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Use of Passion Fruit's Albedo as a Source of Pectin to Produce Araticum (*Annona crassiflora* Mart.) Preserves

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Several Cerrado's fruits with economic potential are consumed *in natura* or processed around the country, however, few data are available in the specialized literature regarding the chemical composition of these fruits and its technological application. Due to this, there is a need for scientific research on these cerrado´s fruits and its functional value. In the food industry, the juices production and other productions that use fruits as raw material generate a significant residue amount, which have technological and nutritional potential. Because of thatthe objective of this present work was to characterize Araticum fruit (*Annona crassiflora* Mart.), as well as optimazing the this fruit process in the form of Araticum preserve, using passion fruit´s albedo, discarded as waste by the industry, as a source of pectin. For characterization, moisture analysis, total soluble solids, titratable total acidity, vitamin C, lipid content, protein, total dietary fiber, reducing and non-reducing sugars and antioxidant activity were carried out by the DPPH method. For processing, were used a 2^3 factorial design complete with three center points. The Araticum, presented low acidity, soluble solids at about 24 °Brix and moisture of 60%. The value of ascorbic acid found for the fruit was 58.11 mg /100 g of fruit, whereas the lipid content found in Araticum was 2.83%, that is, they are not fruits with a high fat content for a low calorie diet. The antioxidant activity was 27.19 mg of DPPH/g of fruit. During the optimization, it was observed that the best formulations, in terms of obtaining Araticum preserve with higher concentrations of protein, vitamin C, fibers, and of higher yield are those with high concentration of citric acid and the higher pulp/sugar ratio.
Keywords: Cerrado, Araticum, New Product, optimization.

1. Introduction

Araticum (*Annona crassiflora* Mart.) is a native fruit from Brazilian's Cerrado. This fruit species has great social and economic potential. Research on native cerrado fruits is scarce and may be of great importance for a natural and sustainable use of its potential (De Melo, 2015).
The formulation of fruit preserves is an option for using surplus fruit adding value to the products. This type of processing can also be used as a way to consume seasonal fruits all year round (Oliveira, 2018).
The increasement on demand for products that combine nutritional aspects, quality and prolonged shelf life has led the food industry to become gradually involved in the development and optimization of new food formulations (Cunha, 2016).
During the production of passion fruit juice (*Passiflora edulis*), a significant organic waste amount is generated, which has enormous potential and can be used as raw material in the production of co-products with technological and functional application in the food industry (Uehara et al., 2017).
Thus, the objective of this work was to characterize Araticum fruits (*Annona crassiflora* Mart.), as well as optimizing the Araticum preserves process replacing industrial pectin by a natural source.

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2. Material and methods

The fruits were obtained from the Brazilian's Cerrado, selected according to the state of maturation and conservation.

For the fruits characterization were done this following analysis according to the methodologies described by Adolfo Lutz Institute (2008) and AOAC (1992): centesimal analysis, pH, titrable acidity, vitamin C, reducing and non-reducing sugars. It was also evaluated the antioxidant capacity of fruit extracts by reducing the stable radical DPPH (1,1-diphenyl-picrylhydrazyl), a method proposed by Brand-Williams et al. (1994) and carried out according to the method described by Rufino et al., (2007) modified.

2.1 Experimental planning - Fruit processing

The fruits were submitted to the following processes: debarking / pulping / juice extraction, water addition (if necessary), previous dissolution of pectin, formulation (sugar addition, pectin and acid), concentration at atmospheric pressure, hot filling / closure packaging / storage. Albedo's passion fruit was used as a source of pectin, as described by Silva et. al. (2012).

For optimization of Araticum preserves was used the response surface methodology with complete factorial design 2^3 according to the methodology described by Box and Draper (1987), Table 1, whose purpose is to evaluate the influence of three factors such as citric acid concentration, pulp/sugar ratio and albedo concentration as a source of pectin (independent variables) on (RA), antioxidant activity (AA), vitamin C (VC), soluble solids (SS), protein (PR), total dietary fiber (FB).

Table 1: Experimental design 2^3 for the elaboration of Araticum Preserves.

Testing	**Coded variables**			**Real variables**		
	X_1	X_2	X_3	X_1 (%)	X_2 (m/m)	X_3 (%)
1	+1	+1	+1	1	60/40	3
2	-1	-1	+1	0	40/60	3
3	+1	-1	+1	1	40/60	3
4	-1	+1	+1	0	60/40	3
5	+1	+1	-1	1	60/40	0
6	-1	+1	-1	0	60/40	0
7	+1	-1	-1	1	40/60	0
8	-1	-1	-1	0	40/60	0
9	0	0	0	0,5	50/50	1,5
10	0	0	0	0,5	50/50	1,5
11	0	0	0	0,5	50/50	1,5

Nota: X1= concentração de ácido cítrico (%); X2= razão polpa/açúcar (m/m) e X3= Concentração de albedo (%).

2.2 Characterization of Araticum Preserves

The pH, titratable acidity (TA), non-reducing sugars (TRS), reducing sugars (RS), vitamin C (VC), soluble solids (SS), protein (PR) and total dietary fiber (TF) were conducted according to the methodology described by the Adolfo Lutz Institute (2005) and AOAC (1992). The antioxidant activity (AA), was performed as described by Rufino et al. (2007) modified. For the texture profile analysis of Araticum preserve samples, a Texturometer TA. XT. Plus was used.

3. Results and Discussion

The physicochemical composition of Araticum (Annona crassiflora Mart.) fruits are summarized in Table 2.

Araticum presented low acidity levels, arround 0.5%. According to Cechi, (2003), the organic acids present in fruits influence on taste, odor, color, stability and maintenance of the processed food quality. The soluble solids content has a high positive correlation with the sugar content and, therefore, is generally accepted as an important qualitative characteristic (Aulenbach, 1974; Silva et al., 2003). The value for soluble solids observed was 24° Brix, close to that found by Pinedo et al., (2013). According to Cecchi, (2003), fruit moisture has ability to influence its stability, quality and composition. The moisture found for the Araticum pulp was 60%, an approximate value also found by Pinedo et al. (2013) for the same fruit that was 67%. Ascorbic acid plays several biological functions related to the immune system, formation of collagen, iron absorption, inhibition of nitrosamines formation and antioxidant activity (Vannuchi et al., 1998; Silva et al., 2004). Morais et al. (2017) reported an average value of 5.27 mg /100g of ascorbic acid for Araticum in the mature stage, which was lower than that found (58.11mg /100g). It is understood that changes on the ascorbic acid content on the same fruit are due to different factors or environmental stresses during planting, harvesting and storage. In addition to the maturation fruit stage, which will also influence the ascorbic acid content in the fruit, fruit maturation tends to decrease levels of ascorbic acid (Zamudio, 2009).

Table 2: Physicochemical composition of Araticum fruit.

Characteristics	Averages ± SD
Total acidity (%)	0,63 ± 0,09
Brix (º)	24 ± 0,40
Moisture (%)	60,31± 2,06
Vit C (mg/100g)	58,11± 2,02
Lipids(%)	2,4± 0,78
pH	4,83± 0,01
Proteins(%)	4,78± 0,12
Ashes(%)	0,6± 0,02
Total dietary fiber (%)	9,28± 0,74
Reducing sugars(%)	13,90± 0,16
Non-reducing sugars(%)	7,94± 0,91
Antioxidanty activity (mg/g)	27,19± 2,18

The lipid content found in Araticum was 2.4%. Rocha et al. (2013) in a study on the centesimal composition, energetic value and minerals of several Savannah fruits obtained lipid values such as: 0.3% to Cagaita fruits, 0.3% to Cashew fruits and 1.36 % in the Jatobá fruits. Morais (2017) reported lipid contains of 1.06 % to Araticum pulp. In this way, this fruits being suitable for a low calorie diet. The pH observed on the Araticum pulp was 4.83, similar to pH value found by Pimenta et al. (2014), which was 4.45, on same species fruits. The protein content of Araticum fruits studied in this work was 4.78%. The values of reducing and non-reducing sugar found in this study were 13.9% and 7.24%, respectively. These values were higher than those found in the literature for umbu pulp, which was 4.92% and 5.58% for reducing and non-reducing sugars (Silva et al., 2016). Morzelle, (2015) found for typical Cerrado's fruits such as curriola, gabiroba and murici, antioxidant activity values of 13.69 mg DPPH / g, 49.00 mg DPPH / g and 56.00 mg DPPH / g respectively. The fruits of Araticum, cagaita, cajuzinho, mangaba, lobeira, jurubeba and tucum are expressive sources of antioxidant compounds.

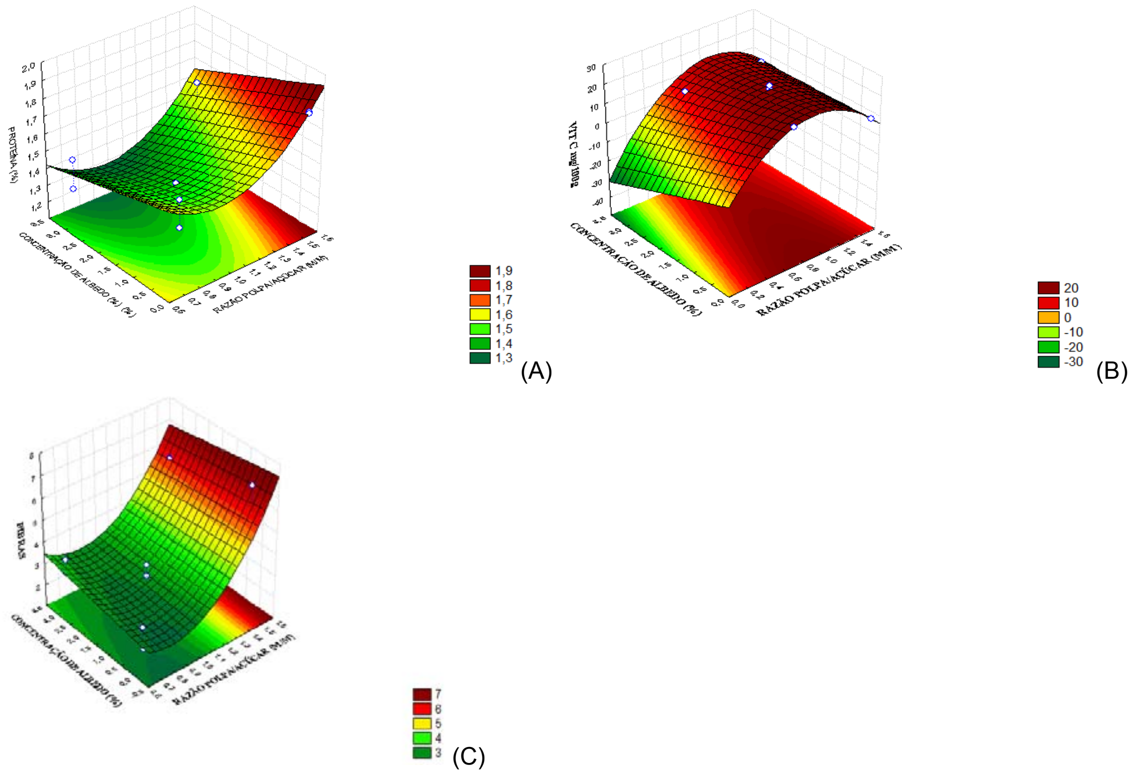

Figure 1: Response Surface Graphs. (A) Protein Analysis, (B) Ascorbic Acid Analysis, (C) Fibers Analysis.

Figure 1 shows the response surface for the protein amount (A), vitamin C (B) and fibers (C) of Araticum preserves. It is noticed that the nutritional characteristics is directly influenced by the pulp / sugar ratio, where in larger pulp amounts the model indicates higher levels of the variables in question, which is explained by the fact that Araticum pulp is the main source from which these characteristics come from. Santana (2012) points out that because it has a high crude fiber content, albedo's passion fruit is an excellent way to add value to the product, increasing the fiber amount, developing products for people who want to increase daily fiber intake.
When the analyzed variables were yield, total acidity, soluble solids and pH, the model indicates that the optimal formulations are those with high citric acid amounts (Figure 2). According to Menezes (2009) the sugar amount added in the formulation of a fruit preserves interferes directly with the percentage of soluble solids indicated to terminate the heating process to which it is subjected, in this way, when the sugar amount at the formulation is higher, less time is used in the baking process of fruit preserves, evaporating less water and increasing the yield. For stable gel formation, it is necessary to obtain an optimum pH and, for this process to occur effectively, it is necessary to obtain pH at the range of 3.2 to 3.5 (Wed, 2016). In this way, it is necessary to add citric acid to the gel formation, providing the cut-off point to the fruit preserves.

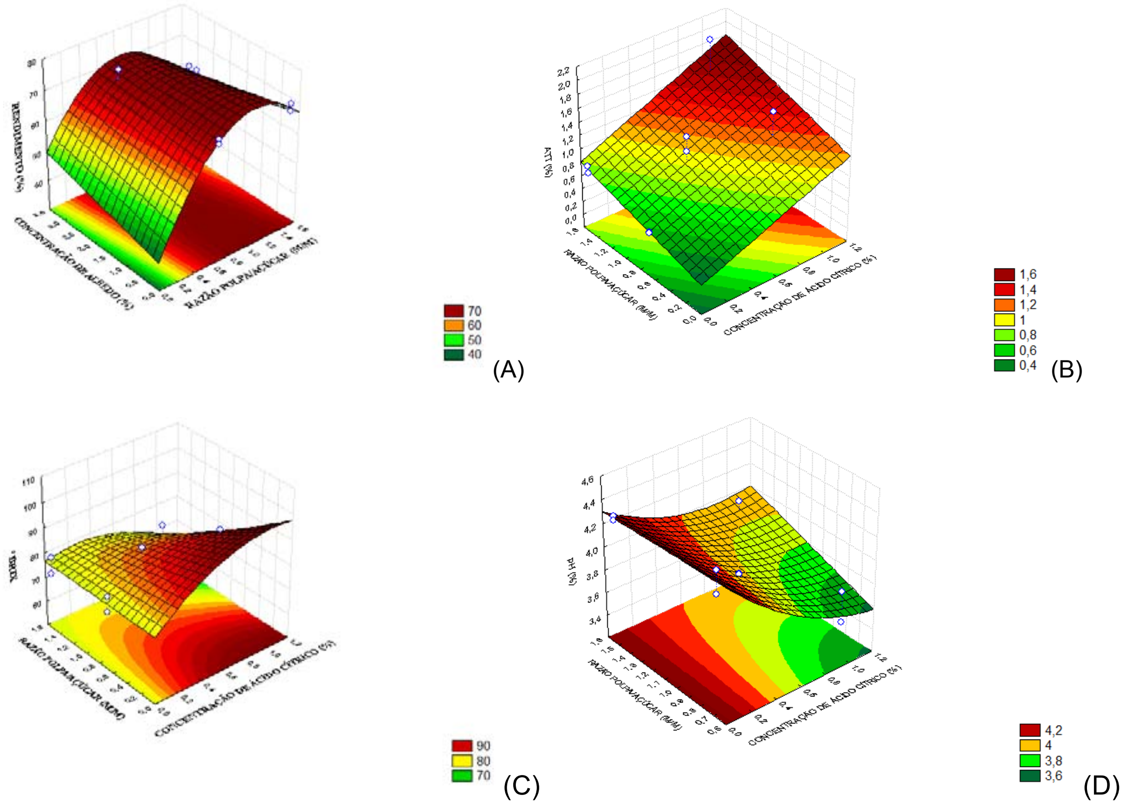

Figure 2: Response Surface Graphs. (A) Yield; (B) Total acidity; (C) Soluble Solids; (D) pH.

The decreasement in the pulp amount and the increasement in the citric acid amount used in the formulations enhanced the reductive sugars contents (Figure 3A). The model also indicates that in relation to reducing sugars, lower pulp content and higher acidity, promoted an increase of non-reducing sugars (Figure 3B). In this work, at the end of the Araticum preserves process, the presence of sucrose was higher than that of glucose which, according to Menezes (2009), indicates a lower degree of hydrolysis in this process, which is desirable for the physical stability. When the texture was evaluated, it was observed that both hardness (C) and tack (D) showed a tendency to increase in the tests where the sugar content was high. According to Soares Júnior et al. (2003), the increasement in the soluble solids content causes an increasement in adhesiveness too, since this fact indicates water evaporation and consequently the pectin hydrolysis.
None of the independent variables studied influenced the antioxidant activity of the Araticum preserves, and the sweetness maintained the approximate values already observed for the fruit before processing.

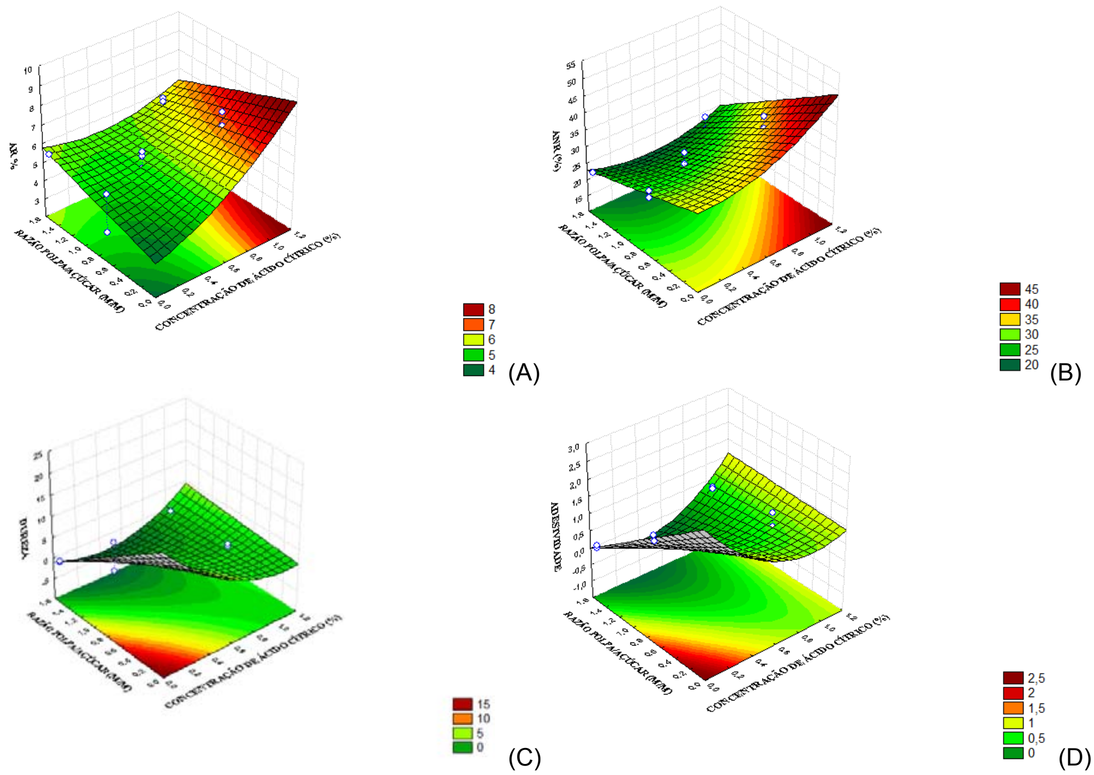

Figure 3: Response Surface Graphs. (A) Reducing Sugars (B) Non-Reducing sugars; (C) Toughness; (D) Adhesiveness.

4. Conclusions

The analyzed fruit presented good soluble solids amount in its sample, making it a fruit with high value for food industry, due to its potential for the production of jams, jellies and ice cream. It has low lipid content, making it suitable for low-calorie diets. The Araticum presented a fruit with expressive antioxidant activity when compared to other fruits.

In order to obtain Araticum preserves with higher percentages of vitamin C, protein and fiber, besides a good yield it is necessary to increase the concentration of citric acid (1%) and quantity of pulp. Thus, the model recommends two optimized versions of Araticum preserves, where pulp / sugar ratio of 60/40 and 40/60, as well as the maximum citric acid concentration.

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