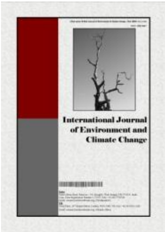

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Effect of Osmotic Dehydration on Drying Method and Physicochemical Properties of Pineapple (*Ananas comosus. var. Queen*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Osmotic dehydration in pineapple cubes by using sucrose solution is able to improve the quality like colour, aroma, texture, appearance as well as overall acceptability. The physico-chemical properties of the product were evaluated during the experiment. There were significant differences among different treatments. The range of recovery % (13.210%-14.780%), TSS°Brix (54.52°Brix-75.40°Brix), reducing sugars % (30.14%-39.80%), non-reducing sugars % (14.67%-43.70%), total sugars (50.20%-73.85%), acidity% (1.45%-1.67%), pH (3.32-3.95), ascorbic acid % (25.1%-35.1%) moisture% (9.95-15.90%), weight loss % (10.25%-32.04%), solid gain % (11.87%-18.65%), dehydrated yield % (13.02%-14.95%), dehydration ratio (6.75-7.77), rehydration ratio (1.23-1.71) were observed.

Keywords: Pineapple; drying method; osmosis; dehydration.

1. INTRODUCTION

Pineapple (*Ananas comosus. var. Queen*) is one of the commercially important fruit crops of tropical world belong to the family Bromeliaceae. According to Baker and Collins [1], it probably originated in central and southern Brazil, northern Argentina and Paraguay. It lends itself very well to processing. Due to this, it has become the most important commercial fruit of the world. In India pineapple is cultivated in 1, 16,000 ha with a production of 1980 million

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tonnes. According to Giovanonni [2], Pineapple fruit is non-climacteric in nature and has characteristic pleasant flavor., distinct aroma, exquisite taste and absence of seeds qualifies it as one of the choicest fruits throughout the world. Pineapple is a good source of vitamin A, vitamin C and is fairly rich in vitamin B. It also contains phosphorus and minerals like calcium, magnesium, potassium and iron [3]. The cultivar Queen is rich yellow in colour, weighing about 1-1.5 kg. The flesh is deep golden-yellow, less juicy than Kew, crisp textured with a pleasant aroma and flavour. Eyes are small and deep requiring a thicker cut when removing the skin. It is generally grown in India, Australia and South Africa. Osmotic dehydration is a water removal process that is based on placing the materials, such as fruits, into a concentrated solution of soluble solutes, having a high osmotic pressure and lower water activity. By doing so, a major part of water from the fruits is removed and the time needed for the relatively high temperature air drying decreased. Some other advantages of osmotically pre-drying product when compared to directly air drying the product are a lower drying time, better product quality, better textural quality, vitamin retention, flavor enhancement and color stabilization without sulphite addition [4,5]. Hence, osmotic treatments have been studied in combination with drying method and addition of preservatives. Dehydration is the process of water removal from the food under controlled conditions like temperature, relative humidity, air flow, etc. The main objective of dehydration is to reduce the bulk weight and to reduce water activity. This process is best suited for developing countries with poor thermal processing facilities.

2. MATERIALS AND METHODS

This study was conducted in the Post Harvest Laboratory, Department of Fruit science at college of Horticulture, Rajendranagar, Hyderabad, SKLTSHU during the year 2017-2018. This experiment was conducted in factorial Complete Randomised Design (CRD) with six treatments and four replications. Matured, fully ripe of uniform size, free from pest and disease damage and bruises pineapple fruits cv. Queen were procured from Navsari Fruit Market. The selected fruits were peeled using stainless steel knife. The edible fruit portion was cut into cubes after removing the core. Three different concentrations of sugar syrup *i.e.* 50, 60 and 70°Brix were prepared. 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 [6]. During osmosis process, water flows from the fruit pieces to the syrup and solute was moved into the fruit pieces. 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 (Rashmi et al. 2005). 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 and hot air oven for dehydration with intermittent turning of cubes for quick drying [6]. Fruit pieces were dried at 60°C temperature until constant weight is obtained. The data was recorded on Moisture (%), Weight loss (%), Solid gain (%), Dehydrated yield (%), Dehydration ratio, Rehydration ratio, TSS (°brix), Reducing sugars (%), Non reducing sugars (%), Total sugars (%), Acidity (%), pH and Ascorbic acid (mg/100g^{-1}) after osmosis. The details of factors and different treatments were given below.

Factor- I: (Sucrose ºBrix): Three

S_1:50ºBrix
S_2:60ºBrix
S_3:70ºBrix

Factor- II: (Drying method): Two

D_1: Cabinet tray drier
D_2: Hot air oven drying

Treatment combinations:

1. **S_lD_l**-Sucrose concentration 50ºBrix. + Cabinet tray drying
2. **S_1D_2**-Sucrose concentration 50ºBrix. + Hot air oven drying
3. **S_2D_1**-Sucrose concentration 60ºBrix. + Cabinet tray drying
4. **S_2D_2**-Sucrose concentration 60ºBrix. + Hot air oven drying
5. **S_3D_1**-Sucrose concentration 70ºBrix. + Cabinet tray drying
6. **S_3D_2**-Sucrose concentration 70ºBrix. + Hot air oven drying

3. RESULTS AND DISCUSSION

The observations on physico-chemical composition of fresh pineapple fruits are presented in Table 1. average fruit weight (1.23 kg), average crown weight (0.128 kg), average peel with discarded weight (0.430 kg), average core weight (0.170 kg), yield of the fruit cubes (0.528 kg), average moisture content (88.2%), average TSS (14.8 ºBrix), average ascorbic acid (35.56 mg/100g), average acidity (1.02%), average total sugars (13.20%), average reducing sugars (6.08%), average non-reducing sugars (7.12%), and average pH (3.94) .Similar results found by Surabhi et al. (2007) and Nazaneen et al. [7] in pineapple. After the preparation of osmo-dehydrated pineapple cubes, physico-chemical parameters was evaluated at initial stage in respect of moisture content, water loss, solid gain, dehydrated yield, dehydration ratio, rehydration ratio, TSS (ºBrix), reducing sugars (%), non-reducing sugars (%), total sugars (%), acidity (%), pH and ascorbic acid (mg/100g) which are described as below.

3.1 Moisture (%)

The data pertaining to the effect of sucrose syrup concentration and drying method on moisture content of pineapple cubes was presented in Table 4. Significant differences was recorded in moisture content of osmosed pineapple as influenced by sucrose syrup, drying method and their interaction. The maximum moisture content (14.82%) was recorded in S_1 (50°Brix) and minimum moisture content (9.97 %) was recorded in S_3(70°Brix) with respect to factor sucrose syrup concentration. In factor drying method, the maximum moisture content (12.28%) was observed in D_2 (hot air oven drying) and minimum moisture content (11.55%) was observed in D_1(cabinet tray drying). The interaction among S×D showed significant results. The treatment combination S_1D_2 (50°Brix syrup concentration with hot air oven drying) recorded significantly highest moisture content (15.90%). While, significantly lowest moisture content was found in S_3D_2 (70°Brix syrup concentration with hot air oven drying) *i.e.,* (9.95%). The result indicated that moisture content of osmo-dehydrated pineapple cubes was decreasing with increase in sucrose syrup concentration. This might be due to the increased diffusional changes and osmotic pressure exerted on the fruit cell structure which consequently resulted in greater moisture reduction in higher concentration solutions. However, the minimum moisture content was found in S_3D_2 (70°Brix syrup concentration with hot air oven drying) followed by S_3D_1 (70°Brix syrup concentration with cabinet tray drying) and the maximum moisture content found in S_1D_2 (50°Brix syrup concentration with hot air oven drying).Similar results was observed by Khanom et al. [8] in pineapple.

3.2 Weight Loss (%)

The data pertaining to the effect of sucrose syrup concentration and drying method on weight loss (%) of pineapple cubes was presented in Table 3. Significant differences was recorded in per cent weight loss of osmosed pineapple as influenced by sucrose syrup, drying method and their interaction. The maximum weight loss (31.083%) was recorded in S_3 (70°Brix) and minimum weight loss (15.17%) was recorded in S_1 (50°Brix) with respect to factor sucrose syrup concentration. In factor drying method, the maximum weight loss (26.08%) was observed in D_1 (cabinet tray drying) and minimum weight loss (21.50%) was observed in D_2 (hot air oven drying). The interaction among S×D showed significant results. The treatment combination S_3D_1 (70°Brix syrup concentration with cabinet tray drying) *i.e.,* (32.04%) recorded significantly highest weight loss. While, significantly lowest weight loss was found in S_1D_2 (50°Brix syrup concentration with hot air oven drying) *i.e.,* (10.25%). The result indicated that weight loss of osmo-dehydrated pineapple cubes was increasing with increase in sucrose syrup concentration. The reason was that the viscosity of hyper tonic solution was lowered and the diffusion coefficient of water increased at high temperature. The maximum weight loss was found in S_3D_1 (70°Brix syrup concentration with cabinet tray drying) followed by S_3D_2 (70°Brix syrup concentration with hot air oven drying) and the minimum weight loss found in S_1D_2 (50°Brix syrup concentration with hot air oven drying). Similar results was observed by Khanom et al. [8] in pineapple.

3.3 Solid Gain (%)

The data pertaining to the effect of sucrose syrup concentration and drying method on solid gain (%) of pineapple cubes was presented in Table 4. Significant differences was recorded in per cent solid gain of osmosed pineapple as influenced by sucrose syrup concentration, drying method and their interaction. The maximum solid gain (18.33%) was recorded in S_3

(70°Brix) and minimum solid gain (13.46%) was recorded in S_1 (50°Brix) with respect to factor sucrose syrup concentration. In factor drying method, the maximum solid gain (15.88%) was observed in D_1 (cabinet tray drying) and minimum solid gain (15.36%) was observed in D_2 (hot air oven drying). The interaction among S×D showed significant results. The treatment combination S_3D_1 (70°Brix syrup concentration with cabinet tray drying) *i.e.,* (18.65%) recorded significantly highest solid gain. While, significantly lowest solid gain was found in S_1D_1 (50°Brix syrup concentration with cabinet tray drying) *i.e.,* (11.87%). The result indicated that solid gain of osmo-dehydrated pineapple cubes was increasing as increase in sucrose syrup concentration. However, the maximum solid gain was found in S_3D_1(70°Brix syrup concentration with cabinet tray drying) followed by S_3D_2 (70°Brix syrup concentration with hot air oven drying) and the minimum solid gain was found in T_1C_1 (50°Brix syrup concentration with Cabinet tray drying) during osmotic dehydration. These results was in harmony with experiments of Fito et al. [9].

3.4 Dehydrated Yield (%)

The data pertaining to the effect of sucrose syrup concentration and drying method on dehydrated yield (%) of pineapple cubes was presented in Table 4. Significant differences was recorded in percent dehydrated yield of osmosed pineapple as influenced by sucrose syrup concentration, drying method and their interaction. The maximum dehydrated yield (14.62%) was recorded in S_2 (60°Brix) and minimum dehydrated yield (13.47%) was recorded in S_1 (50°Brix) with respect to factor sucrose syrup concentrations. In factor drying method, the maximum dehydrated yield (14.16%) was observed in D_1 (cabinet tray drying) and minimum dehydrated yield (13.98%) was observed in D_2 (hot air oven drying). The interaction among S×D showed significant results. The treatment combination S_2D_1 (60°Brix syrup concentration with Cabinet tray drying) *r*ecorded significantly highest dehydrated yield(14.95%). While, significantly lowest dehydrated yield was found in S_1D_2 (50°Brix syrup concentration with hot air oven drying) *i.e.,* (13.02%).The increase in recovery of dehydrated yield may be attributed to the transfer of sugars from syrup to fruit slices through osmosis during period of osmo-dehydration.

3.5 Dehydrated Ratio

The data pertaining to the effect of sucrose syrup concentration and drying method on dehydrated ratio of pineapple cubes was presented in Table 5. Significant differences was recorded in per cent dehydrated ratio of osmosed pineapple as influenced by sucrose syrup concentration, drying method and their interaction. The maximum dehydrated ratio (7.50) was recorded in S_1(50°Brix) and minimum dehydrated ratio (6.84) was recorded in S_2(60°Brix) with respect to factor sucrose syrup concentration. In factor drying method, the maximum dehydrated ratio (7.28) was observed in D_2(hot air oven drying)and minimum dehydrated ratio (7.11) was observed in D_1 (cabinet tray drying). The interaction among S×D showed significant results. The treatment combination S_1D_2 (50°Brix syrup concentration with hotair oven drying) recorded significantly highest dehydrated ratio (7.77). While, significantly lowest dehydrated ratio was found in S_2D_1 (60°Brix syrup concentration with cabinettray drying) i.e., (6.75). These results was in harmony with experiments of Fito et al. [9].

3.6 Rehydrated Ratio

The data pertaining to the effect of sucrose syrup concentration and drying method on rehydrated ratio of pineapple cubes was presented in Table 5. Significant differences was recorded in rehydrated ratio of osmosed pineapple as influenced by sugar concentration, drying method and their interaction. The maximum rehydrated ratio (1.68) was recorded in S_2 (60°Brix) and minimum rehydrated ratio (1.35) was recorded in S_3 (70°Brix) with respect to factor sugar concentrations. In factor drying method, the maximum rehydrated ratio (1.50) was observed in D_1 (Cabinet tray drying) and minimum rehydrated ratio (1.44) was observed in D_2 (hotair oven drying). The interaction among S×D showed significant results. The treatment combination S_2D_2 (60°Brix syrup concentration with hotair oven drying) recorded significantly highest rehydrated ratio (1.71). While, lowest rehydrated ratio was found in S_1D_2 (50°Brix syrup concentration with hotair oven drying) *i.e.,* (1.23).Presence of more tissues might have helped in more absorption of water resulting higher rehydration ratio. In contrast, presence of very higher sugars adversely affected water uptake by osmotically dehydrated samples. Similar results was reported Mascheroni (2012).

3.7 TSS

The data pertaining to the effect of sucrose syrup concentration and drying method on TSS (%) of pineapple cubes was presented in Table 6. Significant differences was recorded in TSS of osmosed pineapple as influenced by sucrose syrup concentration, drying method and their interaction. The maximum TSS (75.25°Brix) was recorded in S_3 (70°Brix) and minimum TSS (55.06°Brix) was recorded in S_1 (50°Brix) with respect to factor sucrose syrup concentrations. In factor drying method, the maximum TSS (66.63°Brix) was observed in D_2 (hotair oven drying) and minimum TSS (66.26°Brix) was observed in D_1 (cabinet tray drying). The interaction among S×D showed significant results. The treatment combination S_3D_1 (70°Brix syrup concentration with cabinet tray drying) recorded significantly highest TSS (75.40°Brix). While, lowest TSS was found in S_1D_1 (50°Brix syrup concentration with cabinet tray drying) *i.e.,* 54.52°Brix.The result indicated that TSS of osmo-dehydrated pineapple cubes was increasing as increase in sucrose syrup concentration. However, the maximum TSS was found in S_3D_1 (70°Brix syrup concentration with cabinet tray drying) followed by S_3D_2 (70°Brix syrup concentration with hotair oven drying) and the minimum TSS was found in S_1D_1 (50°Brix syrup concentration with cabinet tray drying) during osmotic dehydration.

3.8 Reducing Sugars (%)

The data pertaining to the effect of sucrose syrup concentration and drying method on reducing sugars (%) of pineapple cubes was presented in Table 6. Significant differences was recorded in percentreducing sugars of osmosed pineapple as influenced by sucrose syrup concentration, drying method and their interaction. The maximum reducing sugars (37.66 %) was recorded in S_1(50°Brix) and minimum reducing sugars (30.70%) was recorded in S_3(70°Brix) with respect to factor sucrose syrupconcentrations. In factor drying method, the maximum reducing sugars (35.92%) was observed in D_1 (Cabinet tray drying) and minimum reducing sugars (33.08%) was observed in D_2 (hotair oven drying). The interaction among S×D showed significant results. The treatment combination S_1D_1 (50°Brix syrup concentration with cabinet tray drying) *i.e.,* recorded significantly highest reducing sugars (39.80%). While, significantly lowest reducing sugars was found in S_3D_1 (70°Brix syrup concentration with Cabinet tray drying) *i.e.,* 30.15%.The result indicated that reducing sugars of osmo-dehydrated pineapple cubes was decreasing with increase in sucrose syrup concentration. The maximum reducing sugars was found in S_1D_1 (50°Brix syrup concentration with cabinet tray drying) followed by S_2D_1 (60°Brix syrup concentration with Cabinettray drying) and the minimum reducing sugars was found in S_3D_1 (70°Brix syrup concentration with cabinet tray drying) during osmotic dehydration. Reducing sugars were higher in dehydrated pineapple cubes than fresh one owing to removal of water leading to concentration of sugars. Similar observations was found earlier by Singh et al. [10] in Aonla.

3.9 Non Reducing Sugars (%)

The data pertaining to the effect of sucrose syrup concentration and drying method on non-reducing sugars (%) of pineapple cubes was presented in Table 7. Significant differences was recorded in non reducing sugars of osmosed pineapple as influenced by sucrose syrup concentration, drying method and their interaction. The maximum non reducing sugars (42.80%) was recorded in S_3 (70°Brix) and minimum non-reducing sugars (15.73 %) was recorded in S_1 (50°Brix) with respect to factor sucrose syrup concentrations. In factor drying method, the maximum non-reducing sugars (30.35%) was observed in D_1 (cabinet tray drying) and minimum non-reducing sugars (29.425) was observed in D_2 (hotair oven drying). The interaction among S×D showed significant results. The treatment combination S_3D_2 (70°Brix syrup concentration with hotair oven drying) (41.90%) recorded significantly highest non reducing sugars (41.90%). While, significantly lowest non-reducing sugars was found in S_1D_2 (50°Brix syrup concentration with hotair oven drying) *i.e.,* (14.67%). The result indicatedthat non-reducing sugar of osmo-dehydrated pineapple cubes was increasing as increase in sucrose syrup concentration. However, the maximum non reducing sugars was found in S_3D_1 (70°Brix syrup concentration with cabinet tray drying) followed by S_3D_2 (70°Brix syrup concentration withhotair oven drying) and the minimum non-reducing sugars was found in S_1D_2 (50°Brix syrup concentration with hotair oven drying) during osmotic dehydration. Similar types of observations was also recorded by Meenakshi et al. [11] in Aonla.

3.10 Total Sugars (%)

The data pertaining to the effect of sucrose syrup sugar concentration and drying method on total sugars (%) of pineapple cubes was presented in Table 7. Significant differences was recorded in percent totalsugars of osmosed pineapple as influenced by sucrose syrup concentration, drying method and their interaction. The maximum total sugars (73.50 %) was recorded in S_3 (70°Brix) and minimum total sugars (53.40 %) was recorded in S_1 (50°Brix) with respect to factor sucrose syrup concentrations. In factor drying method, the maximum total sugars (66.29%) was observed in D_1 (cabinet tray drying) and minimum total sugars (62.51%) was observed in D_2 (hotair oven drying). The interaction among S×D showed significant results. The treatment combination S_3D_1 (70°Brix syrup concentration with cabinet tray drying) recorded significantly highest total sugars (73.85%). While, significantly lowest total sugars was found in S_1D_1(50°Brix syrup concentration with cabinet tray drying) *i.e.,* (56.60%). The result indicated that total sugarsof osmo-dehydrated pineapple cubes was increasing as increase in sucrose syrup concentration.The maximum total sugars was found in S_3D_1 (70°Brix syrup concentration with cabinet tray drying) followed by S_3D_2 (70°Brix syrup concentration with hotair oven drying) and the minimum total sugars was found in S_1D_2 (50°Brix syrup concentration withhotair oven drying) during osmotic dehydration.The increment of total sugar content was due to the solute gain action during osmosis. Similar types of observations was also recorded by Relekar [12] in osmo-dehydration of sapota.

3.11 Acidity (%)

The data pertaining to the effect of sucrose syrup concentration and drying method on acidity (%) of pineapple cubes was presented in Table 8. The maximum acidity (1.66%) was recorded in S_2(60°Brix) and minimum acidity (1.46%) was recorded in S_3(70°Brix) with respect to factor sucrose syrupconcentrations. In factor drying method, the maximum acidity (1.60%) was observed in D_1 (cabinet tray drying) and minimum acidity (1.53%) was observed in D_2(hotair oven drying). The interaction among S×D showed significant results. The treatment combination S_1D_1 (50°Brix syrup concentration with cabinet tray drying) recorded significantly highest acidity(1.67%). While, significantly lowest acidity was found in S_3D_2 (70°Brix syrup concentration with hotair oven drying) *i.e.,* (1.45%). The result indicated that acidity of osmo-dehydrated pineapple cubes was decreasing as increase in sucrose syrup concentration. The maximum acidity was found in S_1D_1 (50°Brix syrup concentration with cabinet tray drying) followed by S_2D_1(60°Brix syrup concentration with cabinet tray drying) and the minimum acidity was found in S_3D_2 (70°Brix syrup concentration with hotair oven drying) during osmotic dehydration. Thedecrease in acidity might be attributed to leaching of acid from fruit slices to hypertonic solution through a semi-permeable membrane. The similar results was reported Nazaneen et al. [7] in Pineapple.

3.12 P^H

The data pertaining to the effect of sucrose syrup concentration and drying method on P^H of pineapple cubes was presented in Table 8 and. Significant differences was recorded in P^H of osmosed pineapple as influenced by sucrose syrup concentration, drying method and their interaction. The maximum P^H (3.68) was recorded in S_3 (70°Brix) and minimum P^H (3.32) was recorded in S_1 (50°Brix) with respect to factor sucrose syrup concentration. In factor drying method, the maximum P^H(3.57) was observed in D_1 (cabinet tray drying) and minimum P^H (3.39) was observed in D_2 (hotair oven drying). The interaction among S×D showed significant results. The treatment combination S_3D_1 (70°Brix syrup concentration with cabinet tray drying) recorded significantly highest P^H(3.95). While, significantly lowest P^H was found in S_1D_1 (50°Brix syrup concentration with cabinet tray drying) *i.e.,* (3.32).The result indicated that P^H of osmo-dehydrated pineapple cubes was increasing as increase in sucrose syrup concentration. However, the maximum P^H was found in S_3D_1 (70°Brix syrup concentration with cabinet tray drying) followed by S_2D_1 (60°Brix syrup concentration with cabinet tray drying) and the minimum P^H was found in S_1D_1 (50°Brix syrup concentration with cabinet tray drying) during osmotic dehydration.

Table 1. Physico-chemical parameters of fresh pineapple fruit

S.No	Physical parameters	Results
1.	Avg. weight of fruit (g)	1.23 kg
2.	Crown	0.128 kg
3.	Peel with discarded	0.430 kg
4.	Core	0.170 kg
5.	Yield of the fruit cubes	0.528 kg
	Chemical parameters	**Results**
1.	Moisture content (%)	88.2%
2.	TSS (^{0}Brix)	14.8^0
3.	Ascorbic acid (mg/100g^{-1})	35.56 mg 100g^{-1}
4.	Acidity (%)	1.02%
5.	Total sugars (%)	13.20%
6.	Reducing sugars (%)	6.08%
7.	Non-reducing sugars (%)	7.12%
8.	P^H	3.94

Table 2. Recovery (%) of fruit cubes after osmotic dehydration

Treatments	Drying method		
Sugar syrup concentration	**Recovery (%)**		
	D_1	**D_2**	**Mean**
S_1	13.850	13.210	13.530
S_2	**14.780**	14.660	**14.720**
S_3	14.183	13.700	13.941
Mean	**14.271**	13.857	
	S	**D**	**S x D**
SE(m)	0.140	0.114	0.197
C.D.	0.418 2.808	0.341	0.581

Table 3. Effect of sucrose syrup concentration and drying method on Moisture loss (%) and Weight loss (%)ofosmo - dehydrated pineapple cubes

Treatments	Drying method					
Sugar syrup concentration	**Moisture (%)**			**Weight loss (%)**		
	D_1	**D_2**	**Mean**	**D_1**	**D_2**	**Mean**
S_1	15.210	18.320	16.765	20.090	10.250	15.170
S_2	13.110	14.418	13.764	26.130	24.153	25.141
S_3	**10.558**	11.240	**10.899**	**32.040**	30.125	**31.083**
Mean	**12.959**	14.659		**26.087**	21.509	
	S	**D**	**S x D**	**S**	**D**	**S x D**
SE(m)	0.145	0.179	0.309	0.260	0.213	0.368
C.D.5 %	0.435	0.119	0.926	0.780	0.637	1.103
C.V.	2.977			3.095		

Table 4. Effect of sucrose syrup concentration and drying method on Solid gain(%) and dehydration yield(%)ofosmo - dehydrated pineapple cubes

Treatments	Drying method					
Sugar syrup concentration	**Solid gain (%)**			**Dehydrated yield (%)**		
	D_1	**D_2**	**Mean**	**D_1**	**D_2**	**Mean**
S_1	11.875	15.050	13.463	13.920	13.020	13.470
S_2	17.125	13.025	15.075	14.953	14.300	**14.626**
S_3	**18.65**	18.025	**18.338**	13.623	14.153	13.888
Mean	**15.883**	15.367		**14.165**	13.981	
	S	**D**	**S x D**	**S**	**D**	**S x D**
SE(m)	0.154	0.126	0.218	0.131	0.107	0.185
C.D. 5%	0.218	0.377	0.653	0.391	0.320	0.554
C.V.	2.794			2.642		

Table 5. Effect of sucrose syrup concentration and drying method on Dehydration ratio and Rehydration ratio ofosmo - dehydrated pineapple cubes

Treatments	Drying method					
Sugar syrup concentration	**Dehydration ratio**			**Rehydration ratio**		
	D_1	**D_2**	**Mean**	**D_1**	**D_2**	**Mean**
S_1	7.233	**7.770**	**7.501**	1.688	1.230	1.459
S_2	6.753	6.930	6.841	1.660	**1.713**	**1.686**
S_3	7.348	7.140	7.244	1.303	1.405	1.354
Mean	**7.11**	7.280		**1.50**	1.449	
	S	**D**	**S x D**	**S**	**D**	**S x D**
SE(m)	0.069	0.056	0.097	0.020	0.016	0.029
C.D. 5%	0.205	0.168	0.291	0.060	0.049	0.085
	2.697			3.802		

Table 6. Effect of sucrose syrup concentration and drying method on TSS(TSS °Brix) and reducing sugars (%) ofosmo - dehydrated pineapple cubes

Treatments	Drying method					
Sugar syrup concentration	**TSS (TSS °Brix)**			**Reducing sugars (%)**		
	D_1	**D_2**	**Mean**	**D_1**	**D_2**	**Mean**
S_1	54.520	55.618	55.069	39.800	35.513	37.656
S_2	68.855	69.198	69.026	37.800	32.503	35.151
S_3	75.408	75.100	75.254	30.148	31.253	30.700
Mean	66.261	66.638		35.916	33.089	
	S	**D**	**S x D**	**S**	**D**	**S x D**
SE(m)	0.655	0.535	0.926	0.324	0.265	0.459
C.D.5%	1.961	1.654	1.968	0.971	0.793	1.373
	2.788			2.658		

Table 7. Effect of sucroseconcentration and drying method on Non reducing sugars (%) and total sugars (%) ofosmo - dehydrated pineapple cubes

Treatments	Drying method					
Sugar syrup concentration	Non Reducing sugars (%)			Total sugars (%)		
	D_1	D_2	Mean	D_1	D_2	Mean
S_1	16.800	14.675	15.738	56.600	50.200	53.400
S_2	31.573	30.700	31.138	68.425	64.200	66.313
S_3	43.700	41.900	42.800	73.850	73.150	73.500
Mean	30.358	29.425		66.292	62.517	
	S	D	S x D	S	D	S x D
SE(m)	0.302	0.247	0.427	0.608	0.497	0.860
C.D.5%	0.905	0.739	1.280	1.821	1.487	2.575
	2.860			2.671		

Table 8. Effect of sucrose syrup concentration and drying method on acidity (%) and P^Hofosmo - dehydrated pineapple cubes

Treatments	Drying method					
Sugar syrup concentration	Acidity (%)			P^H		
	D_1	D_2	Mean	D_1	D_2	Mean
S_1	1.700	1.550	**1.625**	3.325	3.325	3.325
S_2	1.550	1.550	1.550	3.450	3.425	3.438
S_3	1.475	1.450	1.463	3.950	3.425	3.688
Mean	1.575	1.517		3.575	3.392	
	S	D	S x D	S	D	S x D
SE(m)	0.018	0.015	0.026	0.034	0.028	0.049
C.D.5%	0.054	0.044	0.077	0.103	0.084	0.145
	3.323			2.790		

Table 9. Effect of sucrose syrup concentration and drying method on Ascorbic Acid (%) ofosmo - dehydrated pineapple cubes

Treatments	Drying method		
Sugar syrup concentration	Ascorbic Acid (%)		
	D_1	D_2	Mean
S_1	28.500	27.525	28.013
S_2	35.100	30.200	32.650
S_3	27.700	25.100	26.400
Mean	30.433	27.608	
	S	D	S x D
SE(m)	0.241	0.197	0.341
C.D 5 %.	0.723	0.590	1.022
	2.352		

3.13 Ascorbic Acid (%)

The data pertaining to the effect of sucrose syrup concentration and drying method on ascorbic acid (%) of pineapple cubes was presented in Table 9. Significant differences was recorded in per cent ascorbic acid of osmosed pineapple as influenced by sucrose syrup concentration, drying method and their interaction. The maximum ascorbic acid (32.65%) was recorded in S_2(60°Brix) and minimum ascorbic acid (26.40%) was recorded in S_3(70°Brix) with respect to factor sucrose syrup concentrations. In factor drying method, the maximum ascorbic acid (30.43%) was observed in D_1 (Cabinet tray drying) and minimum ascorbic acid (27.60 %) was observed in D_2(hotair oven drying). The interaction among S×D showed significant results. The treatment combination S_2D_1 (60°Brix syrup concentration with cabinet tray drying) recorded significantly highest ascorbic acid (31.10%). While, significantly lowest ascorbic acid was found in S_3D_2 (70°Brix syrup concentration with hotair oven drying) *i.e.,* (30.21%). The result indicated that ascorbic acid of osmo-dehydrated pineapple cubes was increasing with increase in sucrose syrup concentration. However, the maximum ascorbic acid was found in S_2D_1 (60°Brix syrup concentration with cabinet tray drying) followed by S_2D_2 (60°Brix syrup concentration with hotair oven drying) and the minimum ascorbic acid was found in S_3D_2 (70°Brix syrup concentration with hotair oven drying) during osmotic dehydration. Similar type of observations was recorded by Relekar [10] in osmo-dehydration of sapota.

4. CONCLUSION

This study presented the effect of Osmotic Dehydration on drying method and physicochemical Properties of Pineapple. The primary goal of dehydration is to reduce bulk weight and water activity. Osmotic treatments have been studied in combination with drying method and addition of preservatives. This method is best suited for developing countries with limited thermal processing capacity. The product's physico-chemical characteristics were thoroughly assessed.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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