

# Farmers' Preferred Characteristics of New Varieties of Jute Mallow (*Corchorus olitorius* L) and Their Implications for Variety Selection in the Koulikoro region of Mali

## ABSTRACT

Jute Mallow (*Corchorus olitorius* L) is an important leafy vegetable in West Africa. The leaves are an important source of protein, lipids, carbohydrates, fibre, beta-carotene, sodium, potassium, magnesium, iron, calcium, vitamins A, B and C, etc. In Mali, apart from the fact that the *C. olitorius* grows spontaneously in the wild, it is produced in all regions through household gardens. The leaves are harvested and used fresh or dried in the diet. In some countries, leafy vegetables are still neglected and underused because of their very localized use and their wild or semi-wild nature, despite their socio-economic interest. In Mali, very little information is available on *C. olitorius* and, until now, very little research has been carried out on this plant. This study was initiated ~~with the goal of improving~~ to improve the value of leafy vegetables by releasing new varieties of *C. olitorius* based on the characteristics preferred by producers. The study was carried out in the Koulikoro region, in the Sudano-Sahelian zone of Mali. Seeds of six varieties of *C. olitorius* were randomised to three varieties coded A, B and C per package for 180 producers. A survey questionnaire was established beforehand to take into account the socio-economic characteristics of the producers and the agronomic characteristics of the varieties in the field. The data collected was analyzed using IBM SPSS 25 software. Based on producers' perceptions, three *C. olitorius* varieties were identified and proposed for release ~~on the basis of~~ based on their good leaf yield, leaf size, disease resistance and taste. These varieties were: Bafia, Line H and Sudan 4.

**Key-words:** Variety, preference, characteristic, *Corchorus olitorius*, Koulikoro

## 1. INTRODUCTION

In Africa, traditional vegetables play an important role in the diet of rural and urban populations. They help to improve the quality of food rations by providing micronutrients. The benefits of traditional vegetables are considerable in the fight against malnutrition (Parkouda et al., 2016) and they are one of the main sources of cash income.

Jute Mallow (*Corchorus olitorius* L) is an annual herbaceous plant in the Malvaceae family, native to tropical and subtropical regions. Its geographical origin was often controversial, as it has been cultivated for centuries in both Asia and Africa, and is found in the wild on both continents. In tropical Africa, it is reported as a wild or cultivated vegetable in many countries (Loumerem and Alercia, 2016). *Corchorus olitorius* is grown for culinary use in Africa and the Near East, while in Asia it is used more as jute fibre. It is a popular leafy vegetable indigenous to most tropical African countries and is used as a mucilaginous vegetable (Fondio, 2005). This leafy vegetable is highly prized in many countries around the world, and goes by many names and recipes: ademè in Benin, crincrin or ninnouwi in Togo, mouloukhia in North Africa, fakouhoy in Mali, kpala in Côte d'Ivoire. It is also known as Egyptian spinach, red jute or the mallow of the Jews ([www.hamidouhorticulture.com](http://www.hamidouhorticulture.com)).

The leaves of the *C. olitorius* are an important source of protein, lipids, carbohydrates, fibre, beta-carotene, sodium, potassium, magnesium, iron, calcium, vitamins A, B and C, etc (Aglinglo et al., 2022). *C. olitorius* could be a powerful weapon against nutritional deficiencies, especially in developing countries (Kiebre et al., 2016). It is a medicinal plant traditionally used in the treatment of fever, tumours, pectoral pain, dysentery, aches, enteritis, cystitis, piles and dysuria (Adegoke and Tayo, 2009).

*Corchorus olitorius* is better known in Mali under the name "Jofon" from the local language bambara Bambara or Bamanankan (the country's most widely spoken language), an ethnic group generally found in the south and center of the country.

In Mali, although the *C. olitorius* grows spontaneously in the wild, it is produced in all regions through home gardens. The leaves are harvested and used fresh or dried in food. Its greatest importance comes from its use in the preparation of “*Fakoye*” sauce, which originates from the Songhaï ethnic group, who generally live in the north of the country. The value chain for this plant is a source of income for women (Aglinglo et al., 2022).

Leafy vegetables remain neglected and underused by researchers and national agricultural programmes in several countries, due to their very local usage, their wild or semi-wild nature and the very large number of species involved, despite the socio-economic interest (Gotor, 2011). They are also neglected by consumers because of their association with rural lifestyles and low social status, and are therefore often considered a poor man's food (Gotor, 2011).

In Mali, very little information is available on *C. olitorius* and very little research has been carried out on this plant up to now.

This study was initiated ~~with the aim of enhancing~~to enhance the value of leafy vegetables by introducing new varieties of *Corchorus olitorius* based on the characteristics preferred by producers in Mali.

## **2. MATERIAL AND METHODS**

### **2.1. Study site**

The study was carried out in the Sudano-Sahelian zone of Mali (Latitude and longitude). It involved 27 villages in seven rural communes (Baguineda, Koulikoro, Mandé, Nonkon, Nonsombougou, Sanankoroba and Siby) in the Koulikoro region. ~~Average-~~The average annual rainfall is between 700 and 1200 mm/year. Over the course of the year, the average monthly temperature can drop to 29°C and rise to 40°C. The area is irrigated by several rivers: the Niger, the Baoulé, the Sankarani, the Bagoé, the Bani and the Bafing (FAO, 2015). Agriculture is the main economic activity in the area. Market gardening and arboriculture are practiced with highly appreciable production. The main crops grown are: maize, sorghum, millet, rice, cowpea, fonio and vegetables such as tomatoes, onions, lettuce, cabbage, eggplant, amaranth, okra, peppers, etc. and tubers (sweet potatoes, cassava, yams) (DIARRA, 2021). Fruit production includes mangoes, shea nuts, oranges and bananas (Dabo, 2023). The main cash crops are cotton, groundnuts, tobacco and sesame. Livestock rearing, beekeeping and fishing complete the picture (Diarra, 2021).

### **2.2. Plant material**

The plant material consists of six varieties of *Corchorus olitorius*: Aziga, Bafia, Big leaves, IP2, Line H and Sudan 4. The seeds of the different varieties were provided to producers by the project without charge.

### **2.3. Randomization and distribution of test packages**

The six jute mallow varieties were randomized to three varieties coded A, B and C per package for 180 producers. The producers were distributed among the 10 managers (surveyors). Each manager received packages for these 18 growers.

Each producer received a package containing seeds for three varieties coded A, B and C as indicated by the Tricot (“sets of three”) resulting from a random distribution of the different varieties. The growers do not know the names of their three technological options (in this way, they are not influenced), but they only know the codes “A”, “B” and “C”.

### **2.4. Test installation**

#### **2.4.1. Lifting seed dormancy**

Fresh seeds, and sometimes even old seeds, are dormant due to the impermeability of their seed coats. Lifting the dormancy is a very important step, as it stimulates the enzymes involved in seed germination. The technique adopted is heat shock, which involves wrapping the seeds of each variety separately in a piece of cloth marked A, B and C and immersing them in hot water at a temperature of 75-80°C for 15-20 seconds. Then remove and re-immerses in lukewarm water immediately for 5 - 10 minutes. Leave to dry in the shade for at least 12 hours.

#### **2.4.2. Preparing the nursery**

The nursery was set up by making beds one metre wide, of varying lengths and well-well-levelled. The seeds were placed in furrows 2 cm deep and 10 to 15 cm apart. The seeds were covered with a light layer of fine sand, followed by moderate watering. The beds are covered with straw until the seeds emerge, to protect them from rain, sun, water and poultry. Watering is done twice a day, morning and evening.

#### **2.4.3. Transplanting**

Transplanting was carried out on the 21st day after sowing in the nursery. Vigorous seedlings of around 10 cm in height were chosen for transplanting. Transplanting was carried out in the evening to allow the seedlings to take root properly.

The seedlings were transplanted, one plant in each of three rows, with a spacing of 60 cm between rows and 40 cm between plants.

#### **2.4.4. Data collection**

A questionnaire was prepared in advance to take into account the socio-economic characteristics of the producers and the agronomic characteristics of the varieties in the field. Ten surveyors were recruited and trained in the use of the questionnaire and the data collection tablets. The interviewer is the person in charge of the trial.

Socio-economic data was collected from producers on the day of sowing in the nursery. Information was collected on gender, age, level of education, occupation, family type, area available, land rights, vegetables grown and places of sale.

The agronomic characteristics were determined by simple visual observation for the three varieties coded A, B and C at each grower's site. The characteristics selected relate to: germination, vigor at emergence, resistance of the varieties to biotic constraints (diseases and pests), abiotic constraints (drought, flooding), production, leaf size, taste and marketability.

Triadic comparisons of 'Tricot' technology options are a participatory research approach aimed at decentralizing the evaluation of technologies adapted to local conditions and obtaining experimental data with higher external validity. Through field visits by the investigators, questions are put to the farmer in front of the three plots (A, B and C) of his trial.

The answer to each question, based on the grower's perception of new technologies and product concepts, is recorded on forms in the tablet.

#### **2.5. Data analysis**

The data collected was directly entered into the tablets and then uploaded to ClimMob using the ODK Collect application for analysis. The downloaded data was analyzed using IBM SPSS Statistics V. 25 analysis software. Descriptive statistics were used to estimate means and extreme values. Graphs were produced using Excel version 2019.

### **3. RESULTS**

#### **3.1. Socio-economic characteristics of farms**

The average age of those surveyed was 40, with a minimum of 19 and a maximum of 67. The majority of producers were women (81%) and 19% were men. Housewives accounted for 63.4% and farmers for 31.4%. The number of years of study was 0 and the maximum was 14 years, with an average of about 2 years. ~~The~~ 17% of people could read in French, compared with 83% who could not. The types of ~~the~~ family identified were 56.9% polygamous (the head of the family married to at least two women and had children), 30.1% nuclear (two parents and children, possibly with grandparents) and 13.1% single-parent (one parent with children, possibly with grandparents). The number of people living together for at least 6 months a year sharing meals in a family was 69 for the maximum and 1 person for the minimum, with an average of around 17 people. The minimum area of land was 40 m<sup>2</sup>, with a maximum of 40,000 m<sup>2</sup> and an average of 6,746.99 m<sup>2</sup>. In terms of farm acquisition, 73.9% of ~~the~~ land was acquired by inheritance and 18.3% by donation. The majority of those surveyed produced mallow jute for food consumption (83.7%) and only 16.3% sold their produce. The main place of sale was the market. Sales at the edge of the fields and to family neighbors were significantly lower.

#### **3.2. Agronomic characteristics of varieties in the field**

We collected a total of 130 valid questionnaires from the 180 producers who received packages of the three varieties, i.e. a response rate of 72%. The 50 producers who did not respond received the seed late and were unable to set up the plots, or lost trial plots. The results of the study are shown below:

##### **3.2.1. Vigor at emergence and survival rate of varieties**

Nursery sowing was carried out in June (15.4%), July (53.1%), August (19.2%) and September (12.3%). Transplanting was carried out in the evening, 15 to 21 days after sowing in the nursery.

The most vigorous variety at emergence was IP2, followed by Bafia, according to 20.8% and 20% of growers respectively. The least vigorous variety was Aziga (10%).

All varieties recorded a very low survival rate after transplanting from the nursery to the field. This low survival rate was due either to the heat or to the type of soil, depending on the grower. The results obtained show that the two most vigorous varieties, IP2 and Bafia, were also indicated by growers as the varieties with the highest survival rates, with 20% and 18.5% respectively. The variety with the lowest survival rate was Aziga (7.7%).

##### **3.2.2. Drought and flood tolerance of jute mallow varieties**

The majority of producers did not answer these questions, as they had neither observed drought nor flooding of their plots (the plots were owned by several producers).

Nevertheless, 11.5% of growers considered that the Bafia, Big leaves and IP2 varieties were the most tolerant to drought. The most sensitive varieties were Line H and Sudan 4, according to 8.5% of growers.

The Bafia variety was indicated as the most tolerant to flooding by 14.6% of producers, followed by IP2 (12.3%). The least tolerant was Aziga (3.8%) followed by Big leaves (6.9%).

### 3.2.3. Disease and pest resistance of jute mallow varieties

Several producers reported that they had not noticed any disease or pest damage on their plots. They therefore did not give their opinion on the varieties ~~in relation to~~ concerning this question. The producers who made the observation found that the most disease-resistant variety was Sudan 4 (15.2%), followed by Bafia (13.3%). The most susceptible was Big leaves (8.6%).

The variety most resistant to pests was Bafia according to 18.1% of producers and Big leaves ~~was~~ were reported as the most susceptible to pests by 8.6% of producers.

### 3.2.4. Leaf size and yield of jute mallow varieties

Figure 1 illustrates the variation in leaf size and yield among the jute mallow varieties. Regarding the leaf yield of the varieties, several producers were unable to give their opinion, as the density of plants was low due to low survival rates. The varieties identified as having the largest leaves were IP2 and Line H, followed by Bafia, according to 17.1 and 16.2% of growers respectively. The variety with the smallest leaves was Aziga (9.5%).

The variety with the highest yield was Sudan 4 (10.5%) followed by Aziga and Bafia (9.5%). The ~~lowest lowest~~-yielding varieties were Big leaves and IP2 (6.7%).

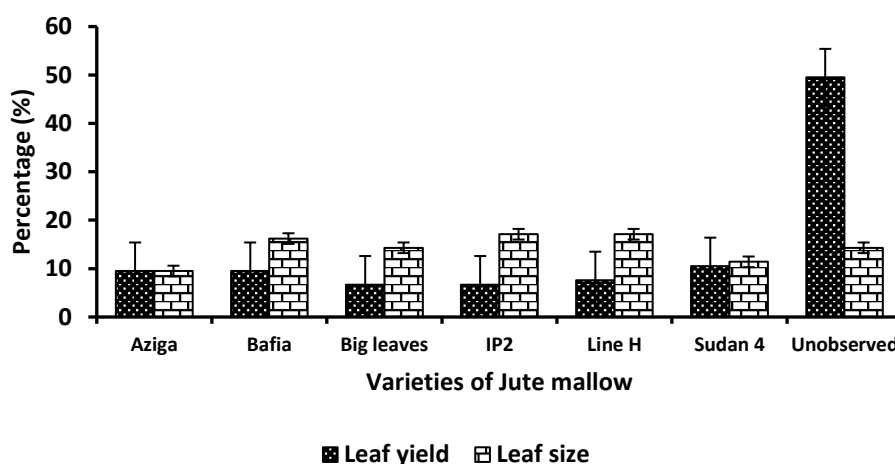


Figure 1. Variation in leaf size and leaf yield of jute mallow varieties according to producers

### 3.2.5. Taste and marketability of jute mallow varieties

Bafia and Aziga were identified by 25.7% and 6.2% of producers respectively as the varieties with the best taste (Figure 2). The variety with the least favourable taste was Big leaves (10.5%).

The varieties that were easy to market were Line H followed by IP2 according to 22.9% and 21.9% of growers respectively. The hard-to-market variety was Aziga, according to 9.5% of producers (Figure 2).

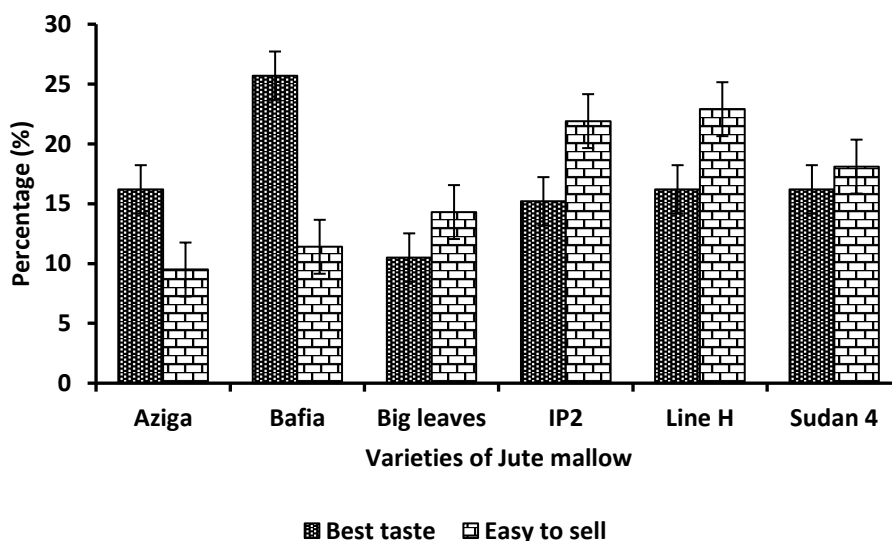


Figure 2. Variation in taste and marketing ability of jute mallow varieties according to producers

#### 4. DISCUSSION

The survey was carried out in 27 villages belonging to 7 rural districts in the Koulikoro-Mali region. Most of the people surveyed were young, with an average age of 40. A study of okra producers carried out in the same region by Sissoko et al (2024) found that the average age of okra growers surveyed was 41. The majority of producers were women, whose main activity was the family household. A similar result was obtained by Nakaziba et al (2020) during an ethnobotanical survey of *Corchorus olitorius* in the Oyam district of northern Uganda.

The largest families were large polygamous families farming on inherited land. These results are in line with those obtained by Grazioli et al (2022) in a study conducted in Nigeria, where most of the respondents farmed on inherited land. The majority of survey respondents produced jute mallow for food consumption. The jute mallow plays an important role in the diet because it enables people to survive in times of food shortage and provides nutrients that are rare in the diet (Herzog, 1992). A few producers were selling their produce, and the main place of sale was the market; sales at the borders of the fields and to neighbours in the families were significantly low. According to Sow and Diarra (2020), the sale of vegetables is a source of income for women in Mali, as part of local agriculture, an economic opportunity for millions of women in Africa. The same is true of Burkina Faso, where *Corchorus olitorius* is still grown as a proticulture and is used as a leafy vegetable for picking, providing a source of income for women, especially in peri-urban and urban areas where the plant is increasingly cultivated (Kiebre et al., 2016). According to a study in Benin, *Corchorus olitorius* growers sell their own-harvest at the market (Komlan et al. 2013).

The varieties identified by producers as the most vigorous at emergence were IP2 and Bafia, which also obtained the highest survival rate. The least vigorous variety with a low survival rate was Aziga. Most of the people surveyed had not noticed any drought or flooding in their plots, as the plots were ~~arrogated-inhabited~~ by several growers. Although *Corchorus olitorius* grows best during the rainy season, it is a drought-resistant plant. It can persist for up to a month without rain, but irrigation improves its growth rate and yields. It also tolerates a high level of rainfall, but is very sensitive to excess water when young (Nakaziba et al. 2020). The varieties identified as the most tolerant to drought and flooding were Bafia, Big leaves and IP2, according to some growers. However, the varieties most sensitive to drought and flooding were Line H and Sudan 4. Drought ~~has a negative effect on~~ the growth of *Corchorus olitorius* (Shiwachi et al., 2020). The vulnerability to flooding of vegetable crops in general and of *corchorus olitorius* in particular has been reported by Bongongo (2023).

The disease- and pest-resistant varieties were Sudan 4 and Bafia. The most susceptible was Big leaves. Like other vegetable crops, *Corchorus olitorius* is affected by diseases, but the most important ~~was-is~~ pests. The most damaging pests were stink locusts (*Zonocerus variegatus*), caterpillars (*Acrea spp.*), armyworms (*Spodoptera littoralis*) and flea beetles (*Podagrica spp.*). During the dry season, red mites (*Tetranychus cinnabarinus*) often attack the leaves (Alissou, 2011).

The varieties IP2, Line H and Big leaves were identified as the varieties with the largest leaves, but their leaf yield was low. On the other hand, Sudan 4 and Aziga were identified as ~~high-high~~-leaf yield varieties with small leaf sizes. This result confirms the findings of Kiebre et al (2016), who found a negative correlation between leaf yield and leaf blade width. The Bafia variety was identified as the variety with good leaf yield and large leaf.

Bafia and Aziga were the two most popular varieties with producers in terms of taste. The variety most appreciated on the market by customers was Line H. Products sell better according to the freshness, flavor and size of the leaves, and according to the color, size, taste and shape of the fruit. The same observation was made ~~by~~ (Camille, 2018) in the manual for preparing and selling fruit and vegetables from the field to the market.

#### 5. CONCLUSION

Throughout the world, the participatory approach has been used to solicit the opinions of producers (farmers) in the choice of varieties to be used in their fields. It helps to understand farmers' varietal preferences and to involve them in improving agricultural production.

~~The aim of this work was~~ ~~work aimed~~ to study the different *Corchorus olitorius* varieties introduced at farmers' sites ~~in order~~ to identify the best varieties according to farmers' preferences.

The application of the tricot approach enabled producers to better appreciate the different varieties.

Based on farmers' perceptions, ~~a number of several~~ *Corchorus olitorius* varieties have been identified and proposed for homologation. These varieties are Bafia for its good leaf yield, leaf size and taste; the Line H variety for its leaf size and its appreciation on the market by customers; and Sudan 4 for its leaf yield and disease resistance.

## REFERENCES

- 1 Parkouda, C., Ba/Hama, F., Tenkouano, A., Amga, R.K., and Diawara, B. (2016). Traditional African Vegetables: Good Practices for Conservation and Transformation. AVRDC - The World Vegetable Center, Taiwan ». AVRDC, no 16-798: 103.
- 2 Loumerem, M, et Alercia A. (2016). « Descriptors for Jute (*Corchorus Olitorius* L.) ». Genetic Resources and Crop Evolution 63 (7): 1103-11. <https://doi.org/10.1007/s10722-016-0415-y>.
- 3 Fondio, L. (2005). « Contribution to knowledge of the development of Tomi okra: *Abelmoschus caillei* (A. Chev.) Stevels (Malvaceae), in central Côte d'Ivoire. The effect of water and fertilizer inputs according to sowing periods. Doctoral thesis no. 431/2005. Cocody-Abidjan: University of Aocody Abidjan.
- 4 Jute Mallow (*Corchorus olitorius*). [Online] Available: <https://www.hamidouhorticulture.com/product-page/cor%C3%A8te-potag%C3%A8re-corchorus-olitorius>. (January 2023).
- 5 Aglinglo, LA, Legba EC, N'Danikou S, Salaou M, Dako A, Sidibe A, Dolo AN. (2022). « Practical guide to growing *Corchorus olitorius* and seed production ». N° 23-1060, 2022.
- 6 Kiebre, M., Kando, P.B., Kiebre, Z., Sawadogo, M., Sawadogo, N., Sawadogo, B., Nanema, R.K., et Traore, R.E. (2016). « Agromorphological evaluation of vegetable cortege accessions (*corchorus olitorius*. L) from Burkina Faso » 14 (1).
- 7 Adegoke, A.A., and Tayo A. (2009). « Phytochemical composition and antimicrobial effects of *Corchorus olitorius* leaf extracts on four bacterial isolates. British Columbia Author affiliation » Vol.3 (No.3): pp.155-159.
- 8 Gotor E. (2011). Leafy vegetables from Africa - Kenya. Local biodiversity: production, marketing and consumption. FAO Nutrition and Consumer Protection Division (AGN). 2 p. [Online] Available: <https://www.ipcinfo.org/fileadmin/> (November 2023).
- 9 FAO. (2015). AQUASTAT Country Profile – Mali. 20 p.
- 10 Diarra, B. (2021). « Monitoring the activities of the 2020-2021 agricultural season in OPIB's sector II, for the purpose of obtaining the Brevet de Technicien Agricole (B.T.A)'. Final year internship report. Baguineda: Agriculture Learning Centre (CAA) of Same (Kayes).
- 11 Dabo, D. (2023). Improvement of agricultural production techniques in the village of Teneya, commune of Siby". Report on end-of-cycle course. Agricultural Extension Certificate. CAA de Samanko. 53 p.
- 12 Sissoko, S., Diawara, M.O., Guindo, E., Traoré M., Camara, A.Y., Dolo, A. (2024). Participatory rural appraisal of new okra varieties and farmers' management practices on okra farms in Mali. *Journal of Genetics, Genomics & Plant Breeding* 8(3) 92-100. ISSN (Online): 2581-3293.
- 13 Nakaziba, R, Anyolitho, M.K., Amanyana, S.B., Ogwali-Okeng, J., Alele, P.E. (2020). Traditional uses of *Corchorus olitorius* L in Oyam District, Northern Uganda: A cross-sectional ethnobotanical survey. Research Square. 11 p. <https://doi.org/10.21203/rs.3.rs-18590/v1>
- 14 Grazioli, F., Borelli, T., Ghione, A., Calabrese, J., Bilali, HE., Bogliotti, C., Lecci, S. (2022). Supporting and enhancing the heritage of local cultures in Burkina Faso and Niger to improve living conditions and ecosystems. Report on the process of selecting NUS and target areas. Projet SUSTLIVES. FOOD/2021/422-681. Programme DeSIRA - Development Smart Innovation through Research in Agriculture. AICS, CIHEAM-Bari, CNR, LUKE, Université Joseph Ki-Zerbo, Université Abdou Moumouni. 183 p.
- 15 Herzog, F.M., (1992). Biochemical and nutritional study of wild food plants in the south of Baoulé, Cote d'Ivoire. Thesis EPFZn°9789,134p.
- 16 Sow M, and Diarra M. (2020). Mali: A wonder of nature called fresh okra. <https://amap.ml>. visited on 15 January 2024.
- 17 Komlan, C, Adegbola, A., Adegbidi, S., Adetonah And Mensah, G.A. (2013). "Analysis of marketing systems for Jute Mallow (*Corchorus olitorius* L.) produced at Agbédranfo in south-west Benin (Couffo Department)" 27 p.
- 18 Shiwachi V., Komoda M, Koshio K., et Takahashi H. (2008). « Effect of soil moisture stress on the growth of *Corchorus olitorius* L. », *African Journal of Agricultural Research*. Vol. 4 (4), pp. 289-293. 5 p. ISSN 1991-637X.

- 19 Bongongo, M.G. (2023). « Climatic risks and vulnerability of market garden crops in the Ndjili river valley, Kinshasa, Democratic Republic of Congo », 9 p.
- 20 Alissou, A.E. (2011). « Analysis of market gardening practices in the rice-growing lowlands of Agbédranfo-Vovokanmey (Couffo) and Houinga (Mono) in southern Benin, and the effect of nitrogen on the growth and production of crincrin. (*Corchorus olitorius* L.) ». Benin.
- 21 Camille, B. (2018). « Study of the effect of soil salinity on the nutritional value of *Amaranthus cruentus* leaves, Faculty of Bioengineering: Agronomic Sciences - Food Science, Technology and Quality », 150 p.

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