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Evaluation of dehydration parameters of habanero chili (*Capsicum chinense jacq*.) by tray method, for the conservation of seasonal fruits

Evaluación de parámetros de deshidratación de chile habanero *(Capsicum chinense jacq.)* por método de charolas, para la conservación de frutos de temporada

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Abstract

Dehydration is a food preservation procedure that, by eliminating all free water from it, prevents microbial activity and reduces enzymatic activity, which allows us to give the dehydrated product a long shelf life. This project aims to find the optimal parameters of dehydration in which the data is easy to use for the control of the shelf life of habanero chili, this being a simplified method that allows the producer to adapt techniques to guarantee the commercialization of their product. Due to its high degree of pungency or itching, it has a variety of uses in the food industry, its national average yield of habanero pepper is around 12 (Ton / ha) (Inforural, 2020).

Dehydration, Conservation, Useful life, Optimization

Resumen

La deshidratación es un procedimiento de conservación de alimentos que al eliminar la totalidad del agua libre de este, impide la actividad microbiana y reduce la actividad enzimática lo que nos permite darle una larga vida de anaquel al producto deshidratado. El presente proyecto pretende encontrar los parámetros óptimos de deshidratación en la que los datos sean de fácil manejo para el monitoreo de la vida útil de chile habanero, siendo este un método simplificado que permita al productor adaptar técnicas para garantizar la comercialización de su producto. Por su grado elevado de pungencia o picor tiene una diversidad de usos en la industria alimentaria, su rendimiento promedio nacional de chile habanero es alrededor de 12 (Ton/ha) (Inforural, 2020)

Deshidratación, Conservación, Vida útil, Optimización

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Introduction

The present investigation consists of obtaining data that will help to evaluate the parameters of dehydration of habanero chili (*Capsicum chinense jacq.*) by tray method, for the conservation of seasonal fruits, the interest in obtaining technical scientific data is derived from the fact that in the region of the central zone of the State of Veracruz and specifically in the region of Huatusco and surrounding municipalities where there are several cultivation areas and the producers do not have the strategies for the conservation of their product, which is normally marketed in semi-ripe fruits so its shelf life is very short in addition to being a seasonal product.

According to (Arias 2000) some of the most common causes of losses during harvesting are: unqualified personnel for production and harvesting, inadequate maturity, poor selection of the product, inappropriate handling boxes, mechanical damage, inopportune time of harvest, excessive harvesting period, exposure of the product to the sun, excessive permanence of the harvested product in the field, poor sanitary conditions, deficient, to all these problems one of the solutions to improve profits of producers is to offer their products only in seasons, because they do not have more practical methods of preserving them.

Within good post-harvest handling practices (López 2003), it indicates that once fruits and vegetables are harvested, they need to be prepared for sale, either in the orchard, at retail, wholesale or supermarket chains, some have focused their techniques to develop new products such as sauces, however many companies or even direct consumers demand this product to develop their own by-products with peculiar characteristics, which necessarily requires the beginning of another value chain to complete them in the design of new products. Dehydration is a good alternative so that they can have a physical product and adapt it to the needs that producers require.

Problem

Mexico excels in the generation of chili varieties in the world; around 90% of the chili consumed worldwide is of Mexican origin.

Other producing countries are China, Indonesia, Turkey, Spain, United States and Nigeria. (Macías *et al*, 2017). It is of great importance to look for conservation alternatives by giving it an added value.

Objective

Experimental evaluation of the drying process of habanero chili (Capsicum chinense Jacq.).by the tray method, in order to obtain the ideal parameters for its conservation and handling.

Specific objectives

– Characterization of habanero peppers at different degrees of maturity, considering the following aspects (Degree of Maturity, Length (mm) Width (mm) Weight (g) Density (gr/ml).
– Adequacy of specific dehydration conditions.
– Determination of drying curves for habanero chili slices.

Theoretical Framework

Dehydration is the reduction of the amount of water by treating the food by artificial heat (previously heated air, hot surfaces, etc.), i.e., artificially or industrially. Foods that can be dehydrated are fruits, vegetables, legumes, mushrooms, spices, milk and eggs. Drying is the reduction of the amount of water by treating the food under environmental conditions (sun, wind, etc.), i.e., in a natural or artisanal way. (De Michelis *et al*, 2015).

Habanero peppers (*Capsicum chinense*) are traditionally produced in the Yucatan Peninsula: Campeche, Yucatan, and Quintana Roo. Traditional open field yields vary from 10 to 40 tons per hectare.

Fruit Characteristics

The habanero chile is a herbaceous plant or shrub, branched, reaching a size of up to 2.5 m high. Immature specimens of habanero peppers are green in color, but their color varies at maturity (Macías *et al*, 2017). The most common colors are orange, semi-mature and red at maturity.

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According to scientific research, the origins of habanero peppers, is in the area from southern Brazil to northern Argentina, through eastern Bolivia and western Paraguay (Macías *et al*, 2017).

Itching

Capsaicin, the main capsaicinoid, stimulates the mucous membrane of the stomach, increasing salivary secretion and peristalsis (contractions of the intestine that move food forward), which stimulates appetite.(Nancy Lau *et al*, 2011).
In addition, hot peppers intensify nasal and tear secretion, as well as gastric juices. Also, capsaicin has an anti-inflammatory and anti-irritant effect.

Size

When we talk about fruit quality we refer to its appearance and different sensory characteristics such as size according to (Maldonado *et al*, 2020) the quality of the fruit is related to the appearance where it is described that several morphologies can be found where bell-shaped, elongated, square, triangular and round shapes stand out. The size ranges from 1.14 to 9.88 cm and the weight varies between 0.46 and 24.2 g.

– Preserving food for long periods of time. Once the amount of water present in a food has been reduced, it will be possible to keep it for months or even years in airtight jars without it deteriorating.
– Reduced storage space in your pantry. Dehydration can be a good idea to store more food in less space.
– Preserve food properties. Properly dehydrated foods lose water, but retain most of their nutrients that other preservation or cooking methods might alter.
– Experiment with new textures. You can choose to thinly slice foods to reduce drying times, or leave them whole to rehydrate when you are ready to use them. Also, you can pulverize vegetables to easily add them to cold soups, smoothies, infusions, etc. and reduce the preparation time of your menus.
– Consume more fruits and vegetables. Having a variety of dehydrated fruits and vegetables on hand can be stimulating when cooking and allows you to add more plant-based ingredients to your dishes.
– Have healthier snacks on hand. Dried fruits and vegetables can be used to make snacks or to make homemade granola with nuts and oats. You can also prepare salty or sweet raw crackers, light and nutritious.
– Dehydration is an ideal method to take advantage of fruits and vegetables to give them added value and prolong their shelf life.

Methodology

The present project was implemented in the facilities of the Food Industry Engineering laboratory at the Instituto Tecnológico Superior de Huatusco in the state of Veracruz, carrying out one of the most used processes for the preservation of food and seasonal fruits.

Identification of the problems of habanero peppers

First, the problem of the product was identified, which consisted of the fact that this product is marketed in a way that sometimes affects the stability of its composition or tends to decompose faster due to the conditions in which it is exposed. Therefore, a drying of habanero peppers was carried out in an industrial dehydrator model FD-1, applying a variation of time-temperature ratio and taking into account the moisture losses that are perceived in the samples placed in the dehydrator before and after drying in order to reach the desired optimum point which will allow us to give better handling to the product after processing and give it a longer shelf life.

Some of the fruit drying procedures were investigated, and which degree of maturity was the most optimal for dehydration, either by any of the existing types of drying, but choosing the most feasible for the fruit. A fundamental aspect when considering post-harvest handling of fruit is that they are still alive.

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In this sense, the harvested fruit continues breathing, ripening in some cases and initiating senescence processes, all of which implies a series of structural, biochemical and component changes that are specific to each fruit (Arias, 2000).

Fruit Dehydration

Within food engineering there is a range of products with great interest as an object of study, among them are dehydrated products, according to (Perez, 2008). To preserve food, external and internal factors, temperature, oxygen, relative humidity and/or water activity (aw), light for preservation, the most appropriate packaging and shelf life must be considered. Dehydration and drying are the most widely used preservation methods throughout the history of mankind. In the past, fruits, grains, vegetables, meats and fish were dried in the sun to provide food in times of scarcity.

Although the objective of both is to reduce the amount of water in fresh food, what differentiates them is the method used to do so (Pedro *et al*, 2016). Dehydration is generally understood as the operation by which water is totally or partially removed from the substance containing it. This definition can be applied to solids, liquids and gases. And as it is expressed it can serve to describe various unit operations such as evaporation, adsorption, etc.

The habanero chili should be washed after being cut and avoid handling it if it had contact with other objects, this is to prevent the spread of microorganisms which produce fungi even after dehydration. It is advisable to wash hands thoroughly, as well as to disinfect the area where the practices are carried out. Samples were taken of each habanero chile fruit cut into slices of different weights in order to experiment with different degrees of maturity and testing with different temperatures and times.

Fruit selection

The fruits with the best quality in terms of size, pigmentation and different degrees of ripeness were selected to collect data by drying test, saving them in an Excel database to later represent them through linear graphs, moisture losses, comparison of weights and percentage of loss in a desiccator (Gómez, 2010).

(Gómez, 2010) The fruit is presented between 120 and 140 days after transplantation whose shape is bell-shaped with three locules on average (Estrada, 2018) ripen red, orange, yellow and even white. Verifying all these aspects, fruits with different maturity times were collected.

Classification

Subsequently, they were sorted by maturity grade considering their organoleptic characteristics of color and texture

Figure 1 Degrees of Maturity

They are selected by differentiating the color and size, then they are cut into slices and weighed on the scale, taking the observations of the weight of each sample that is cut from different fruit to have a better perception according to the drying and thus obtain relevant data that gives us the loss of these samples.

Characterization.

The characterization consists of identifying each sample of habanero peppers at different degrees of maturity, considering the following aspects (Degree of Maturity, Length (mm) Width (mm) Weight (g) Density (gr/ml), Weight (g) Density (g/ml), Weight (g) Density (g/ml), Length (mm) Width (mm) Weight (g) Weight (g) Density (g/ml)

Figure 2 Characterization

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Dehydration

The samples were introduced in a tray dehydrator in order to dehydrate by convective method different presentations of habanero peppers (slices and whole peppers, variables of analysis are: the color at harvest time according to the previous characterization, as well as the optimum dehydration temperatures and times.

Figure 3 Characterization

Dry samples

After drying, depending on the time and temperature, the samples were introduced into the dehydrator and allowed to cool down a little to avoid burn injuries. Once the equipment cools down a little, we use tweezers to remove the samples from the dehydrator to be weighed on the analytical balance and calculate the moisture loss obtained by our sample.

Figure 4 Dry samples

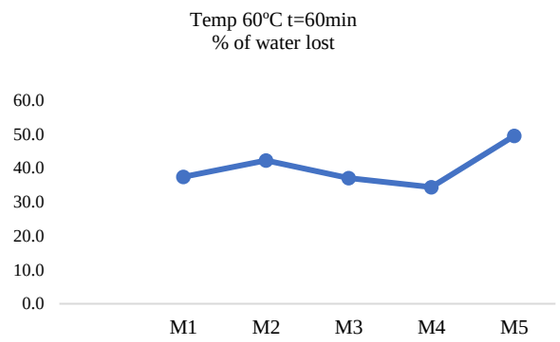
Results

Once the data of the samples were registered, we proceeded to make our database to get the results of moisture loss of our product, to later be represented in tables and make the comparison of all the data obtained through graphs, each sample was assigned a letter to identify them accurately to observe the behavior they presented after drying and was also given a number since each sample is of different weight and they were ordered from the largest to the smallest. Each sample was cut from a different fruit in terms of maturity and size.

The following tables show the results obtained in our evaluation of parameters for the dehydration of the habanero chili fruit according to the processes carried out. It is worth mentioning that each table specifies the process number, the initial weight (I) of each sample before placing it in the dehydrator, the final weight (F) once the sample was dried, the loss in grams (gr) obtained, the drying loss in percentage (%), the loss of the product in the desiccator (D) and finally the final percentage.

Sample	Weight(I)	Weight (F)	Loss(gr)	% of weight lost
M1	2,86	1,79	1,07	37,4
M2	2,51	1,45	1,06	42,2
M3	1,73	1,09	0,64	37,0
M4	1,63	1,07	0,56	34,4
M5	0,89	0,45	0,44	49,4

Table 1 Table of data for the first test (slice samples)



Graph 1 Second Test Graph (Samples in Slices)

The variation of the water loss of each of the samples is observed.

Each sample lost water according to its weight and size; the larger the sample, the less water was lost. The following table shows the data obtained in the second slice drying test.

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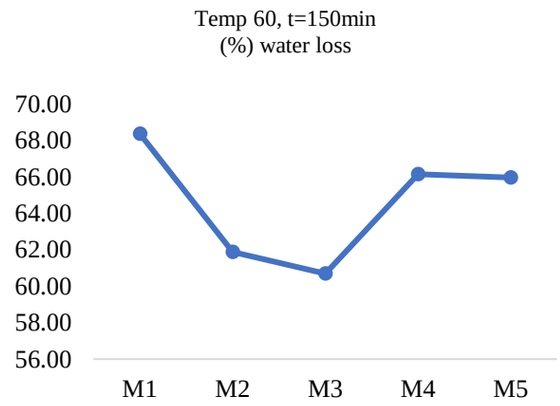
Sample	Weight(I)	Weight (F)	Loss (gr)	Drying loss (%)
M1	2,34	0,74	1,6	68,38
M2	2,23	0,85	1,38	61,88
M3	2,01	0,79	1,22	60,70
M4	1,95	0,66	1,29	66,15
M5	1,94	0,66	1,28	65,98

Table 2 Table of data from the second test (samples in slices).



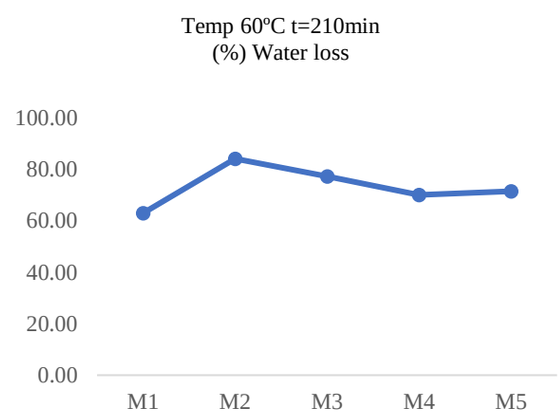
Graph 2 Second Test Graph (Slice Samples)

The second drying operation in slits is shown, where the progress obtained is observed, but the time was extended, as they are the first tests that were carried out, optimal results were not yet obtained in our tests.

The following table shows the test that was carried out by increasing the exposure time at the same temperature.

Rajas	Weight(I)	Weight (F)	Loss(gr)	Drying loss (%)
M1	1,97	0,73	1,24	62,94
M2	1,57	0,25	1,32	84,08
M3	1,27	0,29	0,98	77,17
M4	1,2	0,36	0,84	70,00
M5	1,19	0,34	0,85	71,43

Table 3 Table of data third test (samples in slices)



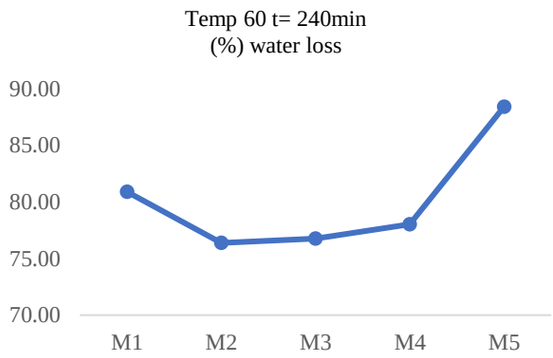
Graph 3 Third Test Graph (Slice Samples)

It can be seen in the previous graph that up to 70% of moisture was eliminated from the slice samples, the processes were continued until the desired parameter of this project was obtained. The data obtained from the drying of habanero peppers were analyzed, showing that the less time a process takes, the more feasible the product is; when dehydrating whole peppers, more time is needed, or another factor that influences is the low temperature to which the sample is exposed.

Rajas	Weight(I)	Weight (F)	Loss(gr)	Drying loss (%)
M1	1,83	0,35	1,48	80,87
M2	1,82	0,43	1,39	76,37
M3	1,72	0,4	1,32	76,74
M4	1,41	0,31	1,1	78,01
M5	1,38	0,16	1,22	88,41

Table 4 Table of data fourth test (Sliced Samples)

This sample shows the most favorable results in terms of water loss in the process, but the disadvantage was the time.



Graph 4 Graph Fourth Test (Slice Samples)

The following data shown in the following table are from the penultimate drying process carried out at a temperature of 72 °C for a time period of 2 hours 30 minutes.

Integrals	Weight(I)	Weight (F)	Loss(gr)	Drying loss (%)
M1	2,27	0,25	2,02	89,0
M2	1,92	0,24	1.68	87,5
M3	1,78	0,33	1.45	81,5
M4	1,3	0,15	1.15	88,5
M5	1,74	0,26	1.48	85,1

Table 5 Table of data fifth process (Samples in Raja)

In this process with temperature change, up to 88% water loss was obtained from the habanero samples, so an alternative was to dry small samples in slices at the temperature represented in the table above, the data are presented in the following graph.

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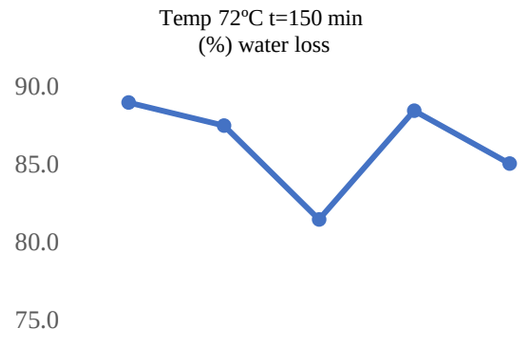


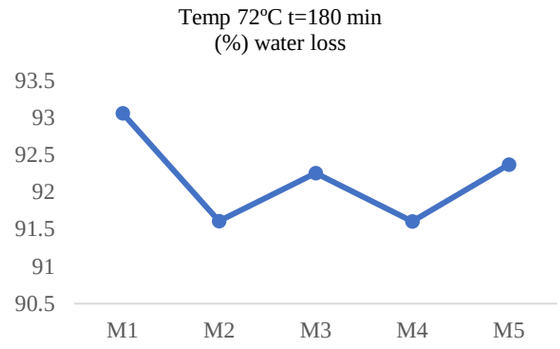
Graph 5 Fifth Process Graph (Sample in slits)

Comparing the previous results with those of these last tests, an improvement in the drying process can be observed, the temperature was increased to reduce the process time and thus obtain better results in terms of the fact that the fruit must lose at least 90 to 95% of water to give better performance in terms of shelf life, the more water is eliminated, the more fungal growth is avoided.

The following table shows the most relevant results of this project.

Integrals	Weight(I)	Weight (F)	Loss(gr)	Drying loss (%)
M1	1,44	0,1	1,34	93,05
M2	1,43	0,12	1,31	91,60
M3	1,42	0,11	1,31	92,25
M4	1,31	0,11	1,20	91,60
M5	1,31	0,1	1,21	92,36

Table 6 Sixth process data table (Sliced samples)



Graph 6 Graph Sixth Process (Slice Samples)

Our drying process favored in every aspect in which the dehydration operation time was reduced and we obtained the ideal parameter desired in this project.

Conclusions

It is successfully concluded that our process used in the drying of habanero chili ((capsicum chinense jacq) was acceptable in the results that were intended to be obtained to preserve the product in storage issues once it is harvested and also to be marketed. For this reason, several tests were carried out to avoid damage to the product and thus obtain a better quality and shelf life.

The graphs and tables show the average water loss of the fruit from the first test to the last, which was the most accurate in terms of results. According to the averages obtained, it was concluded that the most acceptable drying prognosis was 93% water loss in the dehydrated product, which is the average demand at which dehydrated foods or products should be processed.

It was also observed that starting the drying tests, very real results were not obtained, and with each process carried out, very low data were obtained to the drying standard, due to the fact that the samples were exposed to very low temperatures, observing in the whole samples that they tended to lose less water than the samples in slits.

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