

Fruits and vegetables dehydration

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Abstract. Dehydration diagrams were determined by means of Differential Thermal Analysis, DTA, and Thermo Gravimetric Analysis, TGA, curves of several simultaneous fruits and vegetables, all under the same conditions. The greater mass loss is associated with water containing in the structure of the investigated materials at low temperature. In poblano chile water is lost in a single step. The banana shows a very sharply two stages, while jicama can be observed although with a little difficulty three stages. The major mass loss occurs in the poblano chile and the lower in banana. The velocity and temperature of dehydration vary within a small range for most materials investigated, except for banana and cactus how are very different.

1. Introduction

It is a commonly thought that there are fruits with a high water content and others that don't. In the case of vegetables in general, we can also make this approximation. To really know if this is so, an experiment was designed to analyze water loss of water from various fruits and vegetables. In the literature no similar data is found [1-6], although there are many studies concerning the drying velocity and water lost with time in many fruits and vegetables. Usually the water lost is associated with low temperatures, that is, normally low than 200 °C. Greater temperatures produce the destruction of the whole structure. In most investigations of dehydration type, the tests are isothermal and mass losses are evaluated with increasing time. The analysis in this paper are isochronous, here the mass loss is measured as the temperature is increased at a fixed heating rate. We don't know a study of this kind and we think it is very important to characterized the thermal behavior of the chosen materials.

2. Methodology

Different fruits and vegetables were chosen: banana, grape, peach, guava, kiwi, mango, yellow apple, green and chinese melon, poblano chile, jicama and cactus. We determined the weight loss, TGA, curve and the Differential Thermal Analysis, DTA, in a Shimadzu equipment, model DTG-60, located in our Department. Temperature varied from ambient to 300 °C, the scan was performed at a rate of 10 °C per minute under a nitrogen flow rate of 10 cm³ per minute. The mass used in this work for each material was about one milligram of pulp and always shelled or without skin, such as in the case of cactus, jicama and chile poblano.

3. Results

The results of the material lost can be seen in Figure 1: banana in blue line, is completely different from the rest, first because it presents clearly two stages of water loss and second because their mass loss is lower compared to the other. The first drop ends up to 120 °C, with a mass of 60 %, ie. a loss of 40 %; then a second drop ending at 220 °C as a final mass lost of 40 %, representing a loss of 60 % and then a continuous loss until 300 °C it represents a total mass of 29 % that is, a total lost of 71 % of its initial mass.

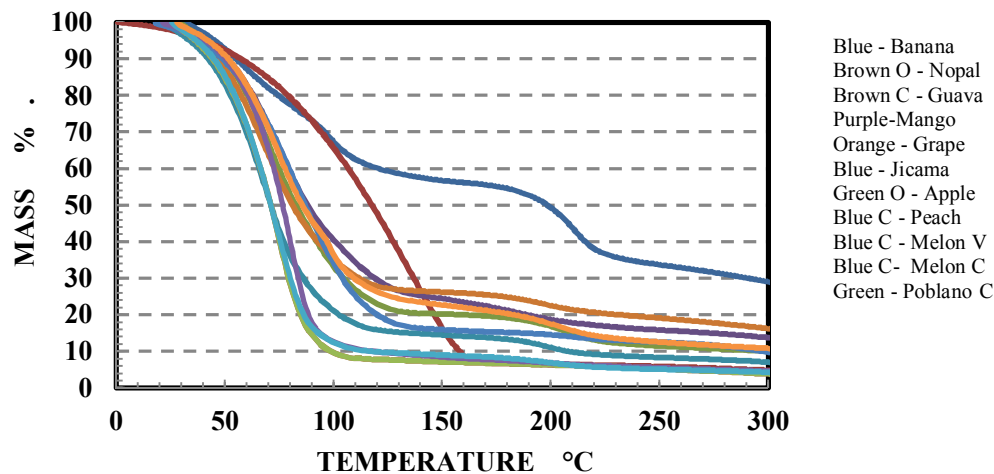


Figure 1. Graph of mass loss of all materials. The sequence of the colors-materials are near the 300 °C temperature.

The second curve is the cactus, in dark brown line, which is also completely different, as it shows a simple fall and that around 160 °C and shows a mass less than 10 %, ie., a greater lost of 90 % of its initial mass and at near 300 °C, perhaps it has only 5 % of its initial mass that is, a lost of 95 % of its initial mass.

The rest of the materials are grouped with a more or less similar pattern, with one, two or three small steps and a final and continuous fall between 200 and 300 °C. At this temperature there are the mass of all of them is between 18 and 4 %, which corresponds to a loss of 82 and 96 %. The first case presents guava, in line light brown, and the last value on the graph corresponds to melons, poblano chile and cactus. To observe better the differences we analyze the total graph in small steps, the first until 100 °C, in Figure 2.

The first thing to note is that not all curves begin its loss mass at the same temperature. It shows that the more stables begins at higher temperature like the cactus and the more instable are like the poblano chile.

Second, at 100 °C the materials that have less lost mass is cactus and banana with a mass of 68 %, ie., a lost of 32 % of its original mass. Those who have lost more mass are the poblano chile, green line, melons in blue line and mango, in purple line, with a mass of 10 % ie. a loss of 90 % of the original mass. Follow by peach, in blue color, with a loss of 80 %, that is, with and end mass of 20 %. The rest of materials lost slightly less mass and are grouped between 40 and 36 % by mass, that is, with a loss of 60 to 68 % of the original mass.

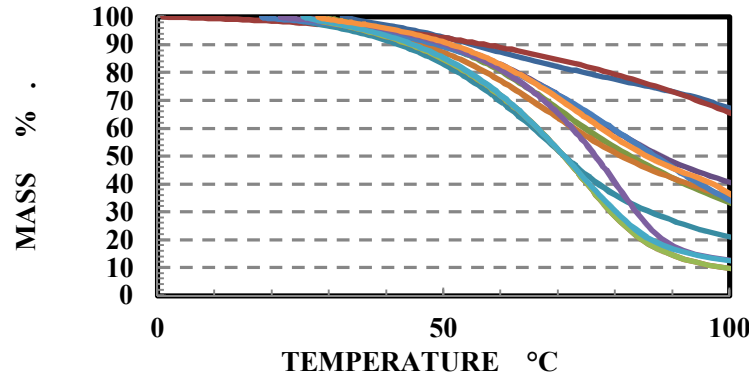


Figure 2. Materials tested until 100 °C.

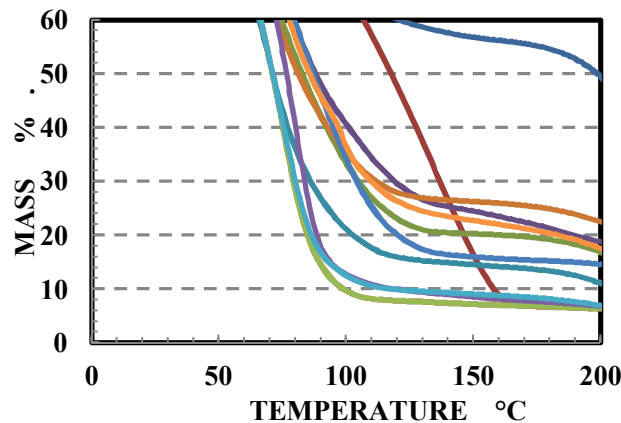


Figure 3. Materials behavior until 200 °C.

For temperature near 200 °C we show in figure 3, the behavior to the materials investigated. Again banana, in blue line, has the lower mass loss about 51 % it represent the 49 % of the original mass. The greatest loss is now 93 % for the poblano chile, in light green line and is about the same with melon, in light blue and nopal in coffee line.

The rest are between 73 and 90 % lost of the original mass, that is, its remains a mass a 27 and 10 % of the initial mass. The first is the guava, in light brown and the second in blue, the peach.

Finally what happens between 200 and 300 °C, is shown in Figure 4. The greatest loss corresponds to the poblano chile, light green, with a little over 96 %, followed by the green melon, blue color, with a little more than 95.8%, followed by Chinese melon, in purple, with 95.5 % Chinese melon, in purple, and the cactus in brown, with 95 %. Below is the peach in strong blue color, with 93 %, followed by the kiwi, light blue, with 92 % then there are almost together jicama and apple 90 %, very close to the grape, orange, with 89.2 % above the handle in purple, with 86.2% and finally guava, coffee, with 83.8 % of the original mass.

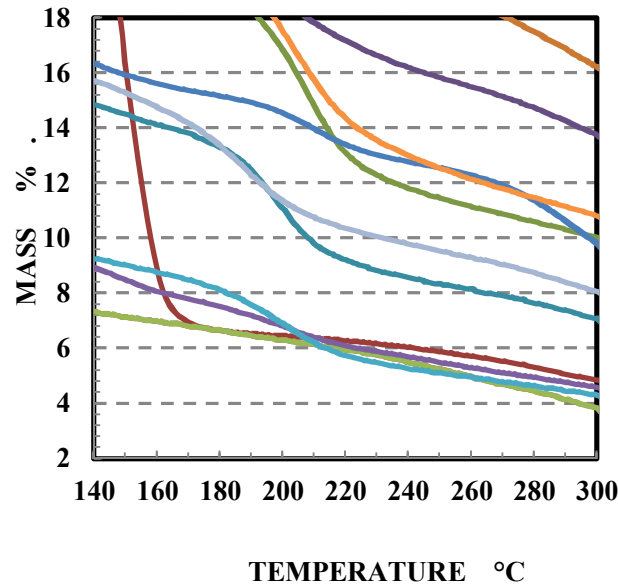


Figure 4. Materials investigated at 300 ° C.

3. Discussion

The values of lost mass obtain are in agreement with the literature values. But we couldn't found in literature is at what temperature this lost happens. And that is the contribution of this work. In general the composition of fruits and vegetables is water 80-90 %, carbohydrates 20-5 %, fiber 2 %, the vitamins, proteins, fat, minerals, scents and pigments less than 0.5 %. Banana is known as the mayor carbohydrate content with 20 %, melon with 5 % and the others 10 %. The carbohydrates are fructose, sucrose and glucose. The fiber is mainly pectin and hemicelluloses. The minerals are potassium, magnesium, iron and calcium. Vitamins: carotenes, vitamin C and B.

The fruits and vegetables lost first water at low temperature, 100-150 °C, then the water on the structure of all the others components 150-250 °C and finely near 300 °C, this structures collapse loosing materials in form of gases like CO or CO₂, and others.

4. Conclusions

The mass lost can be related to the temperature as follows: three types of curves were detected as the loss of water: as the banana with low mass loss (70 %); the second type, as the curve of the poblano chile with a great lost of water (98 %) and finally the third type of curve where the loss is intermediate but large (90 %) but at a slower rate, as are the curves of the other materials investigated.

According to evolution, ie., the number of stages in which meanly water is lost at low temperature, we found that occur in one, two or even three stages during dehydration or mass lost. The poblano chile and cactus have a one stage, while the grape, apple, peach and kiwi have two stages. Finally, jicama is the only one that was very slightly three stages. The mango and melons are not very clearly seen, but are estimated to be two steps. By the way, in the case of melons, green and chinese, it is difficult to find differences between them, only a slight changes by 170 °C is found.

References

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