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Drying Curves and Colour Changes of Cassia Alata Leaves at Different Temperatures

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Abstract. Cassia alata plant has been commonly used as medicinal herbs for treating fungal infection such as ringworm and eczema. Nevertheless, a few studies on drying characteristics have focused on C. alata. This work aims to investigate the drying characteristics of C. alata leaves at different temperatures. Moreover, the effects of different drying temperatures on colour qualities of C. alata leaves had been determined. The leaves were dried at different temperatures (40, 50, 60, 70, 80 and 90 °C) using a laboratory oven. Dried and fresh leaves were analyzed for the moisture content and colour analysis. The EMC of C. alata leaves decreased from 0.30 to 0.10 g water/dry matter as the temperature increased from 40 °C to 90 °C. The colour qualities of C. alata leaves were lower with increasing drying temperature.

1 Introduction

Drying process is very important to prolong the shelf life of the product and it is also important to preserve the chemical and physical properties of the products. Drying of herbs inhibits microbial growth and forestalls certain biochemical changes. Sun drying is commonly used by small-scaled entrepreneurs to dry the herbs [1]. In spite of the low cost in using this method, it has some great disadvantages to it such as contamination and also from the hygienic aspects. Furthermore, the final moisture content of the material is always relatively high after being sun dried. Alternative methods in drying process are oven drying, hot air drying and freeze drying. These methods are performed in a closed system which ensures better air circulation and controlled conditions while drying.

Nevertheless, drying variables, especially temperature and the drying method, can alter the appearance and chemical constituents of herb quality. The total polyphenols and antioxidants of Capsicum chinense Jacqui (Cumari chilli pepper) was reported decreased when dried at 65°C compared to 55 and 45°C in a fixed moisture [2]. Colour, is nevertheless an important characteristic to be sustained as it can provide the first impression of the dried product quality. Colour is related to consumers' appreciation of a product as they tend to associate product colour and other visual properties with its taste, hygienic security, shelf life, nutritional value and personal satisfaction [3]. Furthermore, colour is directly linked to aroma and taste of the product.

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Oven drying is found out as a better way compared to sun drying in maintaining the colour of herbs [4]. However, there is lack of information on the effects of different oven drying temperatures on colour changes of C. alata leaves. Thus, the aims of this study were to determine the drying curve and colour changes of C. alata leaves at different temperatures of oven drying (40, 50, 60, 70, 80 and 90 °C). The hypothesis of this study is that the equilibrium moisture contents and colour qualities of C. alata leaves decrease with the increasing temperature. Therefore, we expected to determine which drying temperature is best for preserving the colour quality of C. alata during industrial scale production.

2 Materials and methods

2.1 Plant cultivation

C. alata plants were grown at the Institute of Sustainable Agrotechnology (INSAT), Sg. Chucuh, Perlis, Malaysia. The plants were grown from cuttings and maintained according to the standard practiced adopted by the majority growers in Malaysia.

2.2 Samples preparation

Fresh leaves were harvested, washed and rinsed. The leaves were then immediately removed from the twigs for subsequent drying treatments.

2.3 Drying process

About 10 g of C. alata leaves were oven dried at six different temperatures (40, 50, 60, 70, 80 and 90°C) by using laboratory oven until constant weight was obtained. The samples were replicated five times for each temperature and the data were recorded.

2.4 Colour properties determination

Colour properties (L*, a* and b*) of C. alata leaves were determined by using Minolta Chroma meter CR 400 (Minolta Co., Osaka, Japan).

2.5 Statistical analysis

All measurements were carried out in triplicate and the results were statistically analyzed using JMP pro 11 package to determine the average value and standard error.

3 Results and discussion

3.1 Drying curve of cassia alata leaves at different temperatures

Drying curves (Fig. 1) were experimentally obtained by plotting the moisture content versus drying time. A considerable time period is required to achieve complete drying and to reach equilibrium moisture content (EMC). At initial stage of the drying process, the moisture contents of C. alata leaves were high due to the availability of free moisture samples at the initial stage. The moisture contents of leaves were decreasing with increasing temperature. This finding agreed with work of Seremet et al. (2016), who also found that drying removes the water from the food and consequently inhibits the development of microorganisms, improves food preserving as well as proper storage [5]. Fig. 2 shows that C. alata took about longest duration (7 hours) to remove its free moisture at 40°C, while shortest duration (30 minutes) to remove the free moisture at 90°C. The moisture desorption rate increased with higher temperature of oven drying as demonstrated by a lower EMC and shorter time to reach the EMC was consistent with those reported in literature [6]. The EMC of C. alata decreased from 0.30 to 0.10 g water/dry matter as the temperature increased from 40°C to 90°C.

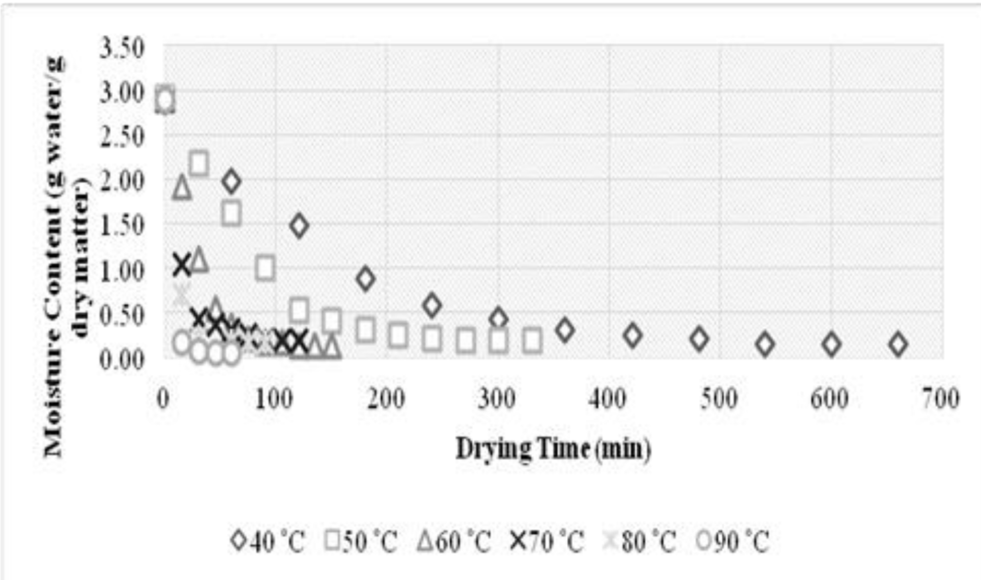

Fig. 1. Drying curves of C. alata leaves at different temperatures

The drying curves agreed with the theory of drying [7]. Initially, sensible heat was transferred from the oven drying to the fresh leave and the moisture was removed from the leave. The rate of evaporation increased during this period. Then, the moisture kept being removed from the saturated leaves surface. During this period, the rate of evaporation was the highest and it changed very little as the moisture content was reduced. As illustrated in Fig. 1, the actual drying rate was seen to fluctuate within this period; it could be attributed to the phase transition of water from the leave surface to the surrounding air. The falling-rate period coincided with the last stage of drying. The material surface in the falling rate period was no longer saturated with water and the drying rate was controlled by diffusion of moisture from the interior of solid to the surface [8].

3.2 Colour changes of C. alata leaves f at different temperatures

The determination of the colour quality is based on brightness (L*), greenish to reddish (a*), and blue to yellowish (b*) colour. For L*, the scale is given as 0 which is black and 100 as white. For a*, negative value indicates greenness and positive value indicates reddish. Meanwhile for b*, negative value means blue and positive indicates that the yellowish. The effect of drying temperatures to the colour quality of C. alata leaves is as shown in Table 1. The results showed that the L* values of the leaves decreased as the temperature increased. However, the L* values of C. alata were not significantly different when dried at 40 and 50°C compared to the fresh leaves. This demonstrated the colour of leaves became dark green as they were dried at higher temperature. The decreased in L* value when dried at all drying temperatures which was possibly due to drying time and drying temperature [9].

Table 1. Colour changes of C. alata leaves at different temperatures

Drying Temperature (˚C)	**Color Parameters**		
	L*	**a***	**b***
Fresh	55.72 ± 0.59	-13.51 ± 1.01	28.02 ± 0.59
40	54.10 ± 0.75	-12.10 ± 1.51	27.88 ± 1.49
50	51.83 ± 2.15	-7.67 ± 1.17	23.84 ± 0.66
60	47.36 ± 0.93	-6.04 ± 0.90	23.08 ± 3.60
70	46.08 ± 3.01	-5.75 ± 1.12	22.80 ± 2.48
80	40.76 ± 5.29	-3.82 ± 0.94	20.46 ± 3.07
90	36.10 ± 3.00	-2.88 ± 1.71	20.44 ± 2.83

Mean values ± standard deviation

The value a* represents the greenness (negative value) to reddish (positive value) of the leaves. Table 1 shows an increase in a* values of the leaves with increasing the temperature (-13.51, -12.10, -7.67, -6.04, -5.75, -3.82 and -2.88 respectively). The green colours of leaves decreased as they were dried at higher temperature. The change of colour was probably due to heat degradation of chlorophyll. This finding was similar with work, which also found that the value of a* showed more positive as the drying temperature increased which indicated a change in colour from green to reddish tone [10]. The natural green colour of leaves is due to mixture of chlorophyll which is directly related to magnesium. During drying, the magnesium molecules were changed to pyropheophytin and pheophytin [11]. Therefore, greenness was reduced at higher temperatures. The degree of greenness is an important characteristic for customers to determine the final dried products [10]. Some literatures reported that the reduction of green shade in the leaves was also probably due to the undesirable enzymatic browning reaction during drying process [12]. This reaction was possibly due to the activity of polyphenol oxidase (PPO), which oxidizes polyphenols to produce quinines in the leaf tissues.

The b* values indicates the blue negative value) and yellow (positive value). The increase in temperature did not seem to affect much on the b* value of C. alata leaves (Table 1). The range of b* values was from 28.02 to 20.44 which indicated gradual colour changed from yellow towards blue. However, the change was not very noticeable through the difference of temperatures. A decrease in the yellowness (b* values) for C. alata leaves was probably due the decomposition of carotenoid compound [13].

4 Summary

Equilibrium moisture content (EMC) is a significant factor in biomass drying as it can provide a guideline for expediting drying and for terminating the drying process in a timely manner to save energy. With higher temperature of oven drying, the moisture desorption rate increased as demonstrated by a lower EMC and shorter time to reach the EMC. However, the colour qualities of C. alata leaves were lower with increasing drying temperature. This study suggests that the colour quality of C. alata was the best at the temperature of 40 °C. Low oven-drying temperature was better in preserve the colour quality of C. alata leaves.

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