บทความวิจัย

DRYING MEDICAL PLANTS IN CHAI BADAN, LOPBURI BY SOLAR DRYER FOR PRODUCING THAI HERB PRODUCTS

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ABSTRACT

In this study, white fingerroot, turmeric, and green chiretta were dried using a solar dryer, reducing their moisture contents to 9.72, 10.14, and 9.83% on the wet basis (wb), respectively. The HPLC technique was used to examine the active components. The flavonoids, which include Pinostrobin 66.57 mg/g and Panduratin A 3.04 mg/g, are the active component of dried white fingerroot. Fresh and dried turmeric were found to have 6.78 mg/g and 48.23 mg/g of curcumin, respectively. The dried green chiretta leaf and stem powder contained 34.94 mg/g of andrographolide. In addition, the Thai Community Product Standard of 480/2547 indicated that the total microorganism was fewer than 1×10^3 colonies/gram. Finally, the powdered dry herb was placed into capsules for easy application.
Keywords: COVID-19, Solar dryer, Fingerroot, Turmeric, Andrographis, Curcumin

Introduction

This project was inspired by an academic initiative to increase the value of community products and combat the COVID-19 outbreak in local areas, by the national strategy for social equality. The Chai Badan district in Lopburi province, Thailand, falls under the responsibility of Phranakhon Rajabhat University and is renowned for its agricultural produce, including fingerroot, turmeric, and green chiretta. The project aimed to explore and enhance the processing of these herbs, while preserving their traditional medicinal properties. White fingerroot, for example, is widely recognized as an important herb, with anti-COVID-19 effects attributed to two key substances -

Panduratin A and Pinostrobin - found in its extract. Panduratin A and Pinostrobin can help prevent infection with the COVID-19 virus (Kanjanasirirat et al., 2020). Turmeric, on the other hand, is a beloved Thai herb known for its rich colors and aroma, as well as its medicinal properties. It contains curcuminoids and has been designated as a "Miraculous herb" by the Government Pharmaceutical Organization and included in the National List of Essential Medicines. Turmeric is classified in Thai herbal medicine formula that has properties to prevent and treat various diseases. The herb has recently been in the spotlight for its potential to treat COVID-19 (Chabot & Huntwork, 2021). Similarly, green chiretta has drawn attention for its potential to combat COVID-19, with the National Drug System Development Board's recent announcement that it can be used to relieve cold symptoms and treat the virus. Scientists are currently exploring the mechanisms behind andrographolide and its derivatives, which have shown promise in inhibiting the multiplication of the COVID-19 virus in vitro. Through an integration of various sciences, including biochemistry, molecular biology, pharmacology, and toxicology, these herbs hold great potential in the fight against COVID-19 (Akaji et al., 2022; Benjaponpithak et al., 2021).

In Southeast Asian countries like Thailand, solar drying is a popular way to preserve fruits and vegetables in rural areas. It is considered an environmentally friendly and renewable technology (Janjai, 2012; Usub et al., 2008; Wang et al., 2014). The dryer has a parabolic curved roof that allows sunlight to enter through the polycarbonate sheet. Using polycarbonate sheets as a transparent material to cover the dryer has many benefits. While solar radiation can penetrate the sheet, a small amount of infrared radiation is emitted, allowing everything inside the dryer to dry evenly. The sheets are connected using a device that prevents air and water leakage, and there is also a coating that protects against ultraviolet radiation.

This work aimed to study the drying of fingerroot, turmeric, and green chiretta by an area of 1x2 m^2 of parabolic cover-shaped solar dryer. The dried herb powder was analyzed for characteristics, active ingredients, and total microorganisms to value-added fingerroot, turmeric, and green chiretta in another way.

Methods

1. Materials

White fingerroot (*Boesenbergia rotunda*), turmeric (*Curcuma longa* L.), and green chiretta (*Andrographis paniculata*), as shown in Figure 1, were obtained from the Community Enterprise of Chai Badan district, Lopburi province, Thailand. Green chiretta was used during the unfolding stage, the leaves are large, and light green, becoming dark green. While white fingerroot and turmeric were used in the form of mature tubers.

Figure 1 Shows fingerroot; (a), turmeric; (b), and green chiretta; (c)

2. Solar dryer System

The drying process was conducted between March 1, 2022 and March 4, 2022, at Phranakhon Rajabhat University, Thailand at latitude 13.8760° N and longitude 100.5910° E. White fingerroot, turmeric, and green chiretta were washed, trimmed, and spread in a tray. Figure 2 shows the solar dryer with a drying area of 1x2 m^2. In this research, a Kipp & Zonen pyranometer model CMP11 was used to measure solar radiation. K-type thermocouples were placed in the middle of the dryer at positions 1 m from the front wall and were used to measure an electric potential difference that converted to temperature and a Yokogawa data logger model DC100 was used to record data in this study. The collected data was further analyzed.

Figure 2 The parabola dome solar dryer

3. Moisture content measurement

Moisture content measurements were conducted using the oven drying method according to AOAC (2000). About 3 g of the sample was taken and dried in the hot air oven (BINDER, FD, Germany) at 105°C for 3 hours. The drying sample was cooled in a desiccator until constant weight and was weighed periodically at 2-hour intervals using an electronic digital balance (Tanita, KD-200, Thailand). Finally, the moisture content of the product was determined. Drying continued for subsequent days until a constant moisture content of about 10% (wb) was achieved. The Thai Herbal Pharmacopoeia specifies that the moisture content of whole medicinal plants without essential

oils and herbal plants containing essential oils must not exceed 10% w/w and the moisture content corresponded to that of high-quality dried products.

4. Color measurement

The color of both the fresh products and dried products was also measured to compare by a colorimeter (Minolta, model CR-300) in CIE chromaticity coordinates L*, a*, and b*, where L* describes lightness, a* describes intensity in the red-green axis, and b* describes intensity in the yellow-blue axis (Maisont et al., 2022).

5. Chemical compound measurement

The chemical compounds of the sample were determined by the High-performance liquid chromatography (HPLC) technique and were analyzed by Central Laboratory (Thailand) Co., Ltd. (2022).

6. Statistical analysis

The results were expressed in the calculated means and standard deviations. Statistical analysis was performed using SPSS software (SPSS Statistics 19.0). Data were analyzed by analysis of variance with a one-way ANOVA and Duncan's test was used to determine the difference mean between treatments at the 5% significance level.

Results and Discussions

1. Experimental results

Agricultural products including fingerroot, turmeric, and green chiretta were dried by the parabola dome solar dryer. In general, solar dryers utilize both direct and diffused radiation which is called global radiation. Therefore, in evaluating the performance of the dryer, the global radiation will be measured using a pyranometer with a broad spectrum of response to the solar spectrum. Incident solar radiation on the solar collector of the dryer or on the products to be dried is an important parameter for evaluating the performance of solar drying. Figure 3 shows the variations in solar radiation between March 1, 2022, and March 4, 2022.

Since the beginning of March is the summer season in Thailand, there is a relatively high amount of sunlight throughout the day. The solar radiation intensity measured during this experiment was approximately 200 W/m^2 in the morning and increased to about 800 W/m^2 at noon time, then gradually decreased until the evening. This result corresponds to the air temperature inside the dryer as shown in Figure 4.

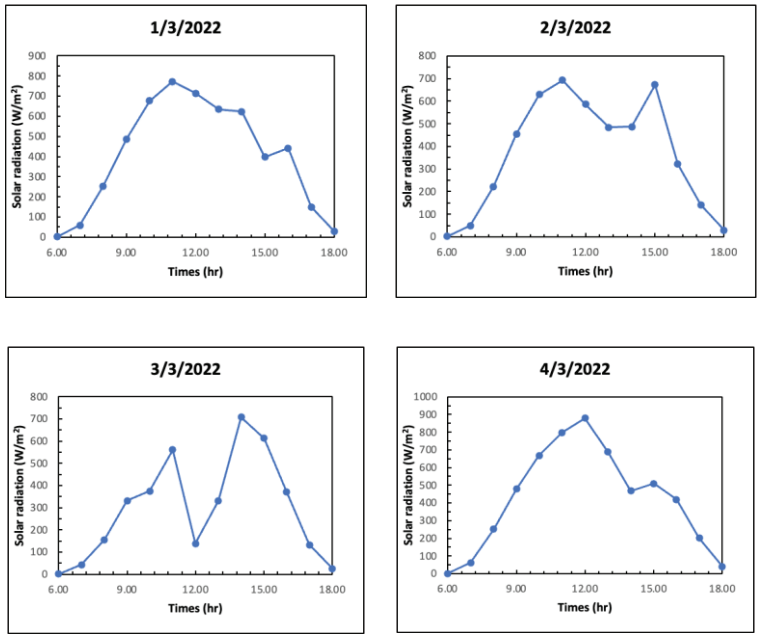

Figure 3 Variation of daily solar radiation

The roof is made of steel pipes that are curved into a parabolic shape. The angle of incidence of the rays on the roof facilitates the transmission of solar radiation throughout the day. There are two layers of galvanized metal floors between the layers with insulation. The top is covered with a polycarbonate sheet. One side has an air inlet. On the other side, there is a fan that uses solar cell power to ventilate the air out. Inside, there are two trays for placing products that need to be dried. The dryers can be moved due to the presence of wheels on the pole. It can be positioned in different directions as needed. Measuring temperature requires an instrument known as many types as possible of thermometers. The type commonly used in solar radiation drying applications is thermocouples because it can measure the temperature of the air at various points within the dryer conveniently. A thermocouple consists of two junctions of metal wires, one junction connecting the pyranometer and another junction connecting the object to measure the temperature. There will be an electric potential difference between the two junctions. This potential difference can be converted to temperature. The data obtained from the pyranometer, and thermocouples is an electrical signal which will be recorded by a data logger and can be transferred to a computer for analysis conveniently.

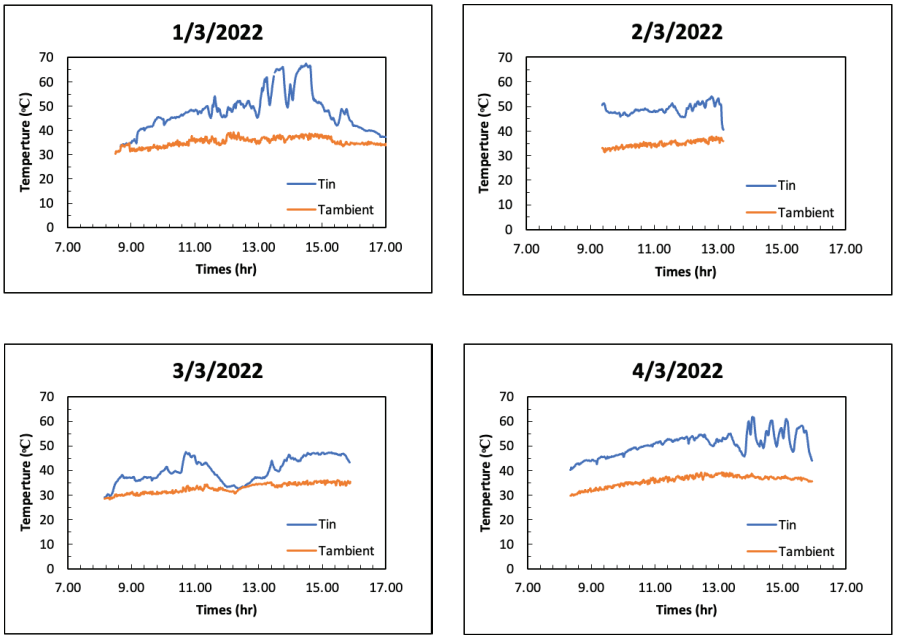

Figure 4 The air temperature in the solar dryer and ambient air

The measurement results in Figure 4 show that the daily ambient air temperature is about 30 to 35 ℃ throughout the day. The air temperature inside the dryer is slightly higher than the ambient air temperature in the morning then it will increase to a maximum of about 55℃ during mid of the day, and then gradually decline until the evening the air temperature inside the dryer is again close to the ambient air temperature outside. However, on March 3, 2022, it still rains from 11:00 AM to 1:00 PM, causing the air temperature inside the solar dryer drop below what it should be. Furthermore, it was also found that when high-intensity radiation, the temperature inside the dryer is very high and then the fan will spin faster as well. Making it possible to ventilate hot air. On the other hand, when the solar radiation intensity is low, the temperature inside the dryer is low and the fan speed is slow. So, the temperature of the air inside the solar dryer does not decrease too rapidly. The dryer has an exhaust fan that spins with electrical energy from solar panels is a mechanism for controlling the temperature inside the dryer by a natural process. Accordingly, the solar dryer has sufficient potential to dry fingerroot, turmeric, green chiretta, or other agricultural products.

Fingerroot had an initial moisture content of approximately 87% (wb), upon completion the moisture content was reduced to 9.7% (wb). And turmeric had an initial moisture content of about 89% (wb), upon completion of drying the moisture content decreased to 9.4% (wb). Fingerroot and turmeric were dried in the solar dryer on March 1-2, 2022. Green chiretta was then dried in the solar dryer on March 3-4, 2022, with an initial moisture content of about 75% (wb). The drying

occurred during the falling rate period in which there was a steep fall in moisture content during the initial drying stages before slowing in later stages (Maisont et al., 2022). The moisture content was reduced to 9.8 % (wb) upon completion. It takes only two days to dry the product with the solar dryer is very satisfying. In addition, farmers do not have to worry about rain or insects interfering with the product which will cause damage to the product, resulting in health problems as well. Drying with a solar dryer still has more advantages than natural drying (Čiplienė et al., 2015; Condorí et al., 2017; García-Valladares et al., 2020; Usub et al., 2008).

2. Qualities of the dehydrated product

Table 1 shows the moisture contents of dried fingerroot, turmeric, and green chiretta were 9.72, 10.14, and 9.83% (wb), respectively Because the polycarbonate sheet is used as a cover material on top of the solar dryer has UV protection properties that keep the color of dried agricultural products slightly different from the fresh products as shown in Figure 5.

Table 1 Moisture content and color values of fresh and dried fingerroot, turmeric, and green chiretta*

Plants		Moisture content (%)	Color		
			L*	a*	b*
Fingerroot	Fresh	87.00 ± 0.57	42.60 ± 0.88	8.94 ± 0.29	21.52 ± 0.25
	Dried	9.72 ± 0.06	61.73 ± 0.21	9.91 ± 0.38	29.48 ± 0.18
Turmeric	Fresh	89.04 ± 0.77	45.68 ± 0.35	10.04 ± 0.38	25.76 ± 0.44
	Dried	9.44 ± 0.11	47.98 ± 0.34	19.93 ± 0.19	34.45 ± 0.32
Green chiretta	Fresh	75.15 ± 0.57	33.62 ± 0.98	-7.81 ± 0.38	14.09± 0.86
	Dried	9.83 ± 0.14	45.65 ± 0.91	1.67 ± 0.28	20.26 ± 0.26

*The mean value ± standard deviation of three replicates in the same column for each plant followed by different letters are significantly different ($p \leq 0.05$).

Figure 5 shows the characteristics of fresh, dried, and ground products; fingerroot (row 1), turmeric (row 2), and green chiretta (row 2)

The L*, a*, and b* values of dried Fingerroot were 61.73, 9.91, and 29.48, respectively, indicating a red undertone, thus the product was a red-brown color. While the L*, a*, and b* values of dried turmeric and dried green chiretta were 47.98, 4.79, and 34.45, and 43.16, 1.24, and 19.06, respectively, indicating a green undertone, the product was a green-light brown color. It was suggested that the solar-dried treated samples became lighter than the fresh samples (Nimnuan & Nabnean, 2019).

An active compound found in Fingerroot by HPLC technique was Flavonoid. It consists of Panduratin A and Pinostrobin (Kanjanasirirat et al., 2020). After drying, the Panduratin A and Pinostrobin contents of dried Fingerroot were 3.04 and 6.65 mg/g, respectively. The active compound found in turmeric was curcumin, which was 48.23 mg/g, and the active compound found in green chiretta was andrographolide (Benjaponpithak et al., 2021), which was 47.52 mg/g after drying.

In addition, the dry sample was analyzed for microorganisms. It was found that the total microorganism was less than $1x10^3$ colony/g, which was under the regulation of the Thai agricultural standard 480/2547 that the total microbial requirement for dry herb is not more than $5x10^5$ colony/g. Finally, the dried herb powder including fingerroot, turmeric, and green chiretta was packed in capsules of 0.2070, 0.1934, and 0.2169 g/capsule, respectively, for convenience using as shown in Figure 6.

(a) (b) (c)

Figure 6 The products in capsules, fingerroot (a), turmeric (b), and green chiretta (c)

The Thai Food and Drug Administration published a list of plants suitable for use in dietary supplements in 2017. They recommend a daily intake of no more than 50 mg of curcuminoids and 966 mg of flavonoids from turmeric and white fingerroot extract. The Department of Thai Traditional and Alternative Medicine also advises that one should not consume more than 180 mg of andrographolide per day when using *Andrographis paniculata* products for COVID-19 treatment. Based on the important substances found in the dried products in this study, it is suggested that white fingerroot, turmeric, and green chiretta should not be consumed in amounts exceeding 4, 3, and 1 capsule per day, respectively. It is recommended that individuals with normal health, children, and pregnant women avoid consumption.

Conclusions

The solar dryer has sufficient potential to dry fingerroot, turmeric, green chiretta, or other agricultural products. Fingerroot, turmeric, and green chiretta had a final moisture content of 9.72, 10.14, and 9.83% (wb), respectively after two days from drying. Active ingredients including flavonoid, curcumin, and andrographolide were found in the dried products of fingerroot, turmeric, and green chiretta, respectively. The dried products were pulverized into powder and packed in capsules which are easy to use. The increasing value of white fingerroot, turmeric, and green chiretta by drying in a parabolic roof-shaped solar dryer was accomplished. The information may assist in the decision to use it as alternative medicine, and the final product's subjective quality can be kept and treated during the COVID-19 pandemic situation.

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