



Contributions and Appreciation of *Adansonia digitata* L. Food Products in Zinder Region, Niger

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Authors' contributions

This work was carried out in collaboration among all authors. Author IA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AS and MS managed the analyses of the study. Authors JG and RAS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Wild tree species play an important role in the diet of the people. However, few studies tried to assess the food products of those wild tree species in Sahel region. This study focuses on identifying the contribution of *Adansonia digitata* process products through the survey and sensory evaluation due to nutritional value and increase of income to the population. The *A. digitata* is used in Africa as food and traditional pharmacopeia. Its leaves are excellent sources of nutrients. The *A. digitata* pulp rich in vitamins is used to make juice and jam. The seeds are processed into virgin oil. The sensory evaluation at Sahara Sahel Foods revealed that *A. digitata* pulp juice as the highest overall accepted product and its jam the less. The survey at both Zinder city and Baban Tabki village showed that the *A. digitata* products are more useful in the villages than in the city with 65%

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and 35% appreciations respectively. These products are an aftertaste for the local population to increase their income and improve their nutritional status as well as health status. This study provides a baseline data about *A. digitata* food products in Zinder region, which could play a crucial role in the conservation of the *A. digitata*. This study recommends the use of *A. digitata* trees in the national tree plantation programmes in Zinder region.

Keywords: Baobab tree; Sahara Sahel foods; nutrients; sensory evaluation.

1. INTRODUCTION

A detailed description of the plant was proposed around 1750 by Michel Adanson, a French botanist who spent several years in Senegal, and took samples to Paris. *Adansonia digitata* is the scientific name proposed by Carl Von LINNE and Bernard de Jussieu. It is a secular tree belonging to the *Bombacaceae* family, imposing by its size, it is the most massive of all known woody species, unlike other species of the genus *Adansonia* endemic to Madagascar or Australia (*Adansonia grandidieri* Baill., *Adansonia madagascarensis* Baill., *Adansonia suarezensis* H. Perrier and *Adansonia* Baill., etc.). It is mainly present in the sub-humid and semi-arid regions of the South of the Sahara. Remarkable for its particular shape, it is very characteristic of the landscapes of the African savannah [1–3]. *Adansonia sphaerocarpa* A. Chev is the synonym of the *Adansonia digitata* according to Arbonnier [3].

The different parts of the plant, including the roots, trunk, bark, leaves, pulp, and seeds are used for therapeutic and nutritional purposes; in addition, several parts of the plant are used in processing to obtain a range of products. These are leaves, fruits, and seeds. The leaves are *A. digitata* (5, 7 or 9 leaflets) and reach up to 20 cm in diameter [4]. The leaves appear irregularly a little before the rainy season [3]. The *A. digitata* has the ability to regenerate from its bark when it is removed [5]. Fruits are formed from a woody outer part or a hard-outer capsule (the epicarp). At maturity, they fall from the tree. The epicarp (sort of shell), with a thickness of 8 to 10 mm [6], is covered with a yellow-green down, which encloses at maturity a dry floury pulp of white color (the endocarp). The seeds: incorporated into the pulp where there is also a tangle of large fibers of reddish-brown color. They are dark brown to reddish-black in color. There are hundreds of them per fruit [7].

The difficulty of African agriculture in solving its fundamental problems constitutes a challenge size to rural development and by extension to the

development of all of Africa. This challenge is currently reflected in the need for diversification of agriculture through the promotion of all resources, improving the standard of living of rural people and developing new production systems that will increase productivity sustainably natural resources while safeguarding environmental capital for generations future [8], [9]. The nutritional and medical contribution of wild plants are well established. About 350 species have been identified and provide essential products (medical substances, lumber, fuelwood, oil, vegetables, fruit and many others) [7]. The contribution of non-timber forest products to food and nutrition security is essential. In Benin, a study by Assogbadjo et al. [10] has shown the essential role of *A. digitata* with its products (leaves, fruits) in feeding the local population and improving the country's nutritional levels.

The Zinder Region happened to be the areas of *A. digitata* concentration in Niger mainly distributed in the departments of Mirriah (Koléram, Falki Baba, Falki Est, Houtorou, Tsamkaka, Jan Wando) and Magaria (Dan Tchiao, Tik) (Fig. 1.). The density of the stand is remarkable in places in the fields, in the villages or around. This shows the integration of this species into the production system of goods and services by rural producers. In Zinder, the *A. digitata* is part of the family heritage, shared between heirs. Indeed, it emerged from interviews with producers, that even if the land is sold, the baobab tree does not change owners, reported the work of Koudoussou [11] on the *A. digitata* parks of the municipalities of Mirriah and Dogo, Zinder region. Therefore, the objective of this work is to investigate the appreciation of *A. digitata* products diversity in the Zinder region. In addition, the contribution of these foods to the population food basket, through the increase of revenue and identification and processing methods of the plant organs products.

2. MATERIALS AND METHODS

For the processing of the different *A. digitata* products, different materials were used at the

local company Sahara Sahel Foods (SSF) processing facilities in Zinder. Fresh leaves and fruits were purchased from rural suppliers around de Zinder city mainly from Mirriah and Magaria localities (Fig. 2 and Table 1). This work was part of student internship in Zinder region from 10th November 2018 and 10th February 2019.

Two types of surveys were carried during this study, first was concerned female groups, households in the *A. digitata* concentration habitant (Fig. 1) zone and in the center of Zinder city, and the second was on the sensory evaluation of the different *A. digitata* products of

the SSF in the Zinder township. The survey was carried out using women groups association subjected of an interview on the consumption of *A. digitata*, the different modes of transformation as well as the problems linked to consumption; and households were also visited both in Zinder township and the Banban Tabki villages located away from Zinder city.

On 2 levels: -women's groups: 5 women's groups were the households: 40 households were visited, namely 20 in the Zinder township and the others in Banban Tabki villages located away from Zinder city.

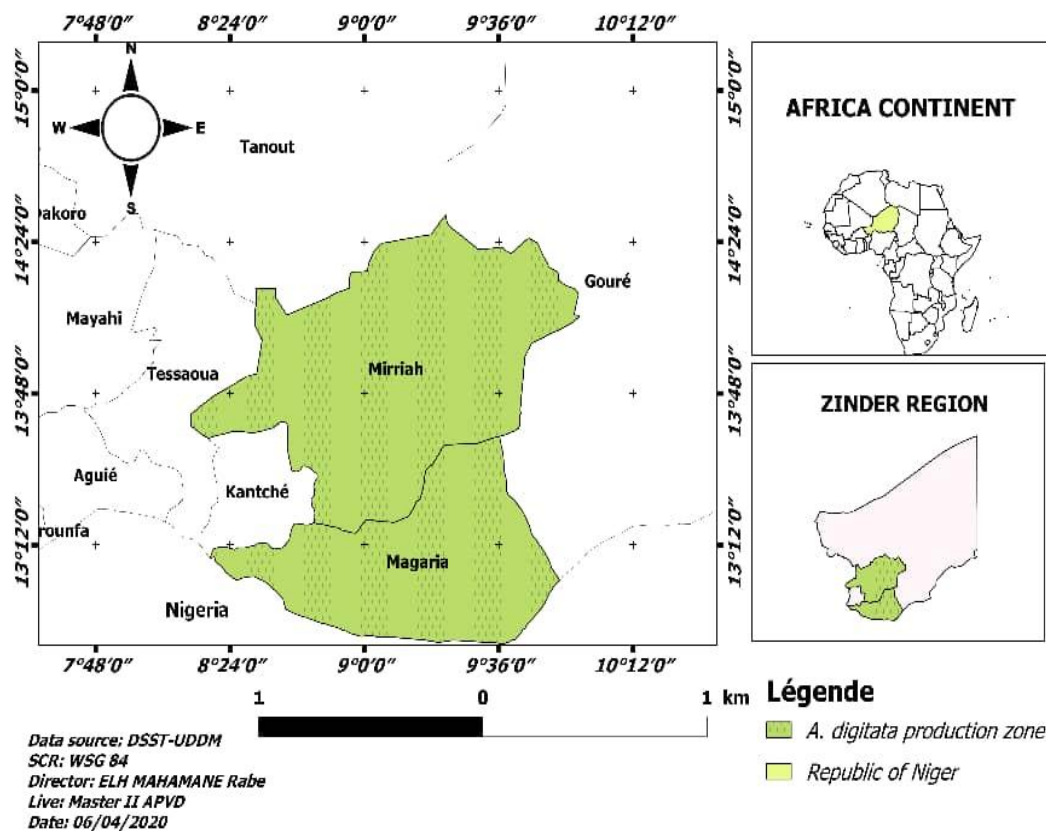


Fig. 1. Map of concentration *A. digitata* trees population in Zinder region, Niger

Table 1. Cost of purchases raw materials for the *A. digitata* products making in Zinder

No	Product to be made	Raw materials	Cost/Kg (USD)
1	Dried packed leaves	Fresh leaves	0.2
2	Packed powdered leaves	Fresh leaves	0.2
3	Packed powdered pulp	Dried fruits	0.4
4	juice	Dried pulp	
5	oil	Dried seeds	



Fig. 2. Images of leaves and fruits of *A. digitata* from Zinder region, Niger

2.1 Processing of the *A. digitata* Products

The *A. digitata* products were identified in the Zinder region and their processing are reported according the SSF facilities:

- The *A. digitata* leaves processed into dried and powdered products using a solar dryer and grinding machine.
- The dried fruits were processed to get packaged pulp product that is used in making the juice.
- The pulp removal results with the enough seeds that are used for *A. digitata* oil extraction using a press oil expeller model No 6yl-100, Henan, China.

2.2 Sensory Evaluation

The sensory evaluation was performed on a panel of 150 untrained people (customers and visitors of SSF, Zinder, were submitted to appreciate the *A. digitata* processed product) separately used to evaluate the samples. The panelists were composed both women and men. Each evaluator was offered an aliquot of *A. digitata* either leaves, juice, jam and oil. The samples were subjected to an acceptance hedonic test, applying a hedonic scale of 5 points. A note of 1 to 5 scale (too bad, bad, like, good and very good) has been awarded.

2.3 Data Analysis

Data were processed and means and percentages analyses were carried out using Microsoft® Word and Excel 2013 software.

3. RESULTS AND DISCUSSION

Table 2 shows the different results from the household and consumer survey. This made it possible to discover the different uses (Fig. 3.), the problems linked to consumption and the appreciation of the taste of the different *A.*

digitata products found at the level of the SSF. The quality differs between the different sellers of *A. digitata* leaves and this is explained by the drying method and the conservation of the products. At the SSF level, drying is done at open room temperature ($\pm 35^{\circ}\text{C}$), with express shelf life or expiry date. On the other hand, among local producers and sellers of *A. digitata* products, especially the leaves, drying takes place under the sun with stocks that can take months or even years, hence the change in the quality and taste of the products are unsatisfactory. The leaves are more consumed in the villages than in the city of Zinder like it was reported in the work of Agúndez et al. [12]. It was found that 65% of the households visited did not record any problems related to consumption *A. digitata* products (Table 2). The leaves are used in its powdered form to make sauce or consumed directly in water or fresh milk mixture. Furthermore, the *A. digitata* leaves are reported to contain considerable nutrients and micronutrients such as iron; thus, in the region, the pregnant women are advised to consume more *A. digitata* leaves during prenatal consultations in order to prevent themselves from anaemia. The leaves are harvested regularly in the region meaning that affordable and available to the consumers. Previous works showed how the business around the *A. digitata* products help to increase the income of households in the Zinder region [11–14].

On the other hand, in the rare case in the Zinder city, 12% of the households reported having said that the unpleasant taste makes them not to consume *A. digitata* leaves, and 23% of households consume less frequently the leaves. For the remaining, they have reported to appreciate rarely the product. The leave as the sauce are only consumed by the households when the quality is improved with other ingredients; moreover, it is a reality that the sauce *A. digitata* leaves in the region become a

specialty of references often called by the Zinder region diaspora; indeed, a culture thing [15,16] is very well enriched (all that is needed as ingredients). The quantity used varies according to the needs of consumers, especially the size of the household. Besides, the leaves as a popular product of *A. digitata* in the Zinder region, the fruits are also another one with the process fruit pulp resulting to the various food products. The small-scale processing factory (SSF) is a living testimony to the processing of *A. digitata* fruits in the Zinder with the product such as natural juices, jams, enriched porridge, fermented candy milk, etc. In addition, the survey revealed that the fresh seeds are crunched and consumed by women in the village as traditional medicines. It was found also the virgin oil from *A. digitata* seeds is attracted by the SSF and used for cooking or domestic oil.

At the SSF *A. digitata* products were subjected to sensory evaluation to achieve the consumers preferences using both customers, visitors and quality control team members. Fig. 4. showed the overall acceptability by the panelists on the various *A. digitata* products (juice, jam, oil and dried leaves) produced in SSF. The appreciations were mainly. The trends revealed that the *A. digitata* pulp juice recorded the highest acceptability (66.67%) followed by the leaves (67%) and then the virgin oil (63%). At the other hand, the lowest records of overall acceptability were found to be related to virgin oil *A. digitata* and jams with 3.34% and 3.33% respectively (Fig. 4.). In fact, the juice is very popular and well known to the population, probability what desert its acceptability during this evaluation. Different parts of *A. digitata* are used for human food such as fruits, and the traditional African pharmacopoeia such as an analgesic, antipyretic, anti-inflammatory and antioxidant, it can treat dysentery, diarrhea, etc. Previous research reported the presence of the nutrients in the baobab tree organs [2,17]. This is

the fact that *A. digitata* products are acceptable by the consumers and appreciated by the local populations. In addition, the baobab tree is globally an important source of income for women, as well as for tree owners, even though the whole value chain benefits from it. Indeed, it was recorded that the slightest deficit in the production of *A. digitata* leaves in the locality of Mirriah was felt throughout on the local and regional economy; moreover nationwide (Niger) [18].

Different problems are linked to consumption according to the results of the survey. The tangy taste present in the pulp, the preservation and drying of products that are made in the sun, make the quality of nutrients and micronutrients disappear. This was also found [2] according to which the composition of the fruits can be influenced by the environment, such as the type of soil, the water or the intensity of the sun. Shade-dried baobab leaves may contain twice as many retinol equivalents (provitamin A) as sun-dried leaves, although sun drying is the local practice. Likewise, the age of the product samples can also induce a certain variability in their composition [9,17]. Despite some difficulties in the value chain of *A. digitata*, this result shows that it is an excellent source of nutrients and this can vary depending on the processing and packaging methods of the product. In Niger, malnutrition remains a public health problem and traditionally varies with the lean season. This situation is also linked to chronic food deficits observed in vulnerable areas such as in the Zinder region; thus, to fight against malnutrition, it is not enough to focus only on the treatment protocol, but also on the different prevention methods based on the supply of nutritious and balanced foods that meet the needs of the body [19]. The *A. digitata* products are the perfect solution to support this matter in the region, mostly accessible and affordable by the local population (Table 1).

Table 2. Appreciation of *A. digitata* leaves and derived products by the consumers

	Zinder city		Baban Tabki villages
Usages	<ul style="list-style-type: none"> • Sauce • Food additive 		<ul style="list-style-type: none"> • Sauce • Herbal tea (infusion) • Food additive • Soap
Constraints	Seldom bitter taste		none
Appreciation (%)	23	12	65

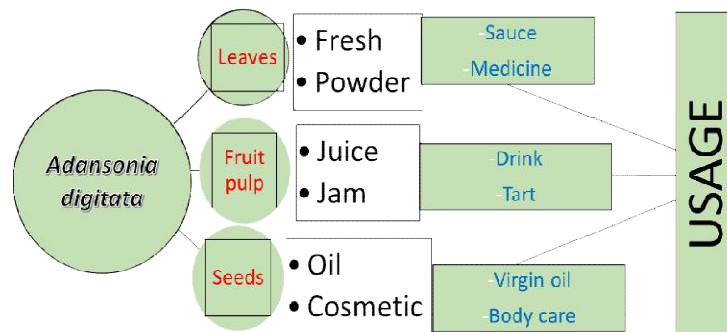


Fig. 3. Zinder region *A. digitata* derived products and usage

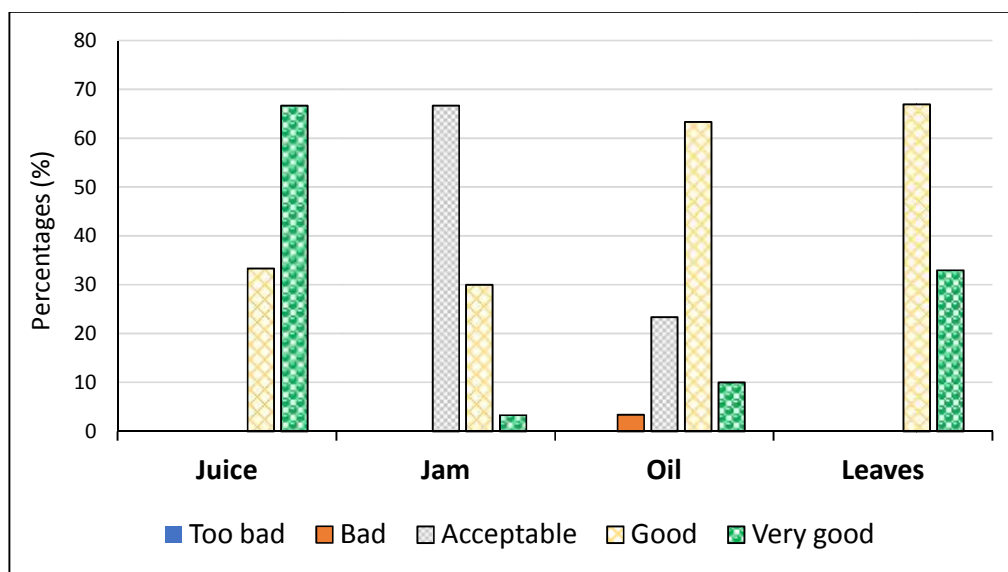


Fig. 4. Overall acceptability of *A. digitata* products from SSF, Zinder

4. CONCLUSION

It is concluded based on our results that *A. digitata* is used as food and traditional pharmacopoeia in the Zinder region. The consumer's survey and sensory evaluation at SSF revealed how acceptable are *A. digitata* products. At the level of the SSF, different products are obtained based on their processing and this contributes to improving the quality and increasing consumption of *A. digitata* products. In addition, this study found out that the nutritional quality may not be the same on raw products and finished products, through the different processing methods used at the level of the SSF and by local producers. Studies carried out before sheared light on the nutritional value of the raw parts of *A. digitata* products (leaves, pulps, and seeds), yet little on study on

nutritional value, solubility and bioavailability of the *A. digitata* processed organs are done. This tree could be the turning point due to its many virtues to improve local population foodstuff in the context of fighting food insecurity and malnutrition for climate change adaptation.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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