Production of Osmotic Dehydrated Nipa Palm

Janwipa Supaking
Lecturer, Food Technology Program, Dhonburi Rajabhat University, Thailand
E-mail: janwipa.p@dru.ac.th

Abstract

The objectives of this research were to 1) study the physical characteristics, proximate composition and chemical properties of fresh nipa endosperm from Phra Samut Chedi district, Samut Prakarn province 2) study the appropriate ratio between the nipa endosperm and sucrose solution for production of osmotic dehydrated nipa endosperm and 3) study of physical and sensory properties of osmo-dried nipa endosperm. The average weight of halved fresh nipa endosperm was 11.77±2.61 g and the length, width and thickness were 41.77±2.57 mm, 27.41±1.03 mm and 12.35±1.14 mm, respectively. The results showed that the fresh nipa endosperm contained 6°Brix TSS, 0.97±0.01 water activity (a_w). The proximate composition indicated the moisture, crude protein, total fat, carbohydrate, ash and dietary fiber percentage (%) were 88.82±0.01, 0.92±0.04, 0.02±0.00, 9.47±0.03, 0.78±0.01 and 4.33±0.01, respectively. A study of different ratio between nipa endosperm and sucrose solution were 1:1, 1:2, 1:3 and 1:4. The result indicated that high ratio caused the increase of water loss and sugar gain in the product. L* and b*were slightly decreased, while a* was slightly increased after drying at 60ºC for 6 hr. However, the appropriate condition for osmosis was at 1:3 which had the highest overall acceptable sensory score as evaluated by 100 consumers ($p \le 0.05$).

Keywords: *Nypa fruticans*, osmotic dehydration, food processing

1. Introduction

Nipa (*Nypa fruticans*) is a monoecious palm with special characteristics. Contrast to usual palms like coconut (*Cocos nucifera*) and oil palm (*Elaeis guineensis*), it thrives in river estuaries and brackish water environment in which salt and fresh water mingle (Pramila and Shiro, 2011). It is one of the most widely utilized mangrove species plant with the oldest known fossil, with pollen dated 70 million years old, with products obtained from the leaves, inflorescences, and fruits. The leaves have traditionally been used for roof thatching, and parts thereof are used for making umbrellas, raincoats, hats, mats, brooms, baskets, cigarette wrappers, ropes, and as a source of fuel wood. The gelatinous endosperm is also rich in carbohydrates, fibers, minerals, and vitamin A (Osarbo *et al*., 2008) and can be eaten raw or preserved in heavy syrup while the hardened ones from the ripened fruits are used as vegetable ivory, and buttons (Teo *et al.*, 2010). However, it is highly perishable fruit which deteriorates quickly when not stored properly, usually requires some sort of refrigerated storage and needs preservation methods (such as canning, drying, freezing and osmotic dehydration, etc.) to increase its shelf life.

Osmotic dehydration has received greater attention in recent years as an effective method for preservation of fruits and vegetables. Being a simple process, it facilitates processing of fruits and vegetables such as banana, sapota, fig, guava, pineapple, apple mango, grapes, carrots, pumpkins, etc. with retention of initial fruit characteristics viz., color, aroma, texture and nutritional composition. It is less energy intensive than air or vacuum drying process because it can be conducted at low or ambient temperature. It has potential advantages for the processing industry to maintain the food quality and to preserve the wholesomeness of the food. It involves dehydration of fruit slices in two stages, removal of water using as an osmotic agent and subsequent dehydration in a dryer where moisture content is further reduced to make the product shelf stable (Chavan & Amarowicz, 2012)

The local people in Phra Samut Chedi district, Samut Prakarn province have used of the young seeds for dessert and drink production, for example, stuffing for chinese pastry and sweet bread, crispy jelly , a Thai dessert called Kay – sorn lum jiak, sliced nipa endosperm in syrup and drink from nipa endosperm. However, production of osmotic dehydrated nipa endosperm in this area is not noted. This research attempted to study the appropriate ratio between the nipa endosperm and sucrose solution for production of osmotic dehydrated nipa endosperm. The results were propagated to the community enterprises in Phra Samut Chedi district aiming to encourage more utilization on local nipa palms.

2. Research Objectives

This research consisted of three objectives:

2.1 To study the physical characteristics, proximate composition and chemical properties of fresh nipa endosperm;

2.2 To study the appropriate ratio between the nipa endosperm and sucrose solution for production of osmotic dehydrated nipa endosperm;

2.3 To study of physical and sensory properties of osmo-dried nipa endosperm.

3. Research Methodology

3.1 The study of the physical characteristics, proximate composition and chemical properties of fresh nipa endosperm

The nipa endosperm used for this study were collected at 5-7 month’s maturity from Phra Samut Chedi district, Samut Prakarn province (Figure 1).

3.1.1 The physical characteristics of fresh nipa endosperm in this study were weight, size dimensions and color measurement

- Weight using a precision weighing balances (2 decimal places), SCALTECT
- Size for each fruit, three linear dimensions, length, width, and thickness, were measured using a Vernier caliper (Figure 2).

Hence measurement of all weight and size dimensions were replicated fifty times for halved of nipa endosperm**.**

- Color measurement using Lovibond RT 100 Reflectance Tintometer. Instrumental color data was provided in accord with the CIE system in terms of L* (lightness), a* (redness and greenness) and b* (yellowness and blueness)

Figure 1. Nipa endosperm

3.1.2 The study of the proximate composition and chemical properties of fresh nipa endosperm

- Proximate analysis was done on moisture, crude protein, total fat, carbohydrate, dietary fiber, and ash (National Food Institute based on AOAC, 2012 standard analytical methods).
- Total soluble solids using hand refractometer.
- a_w using *Novasina AW SPRINT TH 500.*

3.2 The study the appropriate ratio between the nipa endosperm and sucrose solution for production of osmotic dehydrated nipa endosperm

3.2.1 The nipa endosperm were washed and blanched for 5 minutes prior to immersed into the sucrose solution with 0.1 %KMS. The nipa endosperm and sucrose solution (30ºBrix) were studied at 4 different levels; 1:1, 1:2, 1:3 and 1:4. Every day, each solution was taken out and boiled to increase the sucrose concentration by 10ºBrix every day until reaching 60ºBrix. The osmosis process was performed at ambient temperature. At the end of the process the sucrose solution were drained off and the samples were rinsed quickly with running water (below 30 s) to eliminate the solution from the surface and carefully blotted with tissue paper to remove the excess surface water. The weight and moisture content data of fresh and dehydrated nipa endosperm were used to calculate the water loss (WL) and solid gain (SG), according to the following equations 1 and 2 (Kaymak-Ertekin and Sultanoglu, 2000):

$$WL (\%) = \frac{(Wi\ Mi - Wf\ Mf)}{Wi} \times 100 \quad (1)$$

$$SG (\%) = \frac{[\ Wf\ (1-Xf) - Wi\ (1- Xi\ )]}{Wi} \times 100 \quad (2)$$

Where Wi= initial mass of sample (g), Wf= mass of the sample after time (t) of osmotic dehydration (g), Xi = water content as a fraction of the initial mass of the sample and Xf = water content as a fraction of the syrup at time (t).

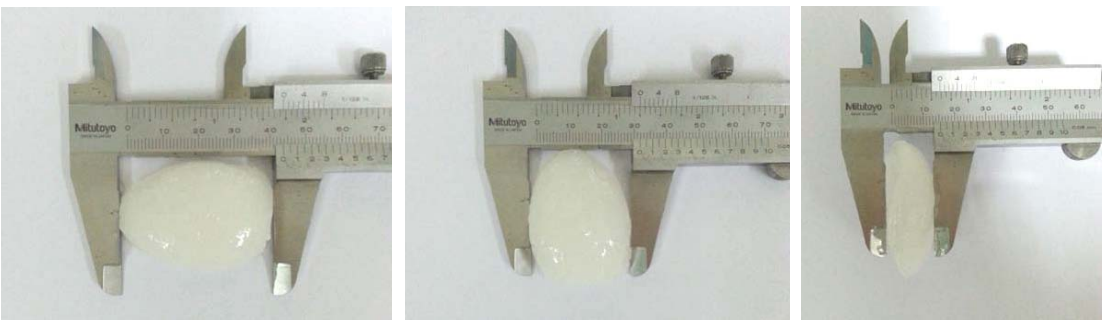
3.3 The study of physical and sensory properties of osmo-dried nipa endosperm

The dehydrated nipa endosperm were dried by using solar drying cabinet at 60ºC until the moisture content and a_w were lower than 18% and 0.75 respectively (TCPS 136/2550). Then, the color measurement of final products were performed in triplicates. The experimental designs for color was a completely randomized design (CRD).

Sensory properties of the final product were measured by 100 panelists. A structured 9-point hedonic scale was used to evaluate acceptance of the product with respect to appearance, color, texture, flavor and overall acceptability, where the lowest point 1 = extremely dislike and the highest point 9 = extremely like. The samples were presented to a test panel on a white plate labeled with three-digit**.** The experimental design for sensory evaluation was a randomized complete block design (RCBD). Data was subjected to analysis of variance (ANOVA) and *the means were* separated using *Duncan's* multiple range test (DMRT) at p≤0.05.

4. Research Results

A summary of the results of the determined physical characteristics of the halved nipa endosperm is shown in Table 1. The nipa endosperm is soft and milky white in color (Figure 1). The mean weight, length, width, and thickness of the halved nipa endosperm were found to be 11.72±2.61 g, 41.77±2.57 mm, 27.41±1.03 mm, and 12.35±1.14 mm, respectively. The lightness (L*), redness (a*) and yellowness (b*) values of fresh nipa endosperm were 49.19±0.74, 0.18±0.04 and 1.98±0.15, respectively.



a b c

Figure 2. Size measurement of Nipa endosperm; length (a), width (b) and thickness (c)

Table1
The physical characteristics of the halved nipa palm endosperm

parameter	data
Weight (g)	11.72±2.61
Size (mm)	
- length	41.77±2.57
- width	27.41±1.03
- thickness	12.35±1.14
color	
- L*	49.19±0.74
- a*	0.18±0.04
- b*	1.98±0.15

Mean value (±standard deviation)

The proximate composition of the studied fresh nipa endosperm found in the experiment was showed in Table 2. The results showed that the fresh nipa endosperm contained 6°Brix TSS, 0.97 ± 0.01 water activity (a_w) and proximate composition including moisture, crude protein, total fat, carbohydrate, ash and dietary fiber percentage (%) were 88.82 ±0.01, 0.92 ±0.04, 0.02 ± 0.00, 9.47±0.03, 0.78±0.01 and 4.33 ±0.01, respectively.

Table 2
The proximate composition and chemical properties of fresh nipa endosperm

parameter	data
TSS	6°Brix
a_w	0.97 ± 0.01
proximate composition (%)	
- moisture	88.82±0.01
- crude protein	0.92 ±0.04
- total fat	0.02 ± 0.00
- carbohydrate	9.47±0.03
- ash	0.78±0.01
- dietary fiber	4.33 ±0.01

Mean value (±standard deviation)

Mass transfer in osmotic dehydration is a combination of simultaneous water loss and solute uptake. For that reason, the experimental data of WL and SG were analyzed and displayed in joint way in the present study. Table 3 showed the WL and SG of osmotic dehydrated nipa endosperm at different ratio between nipa endosperm and sucrose solution were 1:1, 1:2, 1:3 and 1:4 (starting at 30ºBrix and increasing by 10ºBrix every day until reaching 60ºBrix). The result indicated that high ratio caused the increase of water loss and sugar gain in the product and no difference between ratio 1:3 and 1:4 ($p>0.05$). Therefore, the ratio at 1:3 was used for further studied due to economic reason.

Table 3
Water loss and solids gain for the different treatments of osmotic dehydrated nipa endosperm

treatment	WL	SG
1:1	15.49±0.36[a]	9.01 ±0.12[a]
1:2	22.41±0.40 [b]	12.44±0.37[b]
1:3	25.05±0.67 [c]	13.41±0.25[c]
1:4	25.69±0.16 [c]	13.92±0.05[c]

Means within the same column with different letters are significantly different ($p \leq 0.05$)

Color is an attribute of food quality which initially being judged by a consumer at the point of purchasing food products. Loss of color during osmotic dehydration and drying process are the most significant changes (Osorio *et al*., 2007). Color degradation of dehydrated foods related to the browning reaction such as enzymatic or non-enzymatic browning (Ames, 2003). Therefore, the color parameters of nipa endosperm were measured before and after drying of osmotic dehydrated nipa endosperm. The osmotic dehydrated nipa endosperm at different ratio between nipa endosperm and sucrose solution were dried by using solar drying cabinet at 60ºC until the moisture content and a_w were lower than 18% and 0.75, respectively (TCPS 136/2550). The color of product was illustrated in Figure 3 and Table 4. It was revealed that the redness (a*) slightly increase ($p \leq 0.05$) with increase in ratio between nipa endosperm to sucrose solution, while both lightness (L*) and yellowness (b*) were slightly decreased ($p \leq 0.05$).

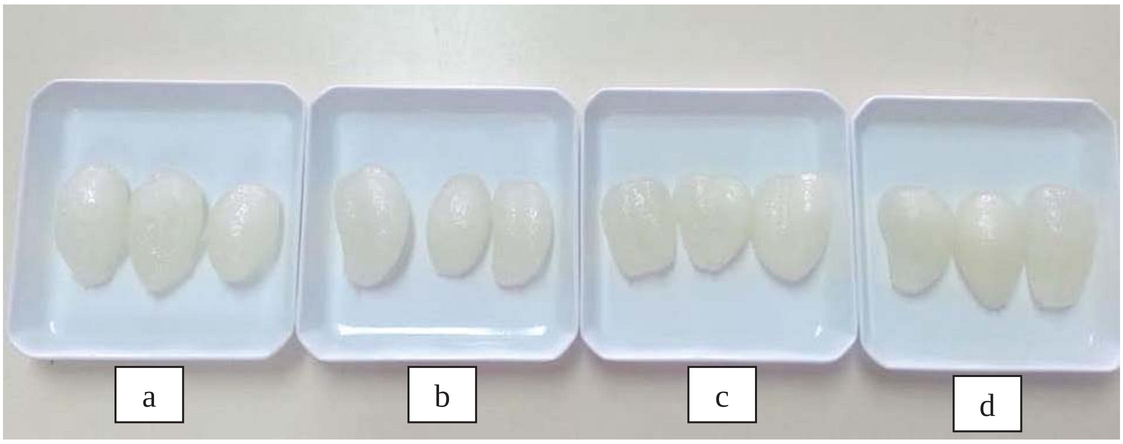


Figure 3. The product color after drying at 60ºC, 6 hours with different ratio between nipa palm endosperm and sucrose solution; 1:1 (a), 1:2 (b), 1:3 (c) and 1:4 (d)

Table 4
The color measurement of the osmo-dried nipa endosperm

treatment	color		
	L*	a*	b*
1:1	42.48±0.64 [a]	0.44±0.05 [a]	1.83±0.04 [a]
1:2	41.08±0.67 [ab]	0.62±0.06 [b]	1.53±0.05 [b]
1:3	40.84±0.96 [b]	0.74±0.02 [b]	1.27±0.02 [c]
1:4	40.14±0.86 [b]	0.92±0.09 [c]	0.94±0.12 [d]

Means within the same column with different letters are significantly different ($p \leq 0.05$)

The parameters employed in the process of osmo-dried nipa endosperm for all treatments did not cause any differences in color, texture and flavor ($p>0.05$) (Table 5), while 1:3 condition had the highest overall acceptable sensory score as evaluated by 100 consumers ($p \leq 0.05$).

Table 5
Sensory properties of the osmo-dried nipa endosperm

treatment	Sensory attribute				
	appearance	color[ns]	texture[ns]	flavor[ns]	overall acceptance
1:1	6.22±1.56[ab]	6,53±1.39	6.09±1.65	6.30±1.46	6.31±1.36 [a]
1:2	6.11±1.51[a]	6.47±1.31	6.08±1.79	6.05±1.60	6.24±1.45 [a]
1:3	6.69±1.48 [c]	6.72±1.30	6.26±1.86	6.45±1.83	6.77±1.41[b]
1:4	6.46±1.46[bc]	6.79±1.33	6.34±1.92	6.38±1.86	6.47±1.55[ab]

Means within the same column with different letters are significantly different ($p \leq 0.05$)

5. Discussion

Based on the results of this study, there were some points to be discussed as follows:

5.1 The fresh nipa endosperm in this study was collected at 5-7 month’s maturity from Phra Samut Chedi district, Samut Prakarn province. It was soft and milky white in color. Weight (11.72±2.61 g) and length (41.77±2.57 mm) lower than nipa endosperm from Kedah, Malaysia (weight =19.60±0.8 g and length = 45.00±0.50 mm) as described by Prasad *et al.* (2013). The proximate composition of nipa endosperm is likely that nipa endosperm from various habitats and region almost have the same chemical characteristics and are rich in lignocellulosic material (Pramila and Shiro, 2011)

5.2 From the results of analysis for WL and SG, it was found that high ratio between nipa endosperm and sucrose solution caused the increase of water loss and sugar gain in the product and no difference between ratio 1:3 and 1:4 ($p>0.05$). This can be attributed to the large osmotic driving force between the fruit and the surrounding hypertonic osmotic solution (Falade *et al.*, 2007). These results indicated that some benefits in terms of faster WL could be achieved by choosing a higher concentration of osmotic solution. However, a much greater SG is also observed (Azoubel and Murr, 2004). Thus, ratio between nipa endosperm and sucrose solution of 1:3 was chosen due to its lower cost.

5.3 From the results of analysis for color measurement of fresh nipa endosperm using L*, a* and b* values were 49.19±0.74, 0.18±0.04 and 1.98±0.15, respectively. After drying of osmotic dehydrated nipa endosperm, it was revealed that the a* value slightly increase ($p \le 0.05$) with increase in ratio between nipa endosperm and sucrose solution, while both L* and b* values were slightly decreased ($p \le 0.05$). It could be a result of browning reactions occurring during drying. The Maillard reaction is mainly responsible for browning development in osmo-dried fruit during the drying process (Phisut *et al*, 2013). However, Falade *et al*. (2007) observed darker color in osmo-dried watermelon since the increment of pigment content during osmotic dehydration and the drying process.

6. Conclusion

The mean weight and size dimensions ; length, width and thickness of halved fresh nipa endosperm used in this study were 11.77±2.61g, 41.77±2.57 mm, 27.41±1.03 mm and 12.35±1.14 mm, respectively. It contained 6°Brix TSS, 0.97 ± 0.01 water activity (a_w) and proximate composition including moisture, crude protein, total fat, carbohydrate, ash and dietary fiber percentage (%) were 88.82 ±0.01, 0.92 ±0.04, 0.02 ± 0.00, 9.47±0.03, 0.78±0.01 and 4.33 ±0.01, respectively. It was found that high ratio between nipa endosperm and sucrose solution caused the increase of water loss and sugar gain in the product and a* increased, while both L* and b* decreased after drying at 60ºC for 6 hr. Thus, the ratio between nipa endosperm and sucrose solution at 1:3 was appropriate condition for osmosis process due to highest overall acceptable sensory score and lower cost.

7. Recommendations

The recommendations based on the research results can be divided into 3 points as follows.

7.1 From the results of analysis for sensory properties, some panelists had a comment about the hardness of product. Due to raw material quality is an important parameter that affected to the texture of finished product. Further work is needed to control the hardness scale of nipa endosperm which led to produce softer product texture.

7.2 The further researche on phytochemicals andantioxidant capacity from nipa endosperm including osmo-dried nipa endosperm should be done.

7.3 Further work should be carried out to study the combination of osmotic agents in the treatment on the characteristic of osmo-dried nipa endosperm.

References

Ames, J.M. (2003). Browning. *Encyclopedia of Food Science and Nutrition (2nd)*. Elsevier Science Ltd. UK. pp. 665-672.

Azoubel, P. M. and Murr, F. E. X. (2004). Mass transfer kinetics of osmotic dehydration of cherry tomato. *Journal of Food Engineering*. 61:291–295.

Chavan, U.D. and Amarowicz, R. (2012). Osmotic Dehydration Process for Preservation of Fruits and Vegetables. *Journal of Food Research*. 1 (2); 202-209.

Pramila T, Shiro S. (2011). Chemical characterization of various parts of nipa palm (Nypa fruticans). *Industrial Crops and Products*. 34(3):1423-1428.

Falade, K. O., Igbeka, J. C. and Ayanwuyi, F. A. (2007). Kinetics of mass transfer and colour changes during osmotic dehydration of watermelon. *Journal of Food Engineering* 80: 979-985.

Kaymak-Ertekin,F. and Sultanoglu M. (2000). Modelling of mass transfer during osmotic dehydration of apple. *Journal of Engineering*. 46: 753-758.

Osabor, V.N., Egbung, G.E. and Okafor, P.C (2008). Chemical Profile of *Nypa fruiticans* from Cross River Estuary, South Eastern Nigeria. *Pakistan Journal of Nutrition*. 7 (1): 146-150.

Osorio, C., Franco, M. S., Castaño, M. P., González-Miret, M. L., Heredia, F. J. and Morales, A. L. (2007). Colour and flavour changes during osmotic dehydration of fruits. *Innovative Food Science and Emerging Technologies*. 8: 353–359.

Phisut, N., Rattanawedee, M. and Aekkasak, K. (2013). Effect of osmotic dehydration process on the physical, chemical and sensory properties of osmo-dried cantaloupe. *International Food Research Journal* . 20(1): 189-196.

Prasad, N., Yang, B., Kong, K.W., Khoo, H.E., Sun, J., and Azlan, A. (2013). Phytochemicals and Antioxidant Capacity from Nypa fruticans Wurmb Fruit. *Evidence-Based Complementary and Alternative Medicine*. 9 p.
TCPS 136/2550 (2007) *(Thai): DRIED* FRUIT. Retrieved from https://law.resource.org/pub/th/ibr/th.ps.136.2550.pdf [22 April 2015]

Teo, S., Ang, W. F., Lok, A. F. S. L., Kurukulasuriyal, B. R. and Tan, H. T. W. (2010) The Status and Distribution of The Nipah Palm, *Nypa Fruticans* Wurmb (Arecaceae), in Singapore. *Nature in Singapore*. 3: 45–52