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Drying and Pickling of Cucumber Slices

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ABSTRACT

Drying and pickling are the most ancient and effective methods to preserve food which are used so far. In particular, drying cucumber slices using a dehydrator has been shown to significantly reduce their moisture content from 89% w.b. to 4.5% w.b. and lower their water activity from 0.98 to 0.17, making them safe from microbial activity. Moreover, storing these dried cucumber slices for up to 9 days did not result in any significant increase in water activity. The cucumber slices also pickled using different vinegar solutions. It has been observed that with increase in storage period pH of the solution as well as pickles decreases. Vinegar concentration of 480 and 600 ml have shown similar trend. This study showed that drying and pickling can be used to preserve cucumber slices for longer period.

Keywords: Drying, pickling, water activity, moisture content, pH, storage

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INTRODUCTION

Fresh fruits and vegetables begin to deteriorate or spoil, as soon as they are harvested (Jaeger *et al.* 2023). Most of the spoiling caused by the microorganism such as bacteria, mold, yeast or chemical and enzyme activity within the food (Rawat 2015). Therefore, it is important to preserve food to increase shelf life and made available for consumption throughout the year (Okoye and Oni 2017). The primary objective of food preservation is to prevent or slow down the growth of micro-organisms including molds, yeasts and bacteria as the growth of these micro-organisms causes spoilage of food. Food preservation also minimizes preparation time and energy at home. The major food preservation techniques involve thermal and non-thermal techniques some of them are as follows drying, sugaring salting, pickling, extrusion, cooking, blanching, irradiation etc (Gaikwad *et al.* 2021).

The cucumber (*Cucumis sativus* L.) belongs to the Cucurbitaceae family, which also includes various types of melon and squash (Verheul *et al.* 2013). Cucumber is the world's fourth most cultivated vegetable crop (FAO 2011) and is frequently eaten either fresh, processed (pickled), or as an ingredient in food products. Cucumbers, with high moisture content of about 95% (w.b.), provide superior hydration when consumed. Additionally, it hydrates the body, regulates blood pressure, controls body weight, lowers cholesterol, prevents cancer, promotes bone health, reverses diabetes, and has antioxidant activity (Minh 2013). Because of its high moisture content, further processing is extremely delicate (Dermesonlouoglou *et al.* 2019). Even when refrigerated, cucumber is quite susceptible to microbial spoilage, making it sometimes convenient to use conservation techniques like drying and pickling to extend shelf life (Guine´ *et al.* 2014).

One of the earliest methods of food preservation is drying, which aims to dry food up to the point where it is microbiologically safe and can be stored for a longer time (Nawirska *et al.* 2009). By vaporizing or sublimating the water from the food, this process lessens the amount of water that is available for microbial, enzymatic, or chemical reactions that can lead to food degradation (Guine´ 2018). Hot air-drying techniques are extremely adaptable and significant in many different ways. These include drying in rotating drum dryers, tunnels with conveyor belts, chambers with trays, and even fluidized bed dryers. Among them tray dryers has been widely used for drying of fresh fruits and vegetables.

Another method is pickling, one of the oldest ancient methods of preserving various foods, including fruits, vegetables, fish, and meat (Behera *et al.* 2020). Pickling imparts distinct and palatable flavour, texture, and colour changes that develop in fermented pickles over time. Antioxidants, probiotics, vitamins (vitamins C, A, K, and folate), and minerals (iron, calcium, and potassium) are all present in pickles in good amounts (Minh 2013). Therefore, in the present study cucumber slices were dried and pickled and its moisture content, water activity, and pH were determined with storage period.

MATERIALS AND METHODS

Raw materials and sample preparation

Fresh cucumbers were purchased from the local market of Carbondale, Illinois (USA). Cucumbers were washed and extra moisture was removed using muslin cloth. After washing cucumbers were trimmed from top and bottom and then sliced into uniform discs (10 mm thickness) with the help of knife and taken for further study.

Drying of cucumber slices

The cucumbers were dried using food dehydrator (NESCO, American Harvest, Gardenmaster). The dehydrator temperature was first set at 125 °F (51.67 °C). After attaining the required temperature, the cucumber slices were placed, spaced apart in dehydrator trays and kept inside dehydrator for four hours. The weight of sample was measured every hour using weighing balance (ALF203, Fisher Science Education, Ohaus Corp., Pine Brook, USA) having least count of 0.001 g.

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Pickling of cucumber slices

Four pickling solutions were used as the treatments. The solution contained 5% distilled vinegar solution, distilled water, sugar, and salt (Table 1). The cucumbers were cut into uniform slices and the pH was measured with pH meter. They were then placed into the mason jars that contained the pickling solutions. The treatments were placed in room temperature for nine days. The pH of the solution was recorded for nine days. The pickles were taken out of the jars and crushed; the pH values were measured for final three days. All measurements were taken three times for each treatment.

Table 1: The four pickling solutions (treatments) used in the experiment

Treatments	5% distilled vinegar solution (ml)	Distilled water (ml)	Sugar (g)	Salt (g)
Solution 1	600	0	200	20
Solution 2	480	120	200	20
Solution 3	360	240	200	20
Solution 4	240	360	200	20

Storage studies

The dried and pickled cucumber slices were stored in Mason jar for storage studies. The change in water activity and pH was measured during 9 days storage period.

Moisture content and Water activity analysis

The moisture content was measured using hot air oven. Initial weight of the sample was determined using AOAC method (Anonymous 1990). Water Activity (aw) affects many food properties, especially shelf life and texture. Water activity above 0.7 leads to fungal, bacterial, microbial growth along with the enzymatic action leading to food deterioration /spoilage. Since, water activity is an important parameter to achieve required food stability through the control of microbiological growth (food safety) & chemical activities. It is significant to measure the water activity for dried product to check for its freshness, safe to use and storage. The water activity of cucumber was measured using water activity meter (CH-8853 Lachen, LabSwift-aw, Novasina AG, Switzerland). The moisture content was determined using formula:

$$MC\ (\%\ w.b.) = \frac{Wm}{Wm + Wd} \times 100$$

Where,

MC (% w.b.) = moisture content; W_m = weight of moisture, g;

W_d = dry weight of cucumber slices, g;

RESULTS AND DISCUSSION

Drying of cucumber slices

Initial weight of sample was 478 g and after trimming it was reduced to 436 g. Initial moisture content was 88.99 % (w.b.). Drying continues for 4 hours and the final moisture content reached 4.5 % (w.b.). Fig. 1 showed the drying curve of cucumber slices. The curve followed exponential trend with R^2 = 0.998. After 4 hours values obtained were almost constant and product was dried. This information is useful in determining the time required for drying for larger batches under same drying conditions.

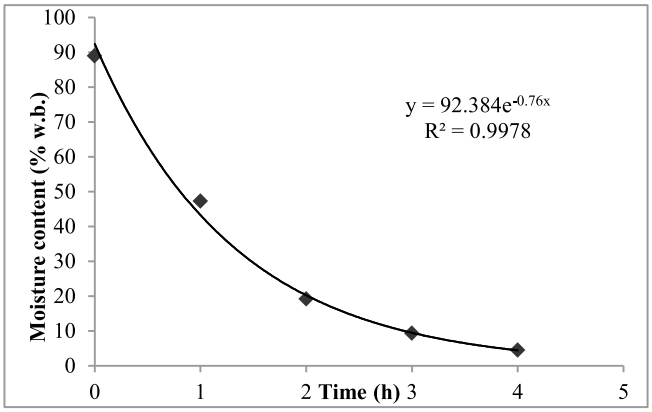

Fig.1: Drying curve of cucumber slices

Effect of storage on water activity

Fig. 2 represents the water activity before drying and after drying. The final water activity obtained was considered as safe storage condition. The water activity after drying increased with increase in days then constant from Day 5 to Day 7 and then again increased with increase in Day 8 (Fig. 3). The water activity showed polynomial trend of 2nd order with R^2 = 0.975. In general, bacteria require higher values of aw for growth than fungi, gram-negative bacteria having higher requirements than gram-positive (Rockland and Beuchat, 1987). Therefore, water migrates specific energy level to grow and survive. Different foods have different water activity values. Thus, depending on the available water activity of that product we can predict the nature from areas of high aw to areas of low a_w.

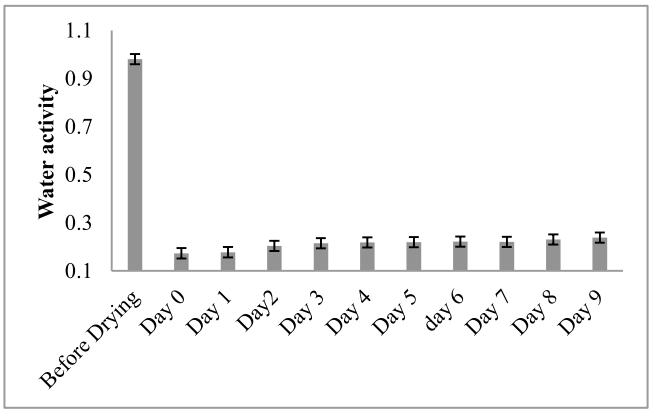

Fig. 2: Water activity of cucumber slices

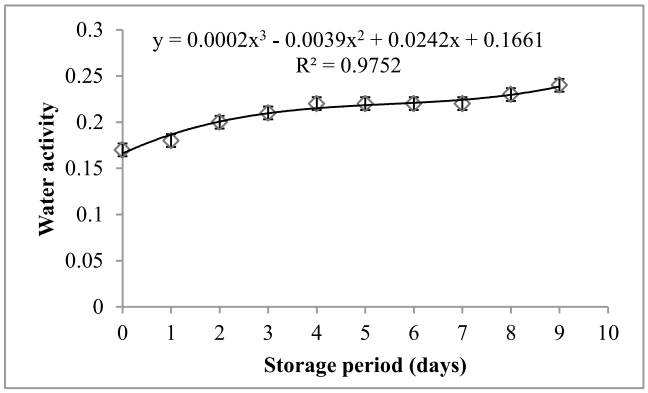

Fig. 3: Effect of storage period on water activity

The pH of the cucumbers was 5.57 prior to the treatments. The pH of the solutions was measured for nine days, the 600 ml vinegar solution had the lowest pH followed by the 480 ml, 360 ml, and 240 ml. Similar trends for the pH of the solution was observed, all four solutions started with a lower pH value and steadily increased until the fourth day (Fig. 4). The pH increases in the solution in the first three days maybe due to the cucumbers reacting with the vinegar. The pH of the solution then decreased or became stable. The pickles in the 600 ml treatment had the lowest pH value, followed by the 480 ml, 360 ml, and 240 ml (Fig. 5). Interestingly, the 480 ml and 600 ml treatment had similar pH value on day 8 and day 9. The pickles showed similar trend in the four treatments. The results from the experiments agree with the hypothesis that the more concentrated the vinegar solution is, the more acidic the pickles become.

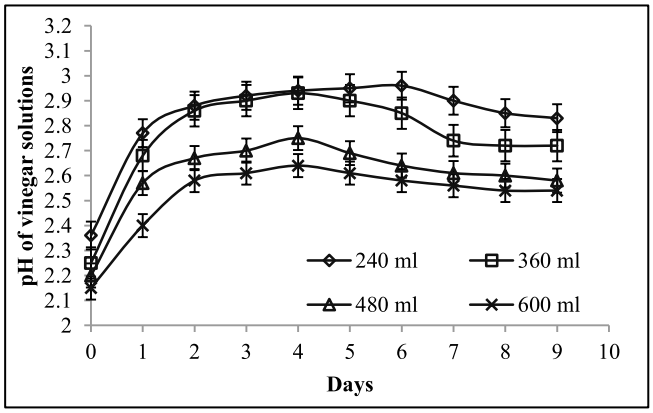

Fig. 4: The change in pH of vinegar solutions with storage period

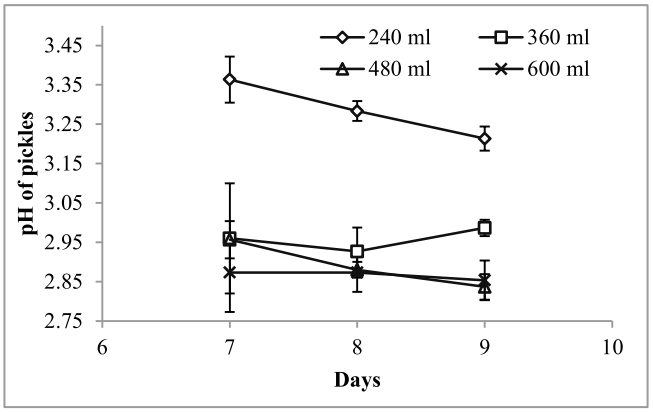

Fig. 5: pH of pickles in different vinegar solutions

CONCLUSION

Drying cucumber slices with hot air led to rapid reduction in moisture content, subsequently lowering water activity. Moreover, there was no noticeable increase in water activity during storage. Pickling cucumber slices resulted in a significant decrease in pH, with solutions containing 480 ml and 600 ml of vinegar displaying similar outcomes. Overall, this study demonstrates that both drying and pickling techniques can be effectively used for preserving cucumber slice. Additionally, both the methods could help to reduce food waste, ensure a more stable supply of food, and offer consumers access to cucumbers even when they are out of season.

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