RESEARCH ARTICLE

NUTRITIONAL CHARACTERISATION OF A CANISTEL (Pouteria campechiana) NECTAR

Djuikwo Nkonga Ruth Viviane¹, PevetmiNjuchouket Abdel Malik¹, Yadang Germaine² and Djouhou Michelle¹

¹Laboratoire des Sciences Alimentaires et Métabolisme, University of Yaoundé I, Yaoundé, Cameroon
²Department of Food Science and Nutrition, Ecole Nationale des Sciences Agro-Industrielles, University of Ngaoundéré, Cameroon

ABSTRACT

Canistel is a fruit with remarkable nutritional characteristics, yet it remains little known, under-exploited and subject to numerous post-harvest losses in Cameroon. The objective of this work was to formulate nectars based on canistel, to evaluate their organoleptic, nutritional and microbiological qualities. The parameters studied were analysed by standard methods. The results showed that, of the nectars formulated, the one with 50% canistel was the most appreciated. With the exception of trace elements, the nutritional composition of the nectars improved with increasing canistel. Per 100 mL, the crude fibre content of these nectars was significant (0.17±0.003g for B25 and 0.36±0.003g for B50), as were vitamin C (72mg and 176±8.00 mg for B25 and B50 respectively) and carotenoids (0.06 mg for B25 and 3.49 mg for B50). The results of the mineral content indicate that canistel nectar is a good source of macro- and micro-nutrients, with potassium as the predominant element. Antinutrients were traced and the results of the microbiological analysis showed that these nectars were suitable for consumption.

INTRODUCTION

Fruits are the dietary food good for health (Brat and Cuq, 2007). The WHO recommends the consumption of 400g of fruit and vegetables per day to maintain good health (FAO/WHO, 2003). They are consumed fresh or in the form of processed products such as biscuits, cakes, jams or drinks. Among the beverages are nectars, which are a category of fruit juices generally reserved for very pulpy or acidic fruits that must be diluted with water and then sweetened or not, depending on the desired taste. (Fredol, 2005). Tomatoes, bananas, watermelons, apples, grapefruits and oranges are among the most consumed and processed fruits in the world (Peggy, 2021). The high consumption of these fruits is at the expense of others that seem to be neglected or ignored by a large part of the population (Ranaivoson, 2015). This is the case of the canistel (Pouteria campechiana) which is a fruit of the Sapotaceae family, native to Central America and southern Mexico (Fasnaet al., 2012).

This fruit is cultivated in many American countries, but also in Africa and Asia (Ledesma and Campbell, 2015). In Cameroon, it is found almost everywhere, especially in the departments of Haute-Sanaga, Mbam, Lekié, Bamboutos and Noun. The fruit is available from May to September and from December to February. Canistel has exceptional nutritional and therapeutic properties. Its carotenoid content varies from 190 to 2,300 mg/100g, much richer than sweet potato, considered to be the richest plant food in carotenoids (85,425 mg) (Lanerolle et al., 2008; Briendet et al., 2017). The high carotenoid content of canistel would be an asset in the fight against Avitaminosis A, which has high mortality and morbidity rates. Its therapeutic management is complex and very costly. Therefore, patients are encouraged to use natural substances from plants and foods (UNICEF, 2019). Numerous studies have been carried out with the aim of enhancing the value of canistel. Notably that of Laborde et al. (2016) focused on the development of a canistel-based cake, those of Dalia (2014) and Thiruchchelval (2018) on the acceptability of canistel-based biscuits and many others. All of these authors noted the appreciation of products made from canistel processing. In Cameroon, Kenge et al. (2020) showed that ethanolic extracts from canistel fruits could help in the treatment of Alzheimer's disease. To our
knowledge, no scientific study on the transformation of canistel into nectar has been conducted. This work is being carried out with the aim of formulating nectars based on canistel and evaluating their organoleptic, nutritional and microbiological qualities in order to contribute to the fight against avitaminosis.

**MATERIALS AND METHODS**

**Collection of samples:** The fruits of *Pouteria campechiana* were harvested in the dry season (January 2021) in a home garden in the town of Foumban in West Cameroon.

**Preparation of nectars:** The nectars were prepared using the CODEX STAN 247 (2005) standard for fruit nectar. This standard stipulates that the preparation of nectars require a minimum of 25% fruit and a maximum of 50%. The other ingredients vary according to the consumer’s choice. In this study, water, sugar and lemon purchased from a market in Laplace were added. The preparation of the nectars was carried out using canistel puree with the proportions 25%, 30%, 35%, 40%, 45% and 50%. Each nectar received constant amounts of sugar (5%) and lemon (3%). The nectars were filled into glass bottles, pasteurised at 65°C for 30 minutes, and cooled to room temperature. Sensory, physico-chemical, nutritional and microbiological qualities were evaluated.

**Sensory analysis:** The organoleptic properties of the 6 prepared nectars were determined by a tasting panel of 60 evaluators (aged 19-38; 35 men and 25 women). The panel members were asked to evaluate the taste, colour, smell, consistency and general acceptability of each nectar. Ratings were made on a 9-point hedonic scale for each characteristic ranging from 9 (extremely pleasant) to 1 (extremely unpleasant).

**Physico-chemical analysis:** The pH was determined according to A. O. A. C (1990), a quantity of nectar was introduced into a beaker in which the electrode of the pH meter, initially calibrated, was placed. The pH value was read on the display of the pH meter. The Brix degree (AFNOR, 1986), a drop of nectar was poured onto the lower prism of the refractometer which had been wiped clean. The refractometer slide was lowered and the Brix level was read on the dividing line. The titratable acidity was determined by the AFNOR method (1986). In a beaker, 50 ml of nectar was introduced to which 3 to 4 drops of phenolphthalein are added, the whole is titrated by the sodium hydroxide solution until a pink colour appears.

**Proximal analysis:** The water content was determined by oven drying according to AFNOR (1982). A Mo mass of the fresh sample was dried at 105°C to constant weight in an oven for 24 hours. The result was expressed as a percentage by subtracting the dry matter content from 100. For crude protein, the total nitrogen is determined after mineralisation of the samples according to the kjeldahl method (AFNOR, 1984), and the assay performed according to the colorimetric technique of Devani et al. (year). After mineralisation of the nectar lyophilisate, the samples were assayed and the result was calculated using 6.25 as the nitrogen to protein conversion coefficient. The total lipids were extracted by soxhlet according to the method of Bourely (1982). The test sample was dried in an oven at 105°C, crushed, and placed in dried and tared filter paper bags. The oil was extracted with hexane in a Soxhlet for 12 hours. The oil content was calculated at 0% moisture by the difference in the weight of the bag before and after the lipids have been completely extracted. The ash content was determined by simple incineration according to AFNOR (1981). This consists of completely incinerating the organic matter contained in the sample until white ash was obtained in a muffle furnace set at 550°C.

Crude fibre was determined by the method described by A.O.A.C (1980). This method is based on a sequence of digestion of the powder obtained from the feed with strong acids and strong bases. Soluble sugars were extracted and determined by the DNS (3,5-dinitrosalicylic acid) method described by Fischer and Stein (1961) and total carbohydrate content was determined by the difference method described by A.O.A.C (1984).

**Mineral analysis:** The content of Ca, Mg, K, Na, Fe, Cu, Mn and Zn were determined by flame atomic absorption spectrophotometry according to Benton and Vernon (1990).

**Analysis of bioactive compounds:** The vitamin C content was determined by the method described by Idah et al. (2010), 2,6-dichloro-phenol-indophenol (DCPIP) is used to directly determine the vitamin C present in solution by redox titration. The end of the assay or equivalence is highlighted by an excess of DCPIP (pale pink hue). Total carotenoids by the method of Rodriguez-Amaya and Kimura (2004), the extraction was done with acetone where 0.5 g of sample was introduced into 3 mL of cold acetone for 1 min and filtered, the operation was repeated until the acetone was no longer coloured. The acetone extract was partitioned into petroleum ether (10 mL) and washed with distilled water to remove the acetone. The optical density (O.D.) of the extracts obtained was read at 450 nm on a spectrophotometer. The results were calculated using 2500 as the absorption coefficient of total carotenoids in petroleum ether.

Total phenolic compounds and total flavonoids were determined by the method of Dhar et al. (2012). Extraction was done using 20 mL water/methanol (v/v) solvent for 1 g of lyophilisate. After 30 min of stirring, the whole was filtered. From the extract obtained the determination of phenolic compounds was done using gallic acid as standard and the O.D. was read at 765 nm. For flavonoids the standard was quercetin and the O.D. was read at 430nm.

**Anti-nutrient analysis:** The tannin contents were determined according to Ndhlala et al (2007). In a 50 mL Erlenmeyer flask, 0.125 g of sample and 2.5 mL of 96% ethanol were added. The mixture was centrifuged and the collected supernatant is used for the tannin determination. The absorbance was read at 550nm. Phytates were assayed according to Olayeye et al. (2013). 1g of nectar lyophilisate was introduced into a 100mL flask to which 2% HCl was added. The resulting mixture was filtered. Titration was done with iron III chloride solution (standard) until a persistent brownish yellow colour was observed for 5min. Oxalates were determined according to Aina et al. (2012). 1g of nectar lyophilisate was introduced into an Erlenmeyer flask, 75 mL H2SO4 (3 mol/L) was added. The hot sample was titrated with KMnO4 (0.05mol /L) until a persistent pale pink colour was obtained. The oxalate content was calculated by taking 1ml of KMnO4 as equivalent to 2.2mg of oxalate. Results were

Total phenolic compounds and total flavonoids were determined by the method described by Dhar et al. (2012). Extraction was done using 20 mL water/methanol (v/v) solvent for 1 g of lyophilisate. After 30 min of stirring, the whole was filtered. From the extract obtained the determination of phenolic compounds was done using gallic acid as standard and the O.D. was read at 765 nm. For flavonoids the standard was quercetin and the O.D. was read at 430nm.
Saponins were determined according to the method of Koziol (1990). 0.5 g of lyophilisate of the nectar was introduced into a test tube, 5mL of distilled water was added. The tube was shaken vigorously for 30 seconds. After 5-10 s, the height of the foam formed was measured with a ruler graduated to the nearest 0.1 cm.

**Microbiological analysis** The enumeration of yeasts, moulds and *Escherichia coli* was performed according to ISBN 978-550-84613-0 (2019). For each test, a series of decimal dilutions was carried out and 0.1mL of each dilution as well as the mother solution (nectar) were inoculated on the surface on PDA with chloramphenicol at 37°C for 72h for the search for moulds, on Sabouraud with gentamicin at 25°C for 48h for the search for yeasts and on MacConkey at 37°C for 48h for the search for *E. coli*.

**Statistical analysis** Statistical analyses were performed using IBM SPSS version 20.0 for Windows. The ANOVA test coupled with a Post Hoc test (Turkey) was used for the sensory analysis and the student test for the nutritional analysis; at the 5% significance level. The results were represented as mean ± standard deviation; with the tests performed in triplicate. Microsoft Excel 2016 for Windows was used for the graphical representations.

**RESULTS AND DISCUSSION**

**Table 1. Results of sensory analysis of canister-based nectars**

<table>
<thead>
<tr>
<th>Nectar</th>
<th>Colour</th>
<th>Smell</th>
<th>Taste</th>
<th>Texture</th>
<th>General acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>B25</td>
<td>5.92±1.25*</td>
<td>4.68±1.85*</td>
<td>4.92±1.85*</td>
<td>5.0±1.84*</td>
<td>4.98±1.84*</td>
</tr>
<tr>
<td>B30</td>
<td>5.92±1.85*</td>
<td>5.22±1.64*</td>
<td>5.47±1.78*</td>
<td>5.30±1.69*</td>
<td>5.68±1.85*</td>
</tr>
<tr>
<td>B35</td>
<td>6.86±1.54*</td>
<td>5.82±1.78*</td>
<td>5.00±1.90*</td>
<td>5.28±1.95*</td>
<td>5.28±1.76a</td>
</tr>
<tr>
<td>H40</td>
<td>6.35±1.90*</td>
<td>5.33±1.58a</td>
<td>5.92±1.93a</td>
<td>5.92±1.96a</td>
<td>5.97±1.96a</td>
</tr>
<tr>
<td>B45</td>
<td>6.49±1.78a</td>
<td>5.88±1.64a</td>
<td>5.78±1.74a</td>
<td>5.73±1.64a</td>
<td>5.74±1.38b</td>
</tr>
<tr>
<td>B50</td>
<td>5.86±1.90a</td>
<td>6.05±1.75e</td>
<td>6.05±1.75e</td>
<td>6.05±1.75e</td>
<td>6.05±1.75e</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation from the mean. Values with different letters on the same line are significantly different (p<0.05). B25 (nectar with 25% canistel); B30 (nectar with 30% canistel); B35 (nectar with 35% canistel); B40 (nectar with 40% canistel); B45 (nectar with 45% canistel); B50 (nectar with 50% canistel).

Of the sensory parameters studied, only the colour parameter showed no significant difference between the nectars. The results of the smell, taste, texture and general acceptability of the nectars showed significant differences between B25 and B50. Indeed, more than 58.88% of the panelists had a preference for B50. This percentage could be higher if the latex present in this fruit responsible for its pungent aftertaste noted by the panel was eliminated. Similar conclusions have been made by several authors such as Dalia (2014), Laborde et al., (2016) and Thiruchchelval (2018). For the remainder of this study, B50 (most popular) and B25 (least popular) were selected for characterisation.

**Table 2. Physico-chemical characteristics of canister-based nectars**

<table>
<thead>
<tr>
<th>Parameter for 100mL of nectar</th>
<th>B25</th>
<th>B50</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>3.69±0.04a</td>
<td>3.96±0.03b</td>
</tr>
<tr>
<td>Titratable acidity (g) Brix Degree (%)</td>
<td>0.78±0.04a</td>
<td>1.00±0.07b</td>
</tr>
<tr>
<td>Antioxidant activity (mg)</td>
<td>4.95±0.05a</td>
<td>7.00±0.01b</td>
</tr>
</tbody>
</table>

**Physico-chemical analysis**: The pH of B25 and B50 nectars were below 4.5 as stipulated by ISO 1842. The titratable acidity values obtained were 0.78±0.04 for B25 and 1.00±0.07 for B50.

**Table 3. Proximal composition of canister-based nectars**

<table>
<thead>
<tr>
<th>Parameter for 100mL of nectar</th>
<th>B25</th>
<th>B50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water content (%)</td>
<td>92.11±0.20a</td>
<td>86.72±0.15b</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>0.17±0.02a</td>
<td>0.90±0.08b</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>0.55±0.01a</td>
<td>1.15±0.02b</td>
</tr>
<tr>
<td>Total carbohydrates (g)</td>
<td>6.90±0.16a</td>
<td>10.62±0.21b</td>
</tr>
<tr>
<td>Soluble sugars (g)</td>
<td>0.81±0.04a</td>
<td>5.68±0.69b</td>
</tr>
<tr>
<td>Energy (Kcal)</td>
<td>33.18±0.77a</td>
<td>2.4±0.002b</td>
</tr>
<tr>
<td>Ash (g)</td>
<td>0.12±0.001a</td>
<td>0.36±0.003b</td>
</tr>
<tr>
<td>Fibre (g)</td>
<td>0.17±0.003a</td>
<td>0.03±0.003a</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation from the mean. Values with different letters on the same line are significantly different (p<0.05). B25 (nectar with 25% canistel); B50 (nectar with 50% canistel).

The Brix degrees of the nectars were 4.95±0.05% for B25 and 7.00±0.001% for B50. Due to its higher canister fruit content, B50 had a higher Brix level than B25. Titratable acidity is used to determine the degree of acidity in fruit juices due to the presence of citric, tartaric and malic acids. These acids ensure the lowering of the pH value, ensuring the balance between acid and sweet taste (Gurak et al., 2010). According to the Food Codex (1989) the Brix level of a nectar should not exceed 20%. 1°Brix is generally equivalent to 1g of sucrose in 100 mL of solution (ICUMSA, 2015). Due to its low sucrose content, canister nectar is classified according to the food codex as a slightly sweet juice. Proximal analysis The water content of the canister-based nectars were 92.1±0.2 for B25 and 86.7±0.15 for B50. These values are in accordance with the FDA standard (2016). According to the latter, the water content of nectars should be 85% or more.
Table 4. Bioactive compounds contents of canistel-based nectars

<table>
<thead>
<tr>
<th>Parameter</th>
<th>B25</th>
<th>B50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin C (mg)</td>
<td>72.00±0.00,00</td>
<td>176.00±0.00,00</td>
</tr>
<tr>
<td>Total carotenoids (mg)</td>
<td>0.06±0.00,00</td>
<td>3.49±0.01,01</td>
</tr>
<tr>
<td>Phenolic compounds (mg EAG)</td>
<td>5.02±0.66,00</td>
<td>12.51±1.52,02</td>
</tr>
<tr>
<td>Flavonoids (mg EQ)</td>
<td>3.23±0.10,05</td>
<td>6.50±0.00,01</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± standard deviation from the mean (n=3). Values with different letters on the same line are significantly different (p<0.05). B25 (nectar with 25% canistel); B50 (nectar with 50% canistel).

Analysis of bioactive compounds: Table 4 shows the bioactive compounds contained in canistel nectars. The contents of vitamin C, carotenoids, phenolic compounds and flavonoids increased with the addition of canistel to the drinks. The vitamin C content of B50 was very high compared to orange (125.4 mg/100 mL), lime (87.9 mg/100 mL) (Chuku and Akani, 2015), mandarin (32.06 mg/100 mL) and sour sop (20.50 mg/100 mL) nectar (Nwozole et al., 2017). The total carotenoid content of B50 was significantly high compared to mango nectar (2.1 mg/100 mL) (Kumar et al., 2015). This result confirms that canistel is a potential source of carotenoid and could be used to combat avitaminosis A (Lanerolle et al., 2008). The B25 and B50 beverages showed 3.23±0.105 mg/100 mL and 6.5±0.001 mg/100 mL flavonoid content, respectively. Nwozole et al. (2017) found 1.11 mg/100 mL in mandarin nectar and 8.58 mg/100 mL in sour sop nectar. Flavonoids commonly found in plants are bioactive compounds, known for their health benefits through their antioxidant properties (Nadechanok et al., 2017).

Microbiological analysis: Table 3 shows the results of the microbiological analysis of the formulated canistel nectars (B50) could be encouraged to contribute to the coverage of the recommended nutritional intake.

CONCLUSION

Canistel-based nectars were appreciated by the panel with a preference for B50. Their nutritional characteristics were remarkable and increased with the proportion of canistel. At 50% canistel, this nectar could provide 3.49 mg/100 mL carotenoids which proves its potential in the fight against avitaminosis A. Therefore, the consumption of canistel-based nectar (B50) could be encouraged to contribute to the coverage of the recommended nutritional intake.

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