

EFFECT OF STORAGE PERIOD WITH DIFFERENT PACKAGING MATERIALS ON PHYSICO CHEMICAL PARAMETERS AND SHELF LIFE OF OSMOTICALLY DEHYDRATED PINEAPPLE CUBES (*Ananas comosus*.var.*Queen*)

Abstract: The present study was carried out to determine the suitable packaging material for osmo dehydrated pineapple product and also to assess quality of the product during storage. Pineapple slices were steam blanched for 2 min, followed by immersion in osmotic solution containing sucrose syrup of three concentrations *i.e* of 50°Brix, 60°Brix and 70°Brix in combination with 0.1% KMS + 0.3% citric acid + 0.1 % sodium benzoate followed by drying in two methods *i.e.* cabinet tray drying and hot air oven drying at 60°C until the moisture content of the product attained equilibrium. The physico-chemical properties and evaluated for the four months of storage period. During storage period, moisture%, reducing sugars and pH showed an increasing trend while other parameters like TSS °Brix, non-reducing sugars %, total sugars%, acidity%, ascorbic acid%, organoleptic properties showed a decreasing trend. Among the packaging materials, osmo-dehydrated pineapple cubes packed in Aluminum laminated polyethylene of 200 gauge stored at ambient temperature were found to be the best followed by high density polyethylene packaging of 200 gauge in retaining various attributes like minimal moisture gain, better retention of TSS °Brix, acidity%, ascorbic acid% and organoleptic properties when compared to the other packaging material during the four months storage period.

Introduction:

Fruits and vegetables play an significant role in human nutrition as they are supplying complex carbohydrates and proteins, essential minerals, vitamins and dietary fiber [Farkas *et al.* 1969]. Pineapple (*Ananas comosus* (L.) Merr.) is one of the commercially important temperate fruit crops of tropical world with edible multiple fruit consisting of coalesced berries, and the most economically significant plant in the *Bromeliaceae* family. Pineapples may be cultivated from a crown cutting of the fruit, possibly flowering in 20–24 months and fruiting in the following six months. The main producer countries reported are Brazil, Philippines, Costa Rica, Thailand and China. Pineapple fruit accepted by majority of consumers around the world, mainly due to its sensory characteristics, pleasant flavour, distinct aroma, taste and absence of seeds. Furthermore, this fruit contains a proteolytic enzyme called bromelin, which aids in reducing inflammations and also contributes to good digestion . The major pineapple producing states in India are West Bengal, Assam, Karnataka, Tripura, Bihar, Manipur, Meghalaya, Nagaland, Kerala, Arunachal Pradesh, Goa, Jharkhand, Madhya Pradesh, Odisha, Sikkim, Tamil Nadu and Uttarakhand. The aim of this study is to enhance the shelf life of the Pineapple by processing it into a value added dry fruit chunks by using Osmo solar dehydration technology which can be rehydrated and used in fruit salads, laddus, bakery and confectionary items. Though pineapple is having a better post-harvest life, but during the glut season the growers are forced to sell the produce at meager price since the small farmers cannot afford to produce processed forms either canned slices or juice due to higher in processing cost. Value addition has become the watchword as it involves processing and preservation of the commodities which otherwise get disposed at cheaper price or lost without intellectual and technical inputs. In order to prevent losses, avoid gluts in the season and to ensure optimum utilization, it is required to subject these

perishables for processing into more stable value-added products. Osmotic dehydration is a simpler preservation technique that does not require any sophisticated equipment. It is a process that entails the partial removal of water from fruits which is based on a tendency to reach equilibrium between osmotic pressure inside the biological cells (fruit) and the surrounding osmotic solution, which has an increased osmotic pressure caused by high concentration of soluble osmotic agent. Unlike conventional drying processes, osmotic dehydration does not produce a stable product and as such further steps like drying, freezing, pasteurization, canning and frying, or the addition of preservatives are needed (Nanjundaswamy et al. [1978](#)). Therefore, storage stability of osmotically pre-treated products needs to be evaluated critically in order to ensure microbial safety of such products. Therefore, the present work was carried out to evaluate the stability of osmotically pre-treated and subsequently vacuum dried pineapple cubes using three different types of packaging materials on storage

Materials and Methods:

The present study was conducted at Post harvest Laboratory, department of Fruit science at college of Horticulture, Rajendranagar, Hyderabad, SKLTSHU during the year 2017-2018. Pineapple (*Ananas comosus* L.) cv. queen fruits of commercial maturity were collected from gudimalkapoor market, Hyderabad. The fruits, after receiving in the laboratory, were crowned and washed thoroughly in running tap water and air-dried to remove the surface moisture. They were then manually peeled and cored. The prepared fruits were then cut in to cubes measuring $10 \pm 0.5 \text{ mm}^3$ using a sharp knife from the central portion of fruit. The cut surfaces of the cubes were blotted gently with a tissue paper to remove the surface moisture before the osmotic treatment. Three different concentrations of sugar syrup i.e. 50, 60 and 70°Brix were prepared. One kg of sucrose and one kg of water were used to prepare 50°Brix sucrose syrup concentration, 1.2 kg of sucrose and 0.8 kg of water were mixed to prepare 60°Brix sucrose syrup concentration and also 1.4 kg of sucrose and 0.6 kg of water were used to prepare 70°Brix sucrose syrup concentration as fruit pieces to sucrose syrup ratio was 1:2 (Rashmi et al. 2005 and Noroes et al. 2010). During heating of the sucrose syrup solution, 0.3% per cent of citric acid was added. After adjusting the concentration of sucrose syrup, 0.1% of potassium metabisulphite (KMS) and 0.1% Sodium benzoate was added as preservative in sucrose syrup in dissolved form when the syrup got cooled (Chavan *et al.* 2010). The prepared fruit pieces were put in sucrose syrup solution and left for 24 h for osmosis. After 24h, the fruit pieces were drained out of the osmotic solution. Osmosed pineapple cubes were drained and loaded uniformly over stainless steel trays. Before loading, the cubes are shade dried to avoid browning. Inner and bottom of the tray was wiped with glycerin to avoid metal contact. Loaded stainless steel trays were kept in a cabinet tray drier (Ultra Fabtech) and hot air oven (Vista Biocell) for dehydration with intermittent turning of cubes for quick drying. Fruit pieces were dried at 60°C temperature until constant weight is obtained. Dried cubes under each treatment were inspected and the small bits and inferior cubes were discarded before packaging. The dehydrated pineapple cubes were packed in Aluminium laminated polyethylene of 200 gauge & High density polyethylene packaging of 200 gauge and were sealed. The packages were stored under ambient temperature respectively for 4 months. Three treatments i.e. Sucrose concentration 60°Brix. + cabinet tray drying, Sucrose concentration 60°Brix. + hot air oven drying and Sucrose concentration 70°Brix. + cabinet tray drying were chosen for experiment for storage in different packaging material. These treatments were packed in two different packaging materials (High density polyethylene packaging of 200 gauge and Aluminium

laminated polyethylene packaging of 200 gauge) storage at ambient temperature. This experiment was carried out in complete randomized design with four replication. The data was recorded on TSS ($^{\circ}$ Brix), Reducing sugars (%), Non reducing sugars (%), Total sugars (%), Acidity (%), pH, Ascorbic acid (mg /100g⁻¹) and Moisture (%).

Results and Discussions:

TSS ($^{\circ}$ Brix)

Among the treatments, the highest mean TSS (74.49 $^{\circ}$ Brix) was observed in T₃C₁- osmodehydrated cubes packed in aluminum laminated polyethylene of 200 gauge covers stored at ambient temperature (25°C±2°C) followed by T₃C₂- osmodehydrated cubes packed in High density polyethylene packaging of 200 gauge (73.24 $^{\circ}$ Brix). Whereas, the lowest mean TSS was observed in T₁C₂ (67.44 $^{\circ}$ Brix) As the storage period increased there was a continuous significant decline in mean TSS ($^{\circ}$ Brix) from the initial to fourth month storage irrespective of the treatments. There were significant differences among treatments with respect to the TSS ($^{\circ}$ Brix) and the duration of storage. With any given treatment, the TSS ($^{\circ}$ Brix) decreased significantly till fourth month (Table 1). The results of the present investigation reveals that osmo-dehydrated pineapple cubes packed in aluminum laminated polyethylene of 200 gauge have retained maximum TSS ($^{\circ}$ Brix) during storage as compared to osmodehydrated cubes packed in high density polyethylene packaging of 200 gauge bags. The TSS ($^{\circ}$ Brix) content of dehydrated pineapple cubes decreased during the storage. As a result of increase in moisture content the TSS decreased during storage which might be due to the hygroscopic nature of dried product and permeability characteristics of the packaging materials. The similar findings was reported by Patel *et al.* (2013) in Aonla.

Reducing sugars (%)

On first and second month of storage, the highest reducing sugar was observed in treatment T₁C₁ (35.48%, 36.82%) followed by T₁C₂ (34.83%, 36.09%). On the third month of storage the highest reducing sugars was also observed in treatment T₁C₁ (37.46%) followed by T₁C₂ (37.05%) and T₂C₁ (36.85%) over the other treatments. On the fourth month of storage the highest reducing sugars was observed in treatment T₃C₁ (39.79%) followed by T₁C₁ (39.75%). While on first and second month of storage the lowest mean reducing sugars was observed in T₃C₂ (32.61%, 34.63%) followed by T₃C₁ (33.35 % and 35.25%) respectively. In third and fourth month of storage the lowest mean reducing sugars was observed in T₃C₁ (34.16%) and T₂C₂ (38.17%) respectively (Table 2). The results of the present investigation reveals that osmo-dehydrated pineapple cubes packed in aluminum laminated polyethylene of 200 gauge have retained maximum reducing sugars during storage as compared to High density polyethylene packaging of 200 gauge bags. The reducing sugar content of dehydrated pineapple cubes increased during the storage. These results was similar to the findings of Patel *et al.* (2013) in Aonla.

Non Reducing sugars (%)

On first and second month of storage, the highest non-reducing sugar(%) was observed in treatment T₃C₁ (39.82%, 36.52%) followed by T₃C₂ (39.40%, 36.32%). On the third month of storage the highest non-reducingsugars(%) was observed in treatment T₃C₁ (36.32%) followed by T₃C₂ (34.99) over the other treatments (Table 3). On the fourth month of storage the highest non-reducingsugars(%) was observed in treatment T₃C₁ (29.62%) which was on par with T₃C₂ (28.82%). While on first, second month of storage the lowest mean non-reducing sugars (%) was observed in T₂C₁ (30.97%, 28.96%) respectively followed by T₂C₂ (31.06%, 28.99%) while in third and fourth month of storage the lowest mean non-reducing sugars (%). The results of the present investigation reveals that osmo-dehydrated pineapple cubes packed in aluminium laminated polyethylene of 200 gauge have retained maximum non reducing sugars during storage as compared to High density polyethylene packaging of 200 gauge bags. These results was in conformity with the findings of Patel *et al.* (2013) in Aonla.

Total sugars

On first, second, third and fourth month of storage, the highest total sugars (%) was observed in treatment T₃C₁ (72.75, 71.58, 70.81 and 68.62 %) followed by T₃C₂ (72.44, 71.16, 70.32, 68.15%). While on first, second, third and fourth month of storage the lowest mean total sugars (%) was observed in T₂C₂ (65.19, 64.24, 63.29 and 62.16%) followed by T₂C₁ (65.74, 64.80, 63.84 and 62.46%) respectively (Table 4). With increase in the storage period, there was a significant decrease in the total sugars in all the treatments. The results in the present investigation reveals that osmo-dehydrated pineapple cubes packed in aluminium laminated polyethylene of 200 gauge have retained maximum total sugars (%) during storage as compared to high density polyethylene packaging 200 of gauge bags upto four months of storage. This was supported by the findings Giraldo *et al.* (2003) in mango, and Paul *et al.* (2012) in pineapple.

Acidity (%)

On all the days of storage T₁C₁ recorded the highest acidity (%) (1.61, 1.50, 1.49 and 1.44%) followed by T₂C₁ recorded the (1.56, 1.47, 1.44 and 1.41 %). Lowest values for acidity (%) was recorded in T₁C₂ (1.32%) during first month, T₂C₂ (1.31%) during second month, T₃C₂ (1.29%) during third month and T₂C₂ (1.25) during fourth month respectively (Table 5). The results of the present investigation reveals that osmo-dehydrated pineapple cubes packed in aluminium laminated polyethylene of 200 gauge have retained maximum acidity (%) during storage as compared to high density polyethylene packaging of 200 gauge bags upto four months of storage. There is a decline in acidity during storage this might be due to leaching of acid from fruits The similar results was also recorded by Patel *et al.* (2013) in aonla.

p^H

On the first month of storage T₃C₁ recorded the highest P^H (3.67) followed by T₃C₂ (3.60), while T₁C₂ recorded the lowest P^H (3.23). On the second month of storage T₃C₁ recorded the highest P^H (3.73) which was followed by T₁C₁ (3.71), T₂C₁ (3.68) and T₃C₂ (3.64), T₁C₂ (3.55) while T₂C₂ recorded the lowest P^H (3.38). On the third month of storage T₃C₁ recorded the highest P^H (3.858) which was followed by T₁C₁ (3.770), T₂C₁ (3.76), and T₁C₂ (3.75) while T₂C₂ recorded the lowest P^H (3.50). On the fourth month of storage T₃C₁ recorded the highest P^H (3.89) followed by T₁C₁ (3.84), T₂C₁ (3.81) and T₃C₂ (3.74), while T₂C₂ recorded the lowest P^H

(3.60) (Table 6) . The results in the present investigation reveals that osmo-dehydrated pineapple cubes packed in aluminium laminated polyethylene of 200 gauges have retained better pH during storage as compared to high density polyethylene packaging of 200 gauge bags upto four months of storage. This may be due to decrease in acidity and also increase in moisture level during the storage. Similar type of observations was recorded by Kumar (2013) in osmo-dehydrated carrot slices and Patel *et al.* (2013) in aonla.

Ascorbic acid (%)

On the first month of storage T₁C₁ recorded the highest ascorbic acid (%) (29.33%) followed by T₁C₂ (29.22%), while T₃C₂ recorded the lowest ascorbic acid (%) (24.14%). On the second month of storage T₁C₁ recorded the highest ascorbic acid (%) (27.35%) followed by T₁C₂ (27.07), T₂C₁ (25.66%) and T₂C₂ (25.55%), while T₃C₂ recorded the lowest ascorbic acid (%) (21.75%). On the third month of storage T₁C₁ recorded the highest ascorbic acid (%) (25.06%) followed by T₁C₂ (25.17%), T₂C₁ (24.56%) and T₂C₂ (24.20), while T₃C₂ recorded the lowest ascorbic acid (%) (19.64%). On the fourth month of storage T₁C₁ recorded the highest ascorbic acid (%) (22.83%) which followed by T₁C₂ (22.11), T₂C₁ (21.18%) and T₂C₂ (20.51%), while T₃C₂ recorded the lowest ascorbic acid (%) (17.44%) (Table 8). The results in the present investigation reveals that osmo-dehydrated pineapple cubes packed in aluminium laminated polyethylene of 200 gauges have retained maximum ascorbic acid (%) during storage as compared to High density polyethylene packaging of 200 gauge bags upto four months of storage this may be due to leaching of ascorbic acid in hypertonic solution also plays a little role in loss of ascorbic acid. A similar finding was recorded by Rashmi *et al.* (2005) and Surabhi *et al.* (2007) in osmo-dehydrated pineapple slices.

Moisture content:

On the first month of storage T₂C₂ recorded the highest moisture content (12.72%) followed by T₃C₂ (12.63%), while T₁C₁ recorded the lowest moisture content (12.42%). On the second month of storage T₃C₂ recorded the highest moisture content (13.92%) followed by T₃C₁ (13.17%), T₂C₂ (12.90%) and T₁C₂ (12.83%), while T₂C₁ recorded the lowest moisture content (12.71%). On the third month of storage T₃C₂ recorded the highest moisture content (13.56%) followed by T₂C₂ (13.41%), T₃C₁ (13.21%) and T₂C₁ (12.96%), while T₁C₁ recorded the lowest moisture content (12.16%). On the fourth month of storage T₃C₂ recorded the highest moisture content (14.23%) followed by T₃C₁ (13.89%), T₂C₂ (13.85%) and T₂C₁ (13.56%), while T₁C₁ recorded the lowest moisture content (13.10%) (Table 9). The results of the present investigation reveals that osmo-dehydrated pineapple cubes packed in aluminum laminated polyethylene of 200 gauges have retained less moisture content (%) during storage as compared to High density polyethylene packaging of 200 gauge bags up to four months of storage. Moisture content exhibited an increasing trend with increase in storage period. The changes in moisture content may be due to differences in water vapour permeability of the packaging film and aluminum foil having very low water vapour transmission rate. The increase moisture content might be due to the higher relative humidity that was absorbed by the fruit slices during storage period. Similar findings was reported in dehydrated apple rings by Ahsan *et al.* (2008) and Saji *et al.* (2022).

Conclusion:

Among the packaging materials, osmo-dehydrated pineapple cubes packed in aluminum laminated polyethylene packaging of 200 gauge were found to be the best in retaining various attributes like minimal moisture gain, better retention of TSS °Brix, acidity %, ascorbic acid %, and organoleptic properties. Thus it can be concluded that Osmo dehydrated pineapple packed in aluminium pouch is best in shelf stability for a period of 6 months.

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Table 1- Effect of packaging materials on total soluble solids (TSS °Brix) of osmo - dehydrated pineapple cubes during storage.

Treatments	Storage period (months)			
	1	2	3	4
T ₁ C ₁	69.030	68.798	67.833	65.780
T ₁ C ₂	67.443	66.733	66.070	65.240
T ₂ C ₁	68.493	68.138	66.728	65.020
T ₂ C ₂	67.508	66.480	65.985	65.000
T ₃ C ₁	74.490	74.433	73.895	72.798
T ₃ C ₂	73.235	72.520	73.253	72.443
C.D. at 5 %	2.461	3.756	3.962	3.558
S.Em. ±	0.822	1.256	1.323	1.188
CV%	2.347	3.609	3.838	3.510

Table 2.: - Effect of packaging materials on reducing sugars of osmo - dehydrated pineapple cubes during storage

Treatments	Storage period (months)			
	1	2	3	4
T ₁ C ₁	35.488	36.823	37.468	39.755
T ₁ C ₂	34.828	36.095	37.048	39.305
T ₂ C ₁	34.683	35.818	36.845	38.775
T ₂ C ₂	34.223	35.270	36.128	38.178
T ₃ C ₁	33.350	35.253	34.160	39.790
T ₃ C ₂	32.613	34.633	35.330	38.528
C.D. at 5 %	1.182	1.198	2.070	1.188
S.Em. ±	0.395	0.650	0.691	0.680
CV%	2.308	3.649	3.824	3.481

Table 3.: - Effect of packaging materials on non-reducing sugars of osmo - dehydrated pineapple cubes during storage

Treatments	Storage period (months)			
	1	2	3	4
T ₁ C ₁	32.425	30.60	28.078	24.850

T ₁ C ₂	32.133	30.00	28.143	24.900
T ₂ C ₁	30.970	28.96	27.165	23.985
T ₂ C ₂	31.065	28.99	26.995	23.685
T ₃ C ₁	39.828	36.65	36.32	29.620
T ₃ C ₂	39.400	36.52	34.993	28.825
C.D. at 5 %	1.229	1.714	1.767	1.375
S.Em. ±	0.410	0.572	0.590	0.459
CV%	2.393	3.582	3.897	3.532

Table 4: Effect of packaging materials on total sugars of osmo - dehydrated pineapple cubes during storage

Treatments	Storage period (months)			
	1	2	3	4
T ₁ C ₁	67.620	66.822	65.608	64.660
T ₁ C ₂	67.253	66.698	65.115	64.155
T ₂ C ₁	65.748	64.808	63.840	62.460
T ₂ C ₂	65.193	64.238	63.293	62.163
T ₃ C ₁	72.750	71.580	70.810	68.615
T ₃ C ₂	72.440	71.158	70.322	68.148
C.D. at 5 %	2.408	3.651	3.328	3.408
S.Em. ±	0.804	1.219	1.278	1.138
CV%	2.348	3.610	3.845	3.501

Table 5: - Effect of packaging materials on acidity of osmo - dehydrated pineapple cubes during storage

Treatments	Storage period (months)			
	1	2	3	4
T ₁ C ₁	1.613	1.500	1.495	1.440
T ₁ C ₂	1.320	1.353	1.315	1.253
T ₂ C ₁	1.558	1.475	1.440	1.413
T ₂ C ₂	1.450	1.310	1.298	1.245
T ₃ C ₁	1.443	1.398	1.320	1.248
T ₃ C ₂	1.390	1.323	1.288	1.250
C.D. at 5 %	0.051	0.075	0.075	0.066
S.Em. ±	0.017	0.025	0.025	0.022
CV%	2.308	3.610	3.685	3.353

Table 6: Effect of packaging materials on P^H of osmo - dehydrated pineapple cubes during storage

Treatments	Storage period (months)
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	1	2	3	4
T ₁ C ₁	3.560	3.718	3.723	3.783
T ₁ C ₂	3.323	3.555	3.608	3.635
T ₂ C ₁	3.598	3.683	3.513	3.775
T ₂ C ₂	3.518	3.383	3.663	3.555
T ₃ C ₁	3.668	3.735	3.788	3.768
T ₃ C ₂	3.598	3.653	3.783	3.633
C.D. at 5 %	0.125	0.115	0.109	0.119
S.Em. ±	0.042	0.065	0.070	0.064
CV%	2.363	3.606	3.812	3.441

Table 7: - Effect of packaging materials on ascorbic acid of osmo - dehydrated pineapple cubes during storage

Treatments	Storage period (months)			
	1	2	3	4
T ₁ C ₁	29.338	27.350	25.605	22.838
T ₁ C ₂	29.223	27.073	25.170	22.113
T ₂ C ₁	28.800	25.665	24.565	21.188
T ₂ C ₂	28.468	25.550	24.205	20.515
T ₃ C ₁	26.043	23.363	21.633	18.343
T ₃ C ₂	24.148	21.753	19.645	17.440
C.D. at 5 %	0.951	1.386	1.328	1.049
S.Em. ±	0.318	0.463	0.444	0.350
CV%	2.297	3.684	3.780	3.433

Table 8: - Effect of packaging materials on moisture of osmo - dehydrated pineapple cubes during storage.

Treatments	Storage period (months)			
	1	2	3	4
T ₁ C ₁	12.428	12.750	12.165	13.108
T ₁ C ₂	12.548	12.838	12.755	13.713
T ₂ C ₁	12.633	12.713	12.968	13.565
T ₂ C ₂	12.728	12.900	13.415	13.853
T ₃ C ₁	12.405	13.175	13.215	13.895
T ₃ C ₂	12.638	13.920	13.565	14.230
C.D. at 5 %	0.653	0.713	0.753	0.703
S.Em. ±	0.146	0.238	0.251	0.242
CV%	2.329	3.652	3.862	3.524

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