Influence of Heating Intensity and Drying Time of Oven and Microwave on the Moisture and Water Activity of the *Gynura procumbens* Leaves

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ABSTRACT

The heating intensity and drying time by drying using oven and microwave were studied for moisture content and water activity of the *Gynura procumbens* leaves. Drying was conducted by using oven and microwave drying at varied temperature, power and drying time. The result demonstrated that microwave drying at 375W for 21.50 minutes and 925W for 58.50 minutes effectively reduced moisture content and water activity more efficiently than oven drying at 47.5°C and 62.50°C, with 7.50 and 12.50 hours drying time, respectively. Hence, these findings highlight the efficiency of microwave drying in producing shelf-stable *Gynura procumbens* leaves which can be used for pharmacological purposes.

Keywords*:* Gynura procumbens, drying, oven, microwave, moisture, water activity

INTRODUCTION

Gynura procumbens leaves is a medicinal herb that is commonly found and are easily accessible in Malaysia and is often grown through a simple method of stem cutting (Kanzil & Pristesh, 2016; Tahsin et al., 2022). Previous studies have confirmed that *Gynura procumbens* leaves are rich in phytochemical and antioxidant activity contributing to various health benefits (Tahsin et al., 2022; Khuzaidatul Azidah et al., 2019; Tan et al., 2016). Therefore, these leaves have a high potential to be used in the pharmacological industry. However, due to the high moisture content and water activity of the fresh leaves, the leaves are hard to keep for a longer period. Therefore, a solution to increase the shelf life of the leaves is required. One of the simplest methods to preserve *Gynura procumbens* leaves is through drying. Dried herbs retain their quality due to their low moisture and water activity, thus helping in preventing microbe growth and chemical changes during their storage period (Özgüven et al., 2019).

Although sun-drying is easily accessible and cheap, the process takes a long time and this process is not suitable to dry herbs as it will result in low product quality degradation (Thamkaew et al., 2021). Thus, another common conventional drying technique that could minimize these influences by drying in conditions which can be more controllable, such as oven drying is needed. However, the major limitation of this method is its lengthy process, thus, another alternative drying technique is required such as microwave drying to reduce the time taken for drying. Nonetheless, Thamkaew et al., (2021), mentioned that the major drawback of microwave drying is its non-uniform heat distribution, which can lead to uneven heating intensities and potentially longer and inconsistent drying time. In contrast, Alara et al. (2019), observed that oven drying offers more uniform heat distribution, resulting in consistent heating intensities and more predictable drying time. This study aims to determine the effect of heating intensity and drying time of oven drying and also microwave drying. Therefore, microwave drying is compared with oven drying in this study to see how the different heating intensities and drying time affect the moisture and water activity of the *Gynura procumbens* leaves.

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MATERIALS AND METHODS

Raw Materials

The fresh leaves of *Gynura procumbens* leaves was collected from Alor Setar, Kedah, Malaysia. The dirt on the leaves was cleaned thoroughly and the leaves was separated from its stem. Then, only healthy, and fully expanded leaves without any defect was selected. The leaves were ground before drying by using a food chopper for 10 seconds until uniform particles were achieved.

Drying Process

Triplicates of 20 g of the ground leaves was filled in a steel petri dish with the same thickness as in Figure 1. Then, the leaves were dried at 62.50°C for 12.50 hours and 47.50°C for 7.50 hours in the oven (Memmert UNB 300, Germany). For microwave drying, the leaves were dried at 925W for 58.50 minutes and 375W for 21.50 minutes in the microwave (Fujison FS-MO300, Japan). Then, the effect of drying was measured by moisture content (A&D, MX-50, Japan) and water activity (Aqualab, 4TE, USA).

Figure 1 Gynura procumbens leaves sample

RESULTS AND DISCUSSION

Heating Intensities

Figure 2 presents the final moisture content and water activity under oven drying at different drying temperature but with the same duration of drying. As the drying time prolonged, at the temperature of 47.5°C (Figure 2(i)) decreased by 3.27%. In contrast, the same trend could not be observed at temperature 62.5°C as shown in Figure 2 (ii), where the moisture slightly increased by 0.85% as the time increased. Usually, an increase in drying time at the same temperature will result to a decrease in final moisture content. The rate at which materials dry is influenced by the gradient in moisture and heat. A larger gradient in moisture and heat will increase the drying rate. Thus, if gradient driving force is available with an equilibrium approach, drying can be quicker. However, if the gradient is insufficient, the drying rate will be reduced and resulting to a longer drying period (Babu et al., 2018). A possible explanation might be due to external disturbances from outside, such as the oven door being opened and closed multiple times, causing temperature fluctuations to occur which leads to the leaves to temporarily release and reabsorb the moisture and thus, increasing the moisture content. Another possible explanation may be due to analysing the samples before they were cooled sufficiently, which leads to higher uncertainty. Nonetheless, the water activity at 47.5°C with increase in drying time showed a 9.05% decrease (Figure 2 (iii)) and at 62.5°C, the water activity decreased by 28.08% (Figure 2 (iv)). This result is consistent with a study by Schmalko et al., (2005), where water activity in yerba mate leaves reduces with increase of time.

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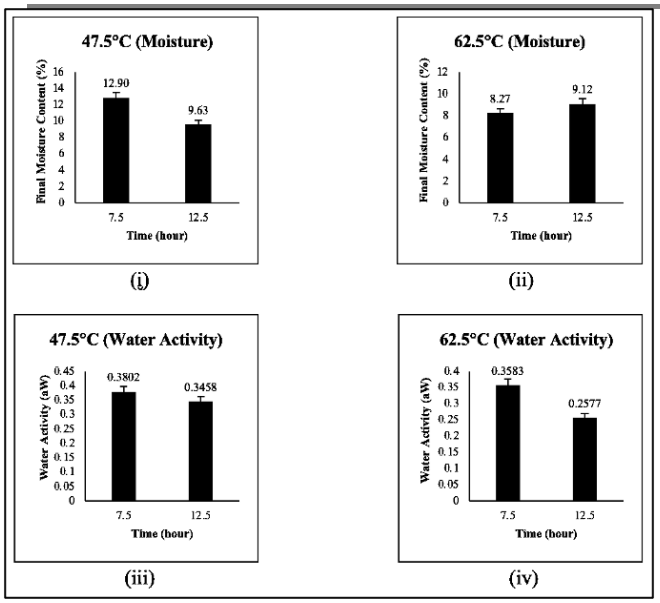

Figure 2 Final moisture content and water activity under oven drying at different drying temperature

At microwave power of 375W, when the drying time was extended, the final moisture content decreased by 51.42% as in Figure 3 (i) and decreased by 13.43% at 925W as shown in Figure 3 (ii). A similar trend was also observed for water activity at 375W with a decrease by 32.52% as in Figure 3 (iii) and decreased by 50% as in Figure 3 (iv). These findings showed that with an increase of drying time, even when drying was conducted at the same microwave power, the moisture content and water activity will still decrease. Similar finding was observed on microwave-dried bay leaves whereby a more rapid decline was observed in moisture content with increase drying time (Mujaffar & Bynoe, 2019).

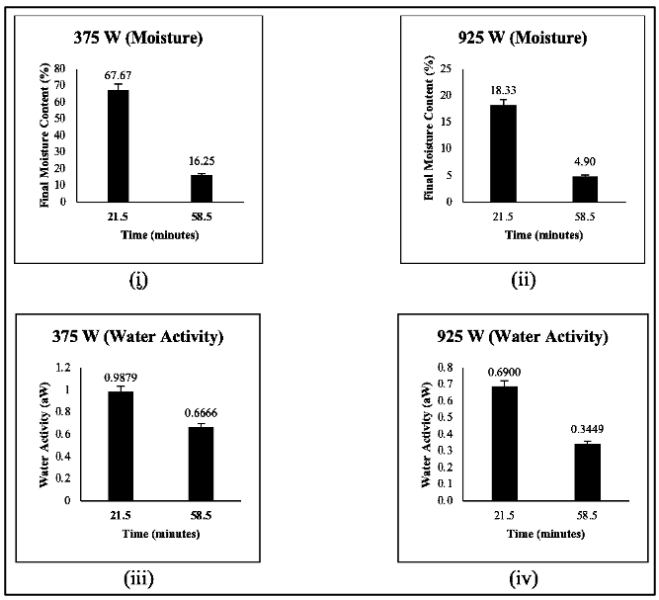

Figure 3 Final moisture content and water activity under microwave drying at different drying power

Drying Time

As depicted in Figure 4, for oven drying, as the temperature of drying time increased, the moisture and water activity decreased. Specifically, for the drying time of 7.5 hours (Figure 4 (i)), moisture decreased by 4.63% with an increase of temperature and at 12.5 hour (Figure 4 (ii)), moisture was also decreased by 0.51% with an increase of temperature. Similar trend can be identified in water activity (Figure 4 (iii) and (iv)) where water activity decreased by 5.76% and 25.48%, respectively. These findings showed that when drying was conducted at the same duration, the temperature can affect the final moisture content where the higher the temperature,

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the more moisture can be reduced. The same concept can be applied to water activity. This is in agreement with statement by Babu et al., (2018), where moisture and water activity reduce with increase in temperature.

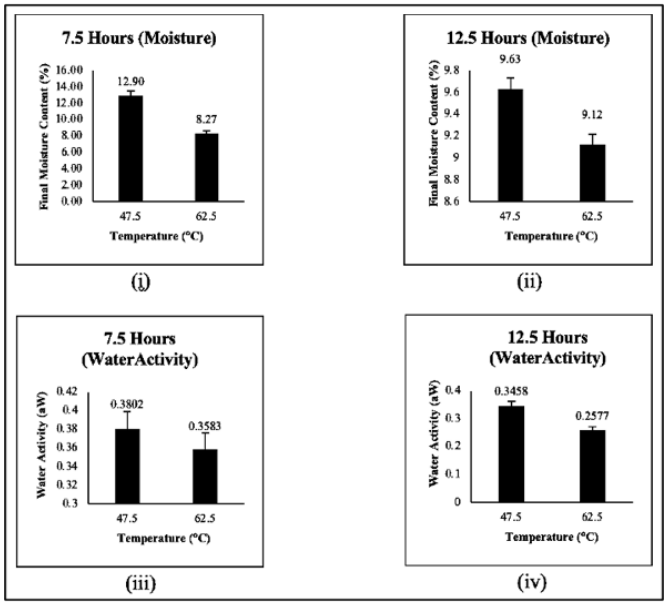

Figure 4 Final moisture content and water activity under oven drying at different drying time

As shown in Figure 5 (i) at 21.50 minutes, as the microwave power of drying increase, the moisture will decrease by 49.34%. Similar trend was observed in Figure 5 (ii) at 58.50 minutes where the moisture decreased by 11.35%. Then, at 21.50 minutes (Figure 5 (iii)), the water activity decreased as well by 30.15% with increment of microwave power. This trend can also be observed at 58.5 minutes (Figure 5 (iv)) where water activity decreased by 48.26%. These findings indicate that with the increase of microwave power, even when drying was conducted with the same duration, the moisture content and water activity will still decrease. Similar finding was observed on a study by İlter et al., (2018), whereby water activity and moisture of garlic puree reduces with increase of microwave power.

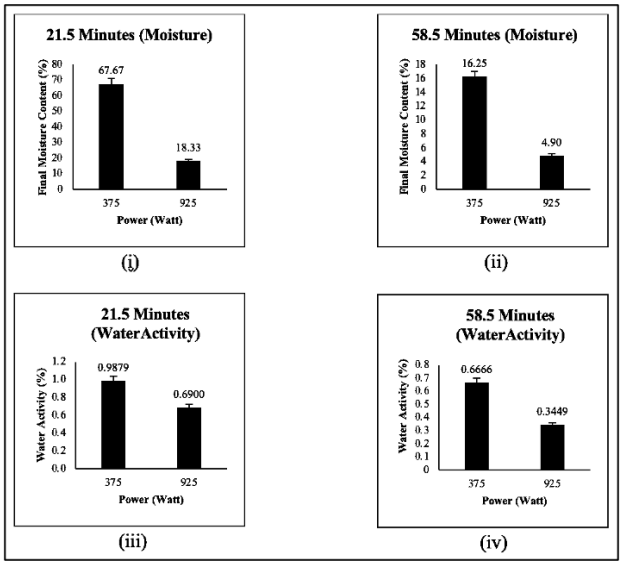

Figure 5 Final moisture content and water activity under microwave drying at different drying time

CONCLUSION

Moisture content and water activity are interdependent. This means that changes in one can affect the other, making it important to monitor both when dealing with food safety and preservation. This explains the reason why when the moisture content of the leaves decreased, the water activity will decrease as well. The study was

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conducted to determine the effect of heating intensity and drying time of oven and microwave drying. Therefore, in this study, microwave drying was more preferred to dry the *Gynura procumbens* leaves as it was able to provide consistent drying, effectively reduced moisture and water activity in a shorter time and maintained stable heating throughout the drying process compared to oven drying. Based on these findings, microwave drying is recommended for its effectiveness, while further optimization of drying conditions and consideration of oven drying for specific needs are suggested.

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