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Technical Note

Palm pulp rheological parameters in function of temperature and content of suspended solids

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Abstract

Açaí and Jussara are typical Brazilian fruits, highly appreciated and nutritionally rich. Besides, since they are perishable products, and it is difficult to extend their lives, beyond the natural fruit consumption it becomes interesting its derivatives consumption in which it is used fruit pulp, which must be submitted to the industrialization processes such as pumping, agitation, pipe transporting and evaporation. In order to make all these stages economically viable, the pulp physical and chemical knowledge is basic. Amongst these properties, the rheological behavior is one of great importance, being useful as quality control measurement and in projects, evaluation and operation of the processing food equipment such as the pumps, agitation, pipes, etc. This work objective was to measure Açaí and Jussara pulps rheological and physical-chemical properties. The results had shown that both pulps presented characteristic composition of the fruits, on the basis of the data found in literature, and pseudoplastic rheological behavior, since the viscosity of both diminished, as the shear tension increased.

Key-words: palm, rheology, viscosity

Introduction

Açaí (*Euterpe oleracea* Mart) is a typical palm from the Amazon Region, whose production is concentrated in the states of Pará and Amazonas, is trade in the other regions only as pulp. Besides having a flavor very appreciated worldwide, it is a refreshing fruit, rich in lipids, vitamin, fiber and mineral salts, with iron with the one with most importance (REIS and GUERRA,1999).

Considered a food with high calorical value, due to the high percentage of lipids, açaí also has high nutritional value, since it is rich in proteins and minerals. In the areas with extractive exploitation, açaí represents the main food base of the population, namely from the riverside dwellers of the region of the Amazon River estuary. The search for fruit pulp for the manufacture of juices, ice-creams and other products have been leveraged due to its peculiar flavor and high energetic potential. These characteristics contribute to the achievement of space in huge national centers, causing a significant increase in the search for the product.

The pulp can be used to prepare juices, candies, ice-creams, vines and liquors, and its consumption is in natura (MORTARA and VALERIANO, 2001; REIS and GUERRA,1999).

The most appropriated process for the exploitation of palm is the sustained management (FLORIANO et al.,1988), which becomes a new source of income of the forest areas and has an important ecological role in the ecosystem (REIS et al.,1993). Thus, besides avoiding the risk of extinction of the species, in its natural state, the income source of hole families which dedicate to the extraction of products from the forest are protected (PEREIRA, 2000).

The demand for açaí in the Brazilian market is expressive, and the product has good possibilities of marked, mainly in Rio de Janeiro, São Paulo, Brasília, Goiás and in the Northeast region. It is estimated that in Rio de Janeiro it is consumed 500 tons/month, in São Paulo 150 tons/month and other stated total 200 tons/month (CARNEIRO, 2000).

From the same family of Açaí, Juçara Palm (*Euterpe edulis* Mart.), also known as Juçara, is found in abundance in the Atlantic Rainforest and also in cerrado, close to the river courses and humid forests, from Bahia to the Rio Grande do Sul, making the direct contact with the fruit easier. Juçara, besides having a much appreciated flavor, is a refreshing and energetic fruit, and since it is rich in lipids present also vitamin A, iron and water (MORTARA and VALERIANO, 2001).

On the other side, one of the great problems of the commerce, either of acaí as Juçara is its characteristic of high perishability, even with refrigeration. According to ALEXANDRE; CUNHA;

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HUBINGER (2004), açaí and Juçara are highly perishable, and its maximum time of conservation is 12 hours, even under refrigeration. The fact responsible for this high perishability is the high microbial load which, together with the enzime degration, is responsible for changes in color and appearance of the sour taste. Currently, the conservation is made trough the process of freezing, which increases significantly the product cost (ILLENSEER and PAULILO, 2002).

It is in this context that there are several trials in reducing the waste, resultant from the great product perishability; among them, it is noteworthy the production of the products derived from the fruit, to which it is used the frozen pulp or the powder product, enabling thus, to make this product available in the market troughout the year, increasing, therefore, its consumption and improving the life quality of the productive families (ALEXANDRE, 2004).

For the manipulation of the different products derived from fruits in the industry of transformation, in general it is used the fruit pulp, which is submitted to the processes of industrialization (pumping, agitation, transport in pipes, evaporation). So that each one of these steps is economically viable, it is fundamental the knowledge of the physical and chemical properties of the pulp submitted to these processes (CUNHA et al, 2008).

For SILVA et al. (2005), among the physical and chemical properties quoted above, the rheological behavior occupies a noteworthy position, and it is useful not only as a measure of quantity but also in projects, evaluation and operation of equipments which process food as pumps, systems of agitation, pipes, among others.

According to PELEGRINE et al. (2000), the importance of the knowledge of the rheological behavior of the food is its use as measure of quality, besides it is indispensible in projects, evaluation and operation of the equipments which process food. Moreover, according to FERREIRA et al (2006), rheological data are of major importance in the economy of energy, which currently has become extremely important so that the operations of exchange of heat and mass are increasingly seen in a more accurate way.

The most recent references reported as the main factors which are responsible for the rheological behavior of the products derived from fruits the fruit type, the temperature and the content of solids as sugar, pectin and fiber. Since all the liquid products derived from fruits are two phase systems composed by solid particles disperse in an aqueous mean, the rheological behavior of them will also be influenced by the concentration, chemical composition, size, shape and distribution of the particles which compose the disperse phase (PELEGRINE and IODELIS, 2008).

The present work had as objective the determination of the rheological and physical-chemical properties of açaí and Juçara pulp, in order to characterize them concerning the apparent viscosity of both properties.

Material and methods

For the determination of the rheological properties of açaí pulp, it was used frost pulp of the fruit, acquired in supermarkets located in the city of Taubaté-SP.

In order to obtain the Juçara pulk, the raw material was acquired in palms located in forests in the region of the Vale do Paraíba. The fruits initially passed through a process of manual selection, discarding the green and spoiled and, after that, they were washed with solution of chlorinated water, peeled and without seeds, besides being sieved for the removal of dirt. Next, they went through the process of bleaching, whose objective was to separate the peel from the pulp, taking advantage of the internal material of the fruits.

This material went through a content removing device (*Model Makanuda*) totally separating the pulp from the peel and seed. It was added water for obtain a more liquid and less viscous pulp. Later, the pulp was pasteurized in order to eliminate any kind of existent microorganisms and with the proper frequency, packed and refrigerated under temperature inferior to 20ºC.

After the performance of the process of obtaining the pulp, it was physic-chemically evaluated, in the Laboratório de Análise de Alimentos (Food Analysis Laboratory) of the Departamento de Ciências Agrárias (Department of Agronomic Sciences) of the Universidade de Taubaté (University of Taubaté) through the following analysis:

-Humidity (A.O.A.C., 1980 - Method 16192);
-Ashes (A.O.A.C., 1980 - Method 16192);
-Total Lipids (BLIGH and DYER, 1959);
-Proteins (A.O.A.C., 1980 – Method 38012);
-pH (ADOLFO LUTZ, N. 4.7.1);
-Soluble solids (ADOLFO LUTZ nº13.6.4);

-Insoluble solids (ADOLFO LUTZ nº13.6.4);
-Pectin (RANGANA, 1977);

It was performed rheological statistic analysis (determination of the pulp viscosity), and the experimental measures were made with a rotational viscosimeter (brand Brookfield Engineering Laboratories), with reading scale of 0 to 100% of torque, easily convertible in value of shear stress through factors of conversion obtained from a table fixed in the viscosimeter.

The experiments were performed in triplicate for each sample, referent to a certain provider, and it was used a new sample for each replication.

The measure system used in this determination was the concentric cylinders, which is composed by two cylinders, considering that only one turns in an angular velocity, while the other remains immobile.

This apparatus maintains a constant rotation speed which corresponds to a certain deformation rate, and the shear stress is obtained through the measure of the torque in the measure cylinder, which remains fixed. Consequently, establishing different angle velocities for the rotation cylinder and detecting the corresponding torque in the measure cylinder, the rheological curves may be obtained for a certain fluid.

Results and discussion

Characterization of the pulp

The lots of the products which were used in the determination of the rheological parameters presented the percent compositions which are characteristics of each product, and the verified results are presented in Table 1.

Table 1. Phisico-chemical properties of the pulps of Açaí and Juçara.

Analysis	Açaí	Juçara
pH	4.62	4.85
Content of soluble solids (º Brix)	4.0	6.65
Insoluble solids (g $100g^{-1}$)	7.81	6.04
% Lipids	3.92	2.20
% Protein	Absent	0.03
Calcium pectate (%)	Absent	0.16
Umidade	92.06	90.22

The analysis referent to the characterization of the pulps of açaí and Juçara were performed aiming at verifying if there is difference of results in the replications. Each value expressed in Table 1 represents the average of the three replications referent to each analysis, for each product, according to what was verified by ALEXANDRE et al. (2004).

Rheological behavior of the pulp

The values of apparent viscosity obtained by different measure systems (different *spindles*) are presented in figure 1, and the values are presented as mean results of the experiment triplicates.

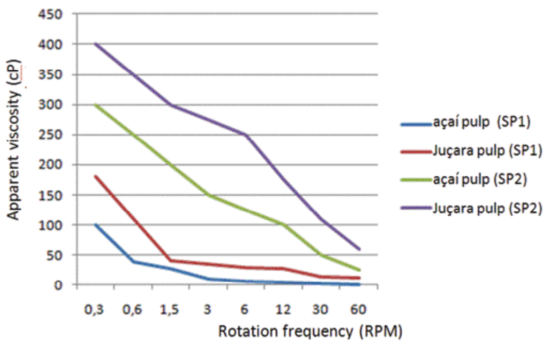

Figure 1. Rheogram of the integral pulps of açaí and Juçara at room temperature.

From the analysis of the results presented in figure 1, it can be verified that the content of soluble soils has great influence in the apparent viscosity of fruit pulp, since the Juçara pulp, which presents higher content of soluble solids according to data from table 1, presented the highest values in the apparent viscosity, for most values of the analyzed rates of deformation.

Probably the content of fat is not the main responsible for the increase in its viscosity, since açaí pulp presented highest values in the apparent viscosity, when compared to Jussara pulp, for the highest values studied in the deformation rate.

Still in relation to the values of apparent viscosity presented in figure 1, it can be verified that either açaí or Juçara pulp presented rheological behavior of pseudoplastic fluid, since the values of apparent viscosity decreased with the increase in the deformation rate, for both measure systems presented. According to data from SILVA et al. (2005), these results are coherent with the results found in other researches, with different fruit pulps.

The pulps from the fruits analyzed present rheological behavior of pseudoplastic fluid probably due to the presence of asymmetric particles in suspension, which in rest present a disordered state, but when submitted to a shear stress, its particles or molecules tend to orientate in the direction of the applied force. The higher the shear stress, the higher the ordination and, consequently, the lower the apparent viscosity (LOZANO, 1994; PELEGRINE, 1999; 2005; SILVA et al., 2005; MORAES, 2006).

In order to view better the influence of the pulp temperature in its rheological properties, figure 2 presents the rheological behavior of Juçara pulp, at room temperature and refrigeration temperature.

Analyzing the results present in figure 2, it can be observed that the temperature also has influence in the apparent viscosity of açaí and Juçara pulps.

The increase of temperature resulted in higher shear stress, for a constant rate of deformation, which reduced the pulp viscosity, increasing the movement of the particles in suspension and reducing, consequently, the product viscosity.

These results obtained are in accordance with the observations made by VIDAL and GASPARETOO (2004) and SILVA et al. (2005), when they analyzed the influence of temperature in the rheological behavior of the pulps of mangoes and acerolas, respectively.

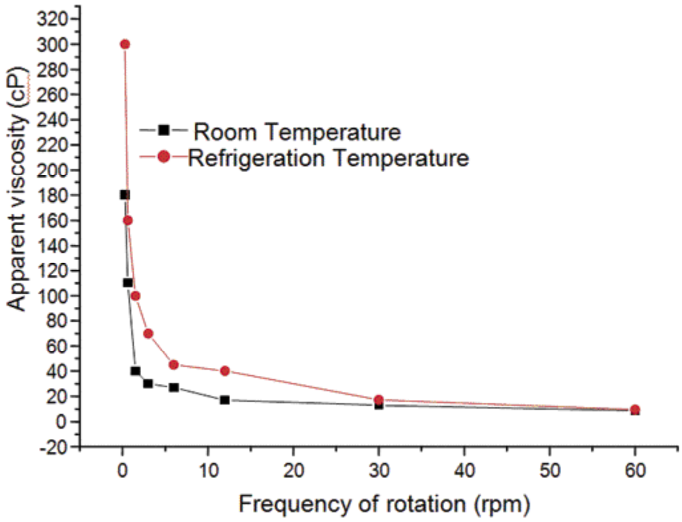

Figure 2. Rheogram of Juçara pulp at different temperatures.

Conclusions

With the conduction of the research it can be concluded that:

- The pulps of açaí and Juçara presented rheological behavior of pseudoplastic fluid;

- The content of soluble soils present in açaí and Jussara pulps are the main responsible for the increase on the value of apparent viscosity of the product;

- The temperature had great influence in the viscosity of the pulp of Jussara, since it decreased considerably when the product temperature increases, from the temperature of refrigeration (approximately 5ºC) for the room temperature (approximately (23ºC).

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