

Microbiological quality and sensory perception of *Sclerocarya birrea* (*A. Rich.*) Hochst. Pulp juice in Niger

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Abstract

The *Sclerocarya birrea* tree is a widespread and little-studied multipurpose forest species in Niger. The objective of this study was to evaluate the microbiological quality and sensory perception of fruit pulp juices from two different regions. The results showed that the germs of alteration range from absence to 22 CFU/g for total mesophilic aerobic flora, from 01 to 08 CFU/g for total coliforms, the absence of yeasts and molds for 4 samples, the presence of yeasts at the level of 3 samples, varying from 02 to 23 CFU/g, and the absence of sulfite-reducing anaerobic germs for all sites. The presence of pathogenic germs in *E. coli* from 03 to 08 UCF/g was noted, but no salmonella was found, and staphylococci were found in at least two samples. There was no effect produced by the descriptors on the acid-sugar and acid-taste balance ($P > 0.05$), and the judges have different rating scales. The correlation analysis shows that there is an agreement among some panel members. The hedonic rating shows that two samples out of six did not obtain a good mean from consumers and global appreciation for the other four samples. It appears that good hygiene and processing practices must be reviewed in juice processing. In addition, the fruits of *S. birrea* are very acidic but also sweet, which requires the search for adequate methods of preservation to improve the taste qualities of its juice.

Keywords: *Sclerocarya birrea*; Juice; Valorization; Microbiology; Sensory analysis; Quality; Niger

1 Introduction

Sclerocarya birrea, commonly known as the African cider tree, is a non-timber forest species that is widely present in most African countries. It is widespread in 29 countries, from Ethiopia to Senegal and from Niger to South Africa. The tree is distributed throughout the frost-free areas of Africa and grows wild in the Sahelo-Sudanese and Sudanese savannahs [1]. It grows in open woodland, common to semi-arid and deciduous savannas of sub-Saharan Africa, and particularly survives well in sandy-loam and clay soils as well as on rocky slopes [2]. In Niger, the species is found in the southern band of the country [3].

In terms of nutritional properties, its fruits are rich in vitamin C, have high levels of antioxidant activity compared to most other edible fruits, and can be consumed fresh, in juice form, or fermented to make alcoholic beverages. Moreover, the fruits might also be processed into jam and jelly, extending shelf life, availability, and consumption beyond the two to three months of the fruiting season [2, 4].

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In most African countries where the *Sclerocarya birrea* tree grows, the tree and its different parts are widely used by rural communities for many centuries. The fruit is frequently processed into non-alcoholic beverages for social and commercial purposes. Thus, *Sclerocarya birrea* provides various advantages by contributing to both household consumption of the fruit and their products for income generation. The best-known areas of use are food, nutrition, health, social, cosmetic and pharmacological [4, 5, 6, 7]. Regarding the traditional interest of the species throughout practically all of Africa, it is necessary to explore the technological valorization of its organs, especially fruits (pulp and nuts) for food use.

Despite the importance of *Sclerocarya birrea* in food products, nutrition, and cosmetics in Niger, there is no organized sector relating to this species, and there are very few efforts on valorizing different parts of the tree in terms of food.

In our previous study, juices were extracted from *Sclerocarya birrea* fruit pulps. Physico-chemical and biochemical properties were determined [8, 9]. This work aimed, therefore, to evaluate the hygienic and organoleptic qualities of pulp juice based on microbiological quality as well as on consumers' sensorial perception

2 Material and methods

2.1 Biological Material

The biological material consists of the pulp juice of *S. birrea* (Figure 1), manually squeezed with a screw press and cold screw press at the Sahara Sahel Food Processing Unit (SSF), a commercial food processing company that valorizes non-timber forest products. All the fruit used in this study consisted of matured and ripe fruit collected from different branches of the selected trees in seven (7) sites, three (3) in Maradi (south-central region) and four (4) in Zinder (east-central region) (Figure 2). Freezing was used as a method of preserving juices, which were then transported under refrigeration to a laboratory where microbiological analysis were conducted.



Figure 1 Juice from the pulp of *Sclerocarya birrea* obtained by cold extraction

The microbial analysis were carried out in the Quality Control Laboratory of ORIBA SARL (Juice and Beverage Production and Commercialization Industry, Niamey City). Samples from 5 sites were selected for consumers' perception analysis.

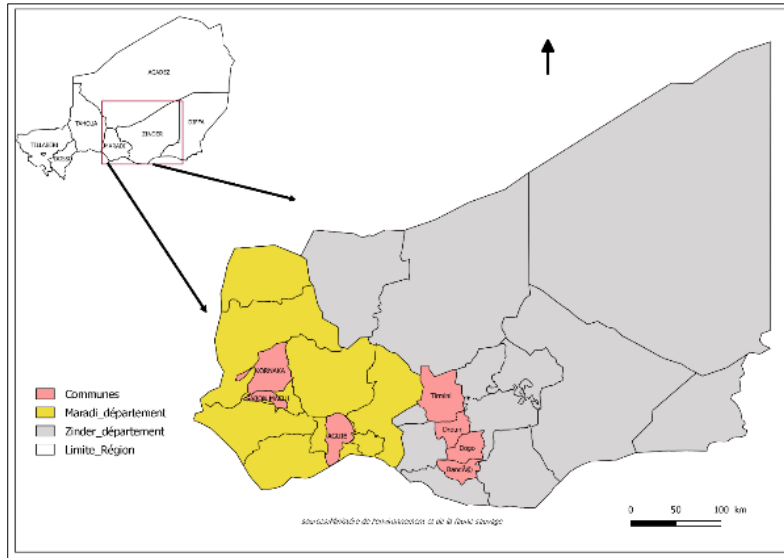


Figure 2 Geographic location map of our study area

2.2 Microbial analysis of pulp juices

A quantitative and qualitative study of the germs present in *S. birrea* pulp juice was carried out. This allowed us to assess the hygienic quality [10] as well as avoid contamination due to the presence of pathogenic microorganisms in the final product for consumption. The study of bacteriological parameters focused on the research and enumeration of germs indicated as pathogens includes:

2.2.1 Enumeration/Numeration

- Total Aerobic Mesophilic Flora (TAMF);
- Total Coliforms;
- Yeast and mold;
- Anaerobic Sulfite-Reductive Microorganisms (A.S.R);

2.2.2 Research

- *Escherichia coli*,
- *Salmonella*,
- *Staphylococcus aureus*.

A simplified presentation of the analysis carried out on the samples, the references for the methods used, and the maximum permissible values are summarized in Table 1.

Table 1 Simplified presentation of the germs sought

Germs sought	CNERNA Standards (Limited values)	References
Flora Mesophile Aerobic Total (CFU/g)	< 10 ⁴	ISO 7937
<i>Escherichia coli</i> (CFU/g)	Absence	ISO 16649-2
Total coliforms (CFU/g)	< 10	ISO 4831
<i>Salmonella</i> (CFU/25g)	Absence	ISO 6579
<i>Staphylococcus aureus</i> (CFU/g)	Absence	ISO 6888-1
Yeast and Mold (CFU/g)	< 10 ³	ISO 215227-1
Anaerobic Sulfito-Reducers (UFC/g)	< 10	7937

UFC: Colony Forming Unit; CNERNA: National Center for Studies and Recommendations on Nutrition and Food During the analysis, the aseptic conditions were maintained and manipulations were performed near the Bunsen Beak.

2.2.3 *Flora Mesophilic Aerobic Total*

For the enumeration of psychotropics and mesophilic aerobic bacteria, the analyses of juices were carried out by deep seeding in PCA (Plate Count Agar) agar (the glucose agar with yeast extract called by the Anglo-Saxons "Plate Count Agar").

- The medium is cooled after sterilization and maintained at a temperature ranging from 44 to 47 °C.
- 1 ml of the juice to be analyzed is transferred and its successive decimal dilutions made in sterile Petri dishes.
- Run 10 to 15 mL with perfect homogenization.
- Allow 4 ml of agar to solidify on a cold surface as a second layer and allow it to solidify again.
- Then incubate at 30 °C for 72 hours for mesophilic bacteria.

2.2.4 *Total and Faecal Coliforms*

For total coliforms and *Escherichia coli* detection and counting, the following protocol was applied:

- Check the integrity of the sample bottle (well-closed bottle)
- Pour 60 ml of the juice to be analyzed into a sterilized ball bottle
- Gently shake the vial to remove the gas (CO₂)
- Pipette 10 ml of the obtained gas-free juice and distribute 1ml in each pre-numbered dish
- Then pour in the pre-prepared VRBL (Violet RED Bile Lactose) enrichment media and cool to 47 ± 2 °C
- Rotate the Petri dishes in a rotating motion several times and allow them to solidify
- Add a second layer of the growing medium and rotate the Petri dishes in a rotating motion several times to allow them to solidify
- Incubate at 30 °C for 24 hours.

2.2.5 *Salmonella*

This analysis involved:

- Check the integrity of the sample bottle (well-closed bottle)
- Pour 60 ml of juice to be analyzed into a sterilized ball bottle
- Gently shake the vial to remove the gas (CO₂)
- Pipette 10 ml of the obtained gas-free juice into each Rappaport medium and incubate at 37 °C for 24 hours
- On the 2nd day, make a sample with a Pasteur pipette sterilized with a flame then inoculate on the medium Hektoen
- Incubate at 37 °C for 24 hours.

2.2.6 *Staphylococcus aureus*

This analysis involved:

- Check the integrity of the sample tubes (well-closed bottle)
- Pour 60 ml of the juice to be analyzed into a sterilized ball bottle
- Gently shake the vial to remove the gas (CO₂)
- Inoculate directly the samples in Baird Parker culture medium + solid egg yolk on a petri dish
- Incubate at 37 °C for 48 hours to allow bacterial growth

2.2.7 *Yeast and Mold*

- This analysis involved using chloramphenicol-sabouraud agar, recommended for the isolation of yeast and mold.
- Peptone water is the nitrogen source of growth, and glucose is the source of energy. Suspend the dehydrated enrichment media with 1 liter of distilled or demineralized water.
- The enrichment media should then be slowly brought to a boil with constant agitation, held for the time it takes to dissolve, and autoclaved at 121 °C for 15 minutes.
- The enrichment medium is cooled and maintained at a temperature of 44 to 47 °C.
- 1 ml of the juice is to be analyzed, and its successive decimal dilutions are transferred to sterile Petri dishes.

- Then, 10 to 15 ml of the enrichment medium is poured, homogenizing perfectly and allowing it to solidify on a cold surface. Then incubate at 30 °C for 3–5 days.

2.2.8 Anaerobic Sulfito-Reducer

- This analysis involved Check the integrity of the sample package (closed)
- Pipette 5 ml of the sample Add 45 ml of buffered peptone water (EPT)
- Pipette 20 ml of this suspension (stock solution) and transfer it to a numbered sterile test tube
- Heat the tube containing 20 ml of the suspension at 80 °C
- 1 in a double bath for 10 minutes to remove the vegetative forms and keep the cystic forms
- A solid TSN medium is combined by liquifying in the bath
- Pipette 2 ml of the previously heated 20 ml, then enrich it into 10 ml of the liquefied TSN medium,
- Rotate the enriched tube and allow it to solidify at room temperature for 20 to 30 minutes. Incubate at 46 °C for 48 hours.

2.3 Sensory analysis of pulp juices

Sensory perception results from the integration of information from the sensory organs.

- Sight: the ability to appreciate form, color, and appearance.
- Olfaction: the ability to smell (sweet, pungent, floral, herbaceous);
- Taste: allows for appreciation of the sweetness, acidity, saltiness, and bitterness of products.
- Audioception: the ability to perceive the crisp and crunchy;
- Tactioception (in the mouth): this allows us to perceive the texture, the temperature, the fondant, the mellow, and the firm; perception of piquant, refreshing, and astringent sensations is possible with trigeminal perception.
- Two methods were used to assess the taste quality of *S. birrea* juice, which are closely described in literature [11, 12].

2.3.1 Classification test

A discriminatory test was used to assess the sensory characteristics of juices at several sampling sites. The sensory descriptive panel consisted of 12 semi-naive subjects (consumer-initiated) according to ISO 8587. The following steps were used to carry out the test:

Sample submission

Each juice sample is poured into a coded, transparent glass. Samples are presented simultaneously, and panelists can taste them as much as they wish. The ranking is then done individually without communication among the panelists to avoid biasing the results.

Questionnaire

The questionnaire (appendix) has been submitted to the panelists. The panelists classified the samples in order of the given attributes based on three descriptors: acidity/sweetness balance, acidity taste, and concentrated texture. The intensity levels vary from 1 to 6.

2.3.2 Hedonic rating test

A hedonic rating test is used to determine customer preferences, their level of enjoyment, and their acceptance of juices. A total of 46 subjects were concerned about the test. The following procedures are followed to set up the test:

Presentation of juice samples

The samples were presented one by one in a specific tasting order (balanced experimental plan) to limit the ranking effect (bias attributed to the rank of product presentation). Each sample is placed in a clear, single-use glass that has a unique code.

Questionnaire

A questionnaire (appendix) for panelists using a 9-point hedonic scale from 1 (I hate) to 9 (I like) to indicate the acceptability of global taste and sensory qualities such as "excellent taste," "natural flavor," and "pleasant odor" was used.

2.4 Statistical analysis

Statistical analysis of the sensory analysis results was performed using XLSTAT 2022.4.1 (1378) software. It uses Microsoft Excel as an interface for data retrieval and display of results [13]. The statistical analysis concerned the characterization of the juices, the analysis of the quality of the sensory panel, and the analysis of preferences. P-values of 0.05 were used and considered significant.

3 Results

3.1 Microbiological quality of juice

The outcomes of the microbiological analyses are displayed according to the type of analysis in the tables below.

3.1.1 Germ's enumeration

The results of Total Aerobic Mesophilic Flora (FMAT), total coliforms, yeasts and molds, and Anaerobic Sulfito-Reducer micro-organisms (A.S.R.) are presented in table 2. The results showed an absence to 22 CFU/g for the total mesophilic aerobic flora. The maximum number of germs was counted from the juices of Bande sites, but all the results remain within the allowable standard. The total number of coliforms varies from 01 to 08 CFU/g of juice from different sources. The results are below the acceptable reference limits. The absence of yeasts and molds was noticed for juices from all the sites from the Maradi region (Sabon Machi, Dan Kada, Dan Gado) and one site in Zinder (Droum). There is no yeast in all the juices analyzed except for the juices from Tirmini (23 CFU/g), Dogo (02 CFU/g), and Bandé (08 CFU/g) from the Zinder region. The results are below the acceptable reference limits. The total absence of anaerobic sulfito-reducer microorganisms (A.S.R) was observed.

Table 2 Outcomes of germs counted from the fruit juices of *S. birrea*

Samples from	Germs counted			
	FMAT (UFC/g)	Total coliforms (UFC/g)	Yeast et Mould (UFC/g)	A.S.R. (UFC/g)
Sabon Machi	03	01	Absence	Absence
Dan Kada	02	08	Absence	Absence
Dan Gado	04	05	Absence	Absence
Tirmini	Absence	01	Yeast: Absence Mould: 23	Absence
Dogo	Absence	03	Yeast: Absence Mould: 02	Absence
Droum	07	08	Absence	Absence
Bande	22	05	Yeast: Absence Mould: 08	Absence
CNERNA Norme	<10 ⁴	<10	<10 ³	<10

3.1.2 Research on pathogenic germs

The results for pathogenic germs, namely *Escherichia coli*, *Staphylococcus aureus*, and salmonella, are presented in Table 3.

Table 3 Outcomes of pathogenic germs from the fruit juices of *S. birrea*

Samples	Pathogenic germs		
	E. Coli (UFC/g)	salmonella (UFC/25g)	Staphylococcus Aureus (UFC/g)
Sabon Machi	03	Absence	Absence
Dan Kada	14	Absence	Absence
Dan Gado	08	Absence	Absence
Tirmini	Absence	Absence	Absence
Dogo	Absence	Absence	02
Droum	08	Absence	Absence
Bande	06	Absence	02
CNERNA Norme	Absence	Absence	Absence

The results for pathogenic germs showed the presence of *E. coli* in all juices except those from Tirmini and Dogo sites. The number varies from 03 to 08 UCF/g and all the juices analyzed were free of salmonella. However, *staphylococci* were found in juices from the sites of Dogo and Bandé (Zinder).

3.1.3 Sensorial analysis

Panel analysis

The purpose of this analysis was to study deeply the perception resulting from the panelists' responses, particularly the discrimination performance of each subject.

Descriptive statistics

The analysis showed that the panelists rated from 1 to 6, and the descriptors for the different juices were subjected to a classification test. The mean per descriptor was 3.45 ± 1.37 for the acid /sugar balance, 2.81 ± 1.32 for the acid/ taste, and 3.00 ± 1.20 for the concentrated texture. The results of the descriptive analysis for 11 panelists are presented in Table 4.

Table 4 Descriptive analysis of *S. birrea* fruit juices

Descriptors	Minimum	Maximum	Mean	Standard deviation
Acid/sugar balance	1.000	6.000	3.455	1.372
Acid/taste	1.000	6.000	2.818	1.321
Texture	1.000	5.000	3.000	1.202

Effect produced

The analysis of variance (ANOVA) consisted of checking whether an effect was produced or not based on descriptors. Hence, for each descriptor, the type III sum of squares of ANOVA for choosing the model was displayed. The results obtained showed that there is no effect related to the analysis of descriptors of the acid/sugar and acid /taste balances ($P > 0.05$). However, there was an effect for the concentrated texture descriptor ($P < 0.05$). Table 5 and Figure 3 present a summary of the comparison of p-values associated with the product factor for the different descriptors.

Table 5 Synthesis of the comparison of p-values associated with the product factor for each descriptor

Descriptors	F	Pr > F
acid sugar balance	0.554	0.697
acid taste balance	0.438	0.781
Concentrated texture	0.954	0.443

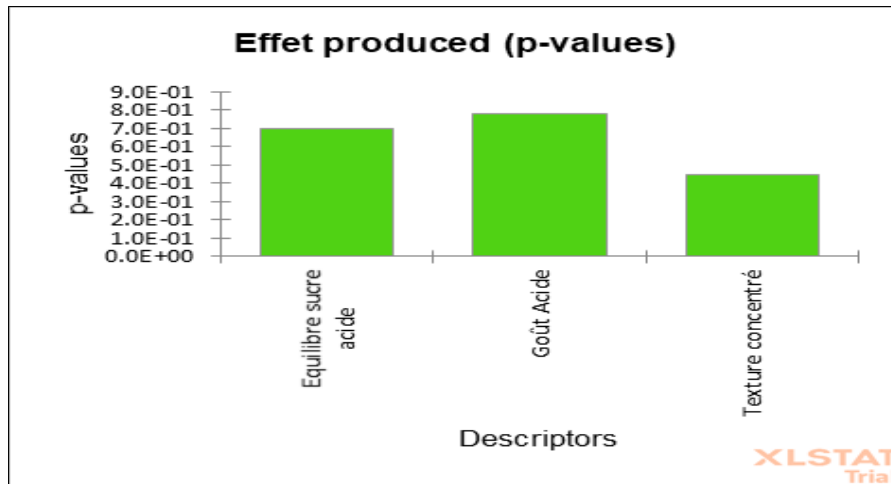


Figure 3 Effects produced for each descriptor according to the associated p-values

Graphical analysis

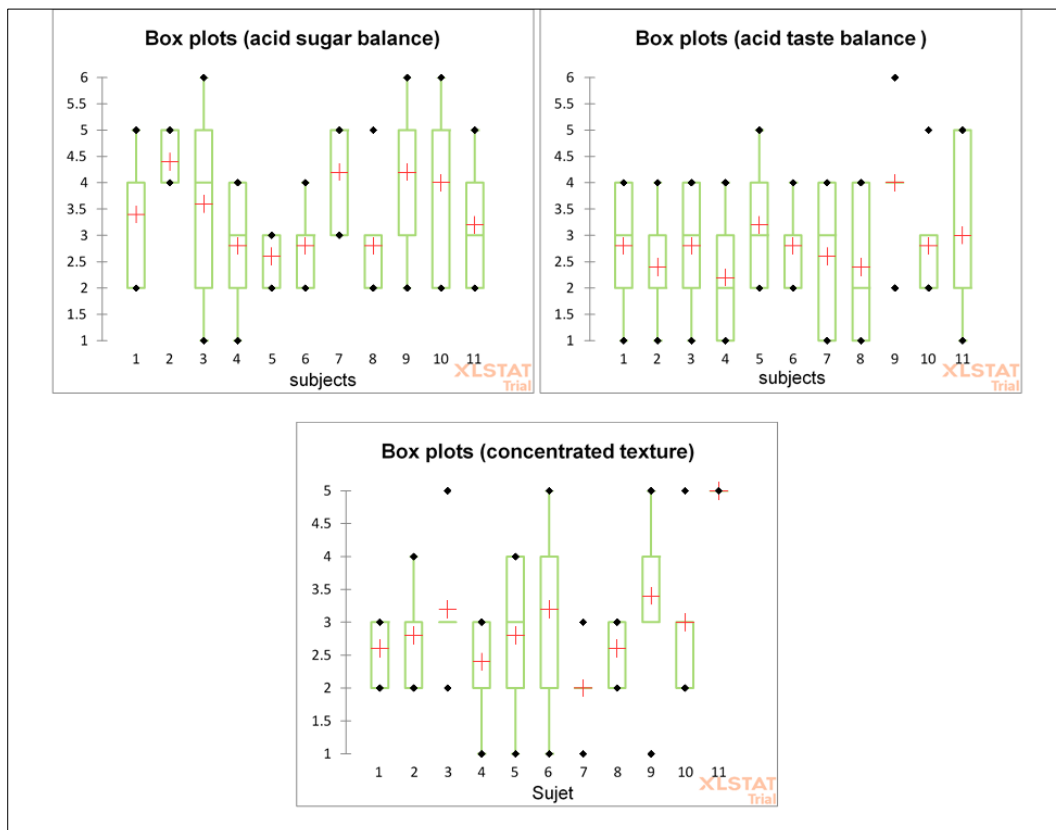


Figure 4 Visualization of the rating scale for 11 panelists

Box plots were used to visualize the distribution of the different ratings of panelists based on descriptors for different products. The results obtained are shown in Figure 4. They make it possible to visualize how different subjects used the rating scale to evaluate the different products based on descriptors. The results obtained are shown in Figure 4.

The box plot for the sugar-acid balance shows that all panelists rated differently, even though panelists 4, 5, 6, and 8 rated closely, as did 7, 9, and 10. Concerning the box plot for sour tasting, shows 1, 3, 6, and 10 have similar meanings with different grading scales except for panelists 1 and 3, who used the same grading scale. Finally, for the concentrated texture, the box plot shows the same scoring amplitude for panelists 1 and 8 with the same trend in terms of the mean. This, therefore, indicates an agreement in judgment between these two panelists on concentrated texture.

PCA correlation circle for all descriptors:

A principal component analysis (PCA) was performed to check whether the panelists agreed on different descriptors and how these allowed for different evaluation possibilities (correlations or not). The red dots represent the corresponding descriptor, and the black dots represent all other descriptors. The results obtained are presented in the following graphs (Figure 5):

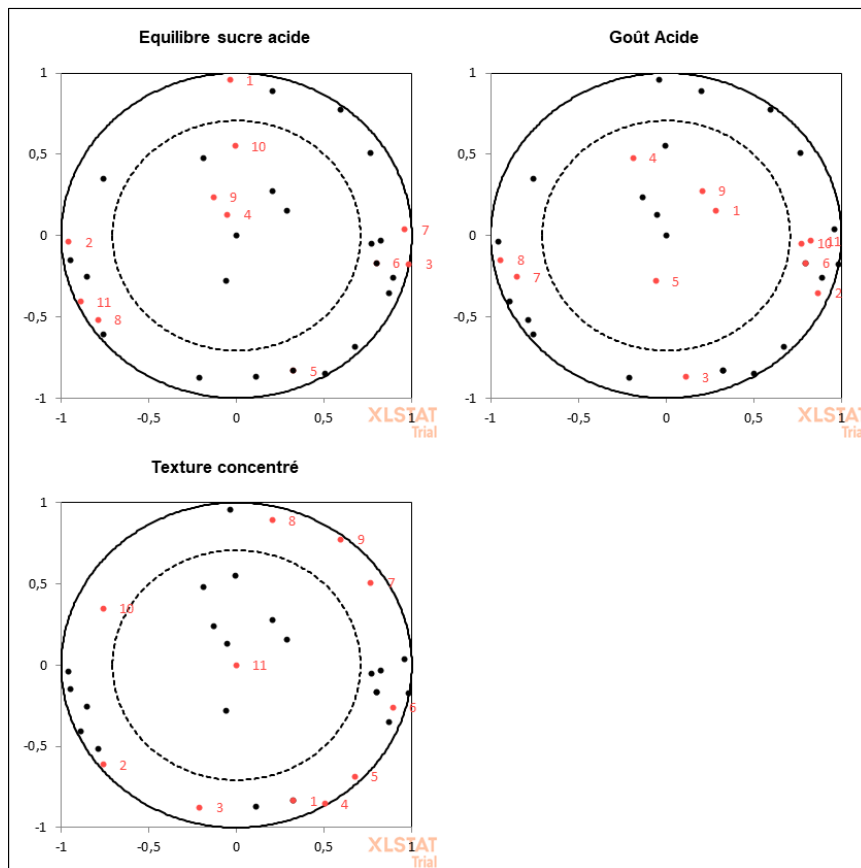


Figure 5 Circle of correlation ACP for all descriptors

The replicated PCA for each descriptor highlights in red the 11 pairs (subject, descriptor) corresponding to the descriptor mentioned in the title of each circle. We can see to what extent the subjects agreed or disagreed with the descriptors. Judges 11-8, 4-9, and 3-6-7 are almost in agreement for the sugar-acid balance, while judges 7-8, 1-9, and 6-10-11 are in the same zone of agreement for the acid taste, but the agreements are more dispersed for the concentrated texture among the judges.

Graphs of % variance

It displays the percentage of variance carried by the PCA graph for each pair of (subject, descriptor). The percentage carried by the first axis is shown in dark gray, and the percentage of variance carried by the second axis is shown in light gray. The results obtained (Figure 6) show that judges 1, 2, and 3 are linked to the two axes for the sugar-acid balance. These judges are poorly represented for the acidic taste, while the judges from 1 to 10 are more related to the first axis for the concentrated texture.

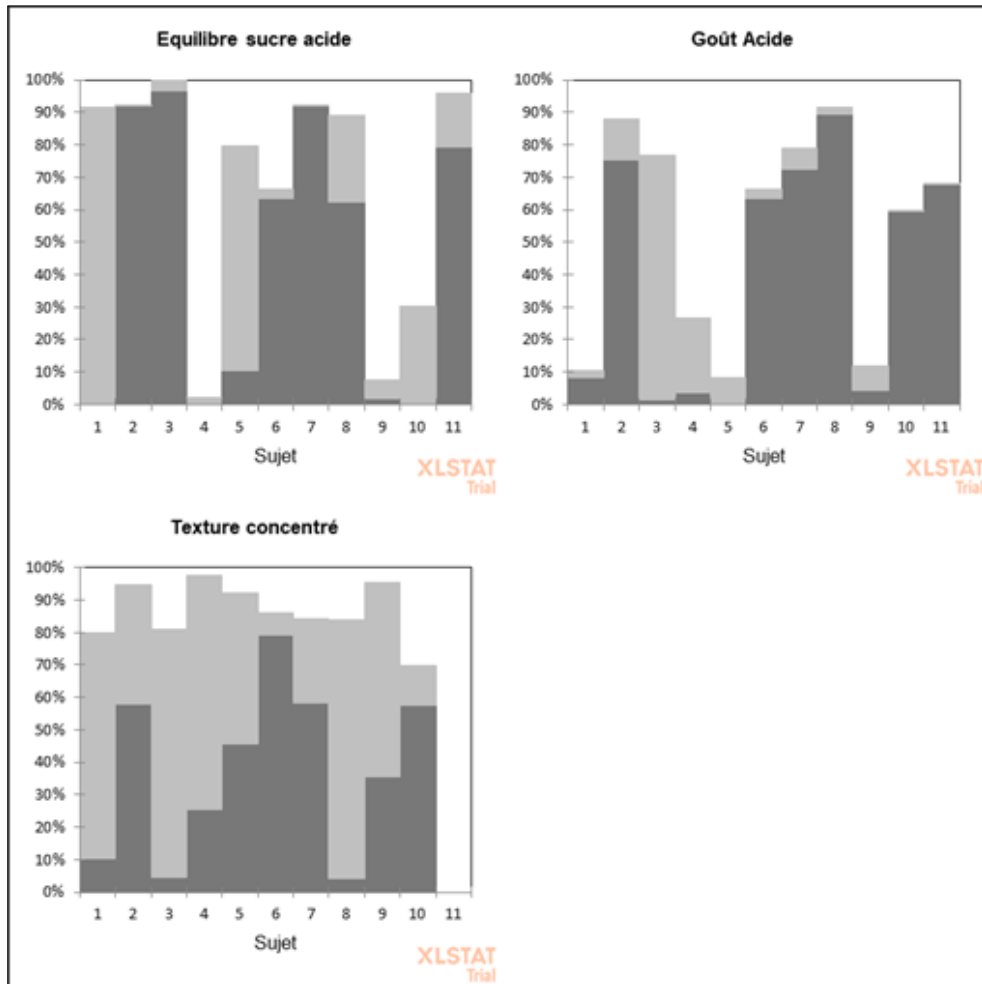


Figure 6 Percentage of variance for each pair (subject, descriptor)

A graph of descriptors constructed by the AFM makes it possible to study more precisely the relationship between the descriptors through a Multiple Factor Analysis (MFA) (Figure7).

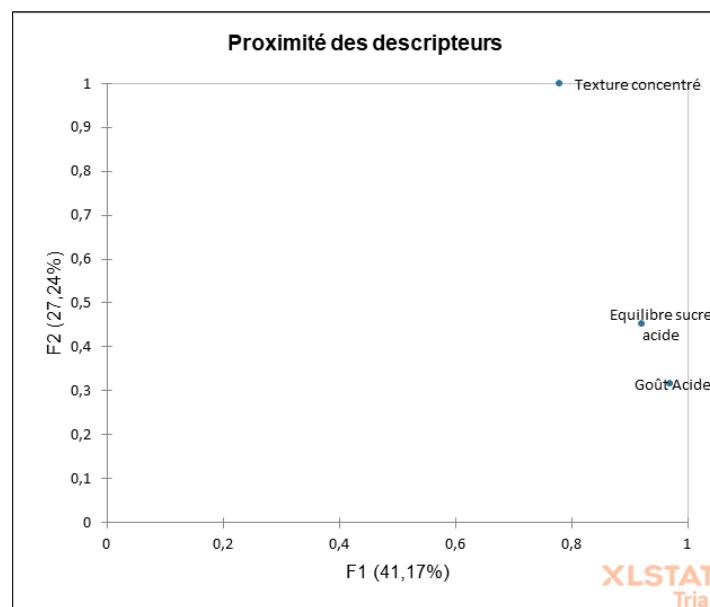


Figure 7 Multiple Factor Analysis

There is a close relationship between acid-sugar balance and acid-taste. This proximity is not observed in the concentrated texture of *S. birrea* juices.

3.1.4 Analysis of consumer preference data

Preference data analysis allows us to see the most popular juices, make two-by-two comparisons and determine if consumers agree.

Mean of the judges before entering

This step is about visualization and analysis before focusing on the subjects. One of the results that may hold our attention is the average of the subjects before centering (this result is not displayed after centering since by definition the mean of the judges will be reduced to 0 (Figure8)).

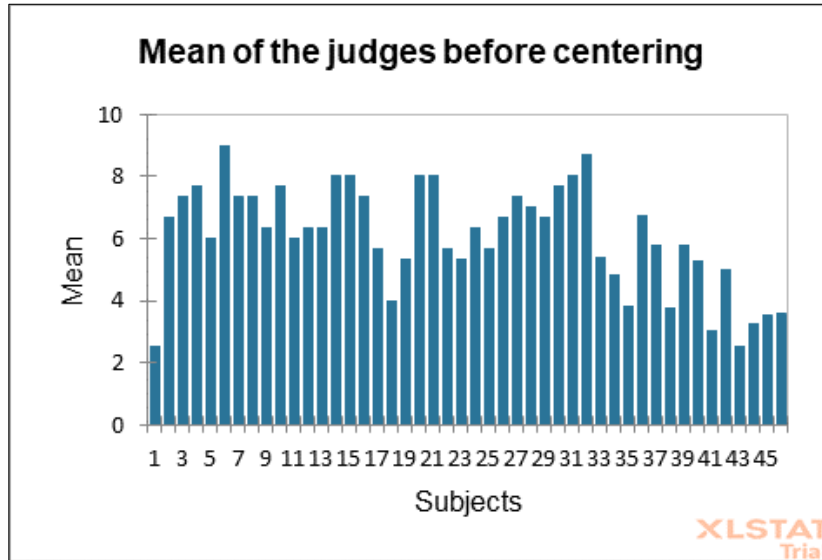


Figure 8 Means of the judges before centering

Mean of the products after centering of the judges

The judges' analysis of the mean of the products after centering reveals that the juices of *S. birrea* from DK and BE have the lowest mean (Fig 9).

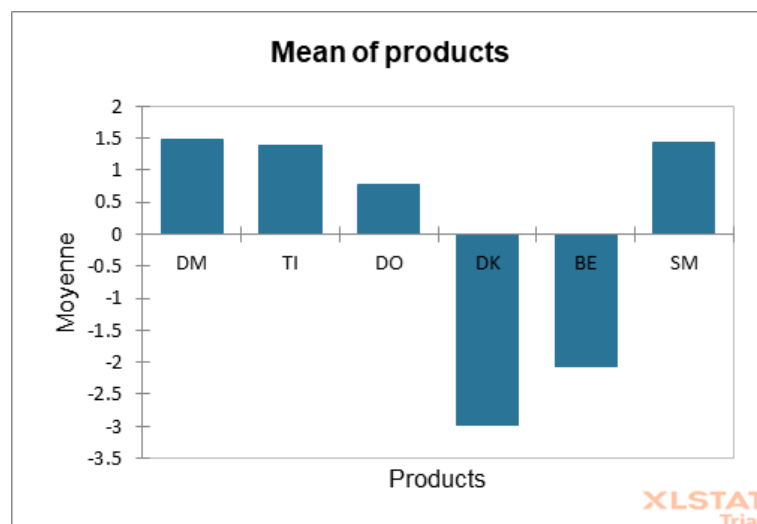


Figure 9 The mean of the products after centering of the judges

Dispersal of preference data

An analysis of the dispersion of the preference data for each *S. birrea* juice shows that the SM, TI, and DM juices were subject to more rating differences than the others, since their interquartile ranges are greater. The results are shown in Figure 10.

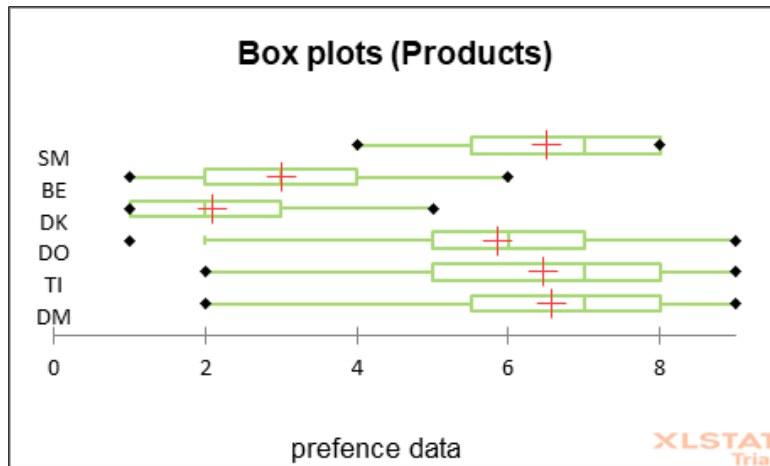


Figure 10 Box plot dispersal of preference data for *S. birrea* juices

Analysis of variance (ANOVA)

The analysis of variance was carried out with the preference data as the dependent variable and the products as the factor. The latter makes it possible to determine if there is at least one product that has an average of preferences different from the others. The results obtained (Figure 11) clearly show that there are two groups of juices. DM, DO, SM, and TI juices are more popular than BE and DK juices.

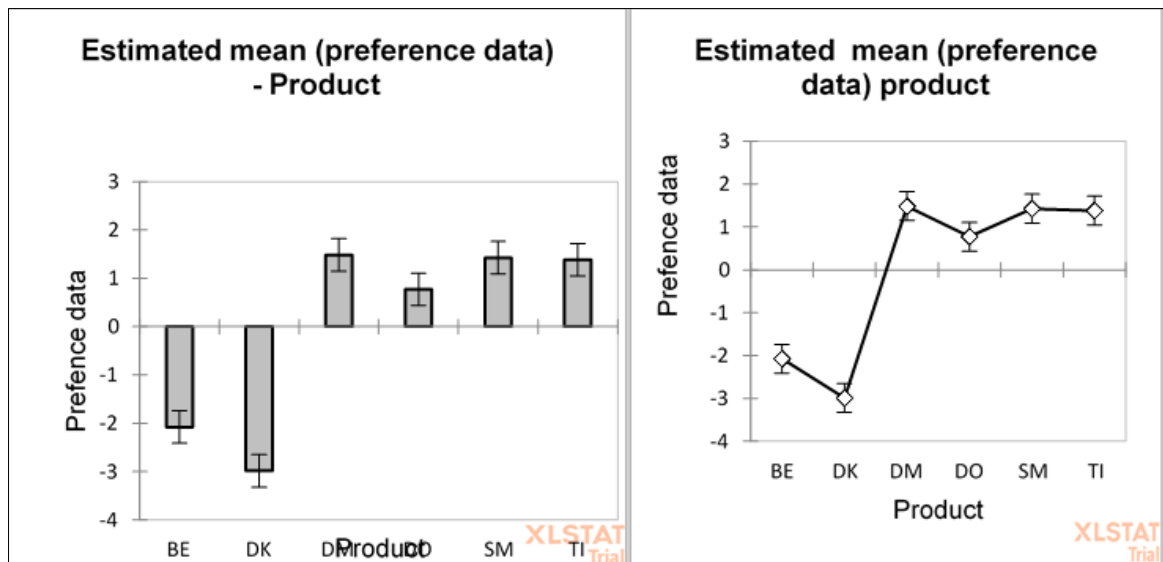


Figure 11 Means of preference data

Infernal preference mapping

It allows you to determine which products are the most popular liked by subject. It also makes it possible to confirm or deny the previous results concerning the means. The results obtained are shown in Figure 12 and confirm consumer preference for DO, DM, SM, and TI juices.

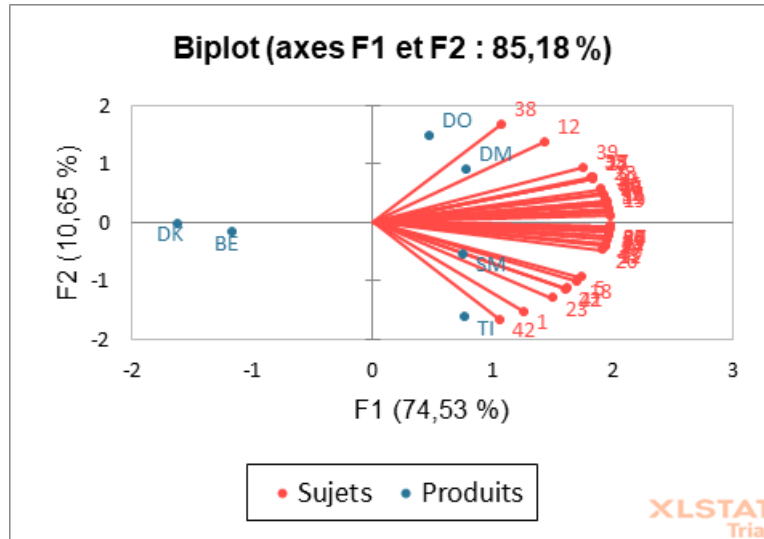


Figure 12 Internal preference mapping cartographic

These results suggest a classification of subjects to study possible groups for this observed preference. This classification is presented in figure 13. It thus makes it possible to observe the existence of groups of subjects. As a result, there are three types of subjects.

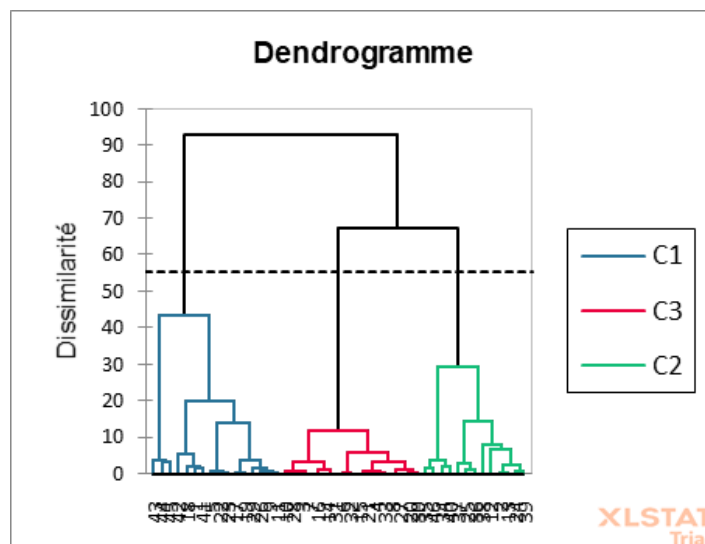


Figure 13 Cluster of subjects

4 Discussion

The microbiological control of food not only makes it possible to assess the risks to the health of consumers but also to indicate whether or not good hygiene practices (GHP) or good processing practices (GMP) are respected during production and/or processing. This was due to the fact that the microbiological quality of *S. birrea* juices from all sources was evaluated. The methodology was based on microbiological quality control according to CNERNA standards. As a reminder, the measured pH of the juices was less than 3 (acid medium) for all sources. pH is not a microbiological parameter; however, it helps to better understand the mechanism of germ growth in a portion of food. Hence, only the juice from Tirmini meets the microbiological quality standards not only for alteration germs but also for pathogenic germs, despite the presence of high mold concentration levels. The presence of yeast and mold colonies in traditional drinks has been recognized in a study conducted by N'Diaye [14], who shows that they can multiply normally in an environment where the acidity is lower (pH < 4.5). The fungal flora in general constitutes a common flora, presenting no health risks for the consumer, according to Jouve *et al.* [15]. Molds present in food are usually considered harmless [16]. The other juices analyzed also meet microbiological quality standards for alteration germs but are unfortunately

contaminated with pathogenic germs of *Escherichia coli* for the majority of the juices (5/7) and *Staphylococcus aureus* for 2 samples out of 7. A lack of good hygiene practices during the processing and/or storage stages of the juices could be implicated as a source of contamination. This demonstrates the low quality of the juices. Other factors would be at the origin of the juice contamination, such as non-compliance with GMPs during handling and poor personal hygiene and clothing of the operators during the extraction of the juices. In addition, the cold processing of *S. birrea* juices without pasteurization is probably a limiting factor in maintaining the microbiological quality of the juices after extraction. The sensory analysis carried out on the juice samples from the pulp of *S. birrea* fruit consisted of carrying out a classification test with a panel of 11 semi-naive subjects and a hedonic test with 46 consumers (naive subjects). These are preference tests for both.

Sensory analysis helps to understand consumer reactions; therefore, it is an excellent tool for product development. By characterizing the product as well as possible, sensory analysis is today an essential tool for Research and Development (R&D) and also marketing/communication teams to better communicate about their products internally with the production teams and externally to consumers [17]. According to [18], the test carried out makes it possible to identify the important characteristics of the products perceived by a jury, and the descriptors which best discriminate against them. The panel analysis carried out for the semi-naive panel (11) made it possible to highlight, for each descriptor, whether or not there is an effect produced. For each descriptor of the juices, it was noted that the rating scale of each member of the jury was independent apart from certain similarity factors linked to the mean obtained. In the analysis of the descriptors, there appeared to be agreements among the judges for the descriptors of the acid-sugar balance and the acid taste. These two descriptors are hence found in the same judgment zones for all the juices analyzed.

The analysis of consumer preference data made it possible to identify the overall appreciation of the juices analyzed. Hence, the juices of the DM, TI, SM, and DO samples are the most appreciated by consumers and are well-rated compared to the juice of the DK and BE samples, which are very poorly appreciated by consumers. This analysis of preference reveals three clusters of subjects for the appreciation of *S. birrea* fruit juices. The importance of hedonic methods relating to consumer preferences aims to compare the overall hedonic appreciation of different products by focusing on individual feelings related to the pleasure or displeasure caused by the food. Unlike descriptive sensory analysis, these methods use naive subjects who have had no practice in sensory analysis [19]. In addition, recruitment of the latter is generally targeted at a specific group of consumers within the product universe of the samples tested. Rating tests aim to capture the hedonic status of one or more products to compare them. To do this, subjects are asked to rate the products presented, generally successively, on a so-called interval scale that can be numerical, semantic, or even visual. Nevertheless, the 9-point hedonic scale [20] seems to be the most frequently used in the literature. As with descriptive analysis, analysis of variance can be used to analyze hedonic data.

5 Conclusion

The technological valorization of fruits in juice realized within the framework of this study was evaluated on the microbiological level and on the sensory level. It appears that good practices (BPH and BPF) must be reviewed to guarantee the hygienic quality of juices extracted from *S. birrea* fruits. The other factors to look closely at concern the possibility of heat treatment (pasteurization) to reduce the load of microorganisms and also to review the processing process to limit the dangers, HACCP would be an immediate solution to explore. The sensory analysis has generally made it possible to show consumers' preference for juices based on origin. The analysis of the panel revealed that of the 3 descriptors of the juice, two are the most noted (acid sugar balance and acid taste), and the concentrated texture as a descriptor is not valid for the extracted juices. The fruits of *S. birrea* are very acidic but also sweet, which requires the search for adequate means of preservation as well as the necessary additives to improve the taste qualities of its juice. The industrial exploitation of this valorization must be the subject of several research and development to set up a non-alcoholic juice of *S. birrea* capable of being preserved at room temperature beyond a week of conservation at 4 °C from natural juice obtained by pressure.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflicts of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study

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