

Comparisons of Antioxidant Activity and Bioactive Compounds of Dragon Fruit Peel from Various Drying Methods

L. Wiset, N. Poomsa-ad and V. Srilaong

Abstract— The peel of dragon fruit is a byproduct left over after consuming. Normally, the use of plants as antioxidant source must be dried before further process. Therefore, the aim of this study is interesting to dry the peel by heat pump dryer (45 °C) and fluidized bed dryer (110 °C) compared with the sun drying method. The sample with initial moisture content of about 85-91% wet basis was dried down to about 10% wet basis where it took 620 and 25 min for heat pump dryer and fluidized bed dryer, respectively. However, the sun drying took about 900 min to dry the peel. After that, sample was evaluated antioxidant activity, β -carotene and betalains contents. The results found that the antioxidant activity and betalains contents of dried peel obtained from heat pump and fluidized bed dryings were significantly higher than that sun drying ($p \leq 0.05$). Moreover, the drying by heat pump provided the highest β -carotene content.

Keywords— Pitaya, betalains, β -carotene, antioxidant.

I. INTRODUCTION

DRAGON fruit or pitaya is one of the tropical fruits under cactus family. In general, there are two species of dragon fruits commonly found in Thailand market i.e. red dragon fruit (*Hylocereus polyrhizus*) and white dragon fruit (*Hylocereus undatus*). The fruit is a rich source of minerals and nutrients [1] including pigment i.e. β -carotene, lycopene and antioxidant properties [2][3][4]. Dragon fruits are usually consumed only the flesh directly or being processed into juice. Therefore, the peel is the major byproduct left over after consuming or processing to other product Nurliyana *et al.* [5] reported that the peel of dragon fruit had the higher antioxidant activity than the pulp. The betalains are the

pigment present in the peel [6]. Betalains in pulps of purple *Hylocereus* species were responsible for the major antioxidant capacity [5].

The coloration of agricultural products can be changed during thermal processing. The plant material undergoes through hot air drying may cause the quality degradation due to color reaction and decomposition of active ingredient [7][8]. This may due to the pigment degradation during drying process and browning reaction occurring, resulted in the colour changes [9][10].

Normally, the drying rate of product is fast when high temperature drying is applied. However, the properties of product are depended on many factors such as drying temperature, drying time, and drying method. There are many ways to remove the moisture content from the products. In this study we focused on heat pump dryer and fluidized bed dryer. The heat pumps are used in heat recovery to transfer heat from a relatively low-temperature source and upgrade it to a higher temperature, and to recover latent heat from high humidity streams. The color of dried agricultural products using heat pumps was better than those products using conventional hot air dryers, but the heat pump dryer was more economical than other systems although the initial cost was higher [11][12][13]. For fluidized bed dryer, the advantages are uniform product moisture content due to complete mixing of grain with drying air and high drying rate due to high contact area of product with the drying air. The limitation of product drying by fluidized bed dryer is the product needed to be floated, so the dragon fruit peel was chopped to small pieces.

The aim of this study is to compare the antioxidant properties, β -carotene and betalains contents of dragon fruit peel obtained from different drying methods.

II. MATERIALS AND METHODS

A. Sample Preparation

The white dragon fruit was purchased from the local market. Fruits were washed and peeled to separate the pulp from the peel. The only peels were used in this study by slicing into two different sizes. The one group, peel was cut into the size with the width x length x height of 3x20x3 mm³ for drying by heat pump dryer. Another size was chopped into the shape with the width x length x height of about 10x5x3 mm³ for drying by fluidized bed dryer. Sample was taken to

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determine the initial moisture content using the oven method at temperature of 103 °C until the weight constant.

B. Drying Conditions

- Heat pump dryer (HPD)

A schematic diagram of heat pump dryer system is presented in Fig. 1. The apparatus has two circuits; one for the drying air and the other one for the refrigerant. The air condition system of vehicle with R12 as a working fluid was applied for the dryer. A reciprocating compressor (Sanden 507) and a 2.3 kW electrical motor were used. The size of a condenser and an evaporator are 0.30 x 0.24 m² and 0.46 x 0.31 m². The dimension of the drying chamber is 0.6 x 0.6 x 0.8 m³ which contained 3 trays of products. An external condenser is combined with an internal condenser. Practically, the solenoid valve is opened to bypass the refrigerant to reject the excess heat at an external condenser when the drying air temperature is higher than a setting temperature. The evaporator bypass air ratio is constant at 60 %.

Sample of sliced peel at each batch about 280 g were dried at temperature of 45 °C with a constant air velocity of 0.5 m/s in a drying chamber. The drying was stopped when the final moisture content of sample reach to about 10% dry by recording the weight every 30 min and calculating to desirable moisture content. Triplicate drying of samples were conducted.

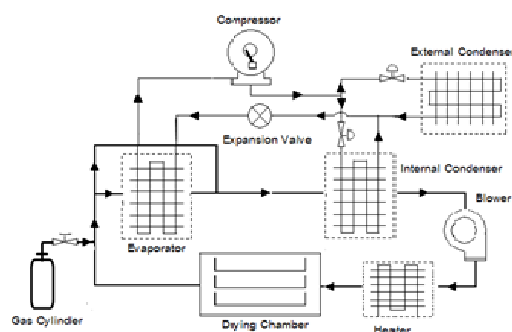


Fig. 1 Schematic diagram of heat pump dryer system

- Fluidized bed dryer (FBD)

A schematic diagram of fluidized bed dryer system is shown in Fig. 2. A batch drying system was developed by the Faculty of Engineering, Mahasarakham University, Thailand. The system consists of a vertical cylinder shape drying chamber with a dimension of 15 cm in diameter and 60 cm in height, 18 kW electrical heater and a backward curve fan driven by 2 kW electrical motor as shown in Fig. 1 and 2. Drying-air temperature was controlled by a proportional integral derivative controller with an accuracy of $\pm 1^\circ\text{C}$. A frequency inverter regulated airflow rate.

Peel drying in a batch in a fluidized bed dryer at temperature of 110 °C with the air velocity of 5 m/s at the bed depth of 2 cm was conducted. Samples about 200 g was used at each batch. To obtain the drying time for peel drying, sample was dried in a batch at different drying times of 5, 10, 15, 20, 25 and 30 min. Then, the drying curve of peel drying

was plotted between moisture content and drying time (data not shown). The drying time to remove the moisture content until it down to 10% was approximately obtained from the drying curve.

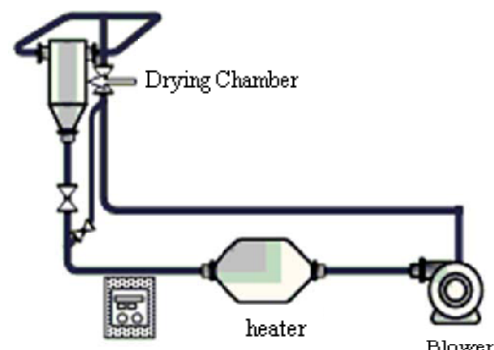


Fig. 2 Schematic diagram of fluidized bed dryer system

- Sun drying

Samples were spread on tray and left for sun drying (ambient air temperature about 30 °C and 50% RH) from 8 am until 5 pm and packed in a plastic bag. The next day was then dried again until the moisture content down to about 10% by sampling and measured by oven method.

C. Sample Determinations

Antioxidant activity was evaluated by the DPPH method (1,1-diphenyl-2-picrylhydrazyl) according to the procedure describe in Thaipong *et al.* [14]. The β -carotene content was determined by the method of Alda *et al.* [15]. And, betalains content was analyzed according to the method of Castellar *et al.* [16].

D. Statistical Analysis

The effects of drying methods on the changes of antioxidant activity and bioactive compounds of the peel were compared by Duncan's multiple range test (DMRT) at the 95% confidence level.

III. RESULTS AND DISCUSSION

The initial moisture content of fresh peel about 85-91% wet basis was dried down to about lower than 10% wet basis prior to property determination. The drying time and drying rate are presented in Table I.

The drying rate of heat pump drying and sun drying is not much difference when compared to fluidized bed. This due to the ambient temperature and temperature in the drying chamber was similar environment. However, the fluidized bed drying had a high drying rate because of the high temperature drying and air flow rate in the chamber.

By visual assessment as shown in Fig. 3, we can see that the color of the peel has changed due to the drying methods. Normally, thermal process results in pigment degradation. The color of peel from sun drying shows the brown color. This

might due to the oxidation of pigment by oxygen which plays the role on the discoloration more than the drying temperature.

TABLE I
EFFECT OF DRYING METHODS ON MOISTURE REMOVAL

Drying Method	Initial MC (%wet basis)	Final MC (%wet basis)	Drying Time (min)	Average Drying rate (min^{-1})
Sun drying	85.10	9.71	900	9.37×10^{-4}
FBD 110°C	85.10	8.59	25	3.06×10^{-2}
HPD 45°C	91.13	9.20	620	1.32×10^{-3}



Fig. 3 Example of o dragon fruit peel; a) fresh peel
b) drying at 110 °C c) sun drying

The dried peel with the high initial moisture content was dried until the moisture content reach to about 10% prior to analyze. The data obtained from different drying method is shown in Table II. The results found that the sun drying method give a lowest value for antioxidant activity, β -carotene and betalains contents.

TABLE II
BIOACTIVE COMPOUNDS OF DRIED DRAGON FRUIT PEEL OBTAINED FROM DIFFERENT DRYING TREATMENTS

Drying Method	Bioactive compounds		
	Antioxidant activity (mM TE/100g DW)	β -carotene ($\mu\text{g/g DW}$)	Betalains (mg/ 100 ml)
Sun drying	$16.97^b \pm 3.55$	1033.6 ± 169.3^b	$3.41^b \pm 0.26$
FBD 110°C	$28.06^a \pm 5.05$	1265.1 ± 129.9^{ab}	$12.10^a \pm 3.01$
HPD 45°C	$25.71^a \pm 4.16$	1361.6 ± 83.0^a	$10.51^a \pm 2.70$

Means with the same letter within a column are not significantly different ($p < 0.05$) by DMRT.

The sun drying method had the low drying temperature leading to the longest the drying time to reduce the high moisture content from the peel down to the safe level. This can be explained that the bioactive compounds in the peels are oxidized by the oxygen. The exposure to the sun light is also the cause of oxidation. According to the appearance of the peel after drying, the change of the color is related to the betalain contents. As the betalain has a red pigment which is similar colour pigment found in beetroot [6]. There is a little red colour of dried peel by sun drying presented in the sample as shown in Figure 1. The drying by fluidized and heat pump dryers provided the non significant difference in bioactive compounds. This because the drying time by fluidized bed dryer with high temperature is less than the heat pump dryer

with low temperature. This could be drawn the conclusion that the factors affecting the antioxidant activity and bioactive compounds are both temperature and drying time.

IV. CONCLUSION

The different drying methods of heat pump dryer at drying temperature of 45 °C, fluidized bed dryer at drying temperature of 110 °C and sun drying had the effect on the antioxidant activity and bioactive compounds. The results found that the antioxidant activity and betalains contents of dried peel obtained from heat pump and fluidized bed dryings were significantly higher than that sun drying ($p \leq 0.05$). Moreover, the drying by heat pump drying provided the highest β -carotene content but not significance with fluidized bed drying.

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