SENSORY PROFILES AND APPRECIATION LEVEL OF THE PULP OF ENDEMIC MALAGASY BAOBAB SPECIES *ADANSONIA GRANDIDIERI*, *ADANSONIA RUBROSTIPA*, *ADANSONIA ZA* AND ONE AFRICAN SPECIES *ADANSONIA DIGITATA*

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ABSTRACT

The baobab fruit contains a white, floury pulp which, when mixed with water, makes a refreshing drink. This pulp is of great nutritional value, being rich in vitamins (notably C and A), minerals and phenolic compounds with antioxidant activity.

With a view to adding value to baobab pulp, the effects of genetic factors on its organoleptic characteristics are studied using sensory analyses. Three endemic Malagasy baobab species: Adansonia grandidieri, A. rubrostipa, A. za, and african species A. digitata are compared with a commonly consumed food: tamarind.

The pulps are processed into nectars and then subjected to descriptive and scoring tests. Organoleptic characteristics are found to be variable and specific to each species. A hedonic test showed that nectars from baobab are as popular as tamarind nectars. On the whole, baobab pulp is appreciated, but improvements need to be made during formulation studies in order to develop the product that will add the most value to baobab pulp.

Keywords: *baobab, pulp, nectar, sensory mapping, appreciation*

INTRODUCTION

Food sensory characters have effect on acceptability by consumers. Although baobab fruits are available in some markets, they do not yet have place in Malagasy eating habits. **(Randrianantenaina, 2012 ; Razafindralambo, 2014).** Also, when their pulps are transformed into juices, these are confused with of other fruits juices: *grandidieri* is often confused with pineapple juice because of its sweetness; *rubrostipa* is often mistaken for papaya juice for its bright yellow color **(Nivoarilanto, 2018),** meaning that baobab does not yet have his own identity profile and emphasizing the need to characterize him. The sensory characterization and the evaluation of the food agreement is part of an iterative process of protection, valorization and marketing of a food. Pulps of 4 baobab species are chosen for this study, three endemics to Madagascar *(Adansonia*

grandidieri, rubrostipa, za) and the African species *Adansonia digitata*. These species are selected for the following reasons:
- their genetic representativeness, *grandidieri* belongs to Brevitubae section, *A. za*, and *A. rubrostipa* to Longitubae section, african species *digitata* represents Adansonia section and is used for comparison.
- their great availability in their natural habitat. In addition to their endemicity, they are frequently and used by the local population **(Razafindralambo, 2014).**

Different parts of this tree held many reputations, fruit pulp is very rich in vitamin C (up to 540 mg/100 g on fresh weight), seeds contain high levels of polyphenols and high antioxidant activity **(Tembo *et al.*, 2017)**, also they have high oil content, up to 28% depending on the extraction method **(Ranjakaharisaina, 2021; Rakoto Harison, 2021 ; Razafindrazaka *et al.*, 2023[b]).** Being reputedly rich in calcium, the leaves and bark are used in decoction to treat dizziness, fatigue and fever but they are not yet part of the local population's dietary habits. However, local populations living around their origin areas are the only ones who are familiar with baobab tree and who benefit from its nutritional advantages. In other regions, its consumption remains marginal **(Razafindrazaka *et al.*, 2023[a])**. When it is presented anonymously, it is difficult to recognize, which means that this product does not yet have its well-defined sensory identities. The aim of this work is to define specific characters for baobab fruits and to detect the differences in the pulp sensory characteristics considering the inter-species variability.

MATERIALS ET METHODS

Four species are chosen because of their availability, in their natural distribution are, baobab fruits (pulps, seeds, oil) are consumed and no allergy or others diseases or toxicity linked to their consumption has been reported **(Ratsimbazafy, 2015).**

For each variety, at each area origin, apparently healthy and mature pods are picked from mature trees (having at least 1 meter in diameter). Fruits obtained from each site are stored individually in labeled bag. In the laboratory, pods were spread out in a solar dryer for 24 hours to reduce any traces of water on the fruits 'walls, then repackaged in their respective transport bags until preparation time. Packages are put-in a dry place. Each fruit is peeled and pitted to obtain the pulp which is reduced into powder using grinder; As *grandidieri* and *za* are collected from 3 different areas, an average sample is prepared for each variety by mixing 10 g of powder from each collection site, *rubrostipa* and *digitata* are from one site each over.

Figure 1: areas collection of baobab fruits

1. Nectar preparation

Twenty-five grams (25g) of pulp powder are added to 100g of sugars and dissolved in a liter of mineral water. The tamarind's nectar is prepared using 50 g of tamarind, keeping the same quantities of sugar and water except that water and pulp are mixed and left to soak for about 30 min. Then, tamarind pulp is crushed with a spatula, preparation is passed through a sieve. the supernatant (juice) was retained. All preparations are done at room temperature. Nectars are stored at 4°C. This preparation produces nectars at 13° Brix, as recommended by CODEX STAN 247-2005 **(Codex Alimentarius, 2005)**, and of approximately the same consistency for both matrices.

2. Sensory tests

The objectives are to define a sensory mapping for the baobab pulp, to detect differences between species and comparing with a well-known food taken as reference. Two types of tests are held: descriptive and hedonic tests. Conditions for carrying out this study are as follows: each assessor has an individual cabin to avoid communication between them, the products tested are coded with random 3-digit numbers and placed in identical containers, participant rinse his mouths between each tasting with mineral water to avoid a carry-over effect.

Two groups of panels are established: a group of 10 panelists performed on sensory analysis for the descriptive profile and a group of 110 untrained assessors for hedonic test

2.1. Characterization of organoleptic profiles

ISO 13299 - 2016 and ISO 6564-1985 methods **(ISO, 2016; ISO, 1985)** are used to describe organoleptic characters of each sample and evaluate their intensity. Ten people having background on food science and sensory analysis are selected to establish these profiles. At the beginning, the aim and the principles of the study are explained to the judge. Samples are presented in a monadic way and anonymously, in a different order for each panelist according to a Williams Latin square. Two sessions are required: a training and an assessment periods. Each session required 3 steps:

- During the first step, 5 samples of baobab and tamarind pulp powder are presented simultaneously to the assessors to familiarize them to the product and generate usefull descriptors. They are asked to describe and notice their perception before, during and after tasting the pulps using 3 sensory categories: appearance/texture, aroma/odor, taste. Participant generate terms for each category. All attributes given by all assessors are ranged in these 3 categories, listed and discussed in group, relevant terms which describe better baobab/tamarind pulp are retained and be used for all assessors, those considered as non-pertinent are eliminated.
- The second step is devoted to describe each sample using the retained terms.
- The third step is focused on the quantification of the intensity of each character. Participants noted the intensity of each character on an intensity scale, from 0 which signifies the absence of perception to 10 which signifies excess.

For the evaluation session, four baobab nectars and one tamarind nectar are presented as samples. This session took place in 3 stages, as described above with the same expert panelists.

2.2. Evaluation of the juices' appreciation

Hedonic test is held to determine product acceptability and consumer preference as described by ISO 6658: 2017 **(ISO, 2017).** For that, 110 untrained assessors are recruited among the panel database of the sensory laboratory of FOFIFA (National Research Centre applied to Rural Development) Antananarivo, based on their availability. They have received training at the beginning to familiarize them on the test processes. Each panel had to express their opinion going from extremely unpleasant to extremely pleasant on a rating scale from 1 to 5 for 4 sensory categories (color, aroma, viscosity, taste) and using the same scale, he had to give his global appreciation according to ISO 6564-1985 **(ISO, 1985).** Five samples: four baobab nectars and one tamarind nectar, are presented to the assessors in a monadic way and anonymously, in a different order for each panelist according to a Williams Latin square.

Data were expressed as means ± SD. Statistical analysis was achieved using Graph Prism 6 software. Significant differences ($p < 0.05$) between the means were determined by analysis of variance (ANOVA) procedures followed by a multiple comparison test (Bonferroni).

RESULTS AND DISCUSSIONS

During the preparation, mineral water is used because its permits to extract all nutrients that can cause effects on sensory characteristics and heat treatment is avoided. Operations that could modify the organoleptic characteristics such as cooking, decantation, sieving (except for tamarind) have been avoided. Indeed, the heat treatment can change the initial flavors, decantation and sieving can eliminate the matters in suspension but risk to change the ratio quantity in pulp / nectar. All nectars obtained are stored at 4°C but put off the fridge 30 minutes before sensory analysis.

1. Sensory profile of baobab juice

Eleven relevant attributes are selected. Baobab nectars are described as follows:

For the appearance category, visually, nectars can be **foamy**, **cloudy** or **had deposits**. The reference color is **beige**. In mouth, they may be **granular** (because there are fine particles in mouth), may be **astringent,** are **persistent in mouth**. They can have **sweet** and/or **acid taste.** For aroma, no typical aroma is detected, however its plant origin is confirmed; 2 descriptors are selected: **tamarind aroma**, **green leaves note.**

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Adansonia grandidieri *Adansonia rubrostipa* *Adansonia za* *Adansonia digitata* Tamarind

Figure 2: Baobab and tamarind nectars

The intensity of each attribute is then placed on a scale of 0 to 10 for each species.

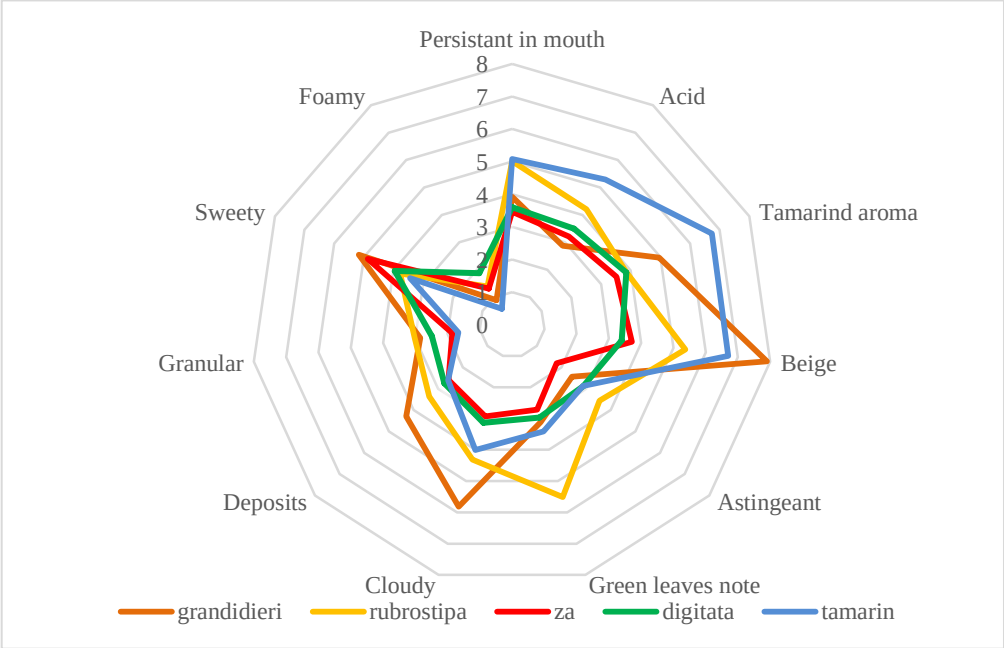

Figure 3: Sensory characteristics of baobab and tamarind nectars

Tamarind nectar is the most acidic nectar, has more pronounced specific aroma and a dark brown beige color. Its flavor persists in mouth.

grandidieri nectar is the sweetest, cloudiest and has most deposits. The nectar has the darkest color; smells the tamarind aroma.

That of *rubrostipa* is characterized by an important astringency in mouth, a pronounced green leave note. It has also a powdery texture and its flavor is persistent. The nectar is foamy but to a lesser degree than that of *digitata*.

The nectar of *za* like that of *grandidieri* is also sweetest.

digitata's nectar does not have a typical sensory character apart from it is the foamiest.

2. Nectar appreciation level

Panelists expressed their agreement through ratings for each character, averages values obtained are summarized in Figure 4.

Color is not perceived as significantly different. The highest score is obtained by *rubrostipa* (3.47) and the lowest by *digitata* (3.10). A similar study was carried out on 100 assessors and using the same rating scale **(Nivoarilanto, 2018).** The samples were tamarind, *grandidieri* and *rubrostipa*. Study revealed a strong appreciation of *rubrostipa*'s color (3.86) followed by tamarind (3.56) and the weakest by *grandidieri* (3.30); but in her studies, the color difference is perceived significantly**.** These results are identical to ours if only these 3 species are considered. Going back to the sensory mapping, *rubrostipa* has medium color intensity while that of *digitata* is low. This means that participants are looking for a product with a character that is neither too strongly nor too weakly colored.

The difference is significant for the aroma ($p<0.0001$). Tamarind odor is the most appreciated (3.41), while that of *rubrostipa* is the least appreciated (2.58). This result could also be explained by the strong green leaves note felt in *rubrostipa* mentioned in its sensory profile.

grandidieri has the most attractive taste (3.23) because of its sweetest, followed by *digitata* (2.87), *za* (2.86), tamarind (2.83) and *rubrostipa* (2.78) which is perceived as slightly acidic and more astringeant in mouth. Likewise, Nivoarilanto **(2018)** reported in her works that tastes of tamarind and *grandidieri* obtained pole positions (respectively 3.62 and 3.60), *rubrostipa* (3.45) is the least appreciated but with a non-significant difference.

grandidieri is perceived as a little viscous (2.90) than others. This result confirms the descriptors attributed to this species, viscous because it has the most suspended matter or deposits. Tamarind is more fluid (2.46). Indeed, at the concentration where these samples were prepared, they are globally considered neither too liquid nor too viscous; neither too sour nor too sweet.

There is a significant difference in overall acceptability (p:0.001). After tamarind (3.34), *za* is the most popular (3.22), *rubrostipa* is the least (2.71). The appreciation could come from the sweeter taste of *za* and the repulsion from the strong astringency and strong acidity of *rubrostipa*.

In her studies on the global appreciation, Nivoarilanto **(2018)** found that *rubrostipa* has the best rating but the appreciation levels are not significantly different between 3 species (*rubrostipa*, *grandidieri*, tamarind). According to her panel, three nectars have a very similar taste, near to tamarind. However, tamarind is easily discriminated by consumers (100%); less than half of assessors were able to identify the juices of *A. grandidieri* (42%) and of *rubrostipa* (27%). Their acidic taste brings them closer to tamarind juice, *grandidieri* is often confused with pineapple juice; *rubrostipa* is often mistaken for papaya juice for its bright yellow color.

Generally, sensory differences permit to establish specific maps for each baobab species. These differences resulted in mixed opinions on each character. On 5 hedonic tests carried out, *rubrostipa* is ranked last 3 times on taste, on aroma and on overall appreciation. Its high astringency could be the causes and could slow down its consumption.

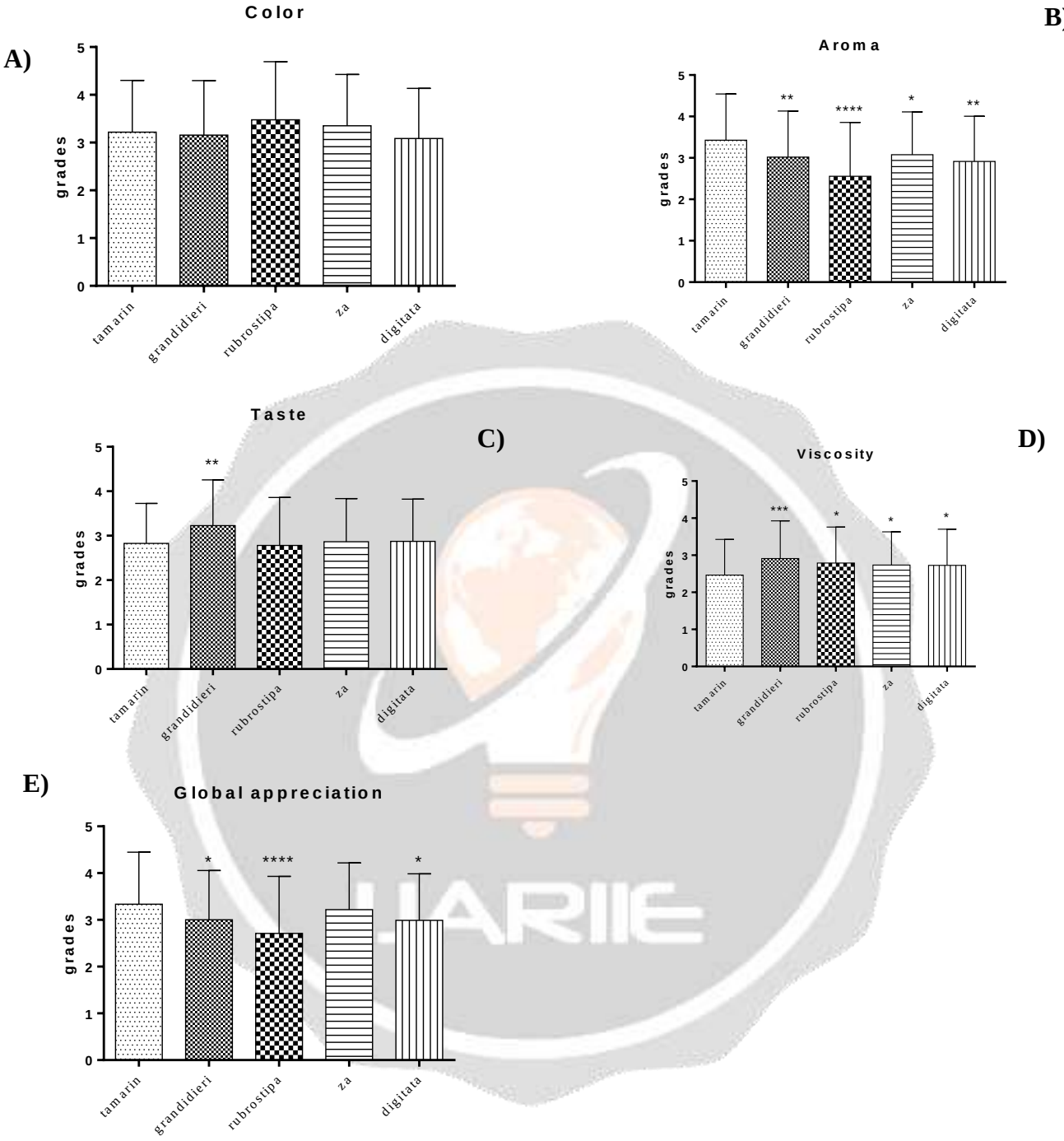

Figure 4: Average hedonic value of the organoleptic characteristics of baobab and tamarind nectars.

Panelists expressed their agreement through ratings for each character. (A) Color, (B) Aroma, (C) taste, (D) Viscosity and (E) Global appreciation. Reported values are means ±SEM and p value were calculated using the Bonferroni multiple comparison test (*: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$ and ****: $p < 0.0001$) with tamarin.

CONCLUSION

Descriptive analysis revealed the existence of sensory characters specific to each species. Hedonic test permits to confirm that baobab pulp is as appreciated as tamarind, and to plan areas for improvement. Two species stand out from the others, *za* and *grandidieri.*, *rubrostipa* is the least appreciated as a whole except for its color.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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