Formulación de un empaque termosellable y comestible para la deshidratación controlada de alimentos frescos

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RESUMEN: La deshidratación de alimentos es uno de los procesos más utilizados a través del tiempo, sin embargo, cuando los alimentos son sometidos a altas temperaturas su sabor y propiedades nutricionales se ven afectados o inclusive disminuidos. Por esto, se ha formulado un empaque termosellable y comestible a base de chia para la deshidratación controlada de productos frescos y así obtener productos de buena calidad. La película se formuló variando la adición de hidratos de carbono (glucosa, miel, azúcar) como plastificantes para después evaluar el contenido de humedad, la transparencia, la permeabilidad al vapor de agua y la velocidad de deshidratación de fresa fresca. Finalmente, la formulación con las carcaterísticas fisicoquímicas más adecuadas fue la adicionada con glucosa. Este empaque presenta una barrera eficaz para evitar la contaminación por microorganismos, así mismo se pudo observar que, además de ser una bolsa flexible, era termosellable y permaneció sellado hasta la deshidratación a peso constante del producto fresco. Se observó también que, en un transcurso de 48 horas, el producto había perdido aproximadamente el 80 a 85% de su contenido de humedad, lo que resulto ser más rápido e inocuo en comparación con el secado al Sol.

Palabras clave: Deshidratación, películas comestibles, chia.

ABSTRACT: Food dehydration is one of the preservation process used through time. However, when foodstuff are process in high temperatures, its flavor and nutritional properties are affected and decreased. So, a chia based thermo-sealable and edible package was formulated to improve product`s final quality when they are dehydrated. Film was formulated varying the addition of different carbohydrates as plasticizers (glucose, honey and sugar). Once the formulation is settled, water content, transparency, water vapor permeability and fresh strawberry's dehydration time. Finally, film formulated with glucose was the most suitable film for the research due to its physicochemical properties. This package is an effective way to present bacterial contamination. It also could be observed, that besides it was a flexible pouch, it eas thermosealable y remained sealed through fresh product reaches a constant weight. It also, was observed that in a 48 hours lapse, fresh product has loosen 80 to 85% of it water weight. Which it turns out to be faster and safer that sun dried.

Keywords: Dehydration, edible films, chia.

Área: Desarrollo de nuevos productos

INTRODUCTION

Chia (Salvia hispanica) in one of the most important crops in Mexico in terms of product exportation. Chia is a product with a high exportation value as high as 300 ton per year. Regardless of this, it also generates important waste in volume which causes that producers lost their production benefits (López, *et al.,* 2017; Torres-Ponce *et al.,* 2015).

According to Kirchoff (1960), Chia was and still is an essential product for the Mesoamerican culture. Besides, it was considered an important species due to its artistic, therapeutical, food and religious uses (Guillet, 1981). The seed has high amounts of protein, antioxidants and linolenic acid which provides antiinflamatory, cardioprotective and hepatoprotective activities, antidiabetic actions and helpfull against arthritis, autoimmune diseases and cancer (FAO, 1978; Bresson *et al.,* 2009; Peirretti and Meineri, 2008; Reyes-Caudillo *et al.,* 2008).

According to the Food and Agriculture Organizaton of the United States (FAO, 2015), about 37% of the food produced in México ends up as waste. To avoid such a large amount of products waste, there have been several proposals in order to generate valuable byproducts. Fiber for bread production and a source of antioxidants and fatty acids and mucilage extracts to be used as preservatives.

Edible films are considered an innovative way to prevent spoilage of foodstuff, they provide a barrier to moisture, solutes and gases (oxygen and CO2) for several types of food. Film is composed by a surfactant, a plasticizer and a the main component (hydrocolloids, lipids and protein) (Han and Floros, 1997). There are many applications for edible films; however, most of the research has been focused for preservative purposes of fresh produce for maintaining their sensory characteristics; such as flavor, texture and color. The loss of sensory characteristics is in most cases due to molds better known as anthracnose (Guimares *et al.,* 2018). In addition, edible films were created for being used instead of plastic wrapping to reduce waste disposals and to use renewable resources. Nowadays, the edibles films research has been focused in incorporating bioactive components such as antimicrobials and antioxidants to produce functional food (Pavli *et al.,* 2018).

Food dehydration is a well-known way to preserve food since many centuries ago. Sun drying is one of the most used around the world mostly due to its low operation costs, However, there is needed certain conditions for it to work and to be a secure way to preserve foodstuff (Ahmed *et al.,* 2013).

The objective of this research work was to formulate an edible package with dehydration purposes to generate safer and higher quality products while lowering dehydration costs.

The most adequate formulation was the one that have glucose with better physicochemical properties of all. Color of the package is slightly brown with good transparency values. Pouch made with this film could maintain seal through dehydration time being also suitable for further usage. It was then stablished that this formulation could be presented as another way to dehydrate and obtained good quality products without using energy or added preservatives.

MATERIALS AND METHODS

Chia mucilage extraction

Chia seeds (*Salvia hispanica*) (250 g) were soaked in one liter of distilled water The mixture was blended at high velocity and then centrifuged (Centrifuge Civeq 80-2, México) at 3000 rpm for 20 minutes. The supernatant was dried in a oven (DZF-6090 90L, China) for 12 hours at 35 ºC. The dried mucilage was obtained in scales and stored at room temperature in plastic bags until use.

Edible film formation

Edible films was formed using 0.2 g of sodium alginate, 0.2 mL of glycerol, 2% of mucilage and a variable quantity of carbohydrate (sugar, glucose and honey) (0.5, 1.0, 1.5 y 2%) in 15 mL of water. Solution was heated until 60 ºC and poured into a 10 cm plastic plate. Plate was the placed into an drier oven at 45 ºC for 3 hours.

Water Vapor permeability

Water vapor permeability was measured by the method proposed by McHugh, Avena-Bustillas and Krochta (1993). In which each film was placed and adjusted on a glass cup containing CaCl2 (0%RH) with a diameter or exposed area of 5 mm. The glass cup was placed in a glass chamber containing a saturated NaCl solution (75%RH). After 2 hours the cup sealed with the film was weighed, and then weighed at intervals of 2 hours until constant weigh was recorded. The same test was carried out in triplicate and the following equation (Eq. 3) was used: $WVP = \frac{wxL}{Axtx\Delta p}$

Where WVP is the water vapor permeability (g/hm2); w is the is the weight gain by the cell (g), L is the thickness of the film, A is the exposed area by the film, t is the time of permeation (h) and DP is the water vapor pressure difference between the inner side of the film and the outside of the film (KPa) (2.64 KPa at 22 ºC).

Transparency values
To determine transparency value the method proposed by Shiku, *et al.*, (2004) was used. Films were cut in 1.0 x 2.0 cm rectangles and placed into spectrophotometer cells. The value was calculated using the following equation (Eq 4): $TV = \frac{A_{600}}{x}$
Where TV is the transparency value; A600 is the measure of absorbance at 600 nm and x is the film thickness (mm). The test was conducted by triplicate and air was used as reference.

Product packaging
Strawberry slices (2mm) were placed between 10x10 cm film squares. Squares were then sealed with a vacuum sealer (Torrey EVD-4, México) with a vacuum time of 45 s and a sealing time of 6 s. Pouch was then left at room temperature and moisture content was measured every 20 min.

Moisture content
Films (3x3 cm squares) were dried at 105 ºC in dry oven (OV-9053, Zenith Lab., USA) and the moisture content was analyzed for 24 hours gravimetrically.

Statistical analysis
Data were analyzed by an Analysis of Variance (ANOVA), Response Surface Analysis and Tukey's multiple range test (p level of 0.05) to detect differences among mean values of using Minitab 15 (LEAD Technologies Inc., N.J. U.S.A.).

RESULTS AND DISCUSSION

Edible films with sugar shown to be more fragile and darker than the one made with honey which had a stickier texture but were more translucid than the one made with sugar. On the other hand, films made by glucose were more resistant. Results for transparency, and water vapour permeability values are presented in the following table (**Table I**).

Table I. Water vapor permeability and transparency values for different formulations

Carbohydrate	Carbohydrate content (%)	Water Vapour permeability (g mm/kPa h m2)	Transparency
sucrose	0.5	3.54+0.2b,x	3.25+0.2a,x
	1.0	3.67+0.1b,x	3.42+0.5a,y
	1.5	3.68+0.1c,x	3.98+0.3a,z
	2.0	4.12+0.2c,y	4.10+0.2a,z
Glucose	0.5	2.92+0.1a,x	3.45+0.1a,x
	1.0	2.81+0.2a,x	3.32+0.5a,x
	1.5	2.63+0.1a,y	2.83+0.9a,y
	2.0	2.12+0.2a,z	2.69+0.3a,y
Honey	0.5	3.52+0.3b,x	3.25+0.5a,x
	1.0	3.62+0.1b,y	3.32+0.9a,x
	1.5	3.41+0.2b,x	3.42+0.3a,y
	2.0	3.21+0.1b,z	3.53+0.4a,y

a-b. different letters mean significative difference among groups
x-z. Different letters mean significative difference within groups

As presented in Table I, values for water vapour permeability were significantly higher ($p<0.05$) in film formulated with glucose than any other formulation. However, these values were even higher than the one observed by Ghanbarzadeh *et al.*, (2008) in which they studied the effect of galactose, fructose and glucose as plasticizers in zein films. These higher results could be due to all three plasticizers have a hydrophilic nature and therefore, they absorb water and create a less dense structure leading to a water loss of the product.

Transparency values were significantly ($p<0.05$) the same. Transparency values were in accordance with the study made by Dick *et al.*, (2015) in which they studied transparency values in chia edible films. This film is translucid enough to function as a see through package.

Moisture content

Moisture content values of the packaged product are present in the following figure (Figure 1).

Results have shown that strawberries in glucose-based pouch were dried in 200 minutes, which considering that additional thermal energy was not applied, it can be considered a fast dehydration. This results were similar to the one obtained from Alonzo-Macias *et al.*, (2012) in which they dried strawberries with two thermal drying methods.

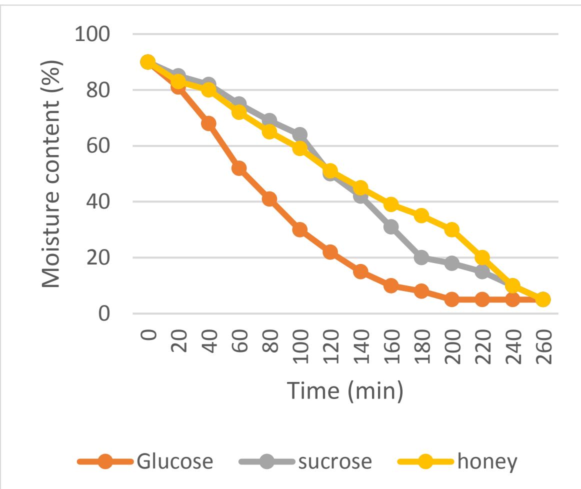

Figure 1 Moisture content (%) was measured every 20 minutes. Strawberry was extracted from Glucose, sucrose and honey based film and was measured every time in triplicate

Fast Drying could be due to the water absorbing properties of the films and also its capacity of maintain its structure as a results of the addition of different plasticizers.

It could also be noticed that drying occur in a three-staged process.

In a first drying stage, films absorbed a lot of the water of the product surface, leading to an even faster solute motion through inside the product.

As a second stage, water from the films evaporate maintaining film structure without any breakage, maintaining product's properties and safety

Finally as a third stage, film's moisture content stabilized with the surrounding atmosphere.

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