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# Impact of Different Drying Temperatures and Osmotic Treatments on Quality of Pineapple Slices during Storage

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**ABSTRACT**

The investigation was carried out using different drying temperatures and osmotic treatments. Storage study was also carried out for a period of 3 months for pineapple slices packed in HDPE bags. The effect on dehydrated pineapple samples determined by moisture content, ash, ascorbic acid, rehydration ratio and pH content. The highest moisture value was found 8.22% for control sample dried at 50˚C after 90 days of storage while lowest 4.49% for 60˚Brix sample dried at 70˚C before storage. The highest ash value was found 3.80% 50°Brix treated sample dried at 50˚C before storage while lowest 0.80% for control sample dried at 70˚C after 90 days of storage. The highest ascorbic acid value was found 169.1 mg/100 g for 50°Brix treated sample dried at 50˚C before storage while lowest 79.8 mg/100 g for control sample dried at 70˚C after 90 days of storage. The highest rehydration ratio value was found 4.88 for control sample dried at 50˚C before storage while lowest 2.57 for 60˚Brix treated sample dried at 70˚C after 90 days of storage. The highest pH value was found 5.2 for 50˚Brix sample dried at 50˚C before storage while lowest was found 4.6 for control sample dried at 70˚C after 90 days of storage packed in HDPE bags. In most of the quality characteristics hot air oven drying at 50˚C for 50°Brix sugar solution treated sample presented better values in comparison to 60˚Brix and control samples.

**KEYWORDS**

Hot air oven; Osmotic dehydration; Ash; pH; Moisture content; Ascorbic acid and Rehydration ratio

## 1. INTRODUCTION

Pineapple 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, chunk and dice, pineapple juice, fruit salads, sugar syrup, alcohol, citric acid, pineapple chips and pineapple puree. 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 [1]. Pineapple is one of the most important fruit crops of north eastern India especially in Arunachal Pradesh. 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, Nigeria, Kenya, Indonesia, Mexico, Costa Rica and these countries provide most of the remaining fruit.

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Many processing techniques can be employed to preserve fruits and vegetables such as drying and dehydration it is one of the most important operations that are widely practiced because of considerable saving in packaging, storage etc. Osmotic dehydration has received greater attention in recent years as an effective method for preservation of fruits [2]. Being a simple process, it facilitates processing of tropical fruits such as banana, sapota, pineapple, mango etc., with retention of initial fruit characteristics viz., colour, aroma and nutritional compounds [3]. It is less energy intensive than air or vacuum drying processes because it can be conducted at low or ambient temperature. It has potential advantages in processing industry that maintain the food quality and also preserve the wholesomeness of the food [4]. It involves dehydration of fruit slices in two stages, removal of water using as an osmotic agent (osmotic concentration) and subsequent dehydration in a dryer where moisture content is further reduced to make the product shelf stable [5].

Drying is the most common form of food preservation and extends the shelf life of the food. The major objective in drying agricultural products is the reduction of the moisture content to a level, which allows safe storage over an extended period. Also, it brings about substantial reduction in weight and volume, minimizing packaging, storage and transportation costs [6]. In the Mediterranean countries the traditional technique of fruit and vegetable drying is by using the sun. This technique has the advantages of simplicity and the small capital investments, but it requires long drying times that may have adverse consequences to the product quality, the final product may be contaminated from dust and insects, suffer from enzyme and microbial activity. In order to improve the quality, the traditional sun drying technique should be replaced with industrial drying methods. By keeping the view to avoid disadvantages it is necessary to use the other mechanical drying hot air oven [7,8]

Hot air oven-drying or convective drying applies hot air to remove water from the food substances. Application of oven-drying in combination with osmotic dehydration was studied on pineapple [9]. Preservation of pineapple slices gained attention in recent years to increase the shelf life and easy handling. The objectives of this study is to determine the physico-chemical attributes of the hot air oven dried pineapple slices [10].

## 2. MATERIALS AND METHODS

Studies were carried out to evaluate the physico-chemical characteristics of the dried pineapple slices. The experiments were conducted in the Process and Food Engineering Laboratory of the Department of Agriculture Engineering, S.V.P.U.A & T. Meerut.

***Raw Materials***

Fresh, good quality pineapple was taken from the local market of Meerut. Pineapples with average weight were chosen for this study. The white sugar were also purchased from the local market.

***Samples preparation with treatments***

The pineapples were washed to remove soil particles attached to the surface. Then sorted cleaned pineapple was cut into 4.5 mm thickness. The sliced pineapple was subjected to pre-treatment.

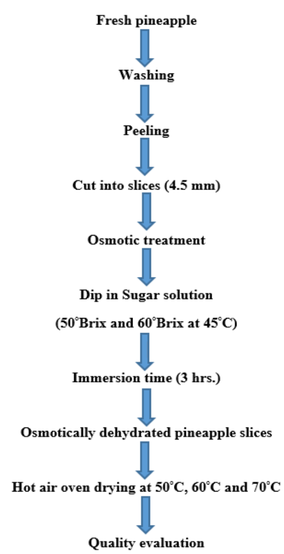


**Figure 1:** Flow chart of osmotic dehydration process [12].

In this, the pineapple slices were dipped in osmotic solution having sugar concentration ranging from $50^{\circ}$Brix to $60^{\circ}$Brix at $45^{\circ}$C temperature for 180 minutes. Then slices were removed from the solution and the surface moisture was removed by blotting paper than after slices were subjected to drying in hot air oven at 50˚C, 60˚C and 70˚C. After drying slices are packaged in HDPE bags and stored at room temperature [11]. The process flow chart for preparation of dried pineapple slices is presented in Figure 1.

### *Hot air oven drying*

The osmotic treated and untreated pineapple slices were dried in the hot air oven. A hot air oven was used for dehydrated pineapple experiments [13]. The pineapple slices were placed uniformly on aluminum trays and experiments were conducted at 50˚C, 60˚C and 70˚C temperature. Weight losses (moisture content) of sample during drying process was determined, every 30 minutes interval and continued until no further weight changes were observed. After drying slices are packaged in HDPE bags and stored at room temperature.

### *Packaging of the dried pineapple slices*

The dried pineapple slices were packed in HDPE bags and were again kept in moisture proof pouches and heat-sealed. The samples were stored at ambient condition for further quality analysis.

### *Determination of proximate composition*

The pineapple slices were analyzed for proximate composition, moisture content, ash content, ascorbic acid, rehydration ratio and pH content using standard methods for all the chemical parameters in triplicate.

### *Moisture content*

The moisture content was determined based on AOAC method [14]. In brief, each samples of pineapple slices (5 g each) were weighed and then dried in an oven at 135˚C for 2 hours. The samples were taken out from the oven, cooled in a desiccator and weighed.

### *Calculation*

$$\text{Moisture Content (\%)} = \frac{(W1-W2)}{W1} \times 100$$

Where:

W1 = weight (g) of sample before drying.

W2 = weight (g) of sample after drying.

### *Ash content*

Total ash was determined gravimetrically by taking known weight of samples (5 g) in tarred silica crucibles. The dried samples after moisture determination were slowly heated over hot plate until the bulk of organic matter was burnt. The crucibles were then placed in a muffle furnace for ash at 550˚C to obtain a carbon free white ash with a constant weight [15]. Ash content of sample was then calculated and expressed as per cent on fresh weight basis.

$$\text{Ash Content (\%)} = \frac{final\ weight\ of\ ash}{initial\ weight\ of\ sample} \times 100$$

### *pH Content*

pH values were determine using the digital pH meter as recommended Ranganna [16].

pH is the measurement of the logarithm of inverse of hydrogen ion concentration in the solution or pH is the measurement of $H^+$ activity.

$$pH = -\log (H^+)$$

Where,

$H^+$ = hydrogen ion concentration (g/liter)

### *Procedure*

The electronic pH meter was first calibrated using 7 pH and 4 pH standard buffer solutions. Then electrode was dipped in the test solution (prepared by mixing 10 ml of sample into 100 ml of distilled water followed by filtration) and the temperature knob was adjusted to temperature of test solution. The function selector switch was set to pH and reading of digital display was allowed to stabilize before it was noted.

### *Rehydration ratio*

Rehydration tests for dehydrated samples were carried out by immersing 5 g sample in 50 ml distilled water at 35°C in a 100 ml beaker kept in a hot water bath to maintain a water temperature of 35˚C for 5 hours [17]**.** Dehydrated samples were evaluated for rehydration ratio, from the weight before and after the rehydration.

$$\text{Rehydration ratio (RR)} = \frac{C}{D}$$

Where:

C = Drained weight of rehydrated sample (g).
D = Test weight of dehydrated samples (g).

### *Ascorbic acid*

Ascorbic acid (mg/100 gm) was determined by the procedure proposed by Ranganna [18].

### *Standardization of dye*

5 ml of standard ascorbic acid solution was taken and 5 ml of $HPO_3$ was added. Fill a micro burette with the dye. Titration was done with the dye solution to pink color which should persist for 15 seconds. Determination of dye factor i.e. mg of ascorbic acid per ml of the dye, using formula proposed by Ranganna [18].

$$\text{Dye factor} = \frac{0.5}{\text{Titre}}$$

### *Preparation of sample*

10 g of sample was taken, blend with 3% $HPO_3$ and make up to 100 ml with $HPO_3$. Filter or Centrifuge.

### *Calculation*

Ascorbic acid content was calculated for the sample from following equation:

$$\text{Ascorbic acid mg/100 g} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume up} \times 100}{\text{Adequate of extract taken for estimation} \times \text{volume of sample}}$$

## 3. RESULTS AND DISCUSSION

### *Effect on moisture content*

The moisture of the samples having dehydrated pineapple slices with control and osmotic treated pineapple slices with 50˚Brix and 60˚Brix. During room temperature storage, it was observed that the moisture content of all samples was found in increasing trend at 0 days, 30 days, 60 days and 90 days of storage. The highest moisture value was found 8.22% for control sample dried at 50˚C after 90 days of storage while lowest 4.49% for 60˚Brix sample dried at 70˚C before storage (initial stage of storage) packed in HDPE bags.

| Quality parameter | Temperatures | 50˚C | | | 60˚C | | | 70˚C | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Storage period (Days) | $T_0$ | $T_1$ | $T_2$ | $T_0$ | $T_1$ | $T_2$ | $T_0$ | $T_1$ | $T_2$ |
| Moisture content | 0 | 7.82 | 5.55 | 5.11 | 7.66 | 5.29 | 5.04 | 6.22 | 4.88 | 4.49 |
| | 30 | 7.98 | 5.67 | 5.43 | 7.78 | 5.47 | 5.25 | 6.32 | 4.98 | 4.55 |
| | 60 | 8.10 | 5.75 | 5.65 | 7.89 | 5.69 | 5.46 | 6.54 | 5.11 | 4.62 |
| | 90 | 8.22 | 5.98 | 5.88 | 7.95 | 5.90 | 5.68 | 6.72 | 5.33 | 4.84 |

$T_0$ = Control $T_1$ = 50˚Brix $T_2$ = 60˚Brix

**Table 1.** Effect of solution and temperature on moisture content of pineapple slices during storage dried at 50˚C, 60˚C and 70˚C.

The higher moisture content causing grow of micro-organisms and lowering protein and other nutritional parameters. It is observed that the moisture content gradually increased due to water vapor transmission through HDPE bags. The complete data are show in Table 1.

### *Effect on pH Content*

The pH of osmotic treated with sugar 50˚Brix and 60˚Brix and control pineapple samples were studied. It was observed that pH content of all samples was found in decreasing trend at 0 days, 30 days, 60 days and 90 days of storage The highest pH value was found 5.2 for 50˚Brix sample dried at 50˚C before storage (initial stage of storage) while lowest was found 4.6 for control sample dried at 70°C after 90 days of storage packed in HDPE bags. The slightly decrease in pH of pineapple slices may be due to reduction of acidity with the increase of storage period. The 50˚Brix and 60˚Brix samples are decreasing the pH level due to increasing the storage period. The complete data are show in Table 2.

| Quality parameter | Temperatures | 50°C | | | 60°C | | | 70°C | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Storage period (Days) | $T_0$ | $T_1$ | $T_2$ | $T_0$ | $T_1$ | $T_2$ | $T_0$ | $T_1$ | $T_2$ |
| pH content | 0 | 5.1 | 5.5 | 5.4 | 5.0 | 5.4 | 5.3 | 4.9 | 5.3 | 5.2 |
| | 30 | 5.0 | 5.4 | 5.3 | 4.9 | 5.3 | 5.2 | 4.8 | 5.2 | 5.1 |
| | 60 | 4.9 | 5.3 | 5.2 | 4.9 | 5.2 | 5.1 | 4.7 | 5.1 | 5.0 |
| | 90 | 4.8 | 5.2 | 5.0 | 4.8 | 5.1 | 5.0 | 4.6 | 5.0 | 4.9 |

$T_0$ = Control $T_1$ = 50˚Brix $T_2$ = 60˚Brix

**Table 2:** Effect of solution and temperature on pH content of pineapple slices during storage dried at 50˚C, 60˚C and 70˚C.

### *Effect on ash content*

The ash content of the samples having dehydrated pineapple slices with control and osmotic treated pineapple slices with 50°Brix and 60°Brix. During room temperature storage, it was observed that ash content of all samples was found in decreasing trend at 0 days, 30 days, 60 days and 90 days of storage.

| Quality parameter | Temperatures | 50°C | | | 60°C | | | 70°C | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Storage period (Days) | $T_0$ | $T_1$ | $T_2$ | $T_0$ | $T_1$ | $T_2$ | $T_0$ | $T_1$ | $T_2$ |
| Ash content | 0 | 0.96 | 3.80 | 2.30 | 0.85 | 3.70 | 2.18 | 0.83 | 3.60 | 2.14 |
| | 30 | 0.95 | 3.78 | 2.28 | 0.84 | 3.68 | 2.17 | 0.82 | 3.58 | 2.13 |
| | 60 | 0.94 | 3.76 | 2.27 | 0.83 | 3.66 | 2.15 | 0.81 | 3.57 | 2.12 |
| | 90 | 0.92 | 3.74 | 2.25 | 0.82 | 3.65 | 2.14 | 0.80 | 3.55 | 2.10 |

$T_0$ = Control $T_1$ = 50˚Brix $T_2$ = 60˚Brix

**Table 3:** Effect of solution and temperature on ash content of pineapple slices during storage dried at 50°C, 60°C and 70°C.

The highest ash value was found 3.80% 50°Brix treated sample dried at 50°C before storage (initial stage of storage) while lowest 0.80% for control sample dried at 70°C after 90 days of storage packed in HDPE bags. The complete data are show in Table 3.

### *Effect on ascorbic acid*

The ascorbic acid were examined from pineapple samples controlled, 50˚Brix and 60˚Brix treated during 0 days, 30 days, 60 days and 90 days storage period respectively. The ascorbic acid was observed that of all samples was decreasing trend during storage. The highest ascorbic acid value was found 169.1 mg/100 g for 50˚Brix treated sample dried at 50˚C before storage (initial stage of storage) while lowest 79.8 mg/100 g for control sample dried at 70˚C after 90 days of storage packed in HDPE bags. The complete data are show in Table 4.

| Quality parameter | Temperatures | 50°C | | | 60°C | | | 70°C | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Storage period (Days) | $T_0$ | $T_1$ | $T_2$ | $T_0$ | $T_1$ | $T_2$ | $T_0$ | $T_1$ | $T_2$ |
| Ascorbic acid | 0 | 90.3 | 169.1 | 130.0 | 87.4 | 166.1 | 127.4 | 81.1 | 162.5 | 125.7 |
| | 30 | 90.0 | 169.0 | 129.5 | 87.0 | 165.8 | 127.0 | 80.7 | 162.1 | 125.3 |
| | 60 | 89.8 | 168.6 | 129.4 | 86.5 | 165.3 | 126.8 | 80.5 | 161.8 | 124.8 |
| | 90 | 89.6 | 168.1 | 128.9 | 86.3 | 164.7 | 126.4 | 79.8 | 161.3 | 124.3 |
| $T_0$ = Control $T_1$ = 50˚Brix $T_2$ = 60˚Brix | | | | | | | | | | |

**Table 4**: Effect of solution and temperature on ascorbic acid of pineapple slices during storage dried at 50˚C, 60˚C and 70˚C.

### *Effect on rehydration ratio*

Rehydration ratio of all samples was in decreasing trend at 0 days, 30 days, 60 days and 90 days of storage at room temperature conditions. The highest rehydration ratio value was found 4.88 for control sample dried at 50˚C before storage (initial stage of storage) while lowest 2.57 for 60˚Brix treated sample dried at 70˚C after 90 days of storage packed in HDPE bags. The complete data are show in Table 5.

| Quality parameter | Temperatures | 50°C | | | 60°C | | | 70°C | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Storage period (Days) | $T_0$ | $T_1$ | $T_2$ | $T_0$ | $T_1$ | $T_2$ | $T_0$ | $T_1$ | $T_2$ |
| Rehydration ratio | 0 | 4.88 | 3.24 | 2.88 | 4.42 | 3.14 | 2.76 | 4.38 | 3.10 | 2.62 |
| | 30 | 4.87 | 3.23 | 2.87 | 4.41 | 3.13 | 2.75 | 4.37 | 3.09 | 2.61 |
| | 60 | 4.85 | 3.21 | 2.85 | 4.39 | 3.11 | 2.73 | 4.35 | 3.07 | 2.59 |
| | 90 | 4.83 | 3.19 | 2.83 | 4.37 | 3.09 | 2.71 | 4.33 | 3.05 | 2.57 |
| $T_0$ = Control $T_1$ = 50˚Brix $T_2$ = 60˚Brix | | | | | | | | | | |

**Table 5:** Effect of solution and temperature on rehydration ratio of pineapple slices during storage dried at 50˚C, 60˚C and 70˚C.

## 4. CONCLUSION

The osmo dried pineapple slices were stored and the study was carried out for at 0 days, 30 days, 60 days and 90 days at room temperature conditions using HDPE packaging material. Among the three different temperatures are used in this experiment, hot air oven dried 50˚C samples attained better quality characteristic as compared to 60˚C and 70˚C dried samples. 50˚Brix sugar treated at 50˚C samples were found to have most protective effect on quality process during storage period. Storage studies carried out for period of almost 3 months showed highly effectiveness of treatments during storage. Pineapple slices was safe for consumption up to 3 months at ambient storage temperature, and it was packed in HDPE bags.

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