

Nutritional composition and vitamin C stability in stored camu-camu (*Myrciaria dubia*) pulp

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SUMMARY. Camu-camu (*Myrciaria dubia*), a native fruit of the Amazon region, is one of the richest sources of vitamin C (2.4 to 3.0g/100g in the pulp) found in Brazil. The purpose of this work was the physical-chemical characterization of some nutrients and the valuation of vitamin C stability in stored camu-camu pulp, produced by the Agronomic Institute of Paraná (IAPAR), Paraná State, Brazil. The vitamin C determination was made by titration with potassium iodate. The fruit produced in Paraná State, presented a lower content of vitamin C than the one native of the amazon region, possibly due to the different development conditions of the plant, and consequently of the fruit, as well as the climatic variation, the humidity and the characteristics of the soil. Regarding the vitamin C stability in stored (-18°C) camu-camu pulp, a considerable decrease in its concentration until the 28th day was observed lost 23% (from 1.57 to 1.21g/100g), staying approximately the same until the end of the experiment. After 335 days of storage, the content found was of approximately 1.16g/100g of pulp, the ascorbic acid losses amounted to 26%. This content was still higher than the one found for most fruits that are good sources of this vitamin.

Key words: Camu-camu, *Myrciaria dubia*, vitamin C, stability.

RESUMEN. Composición nutricional y estabilidad de la vitamina C en la pulpa de camu-camu (*Myrciaria dubia*) almacenada. El camu-camu (*Myrciaria dubia*), fruta nativa de la región Amazónica, es una de las fuentes mas ricas de vitamina C (de 2,4 hasta 3,0g/100g de pulpa) en Brasil. Este trabajo tuvo por objeto la caracterización físicoquímica de algunos nutrientes y la evaluación de la estabilidad de la vitamina C en la pulpa de camu-camu producida por el Instituto Agronómico de Paraná (IAPAR), Estación Experimental de Morretes (PR), Brasil. La determinación de vitamina C se realizó por titulación com iodato de potasio. La fruta cultivada en el estado de Paraná, presentó menor cantidad de vitamina C que la nativa de la región Amazónica, posiblemente, debido a las diferentes condiciones para el desarrollo de la planta y, consecuentemente de la fruta, así como la variación climática, humedad y características del suelo. Con relación a la estabilidad de la vitamina C en la pulpa almacenada en congelador a -18°C, se pudo observar una disminución considerable (23%) en su concentración hasta el 28º día (de 1,57 hasta 1,21g/100g), permaneciendo constante hasta el fin del experimento. Después de 335 días de almacenaje, la cantidad encontrada fue de 1,16g/100g de pulpa, indicando una pérdida de 26%, siendo esta cantidad aún superior a la encontrada en la mayoría de las fuentes de esta vitamina. **Palabras clave:** Camu-camu, *Myrciaria dubia*, vitamina C, estabilidad.

INTRODUCTION

Camu-camu, caçari or araçá d'água (*Myrciaria dubia*), native of the Amazon region, is a bush or small tree, which belongs to the Myrtaceae family (1). In its native environment, it can reach up to about four to eight meters of height (2), and it can stay up to six months submerged in water (3), therefore it grows naturally in the floodplain area (2,4,5). Besides the Amazon, the specie is found in Pará and Rondônia States (Brazil) and in Peru, Venezuela and Colombia (6).

Its great economical potential resides in the fact that it is an excellent source of vitamin C (ascorbic acid), 2,400 to 3,000mg/100g have been quantified in the pulp and getting up to 5,000mg/100g in the peel (7). Therefore, camu-camu, which is practically ignored by the Brazilians, is one of the richest sources of vitamin C, which content is higher than acerola (6,8).

The vitamin C deficiency, know as scurvy causes many changes in the skin and gums, such as small hemorrhages. During the fifteenth and sixteenth centuries, it was observed that the disease scurvy developed during long sea voyages when few fruits and vegetables were eaten. British scientists later discovered that lime juice cured the scurvy (9-11).

Using its antioxidant capabilities, vitamin C can reduce the formation of carcinogenic nitrosamines in the stomach, minimize destruction of vitamin A, and also keep the folate coenzymes intact to prevent their destruction (10,12). Probably the most role of vitamin C is in developing the structural integrity of the three protein chains that are eventually woven together like a rope to form the fibrous protein called collagen (10,13). Vitamin C also improves iron absorption and is involved in synthesizing certain hormones and neurotransmitters (13).

There are three camu-camu species, which are very

similar, two of them (*Myrciaria spp*) are found close to rivers of clear water, and the vitamin C content is smaller than the one of the specie from dark water (*Myrciaria dubia*) (3). The fruit presents a rose or red coloration and purple in its final period of maturation, it possesses a diameter of 10 to 32mm (1), could weigh from 2.2 to 13.5g. The peel and the pulp correspond to 80% of the weight of the fruit (6).

Its consumption is restricted due to its high acidity (7), however, it has an excellent use in the preparation of jellies, juices, ice creams, liqueurs, wines and it can still be used in the enrichment of other foods (4,14).

The purpose of this work was the physical-chemical characterization of some nutrients, the processing, the storage and the vitamin C stability in camu-camu pulp, produced by the Agronomic Institute of Paraná (IAPAR), Experimental Station of Morretes (Paraná State, Brazil); which has been developing experiments with the fruit, with the objective of adapting it to the conditions of the region.

MATERIALS AND METHODS

Sampling

The camu-camu fruits used in this experiment proceeded from the Experimental Station of Morretes of the Agronomic Institute of Paraná, Curitiba section, (Paraná State, Brazil), 1998-1999 production. Camu-camu fruits, were separated in three different maturation levels, denominated unripe, half-ripe and ripe, being determined in the pulp the vitamin C contents.

The fruits in different maturation levels were triturated in a liquefier and hulled in a sieve with 25 mesh, the bagasse (seeds and hull) was discarded. The integral pulp was packed in glass flasks with a 10 mL capacity and submitted storage at -18°C, and the analyses were periodically accomplished the vitamin C content.

Methods

Moisture, ash and crude fiber were determined by gravimetric methods, as it is described by Cunniff (15).

The determination of the vitamin C contents were done weighing approximately 100 mg of pulp of camu-camu and adding 10 mL of sulfuric acid 20% (v/v). After homogenization, the mixture was filtered. To the filtered was added 1.00 mL of potassium iodide 0.1 mol/L and 1.00 mL of 1% (w/v) starch solution. Then the solution was titrated with potassium iodate 0.01 mol/L according to the method described on Normas Analíticas do Instituto Adolfo Lutz (16).

The minerals were determined by atomic absorption spectrometry, as it is described by Cunniff (15).

The protein was obtained by the semi-micro Kjeldahl method, as it is described by Silva (17).

The lipids were extracted from pulp using Soxhlet extractor and the content was determined gravimetrically. Methyl ester were prepared by transmethylation according to the procedure of the ISO (18), using KOH 2mol/L in methanol and n-heptane. Fatty acids methyl esters (FAME) were analyzed using a Shimadzu 14A (Japan) gas chromatograph equipped with flame ionization detector and fused silica capillary column (50m, 0.25mm and 0.20mm of Carbowax 20M). Column temperature was programmed at 10°C/min from 150-240°C. The injection port and detector were maintained at 220°C and 245°C, respectively. Carrier gas was hydrogen(1.2mL/min) and the make-up gas was nitrogen (30mL/min). The split used was 1:100. Identification of fatty acids was made by comparing the relative retention times of FAME peaks from samples with standards from SIGMA (USA). The peak areas were determined by the CG-300 computing integrater (CG Instruments, Brazil). Data were calculating as normalized area percentages of fatty acids.

RESULTS AND DISCUSSION

From Table 1, it can be observed that camu-camu in its unripe level of maturation, presented the largest vitamin C content, possibly due to biochemical transformations of the ascorbic acid during the maturation process.

TABLE 1
Vitamin C content in camu-camu pulp at the three different levels of maturation

Maturation levels	Vitamin C (g/100g of Pulp) ¹
Unripe	1.49±0.03
Half-ripe	1.40±0.04
Ripe	1.38±0.01

¹Results of analyses in triplicate of three samplings.

These differences were also observed in acerola at the different maturation levels: unripe (4.89g/100g of pulp); half-ripe (3.93g/100g of pulp) and ripe (1.79g/100g of pulp) (19).

The vitamin C contents obtained from camu-camu produced in Paraná state, were lower than those of the fruits from the Amazon region presented by Roque (6), which varied from 2.40 to 3.00g of vitamin C for 100g of pulp.

Table 2 presents the results obtained in the determination of some nutrients of camu-camu pulp, from random samplings. The camu-camu presented a high value for moisture compared to acerola (19).

TABLE 2
Composition of camu-camu pulp (g/100g)

Components	Contents ¹
Moisture	94.1±0.1
Protein	0.4±0.0
Ash	0.3±0.0
Crude fiber	0.1±0.0
Lipids	0.2±0.0
Carbohydrate	3.5 ²
Vitamin C	1.41±0.02

¹ Results of analyses in triplicate of three samplings.

² Estimated by difference.

In Table 3, the contents of some minerals found in acerola are presented (19), as well as the results obtained for camu-camu. It can be observed from Table 3, that the sodium, calcium, potassium, manganese, zinc and copper contents found in camu-camu, were higher than the ones founded in to acerola (19). However, the iron, magnesium, cadmium and lead contents were lower in relation to the contents found in acerola. The cobalt content was of 0,1mg/kg, while chrome was not detected by the method used.

TABLE 3
Content of some minerals in acerola and in camu-camu pulp (mg/kg)

MINERALS	Acerola ¹	Camu-camu ²
Sodium	69.8	111.3±4.3
Potassium	280.4	838.8±36.2
Calcium	132.2	157.3±4.4
Iron	5.5	5.3±0.4
Magnesium	145.7	123.8±8.7
Manganese	7.5	21.1±1.1
Zinc	1.9	3.6±0.1
Chrome	-	ND ³
Copper	0.2	2.0±0.2
Cobalt	-	0.1±0.0
Cadmium	0.2	0.01±0.00
Lead	0.4	0.2±0.0

¹ According to Visentainer, Matsushita, Souza and Vieira (19).

² Results of analyses in triplicate of three samplings *in natura* pulp.

³ Not detected.

In Table 4, the composition in fatty acids of camu-camu

pulp is presented.

Most of the fatty acids detected were polyunsaturated (PUFA) with 52.5%, followed by the saturated (SFA) with 35.7%, and the monounsaturated (MUFA) with 11.8%. The Table 4 also shows that tricosanoic and stearic acid are the most predominant saturated acids, with 11.9% and 10.0%, respectively. PUFA α - and γ -linolenic acids with contents of 16.0% and 9.3%, respectively. The α -linolenic acid comprised the greatst proportion of the fatty acids detected. The eicosapentaenoic acid (EPA), was founded in a considerable content (7.0%), considering that it is an acid found commonly in fish oils and sea animals. The analysis of the fatty acids obtained from camu-camu showed that they are of higher quality that obtained from acerola (19).

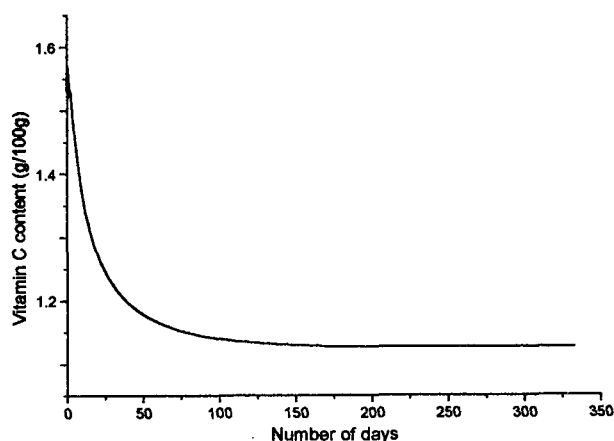
TABLE 4
Composition in fatty acids of camu-camu pulp¹

Fatty acid	Percentage in total lipids
C13:0 (Tridecanoic)	7.2±1.2
C16:0 (Palmitic)	6.6±0.6
C18:0 (Stearic)	10.0±0.7
C18:1 ω 9 (Oleic)	11.8±0.5
C18:2 ω 6 (Linoleic)	9.7±0.4
C18:3 ω 6 (γ -Linolenic)	9.3±0.2
C18:3 ω 3 (α -Linolenic)	16.0±0.7
C20:2 ω 6 (Eicosadienoic)	10.5±0.5
C20:5 ω 3 (EPA)	7.0±0.1
C23:0 (Tricosanoic)	11.9±0.7

¹ Results of analyses in triplicate of three samplings.

Figure 1 show the results from evaluation of the vitamin C stability (ascorbic acid), which showed small variations, instead of being one of the nutrients most sensitive to oxidation. It can still be noticed, that the largest variations occur in the first 28 days of the analysis. This fact can be explained considering a possible oxidation, caused by the presence of oxygen in the flasks in which the pulp was stored. These flasks were sealed without the elimination of oxygen, in the attempt of reproducing the conditions in which the product is usually conserved. Visentainer, Vieira, Matsushita and Souza (20) working with Barbados cherry stored in freezer, observed losses of 1.30% of vitamin C in pasteurized samples at end of 40 days. In this work, for the same time storage the vitamin C loss for samples *in natura* was of approximately 23%. The vitamin C content, during the storage of the camu-camu decreased to 1.16g/100g (26% of loss) up to 100 days, being constant until the end of the storage.

FIGURE 1
Vitamin C stability in stored camu-camu pulp



CONCLUSIONS

Camu-camu it is a natural source of vitamin C. Regarding the vitamin C, it can be observed that the camu-camu produced in Paraná state presented a smaller content than the one native of the Amazon region, possibly due to the different conditions of development of the plant, and consequently of the fruit, as well as the climatic variation, the humidity and the soil characteristics, that might also have influenced the results obtained for the minerals.

Concerning the vitamin C stability in the frozen camu-camu pulp, it can be said that there was a decrease in its concentration until the 28th day, staying approximately constant from the end of the experiment, and after 335 days of storage, the content was approximately 1.16g for 100g of pulp. This content was higher than the one found for most fruits that are sources of this vitamin.

The composition in fatty acids is important from the nutritional point of view, camu-camu possesses a high PUFA/SFA ratio, and therefore a high PUFA percentage. However, camu-camu does not present a significant lipids content.

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