

Xique-Xique Juice Functional Beverage

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Food market interest for functional beverages has increased in the last years, especially for those elaborated with unconventional matrices, such as exotic fruits, succulent plants and cacti. Xique-xique (*Pilosocereus gounellei*), from the Cactaceae family, is a species endemic from Brazil, with a large potential for prospection of bioactive compounds. Therefore, this study aimed to elaborate a potentially functional beverage with xique-xique cladode juice, and to evaluate its physicochemical parameters, phytochemical profile and antioxidant properties.

Keywords: cactus ; functional beverage ; physicochemical characteristics ; bioactive compounds ; antioxidant activity

1. Overview

The search for functional products and their diffusion in the food market have increased in the last years mainly due to the growing incidence of chronic non-communicable diseases and the raising awareness of consumers about the relationship between diet and health, leading to a high demand for healthier foods^{[1][2]}. The world market for functional beverages is expected to grow around 7.8% by the year of 2022, being the fastest growing category among the functional foods^[3]. Some studies have focused on the investigation of unconventional matrices as new sources of bioactive components, such as exotic fruits, succulent plants and cacti, envisaging their use to the development of new functional beverages^{[4][5][6]}.

2. Xique-xique

Xique-xique (*Pilosocereus gounellei* A. Weber ex K. Schum. Bly. ex Rowl) is an endemic plant species from Caatinga biome in Northeastern Brazil, being still an underexplored non-conventional plant food^[7]. This species is widely used by population from this region in folk medicine, being its roots, flowers, fruits and cladodes commonly used for the treatment of urethra and prostate inflammation^[8], constipation^[9], gastritis^[10] and jaundice^[11]. Xique-xique has been also used for human consumption, being its fruits consumed in natura, while the cladodes are used for the production of candies, flour, bakery products and juices^{[9][12][13]}.

Early studies have found a variety of bioactive compounds in xique-xique cladodes, such as phenolic compounds, flavonoids and betalains^{[7][14]}. The contents of these bioactive compounds in xique-xique, especially of phenolic compounds, have been shown to correlate with its high antioxidant capacity. Soluble and insoluble fibers have been also found in xique-xique cladode juice^{[15][16]}. The consumption of xique-xique cladode juice was reported to have protective effects toward intestinal inflammation and decrease oxidative stress in rats with inflammatory bowel disease, besides of having no evident toxic effects^[16]. The results of these studies indicate that xique-xique could be safe for human consumption and a promising raw material to formulate potentially functional foods and beverages.

3. Findings

Four beverage formulations containing xique-xique, passion fruit and lime juice and sweetened with sugar cane syrup were developed in order to investigate its physicochemical parameters, content of total carotenoids, flavonoids and phenolic compounds, profile of phenolic compounds and antioxidant activity, during 21 days of refrigerated storage.

Regarding the beverages physical and physicochemical characteristics, an increase in pH values and increase in titratable acidity were found through the storage period in all beverages formulated. Beverages elaborated with different concentrations of xique-xique juice (B30, B40 and B50) were less acidic when compared to the control beverage (CB), that did not contain xique-xique juice. Beverages formulated with xique-xique juice had also higher values for total ash,

especially B40 and B50, which indicates a high content of minerals. A previous study found high contents of potassium, magnesium and calcium in xique-xique cladode juice^[17]. Therefore, it could indicate that the addition of xique-xique cladode juice to the beverage formulations contributed to the higher mineral contents found in these beverages.

Beverages with higher contents of xique-xique juice also showed better results for the investigated bioactive compounds. The highest content of total phenolic compounds, total flavonoids and total carotenoids were found in B50, which was the formulation with the highest concentration of xique-xique cladode juice. These compounds are widely associated with anti-inflammatory, antimicrobial and antioxidant effects, when consumed in a diet with adequate amounts^{[16][17][18][19]}.

Phenolic compounds profile was also investigated in formulated beverages, where a total of 18 compounds were identified, among them flavanones, flavonols, flavanols, anthocyanins, hydroxybenzoic acids, hydroxynamic acids and polyphenols. Myricetin, epigallocatechin gallate, epicatechin gallate, kaempferol and procyanidin A2 were the most prevalent phenolic compounds in the examined beverage formulations. The B50 formulation had higher procyanidin A2 content when compared to CB, indicating that this compound could be found in higher contents in xique-xique cladode juice. Procyanidins are phytoalexins found in vegetables and fruits have been related to antioxidant, anticancer, antibacterial, anti-inflammatory, cardioprotective and immunomodulatory effects^[20].

The formulated beverages antioxidant activity was determined with FRAP and ABTS methods. In both methods, the beverages formulated with xique-xique cladode juice had higher antioxidant activity when compared to CB. When determined by FRAP method, the formulations B50 and B40 had the highest antioxidant activities. Similar results were found with ABTS assay, where B50 had the higher radical scavenging activity on days 1 and 7 of storage, while B40 had the higher radical scavenging activity on days 14 and 21 of storage.

4. Conclusions

The results of this study indicated significant variations in the measured physicochemical and phytochemical parameters among the four beverages formulated through refrigeration storage time, where beverages with xique-xique cladode juice had lower acidity, and total soluble solids and total sugar contents when compared to CB. Beverages formulated with xique-xique cladode juice had overall an increased content of total flavonoids, total carotenoids and total phenolic compounds, as well as a higher antioxidant activity when compared to CB during 21 days of refrigeration storage. The beverage formulation with the highest concentration of xique-xique cladode juice had the best results regarding the contents of total ash, total flavonoids, total carotenoids and total phenolic compounds and antioxidant activity, indicating its potential as a new functional mixed beverage. Further investigations, such as in vivo analysis, could improve the development of the proposed xique-xique cladode mixed beverages and their insertion in food market as a potentially functional product with health-related properties.

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