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ANTIOXIDANT CAPACIDANT AND BIOACTIVE COMPOUNDS AND HEALTH BENEFITS OF CAMU-CAMU PUREE (Myrciaria dubia (H.B.K) Mc Vaugh)

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ABSTRACT

Camu-camu (*Myrciaria dubia*) H.B.K.) Mc Vaugh) fruits are promising sources of various bioactive compounds such as vitamin C, phenolic compounds and carotenoids. Camu-camu is a fruit native to the Amazon region and is considered the greatest natural source of vitamin C worldwide are also good sources of dietary fiber, potassium, iron, calcium, and various kinds of amino acids such as serine, valine and leucine. Therefore, the presence of different bioactive compounds in camu-camu fruits could be used to retard or prevent various diseases chronic non-communicable such as dyslipidemia, obesity such as cardiovascular and cancer. The objective of this study was to analyze pulp camu-camu evaluate their nutritional composition (lipids, proteins, minerals, vitamins and fiber).Camu-Camu puree with great antioxidant capacity, 3486µmol TE/g. It is also very rich in vitamin C (1946 mg/100g), calcium (8.64 mg/100g, dietary fiber (1.69 g/100g). Camu-camu is also an excellent source of other bioactive compounds, such as minerals and other phenolic compounds. In conclusion, camu-camu can be used to introduce bioactive compounds into food products and to delay or prevent many human diseases.

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INTRODUCTION

Fruits are essential for sound health. Consumption of fruits has been increased because of their high content of bioactive compounds. The most common bioactive compounds are vitamin C, polyphenol, β-carotene and lycopene contents. In recent years, there has been a global trend toward the use of natural phytochemical as antioxidants and functional ingredients, which are present in natural resources such as vegetables, fruits, oilseeds and herbs, (Kaur and Kapoor, ,2001 and Aguiar & Souza, 2015). Natural antioxidants from plant extracts have attracted considerable attention due to their safety. Polyphenol compounds such as anthocyanins, flavonoids and phenolic acids are responsible to reduce oxidative stress (Inoue *et al*., 2008 and Liu *et al*., 2008). It has already been proven that different exotic fruits such as cubiu (Solanum sessiliflorum), açaí (Euterpe precatória), carambola (*Averrhoa carambola*) and taperebá (*Spondias mombim*) (Aguiar & Souza, 2014) significantly reduced the plasma lipids (total cholesterol, low-density lipoprotein cholesterol and triglycerides). Camu-camu fruits are rich in polyphenols which could be used to retard or prevent various human diseases. However, there are few evidence in *in vivo* studies on the polyphenol of camu-camu fruits. Camu-camu (*Myrciaria dubia*) H.B.K.) Mc Vaugh is a member of the Myrtaceae family and it is native to the Amazon region. Camu-camu is an important source of nutritional antioxidant, vitamins C, β-carotene, and phenolic compounds (Chirinos *et al*., 2010). Camu-camu fruits are considered the richest natural source of vitamin C worldwide (Aguiar & Souza, 2015). Bioactive compounds in camu-camu fruits are not only responsible of vitamin C but also responsible of other compounds such as phenolic compounds and β-carotene contents (Chirinos *et al*., 2010,). Camu-camu fruits are also good source of potassium, iron, calcium and phosphorous and various kinds of amino acids such as serine, valine and leucine (Aguiar & Souza, 2015). Japan and the European Union are the main export markets for products such as cellulose, extract and juice. Camu pulps are used as ice cream and puree. Camu whole fruit and slices can be used to make dried products. It appears that the

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fruits are promising sources of bioactive compounds that could be used as functional food not only in the Amazon, but also throughout the world. Therefore, the objective of this study is to provide existing information of the chemical composition and phytochemicals in promoting health, especially vitamin C, polyphenols and β-carotene in the fruit of the camu-camu.

MATERIAL AND METHODS

The study camu-camu was collected manually during the ripening stage in Rio Branco, Roraima (RR), in a region called Santa Izabel de Boiaçú, municipality of Rorainópolis, RR, with the following geographic coordinates: 0˚23'27.3"S to 61˚48'22.5"W. The fruits were placed in sterile plastic bags and transported to the Physical and Chemical Food Laboratory (LFQA) of the Society, Environment, and Health Coordination (COSAS) of the National Research Institute of Amazônia (INPA). The shape of the camu-camu fruits is round and the diameter and length are 1.0 to 3.2 cm and 1.2–2.5 cm, respectively and all camu-camu samples were homogenized in a blender before the physical and chemical analyses (Figure 1), to quantify fiber, protein, cholesterol, sugar, moisture, ash, polyphenols, minerals, fatty acids, lipids, some vitamins, and antioxidants. The moisture, ash, protein, lipid and cholesterol, contents of the camu-camu were analyzed three times as recommended by AOAC, 2005 and sugar also three times as recommended by Mason and Slover, 1971. Soluble and insoluble fiber contents were determined by the method proposed by Asp *et al*. 1983. Vitamin C, carotenes content was measured three times by high-performance liquid chromatography (HPLC) following the method proposed by AOAC, 2005. Calcium, sodium, potassium, magnesium, manganese, iron, zinc, and copper contents were determined by digesting the sample (CEM Coorporation, model MD-2591) and reading the solution with an atomic absorption spectrometer (Variam Spectra AA, model 220 FS). Antioxidant capacity was determined as recommended by Brand-Williams, Cubelier, and Berset, 1995 using 2,2-dyphenyl-picrylhydrazil (DPPH). Ten grams were extracted with 100 ml of 60% ethanol under constant stirring at 30˚C for 24 hours. The extracts were filted by filter paper number one and the fluid portions were analyzed for antioxidant content. The absorbance was read three times at 515 nm, and the antioxidant capacity was calculated as μmol of Trolox equivalents (TE) per gram.

RESULTS AND DISCUSSION

The contents antioxidante capacity in camu camu fruit presente in Table 1., and extremely high antioxidant activity, 3486 μmol TE/g. The ripening process is a critical variable in camu-camu bioactive properties, especially with respect to its reduction potential. These results agree with the antioxidant activity measured during ripening. The antioxidant potential may be related to the phenolic composition of the extracts, but other components may also make an importante contribution. Camu-camu fruits are considered the richest natural source of vitamin C in Brazil (Justi *et al*., 2000). Due to their high level of this vitamin, the Camu-camu derivatives such as pulp, extract and juice are extensively exported to Japan and European Union markets (Akter *et al*., 2011 and Chirinos *et al*., 2010). The content of vitamin C is 20 times higher than Acerola and 100 times greater than lemon (Vidigal *et al*, 2011). Due to it high nutritional value, the Amazon Research National Institute (INPA) introduced the seed of Camu-camu in the interior of Brazil, in Minas Gerais, São Paulo and Paraná states (Yuyama, 2011). Nevertheless, Justi *et al*. (2000) observed that the fruit grown in Paraná presented lower content of vitamin C (1400 mg/100 g in the pulp) than the one from the Amazon region (2400–3000 mg/100 g in the pulp). This suggests that different conditions influencing the development of this plant might modulate the levels of bioactive compounds.

Table 1. Nutritional composition of camu-camu puree

Camu-Camu (Fresh Weight)	Ripe
Carbohydrates (g/100g)	5.9
Ash(g/100g)	0.213
Moisture (g/100g)	92.8
Fiber (g/100g)	1.69
Ferro (mg/100g)	0.232
Sodium (mg/100g)	2.49
Calcium(mg/100g)	8.64
Protein (g/100g)	0. 99
β-Carotene (mg/100g)	0.0246
Cholesterol (mg/100g)	Tr
Fructose (g/100g)	0.3
Glucose (g/100g)	0.2
Tiamin (mg/100g)	0.02
Riboflavin (mg/100g)	0.11
Niacin (mg/100g)	0.49
Polyphenols(mg/100g)	1120
Vitamin C (mg/100g)	1946
Saturated Fatty Acids (g/100g)	0.024
Monounsaturated Fatty Acids(g/100g)	0.039
Polyunsaturated Fatty Acids (g/100g)	0.013
Total Fatty Acids (g/100g)	0.135
Antioxidant Capacity(μmol TE/g	3486

Figure 1. Camu-Camu ripe fruits

Furthermore, Chirinos *et al*. (2010) reported that total phenolic contents in Camu-camu depend on the maturity stages..Different types of polyphenols such as anthocyanins (cyanidin-3-glucoside and delphinidin-3-glucoside), quercetin, quercitrin, rutin, myricetin, naringenin, catechin, kaempferol, ellagic acid and eriodictyol are found in Camu-camu fruits (Akter *et al*., 2011, Chirinos *et al*., 2010, Reynertson *et al*., 2008 and Rufino *et al*., 2010). The total phenolic content of dried Camu-camu is 1161 mg GAE/ 100 g DM (Akter *et al*., 2011) (Table 2). The ellagic acid and flavan-3-ols groups represent the main phenolic compounds in this berry (Chirinos *et al*., 2010). According to Rufino *et al*. (2010) the total polyphenols in aqueous-organic extracts is higher in Camu-camu fruits (11.615 mg GAE/100 g DM) when comparing

with Acerola and Jaboticaba (10.280 and 3584 mg GAE/100 g DM, respectively). On the other hand, the total anthocyanins (42.2 mg/100 g FW). Different methods such as DPPH, 2,2-azinobis (3-ethylbenzothiazoline-6-sulfonic) acid radical (ABTS) and ferric reducing antioxidant potential (FRAP) are used to determine the antioxidant capacity of this fruit. According to Rufino *et al*. (2010), Camu-camu exhibited higher antioxidant capacity than Açaí, Acerola, Jaboticaba and Jambolão when used ABTS (153 µmol Trolox/g of fresh matter) and FRAP (279 µmol Fe2SO4/g FW) assays. In addition, Chirinos *et al*. (2010) reported a positive correlation between total phenolic content and DPPH antioxidant capacity (r^2 = 0.931) but not between ascorbic acid levels and DPPH antioxidant capacity (r^2 = 0.190), suggesting that the antioxidant capacity of the fruit is derived mainly from phenolic compounds. These results demonstrated that the vitamin C-rich fraction was the major contributor to the total antioxidant capacity of camu camu fruit despite the high losses incurred. Nutritional compositions of camu-camu fruits are shown in Table 1. are good source of minerals such as sodium, potassium, calcium, zinc, magnesium, manganese and copper. It also contains small amount of Glucose and fructose are the major sugar for camu-camu fruit. In addition, camu-camu pulps also contain different kinds of fatty acids monousaturated, saturated and polyunsaturated are presented into ripe and unripe. Kaneshima *et al*., (2016) this study exhibited stronger antioxidant activities measured by both single electron transfer assays and a hydrogen atom transfer assay than gallic acid and ascorbic acid. The peel and seeds of camucamu are industrial waste products from the production of camucamu juice, thus, applications of the seeds and peel as functional foods and food additives may be beneficial for the camu-camu industry. The extract of camu-camu seeds and peel showed potent 1,1-diphenyl-2- picrylhydrazyl (DPPH) radical scavenging activity (IC50 ¼ 32.2 mg/ mL), and C-glycosidic ellagitannins, vescalagin (2) and castalagin (3) were shown to be responsible for the DPPH radical scavengingactivity (Kaneshima *et al*., 2013). Many researchers have already considered that camu-camu fruits are a good source of vitamin C, and what we find in the of 1946 mg/100g fresh matter of Vitamin C. (Table 1). According to Chirinos *et al*. (2010) the vitamin C of camu-camu fruits depends on the maturity stages. Vitamin C content in camu-camu was higher than other traditional Brazilian fruits such as acerola (1053 mg/100 g fresh matter), acai (84.0 mg/100 g fresh matter) (Rufino *et al*. 2010). Fiber contents (Table 1.) are also very high, making camu-camu a good natural source of these nutrientes, 1.69g/100g. Studies have shown that high-fiber diets have great therapeutic potential against dyslipidemia, cardiovascular diseases, and some types of cancer. Fibers also decrease intestinal transit time and glucose absorption, with consequent lowering of glycemia and blood cholesterol. Further studies are necessary to elucidate the overall potential of this fruit.

Conclusions

Camu-camu fruits are excellent sources of different bioactive compounds, such as vitamin C, fibers, minerals, and phenolic compounds. Camu-camu fruits show high antioxidant capacity as compared to other fruits. In conclusion, camu-camu fruits can be used to increase the amount of bioactive compounds in food products and to delay or prevent many human diseases.

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