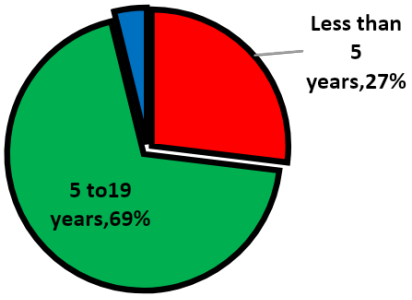

Figure 3: Distribution of individuals surveyed depending on the number of years of experience

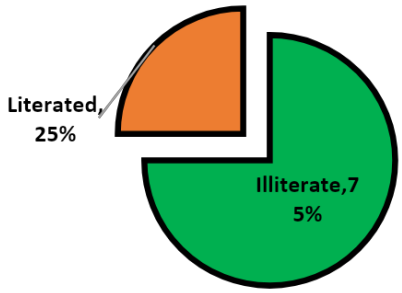

Figure 4: Level of education of producers

Cultivated areas, seed supply, cropping system and yield

The analysis of the areas cultivated by the producers surveyed reveals a notable weakness in the areas exploited. The majority (50%) of producers have less than a quarter (1/4) ha of total area (Figure 5) and more than 27% of respondents cultivate sorrel on two-thirds (2/3) ha. The results of the analysis also show that 58% of respondents inherited their fields (Figure 6) and practice family farming. It appears from Table 1 that only 20% of the producers surveyed produce their own *Hibiscus sabdariffa* seed and more than 80% obtain their supplies from the market. The planting technique used is direct sowing. The red variety (73%) is the most cultivated by producers (Figure 7).

Figure 5: Cultivated area

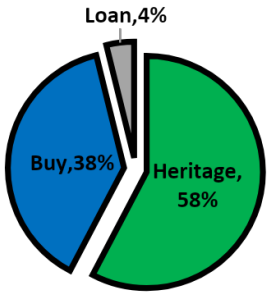

Figure 6: Method of acquiring plots

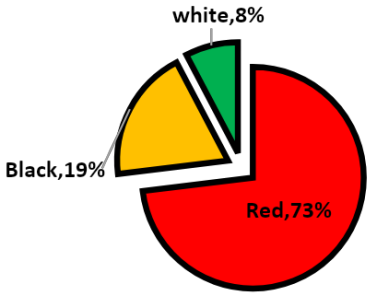

Figure 7: Cultivated varieties

Furthermore, all producers combine the cultivation of sorrel with other crops (millet, sorghum, cowpeas and peanuts) and use mineral fertilizer (100%) with a proportion of 25 kgha^{-1}. However, 46% of respondents encounter parasitic threats in the cultivation of Guinea sorrel (notably stem lesions leading to wilting and crown rot caused by *Rhizoctonia solani* , the circular brown and blackish spots on leaves caused by *Ascochyta hibiscus cannabis*; rust caused by *Puccinia garkiana* , the agent responsible for small necroses and characteristic red-brown spots (rusts); leaf burns caused by *Phomas sp*; Cercospora blight caused by *Cercospora abelmoschi* ; browning or bleaching, rots on roots and stems caused by *Macrophomina phaseolina* ; attacks on the leaves of *Hibiscus sabdariffa* L. from sowing to harvest *by Nisotra uniformis* and *Nisotra dilecta*). The maturity date of Guinea sorrel varies depending on the variety grown. It is on average 46 days for the leaves, 81 days for the calyxes and 93 days for the seeds (Table 1). According to the results of the survey, the average yield of leaves is 876.56 kg ha^{-1}, calyx 426.56 kgha^{-1} and seed 416.41 kgha^{-1} (Table 1).

Table 1: Cultivated areas, mode of exploitation and yield of Guinea sorrel

Settings	Classes	Numbers (n=26)	(%)
Cultivation system	Pure culture	0	0
	Associated culture	26	100
Origin of seeds	Walk	21	80.77
	Seed companies	5	19.23
Use of mineral fertilizer	Yes	26	100
	No	0	00
Parasitic threat	Yes	0	0
	No	26	100
		Average (kg/ha)	**Standard Deviation**
Maturity date	Leaves	45.97	±21.82
	Calyxes	81.25	±8.61
	Seeds	93.13	±10.30
Yield	Leaves	876.56	±464.37
	Calyxes	426.56	±270.30
	Seeds	73.59	±44.56

Sale of products by producers

Most of the production consists of leaves, calyxes and seeds. These products are sold in fresh and dried forms. Marketing is done individually. According to the survey, more than 77% of producers sell the leaves in fresh form at the city's large market in order to meet the needs of the family, mainly in terms of food. On the other hand, the calyxes and seeds are sold in dry forms (Table 2). The results of the survey reveal that all producers (100%) sell their production on the market. The main customers are resellers (70%), retailers (15%) and wholesalers (15%). Furthermore, these producers do not establish any operating accounts. According to the analysis of the survey, the price of a kg of sorrel varies depending on the product and the period.

Table 2: Sale of products by producers

Settings	Classes	Numbers (n=26)	(%)
Form of leaf sale	Dry	20	76.92
	Fresh	6	23.08
Form of sale of calyxes	Dry	26	100
	Fresh	0	0
Form of seed sales	Dry	26	100
	Fresh	0	0
Producers' sales location	On site	0	0
	At the market	26	100
	In the city	0	0
Clients	Resellers	18	69.23
	Retailers	4	15.38
	Wholesalers	4	15.38
Operating account	Yes	0	0
	No	26	100
		Average Price (FCFA)	**Standard Deviation**
Price of a kg of sorrel in FCFA	Leaves	147.80	±16.15
	Calyxes	335.62	±39.71
	Seeds	370.62	±25.65

At harvest in November, the kg of leaves sold at 147 F CFA, at 335 F CFA for the calyxes, and at 370 FCFA for the seeds at the market (Table 2). This price could vary depending on the period and the market for dry leaves and seeds or even doubled in the month of Ramadan for chalices. Generally, the sale is made without an intermediary between the producer and the buyer. Furthermore, no producer has established the operating account at the bank.

Transformation

Identification of actors

Sorrel processing is an activity that particularly concerns women. Thus, analysis of the survey data shows that the majority of actors are women (76%). Among these actresses, the majority (62%) are young people aged between 30 and 44 and 33% are over 45 years old . The average age is 40.80±8.61 years. In addition, the majority of these actors are married. In addition, we observe that around 53% of the actors are illiterate compared to only 47% having been to school. Regarding the ethnic groups of the actors, it appears that almost 98% of the actors are Hausa.

Supply of Guinea sorrel for processing

The leaves, calyxes and seeds used in artisanal processing units mainly come from peri-urban areas of the urban community of Maradi. They are harvested, dried, preserved by producers and sold according to their needs to retailers in the city's markets. Sales prices on the markets fluctuate greatly depending on supply and demand. Furthermore, the sharp increase in sorrel consumption in the city means that certain players are adopting essentially daily supply strategies, purchasing only small, sufficient quantities to be processed. Additionally, some do weekly, monthly and seasonal supplies. It appears from the analysis of the results of the survey that approximately 80% obtain their supplies from the market and 20% obtain their supplies from the village for their processing. All the people surveyed process Guinea sorrel. Among the respondents, 65% process the calyxes, 20% process the leaves and only 15% process the seeds. The products resulting from the processing are sorrel leaf salad, bissap juice and soumbala (Table 3). Indeed, among processors, nearly 65% produce sorrel juice (the majority use the black variety (65%), the red variety (25%) and only (10%) uses the white variety); so around 15% make soumbala, and only 20% make leaf salad. However, all these products are sold in different places: 25% sell their products at the market, 30% at home, 25% at the roadside, 20% also sell at school. The main customers are retailers (100%) and all processors (100%) manage to cover demand (Table 3).

Table 3: Processed parts, supply and demand coverage

Settings	Classes	Numbers (n=20)	(%)
Processed parts	Leaves	4	20
	Calyxes	13	65
	Seeds	3	15
Refueling	Walk	16	80
	Village	4	20
	Fields	0	0
Juice production	Yes	13	65
	No	7	45
Type of calyxes used	Red	5	25
	Black	13	65
	White	2	10

Soumbala making	Yes	3	15
	No	17	75
Making leaf salad	Yes	4	20
	No	16	80
Producers sales location	At the market	5	25
	At home	6	30
	Roadside	5	25
	At school	4	20
Clients	Resellers	0	0
	Retailers	20	100
	Wholesalers	0	0
Cover demand	Yes	20	100
	No	0	0

Flow of products by processors

Place of sale of processed products

Sorrel juice, soumbala and leaf salad are sold in all places and neighborhoods. However, some places are more represented than others (Figure 8). From Figure 8, we realize that these products are the most sold in the city's markets by nearly 45% of the players. In addition, around 30% of sellers are present in homes and almost 15% on roadsides and 5% in schools. In addition to these specific locations, we also have administrative offices with approximately 2.5%.

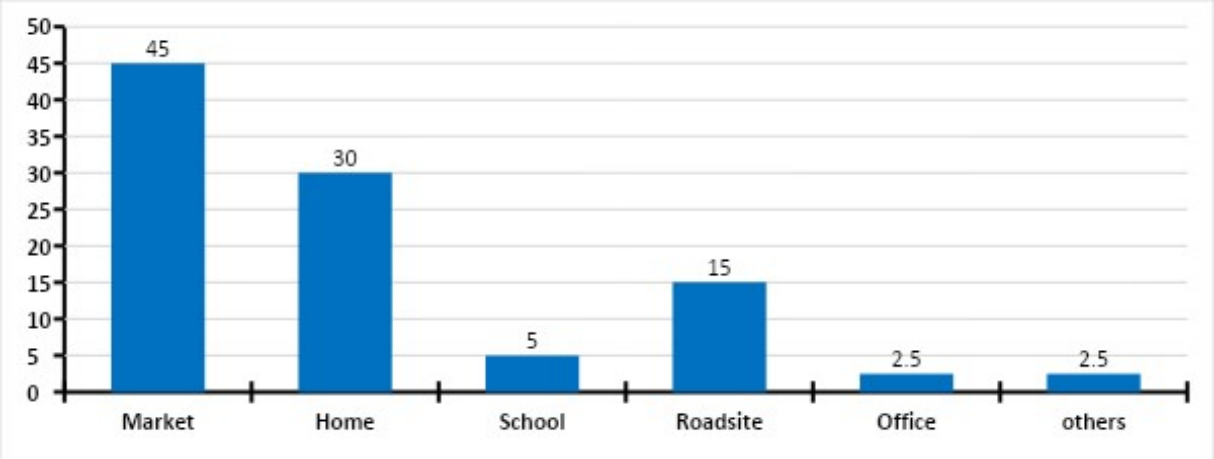

Figure 8: Main places of sale of sorrel products in the city of Maradi

Economic analysis

Although the processing of sorrel remains relatively simple, it has a monetary cost as well as its marketing. The actors through this activity obtain substantial weekly income for the household. Through the weekly operating account of the activity we will identify the different costs and margins. The weekly operating account of the activity allows us to assert without great risk that the sorrel processing activity in the town of Maradi is profitable, with an average weekly net gain of approximately 712 CFA francs for the sheets, or approximately 2,848 CFA francs per month; 2,192 F CFA, for the calyxes, or approximately 8,768 F CFA per month; 1,600 CFA francs for seeds, or around 6,400 FCFA per month (Table 4). It thus provides substantial income to modest and poor households to meet daily needs.

Table 4: Economic analysis

Settings	Average Price ± Standard Deviation (FCFA)
Price per kg of leaves	50±160
Price of leaf salad dish	25±50
Profit in the sale of salad	712.50±217.47
Price per kg of calyxes	450±525
Price per liter of bissap juice	65±100
Profit in the sale of bissap juice	2192.32±4591
Price per kg of seeds	110±117
Price per kg of soumbala	280±335
Gain in the sale of soumbala	1600±360.56

Consumption

Identification of actors

Consumption of sorrel is an activity generally affecting men and women. However, women are the most numerous (55%) and only 45% of actors are men. Analysis of the results of the surveys shows that the majority is made up of young people, with an average age of 37.19±10.86 years. In addition, more than 78% of actors are married, compared to only 12% of singles and 6% of widowers. In addition, we observe that approximately 53% of the actors are literate and only 47% have not attended school. Regarding the ethnic groups of the actors, it appears that almost 70% of the actors are Hausa.

Acquisition and consumption of Guinea sorrel

Guinea sorrel is one of the rare species where all the aerial parts are consumed, the fresh sorrel leaves are pounded, cooked and served with the rice dish as a spice. The chalices are used to make refreshing drinks called bissap. The seeds are used to make soumbala, which is widely consumed by the rural population. Sorrel consumption concerns all sections of the population and all socio-professional categories. According to the results of the survey, the majority (63%) of consumers buy sorrel at the market, 21% acquired it through donations from producers and only 15% of stakeholders produce sorrel themselves for their consumption. However, more than 68% of stakeholders consume sorrel mixed with other foods and 32% consume it in cooked form (Table 5). The average consumption per day is 2 kg per household. However, more than 90% of consumers confirm that the consumption of Guinea sorrel contributes to improving food security. Consumers have no sorrel supply constraints. It should also be emphasized that the respondents do not expect anything from the improvement in the quality of Guinea sorrel (Table 5).

Table 5: Acquisition and form of consumption

Settings	Classes	Numbers (n=19)	Percentage (%)
Acquisition	Production	3	15.78
	Purchase	12	63.15
	Don	4	21.05
Form of sorrel consumption	Cooked	6	31.57
	In mixture	13	68.42
Improved food security	Very satisfaying	6	31.57
	Satisfying	11	57.98
	Not satisfying	0	0
	Do not know	2	10.52
Supply constraints	Yes	0	0
	No	19	100
Expectations for improving the quality of Guinea sorrel	Yes	0	0
	No	19	19

Other uses of Guinea sorrel

According to the majority (68 %) of respondents, in addition to human consumption, Guinea sorrel is used as fodder for animals. The parts used are the stems, leaves, hulls and seeds. Respondents affirm that the stems are the most used parts and are well palatable by animals (Table 6).

Table 6: Other uses of Guinea sorrel

Settings	Classes	Numbers (n=19)	(%)
Fodder for animals	Yes	6	31.57
	No	13	68.42
Parts used as fodder	Stems	7	36.84
	Seeds	2	10.52
	Leaves	2	10.52
	Calyxes	4	21.52
	Shells	4	21.52

Marketing

Identification of actors

Traders are, just like producers (supply) and consumers (demand), essential players in the processes that participate in the dynamics of cultivated diversity. Indeed, the results of the analysis of the Trader Profile show that the majority of traders (62%) are men. The distribution by age group indicates that 19% are under 39 years old, 47% are between 39 and 47 years old and the others (33%) are over 46 years old. The average age is 44.48±11.17 years. The majority (76%) of traders are illiterate (Table 7). Regarding the ethnicities of the actors, it appears that all the actors are Hausa.

Table 7: Socio-professional characteristics of Guinea sorrel traders

Settings	Classes	Numbers (n=21)	Percentage (%)
Gender	Men	13	61.90
	Women	8	38.09
Ages (years)	<39	4	19.04
	39 - 47	10	47.61
	≥48	7	33.33
level of studies	Illiterate	16	76.19
	Literated	5	23.80

Sale of products by traders

Marketing is done by retailers of vegetables and condiments who obtain their supplies directly from producers who sell their products on the market. Analysis of the survey results shows that around 38% sell the calyxes, 38% sell the seeds and only 23% sell the leaves. The majority of traders get their supplies from the market (62%), others get their supplies from the production site (28%) and very few get their supplies from the villages (9%) (Table 8). According to the declarations of 100% of traders, the sale of sorrel is mainly done at the city market. The setting of sales prices on the markets fluctuates greatly depending on supply and demand. However, the majority of actors (57%) declare that the market price is standard and for 43% of actors, the price is fixed on the market by bargaining between traders and customers. According to the declarations of more than 86% of traders, the dry season is the period of strongest marketing. The main customers are retailers (85%) and resellers (15%). Finally, all retailers manage to cover their customers' demand (Table 8).

Retailers and resellers regularly obtain their supplies from mid-November until the end of January from producers at the city's various weekly markets. They buy the kg of leaves at 147 F CFA, for the calyxes at 335 F CFA and for the seeds at 370 F CFA at the harvest market to resell them in detail at 250 F CFA per kg of leaves; at 400 F CFA per kg of calyxes and at 450 F CFA per kg of seeds (Table 8).

Table 8: Sales price, supply and demand coverage

Settings	Classes	Numbers (n=21)	(%)
Sale of Guinea sorrel	Leaves	5	23.80
	Calyxes	8	38.09
	Seeds	8	38.09
Refueling	Walk	13	61.90
	Village	2	9.52
	Field	6	28.57
Producers' sales location	Walk	21	100
Fixing the price on the market	Standard	12	57.14
	Bargaining	9	42.85
Period of strong marketing	Dry season	18	85.71
	Cold season	5	23.80
Clients	Retailers	18	85.71
	Resellers	3	14.28
Cover demand	Yes	21	100
	No	0	0

Discussion

Guinea sorrel producers in the town of Maradi are mostly (60%) under the age of 43 and generally (75%) illiterate. This high rate of illiterate people could be a handicap for the development of the sorrel sector in Niger. Illiteracy and lack of training constitute a limitation to respecting good farming practices (Kaka-Kiari *et al.* , 2023). Sorrel cultivation is an activity mainly carried out by the male gender (85%) with a small percentage of women involved in Guinea sorrel production activities . The low involvement of women in sorrel production could be explained by land status, which traditionally gives primacy to men. The woman in these conditions can only enjoy plots of land in the event of the death of her husband. However, the woman performs some tasks, including bringing meals to the fields for the workers, participating in certain work such as sowing, weeding and harvesting sorrel. These results are similar to those found by Kaka-Kiari *et al.* (2023), who observed more than 60% of men in Guinea sorrel production in Niger. The average duration of the producers surveyed in this activity is 9 years. Which constitutes a considerable asset for the promotion of sorrel cultivation in the Maradi region (Kaka-Kiari *et al.,* 2023). The sign of interest on the part of young people in this activity is also an asset for the development of the sorrel sector. The analysis of the areas cultivated by the producers surveyed reveals a notable weakness in the areas exploited. And the majority of producers combine sorrel cultivation with other crops. This could be due to the fact that Guinea sorrel cultivation is classified as a secondary crop in Niger (Kaka-Kiari *et al.,* 2022a).

Sorrel consumption concerns all sections of the population and all socio-professional categories. According to the results of the survey, the majority (63%) of consumers buy sorrel at the market, 21% acquired it through donations from producers and only 15% of stakeholders produce sorrel themselves for their consumption. However, more than 68% of stakeholders consume sorrel mixed with other foods. In addition to human consumption, Guinea sorrel is used as animal fodder. The parts used are stems, leaves, calyxes, hulls and seeds. The stems are the most used and are well palatable by animals. These results are consistent with those obtained in the Diffa region (Niger) by Kaka-Kiari *et al.* (2023), who reported that in addition to human consumption, Guinea sorrel is used as animal fodder.

Sorrel processing is an activity that particularly concerns women. The results of the survey show that all the actors are women (76%). Among these actors, the majority are young people, with an average age of 40.80±8.61 years. The products resulting from the processing are leaf salad, bissap juice and soumbala. In fact, among the processors, nearly 65% make sorrel juice compared to around 20% who make leaf salad and only 15% who make soumbala. These results are consistent with those obtained by Baba-Moussa *et al.* (2006). However, all these products are sold in different places: 25% sell their products at the market, 30% at home, 25% at the roadside , 20% also sell at school. Similar results were observed in Maroua (Cameroon) by Folefack *et al.* (2008). The main customers are retailers (100%) and all processors (100%) manage to cover demand.

Analysis of the results of the survey shows that the sorrel processing activity in this town is profitable, with an average weekly net gain of around 712 F CFA for the leaves, or around 2848 F CFA per month; 2,192 F CFA, for the chalices, or approximately 8,768 F CFA per month; 1,600 CFA francs for seeds, or around 6,400 FCFA per month. It thus provides substantial income to modest and poor households to meet daily needs (Bakasso, 2010). These results show that the Guinea sorrel value chain generates a significant source of income (Folefack *et al.,* 2008). This also shows that the Guinea sorrel sector could be an income-generating activity (Kaka-Kiari *et al.,* 2023). According to the statements of those surveyed, this income constitutes an invaluable economic resource at the population level. They are used for the purchase of food products, health care, clothing, children's schooling and ceremonies (marriage and baptism).

Conclusion

This study showed that the value chain of Guinea sorrel is a chain that can be described as long and well structured. The main links are production, marketing, processing and consumption. The seniority of producers in this activity constitutes a considerable asset for the promotion of sorrel cultivation. The demand for sorrel is strong and the commercial opportunities are significant, especially in the dry season. Sorrel products play a very important role in household life, and its marketing provides substantial income to meet the daily needs of poor and modest households, and to fight against poverty. In addition, we note that women occupy a prominent place in the transformation. The marketing circuit is characterized in particular by the absence of wholesale traders and the strong seasonality of the product on the market. Furthermore, the strong presence of young people in this activity is an asset for the development of the sorrel sector. To revitalize the Guinea sorrel value chain, better organization of the market and stakeholders, specific training is necessary.

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