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Factors Affecting Mangos Drying

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Abstract

In this research, the drying of mango with a solar dryer was presented. The factors solar radiation, air temperature, relative humidity and moisture content of mango were studied. To investigate its performance, the dryer was used to dry ten batches of mangos. For each batch, 500 kilograms of mangos were dried in the dryer. Results obtained from the experiments showed that drying solar radiation varied from 15 Wm^{-2} to 800 Wm^{-2}, temperatures varied from 32 °C to 65 °C, relative humidity varied from 24% to 80%. In addition, the drying time for drying mangos was 3 days, compared to 5 days required for natural sun drying. Mangos dried in the dryer were completely protected from rain and high-quality mangos were obtained.

Keywords: greenhouse solar dryer; mango

1. Introduction

The mango (*Mangifera indica* L.) is an important commercial fruit that is consumed both fresh and dried product. Known as Mamuang in Thai, the Mango is one of the most popular fruits in Thailand. Used in both, sweet and savoury dishes. The most widely known are mango sticky rice and mango ice cream.

Loei province has a total area of 11,425 square kilometers. Loei Province is located on the Korat Plateau. Also known as Sakon Nakhon basin, most of the topography is mountains in the north and south approach. And there will be a plain area between the valleys that is not very large Alternately in the mountain range. Cultivate agricultural crops are rubber, rice, sugar cane, tapioca, pineapple, longan, corn and mango. There are many varieties of mango. Outstanding are nam dok mai, green mango, mahachanok, etc. Mango can be transformed into products as follows, mango stewed, sliced mango, mango juice and dried mango (sliced mango). The most popular processing method for slicing mango is natural sun exposure. But the quality and cleanliness are not good enough due to rain, dust, insects, so they are not desired by consumers.

In 2019, mango farmers of Loei province were facing a crisis with prices plunging to new lows, due to oversupply. For the last month, the markets for mangos have been showing a downward trend with prices below 10 baht per kilogram.

Farmers solved the problem by making mangoes naturally dried, pickled mango, but neither type of mango was popular to eat. The marketable mangos are bright in color, fragrant, not very sticky and the production process must not contain chemicals.

Therefore, the research group is interested in solving the problem using the drying method. Although our research group has developed many types of dryers and the suitable heat transfer of the dryers for agricultural products. [1 – 3]; But the performance of drying mango was not studied.

In this research, mango drying process will be studied. The parameters to be studied are moisture content of mango, relative humidity, air temperature, air flow rate and solar radiation.

2. Materials and Methods

Experimental setup

The dryer is 9 m in width, 24 m in length and 4 m in height (the dryer consists of 12 polycarbonate sheets on a concrete floor). To ventilate the dryer, 9 DC fans operated by two 50-W solar cell modules and 6 (220 V) AC fans (use an experiment at night or in case of urgent need to suck moisture from the dryer) were installed on the back of the dryer. The dryer at Loei Province, Thailand, this dryer is supported by Department of Alternative Energy Development and Efficiency in 2012 is shown in Fig. 1.

Fig. 1 The dryer at Loei Province, Thailand

Solar radiation are electromagnetic waves. There is a short wave; when passing through the polycarbonate sheet, it turns into a long wave, so it cannot be reflected. The temperature inside the dryer will rise. The air inside the dryer when heated by solar radiation, polycarbonates covered by convection, radiated condensed floor will float to the top of the dryer. The mangos that were dried in the dryer are shown in Fig. 2.

Fig. 2 Mangos were dried in the dryer

Experimental Procedure

The experimental runs were conducted during January, 2020 – September, 2020. The experimental equipment consisted of pyranometer, thermocouples, hot wire anemometers and hygrometers. The experiment used 500 kg of mangos; cleaned, peeled and sliced (The dimension is 5cm in wide, 12 cm in length, and 1 cm in thick). After that they were placed on the trays inside the dryer. In this work, ten

batches of drying tests were carried out. Each day, the experiment was started at 8:00 am and lasted until 6:00 pm (At night, experiments are not performed. Because there is no solar energy provides energy for dryers and solar cells). Continue the drying trials for the following days starting at 8:00 am to 6:00 pm. Until the desired amount of moisture is reached. Placed the samples mango in the dryer (front, middle and back of the dryer) and collecting mass data every hour. Product samples about 0.50 kg from the dryer were weighed at one-hour intervals. After drying by the dryer, the exact dry solid weight of the product samples was determined by the oven method. The moisture content of mango is given by the following equation (1).

$$M_w = \frac{w_t - d}{w_0} \times 100\% \tag{1}$$

Where M_w is moisture content of mango (wet basis; % w.b.). w_0 is initial weight, w_t is the weight at various times and d is dry mass of mango.

Colour of dried mango

The colour of dried mango samples was measured by a chromometer. L*, a* and b* represent lightness (0 to100), green to red (– 60 to + 60) and from blue to yellow (– 60 to + 60) colours, respectively. Out of five available colour systems, the L*a*b* and L*C*h systems were selected because these are the most-used systems for evaluation of the colour of dried food materials. The instrument was standardized each time with a white ceramic plate. Three readings were taken at each place on the surface of samples and then the mean values of L*, a* and b* were averaged [4].

The different colour parameters were calculated using the following equations. Hue angle (h) indicating colour combination (i.e. browning) is defined as:

$$h = \begin{cases} \tan^{-1}(b^*/a^*) & (\text{when } a^* > 0) \\ 180^\circ + \tan^{-1}(b^*/a^*) & (\text{when } a^* < 0) \end{cases} \tag{2}$$

The chroma (C*) indicating colour saturation is defined as:

$$C^* = (a^{*2} + b^{*2})^{1/2} \tag{3}$$

3. Results and Discussion

Experimental results

The experimental runs were carried out in January, 2020 – September, 2020. The results of the experiment are shown in Fig. 3 – Fig. 7.

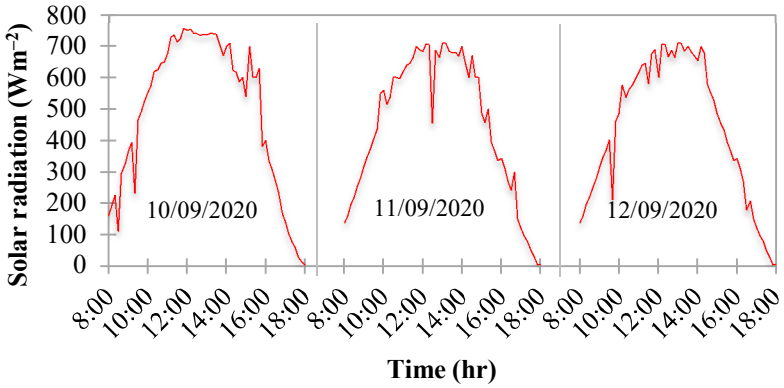

Fig. 3 Solar radiation

Fig. 3: Solar radiation was strongly fluctuated and in accordance with the weather characteristics of the days. The initial solar radiation will have a low value and will continue to rise, reaching a maximum at 12:00 am; the second half will continue to decline until a minimum of 6:00 pm.

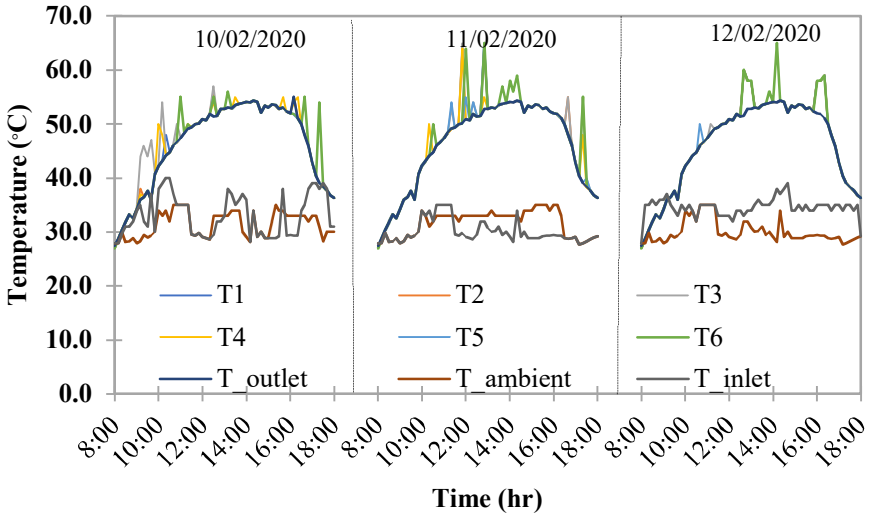

Fig. 4 Air temperature

Fig. 4: The air temperature inside the dryer increases and varies with the solar radiation intensity, the middle and outlet temperatures are higher than the front of the dryer about 1 °C to 2 °C.

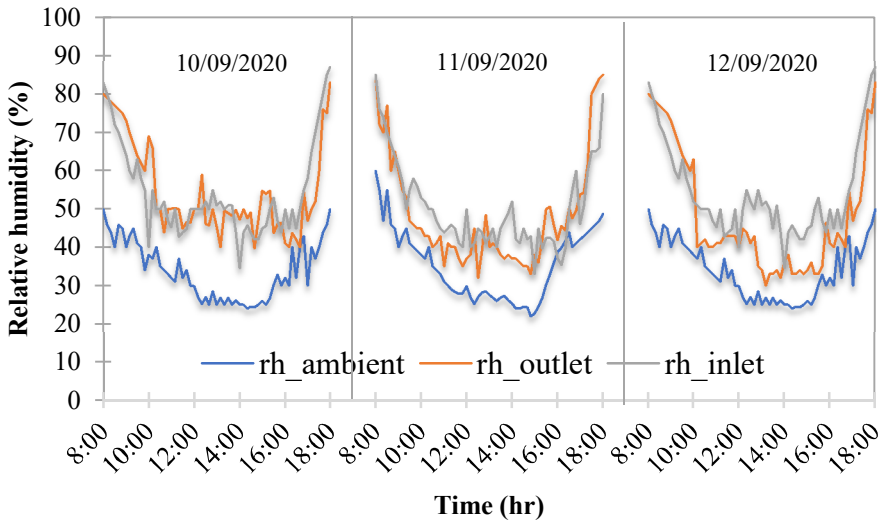

Fig. 5 Relative humidity

Fig. 5: Relative humidity inside the dryer is lower than the outside ambient air relative humidity. Initial relative humidity decreased; the second half has increased.

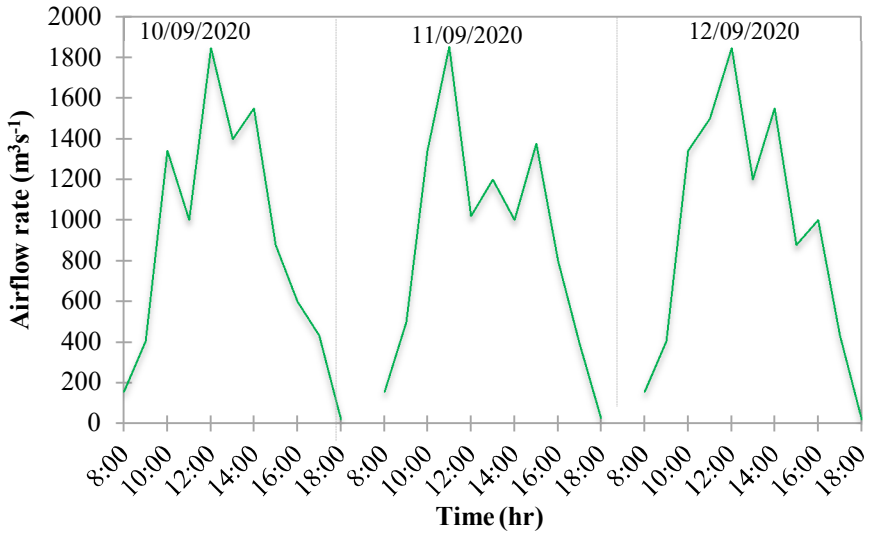

Fig. 6 Airflow rate

Fig. 6: The Airflow rate of the dryer was increased from 29 m^3s^{-1} to 1,800 m^3s^{-1} during drying. The Airflow rate of the dryer varies with the solar radiation intensity.

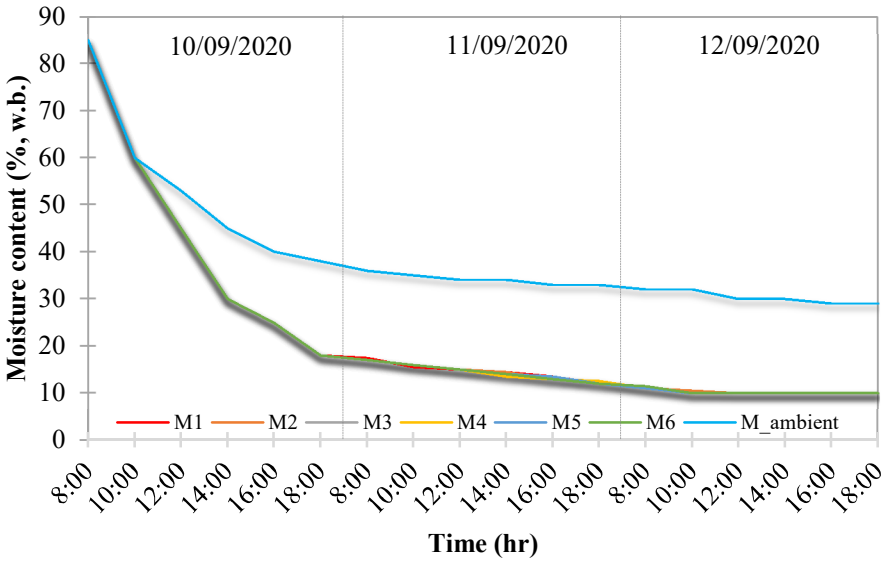

Fig. 7 Moisture contents of mango

Fig. 7: Moisture content (front 2 positions, middle 2 positions and back 2 positions) inside the dryer and the natural sun drying for the experimental runs of solar drying of mango. The moisture content of the mango in the experiment was reduced from the same initial 85%(wb), but finally inside the dryer was 10%(wb) and outside the dryer was 30%(wb) within 3 days. The moisture content of the sample outside the dryer decreases slowly. Depending on the weather conditions, the most important factors are wind and solar radiation.

Colour Measurement

The colour of mango was measured after drying. For dried mango, the value of L*, a* and b* are 79.48, – 2.24, 33.15 respectively. It is indicated that drying caused the colour of the dried mango to be

less red and less yellow, resulting in light yellow colour. There is almost no difference in colour indexes for drying at 32 °C to 65 °C.

4. Conclusion

Ten sets of mangos drying were conducted and the solar radiation varied from 15 Wm^{-2} to 800 Wm^{-2}, temperatures varied from 32 °C to 65 °C, relative humidity varied from 24% to 80% during drying. The mangos dried in the dryer were completely protected from rain, insects, dust and were protected against theft by using a key lock. The dried mango was a high-quality product. The performance of the dryer for drying mango has been experimentally investigated. It was found that the use of this dryer led to considerable reduction in drying time in comparison of that of natural sun drying. Compared the moisture content inside and outside, it was found that there was a difference of 20% (w.b.) over the same period. The moisture content of mango varies with the temperature inside the dryer. From the experiment it was found that the optimum temperature is in the range of 40 °C to 65 °C.

5. Acknowledgement

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6. References

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