Effects of Spray-Drying Parameters on *In Vitro* Functional Properties of Camu-Camu (*Myrciaria dubia* Mc. Vaugh): A Typical Amazonian Fruit

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Abstract: Camu-camu (*Myrciaria dubia*) fruit is a rich source of bioactive compounds but its shelf life is rather short. Therefore, this study was aimed to evaluate the effect of inlet air temperature (*T*) and concentration (*C*) of maltodextrin and arabic gum on the spray-drying process of commercial camu-camu pulps (São Paulo and Manaus). Moisture, solubility, total phenolics (TP), ascorbic acid (AA), and proanthocyanidins (PAC) contents, and *in vitro* antioxidant capacity of the powders (FRAP, DPPH, Folin–Ciocalteu's reducing capacity were measured). Arabic gum resulted in better yields (22% to 30%), powder solubility (84% to 90%), and lower losses of analyzed compounds than the powders manufactured with maltodextrin. Overall, inlet air temperature had a lower impact on the responses studied than the concentration of carrier agents. Polynomial equations were generated for AA ($R^2 = 0.993$), TP ($R^2 = 0.735$), PAC ($R^2 = 0.946$), and for the antioxidant capacity assays ($0.867 \leq R^2 \leq 0.963$). In addition, principal component analysis showed that the lowest concentration of carrier agents (6%) in spray drying resulted in the lowest losses of bioactive compounds and, consequently, the highest antioxidant capacity.

Keywords: antioxidant capacity, freeze-drying, functional food, PCA, phenolics

Practical Application: Camu-camu powder, which is rich in bioactive compounds and antioxidant properties, is an alternative source of functional ingredients for commercial use. It may be added in pharmaceutical manufacture, or in food processing, to meat, bakery and dairy products. Here we presented the effects of some spray-drying conditions, that is, inlet air temperature and concentration of maltodextrin and Arabic gum, on the bioactive compounds and antioxidant capacity of powders. Food industry may use our results as a guide to develop new potentially functional ingredients.

Introduction

Diets rich in fruit have been studied for their potential beneficial effects on the risk of cardiovascular disease, diabetes, cancer, and strokes (Crozier and others 2009). Their high content of phytochemical compounds, mainly polyphenols, has been associated with their health benefits (Espín and others 2007). Camu-camu (*Myrciaria dubia*) is originally from the Amazon rainforest but spread to others states; nowadays, it can be found in almost all states in Brazil. This fruit has high levels of ascorbic acid and polyphenols (flavonoids and ellagitannins), and with significant *in vitro* and *in vivo* antioxidant capacity (Inoue and others 2008; De Souza and others 2010; Akter and others 2011; de Azevêdo and others 2014).

Although camu-camu fruit is consumed locally, it has promising perspectives for agro-industrial purposes. The fruit has a disadvantage to be highly perishable (around 1 wk), which makes the transportation chain more complex and expensive. One alternative to keep the bioactive compounds is dehydration, which is an important method of processing the fruit to extend its shelf life (Vinson and others 2005; Bennett and others 2011; Verma and Singh 2015). Dried fruits are widely consumed all over the world due to their versatility and many technological applications. In this sense, we have been studying different drying process. Previously, the effect of spouted bed-drying on phenolic compounds and bioactivity of camu-camu was assessed (Fujita and others 2013). Another method is spray-drying, which is used in the food industry because of its low cost and wide equipment availability (Koga and others 2016; Santana and others 2016). Microencapsulation by spray-drying has been successfully used not only to increase solubility and production yields, but also to avoid chemical and/or biological degradation and to concentrate bioactive compounds (Gouin, 2004; Dias and others 2015; Laokuldilok and Kanha 2015; Sormoli and Langrish 2016).

As well-known camu-camu has very high vitamin C contents, therefore, many studies evaluated mainly, ascorbic acid (Alves and others 2002; Yuyama and others 2002; Dib Taxi and others 2003; da Silva and others 2005; Chirinos and others 2010). However, in the recent years, a high polyphenolic content has been reported in camu-camu fruit pulp (Rufino and others 2010; Fracassetti and others 2013; Bataglion and others 2015; Neves and others 2015). Thus, there is a clear lack of studies regarding the effect of spray-drying process conditions on those bioactive compounds. According to previous studies, carrier agents are necessary to spray-drying fruit juices, such as Arabic gum, agar, alginate, carbohydrates, maltodextrin, carboxymethylcellulose and others (Favaro-Trindade and others 2008; Dias and others 2015; Verma and Singh 2015). In this study, maltodextrin and Arabic gum were chosen as carrier agents. Maltodextrin is very common and popular in spray drying process and also represents an inexpensive

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