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Study on quality analysis of osmotic dehydrated pineapple slices with different sugar syrup concentrations during storage

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Abstract
In this experiment quality of osmotically dehydrated pineapple slices treated with different sugar syrup concentrations was analyzed. Effect of osmotic dehydration on weight loss (%), dry weight (g/100g), Rehydration ratio (%), Dehydration ratio (%) were investigated to find out the osmotic dehydration technique as a pre-treatment for further pineapple slices drying. The pineapple slices were cut into 0.5mm thickness and were subjected to different sugar syrup concentrations viz. 35°B, 40°B, 45°B, 50°B, 55°B, 60°B for 24 hours and control as no treatment. In all the six treatments 750g of pineapple slices were immersed. After osmotic dehydration it is kept under drying in tray drier at 60°c until it gets desired moisture. Weight loss (%) is highest in control as there is no treatment and maximum weight loss (%) observed in T_1 at (35°B). Dry weight (g/100g) is highest in (25.21g/100g). Dehydration ratio and rehydration ratio (%) is highest (22.04%) and (3.31%) respectively in control and minimum observed in (3.61%) and (2.21%) in T_6 (60°B). The present experiment results revealed that weight loss, rehydration and dehydration ratio (%) were highest in control and maximum in T_1 (35°B), whereas dry weight (g/100g) is highest in T_6 (60°B) and lowest in control (4.53%).Thus, it is concluded that weight loss, dehydration and rehydration ratio are found in control and maximum values are observed in T_1 (35°B). However dry weight (g/100g) is found highest (25.21g/100g) in T_6 (60°B).

Keywords: Pineapple, osmotic dehydration, weight loss, dry weight, rehydration ratio, dehydration ratio

Introduction
Pineapple (*Ananas comosus* L. Merr.) is a tropical fruit grown in both tropical and sub-tropical regions native to American continent Brazil and Paraguay (NHB 2014). The pineapple fruit grows in large number of countries with top world producers among which India is one of them. This fruit is consumed as canned pineapple, juices, fruit salad etc. It contains pleasant flavour, distinct aroma, water, carbohydrates, sugar, vitamin A and low amount of protein, fat, ash fibre etc. Over 70% of annual production is consumed in the fresh form. Up to 40% of agricultural produce is wasted in developing countries, mainly due to the lack of storage and processing facilities, as well as to a limited knowledge of processing technologies (Brahim, 2000) [4]. The increasing production of the fruit and its high perishable nature with lack of facilities for transportation of the produce from the area of production to the consumers provide some necessity to transform it into a more stable and desirable form. To develop that there is an advanced method called osmotic dehydration where fruits are subjected to hypertonic solution. Osmotic dehydration is widely used to remove part of the water content of fruit to obtain a product of intermediate moisture or as a pre-treatment before further processing (Lenart, 1996; Torreggiani, 2004) [5, 10]. Rehman (1990) [8] studied the osmotic dehydration of pineapple. In this Process of osmosis water removed from the fruit sample in a concentrated solution by a semi permeable membrane. This can remove 50% of the water from the fruit sample and the other 50% can be removed by drying in different driers. Thus osmotic dehydration method reduces the load on drier by removing water. This helps in retaining the color, flavor, texture, taste etc.
The main aim of this study is to investigate the quality analysis of osmotically dehydrated pineapple slices with different sugar syrup concentrations.

Materials and Methods
The present research study entitled "Study on quality analysis of osmotically dehydrated pineapple fruits with different sugar syrup concentrations during storage" were conducted in the laboratory, Department of Horticulture and Post-Harvest technology, Bolpur, Palli Siksha

Bhavana (Institute Of Agriculture), Visva-Bharati, Sriniketan, Birbhum (District), West Bengal during the year, 2017-18. The present experiment was laid out in completely randomized design with six treatments (35°B, 40°B, 45°B, 50°B, 55°B, 60°B) and control (no sugar).Pineapple (*Ananas comosus* L. Merr) fruits were obtained from the fruit market, with fully matured fresh fruits with uniform size and shape, free from diseases and insect damages, transportation injuries and bruises, were selected for making the nutritious osmotically dehydrated slices

Fruit slice preparation
The selected Pineapple fruits of uniform size and colour were weighed by using electronic digital balance, washed thoroughly with running tap water. The washed fruits were peeled by removing the upper skin with stainless steel knife. Edible portion of the whole fruit was cut in to uniform slices having 0.5 mm thickness with central cork thrown away. Prepared slices were weighed to record the yield recovery of fresh slices for osmotic dehydration.

Preparation of sugar syrup
Sugar syrup of six different concentrations *viz*., 35°,40°, 45°, 50°, 55°, and 60°Brix was prepared. For 35°Brix 350grams of sugar in 650 ml of water for 40°Brix 400grams of sugar in 600 ml of water for 45°Brix 450gram of sugar in 550 ml of water, 50°Brix 500 gram of sugar in 500 ml of water, for 55°Brix 550 gram of sugar in 450 ml of water, 60°Brix 600 gram of sugar in 400 ml of water all the treatments were made up to one litre volume.

Treatments
Slice thickness: 0.5 mm
Sugar °Brix
T_1: 35°B, Steeping of 0.5 mm slices in 35^0B sugar syrup
T_2: 40°B, Steeping of 0.5 mm slices in 40^0B sugar syrup
T_3: 45°B, Steeping of 0.5 mm slices in 45^0B sugar syrup
T_4: 50°B, Steeping of 0.5 mm slices in 50^0B sugar syrup
T_5: 55°B, Steeping of 0.5 mm slices in 55^0B sugar syrup
T_6: 60°B, Steeping of 0.5 mm slices in 60^0B sugar syrup
T_7: Control.

The fruits were washed, peeled and cut into slices followed by steeping the slices for 24 hours in the above mentioned solution, later tray dried at (55-60 ^{0}C).

Immersion of slices in sugar syrup (osmosis)
Prepared pineapple slices of 0.5mm thickness were dipped in 35°, 40°, 45°, 50°, 55° and 60°Brix sugar syrup solution and this setup was left undisturbed for 24 hours at room temperature (25 ^{0}C). The process of osmosis takes place and water moves out of the fruit pieces to the syrup and fraction of solute moves into the fruit slices. At the end of the osmosis, the fruit slices were taken out of the osmotic solution and were drained in order to remove the sugar coating adhering to the surface of the fruit pieces.

Dehydration
After taking samples for analysis, the osmosed slices of pineapple were spread thinly on aluminium trays which were kept in a tray drier for dehydration. Pineapple slices were thoroughly dried at 55-60 °C temperature till the fruits reached the desired moisture content and product quality.

Fresh weight: The weight of fresh pine apple fruit slices is taken by using digital weighing machine.

Dry weight: The weight of dried pineapple fruit slices is taken by using digital weighing machine.

Dehydration and rehydration ratios
Dehydration ratio was determined as the ratio of weight of the sample before drying to the dried weight of sample. Whereas rehydration ratio was determined as the ratio of the weight of the rehydrated sample to that of dehydrated (Kalra, Tandon, & Singh, 1995).

Dehydration ratio=W/W_D
Rehydration ratio=W_R/W_D

Where, W and W_D are the weight of the sample before and after drying respectively, and W_R is the rehydrated sample weight in (g).

$$\text{Weight loss \%} = \frac{\text{Initial weight – final weight}}{\text{Initial weight}} \times 100$$

$$\text{Dry weight (g/100g)} = \frac{\text{Wt. of dried product}}{\text{Wt. of fresh shreds}} \times 100$$

Statistical analysis
The experiment was laid out in Complete Randomized Design. Data obtained on various characters were analyzed statistically according to the analysis of variance techniques for CRD (Fisher 1950). The critical difference (CD) was calculated to access the significance or non-significance of difference between treatment means. Wherever, it was found significant through ‘F’ test at 1 or 5 per cent level of significance, marked as star in ANOVA Tables.

Result and Discussion
Weight loss (%): The data pertaining in the Table.1 and Fig. 1 show weight loss (%) of osmosed pineapple slices. Various osmotic sugar concentrations significantly affected the weight loss (%) of osmotically dehydrated pineapple. It is observed that the highest weight loss (%) was found in T_7 (95.46%) at control which was followed by (85.40%) in T_1 at (35°B), (83.20°B) in T_2 (40°B) and lowest weight loss (%) value observed in T_6 (74.7%) at 60°B. There was significant effect of different sugar concentrations over weight loss. It indicates that an increase in syrup concentration resulted in the decrease in weight loss. This might be due to the presence of less water molecules in higher concentration of sugar solution.

Dry weight (g/100g): The results presented in Table.1 and Fig.1 indicates dry weight of osmosed pineapple slices. Various osmotic sugar concentrations significantly affected the yield of osmotically dehydrated pineapple slices. Among all the treatments highest dry weight was found in T_6 (25.21%) at (60°B) and other treatments T_5 (55°B), T_4 (50°B), T_3 (45°B) were respectively (23.7%), (22.65%), (18.54%) while lowest in T_7 (4.53%) at control. There was significant effect of different sugar concentrations over dry weight (%). The increase in dry weight might be due to the transfer of sugars from syrup to fruit slices through osmosis during the period of osmotic dehydration. It has been reported that, due to increase in the solid gain and the volume reduction of the osmotic-dehydrated product, there was threefold increase in drier load and process yield (Torreggiani, 1993 and Thippanna, 2005) [11, 9]. Similar results were obtained by (Nanjundaswamy *et al.*, 1978) [6] in indigenous fruits and Adambounov and Costaigue (1983) [1] in banana.

Table 1: Effect of sugar concentrations on weight loss (%), dry weight (g/100g), and dehydration ratio (%), rehydration ratio (%) on osmotic dehydration of pineapple after drying

Treatment	Weight loss (%)	Dry weight (g/100g)
T_1-35°B Sugar syrup	85.40	14.60
T_2-40°B Sugar syrup	83.20	16.73
T_3-45°B Sugar syrup	81.40	18.54
T_4-50°B Sugar syrup	77.34	22.65
T_5-55°B Sugar syrup	76.60	23.37
T_6-60°BSugar syrup	74.70	25.21
T_7-Control	95.46	4.53
C.D (5%)	1.72	0.83
S.E.(m) ±	0.54	0.27

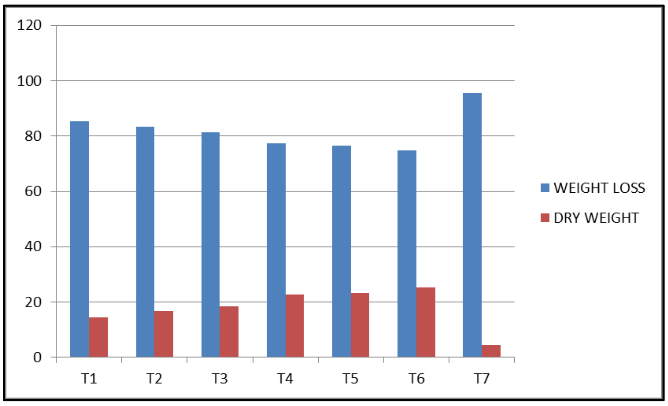

Fig 1: Effect of sugar concentrations on weight loss (%), dry weight (g/100g) on osmotic dehydration of pineapple after drying

Dehydration ratio (%): The data recorded of dehydration ratio (%) by various sugar syrup concentrations are shown in Table. 2 and Fig. 2

It was observed that the highest dehydration ratio was found in T_7 (22.04%) at control and lowest in T_6 (3.61%) at (60°B). There was significant effect of different sugar syrup concentrations over dehydration yield.

The interactions significantly affected the dehydration ratio of osmotically dehydrated pineapple slices. Maximum dehydration ratio (22.04:1%) was observed in control (T_7) and it is minimum (3.61:1%) in sample prepared after osmotic pretreatment with (60°B) sugar syrup in (T_6). This is due to increased concentration of sugar syrup in which water transport from the fruit is high.

These results are in conformity with the findings of (Thippanna 2005) [9] in case of banana. The maximum drying ratio in control was recorded in guava varieties (Allahabad Safeda and Pink flesh) due to presence of low sugars and more concentration of fruit components reported by Anitha and Tiwari (2007) [2].

Rehydration ratio (%): The results from Table. 2 and Fig.2 Revealed that, significant differences were found between different sugar syrup concentrations the highest Rehydration ratio T_1 (2.42%) at (35°B) and lowest at T_6 (2.12%) at (60°B). Maximum rehydration ratio was found in T_7 (3.31%) in control. There was significant effect of different sugar concentrations over Rehydration ratio. Highest rehydration ratio in control samples might be due to presence of low sugars and more concentration of fruit components. Presence of more tissues might have helped in absorption of more water resulting higher rehydration ratio. These results were in accordance with the findings of Bongirwar (1997) and Anitha and Tiwari (2007) [2] in guava varieties. Pointing *et al.*, (1966) [7] concluded that reduced rehydration of osmotically dried fruits and vegetables are caused by the sugar coating on the fruits and vegetables. Less rehydration would be an advantage for dried fruits as snack products. Osmotically dried products can be exposed for several hours without becoming sticky, due to low hygroscopicity.

Table 2: Effect of sugar concentrations on dehydration ratio (%), rehydration ratio (%) on osmotic dehydration of pineapple after drying

Treatment	Dehydration Ratio (%)	Rehydration Ratio (%)
T_1-35°B Sugar syrup	6.84	2.42
T_2-40°B Sugar syrup	5.70	2.34
T_3-45°B Sugar syrup	5.30	2.20
T_4-50°B Sugar syrup	4.41	2.16
T_5-55°B Sugar syrup	4.27	2.26
T_6-60°BSugar syrup	3.61	2.12
T_7-Control	22.04	3.31
C.D (5%)	1.12	0.22
S.E.(m) ±	0.36	0.07

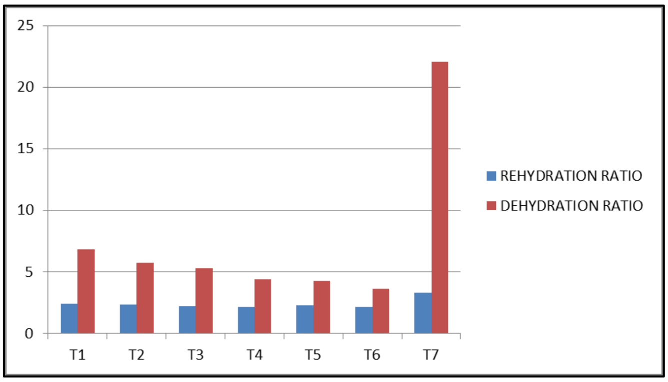

Fig 2: Effect of sugar concentrations on dehydration ratio (%), rehydration ratio (%) on osmotic dehydration of pineapple after drying

Conclusion

From the above experiment it is concluded that pineapple slices treated with different sugar syrup concentrations in the process of osmotic dehydration followed by tray drier the physical quality characteristics were observed. Results revealed that weight loss, rehydration and dehydration ratio (%) were highest in control and maximum in T_1 (35°B), whereas dry weight (g/100g) is highest in T_6 (60°B) and lowest in control (4.53%) Thus, it is concluded that weight loss, dehydration and rehydration ratio are found in control and maximum values are observed in T_1 (35°B). However the dry weight (g/100g) is found highest (25.21g/100g) in T_6 (60°B).

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