Evolution of Ascorbic Acid Degradation During Hot Air Drying of Papaya Maradol (*Carica papaya*).

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Introduction

Papaya (*Carica papaya*) is an important crop widely grown in tropical and subtropical lowland regions, highly accepted worldwide. *C. papaya* is nutritive fruit, rich in vitamins A and C, that presents good organoleptic characteristics and it is fragile and perishable. However, Its fragility is a characteristic that limits large-scale exportation to anothers countries. For that reason, for producers its important keep the quality from harvest to the consumers, and one of the most important techniques used for its conservation is the drying.

The drying is one of the oldest forms of food preservation known to man and is the most important process for water removal from fruit and vegetables and for that, the most frequently method used for the preservation of food (1) Water is one of the main food components and has a decisive direct influence on the quality and durability of foodstuffs through its effect on many physico-chemical and biological changes (2). On the other hand, dry foods have lower costs for storage and transport compared to the fresh food (3).

Conventional air-drying is a simultaneous process of heat and mass transfer, accompanied by phase change (4). The mechanism of drying involves combined heat and mass transfer and, in most cases changes the properties of products (5), these property changes are not just physical but also chemical that in some case are undesirables. In the particular case of fruits, the dried is associated with loss of nutrients (6, 7).

In order to evaluate the severity of the treatment in a drying process has been used indicators of quality. Ascorbic acid is an important nutrient in vegetables, and its degradation has been widely used in food research as an indicator of quality because of its heat labile nature compared to other nutrients in foods (5, 8, 9, 10, 11). Depending on the severity of the treatment, it can cause varying degrees of loss of ascorbic acid during drying and the degradation can be accentuated by the effect of variables involucrated: temperature, air velocity and thickness. For that reason, the aim of this paper was to study the ascorbic acid degradation during drying, with a model that describes it depending of the variables process.

Materials and Methods

C. papaya samples were acquired on a local supermarket of Veracruz, Ver. Mexico. Drying kinetics were realized at two air velocities 1.5 y 2.5 m/s. The thickness of the slices fruit employed were 1.0 and 1.5 cm; the kinetics of degradation of ascorbic acid were realized at four temperatures (40, 50, 60 y 70ºC), each experiment was performed in duplicate, during process was evaluated the ascorbic acid content at specific times. Convective dryer (APEX model SSE17M) was used, which has an operating range of 40 to 120ºC with a maximum air speed of 2.5 m/s.

Destructive samples were obtained every 30 minutes for the first 3 hours, then every hour until to obtain a constant water activity during drying convective. The ascorbic acid content was expressed as a differential of concentration in relation to initial concentration. Ascorbic acid content was expressed as a differential of concentration in relation to initial concentration and a quotient concentration in time was established. Rate constant were determined with natural logarithm of the quotient concentration by slopes method.

Temperature samples were considered together with all dates, a matrix was created and by lineal estimation the model was obtained.
The ascorbic acid (AA) content was determined by HPLC and the moisture content was determinated by AOAC 1980 method (12). The HPLC system was constituted by a Varian Star 8800 pump. The run flow rate was 0.7 ml/min, with KH_2PO_4 1 % as the movil phase. Reverse-phase separation was attained an LC 18 column (150 mm 4.6 mm). The wavelength detection was read at 254 nm, using a waters 2487 UV detector. Samples were filtered through a 0.2 µm sterile acrodisc (Millipore) before into injection into the HPLC. The injection volume for each run sample was 50 µl. Samples were run by triplicate This data were analyzed, according to statistics analysis, the result showed that the variable which one most affected the degradation of ascorbic acid during drying convective, was the temperature. Simply first order degradation has been used for describing ascorbic acid degradation. A first order kinetic was assumed in order to evaluate the rate constant degradation, where the constant k was evaluated to different steps during kinetics for every time according to Arrhenius model.

Result and Discussion

Constants evaluated at different levels of moisture and temperatures (during every kinetics one) were adjusted with a linear regression to a model type Arrhenius (with a linearization for logarithmic transformation) to obtain the following:

$$\ln K = \ln Ko + \beta_1 \ln x + \beta_2 \frac{1}{t} + \beta_{1,2} \frac{X}{T} \qquad 1$$

Where the constant rate, K ($\min^{-1}$), X and T are moisture (g. gss^{-1}) and temperature (K) of the product, respectively. The equation 1, predicted a decrease on constant value while moisture was decreased, it behavior was observed by another investigators (9, 10), one example show when $X = 0.8$ y $T = 320$ K the result obtained is $k = 0.0020\ \min^{-1}$. These values are in the magnitude order as reported Goula and Adamopoulos (9) of $k = 0.0012\ \min^{-1}$ to $X = 0.8$ and $T = 323.15$ K in tomatoes, and by Uddin *et al*. (13) of $k = 0.00160\ \min^{-1}$ to water activity 0.81 and $T = 323.15$ K in kiwi. The effect of the air velocity it was not significant, this could be explained because a high air velocities produces an increase of temperature in the sample. In the table 1, as we can see there are shown the values of the parameters obtained, and with that there were calculated the constant rate in the process.

Table 1. Parameters of the model

Model	Parameters
$\ln K = \ln K_0 + \beta_1 \ln x + \beta_2 1/t + \beta_{1,2} X/T$	$\beta_1 = 0.255$ $\beta_2 = 2368$ $\beta_{1,2} = 191098$

The experimental results are presented in the figure 1, experimental data were analyzed with rate equations of different orders, and a first order equation is found to provide the best fit to describe the degradation of ascorbic acid under drying process. According to the experimental results, the ascorbic acid content decreases while the process going on and the deterioration rate has been found to be maximum at high levels of temperature.

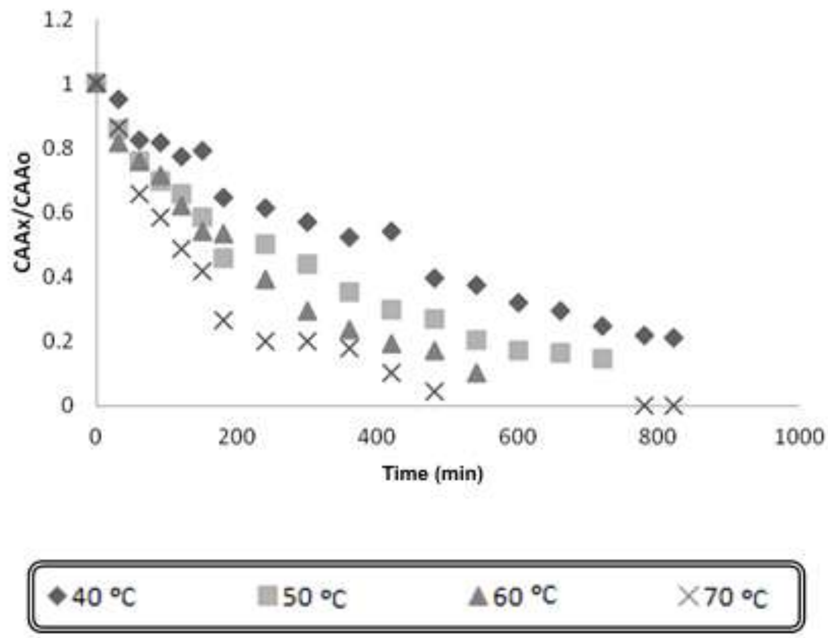

Figure 1. Experimental kinetics of ascorbic acid degradation at 40, 50, 60 and 70°C with thickness slices of 1.0 cm.

Figure 2, shows the drying kinetics obtained at 60 °C and air velocity of 1.5 m/s, the performance of the model vs experimental conditions was compared; the results showed a good prediction for the model. A continue line represents the performance of the model, in all cases studied it predicted adequately the degradation of ascorbic acid in papaya during drying process.

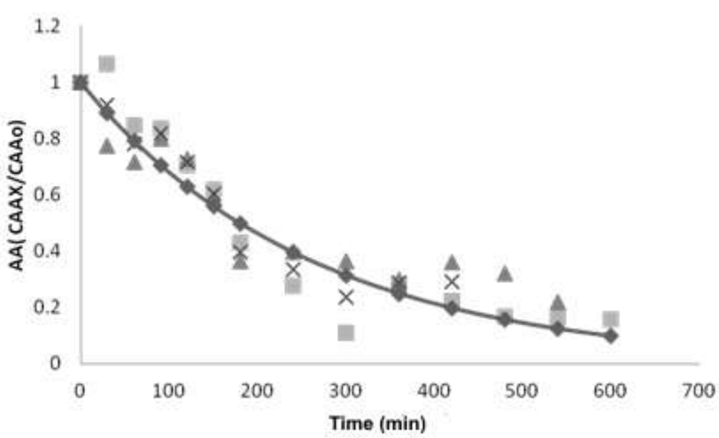

Figure 2. Experimental Kinetics of ascorbic acid at 60°C, *vs* prediction of ascorbic acid degradation with air velocity of 2.5 m/s.

From this results we can conclude that kinetic modelling realized was conducted to develop a functional tool, which in association with a heat transfer model, could predict ascorbic acid degradation in *C. papaya* and another fruits exposed to different heat processes under isothermal or non isothermal conditions.

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