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Research Article

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Mass Transfer Kinetics of Osmotic Dehydration of Pineapple

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Abstract

Current study deals with the kinetics and mathematical modelling of osmotic dehydration of pineapple. Pineapple (*Ananas comosus)*, 10 mm thick slices weighing 50 g each, was studied for the osmotic dehydration using hypertonic solutions of sucrose and fructose. The osmotic dehydration process was performed using three levels of temperature 40°C, 50°C and 60°C, three levels of osmotic solution concentration (40%, 50% and 60%) with sample to solution ratio maintained at 1:4, 1:5 and 1:6 respectively. After each interval of time, moisture loss and solid gain was recorded. It was found that moisture loss and solid gain increased with increase in osmotic temperature and osmotic solution concentration. The highest mass transfer was observed at concentration of 60% and temperature of 60°C. Three models (Handerson and Pabis model, Logarithmic model and Lewis model) were used to analyze osmotic dehydration data. Among the three models, Logarithmic model showed a best fit to the osmotic dehydration data with higher value of coefficient of determination (R^2).

Keywords: Osmotic dehydration; Mass transfer kinetics; Pineapple; Solid gain; Moisture loss

Introduction

Pineapple, also known as Queen of fruits is one of the important commercial fruit crops in the world [1]. The fruit is known for its exceptional juiciness, excellent flavor, taste and numerous health benefits. The fruit is highly perishable containing about 14% of sugar, good amount of vitamin A and B, citric acid, malic acid and bromelin [2]. The bromelin, a protein digesting enzyme, aids in the digestion of proteins when taken with meals [3]. Various food items like squash, syrup, jelly are produced from pineapple. Vinegar, alcohol, citric acid, calcium citrate etc. are also produced from pineapple. Pineapple is also recommended as medical diet for certain diseased persons [4]. Physically, the fruit is hard on the outside and soft on the inside and can be eaten raw or added to desserts and fruit salads. In addition to this, squash, syrup and jelly like food items are also made from pineapple. Thailand, Philippines, Brazil and china are the main pineapple producers in the world supplying nearly about 50% of the total output [5]. The commercial cultivation of pineapple in India is believed to be only four decades old and is largely grown in states like Assam, Meghalaya, Tripura, Sikkim, Mizoram, West Bengal, Kerala, Karnataka and Goa. Osmotic dehydration is basically a water removal process in which materials such as fruits are placed into a concentrated solution of soluble solutes. By doing this, a major part of water is removed from substance and time required for relatively high temperature air drying is reduced. Conventional air drying is energy intensive and cost intensive because it is simultaneous heat and mass transfer process accompanied by phase change [6]. Even though the pineapple is available round the year but there is some peak harvest season at which harvest is so abundant that some of the fruit has to be left in the field or sold at a very low price. One way to increase the value of this crop is by drying it. Conventional air drying may result in browning or caramelization of sugar due prolonged exposure to the heat. Osmotically pre drying pineapple would reduce this problem. The effects of sucrose concentration, processing time, temperature, slice thickness, fruit to syrup ratio on weight reduction and total soluble solids were studied by Singh et al. [7]. It was observed that percent weight reduction and total soluble solids increases with increase in sucrose concentration and temperature. It has been found that 60% sucrose solution at 50°C, 1:4 fruit to syrup ratio and 10 mm thickness give best results [7]. A significant amount of weight loss (47.40) within 4 hours of osmosis was showed by mango slices when osmosed in 67.4° brix of osmotic solution at 40°C having sample to solution ratio of 1:3.34 [8]. About 50% of water was removed from the 5 mm of banana slices when 63°brix sugar solutions was maintained at 75°C within one hour of osmosis and 57.9% of water was removed when slices were osmosed for 2.5 hours [9]. The specific objective of this work was to study the effect of osmotic solution concentration, sample to solution ratio and temperature on mass transfer of the osmotic dehydration of pineapple and to determine the best mathematical model that can describe the kinetics of osmotic dehydration process.

Materials and Methods

Raw material preparation

The experiments were conducted on fresh, ripe and good quality pineapples. The fully ripen pineapples were peeled manually, cored and then sliced into 10 mm thick slices and further divided into four pie wedge shaped pieces. To inactivate enzymes, pineapple slices were blanched at 80°C for a min [10]. Moisture content was determined by placing the samples in an oven at 100°C for 16 to 18 hours or till constant weight was achieved [11]. The samples were then subjected to osmotic dehydration treatment. Figure 1 shows the procedure involved in the osmotic dehydration treatment of the pineapple slices.

Osmotic dehydration treatment

The sucrose and fructose solution made with concentration levels of 40%, 50%, 60% with sample to solution ratio of 1:4, 1:5 and 1:6 respectively were used for each experiment. The samples weighing 50 g were used for each experiment and then immersed in osmotic solutions for 10, 20, 30, 40, 50, 60, 90, 120, 150, 180 and 240 min at a temperature of 40°C, 50°C, and 60°C. The temperature was controlled with hot

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