Study on quality of red chilli powder dried by indirect solar dryer

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Abstract. This study aims to assess effectiveness of indirect solar dryer for drying red chilli. The quality parameters were moisture content and colour (L*,a*,b*) values. The results showed the maximum temperature on sunny hours of the day within drying box varied from 52.4°C to 62.6°C on 3 days drying period with lower final moisture content and better colour of dried chilli powder using Indirect solar drying than dried in the open sun.

1. Introduction
One of the alternative energy sources option for the future is the solar energy. Solar energy produced by solar collector in sunny time can convert into energy to proceed the drying process [1]. Drying process deal with heat transfer and mass transfer. Heat transfer to the product from the heating source and mass transfer of moisture from the interior of the product to the surrounding air. There are various types of solar dryer such as the direct type of solar dryer or the indirect type of solar dryer with the natural circulation mode or the forced circulation mode system. For the indirect type of solar dryer, the product are not to be dried directly to the solar radiation but it dried by air heated that occurs by solar radiation from the solar collector which flow through the product and dehydrates the product [2].

In 2017, North Sumatera Province was produce red chilli was about 159.131 tons and especially in Karo district have red chilli production was about 50,724 tons [3]. The preservation of agricultural product by solar drying can be a method to reduced the food loss by reduce its moisture content. Solar drying as does open sun drying process relies on the sun as it sources of heating energy. Open sun drying known as the most commonly used method due to economical and simple. Farmers only have to spread the agricultural product on the ground exposed to sun light.

Drying process of agricultural products of cocoa beans and coffee beans using Indirect solar dryer have been reported[4,5]. One of the advantage dried by indirect solar dryer is better quality than sun drying [6] Several studies reported for solar drying system for red chilli by the use of a solar tunnel greenhouse dryer [7], a forced convection indirect type [8] but not many reported by the use of indirect solar dryer without blower for air circulation. In this study, the quality of red chilli powder dried using indirect solar dryer system were investigated.
2. Method

2.1 Materials

Red chilli with good quality were obtained from local market in the Karo Regency, washed and sorted before drying. The sampels were spread in a single layer on stainless-steel wire tray. The drying process was compared between open sun drying (OD) and using Indirect solar dryer (ISD). The experiment were carried out in August 2019 at Universitas Sumatera Utara started at 09.00 am to 17.00 pm.

The specification of solar dryer were consist of drying box with dimension of 50 cm length, 50 cm width and 70cm high, with solar collector area with dimension of 150 cm length, 100 cm width and 15 cm high with slope angel of 30°. Plat absorber, glass wool and aluminiumum composite was used for the collector material component. Solar dryer design used in this study shown in Figure 1.

In the daytime, the solar dryer was operated by using hot air resulted by collector and in the night time it was shut down and continued until the next day. During the 3 days (24 h) experimental period, solar radiation, temperature and humidity inside drying box was measured every 1 minutes. The mass of chilli drying in the open sun was also measured every 15 minutes.

Figure 1. (a) Indirect solar dryer ; (b) measurement system of solar dryer; (c) specification of solar collector
2.2. Quality parameters
After 3 days of drying period, the dried chilli then processed using blender become chilli powder. The parameters were done by moisture content determined by the AOAC method [9] and colour value by using a chromameter. Colour was expressed in L*(brightness), a* (redness) and b*(yellowness) coordinates. The results values were expressed as the mean value ± standard deviation (SD) and one way analysis of variance (ANOVA) was obtained using SPSS software.

3. Results and discussions

3.1. Relative humidity and temperature within solar dryer
The daily mean value of solar dryer temperature and solar dryer relative humidity during 3 days varied from approximately 29.4 °C to 62.0 °C, 22.9% to 78.1%, respectively. The solar radiation varied from 107.7 to 673.93W/m². Figure 2 shows the maximum solar radiation was about 673.93W/m² around 12.00-14.00 pm. The solar radiation around 107.7 W/m² in the morning, then it increased along with the increase of light intensity to reach maximum at 12.00 pm and later it decreasing till the evening.

The maximum temperature within solar dryer on the day 1, day 2 and day 3 were 64.5 °C, 58.0 °C and 63.6 °C, respectively, compared with the maximum ambient temperature on the day 1, day 2 and day 3 were 43.8 °C, 42.1 °C, 47.5 °C, respectively, revealed that the drying temperature in solar dryer was higher around 15 to 20°C than the ambient temperature.

![Figure 2](image-url)  
Figure 2. Temperature, relative humidity in drying box and solar radiation on day 1 to day 3.

3.2. Comparison of decreasing weight of chilli between solar dryer and open sun dryer.
During the experiment as shown in Figure 3, the red chillies dried in open sun drying in day 1 it reduced from 1 kg to 0.78 kg, in day 2 it reduced to 0.61 kg and in day 3 it reduced to 0.54 kg, whereas for the red chillies inside the solar dryer in day 1 it reduced from 1 kg to 0.6 kg, in day 2 it reduced to 0.34 kg and in day 3 it reduced to 0.27 kg. The reduced weight of red chilli inside the solar
dryer faster than open sun drying is due to the high temperature and low relative humidity with in solar dryer.

Figure 3. Weight of chilli from solar dryer, weight of chilli from open sun dryer and solar radiation on day 1 to day 3.

3.3. Effect of drying on colour values and moisture content
After 3 days drying period, final moisture content of ISD reached 4.89%. The colour value between ISD and OD in Table 1 shows that the a* values ranged from 6.67 to 11.93 and the b* values ranged from 1.53 to 6.05, dried chilli powder (ISD) lighter with redness and yellowness value near fresh chilli colour value compared with OD. Drying of red chilli using indirect solar drying can reduced the moisture content from 76.56% to 4.89% in 24 h, while with the open sun drying only reduced to 20.97% due to higher temperature was achieved in solar dryer compared to ambient temperature.

Table 1. The colour value (L*,a* and b*) and moisture content after dried for 3 days (24 h).

| Red Chilli | L* (Lightness) | a* (redness) | b* (yellowness) | Moisture Content (%) |
|------------|----------------|--------------|-----------------|---------------------|
| ISD        | 25.38 ± 0.825 a | 11.93 ± 1.260 b | 6.05 ± 0.769 b  | 4.89 ± 1.253 a      |
| OD         | 22.13 ± 1.904 a | 6.67 ± 0.520 a | 1.53 ± 1.214 a  | 20.97 ± 0.784 b     |
| Fresh Chilli | 31.40 ± 0.513 b | 29.16 ± 0.232 c | 7.93 ± 0.550 c  | 76.56 ± 0.876 c     |

Means (± SD) values with different superscript in a column are significantly different (p<0.05). ISD: Indirect Solar Drying; OD: Open Sun Drying.

4. Conclusions
Chilli drying in indirect solar dryer successfully reduce the moisture content from 76.56% to about 5% with in 3 days. In comparison of chilli drying in open sun drying, by using indirect solar drying resulting saving drying time to obtain the lowest moisture content and have better colour value of dried chilli powder.
5. References

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