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Effect of Osmotic Temperature and Solution Concentration on the Moisture loss and Solid Gain of Osmo-dried Ivy Gourd (*Coccinia grandis*)

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ABSTRACT: Osmotic dehydration process involves partial removal of water by immersing fruits and vegetables in sugar solution. The aim of this research was to study the effect of osmotic temperature and osmotic solution concentration on solid gain, moisture loss and weight reduction during osmotic dehydration. Solution-to-sample mass ratio (5:1) and osmosis time (5 hour) were kept constant and osmotic temperature (40, 50 and 60ºC) and osmotic solution (sugar) concentration (40, 50 and 60 %) were varied. The transfer of water and sugar were quantitatively investigated during osmotic dehydration of ivy gourd slices. The osmotic dehydration process was optimized for water loss, solid gain and weight reduction. It was found that the concentration of sugar solution and temperature were the most significant factors affecting the water loss, solid gain and weight reduction during osmotic dehydration of ivy gourd. Effect of temperature and time were more prominent for determining solid gain than the concentration of osmotic solution. The sugar concentration and temperature has direct effect on moisture loss and solid gain. Osmotic temperature of 60°C and sugar concentration of 60ºBrix were found to be optimum condition for osmotic dehydration of ivy gourd. At this optimum condition, water loss, solid gain and weight reduction were found to be 64.4%, 9.45% and 88.75% respectively. The mean value of rehydration ratio of 2.78 was observed at temperature 60°C and sugar concentration 60ºBrix.

Keywords: Osmotic dehydration, Ivy gourd, sold gain, water loss and rehydration ratio.

INTRODUCTION

Ivy gourd (*Coccinia grandis*) belonging to Cucurbitaceae family, used as vegetable commonly known as little gourd and grown throughout Indian sub-continent generally scattered around Asia, Africa, and the pacific Islands (Nagare *et al.*, 2015). The tropical plant of *C. grandis* L. grown in warm and humid climate at ideal temperature of 20 – 30ºC. Conversion of green color to light green color indicates the harvesting index of ivy gourd. The ivy gourd is stored in normal room temperature for 3 to 4 days and refrigerated temperature for 7 to 10 days (Rani *et al.*, 2013).

The tender Ivy gourd is nutritious and good source of β-carotene (vitamin A precursor) and iron, vitamin C, protein and fibers (Renjumol, 2006; Kuo, 2007). In addition to nutrient composition, it is valued for its major biochemical constituents such as alkaloids, glycosides, flavonoids, tannins, saponins (Shigihalli *et al.*, 2018). Ivy gourd is considered as the primary agent to prepare medicines, possess properties such as antipyretic, analgesic, anti-inflammatory, anti-oxidant, anti-mutagenic, etc. Ivy gourd is recommended for diabetic patients. It can be used to prepare various value added or functional food products.

Ivy gourds are quickly susceptible to microbial spoilage because of its perishable nature and rich in nutrients. Thus, it shows that processing potential of ivy gourd needs to be explored for commercialization of ivy gourd. The removal of moisture prevents the microbial growth and minimizes deteriorative reactions. It brings about substantial reduction in weight and volume, minimizing the packaging, storage and transportation costs, enables the stability of the product under ambient temperatures.

In food preservation, drying is one of the easiest and cheapest method for preservation of high moisture fruits and vegetables. The normal shelf life up to 2–3 days can be scaled up to 6 months with an effective drying process (Elangovan *et al.*, 2022). In order to extend the shelf life and preserve the freshness of vegetables, drying process can be adopted with the aid of new products. Osmotic dehydration is an effective method for preservation of fruits and vegetables.

Ramya *et al*. (2017) suggested that osmotic dehydration is a continuous mass transfer process which maintains good organoleptic and functional properties in the finished products. Kroehnke *et al*. (2021) assessed the dried kiwi fruit quality and revealed that the use of sugar alcohol is a good alternative to sucrose and ultrasound-assisted convective drying as an efficient method for the retention of valuable carotenoids and polyphenols. Being a simple process, osmotic dehydration facilitates processing of fruits and vegetables such as sapota, fig, guava, pineapple, carrots, pumpkins, etc., with retention of initial fruit characteristics viz., colour, aroma, texture and nutritional composition. Fasogbon *et al.* (2013) studied the osmotic dehydration characteristics of pineapple slices and found that osmotic dehydration enhanced solid gain, water loss and dry matter loss. It has potential advantages for the processing industry to maintain the food quality, reduce the energy consumption, improve product quality and speed up the drying time (Feng *et al.*, 2019). The most popular osmotic agents are sugars (e.g. sucrose, fructose, glucose) for fruit, and salts (e.g. NaCl, KCl, CaCl) for vegetables and meat as suggested by Kroehnke *et al.* (2021). This technique is useful to extend the shelf life and decrease the cost of energy consumption.

There are various osmotic dehydrated fruits and vegetables that are available in market such as dehydrated onions, dehydrated garlics, dehydrated onion flakes, dehydrated potato flakes, dehydrated carrot flakes, etc. Tylewicz *et al*. (2020) noticed an increase of water loss upto 21.6% in organic strawberries and kiwi fruits upon the application of combined processes i.e. PEF (Pulsed Electric Field) assisted osmotic dehydration. No research work was carried out on osmotic dehydration of ivy gourd regarding effect of process parameters. Hence an attempt was made to prepare osmotic dehydrated ivy gourd product and study the effect of osmotic temperature and osmotic solution concentration on solid gain and moisture loss during osmotic dehydration of ivy gourd.

MATERIAL AND METHODS

A. Sample preparation

Freshly harvested, uniform sized, free from spoilage ivy gourds were purchased from a local vegetable market near Redhills, Chennai. They were washed with running water to remove adhered dirt and soil particles; air surface dried and sliced into uniform thickness of 5±0.5mm and 3.1±2 mm diameter. Digital Vernier caliper was used to measure the thickness and diameter of slices.

B. Experimentation

The prepared samples were weighed and used for osmotic dehydration in sugar solution to sample ratio of 5:1 for 5 hours. Hundred gram of prepared ivy gourd sample was subjected to osmosis in 500 ml sugar solution and initial moisture content of the sample was determined using Hot air oven method. Three levels of Sugar concentration (40, 50 and 60 º brix) and osmotic solution temperature (40, 50 and 60ºC) with six replications were used for conduct of experiment. Water bath was used to maintain the respective osmotic temperature. Frequently the sample solution was agitated to decrease the mass transfer resistance at the surface of the ivy gourd sample and osmotic solution temperature control and aid proper mixing.

At the time of osmosis water was transferred from prepared ivy gourd sample to the sugar syrup and part of solute transferred to the sample. After 5 hours, the samples were removed from the osmotic solution and rinsed rapidly to remove the sugar coating attaching to the slice surfaces. These ivy gourd slices were weighed to determine the amount of water removed from the slices during osmosis.

After osmosis the samples of known weight were kept in a hot air oven for dehydration at temperature of 55-60°C until reaching constant weight. The time required for drying the product to optimum moisture was recorded in different treatments. The dried products were stored in polythene pouches at room temperature.

Osmotic dehydration was estimated by mass transfer between the solution and sample during osmotic dehydration in terms of water loss, solid gain and weight reduction. Water loss, solid gain and weight reduction were calculated according to the following equations as studied by Kaleemullah *et al*. (2002).

$$\text{Water Loss} = \frac{m_i z_i - m_f z_f}{m_i} \times 100 \text{ (g/100 g fresh sample)}$$

$$\text{Solid Gain} = \frac{m_f s_f - m_i s_i}{m_i} \times 100 \text{ (g/100 g fresh sample)}$$

Water Reduction = Water loss – Solid gain (g/100 g fresh sample)

where,

m_i and m_f are the initial and final weight (g) of the samples, respectively;

z_i and z_f are the initial and final mass fraction of water (g water/g sample), respectively;

s_i and s_f are the initial and final mass fraction of total solids (g total solids/g sample), respectively.

C. Re-hydration Characteristics of Dried ivy gourd

Osmotically dehydrated samples of the ivy gourd slices were subjected to Re-hydration test to study the characteristics of rehydration and to evaluate the capability to rehydrate. Dehydrated ivy gourd sample of 5 g was immersed in an adequate volume of water with the ratio of sample to solution (1:25) for 10 minutes at room temperature. The ratio of mass of re-hydrated and the dried sample was determined as stated by Al-Amin *et al.* (2015) as given below

$$\text{Rehydration ratio} = \frac{\text{Weight of rehydrated sample}}{\text{Weight of dehydrated sample}}$$

D. Statistical Analysis

The results were statistically expressed as mean ± standard deviation and means were compared using Duncan multiple test. SPSS IBM Version 20.0 Software was used to calculate Analysis of Variance (ANOVA)

RESULTS AND DISCUSSION

The effect of osmotic solution concentration and temperature on water loss was given in Fig. 1. The water loss significantly increased with concentration of syrup. The figure shows that the higher temperatures seem to accelerate water loss. The same trend was observed for other fruits and vegetables by Ozen *et al.* (2002); Patil *et al*. (2014). The effect of osmotic solution concentration and temperature on solid gain was depicted in Fig. 2. The higher temperatures imply to increase solid gain. The solid gain significantly increased with concentration of syrup during osmotic dehydration process. Similar result was observed by Amidi-Fazli, and Amidi-Fazli (2015) in osmotic dehydration of kiwi fruit. The highest water reduction was observed at higher osmotic solution temperature of 60ºC. Increase in temperature will accelerate water reduction. The weight reduction was increased with increasing concentration of sugar solution (Fig. 3) during osmotic dehydration process. The water loss, solid gain and weight reduction increased with concentrations. Moisture loss, solid gain and weight reduction were faster in the initial period of osmosis and then the rate decreased. This was because osmotic driving potential for moisture as well sugar transfer was kept on decreasing with time as the moisture keeps moving from ivy gourd to solution and solution to ivy gourd. Progressive sugar uptake would result in the formation of high solid sub surface layer, which would interface with the concentration gradients across the sample solution interface and would set as barrier against removal of water and uptake of solid. Besides, rapid loss of water, weight and uptake of solids near the surface in the beginning may result in structural changes leading to compaction of this surface layers and increased mass transfer resistance for water and solids. Similar trends have been reported for other fruits and vegetables during osmosis (Kaur *et al.*, 2014).

The rehydration ratio (RR) of the osmotic dried ivy gourd was accomplished in the range of 1.19 to 2.78. The inequality of the Rehydration ratio of the dried ivy gourd samples may be related to their process conditions most especially during osmotic dehydration prior to drying. Rehydration ratio significantly decreased with respect to osmotic solution concentration (Fig. 4). This may be due to less penetration of subsurface tissue layer with sugar at high concentrations, so less solutes may be transferred into the solution, high amount of water was absorbed (Mozumder *et al.*, 2012). Fig. 4 shows that rehydration ratio significantly ($p<0.01$) increased with increasing osmotic temperature. The same trend was observed by Obajemihi and Asipa (2020) in tomato sample.

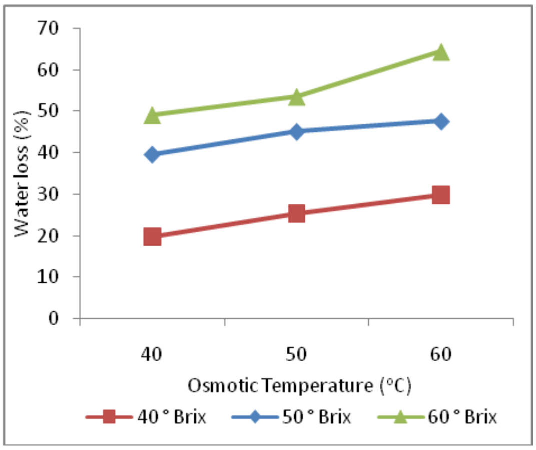

Fig. 1. Effect of osmotic solution concentration and temperature on water loss.

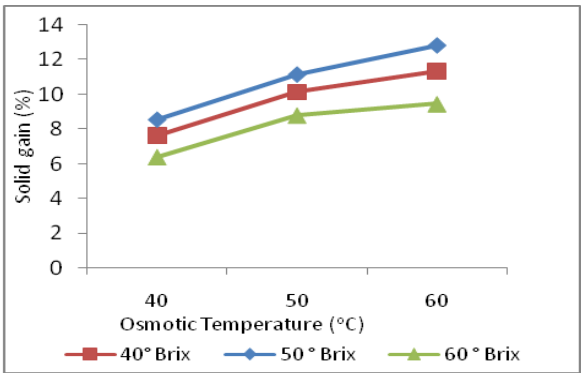

Fig. 2. Effect of osmotic solution concentration and temperature on solid gain.

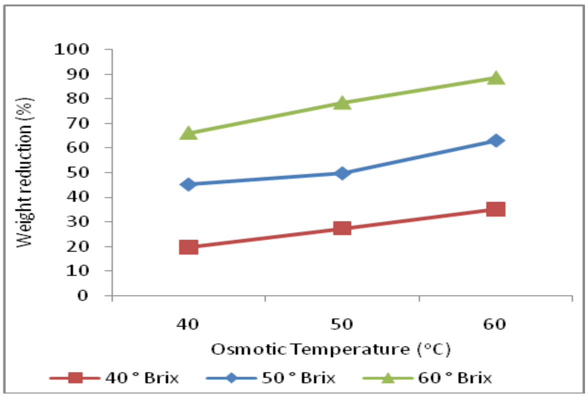

Fig. 3. Effect of osmotic solution concentration and temperature on rehydration ratio.

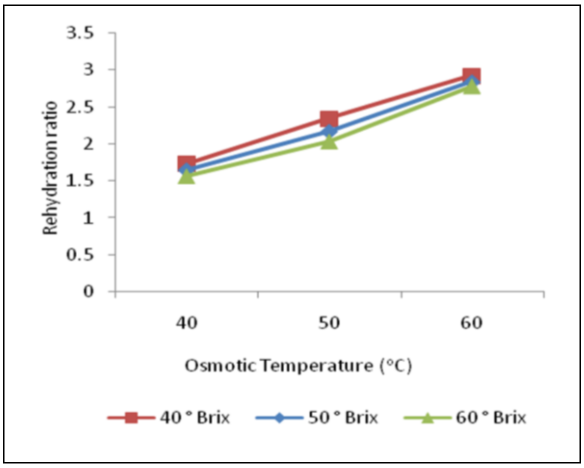

Fig. 4. Effect of osmotic solution concentration and temperature on rehydration ratio.

CONCLUSIONS

The effect of osmotic solution temperature and concentration on water loss during osmotic dehydration depicted that the water loss by ivy gourd slices increased with increase in osmotic solution concentrations and temperature. High water loss, solid gain and weight reduction of 64.4 %, 9.45 % and 88.75% respectively were observed at 60ºBrix osmotic solution concentration and 60ºC temperature. High rehydration ratio of 2.78 was observed at 60ºBrix osmotic solution concentration and 60ºC temperature. High rehydration ratio revealed better quality parameters of the dried samples for human consumption.

FUTURE SCOPE

The osmotic dehydration process can be used for preservation of fruits and vegetables with physically chemically and microbiologically stable without any chemical preservatives. This research study may be extended to determine the phyico chemical, nutritional and shelf life of the osmotic dehydrated ivy gourd.

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