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Preparation of Pineapple (*Ananas comosus*) Candy Using Osmotic Dehydration Combined With Solar Drying

Sultana Anjuman Ara Khanom[1], Md. Mashiar Rahman[2] and M. Burhan Uddin[3*]

[1]Vegetable Technology Research Section, Institute of Food Science & Technology, BCSIR, Dhaka-1205; [2]Enzymology Section, Institute of Food Science & Technology, BCSIR, Dhaka-1205; [3]Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensigh-2202, Bangladesh

**Corresponding author and Email: burhan.ftri@bau.edu.bd*

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Abstract

This study was conducted to develop pineapple candy prepared from fresh pineapple using 40, 50 and 60% sugar solution and then dried in solar drier. Acceptability of the product was also assessed. The thickness of pineapple slices were 0.5 and 1.0 cm. The pineapple slices were dipped into 40, 50 & 60% sugar solutions for overnight and then dried in solar drier. It was found that 0.5 cm thick of pineapple slices dried quickly than 1 cm thick slices. Sensory quality attributes of the prepared pineapple candy were analysed on the basis of colour, flvour, texture and overal acceptability using ANOVA test followed by DMRT test for identification of the best pineapple candy. Samples having 0.5 cm slice, osmosed in 60 % sugar solution and 0.5 cm slice, osmosed in 50% sugar solution were the preferred samples with respect to quality attributes and ranked as "like very much". The samples having 0.5 cm slice, osmosed in 60 % sugar solution was the most acceptable among candies prepared under the study.

Keywords: Osmotic dehydration, pineapple candy, solar drying

1. Introduction

Pineapple (*Ananas comosus*) is a tropical fruit which grows well in the tropical and sub-tropical regions. It is native to Central and South America. Pineapple belongs to the Bromeliaceae family and grows on the ground. Pineapple is a popular fruit of Bangladesh. Preliminary experiments on osmotic dehydration of pineapple carried out by Shahabuddin *et al.* (1990) have shown that solutions with less than 40% sugar content are not very effective for osmosis. Increasing sugar concentration in dehydration solutions has the effect of stimulating water loss while hindering sugar gain (Heng *et al.*, 1990). Concentrated sucrose solutions (50-75° Brix) have been most commonly used (Kim *et al.*, 1987). Lenart and Flink (1984a) found that water loss and total solids in potato were directly proportional to the initial concentration of the sucrose in solution over the range 20-70 per cent. The present work was undertaken to prepare pineapple candy from fresh pineapple and to assess the acceptability of the pineapple candy.

2. Materials and Methods

The experiment was conducted in the department of Food Technology and Rural Industries, BAU,

Mymensingh. The pineapples, having a maturity index between M1 and M2 (10-30% colouration from base) and sugar were collected from a local market. Apparatus used were electric balance, knives, solar dryer, digital moisture meter, and stainless steel pan.

2.1. Preparation of samples

Well matured, firm and ripe medium-sized pineapples (*Ananas comosus*) were washed thoroughly in water, outer skin was peeled manually by knife, cut into pieces of 0.5 and 1.0 cm thickness. The core of the slices was also removed using core remover. The descriptions of samples are given in Table 1.

2.2. Dehydration of candy

The dehydration solute used was sucrose (food grade) sugar manufactured. Solutions of 40, 50%and 60% (w/w) sucrose concentrations were prepared by blending an amount of sucrose with distilled water on a weight to weight basis. The pineapple slices of different thickness were dipped in different concentrations of sugar solution kept in stainless steel pan and were boiled for 30 minutes and then kept at room temperature for overnight. In the preparation of pineapple candy osmotic dehydration step prior to drying was used as described by Ramamurthey *et al.* (1970).

After osmosis, the pieces of pineapple from different sugar solution was removed, drained and then dried in solar dryer at temperature of 55±5 ºC for 5-14 hours. The direct absorption type solar dryer was used in this research .The dryer consisted of a box with single transparent cover (polythene) and blackend interior surface. The pineapple slices (0.5 & 1 cm) in trays were directly exposed in the dryer in which the solar radiation is transmitted through transparent polythene into dryer box and absorbed by the black surfaces of the dryer and converted into heat. To facilitate air circulation, ventilation holes were made at the front side and at the back side of the dryer. Moisture from the slices was evaporated by the heat. The heat also causes circulation of the air which removes the evaporated moisture.

2.3. Storage studies

The dehydrated samples packaged in high density polyethylene were stored at room temperature (27 to 32 °C) for a period of 240 days. The changes in colour, flavour, and moisture content, fungal growth and overall acceptability were observed.

2.4. Sensory evaluation

Sensory evaluation of stored osmosed pineapple samples were carried out in sensory panel laboratory and sensory attributes were tested. A total of 10 panelists, ranging in age from 20–40 years, who were students and staff of the Department of Food Technology and Rural Industries, BAU, Mymensingh participated in this study. Samples were evaluated in a soundproof, humidity-controlled sensory room with individual booths.

Table 1. Description of the samples of pineapple slices

Sample no.	Type	Thickness of slice (cm)	Concentration of sugar solution (% sugar)
S_1	Fresh	0.5	-
S_2	Fresh	1	-
S_3	Osmosed	0.5	40
S_4	Osmosed	1	40
S_5	Osmosed	0.5	50
S_6	Osmosed	1	50
S_7	Osmosed	0.5	60
S_8	Osmosed	1	60

Incandescent lighting was used to mask any colour differences that might have influenced a panelist's judgment. Evaluations were held once a day in the mid-afternoon, three times a week during the whole storage period. A total of three replications were completed. The products were served to each judge who independently examined the colour, flovour, texture and overall acceptability. The hedonic rating test was used to measure the consumers acceptability of the product; and the relevant importance of each factor was compared numerically on a scale of 1 to 9.

3. Results and Discussion

3.1. Effect of thickness on drying rate constant of fresh and osmosed pineapple

The 0.5 cm and 1 cm thick pineapple slices were dried at 60 °C and data were analyzed and drying rate constant was determined by plotting moisture ratio (MR) against time as shown in Figure 1 and given in Table 2. The drying rate constant of fresh samples were higher than the osmosed samples. It is also observed that the drying rate constant decreased with increased thickness.

3.2. Effect of solar drying on fresh and osmosed pineapple slices for different thickness

The pineapple slices of 0.5 and 1.0 cm thickness were dried in solar dryer at 60±2 ºC for 9-15 hours to obtain constant weight. The fresh samples took more time to obtain constant weight than the osmosed sample and also 0.5 cm thick slices took less time than 1.0 cm thick slices. The samples were dried to a final moisture content of 27.25% (Table 3).

3.3. Shelf-life studies

Table 4 shows that there was slight gradual increase in moisture with the storage time. The candy samples were found shelf-stable at room temperature of 27 to 32°C for upto 7 (seven) months of storage.

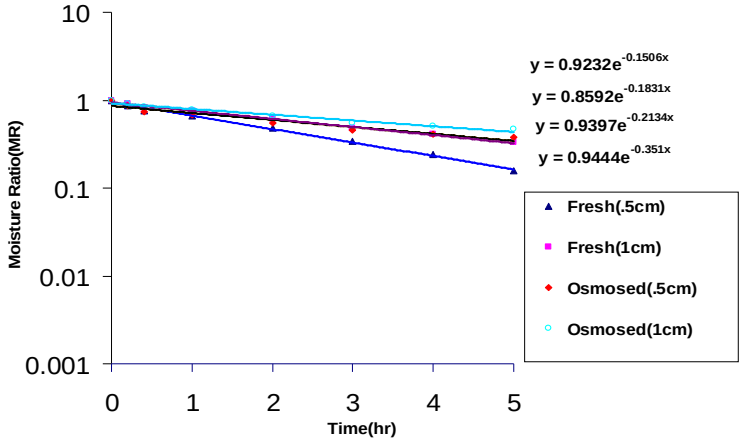

Figure 1. Comparison of drying rate constant of fresh and osmosed pineapple slices

Table 2. Drying rate constant of fresh and osmosed pineapple slices for 0.5 cm and 1.0 cm thickness

Sample Type	Sample Thickness (cm)	Temperature (°C)	Drying Rate Constant per hour
Fresh	0.5	60	-0.315
Fresh	1	60	-0.2134
Osmosed	0.5	60	-0.1831
Osmosed	1	60	-0.1506

Table 3. Comparison of time required to obtain constant weight of slices

Sample	Thickness	Initial moister content (%mc wb)	Drying time (hr) to obtain constant weight	Final moisture content (%mc wb)
Fresh	0.5	86.45	13	27.20
	1.0	86.45	15	27.27
Osmosed	0.5	57.52	11	27.25
(40%) syrup	1.0	66.78	14	27.19
Osmosed	0.5	48.80	10	27.22
(50%) syrup	1.0	54.14	13	27.17
Osmosed	0.5	46.87	9	27.24
(60%) syrup	1.0	46.90	11	27.26

Table 4 . Storage studies on pineapple candy at room temperature

Duration days	Samples	Observations				
		Colour	Flavour	Moisture %	Fungal growth	Overall acceptability
30	S_1	Good	Acceptable	27.20	Not visible	Acceptable
	S_2	Good	Acceptable	27.27	Not visible	Acceptable
	S_3	Good	Acceptable	27.25	Not visible	Acceptable
	S_4	Good	Acceptable	27.19	Not visible	Acceptable
	S_5	Good	Acceptable	27.22	Not visible	Acceptable
	S_6	Good	Acceptable	27.17	Not visible	Acceptable
	S_7	Good	Acceptable	27.24	Not visible	Acceptable
	S_8	Good	Acceptable	27.26	Not visible	Acceptable
60	S_1	Good	Acceptable	27.30	Not visible	Acceptable
	S_2	Good	Acceptable	27.35	Not visible	Acceptable
	S_3	Good	Acceptable	27.32	Not visible	Acceptable
	S_4	Good	Acceptable	27.40	Not visible	Acceptable
	S_5	Good	Acceptable	27.38	Not visible	Acceptable
	S_6	Good	Acceptable	27.28	Not visible	Acceptable
	S_7	Good	Acceptable	27.32	Not visible	Acceptable
	S_8	Good	Acceptable	27.36	Not visible	Acceptable
90	S_1	Good	Acceptable	27.41	Not visible	Acceptable
	S_2	Good	Acceptable	27.45	Not visible	Acceptable
	S_3	Good	Acceptable	27.40	Not visible	Acceptable
	S_4	Good	Acceptable	27.45	Not visible	Acceptable
	S_5	Good	Acceptable	27.48	Not visible	Acceptable
	S_6	Good	Acceptable	27.46	Not visible	Acceptable
	S_7	Good	Acceptable	27.42	Not visible	Acceptable
	S_8	Good	Acceptable	27.46	Not visible	Acceptable

Table 4 Continued

Duration days	Samples	Observations				
		Colour	Flavour	Moisture%	Fungal growth	Overall acceptability
120	S_1	Good	Acceptable	27.55	Not visible	Acceptable
	S_2	Good	Acceptable	27.52	Not visible	Acceptable
	S_3	Good	Acceptable	27.58	Not visible	Acceptable
	S_4	Good	Acceptable	27.56	Not visible	Acceptable
	S_5	Good	Acceptable	27.55	Not visible	Acceptable
	S_6	Good	Acceptable	27.54	Not visible	Acceptable
	S_7	Good	Acceptable	27.55	Not visible	Acceptable
	S_8	Good	Acceptable	27.56	Not visible	Acceptable
180	S_1	Good	Acceptable	27.72	Not visible	Acceptable
	S_2	Good	Acceptable	27.74	Not visible	Acceptable
	S_3	Good	Acceptable	27.72	Not visible	Acceptable
	S_4	Good	Acceptable	27.75	Not visible	Acceptable
	S_5	Good	Acceptable	27.76	Not visible	Acceptable
	S_6	Good	Acceptable	27.77	Not visible	Acceptable
	S_7	Good	Acceptable	27.75	Not visible	Acceptable
	S_8	Good	Acceptable	27.73	Not visible	Acceptable
210	S_1	Slight change	Slight change	27.85	Not visible	Acceptable
	S_2	Slight change	Slight change	27.86	Not visible	Acceptable
	S_3	Slight change	Slight change	27.88	Not visible	Acceptable
	S_4	Slight change	Slight change	27.87	Not visible	Acceptable
	S_5	Slight change	Slight change	27.85	Not visible	Acceptable
	S_6	Slight change	Slight change	27.90	Not visible	Acceptable
	S_7	Slight change	Slight change	27.91	Not visible	Acceptable
	S_8	Slight change	Slight change	27.92	Not visible	Acceptable
240	S_1	Change	Change	28.67	Visible	Not Acceptable
	S_2	Change	Change	28.77	Visible	Not Acceptable
	S_3	Change	Change	28.75	Visible	Not Acceptable
	S_4	Change	Change	28.79	Visible	Not Acceptable
	S_5	Change	Change	28.76	Visible	Not Acceptable
	S_6	Change	Change	28.78	Visible	Not Acceptable
	S_7	Change	Change	28.80	Visible	Not Acceptable
	S_8	Change	Change	28.83	Visible	Not Acceptable

3.4. Sensory evaluation of dehydrated pineapple slices

A two way analysis of variance (ANOVA) at 5% level of statistical significance was conducted for scores given by panelists for colour, flavour, texture and overall acceptability of dehydrated pineapple slices. The mean score for the test parameters of dehydrated pineapple slices are presented in Table 5.

The sample S_5 was the most preferable. But S_5 and S_7 were equally acceptable at 5% level of significance. It can be noted that sample S_5 secured the highest score of 8.7 out of 9, and S_7 secured the highest score of 8.4 points for colour and can be ranked as “like very much”. The samples S_3, S_4, S_6 and S_8 were comparatively less acceptable securing scores of 7.7, 7.3, 7.5 and 8.0, respectively.

Table 5. Mean score of sensory attributes of dehydrated pineapple slices

Product Type	Sensory attributes			
	Colour	Flavour	Texture	Overall acceptability
S_1	4.80^{e}	5.40^{e}	5.40^{c}	5.70^{e}
S_2	4.30^{f}	4.70^{f}	5.20^{c}	5.00^{f}
S_3	7.70^{cd}	7.70^{bc}	7.70^{b}	7.70^{c}
S_4	7.30^{d}	7.10^{d}	7.20^{b}	7.10^{d}
S_5	8.70^{a}	8.20^{a}	8.40^{a}	8.30^{b}
S_6	7.50^{d}	7.30^{cd}	7.30^{b}	7.50^{cd}
S_7	8.40^{ab}	8.30^{a}	8.70^{a}	8.80^{a}
S_8	8.00^{bc}	7.90^{ab}	7.70^{b}	7.80^{c}

Mean with same superscript within a column are not significantly different at 5% level of significance

All samples are ranked as "like moderately". Sample S_1 and S_2 secured score of 4.8 and 4.3, respectively, and can be ranked as "dislike slightly".

In case of flavour, there were significant differences in acceptance of flavour among the samples at 5% level of significance as calculated probability value was less than 0.05. As shown in the Table 5, samples S_7 and S_5 were most acceptable in flavour preference among the samples securing the highest score of 8.3 and 8.2, respectively and were ranked as "like very much". This was followed by the samples S_3, S_4, S_6 and S_8 securing 7.7, 7.1, 7.3 and 7.9, respectively and were equally acceptable which ranked as "like moderately". The sample S_1 securing 5.4 ranked as "neither like nor dislike" and S_2 securing 4.7 ranked as "dislike slightly". Table 5 showes that there were significant differences in texture acceptance among the samples at 5% level of significance as calculated probability value was less than 0.05.

As shown in Table 5, samples S_7 and S_5 were most acceptable in texture preference among the samples securing the highest score of 8.7 and 8.4, respectively and were ranked as "like very much". This was followed by the samples S_3, S_4, S_6 and S_8 securing 7.7, 7.2, 7.3 and 7.7, respectively and were equally acceptable which ranked as "like moderately". The samples S_1 and S_2 secured scores of 5.4 and 5.2, respectively and were ranked as "neither like nor dislike".

In case of overall acceptability, there were significant differences in overall acceptability acceptance among the samples at 5% level of significance. S_7 was most acceptable in overall acceptability preference among the samples securing the highest score of 8.8 and was ranked as "like very much". This was followed by the sample S_5 and also ranked as "like very much". The samples S_3, S_4, S6 and S_8 securing 7.7, 7.1, 7.5 and 7.8, respectively were equally acceptable and were ranked as "like moderately". The samples S_1 and S_2 secured score of 5.7 and 5.0, respectively and were ranked as "neither like nor dislike".

From the above results it is clearly observed that the sample S_7 (0.5 cm slice, osmosed in 60% sugar solution) and S_5 (0.5 cm slice, osmosed in 50% sugar solution) were the most preferred sample with respect to all quality attributes and were ranked as "like very much". However, S_7 was the most acceptable among them.

4. Conclusions

Good quality pineapple candy with high overall acceptability may be processed by osmotic dehydration followed by conventional dehydration (solar drying) with shelf-life of six months at ambient temperature condition.

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