

Cissus Quadrangularis Dryer

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Abstract. *Cissus quadrangularis* is a herb of Thailand. It used for many ailments, especially for the treatment of hemorrhoid. This article proposes the designing and construction of the *cissus quadrangularis* dryer for herbal medicines production. The dryer consists of 4 parts: drying cabinet, infrared heater, motor and blower. In the drying cabinet contains 4 paddles stirrer to stir the herbs for the good heat transfer and ventilation. The suitable drying condition was found by drying at different drying temperature (60 °C, 75 °C and 90 °C) with varying 3 different round speed of paddles stirrer (15 rpm, 25 rpm and 35 rpm). The testing result showed that the suitable drying condition of this dryer occurred in 25 rpm of the paddles stirrer round speed and 90 °C of drying temperature which provided the best product's quality comparing for color, productivity and energy consumption of product.

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1. Introduction

Cissus quadrangularis is a herb of Thailand and can find in many countries in Asia and Africa. It used for many ailments, especially for the treatment of hemorrhoid [1]. In Thailand, The foundation of Chao Phraya Abhaibhubejhr hospital has transferred it to the herbal medicines for using in the hospital which can reduce the consumption of chemical medicines and medical treatment cost. The production process of *Cissus quadrangularis* medicines starts from drying the *Cissus quadrangularis* to 9%wb of moisture content, milling and packing in the capsule. The foundation got these herbs from 2 ways, own plantation and cultivators which made the commitment with the foundation. The herbs from the own plantation were dried by the hot air dryer while the cultivators used solar dryer combined with hot air oven dryer to dry the herbs. With these drying processes there were many weak points for example, contaminate from the environment, too much drying time and high energy consumption. For these

problems, the objective of this study was to design and construct the *cissus quadrangularis* dryer to develop the herbal medicines process of the foundation of Chao Phraya Abhaibhubejhr hospital to solve these all problems.



Fig. 1: *Cissus quadrangularis* [2]

2. Methodology

Since our idea for designing the dryer claimed to solve the problems of the present drying process, so the designing process began from problem analysis, designing, prototype construction and machine testing, respectively.

2.1 Designing

After harvesting, the fresh *cissus quadrangularis* were chopped to the small size pieces about 3-5 centimeter long and passed to drying process. From the problem analysis we found that the main unsuitable product from solar dryer was the contaminated product and the unsuitable of hot air dryer was the long production time and uncertain moisture content of the product in each zone of the dryer because of the uncertain ventilation of the dryer. Many researchers claimed that the suitable method for drying of small piece product was the drying method with agitating which provided the high efficiency of drying [4-10]. From these information, so we designed the dryer which had the paddles stirrer in it to stir for mixing between product and hot air to improve the heat transfer and air ventilation of the dryer. The shape of the *Cissus quadrangularis* dryer is an U – shape (454 mm x 814 mm x 342 mm) of stainless steel, 40 liters of capacity

contains 4 paddles stirrer which are rotated by 2 Hp 3 phases gear motor. On the top of the cabinet installed the 4,800 Watts infrared heater unit. On the wall opposite the material inlet installed the 250 watts blower as shown in Figs. 2-3.

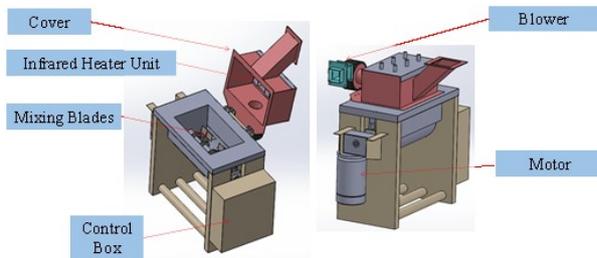


Fig. 2: Composition of the cissus quadrangularis dryer

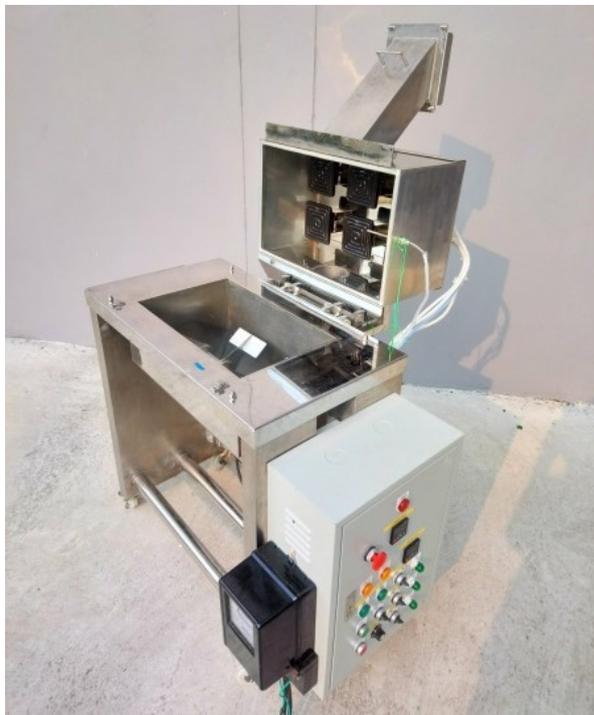


Fig. 3: The cissus quadrangularis dryer

2.2 Experiment

First step of finding the suitable condition of drying by this dryer was finding the appropriate round speed of the paddles stirrer which influenced in drying time, color of product and efficiency of dryer. So we have tested the dryer by varying 3 speeds of the paddles stirrer rotation (15, 25 and 35 rpm) at 60 °C of drying temperature (condition of original process). The indicator of the appropriate round speed of the paddles stirrer were the color of the product which close to the color of the samples from the foundation of Chao Phraya Abhaibhubejhr hospital and the efficiency of dryer. The CIE (L*, a*, b*) system was used to measure the product color where L* indicates lightness, a* and b*

indicate color directions (+a* is the red direction, -a* is the green direction, +b* is the yellow direction, -b* is the blue direction)[3]. The color difference can get from “ΔE*” as shown in Eq. (1).

$$\Delta E^* = \sqrt{(L_1^* - L_2^*)^2 + (a_1^* - a_2^*)^2 + (b_1^* - b_2^*)^2} \quad (1)$$

Where,

L₁^{*} = lightness of reference color

a₁^{*} = red color direction of reference color

b₁^{*} = yellow color direction of reference color

L₂^{*} = lightness of product color

a₂^{*} = red color direction of product color

b₂^{*} = yellow color direction of product color

Next step for finding the suitable condition of drying by this dryer was to find the appropriate drying temperature. From the preliminary experiments, the drying temperature from 60 °C to not exceed 100 °C could provide the acceptable quality of product, so we have dried the Cissus quadrangularis by this dryer at different temperature (60 °C, 75 °C and 90 °C) and use the color of the product as the indicator by comparing to the dried samples from the foundation of Chao Phraya Abhaibhubejhr hospital (Reference color).

After knowing the suitable condition of drying, at this condition we dried the Cissus quadrangularis for determining the drying rate, specific energy consumption (SEC) as shown in Eq. (2) and drying rate.

$$SEC = \frac{\text{Total drying energy}}{\text{Quantity of evaporated water of product}} \quad (2)$$

3. Results and Discussion

Detail	15 rpm	25 rpm	35 rpm
1. Color difference(ΔE*)	14.86	12.30	13.21
2. Drying rate (kg/h)	0.074	0.097	0.106
3. Loss (%)	4.94	18.59	27.44

Table 1: Comparison of drying in different round speed of paddles stirrer at 60 °C of drying temperature

Table. 1 shows that the suitable round speed of paddles stirrer is 25 rpm because of the minimum color difference (ΔE^*), means that the product provided the color which is more similar to the reference color than other round speed, while the drying rate is close to the 35 rpm and more than the 15 rpm. However the 15 rpm provided the minimum loss.

Samples	L*	a*	b*	ΔE^*
Reference color	51.06	3.42	20.76	-
60 °C	34.85	2.99	18.28	16.63
75 °C	31.67	3.35	16.35	20.09
90 °C	36.38	4.12	19.26	16.80

Table 2: Comparison of product's color of drying in different temperature at 25 rpm of paddles stirrer round speed

Table. 2 shows that there are 2 drying temperatures provide the product color close to the reference color, 60 °C and 90 °C. The minimum ΔE^* (16.63) occurs at 60 °C of drying temperature, while ΔE^* at 90 °C is 16.80.

Therefore, two drying temperature conditions were selected for the consideration of the suitable drying temperature, 60 °C and 90 °C, which provided similar ΔE^* . So we selected these 2 drying temperature conditions for consideration in other issues, drying rate and specific energy consumption, as shown in Table. 3.

Detail	60 °C	90 °C
1. Drying rate (kg/h)	0.097	0.170
2. Specific energy consumption, SEC (MJ/kg water evap)	11.66	11.14

Table 3: Comparison of drying in different drying temperature at 25 rpm of paddles stirrer round speed

Table 3 shows that the drying temperature at 90 °C provides the higher drying rate than 60 °C with the lower specific energy consumption (SEC). Therefore the drying temperature at 90 °C has potential in the efficiency of drying.

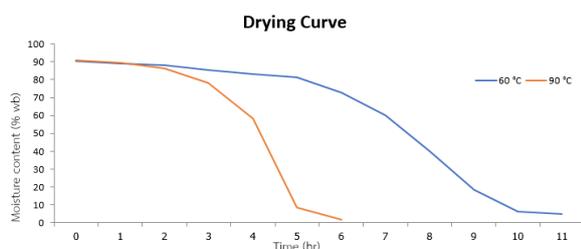


Fig. 4: Drying curve of the drying at 60 °C and 90 °C with 25 rpm of paddles stirrer round speed

Figure 4 shows the drying curve of the drying at 60 °C and 90 °C with 25 rpm of paddles stirrer round speed which shows the moisture content (% wb) of product versus time (h) of the drying. The drying curve of 90 °C is steeper than 60 °C, means that the drying temperature at 90 °C has the higher drying rate than 60 °C. And we can find the drying time in each level of product's moisture content from this figure.

4. Conclusion

The *Cissus quadrangularis* dryer was designed and constructed in new concept by installing the paddles stirrer within the cabinet for a good ventilation and invariable moisture content of product in each zone of dryer. The suitable drying condition was tested by drying at different round speed of the paddles stirrer and temperature. The suitable drying condition was occurred in 25 rpm of the paddles stirrer round speed and 90 °C of drying temperature which provided the similar color of product compare to the reference color, high drying rate (0.17 kg/h) and low specific energy consumption (11.14 MJ/kg water evap).

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Biographies



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