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Effect of Thermal Process and Drying Principle on Color Loss of Pineapple Slices

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Abstract This study is a contribution to knowledge the color loss of pineapple slices during hot air drying process. The kinetics of color degradation of pineapple (Ananas cosmosus) slices were investigated at 40-60°C and at two drying principles: parallel airflow and traversing airflow. Those temperatures are in the range used to dry the commercial pineapple in tropical humid zone. Color changes associated with heat-treated slice were monitored using Hunter colorimeter (L, a, b, total color difference ΔE). The results showed that temperature had a significant effect on the color loss of pineapple slice during the process. At 60°C the color loss is less perceptible. The parallel flow drying process permits us to obtain high color quality during thermal process.

Keywords: *drying principle, thermal treatment, color parameters, quality product*

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1. Introduction

Pineapple (*Ananas cosmosus*) is a tropical fruit and one of the most important commercial fruits of Cameroon [1]. Generally, she consumed fresh during harvest period in the tropical areas. In that particular environment, pineapple fruits are highly perishable and about 40% of the production was lost postharvest. It is necessary to investigate appropriate conservation methods adapted to that context. Thermal treatment is generally applied to extend shelf life of fruit products but drying is still the most widespread conservation method and it is becoming the best alternative to marketing fresh fruits since the demand for high quality dried fruits is permanently increasing all over the world and in particular in Europe [2]. Among the multiple techniques of drying, hot air drying is the conventional and most widely technique used to dehydrate fruits and vegetables [1,3,4]. However, heating processes can affect the quality of product which leads to consumer dissatisfaction. Lignified texture, slow or incomplete rehydration, color loss, loss of juicy characteristic, are the negative attributes of dried food [3]. The color of dry product is one of important criteria appreciation of consumers.

In the literature, during drying of fruits, some reactions contribute to the formation of a brown pigment that is undesirable with respect to color, flavor and market value [1,5,6].

Many researches were reported on quality degradation kinetics of some products [7,8,9,10,11]. Kinetic models have been developed to evaluate color degradation and non-enzymatic browning reactions during processing of fruit products such as apple juice [12], pear puree [13] and peach puree [14]. The effects of thermal processing on the color degradation kinetics of pineapple puree [10], juice pineapple [15,16] are available. In the same way, the kinetics of color changes of product due to hot air drying was studied for banana piece [17], kiwifruits [18]. While there are many literature studies on the kinetics of changes in fruits and fruit derivatives, little work has been conducted on the processing of pineapple slice, and no kinetic studies related with the color change during hot air drying of this particular fruit were found in the literature. This is, probably, due to their heat sensitive compounds.

This work was oriented at investigating the color loss of pineapple slices as affected by drying principle during hot air processing.

2. Materials and Methods

2.1. Preparation of Pineapple Slices

Fresh pineapples were obtained from a local market in Montpellier-France. After watching, hollow cylinders were removed using a stainless steel extractor (H.P AURIOL). These hollow cylinders are sliced on to 7 ± 0.1 mm thick slices by using electric knives (Italiana Macchi). The total soluble solid (TSS) value of fresh pineapple slices were obtained in the ranges of 14.3–5.7 Brix.

2.2. Drying Treatment

The influence of temperature on color was examined between 40 and 60°C at intervals of 10°C and the influence of drying principle was evaluated between parallel flow drying and traversing flow drying (Edoun, 2010).

2.3. Color Measurement

Color changes of pineapple slices were analyzed by measuring the transmittance using a Hunter Lab of CIRAD of Montpellier-France. The instrument was calibrated with white reference tiles A glass cell containing a piece of pineapple was placed in the cell transmittance specimen compartment and three Hunter parameters, namely ‘‘L’’ (lightness), ‘‘a’’ (redness and greenness) and ‘‘b’’ (yellowness and blueness) were measured and total color differences were calculated from L, a and b values.

The color degradation of pineapple slices can also be expressed as a single numerical value ΔE. This value defines the magnitude of the total color difference. The ΔE value is expressed by the following equation:

$$\Delta E = \sqrt[2]{(a_0 - a)^2 + (b_0 - b)^2 + (L_0 - L)^2} \qquad (1)$$

Where L_0, a_0 and b_0 represented the reading at time zero, and L, a and b represented the instantaneous individual readings during hot air drying processing. All experiments were performed in three replicates.

3. Results and Discussion

The results obtained were presented in terms of L/L_0, b/b_0, a/a_0 and $\Delta E/\Delta E_0$, where L_0, a_0, b_0 and ΔE_0 represented the initial values once the sample temperature had reached the set temperature. The plots between relative Hunter parameters and processing time at different temperatures, at parallel airflow and traversing airflow are shown in Figure 1-Figure 4 (a-b).

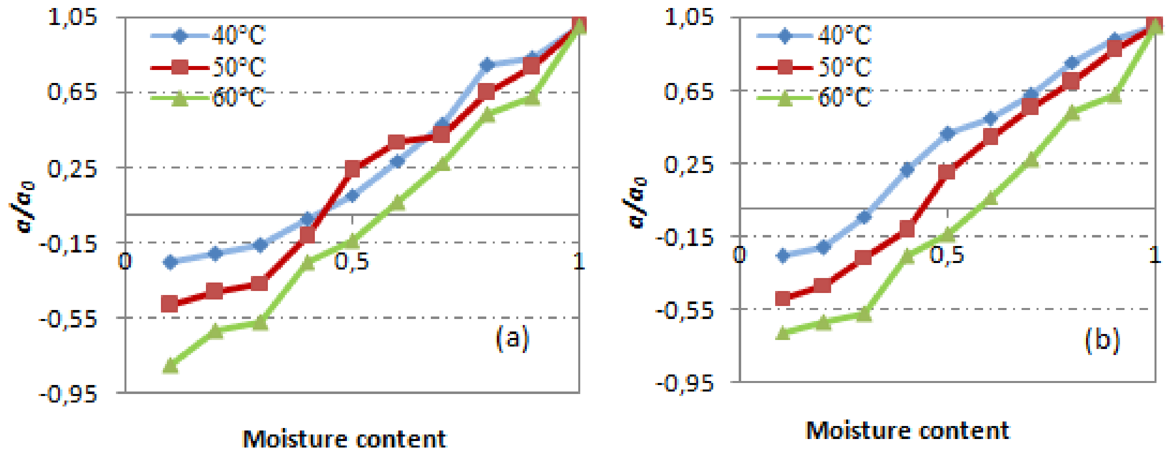

Figure 1. The change of redness of pineapple slices at 40°, 50° and 60°C, a) parallel airflow and b) traversing airflow

3.1. Color Parameter ‘a’

Figure 1 (a) and (b) shows an increase in relative a values during heat treatment under various conditions. At the end of drying, a/a_0 is negative because a_0 is negative. The degradation of Hunter a values of pineapple slices increase when treatment temperature increases. The positive values of a parameter implied that dried pineapple slices were redder than fresh pineapple. In addition, increase of redness is more important during traversing flow drying. Many studies of the color changes during heat treatment of fruit puree or juice demonstrated similar result but effect of drying principle on relative Hunter parameters have not been described in the literature.

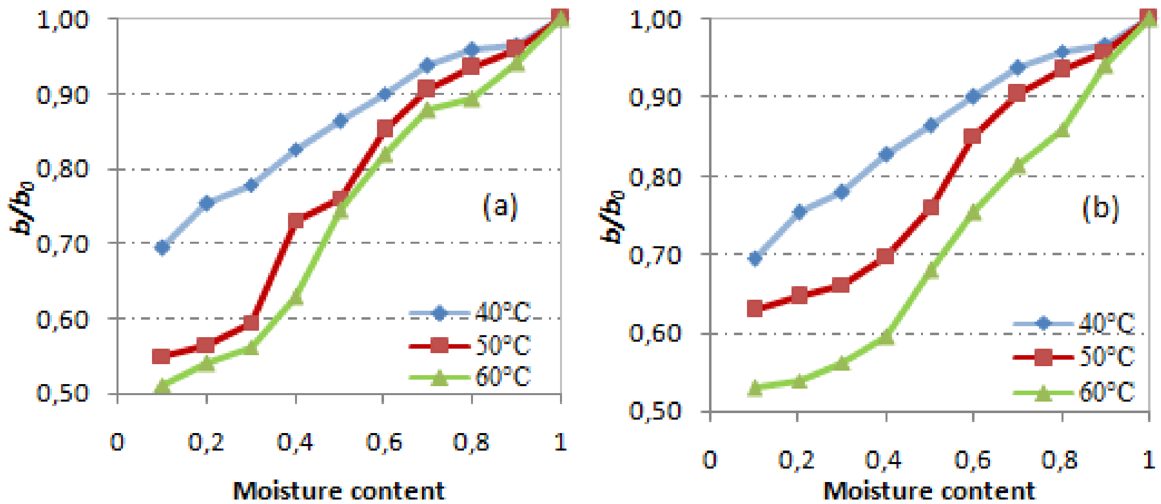

Figure 2. The change of yellowness of pineapple slices at 40°, 50° and 60°C, a) parallel airflow and b) traversing airflow

3.2. Color Parameter 'b'

The major color of pineapple is yellow; the amount of this pigment in the pineapple is an excellent indicator of quality. In this study, the b value was used as an indicator to describe the pigment destruction in the pineapple slice. Figure 2 a-b show plots between relative Hunter parameter b and processing time at different temperatures and at parallel airflow and traversing airflow. The relative visual yellow color parameter (b values) decreased during heat treatment under various conditions and this degradation increased with the higher heating temperatures. This could be explained by the assumption that high temperature accelerated the carotenoid isomerization which led to the loss of yellowness. Against, reduction of yellow color parameter (b values) is more important during traversing flow drying.

3.3. Color Parameter 'L'

The change of parameter L values during drying process at 40, 50, 60°C and at parallel airflow and traversing airflow are illustrated in Figure 3 a-b. With increasing temperature and time, pineapple slices became darker which corresponded to a decrease in L value. The degradation in L value might be influenced by an increase in a value and a decrease in b value. These results show that the reduction in the luminosity is not a consequence of a single mechanism. In addition, decrease of luminosity is more important during traversing flow drying. Indeed, drying time is longer during cross-flow drying and the literature showed that times affect the change of color during the heat treatment of the agro-products. Most of the previous works demonstrated that the changes in L value as affected by heat treatment but the effect of drying principle are not available.

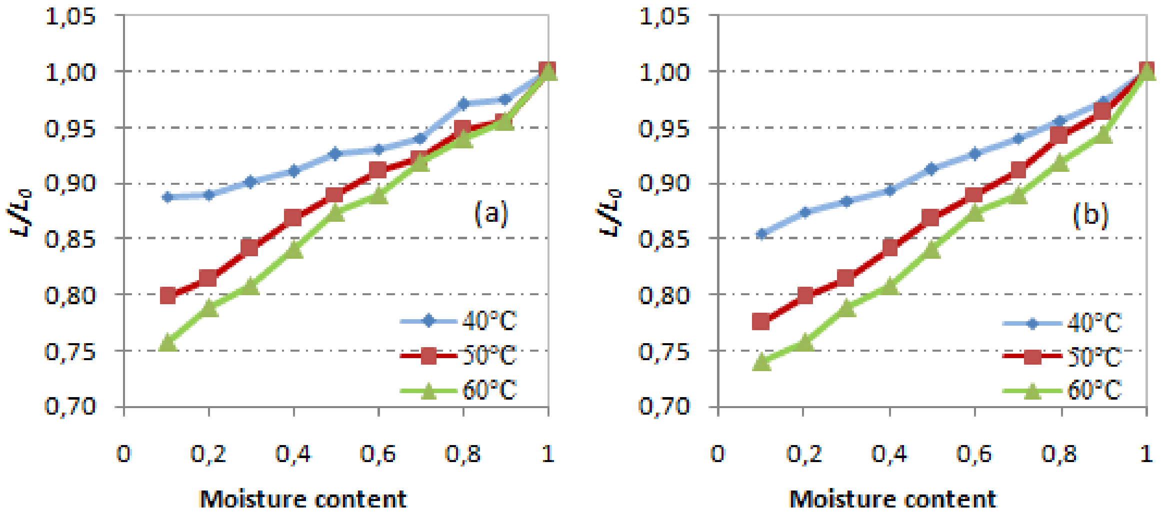

Figure 3. The change of lightness of pineapple slices at 40°, 50° and 60°C, a) parallel airflow and b) traversing airflow

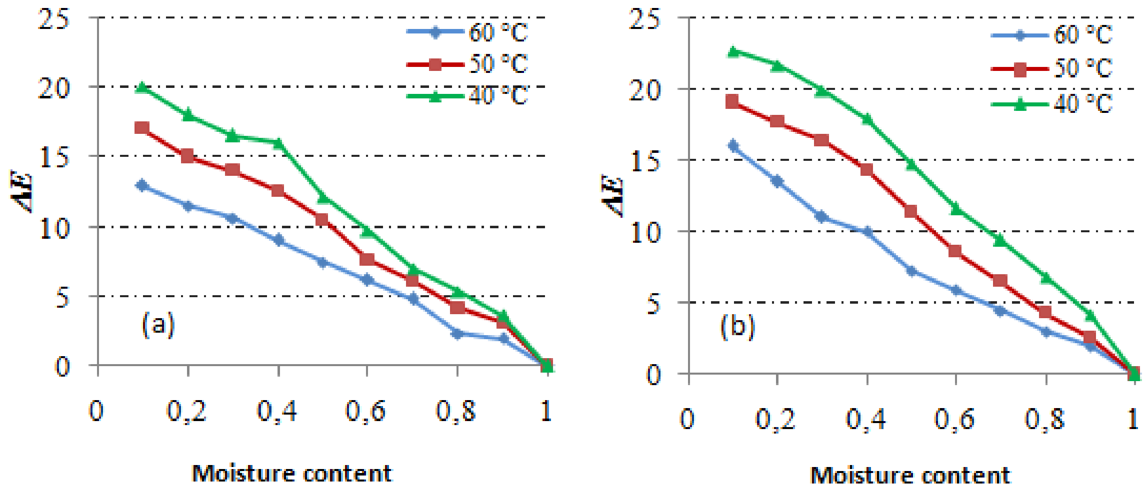

Figure 4. The change of total color different of pineapple slices at 40°, 50° and 60°C, a) parallel airflow and b) traversing airflow

3.4. Color Parameter 'ΔE'

To describe the total color of pineapple slices, the combination of parameters L, a and b, were determined in terms of total color difference (ΔE). The plot between the total color difference of pineapple slices and time is shown in Figure 4 a-b. Total color difference (ΔE) increases with time and decrease with treatment temperature in range of 40 to 60°C. The results showed that ΔE decreased significantly at higher heating temperatures and prolonged processing times. Previous studies of the color change during heat treatment showed opposite results. Indeed, in previous work the tubes (filled with the juice or puree) were sealed at both ends before being subjected to the heat treatment in a water bath. This methodology eliminates the effect of air on the color change during treatment. The objective of the present study was to evaluate color changes during real drying conditions in tropical areas. Color changes of pineapple slices may be certainly the result of more than one reaction. These reactions may not occur simultaneously at one temperature [16]. Therefore, temperature was an important driving force behind the changes in the color of dried products. Some authors showed that the change in ΔE was influenced by both non-enzymatic browning and pigment destruction.

4. Conclusion

Color degradation of pineapple slice was studied at temperatures ranging from 40 to 60°C and two drying principle. The result when the temperature increased the color variation showed a clearer tendency, describing a shift from the yellow to red hues. The lightness decrease with increase of temperature. But the inverse was obtain for the total color different The parallel flow permits us to obtain de best quality of pineapple in terms of color degradation. The information obtained in this study could be used as a guideline for choosing drying principle process to reduce the quality degradation of the pineapple slices. The describing temperature dependence of the reaction rate constant for all that parameters is the objet for future work.

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