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Vacuum Drying Characteristics for *Piper betle* L. Leaves

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Abstract: *Piper betle* L. leaves locally known as sirih and betel in English. Betel leaves scientifically proved to have a phytochemicals compound which has potential of bioactivities. To preserve the quality of this herbs, drying process must be carried out. As the drying process applies heat take longer time to dry the product, the degradation and decomposition of valuable phytochemicals within the herbs may take place. This present work was carried out to investigate the drying characteristics of betel leaves. Drying experiments were carried out at vacuum oven chamber with pressures of 0.0, 0.5 and 1.0 atm and the drying temperatures studied are 30, 50 and 70°C. The effects of drying pressure and temperatures on the drying time, drying rate and product quality in terms of colour of betel leaves were evaluated. The results showed that increasing drying temperature combined with increasing vacuum pressure accelerated the vacuum drying process. The change in colour values was dependent on the drying temperature where higher temperature caused darker product compared to lowest temperature. Temperature of 50°C showed the best appearance while shorter drying time take place at temperature of 70°C with pressure of 0 atm.

Key words: Betel leaves, drying pressure, drying kinetic, drying quality, colour analysis

INTRODUCTION

Betel (*Piper betle* L., Piperaceae) also traditionally known as sirih in Malaysia. This plant originates from the central and eastern part of peninsular Malaysia but more popular in India compared to other countries since ancient times (Guha, 2006). Traditionally, betel leaves are used to treat bad breath, boils and abscesses, conjunctivitis, cuts and injuries and etc. Current research has reported that betel leaves contains an active compound called eugenol and hydroxychavicol which contribute to many bioactivities (Mazura *et al*., 2007; Rathee *et al*., 2006; Nalina and Rahim, 2007).

Betel is the material which cannot be preserved for long periods without proper processing. In order to prolong it's shelf life and preserved the phytochemical compounds content, a rapid drying process must be applied. Drying is a preservation process of any product by lowering the amount of moisture content in the materials (Drouzas and Schubert, 1996). According to current research of drying betel leaves, shorter drying time need to preserve the quality (Pin *et al*., 2009). Previous research has reported that vacuum drying has insignificant effect on the vacuum drying process. Drying process generally known to be dependent on the temperature, as the temperature increases, shortened the drying time (Wu *et al*., 2007).

The present work was undertaken to study the drying characteristics by considering the drying kinetics of vacuum drying for betel leaves and the quality behavior in terms of colour of dried betel leaves.

MATERIALS AND METHODS

Sample preparation: Fresh betel leaves were collected from Herbal Technology Centre (HTC), Forest Research Institute Malaysia (FRIM), Kepong. The leaves were cleaned using tab water and clean cloth to remove dirt and impurities. Initial moisture content was then measured using moisture analyser (AnD MX-50, US).

Drying of the betel leaves: Ten grams of betel leaves were distributed uniformly as a thin layer on a tray and dried in vacuum oven (Model OV-11, Korea) at temperature of 30,

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50 and 70°C with pressure of 1.0, 0.5 and 0.0 atm for each temperature. The weight of the samples was measured every 15 min for first 3 h and every one hour for the continuous hours using a digital balance (Model Pioneer™, OHAUS, US). After each drying experiment, the dried samples were cooled down and stored in airtight jar. Drying experiments were done triplicate at each temperature and the average moisture ratio are used for the purpose of plotting the drying curves.

The moisture content of the betel leaves were measured by using moisture analyzer (AnD MX-50, US) at temperature of 105°C. The initial moisture content of the betel leaves was determined as 78.8% wet weight basis.

The moisture ratio (M_R) and drying rate (D_R) using drying experiments were calculated using the following equations:

$$M_R = \frac{M - M_e}{M_0 - M_e} \tag{1}$$

$$D_R = \frac{M_{t+dt} - M_t}{dt} \tag{2}$$

where, M, M_0, M_e, M_t and M_{t+dt} are the moisture content, initial moisture content, equilibrium moisture content, moisture content at t and moisture content at t+dt, respectively, t is drying time (min).

Colour measurement: The colour of the betel leaves was measured by a Color Reader CR-10 colour meter (Konica Minolta Sensing, Japan) before and after drying. The L*, a* and b* values are the averages of five readings. The colour brightness coordinate L* measures the whiteness value of a colour range from black at 0 to white at 100. The chromaticity coordinate a* measure red when positive and green when negative and the chromaticity coordinate b* measures yellow when positive and blue when negative (Doymaz *et al.*, 2006).

RESULTS

Drying characteristics of betel leaves: Figures 1, 4 and 7 show the drying curves of betel leaves at different air temperatures and vacuum pressures. As shown in the Fig. 2, 3, 5, 6, 8 and 9, as the pressure reduced, drying time of betel leaves were decreased compared to normal atmospheric condition.

Colour assessment: The results of colour parameters obtained from vacuum drying processes of various drying conditions are presented in Table 1 shows the colour data in terms of L*, a* and b* values of fresh and dried betel leaves.

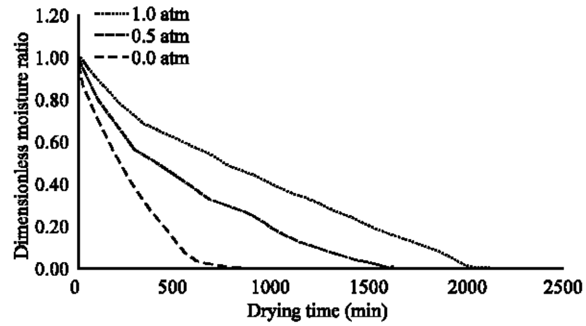

Fig. 1: Variation of moisture ratio with time at different pressure for temperature of 30°C

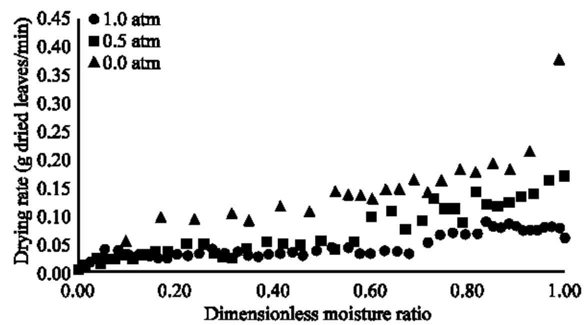

Fig. 2: Variation of drying rate with moisture ratio at different vacuum pressure for 30°C

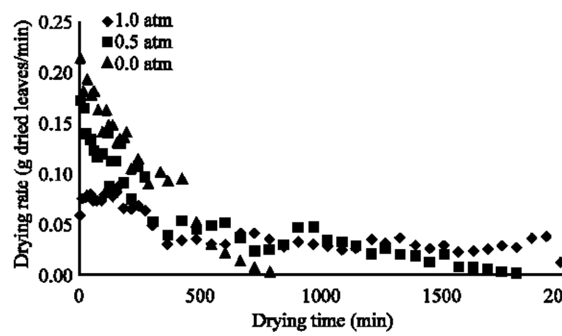

Fig. 3: Variation of drying rate with time at different vacuum pressure for 30°C

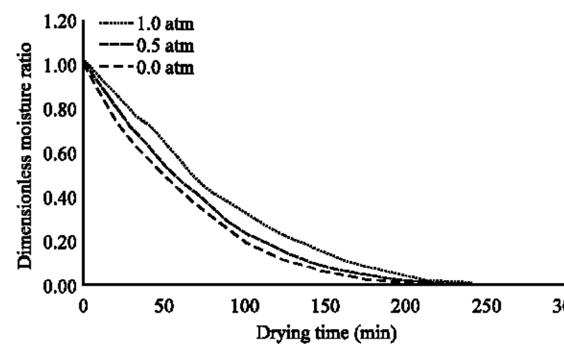

Fig. 4: Variation of moisture ratio with time at different pressure for temperature of 50°C

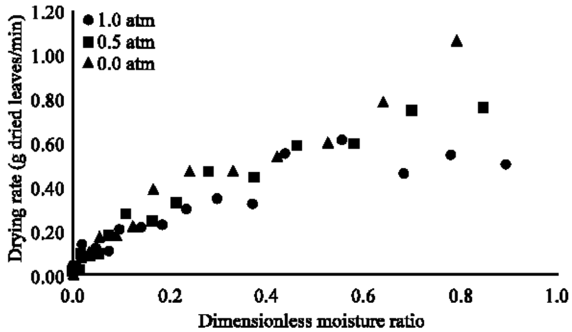

Fig. 5: Variation of drying rate with moisture ratio at different air pressure for 50°C

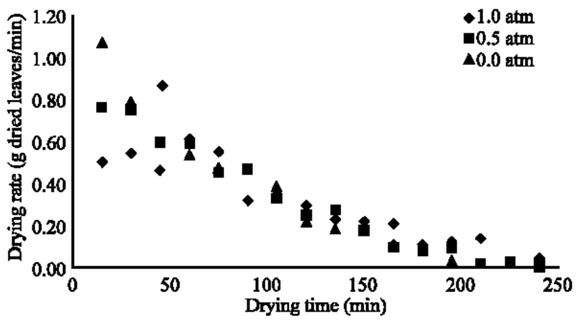

Fig. 6: Variation of drying rate with time at different vacuum pressure for 50°C

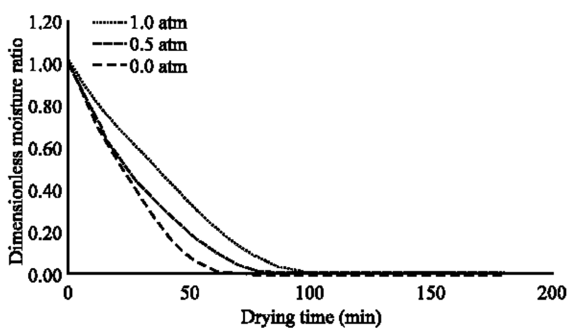

Fig. 7: Variation of moisture ratio with time at different pressure for temperature of 70°C

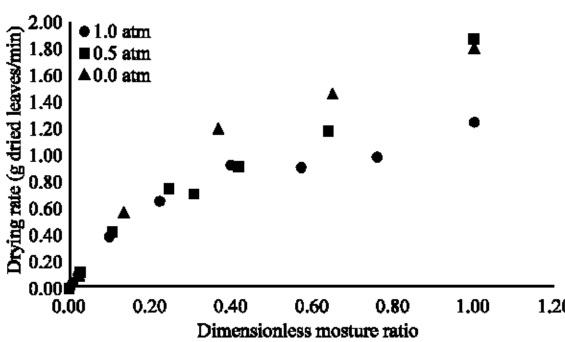

Fig. 8: Variation of drying rate with moisture ratio at different air pressure for 70°C

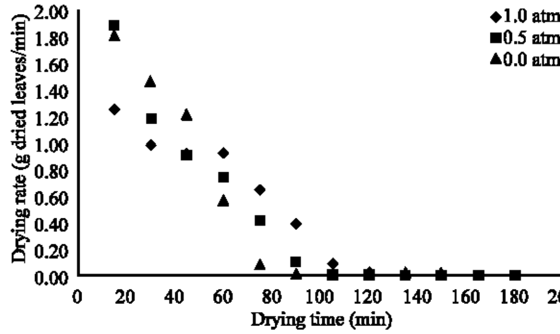

Fig. 9: Variation of drying rate with time at different vacuum pressure for 70°C

Table 1: Colour values of dried betel leaves

Temperature (°C)	Pressure (atm)	L*	a*	b*
30	0.0	31.27±1.24	2.43±0.25	15.37±0.40
	0.5	31.43±1.27	2.73±0.40	15.13±0.90
	1.0	31.40±0.40	2.60±0.35	14.53±0.45
50	0.0	28.70±0.35	0.53±0.15	15.17±0.67
	0.5	28.97±1.46	0.23±0.59	15.97±0.06
	1.0	28.73±0.31	0.40±0.17	14.80±0.26
70	0.0	22.60±1.08	4.23±0.21	11.17±0.21
	0.5	26.33±0.38	4.40±0.17	13.33±0.15
	1.0	26.80±0.30	4.43±0.15	14.00±0.40
Fresh		31.80±0.30	-3.03±0.12	15.73±0.91

Values are Means±Standard deviation

DISCUSSION

Drying characteristics of betel leaves: The drying rate decreased continuously throughout the drying period. The constant rate period is absent in the vacuum drying of betel leaves. All the drying process of betel leaves took place in falling rate period. Internal diffusion within the product controls the drying process of betel leaves (Pin *et al*., 2009).

Colour assessment: As shows in Table 1, L* values reduced as the temperature increased compared to fresh ones. The greatest loss in brightness was determined at temperature of 70°C, 0.0 atm pressure application, whereas higher values were obtained at 30°C. Redness value (a*) resulted at 50°C the values were closed to the fresh leaf compared to other conditions. Highest values obtained of a* values was determined at 70°C followed by 30°C. The b* values of fresh samples were higher than those dried samples. At temperature of 30 and 50°C, b* values shows the closest value to the fresh samples compared to 70°C. Significant values of all chromaticity loss at 70°C occurred due to burning at the samples surface resulted in some darkening while at 30°C significant loss of a* values caused by longer drying time compared to other temperatures. The 50°C has found to be the best temperature in determined the best quality in terms of colour. This findings has resulted that the changes of colour in drying process of betel leaves was affected only by the temperature as there was insignificant different for various pressure condition.

CONCLUSION

Vacuum drying of betel leaves under investigated drying conditions took place in the falling rate period. By increasing drying temperature with combination of reduced pressure shortened the vacuum drying process. Based on the experimental results reported herein, vacuum condition had insignificant effect on colour assessment. However, colour analysis showed that green colour of betel leaves is preserved at 50°C for all vacuum drying condition.

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