Macrothink Institute™

**Journal of Food Studies**
ISSN 2166-1073
2022, Vol. 11, No. 1

# Inventory of Local Practices of Use and Conservation of Baobab Products in Two Regions of Mali

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Received: September 22, 2022 Accepted: October 31, 2022 Published: November 14, 2022

doi:10.5296/jfs.v11i1.20464 URL: https://doi.org/10.5296/jfs.v11i1.20464

**Abstract**

The baobab (*Adansonia digitata*) occupies an important place in the diet of local populations

in Mali. This work aimed to conduct an ethnobotanical survey in two regions of Mali: Ségou (municipality of Cinzana) and Mopti (municipalities of Bankass and Koropin) in order to determine the forms of use of baobab organs. The survey was conducted using a semi-structured questionnaire and direct interviews. The results showed that all parts of the baobab were used, with the leaves (100%) and the fruit pulp (98.30%) as the most consumed. In addition, the barks (68.30%), the branches, and the trunks (60%) were also widely used for socio-economic and therapeutic needs. All the edible organs were consumed in the sauce. The pulp was mainly consumed in the form of cream (96.70%), porridge (43.30%), and juice and syrup (10%). Despite their nutritional values, the seeds were little used (8.30%) and transformed into soap, oil "soumbala" and "datou" (forms of local spices). The taste (30-66.70%) and the color (1.70-38.30%) were the main criteria used to assess the quality of edible organs. The sun drying (100%) was the main method of preservation. Due to the bad storage conditions, the populations are facing problems of termite and worm infestation (20%). These results indicate the need to develop improved technologies to better preserve the nutritional quality of baobab products.

**Keywords:** Ethnobotanical survey, Baobab, local practices, Mali

## 1. Introduction

For several years, Mali has been facing food and nutritional crisis. The prevalence of food insecurity was estimated at 16.3%, including 1.9% of severe food insecurity. There is also an uneven distribution of these statistics according to the regions and the rural and urban areas. For instance, they varied from 19.2% in rural areas to 7.8% in urban areas (ENSAN, 2020). According to the thresholds defined by the World Health Organization (WHO), the nutritional situation of the Malian population is currently on the edge of the emergency threshold with more than 10% of global acute malnutrition and more than 2% of severe acute malnutrition. These statistics are even more alarming among children in Mali with an anemia rate rising to 81.90% in 2020 (Olive et al., 2020).

To respond to these challenges, the scientific world is working to find wild fruit species with high nutritional values in order to supplement the basic cereals and effectively fight against the food insecurity and the malnutrition. So, many West African wild fruit species have been proposed and investigated in recent decades: *Adansonia digitata*, *Zizyphus mauritiana*, *Detarium microcarpum*, *Balanites aegyptiaca*, *Saba senegalensis*, *Tamarindus indica*, *Cordylla pinnata*, *Cordia myxa*, etc. ( Diop et al., 2005; Diarra et al., 2016; Ali et al., 2019 ; Konaré et al., 2022).

Among these proposed species, the baobab *(A. digitata*) is one of the most important in the Sub-Saharan African zone (Leakey et al., 2022). All its parts are used in food, traditional medicine and cosmetics (CUC, 2010 ; Cissé, 2012). The consumption of its leaves, seeds and fruit pulp provide various nutrients (vitamins, mineral salts and proteins) essential to the organism of populations whose diets are mainly cereal-based (Sidibe & Williams, 2002 ; Bamalli et al., 2014; Ali et al., 2019). Accordingly, many West African authors have examined the variability and determined the nutritional parameters of these edible parts (Diop et al., 2005 ; CUC, 2010 ; Assogbadjo & Loo 2011 ; Sogodogo et al., 2021). However, in Mali, work relating to the baobab is essentially limited to the inventories (Diarra et al., 2016;

Kouyate et al., 2020; Sogodogo et al., 2021) and studies of morphological variability (Kouyaté et al., 2011). Similarly, some studies on the evaluation of some nutritional parameters of its leaves have been conducted by Diarra et al. (2020). However, studies have shown that traditional use practices from harvest to consumption can negatively impact the nutritional quality of fruit species (Marouzé et al., 2008). The purpose of this study was to inventory and diagnose these traditional use practices and the main constraints related to the conservation and storage of baobab products.

## 2. Materials and Methods

### *2.1 Study Area*

Mali, with a surface area of 1,246,814 $km^2$, has an estimated population of 20,933,072 inhabitants against a density of 16.79 inhabitants per $km^2$ (Populationdata.net, 2022). The study was conducted in the communes of Bankass, Kopropin and Cinzana (Figure 1). The first two communes are located in the Mopti region and the last one in the Segou region. These sites were chosen due to the high consumption of baobab by the local communities and the high frequency of the species.

### *2.2 Data Collection*

The ethnobotanical survey was carried out during the month of September 2016 simultaneously in the two regions. It was realized with the facilitation of traditional authorities in each village. The men and women were randomly selected without distinction of gender, religion and ethnicity. The questions concerned the socio-demographic characteristics of the respondents (sex, age, level of education). They also focused on the used parts of the baobab, their forms of use, their conservation and packaging processes and the constraints encountered during conservation.

The survey was carried out according to the protocol described by Diarra et al. (2016) using a semi-structured questionnaires and direct interviews. The language used was the local language of each village. The semi-structured interviews are based on a list of questions previously defined in a form that has been completed by the interviewers.

### *2.3 Data Analysis and Processing*

The respondent's data were processed with SPSS Statistics 23. The means and frequencies generated by SPSS were extracted in Excel format, which was also used to draw the graphs. The map was produced using Arc GIS cartographic software version 10.3.

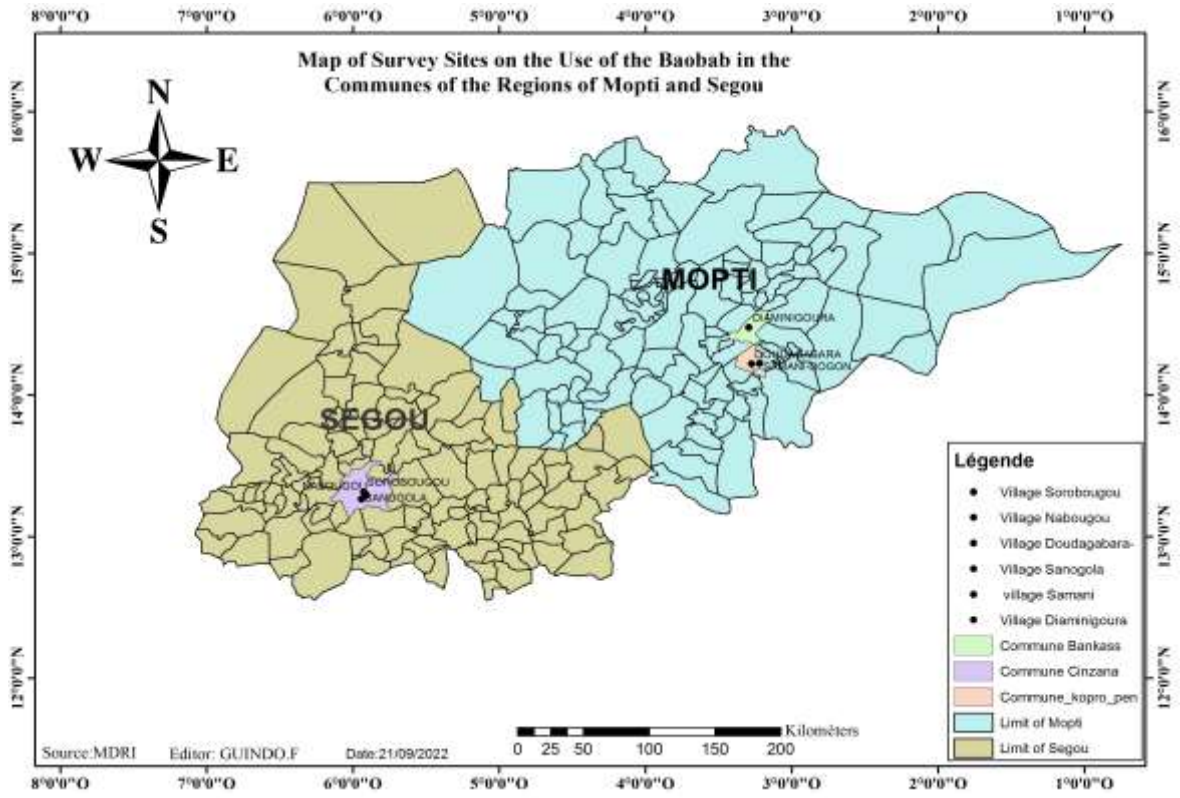


Figure 1. Map of survey sites

## 3. Results

The main data collected during the survey in the localities of Kopropin, Bankass and Cinzana were the socio-demographic characteristics of the interviewed people and their local practices of use and conservation of different parts of the baobab.

### *3.1 Sociodemographic Characteristics of the Surveyed People*

#### 3.1.1 Distribution by Gender and Site

The Table 1 presents the repartition of the surveyed people according to the site and the gender.

Table 1. Distribution of people by gender and site

| Gender | Sites | Counts | Percentages |
|---|---|---|---|
| Female | Cinzana | 16 | 26.67% |
| | Kopropin | 7 | 11.70% |
| | Bankass | 8 | 13.33% |
| Male | Cinzana | 14 | 23.33% |
| | Kopropin | 9 | 15.00% |
| | Bankass | 6 | 10.00% |
| | Total | 60 | 100% |

A total of sixty (60) people were interviewed in the three municipalities, including 29 men

(either 48.33%) and 31 women (either 51.67%). The highest proportions were recorded in the village of Cinzana (Ségou Region) with 26.67% for the women and 23.33% for the men (Table 1).

3.1.2 Age Groups

The Figure 2 represents the age categories of the respondents.

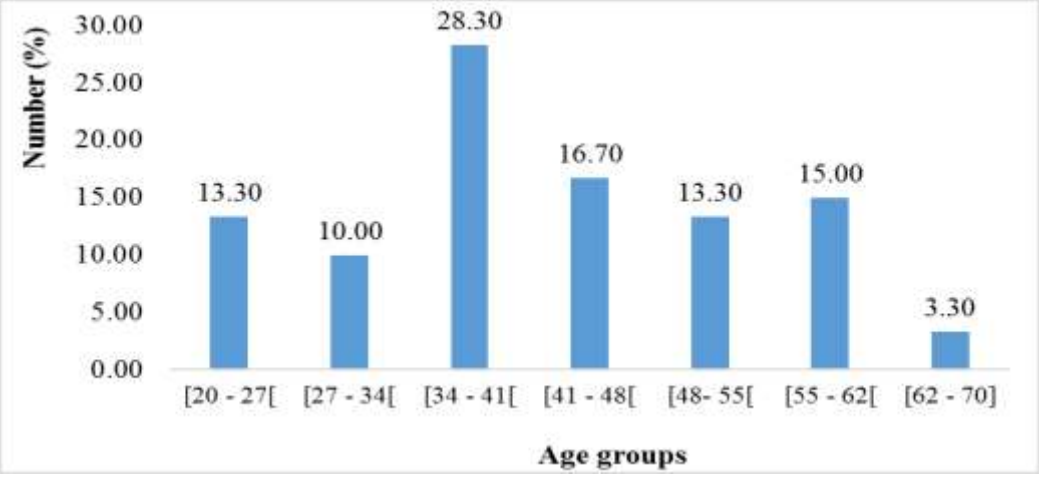


Figure 2. Age distribution of respondents

The age of the respondents varied from 20 to 70 years of which 28.30% belonged to the age group of [31-41], followed respectively by 16.70% for the age group of [41-48] against a minority (3.30%) who belonged to the age group of [62-70].

3.1.3 Educational Levels

The Figure 3 illustrates the educational levels of the respondents according to gender.

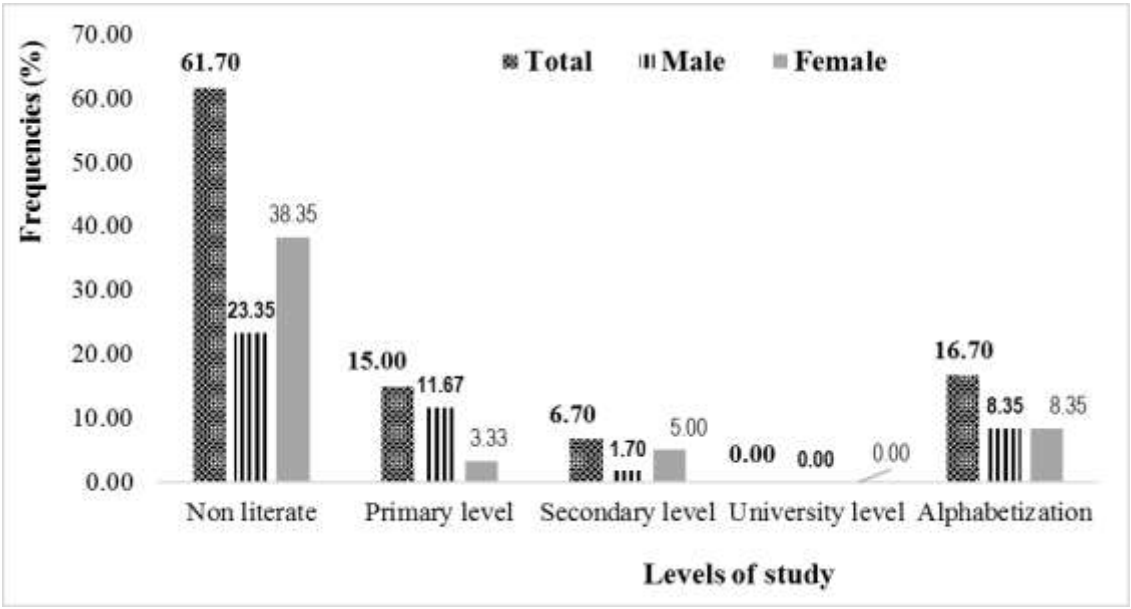


Figure 3. Level of education of respondents

These results show that the rate of schooling remains low in the tree municipalities, since more than half of the surveyed people (61.70%) are illiterate against 15% who have a level of primary education, including 11 67% men and 3.3% women. Among the alliterated, women were the most numerous with 38.35% against 23.35% of men. In addition, some residents (16.70% of respondents) have benefited from a literacy program in the context of capacity building. We also note that none of the respondents has reached the university level.

The Figure 4 shows the educational levels of the respondents by site.

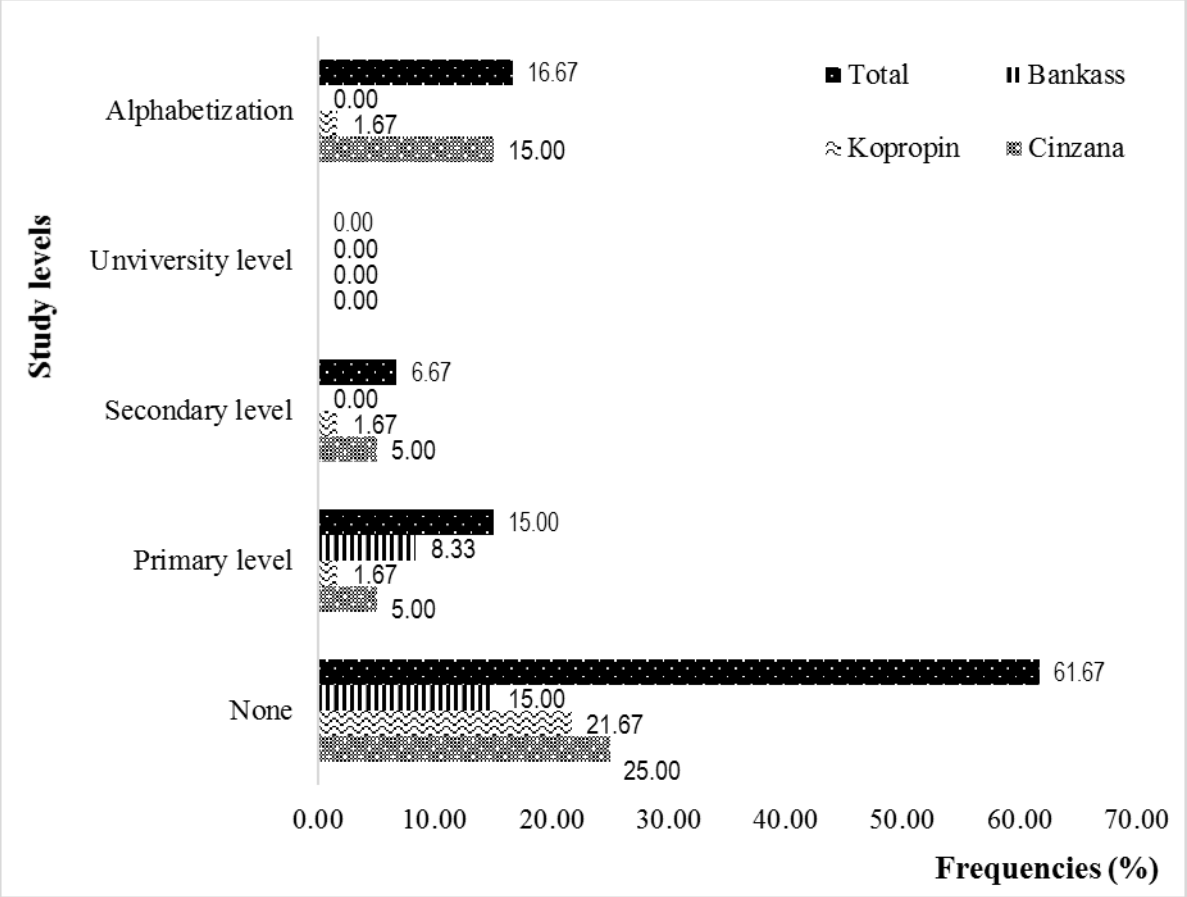


Figure 4. Study levels by site

As shown in the Figure 5, there is an uneven distribution of study levels across sites. It appears that the municipality of Cinzana with 25% followed by that of Kopropin with 21.67% have the highest rates of non-schooling. Despite this fact, the informal training program (literacy) reached very few people, 5% for Cinzana and 1.67% for Kopropin.

*3.2 Baobab Products*

3.2.1 Use of Baobab Products

The data collected on the use of the baobab concerned the forms and frequencies of use of the different parts of the baobab, the constraints linked to the transformation of the edible parts, the criteria for assessing the quality of the edible organs of the baobab as well as the

processes for preserving and packaging edible organs.

The Figure 5 illustrates the frequency of use of the different products of the baobab.

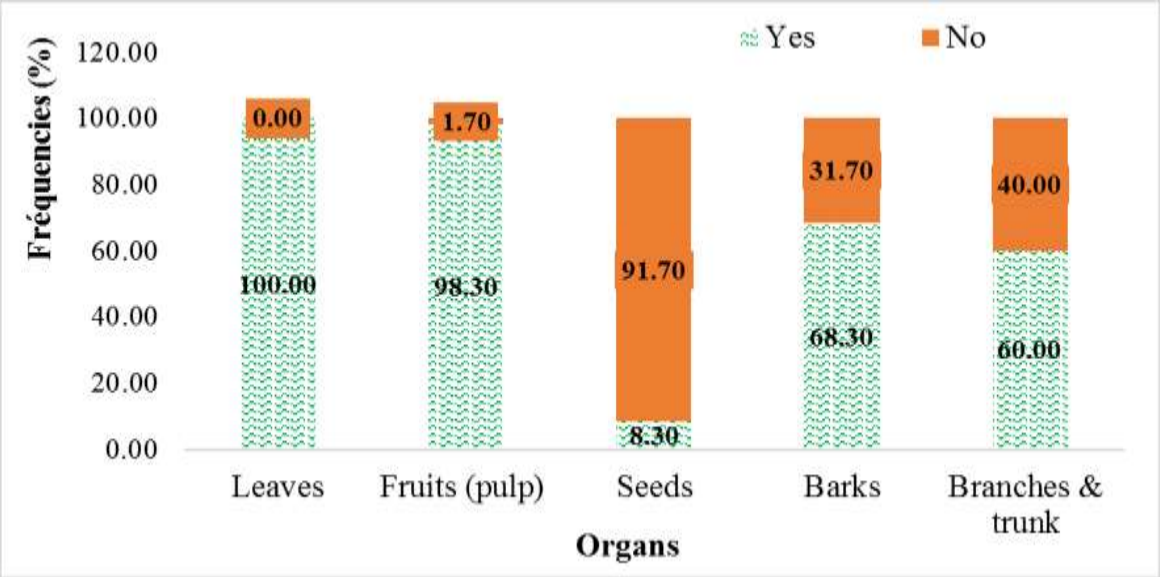


Figure 5. Frequencies of use of baobab organs

The survey carried out showed that the baobab leaves are the most used organs (100%) followed by the fruit pulp (98.30%). For socio-economic and therapeutic needs, the bark (68.30%), the branches and the trunks (60%) are also highly prized by the local populations. On the other hand, only 8.30% of those questioned used the seeds. There is also a strong use of bark (68.50%) and branches (60%), which constitutes a real threat to the survival of the species.

3.2.2 Forms of Use or Consumption

The forms of use of the baobab's different organs by areas are illustrated in the Table 2.

Through the analysis of this table 2, it appears a diversified use of baobab's organs. The barks are used as ropes or lianas (63.30%), 40% as baskets and mats. The "Dégué" represents the main form of consumption of the fruit pulp with 96.70% followed by porridge with 43.30% and 13.30% as couscous. As for the seeds, they are mainly used as sauce (65.10%) and 6.80% as "soumbala". The leaves are used throughout the sauce (100%) and as a couscous binder in Cinzana and Bankass (46.70%). In Kopropin, the leaves are also eaten in the form of salad (1.67%).

Table 2. Forms and frequencies of use of the different baobab organs by site

| Organs | Forms of use | Frequencies of use per site (%) | | | |
|---|---|---|---|---|---|
| | | Cinzana | Kopropin | Bankass | Total |
| Leaves | Sauce | 50,00 | 26,67 | 23,33 | 100 |
| | Binder for couscous | 31,70 | 0 | 15 | 46,70 |
| | Porridge | 3,30 | 0 | 0 | 3,30 |
| | In the form of salad | 0 | 1,70 | 0 | 1,70 |
| | Others | 5,00 | 6,70 | 0 | 11,70 |
| Seeds | Sauce | 15,00 | 26,67 | 23,33 | 65,10 |
| | Couscous | 3,30 | 0 | 0 | 3,30 |
| | «Soumbala » | 6,80 | 0 | 0 | 6,80 |
| | Soap | 1,70 | 0 | 0 | 1,70 |
| | Oil | 5,00 | 0 | 0 | 5,00 |
| | Production of «datou » | 1,70 | 0 | 0 | 1,70 |
| | Others | 10,00 | 3,30 | 0 | 13,30 |
| Pulp | Sauce | 1,70 | 0 | 0 | 1,70 |
| | Couscous | 13,30 | 0 | 0 | 13,30 |
| | Porridge | 25,00 | 10,00 | 8,30 | 43,30 |
| | «Degu é »or cream | 50,00 | 26,70 | 20,00 | 96,70 |
| | Juice / Syrup | 5,00 | 1,70 | 3,33 | 10,00 |
| Bark | Ropes or lianas | 33,33 | 13,30 | 16,67 | 63,30 |
| | Medicines | 1,70 | 0 | 0 | 1,70 |
| | Baskets, mats | 20,00 | 16,67 | 3,33 | 40,00 |
| | House roof construction | 1,67 | 3,33 | 13,30 | 18,30 |

3.2.3 Main Constraints During the Processing

The Figure 6 shows the main constraints during the processing of baobab products.

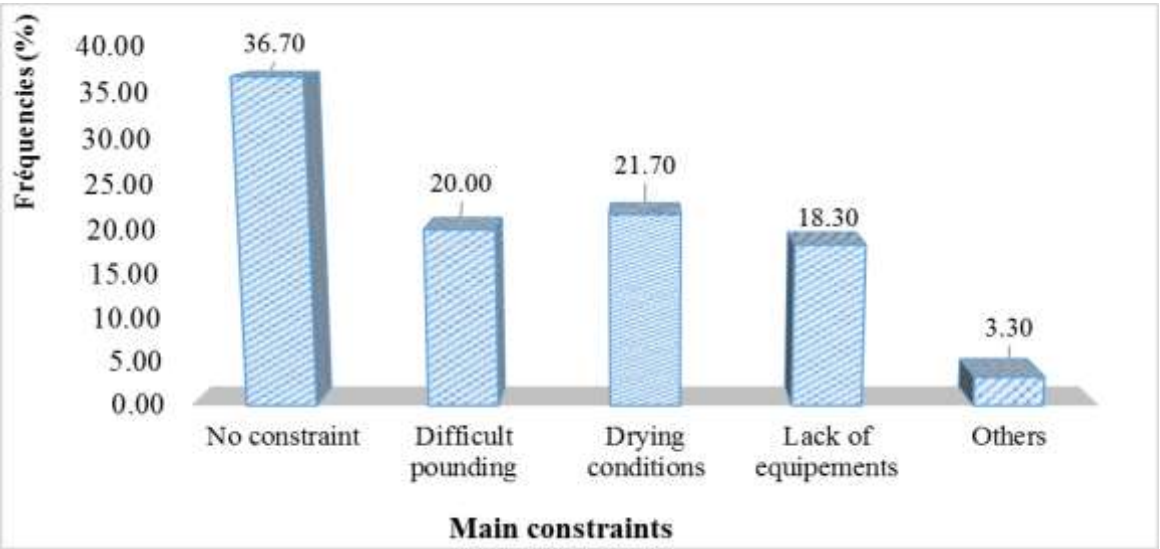


Figure 6. Main constraints during the processing of Baobab products

The constraints mentioned by the populations were the drying conditions with 21.70% followed by the difficult pounding with 20% and the lack of equipment with 18.30%. However, a significant proportion (36.70%) of the respondents declared that they did not encounter any constraints when transforming the baobab into consumable products.

3.2.4 Qualitative Assessment Criteria

The Figure 7 illustrates the different criteria that the respondents used to judge the quality of the edible organs of the baobab.

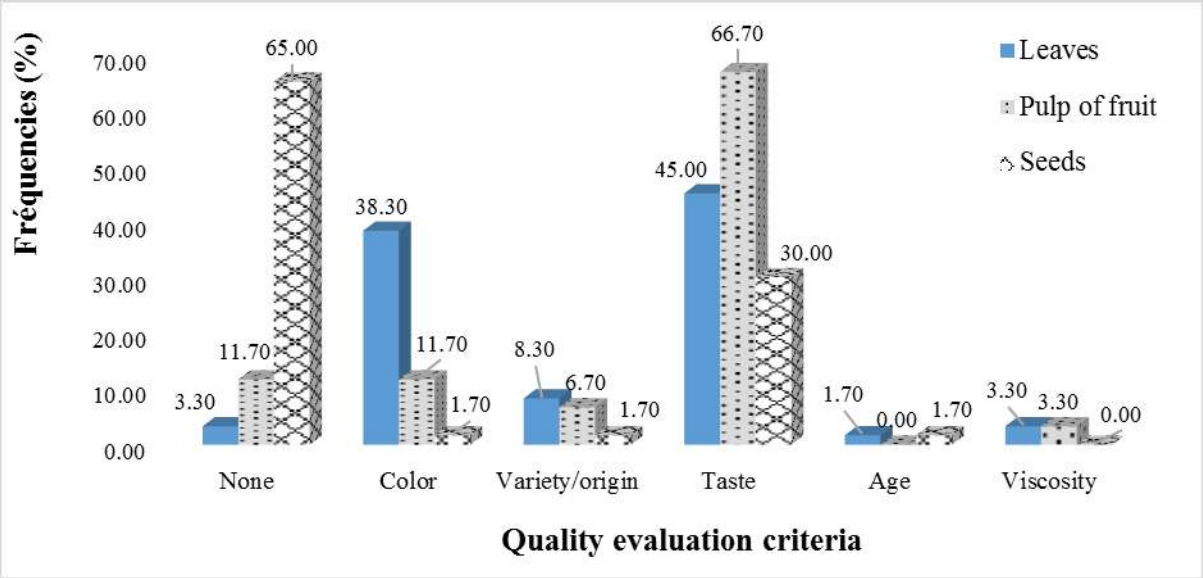


Figure 7. Criteria used for assessing the quality of baobab edible organs

Indeed, as shown in the Figure 8, the taste remains the main criteria for assessing the quality of the leaves with 45% and of the pulp with 66.70%. A good part of the interviewed people also rely on the color to estimate the quality of the leaves (38.30%) and the pulp (11.70%). Other criteria such as viscosity, origin and age of organs are also used to appreciate the quality. These results confirm the low level of baobab seeds consumption; because 65% of respondents declared that they do not use any criteria for assessing this organ, i.e. very few people know a good seed.

3.2.5 Preservation and Packaging Techniques

The equipements used for packaging and preserving the edible organs of the baobab are illustrated in the figure 8.

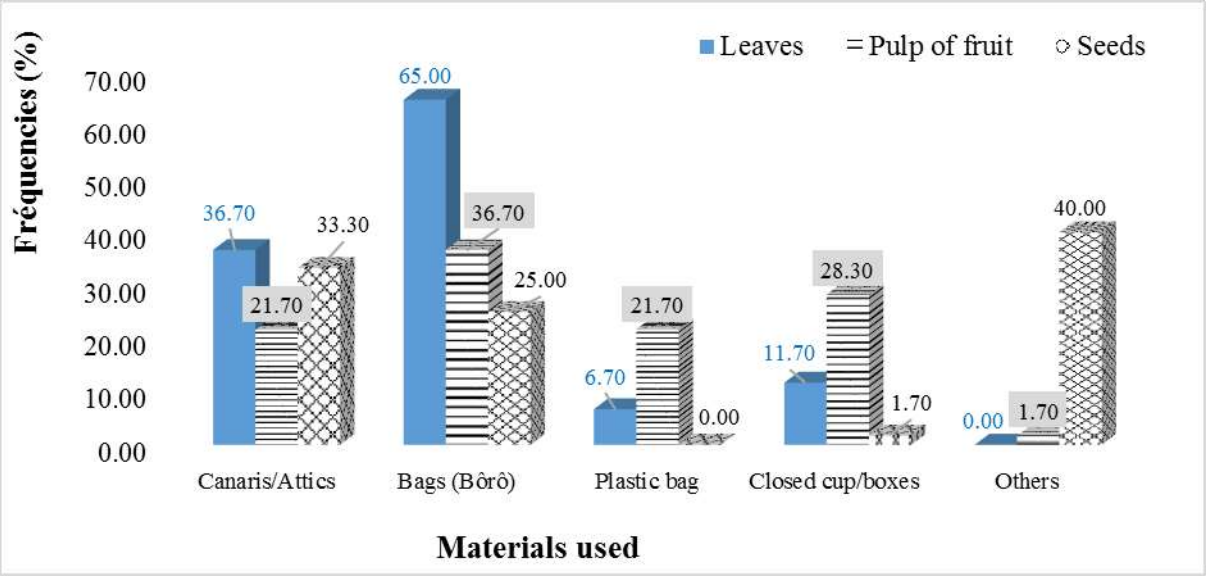


Figure 8. Materials used for packaging and preserving edible organs

This Figure 8 reveals that the edible organs were preserved after drying in the sun by most of people (96.70%) against only 3.30% who dried in the shade. An overwhelming majority (88.30%) was unaware of the existence of an improved method of preservation. The leaves are kept in bags by 65% of respondents, in canaries by 36.70%, in cups or in closed boxes by 11.70% and in plastic bags by 6.70%. As for the seeds, they are kept in canaries/attics by 33.30% against 25% in bags. The fruit pulp is preserved and packaged in bags by 36.70%, in closed boxes by 28.30% and canaries by 21.70%.

3.2.6 Conservation constraints

The various constraints related to the conservation of eatable products are described in the Figure 9.

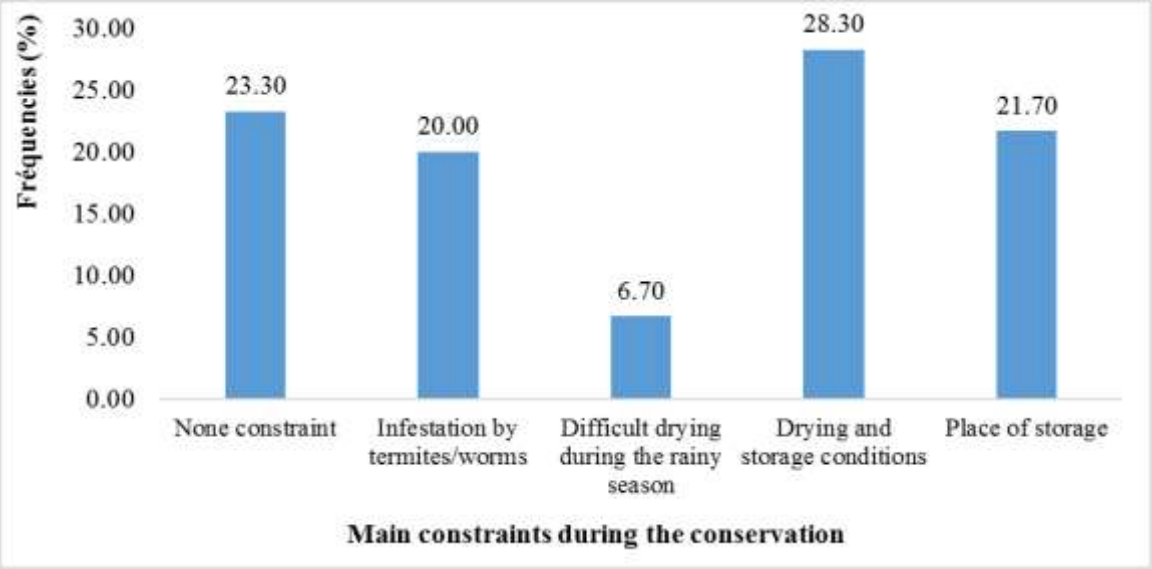


Figure 9. Constraints encountered during the conservation of Baobab eatable products

The survey data as illustrated in the Figure 9 showed that the drying and storage conditions (28.30%), followed by storage location (21.70%) and the termite and worm infestations (20%) represented the main constraints encountered during the conservation; even if 23.30% declared that they had not encountered any constraints for the conservation of edible parts.

As a source of procurement of edible baobab products, the picking remains the mainly source.

## 4. Discussion

The objective of this study was to identify and analyze the traditional use practices of baobab products for better valorization in order to contribute to the food and nutritional security. The sociodemographic characteristics of interviewed people were also noted.

The survey revealed a low-rate level of schooling in the investigated municipalities (61.70%). Among the respondents, 15% had a primary education level, including 11.67% of men and 3.3% of women (Figure 4). In a recent study on the perception of farmers relating to the exploitation of the baobab in the commune of Cinzana in Mali, Sogodogo et al. (2021) had reported illiteracy rates (57 – 66%) similar to ours. Among those alliterated, the women were the most numerous with 38.35%. This fact could be due to the preponderant social role played by the women in Malian society. However, it has been reported that the age and the level of education play an important role in the conservation and survival of the baobab (Sogodogo et al., 2021).

In relation to the use of baobab organs, all parts of the baobab are used. The leaves (100%) and the fruit pulp (98.30%) were the most consumed. Furthermore, the bark (68.30%), the branches and the trunks (60%) were also widely used by the population for socio-economic and therapeutic needs. This massive use of bark and branches would constitute a threat to the species (Kouyaté et al., 2011; Sogodogo et al., 2021). This excessive use of bark would be linked to its many therapeutic properties; since they are used in the management of diabetes (Konaré et al., 2022), fever, malaria, diarrhea, inflammation of the digestive tract, menorrhagia, toothache, burns and superficial wounds (CUC, 2010). The local communities used all edible organs in the sauce: leaves (100%), seeds (65.10%) and pulp (1.70%). The fruit pulp is mainly consumed in the form of cream (96.70%) and in porridge (43.30%). It is also consumed in the form of syrup and juice (10%), which corroborates the work of Konaré et al. (2022) who had mentioned that certain wild fruits (baobab, Parkia, Saba, jujube, etc.) were undergoing transformations to be available all year round. As for the seeds, despite being poorly exploited (8.30%), they were transformed into soap, “soumbala”, “datou” and oil in the commune of Cinzana. This information agrees with those of Diop et al. (2005) ; Sow et al. (2018) who reported that the seeds were used as soup thickeners and flavor enhancers in sauces and stews after drying and fermentation.

The criteria for assessing the quality of the edible parts of the baobab, the taste was the main criteria followed by the color. Sidibe & Williams (2002) had also reported the same criteria used by local populations to assess the quality of baobab organs: taste for the pulp and leaves, color for the seeds and barks.

The sun drying was the main method of preserving these edible parts used by the most respondents (96.70%). However, it is very important to dry the leaves and fruits in the shade in order to retain more vitamins (CUC, 2010). Curiously, 88.30% of respondents were unaware of the existence of an improved conservation method, which confirms the low rate of illiteracy recorded in these communes. Consequently, due to their poor packaging and storage practices (canaries, granaries, bags), the stored baobab products were infested by the termites and worms. Faced with these conservation difficulties, the picking was the main source of supply for local populations (78.30%). Some women claime that the fresh leaves are healthier than the dried one (Savard, 2003). It is known that the traditional practices such as the mode of picking (use of sharp objects and sticks) and the packaging (canaries, granaries, partially closed bags) are a source of contamination (CUC, 2010)) and therefore have a negative impact on their conservation. These practices constitute also a danger to the survival of the species (Sogodogo et al., 2021). It has also been reported that the packaging since harvesting, the various manual transformations improve the quality and the nutritional values of products that contribute to achieve the sustainable food security (Marouzé et al., 2008).

## 5. Conclusion

The data from this study allowed analyzing the traditional practices for the use of baobab products. The study revealed that all the organs of the baobab remain widely consumed by local populations in Mali. The sun drying remains the main process for preserving these edible organs and the constraints identified during the conservation of these organs were the drying conditions, especially during the rainy season, which coincides with the harvesting of the products. In addition, the population is also confronted with problems of infestation by termites and worms due to their mode of packaging and storage. It also appears that the seeds compared to the pulp and leaves are little used due to the ignorance of the quality criteria and the insufficiency of processing techniques. The analysis of these data reveals a compelling need for training of the local populations on the appropriate techniques of drying, transformation and storage of the edible parts of the baobab on the one hand and on the other hand, the processes of their efficient transformation that can bring an added value.

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