



ISSN: 0976-3376

Available Online at <http://www.journalajst.com>

ASIAN JOURNAL OF  
SCIENCE AND TECHNOLOGY

Asian Journal of Science and Technology  
Vol. 12, Issue, 07, pp. 11781-11786, July, 2021

## RESEARCH ARTICLE

# NUTRITIONAL CHARACTERISATION OF A CANISTEL (*Pouteria campechiana*) NECTAR

Djuikwo Nkonga Ruth Viviane<sup>1\*</sup>, Pevetmi Njouchouket Abdel Malik<sup>1</sup>, Yadang Germaine<sup>2</sup> and Djouhou Michelle<sup>1</sup>

<sup>1</sup>Laboratoire des Sciences Alimentaires et Métabolisme, University of Yaoundé I, Yaoundé, Cameroon

<sup>2</sup>Department of Food Science and Nutrition, Ecole Nationale des Sciences Agro-Industrielles, University of Ngaoundéré, Cameroon

### ARTICLE INFO

#### Article History:

Received 21<sup>st</sup> April, 2021  
Received in revised form  
11<sup>th</sup> May, 2021  
Accepted 03<sup>rd</sup> June, 2021  
Published online 30<sup>th</sup> July, 2021

#### Key words:

*Pouteria campechiana*,  
Nectar, Nutritional Value,  
Avitaminosis A.

### 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 ( $0.17 \pm 0.003$ g for B25 and  $0.36 \pm 0.003$ g for B50), as were vitamin C (72mg and  $176 \pm 8.00$  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.

**Citation:** Djuikwo Nkonga Ruth Viviane, Pevetmi Njouchouket Abdel Malik, Yadang Germaine and Djouhou Michelle, 2021. "Nutritional characterisation of a canistel (*pouteria campechiana*) nectar", *Asian Journal of Science and Technology*, 12, (07), 11781-11786.

Copyright © 2021, Djuikwo Nkonga Ruth Viviane et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

## 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 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, Kengne et al. (2020) showed that ethanolic extracts from canistel fruits could help in the treatment of Alzheimer's disease. To our

\*Corresponding author: Djuikwo Nkonga Ruth Viviane,  
Laboratoire des Sciences Alimentaires et Métabolisme, University of Yaoundé I, Yaoundé, Cameroon.

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 Bourelly (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 0.5g 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 H<sub>2</sub>SO<sub>4</sub> (3 mol/L) was added. The hot sample was titrated with KMnO<sub>4</sub> (0.05mol /L) until a persistent pale pink colour was obtained. The oxalate content was calculated by taking 1ml of KMnO<sub>4</sub> as equivalent to 2.2mg of oxalate. Results were

expressed as mg/100 mL nectar. 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  $\pm$  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 canistel-based nectars**

Nectar	Colour	Smell	Texture Taste	General acceptability	
B25	5.92 $\pm$ 1.65 <sup>a</sup>	4.63 $\pm$ 1.85 <sup>a</sup>	4.92 $\pm$ 1.63 <sup>a</sup>	5.08 $\pm$ 1.84 <sup>a</sup>	4.80 $\pm$ 1.84 <sup>a</sup>
B30	5.92 $\pm$ 1.58 <sup>a</sup>	5.22 $\pm$ 1.48 <sup>a</sup>	5.47 $\pm$ 1.70 <sup>ab</sup>	5.68 $\pm$ 1.80 <sup>a</sup>	5.75 $\pm$ 1.70 <sup>b</sup>
B35	6.10 $\pm$ 1.54 <sup>a</sup>	4.82 $\pm$ 1.73 <sup>a</sup>	5.07 $\pm$ 1.50 <sup>a</sup>	5.28 $\pm$ 1.97 <sup>a</sup>	5.28 $\pm$ 1.74 <sup>ab</sup>
B40	6.35 $\pm$ 1.09 <sup>a</sup>	5.33 $\pm$ 1.76 <sup>a</sup>	5.92 $\pm$ 1.54 <sup>a</sup>	5.92 $\pm$ 1.78 <sup>a</sup>	5.97 $\pm$ 1.56 <sup>b</sup>
B45	6.05 $\pm$ 1.48 <sup>a</sup>	5.38 $\pm$ 1.61 <sup>a</sup>	5.72 $\pm$ 1.51 <sup>a</sup>	5.67 $\pm$ 1.89 <sup>a</sup>	5.77 $\pm$ 1.50 <sup>b</sup>
B50	5.90 $\pm$ 1.70 <sup>a</sup>	5.67 $\pm$ 1.70 <sup>a</sup>	6.03 $\pm$ 1.77 <sup>a</sup>	6.07 $\pm$ 1.80 <sup>b</sup>	6.07 $\pm$ 1.71 <sup>b</sup>

Values are expressed as mean  $\pm$  standard deviation from the mean. Values with different letters in the same column 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 Thiruchelval (2018). For the remainder of this study, B50 (most popular) and B25 (least popular) were selected for characterisation.

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

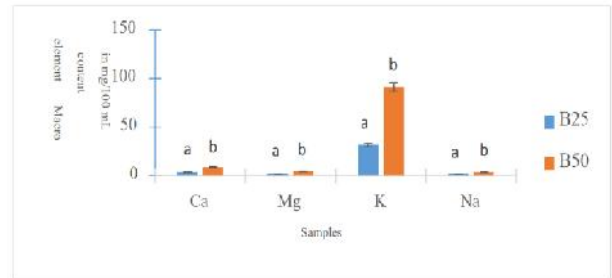
Parameter for 100mL of nectar	B25	B50
pH	3,69 $\pm$ 0,04 <sup>a</sup>	3,96 $\pm$ 0,03 <sup>b</sup>
Titrateability (g) Brix Degree (%)	0,78 $\pm$ 0,04 <sup>a</sup>	1,00 $\pm$ 0,07 <sup>b</sup>
	4,95 $\pm$ 0,05 <sup>a</sup>	7,00 $\pm$ 0,001 <sup>b</sup>

**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 $\pm$ 0.04 for B25 and 1.00 $\pm$ 0.07 for B50.

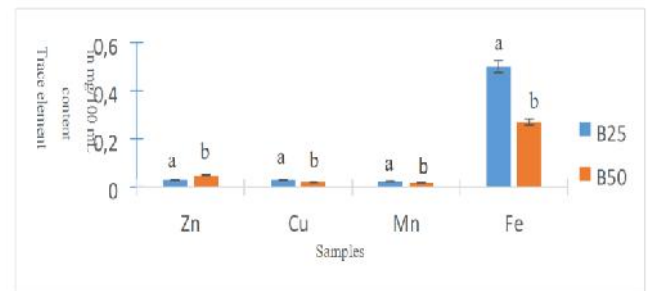
**Table 3. Proximal composition of canistel-based nectars**

Parameter for 100mL of nectar	B25	B50
Water content (%)	92,11 $\pm$ 0,20 <sup>a</sup>	86,72 $\pm$ 0,15 <sup>b</sup>
Protein (g)	0,17 $\pm$ 0,02 <sup>a</sup>	0,90 $\pm$ 0,08 <sup>b</sup>
Fat (g)	0,55 $\pm$ 0,01 <sup>a</sup>	1,15 $\pm$ 0,02 <sup>b</sup>
Total carbohydrates (g)	6,90 $\pm$ 0,16 <sup>a</sup>	10,62 $\pm$ 0,21 <sup>b</sup>
Soluble sugars (g)	0,81 $\pm$ 0,03 <sup>a</sup>	5,64 $\pm$ 0,69 <sup>b</sup>
Energy (Kcal)	33,18 $\pm$ 0,77 <sup>a</sup>	0,24 $\pm$ 0,002 <sup>b</sup>
Ash (g)	0,12 $\pm$ 0,001 <sup>a</sup>	0,36 $\pm$ 0,003 <sup>b</sup>
Fibre (g)	0,17 $\pm$ 0,003 <sup>a</sup>	

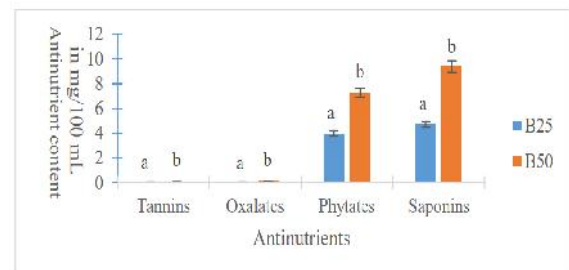
Values are expressed as mean  $\pm$  standard deviation from the mean ( $n=3$ ). Values with different letters on the same line are significantly different ( $p < 0.05$ ). B25 (nectar with 25% canistel); B50 (nectar with 50% canistel).



**Figure 1. Macro-element content of canistel nectars**



**Figure 2. Trace element contents of canistel nectars.**



**Figure 3. Anti-nutrient content of canistel nectars.**

The Brix degrees of the nectars were 4.95 $\pm$ 0.05% for B25 and 7.00 $\pm$ 0.001% for B50. Due to its higher canistel 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, canistel nectar is classified according to the food codex as a slightly sweet juice. Proximal analysis The water contents of the canistel-based nectars were 92.11 $\pm$ 0.2% for B25 and 86.72 $\pm$ 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 compound contents of canistel-based nectars**

Parameter for 100mL of nectar	B25	B50
Vitamin C (mg)	72,00±0,00 <sup>a</sup>	176,00±8,00 <sup>b</sup>
Total carotenoids (mg)	0,06±0,00 <sup>a</sup>	3,49±0,01 <sup>b</sup>
Phenolic compounds (mg EAG)	5,02±0,66 <sup>a</sup>	12,51±1,52 <sup>b</sup>
Flavonoids (mg EQ)	3,23±0,105 <sup>a</sup>	6,50±0,001 <sup>b</sup>

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).

**Table 5. Microbial concentration of B25 and B50 nectars**

B25	E1	E2	E3	E4	E5	ISBN 978-550-84613-0: 2019
<i>E. coli</i> (CFU/mL)	75	1	0	0	0	<100
Yeast (CFU/mL)	100	0	2	0	0	<1000
Mould (CFU/mL)	0	4	1	0	0	<1000
B50	E1	E2	E3	E4	E5	ISBN 978-550-84613-0: 2019
<i>E. coli</i> (CFU/mL)	0	0	1	0	0	<100
Yeast (CFU/mL)	0	0	100	0	0	<1000
Mould (CFU/mL)	0	0	0	100	0	<1000

Canistel nectar would therefore be a good source of hydration for the body. The results in Table 3 show that the addition of canistel in the preparation of nectar increases the nutrient content. There is an increase of 81% in protein, 52% in lipids, 50% in ash and 51% in crude fibre. The 50% canistel nectar contained 0.36±0.003 g/100 mL crude fibre. This value is higher than the fibre contents of papaya (0.27g) and pineapple (0.16g) nectar (Ogbonnalet al. 2013). Similarly, the lipid content of the formulated B50 canistel drink was found to be higher than that of mandarin (0.86g) and soursop (0.35g) nectar found by Nwozolet al. (2017). It would be interesting to know the composition of these lipids. On the other hand, canistel-based drinks have lower carbohydrate contents than that given by orange (14.56g) and lime (23.05g) nectar found by Chuku and Akani (2015) in Nigeria. Moderate sugar content is a health benefit (Gurak et al., 2010). It should be noted that the canistel itself being sweet only required 5% addition of sugar during the preparation of the nectar. The B25 and B50 nectars contain 33.18±0.77 Kcal and 56.48±0.69 Kcal of energy per 100 mL respectively. The authors of CCAF (2004) estimated the average energy intake of nectars to be 52.39 kcal/100 mL.

**Mineral analysis :** Minerals are present in varying amounts in the formulated canistel nectars (Figure 1 and 2). Also, their contents increase with the addition of canistel except for manganese which remained constant and iron which instead experienced a reduction of 86%. The iron content of the 25% canistel drink was high compared to orange (0.4mg), lime (0.5mg) (Chuku and Akani, 2015), mandarin (0.08mg) and soursop (0.25) nectars (Nwozolet al., 2017). Based on figure 2, it should be noted that formulated canistel nectars are a potential source of iron.

**Anti-nutrient analysis:** Among theantinutrients studied, tannins (0.03±0.002mg/100mL for B25 and 0.06±0.003mg/100mL for B50) and oxalates (0.03±0.01mg/100mL for B25 and 0.12±0.01mg/100mL for B50) are present in trace amounts regardless of the proportion of canistel used for nectar preparation. Similarly, phytates (3.98±0.001mg/100mL for B25 and 7.27±1.57mg/100mL for B50) show low levels compared to soursop nectar

(19.28±1.16mg/100mL) (Nwozolet al., 2017). These low antinutrient contents of canistel nectars suggest good bioavailability of minerals. Saponin contents were 4.71±0.37mg/100 mL and 9.36±0.64 for B25 and B50 respectively. Saponins are known to reduce the absorption of some nutrients such as glucose and cholesterol in the gut through intraluminal physicochemical interactions. They have hypoglycaemic and hypocholesterolaemic effects (Price et al., 1987).

**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/100mL), lime (87.9 mg/100mL) (Chuku and Akani, 2015), mandarin (32.06 mg/100mL) and soursop (20.50 mg/100mL) nectar (Nwozolet al., 2017). The total carotenoid content of B50 was significantly high compared to mango nectar (2.1 mg/100mL) (Kumar et al., 2015). This result confirms that canistel is a potential source of carotenoid and could be used to combat avitaminosis A (Lanerollelet al., 2008). The B25 and B50 beverages showed 3.23±0.105 mg/100 mL and 6.5±0.001 mg/100mL flavonoid content, respectively. Nwozolet al. (2017) found 1.11 mg/100mL in mandarin nectar and 8.58 mg/100mL in soursop nectar. Flavonoids commonly found in plants are bioactive compounds, known for their health benefits through their antioxidant properties (Nadechanoket al., 2017).

**Microbiological analysis :** The ISBN standard stipulates that the number of *Escherichia coli* colonies must be less than 100 and those of yeasts and moulds less than 1000. The results of the microbiological analysis were in accordance with the above standard. Despite the presence of some colonies. It would be necessary to respect more the rules of hygiene during the formulation. The canistel nectars prepared in this study are suitable for consumption.

## 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.

**Declaration of conflicts of interest:** The authors have declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

## FINANCING

The authors received no financial support for the research, authorship and/or publication of this article.

## REFERENCES

- A.O.A.C. 1980. Official Methods of Analysis <sup>13th</sup> Ed William Horwitz, Washington, D.C. Association of Official Analytical Chemistry.

- A.O.A.C. 1990. Association of Official Analytical Chemistry, Helrich, editor. Official Analytical Chemistry 15<sup>th</sup> Ed. Arlington. AB. Sweden.
- AFNOR. 1981. Fats, oilseeds and derived products. *Recueil de normes françaises*. AFNOR, Paris France, 2<sup>nd</sup> edition.
- AFNOR. 1982. Products derived from fruits and vegetables. *Recueil des normes françaises*. 1<sup>st</sup> edition, Paris la Défense France.
- AFNOR. 1984. Agricultural food products: general guidelines for the determination of nitrogen with mineralisation according to the Kjeldahl method. *Recueil de normes françaises* AFNOR, Paris France.
- AFNOR. 1986. Resistance to attack by a boiling aqueous solution of an alkaline mixture Test method and classification;
- Agte, V. V., Tarwadi, K. V., & Chiplonkar, S. A. 1999. Phytate degradation during traditional cooking: Significance of the phytic acid profile in cereal-based vegetable meals. *Journal of Food Composition and Analysis*, 12, 161-167.
- Aina V. O., Sambo B., Zakari A., Haruna H. M. S., Umar K. R. M., Akinboboye and
- Adama M. 2012. Determination of Nutritional and Anti-Nutrient Content of *Vitis vinifera* Grapes Grown in Bomo Area C Zaria, Nigeria. *Advance Journal of Food Science and Technology*. 46: 445-448.
- Benton Jones, Jr and Vernon W. Case 1990, Sampling, handling and analyzing plant tissue samples. In R.L. Westerman ED Soil testing and plant Analysis 3<sup>rd</sup> ed. SSSA Book Series No. 3.
- Bourelly J. 1982. Observations on the dosage of cotton seed oil; *Coton et fibres Tropical*. 27 2: 183-196.
- Bourokaa A. 2012. Biochemical study of fruit juice adulteration. Université de Carthage - Microthesis. National Institute of Applied Sciences and Technology.
- Braide W., Oranusi S. U. and Otali C. C. 2012. Nutritional, antinutritional, minerals and vitamin compositions of fourteen brands of fruit juice sold in onitsha main market. *FS J Res Basic & App Sci*. Vol 1. No 3.
- Briend A., Vidailheta M., Rieub D., Feilleta F., Bocquet A., Chouraquad J. P., Darmaune D., Dupontf C., Frelutg M.-L., Girardeth J. P., Hankardi R., Rozée J. C., Siméonid U., Turckj D. 2017. Vitamin A in Pediatrics: an update from the Nutrition Committee of the French Society of Pediatrics. *Arch Pediatr*; 24.
- CCAF 2004. Contribution of fruit juices and nectars to nutritional intake. Survey of food consumption and behaviour in France.
- Chuku E. C., Akani N. P. 2015. Determination of proximate composition and microbial contamination of fresh juice from three citrus species. *IIARD International Journal of Biology and Medical Research* Vol. 1 No.1.
- CSS Conseil Supérieur de la Santé. 2009. Nutritional recommendations for Belgium. P 53.
- Dalia A. and Paragados. 2014. Acceptability of canistel *Lacuma nervosa a.dc* fruit flour in making cookies. *Asia Pacific Journal of Multidisciplinary Research*. Vol. 2, No. 1.
- Danso, J., Francis, A., Reindorf, B., John, B., and David, B. 2019. Effect of drying on the nutrient and antinutrient composition of *bombax buonopozensesepals*. *African Journal of Food Science*, 131, 21-29.
- Devani M., Shishoo J., Shal S., and Suhagia B. 1989. Spectrophotometrical method for determination of nitrogen in Kjeldahl digest. *JAOAC*, 72: 953-956.
- Dhar P., Ratna C., Sayani M., Sauradip S., Sreedipa B., Sanjukta D., Hemanta K., Santinath G. 2012. Antimicrobial activity of *Sesbania grandiflora* flower polyphenol extracts on some pathogenic bacteria and growth stimulatory effect on the probiotic organism *Lactobacillus acidophilus*. *Microbiological Research*. Vol 167, Issue 8, 2012, P 500-506.
- Fasna A., farhana, Duniya J. and Aiswarya G. 2019. *Pouteria campechiana*: a short review. *World journal of pharmacy and pharmaceutical sciences*. Volume 8, Issue 5, 193-201.
- FDA Food Department of Agriculture of USDA. 2016. Guidance for industry: Juice HACCP hazards and controls guidance 1st ed.. Final Guidance.
- Fischer E. and Stein E. 1961. DNS colorimetric determination of available carbohydrates in foods. *Biochemical Preparation*, 8: 30-37.
- Gafar, M., Itodo A., and Senchi, D. 2012. Nutritive and Anti - Nutritive Composition of Chanca Piedra Stone Breaker. *Food and Public Health*, 22, 21-27.
- ICUMSA International Commission for Uniform Methods of Sugar Analysis. 2015. *Method Book*. Germany. Bartens.
- Idah PA, Musa J.J. and Abdullahi, M. 2010. Effects of storage period on some nutritional properties of orange and tomato. *Assumptio University journal of technology* 133: 181-185.
- Kengne A. Tagne J., Doungue H., Kemtsop M., and Oben J. 2020. Evaluation of the effect of *Pouteria campechiana*'s fruit powder and ethanolic extract on aluminum-chloride induced alzheimer's disease. *Journal of Food Science and Nutrition Research*; 3 2: 083-091
- Koziol, M. 1990. Afrosimetric estimation of threshold saponin concentration for bitterness in quinoa *Chenopodium quinoa* Willd- *journal of the Science of Food and Agriculture*, 542, 211 - 219.
- Kumar, R., Bawa, A. S., Kathiravan, T. and Nadasabapathi, S. 2015. Optimization of pulsed electric field parameters for mango nectar processing using response surface methodology. *International Food Research Journal* 224: 1353-1360.
- Laborde G. M. R., Padilla D. J. M., Saddul O. I. 2016. Development of a healthy, nutritious, and delicious tinea *pouteriacampechiana* polvoron..
- Lanerolle M. S., Priyadarshani A. M. B., Sumithaarachchi D.B. and Jansz E. R. 2007. The carotenoids of *Pouteria campechiana* sinhala: *ratalawulu*. *J. Natn. Sci. Foundation Sri Lanka*. 36 1: 95-9.
- Ndhlala, Kasiyamhuru, Mupure, Chitindingu, Benhura and Muchuweti. 2007. Phenolic composition of *flacourtia indica*, *Opuntia megacantha* and *Sclerocaryabirrea*. *Food Chemistry*. 1031 : 82- 87.
- Nwozol S. O., Aladesurul O. O., Hamed W. A. 2017. Evaluation of the proximate, mineral and vitamin content of juices produced from imported and local lesser known fruits in nigeria. *Annals. Food Science and Technology*. Volume 18, Issue 3.
- Ogbonnal A. C., Abuajah C. I., and Ekpe G. E. 2013 A comparative study of the nutritive factors and sensory acceptance of juices from selected Nigerian fruits. *Croatian Journal of Food Technology, Biotechnology and Nutrition*. 8 1-2, 47-51.
- Olayeye, Owolabi, Adesina, Oisiaka. 2013. Chemical composition of red and white cocoyam *Colocasia*

- esculenta* leaves. *International Journal of Sciences Resources*. 121- 125.
- Price, K. R., Johnson, L. I., and Ferewick, H. 1987. The chemical and biological significance of saponins in food and feeding stuffs CRC critical Review in food. *Science & Nutrition*, 26, 127-135.
- Prolongeau V., Renaudin N. 2009. Voluntary commitment charter for nutritional progress: fruit juice and nectar. General public version, UNIJUS, pp 6.
- Ranaivoson R. F. 2014. Valorisation of the canistel. Rapport de fin de stage. Université d'antananarivo. 21p.
- Ranaivoson R. F. 2015. Contribution to the valorisation of *Pouteria campechiana* or canistel. Final thesis for the title of master engineer in chemical and industrial process engineering. University of antananarivo. 8 p.
- Rodriguez-Amaya D. B. and Kimura M. 2004. HarvestPlus Handbook for Carotenoid Analysis. HarvestPlus Technical Monograph2. Washington, DC and Call: international Food Policy Research Institute IFPRI and International center for Tropical Agriculture CIAT. P 35-36.
- Thiruchchelvan N., Sewwandi J.M.A.M., and Aruna Kumara U.M. 2018. Acceptability and proximate evaluation of a new biscuit developed using *pouteriacampechiana*[lavulu] fruit flour.
- Nadechanok, J., Saisunee, L., Aphiwat, T., and Stephen, G. 2017. Phytochemical screening, phenolic and flavonoid contents, antioxidant and cytotoxic activities of *Graptophyllum pictum* L. Griff. Chiang Mai. *Journal of Science*, 441, 193-202.
- WHO. 2014. Fruit and vegetables for health. Report of the joint workshop.
- FAO/WHO. 2003. Diet, nutrition and prevention of chronic diseases. Report of a WHO/FAO Expert Consultation. Geneva, World Health Organization, WHO Technical Report Series, No. 916.
- Peggy Fernandez. 2021. The most popular fruit in the world. Retrieved from <https://fr.ripleybelieves.com/most-popular-fruit-in-world-393>

\*\*\*\*\*