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To study the osmotic dehydration characteristics of pineapple (*Ananas comosus*) slices

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Abstract
The present study is carried out the effect of pretreatments on osmotic dehydration in 50ºBirx and 60ºBrix sugar solutions at 45 ºC syrup temperature. The osmotic dehydration is a process of partial removal of water from the sample by immersing in the osmotic solution. The osmotic dehydration is a preservation technique to remove the water which is present into the sample. The yield of maximum water loss, mass reduction and solid gain in osmo-convective pineapple slices. The optimum operation condition was found to be temperature of 45 ºC of syrup concentration for 60ºBrix sugar solution after 180 minutes.

Keywords: Dehydration, pineapple slices, optimization, water loss, solid gain and mass reduction

Introduction
Pineapple (*Ananas comosus*) is a tropical fruit grown in the tropical and sub-tropical regions. It's grown on large scale in India and now India is the second largest producer of fruits after Brazil. Pineapple is largely consumed around the world as canned pineapple slices. It mainly contains water, carbohydrates, sugars, vitamins A, C and carotene and refreshing sugar-acid balance and a very rich source of vitamin C and organic acids (Bartolomew *et al.*, 1995) 1996 [1]. Pineapple is one of the most important fruit crops of north eastern India especially in Arunachal Pradesh of India. Thailand, Philippines, Brazil and China are the main pineapple producers in the world supplying nearly 50 % of the total output. Other important producers include India.

The osmotic dehydration process and influence of its process variables such as pretreatment, temperature of sugar solution and additives on the mass transfer in osmotic dehydration of various fruits was studied and reported that the apple slices reduced to 50 per cent of original weight by using 60 – 70^{0}C Brix sugar solution and superior quality. It's indicated that there was no need of sulphur dioxide treatment to prevent loss of color. The osmotic air-dried products were high in superior quality and reported that the osmosis process removed water from fruits slices to the extent of 40 – 50 per cent of the weight, but not enough for storage. Therefore, to remove water up to safe levels further drying is needed. Bongirwar and Sreenivasan (1977) [2] indicated that the high temperature above 60^{0}C modifies the tissue characteristics favouring impregnation phenomena and thus solid gain. Rahman and Lamb (1991) [3] reported the rate of sucrose diffusion is a function of solute concentration and temperature. The diffusion coefficient decreased with the increase in solid content during the osmosis and increased with the drying air temperature.

Materials and Methods
Experimental procedure
The pineapple was procured from the local market of Meerut. The pineapple was then washed, and cut into 4.5 mm slices. The slices were put in osmotic solution having sugar concentration ranging from 50 to 60 °Brix at 45 ^{0}C temperature for 180 minute. After the osmotic treatment then, slices were spread on the tissue paper for 5 min to remove the surface moisture. The weight of osmotically dehydrated pineapple slices was recorded. Slices were then put in pre-weighed petri-dish for moisture determination by vacuum oven method. Each treatment replicated thrice and average moisture content was recorded.

Preparation of the samples

Good quality pineapple of selected variety (queen) was procured from the local market of Meerut. Procured pineapple was washed with water and unwanted material like dust, dirt, and surface adhering were removed. The fruits were then peeled off with the help of a stainless steel knife and both the ends of the fruits were trimmed off using a stainless steel knife and cut into slices of 4.5 mm thickness. The thickness was measured with Venire caliper having least count of 0.001 mm.

Preparation of osmotic solution

Osmotic solution was prepared with distilled water by blending the desired solute (w/b) basis). Sugar was used as osmotic agent. Selected quantities of sugar were added with osmotic solution to improve the osmotic dehydration process and quality of samples. A stirrer was used to dissolve the solute content. An electronic balance was used to weigh sugar. Based on the preliminary trials and review of literatures, two concentrations each of sugar (50°B and 60°B) at temperature levels of 45 °C were used to carry out the experiments Concentrations were checked by HRN-18 hand refractometer.

Osmotic dehydration of pineapple slices

In osmotic dehydration the prepared samples (pineapple slices) were weighed approximately 300gm for every experiment and immersed in sucrose solution (50 and 60°Brix) contained in a 1000 ml glass beaker. The beakers were placed inside the constant temperature water bath. The solution in the beakers were manually stirred at regular intervals to maintain uniform temperature 45^{0}C and kept for 3 hrs. The beakers were removed one by one from water bath at designed time, samples were taken out and placed on absorbent paper for 5 minute or were immediately rinsed in flowing water and placed on tissue paper to remove the surface moisture to eliminate excess solution from the surface before weighing. Finally the samples were weighted and their moisture contents were determined. After the osmotic treatment the slices were wiped by using the blotting paper and were drying.

Determination of water loss (WL) and solid gain (SG)

Osmotic dehydrated samples were blotted with tissue paper and later weighed for determination of WL and SG as shown by the following equation (Aktas *et al.*, 2007) [4]

$$WL = \frac{W_{wo} - W_w}{W_o} \times 100$$

$$SG = \frac{W_s - W_{so}}{W_o} \times 100$$

Where, WL and SG are water loss and solid gain in %, respectively.

W_{wo} is the initial water mass,

W_w is the mass of water at time t,

W_S is the solid mass at time t,

W_{so} is the initial solid mass

Results and Discussion

Effect on water loss, solid gain and mass reduction

The effect of sugar concentration (50°Brix & 60°Brix) and t ime on water loss, solid gain, mass reduction at constant temperature of 45 °C and solution to product ratio 6:1 during osmotic dehydration for Treatments T_1 and T_2.

Solid gain

The solid gain by pineapple slices during osmosis is given in the table. The solid gain during osmotic dehydration when immersed in syrup concentration of 50^{0}B and 60^{0}B held at 45 °C temperature was found in the range of 5.22 to 17.23%.The variations in solid gain are shown in the table 1. The solid gain varied from sample to sample. It was found that with the increase in the syrup concentration and temperature, the solid content was found to be increased. This result was supported by Silveira *et al.*, (1996) [5]. The increase in solid gain is also possible due to absorption during osmosis Sankat *et al.*, (1996) [6]. The maximum value of solid gain was 17.49% for the 60^{0}B syrup concentration and minimum value of solid gain was 5.22% was found for the 50°B syrup concentration.

Table 1: Effect of solution and temperature (45 °C) on solid gain (%) pineapple slices

Treatments	Time (min)						
	0	30	60	90	120	150	180
T_1 (50^{0}Brix)	0	5.2221	10.4999	13.7221	15.2288	16.2288	16.8888
T_2 (60^{0}Brix)	0	7.4999	11.3888	14.1288	15.7621	16.8155	17.4999

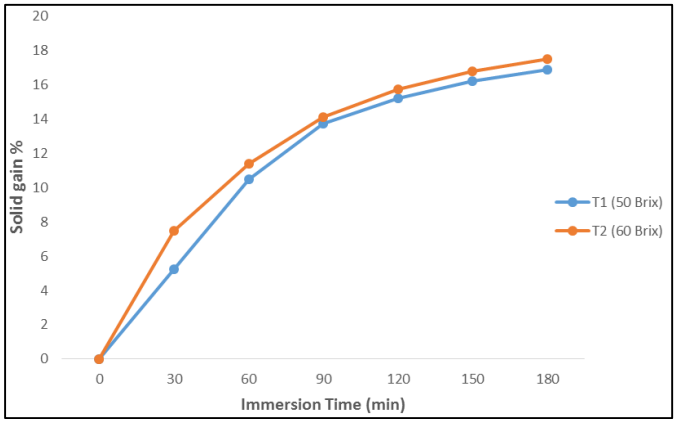

Fig 1: Effect of solution and temperature (45 °C) on solid gain (%) pineapple slices

Water loss

The kinetics of water loss at different process conditions was obtained. The mean values of water loss for the different set of experiments are presented in Table 2. The effect of different independent variables viz., temperature, and dehydration time, concentration of osmotic solution and mass ratio on water loss is given in Fig.2. It can be depicted from the figures that with the increase in the concentration of osmotic solution, the loss of water or the removal of water increased. The maximum water loss was 52.49%, found for samples osmotically dehydrated at 45^{0}C for 180 min with osmotic solution of 60°B concentration. The minimum 6.66% water loss was found for samples osmotically dehydrated at 45 °C for 30 min with osmotic solution 50^{0}B concentration. This suggests that at same temperature of osmotic of solution, higher concentration is responsible for increasing the water loss.

Table 2: Effect of solution and temperature (45 °C) on Water loss (%) of pineapple slices

Treatments	Time (min)						
	0	30	60	90	120	150	180
T_1 (50^0Brix)	0	11.8887	25.4999	35.3887	40.8954	45.6621	48.5554
T_2 (60^0Brix)	0	17.4999	28.0554	36.7954	43.0954	48.1488	52.4999

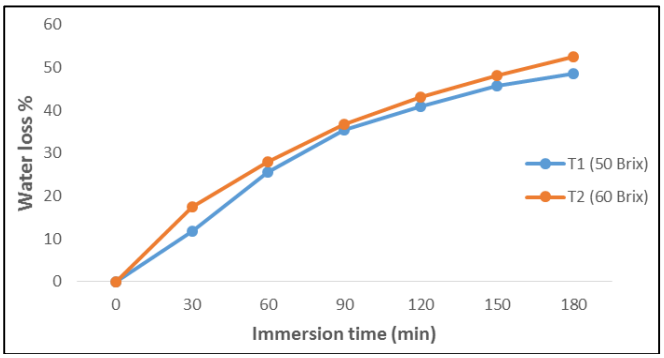

Fig 2: Effect of solution and temperature (45 °C) on Water loss (%) of pineapple slices

4.3 Weight reduction

The weight reduction of pineapple slices during the osmotic dehydration process for each after 1, 2 and 3 h, respectively. The mean values of weight reduction for the different set of experiments are presented in Table 3. Three-dimensional plots have been developed between osmotic dehydration time, concentration of osmotic solution and weight reduction of dehydrated slices at different concentration Fig.3. The maximum weight reduction was 35.0% for samples osmotically dehydrated at 45ºC for 180 min with osmotic solution of 60^0B concentration, whereas the minimum reduction in weight was found to be 6.66% for the samples osmotically dehydrated at 45ºC for 30 min with osmotic solution of 50^0B concentration. It has been observed that as the concentration of osmotic solution increased, the weight reduction increased. This suggests that at same temperature of osmotic solution, higher concentration is responsible for increasing weight reduction.

Table 3: Effect of solution and temperature (45 °C) on weight reduction (%) of pineapple slices

Treatments	Time (min)						
	0	30	60	90	120	150	180
T_1 (50^0Brix)	0	6.6666	15.0000	21.6666	25.6666	29.3333	31.6666
T_2 (60^0Brix)	0	10.0000	16.6666	22.6666	27.3333	31.3333	35.0000

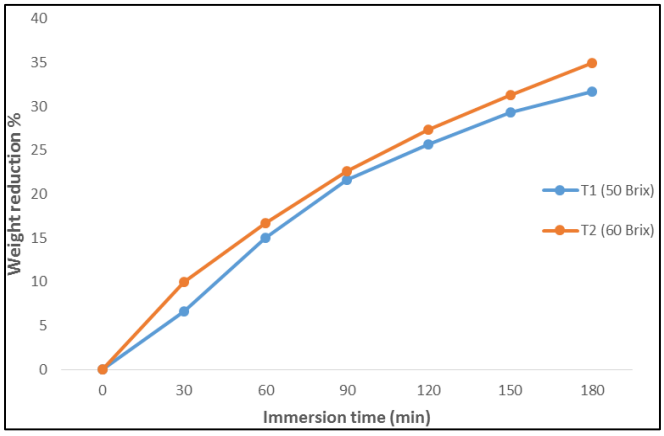

Fig 3: Effect of solution and temperature (45 °C) on weight reduction (%) of pineapple slices

Summary and Conclusion

Pineapple was treated at different brix of sugar solution at 50ºBrix and 60ºBrix. During the osmotic dehydration process dependent variables were carried out such as Water loss, Solid gain and Mass reduction. In this study, it can be concluded that the slices which are treated with 60ºBrix sugar solution at 45 ºC temperature show the maximum dependent variables

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