

Water sorption isotherms of spray dried cherimoya puree

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INTRODUCTION AND OBJECTIVE

Cherimoya (*Annona Cherimola*) is a subtropical fruit of warm climates which must be kept at low temperatures to avoid or delay post-harvest damages. Its main disadvantage during processing is the high susceptibility to oxidation at room temperature, which also affects storage. The high sensitiveness to external damage and the consequent large amounts of discarded fruit per year have made the production of cherimoya puree an alternative for this fruit industry. That puree can be used as a raw material in the formulation of dairy products or juices. However, its use as puree has some limitations such as browning due to the rapid oxidation and handling difficulties due to the high viscosity of the puree. Therefore, spray-drying of cherimoya purée arises as one potential solution that can be applied to avoid the problems mentioned.

Water is one of the most important components in food because of its influence on product characteristics and stability. Thus, consideration of the moisture sorption phenomena is essential for better understanding of the drying principles. Moisture sorption data establish the relationship between moisture concentration and partial pressure or water activity. They are important in the field of drying, mixing, packaging and storage of food materials. They also facilitate the determination of the process end-point, at optimal moisture content, necessary to achieve product stability. The knowledge of sorption isotherms is extremely important to the food industry development. They are used for modelling drying process, design and optimization of drying equipment, prediction of shelf-life stability, calculation of moisture changes which may occur during storage and selecting appropriate packaging materials.

The aims of this study were to provide experimental data for the adsorption characteristics of spray-dried cherimoya pulp and to fit such experimental data to different sorption isotherms models.

MATERIALS AND METHODS

A cherimoya preparation was obtained by mixing 150 g of cherimoya purée (homogenized pulp), 275 g of water and 75 g of milk powder, to achieve a total of 500 g. The initial humidity of this preparation was 74%.

For the spray drying process, a Buchi mini spray dryer Model 190 (Flawil, Switzerland) was used. The cherimoya preparation was pumped by means of a peristaltic pump to the atomizer, and a two-fluid nozzle was used to perform atomization with compressed air. The feed temperature and the feed rate were 36.5 °C and 8 mL/min, respectively. Cherimoya purée was spray dried with an air inlet temperature of 155 °C, which decreased during the process to 85 °C. The final product was cherimoya powder with 7.5% of humidity.

A gravimetric technique was used to determine the equilibrium moisture content of cherimoya powder at seven relative humidities (from 4% to 96% approximately) and at five temperatures between 10 and 50 °C. Cherimoya powder samples (1 ± 0.001 g) were placed in previously weighted glass desiccators and dried over a plate at 55 °C under vacuum and over silica gel for two days. Later, the samples were kept in desiccators over sulphuric acid solutions of known concentrations that provide different relative moistures. The desiccators were placed in temperature-controlled oven to get 10 to 50 °C and the samples were allowed to equilibrate until no significant difference in weight was detected (± 0.001 g).

RESULTS AND DISCUSSION

The experimental moisture sorption data for cherimoya puree powder at temperature range studied (10-50 °C) followed the characteristic type III classification, when water is adsorbed a monolayer or multilayers can be formed. This is the typical shape of isotherms of products with high sugar content as observed by Falade (2004) and Vazquez (1999). An increasing trend of moisture content of spray dried cherimoya at all the temperatures studied was observed and agreed with the fact that the higher the value of a_w the higher moisture adsorbed. However, the main reason of the shape observed in cherimoya pulp puree can be related to sugar states during the sorption process, as described by Goula (2008). At low water activities sugars are in crystalline form and water can be adsorbed just to the surface –OH sites of the sugar and it is also strongly bound to polysaccharides pectines and proteins but at higher relative humidity crystalline form of sugars pass to amorphous form and moisture content increased sharper with water activity.

Models fitted for spray dried cherimoya puree were as follows: GAB, GAB modified, Oswin modified, Henderson modified, Chung-Pfost modified and Halsey. Among them, the Henderson modified model (Thomson 1968), represented by the following equation:

$$X = \left(\frac{\ln(1 - a_w)}{-a \cdot (T + c)} \right)^{1/b}$$

(where X is the moisture content, a_w is the water activity and T is the temperature) yielded the best fit ($R^2 = 0.958$), with the following parameters:

$a = 4.04E-3$, $b = -1.28E-2$, $c = 3.81E-1$

The experimental data and the values predicted by the Henderson modified model are represented in Figure 1.

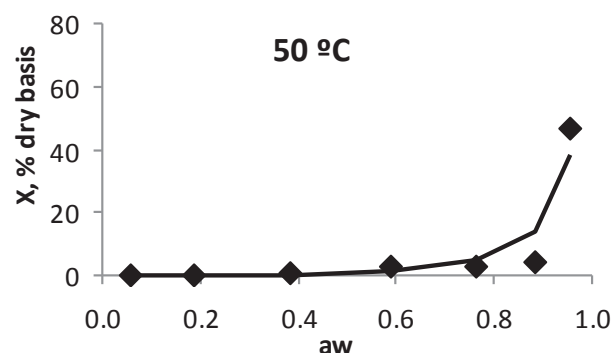
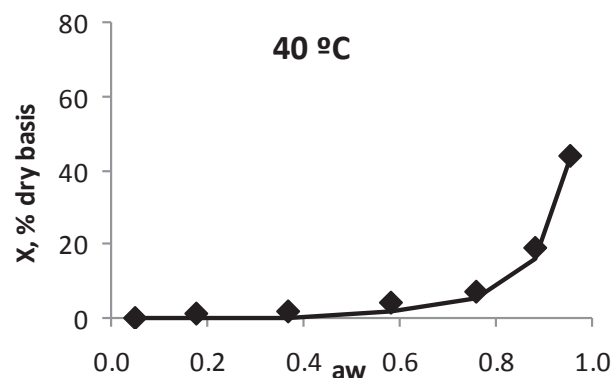
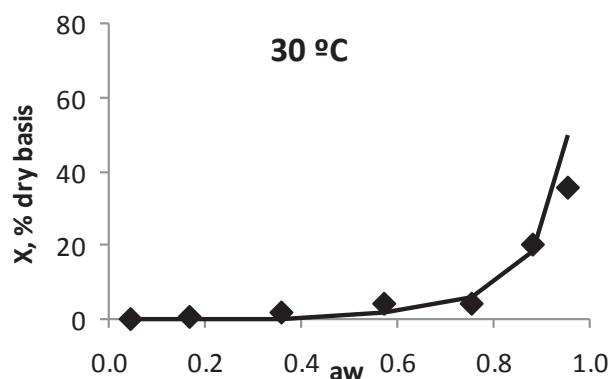
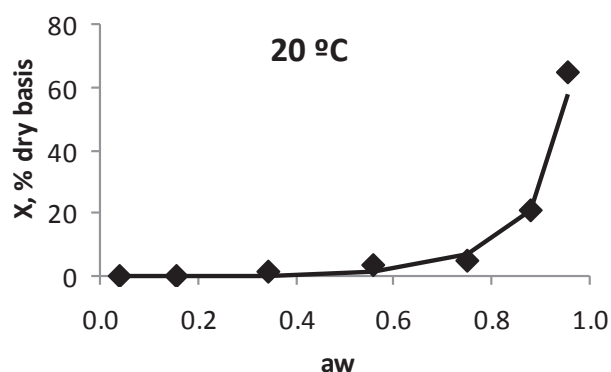
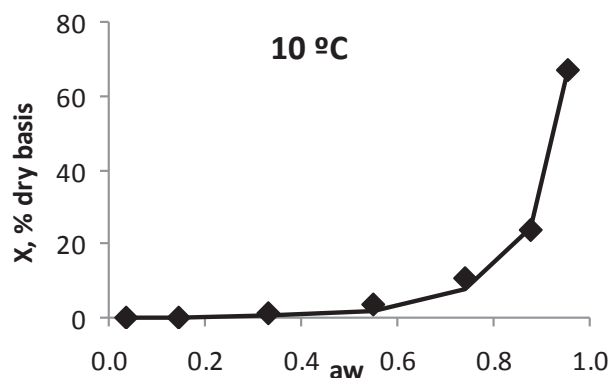


Figure 1 : Sorption isotherms fitted to the Henderson modified model

CONCLUSIONS

Moisture adsorption isotherms of spray-dried cherimoya puree were successfully fitted to the Henderson modified model in the 10 - 50 °C temperature range.

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