Effect of initial moisture content on physical properties of Orthosiphon stamineus ground powder during storage

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Abstract. Initial moisture content of ground powder is very important factor in maintaining the physical quality of the product during storage. This research was conducted to investigate the effect of initial moisture content of Orthosiphon stamineus ground powder on physical properties such as moisture content, water activity and colour properties during short term storage period. In this research, the experimental treatments were arranged in a completed randomized design (CRD) that consisted of two main factors which were initial moisture content (8, 13 and 20 %) and storage period (0, 2, 4, 6, 8 and 10 weeks). The changes of moisture content, water activity and colour properties were analyzed using moisture analyzer, water activity meter and chroma meter, respectively. From the results, it was revealed that the best initial moisture content to maintain the quality of O. stamineus ground powder was 13 %. At early of storage period, moisture content and water activity were slightly reduced and they started to stable at week 8 to 10. The consistency of moisture content and water activity is expected to last for the next 6 months under same storage condition. However, it could be observed that the colour of O. staminus ground powder was slightly affected during short term storage.

1. Introduction
Orthosiphon stamineus or “Misai Kucing” was classified in Lamiaceae family. O. stamineus gets its common name from its white purple flowers with long stamens shaped like cat’s whiskers. O. stamineus can grow to a height of 1.5m [1]. In Malaysia, O. stamineus is popular among the traditional medicinal practitioners because of its healing properties. The leaves of O. stamineus can be used traditionally as treatment or health supplements for rheumatism, diuresis, oedema, hepatitis, jaundice, biliary lithiasis, hypertension, diabetes and eruptive fever. Besides, the O. stamineus leaves also can treat kidney ailments including angiogenesis-dependent diseases [2].

The demand of this herb becomes higher in the market due to its potential uses in pharmaceutics industry. Therefore, this is the main reason this research is done with the aim to fulfil the demand from the consumers in locally or globally to obtain the high quality of O. stamineus product especially in a ground powder form. The medicinal product in ground powder form is easier to handle during storage and transportation besides can prolong the shelf life. However, the physical and chemical properties of the herbal product could change during the processing and storage time [3]. Storage time is very important factor in production of herbal products. The storage time must be controlled efficiently to

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maintain the physical and chemical quality of the herb. The temperature, relative humidity, moisture content and light intensity can also affect the storage time [4]. Besides that, information on moisture sorption behaviour of food is important to determine water interaction with foodstuffs. Water activity is the most important factors that should be considered in controlling the microbial growth in food products. It was reported that when reduce water activity below 0.70 prevent microbial growth. The water activity should in low range to preserve food ingredients [5].

Lack of proper storage information on *O. stamineus* ground powder can affect the commercial quality of the final products. Appropriate initial moisture content and storage period are important aspects for extending the shelf life of *O. stamineus* ground powder. Therefore, this research was conducted to investigate the effect of initial moisture content and storage period towards the physical properties of *O. stamineus* ground powder such as moisture content, water activity and colour changes (ΔE and h°).

2. Materials and Methodology

2.1. Preparation of Experimental Material

The local-purchased of *Orthosiphon stamineus* ground powder was re-dried using laboratory oven at 40 °C until desired initial moisture content levels of 8 to 20 % were achieved. The moisture content of the *O. stamineus* ground powder was obtained using MX-50 moisture analyzer.

2.2. Experimental Treatment and Design

The experimental treatment was designed based on two main factors level. The main factors in this study were initial moisture content and storage period. The initial moisture content was set at 8, 13 and 20 % and storage intervals were 0, 2, 4, 6, 8 and 10 weeks. The samples were stored under room temperature of ± 25 °C with average relative humidity of ± 60 % RH. The experiment was arranged in a completed randomized design (CRD) with 3 replications. About 5 g of *O. stamineus* ground powder with 8, 13 and 20 % initial moisture content was packed neatly in a zip-locked plastic bag. The samples were stored for 10 weeks of storage period.

2.3. Moisture Content Analysis

The percentage of moisture content expressed as wet basis (w.b) of *O. stamineus* ground powder was determined using MX-50 moisture analyzer. Measurement was done based on the thermo-gravimetric principles according weight loss of the sample dried by heating. Drying temperature was set to 105°C with constant temperature drying.

2.4. Water Activity Analysis

The water activity value of *O. stamineus* ground powder was determined using AQUA LAB water activity meter. The water activity was measured by equality the liquid phase water in the sample with the vapour phase water in the headspace. The samples were placed on the cup that seals inside the sample chamber. The dew point sensor detected the temperature of the air in the chamber. Measurement was done based on the chilled-mirror dew point technique.

2.5. Determination of Colour Changes

The Konica Minolta Chroma meter was used to measure the colour changes of stored samples for 10 weeks. The colour changes of samples are defined by colour coordinates which L* indicates lightness, a* is the red/green coordinate and b* is the yellow/blue coordinate. Coordinate L* represents clarity (L* = 0 black and L* = 100 colourless), red/green colour coordinate (a*> 0 red and a* < 0 green) and yellow/blue coordinate (b*> 0 yellow and b*< 0 blue). Delta E (ΔE) is the total difference which combine all parameters L*, a* and b* values is a colorimetric parameters used to analyze the variation of colours (Eq.1). The ΔE is representing colour different between sample and standard. Meanwhile, the value of hue angle indicates the true colour that cannot be seen through naked eye (Eq.2).
\[ \Delta E = \sqrt{(L^* - L_0)^2 + (a^* - a_0)^2 + (b^* - b_0)^2} \]  

\[ \text{Hue Angle} = h^* = \arctan \left( \frac{b^*}{a^*} \right) \]  

2.6. Statistical Analysis

The experiments were conducted based on completed randomized design (CRD). The data obtained were analyzed statistically based on the means, standard deviations and standard errors.

3. Results and Discussion

3.1. Moisture Content

In general, the changes of sample moisture content were radically affected by initial moisture content as shown in Figure 1. The samples with high initial moisture content (20 %) steadily decreased in moisture content throughout the storage time and started to consistent at 13.56±0.38 %. Meanwhile, the samples with medium initial moisture content (13 %) had slightly decreased trend and stabilised at 10.91±0.19 %. Otherwise, the samples with low initial moisture content (8 %) had significantly increased in moisture content during storage and the moisture level approximately around 10.57±0.44 %. The moisture content of samples with low and medium initial moisture content remained constant throughout 10 weeks of storage period. This unique phenomenon might be due to the movement of the water either adsorb or desorb into the samples during storage process. These processes also known as adsorption isotherm and desorption isotherm. Normally, the equilibrium moisture content will be achieved when the moisture content in the stored samples is consistent. One of the researchers also reported that desorption isotherm usually gave higher values of equilibrium moisture content than adsorption isotherm [6].

Moisture content is an essential parameter that needs to be indicated during storage especially for ground powder herbal material. Excessive of moisture content can affect the rheology of ground powder especially their bulk density and flowability. In addition, it also can affect the chemical and physical properties of the powder during storage process [7, 8]. The storage relative humidity and temperature also can influence the changes of moisture content [4]. It also reported that when the foods reached the equilibrium moisture content, the moisture decrease and causing the product dried. The dried foods were not easily exposed to the spoilage food and can increase the shelf life [9].

![Figure 1. The changes of moisture content during storage.](image-url)
3.2 Water Activity

Water activity ($a_w$) is an important parameter to control the water content in food herbal materials to prevent the spoilage by microbial and prolongs the shelf-life [5]. Water activity is measured energy status of water in a system. The changes of water activity during 10 weeks of storage period at 8, 13 and 20 % initial moisture content are shown in Figure 2. For the stored samples with high initial moisture content (20 %) exhibited the decreasing trend of water activity from $0.84 \pm 0.03$ to $0.65 \pm 0.01$ throughout 10 weeks of storage period. The samples with medium initial moisture content (13 %) exhibited the decreasing trend similar to high initial moisture content samples from $0.71 \pm 0.04$ to $0.65 \pm 0.01$. Contrary, the samples with low initial moisture content (8 %) had significantly increased in water activity during storage and obtained the water activity levels from $0.55 \pm 0.01$ to $0.65 \pm 0.01$.

![Figure 2. The changes of water activity during storage.](image)

Generally, from the results, it can be observed that the samples with low, medium and high initial moisture content stabilized at $0.65 \pm 0.01$. These results indicated that moisture adsorption and desorption had occurred during storage. It similar to the results reported by others researcher [5]. They reported that reduction of water activity below 0.7 prevent microbial growth during storage. The water activity also play main role in quality attributes that include texture, aroma, shelf life and flavour of herbal materials.

3.3 Colour Changes

Delta E ($\Delta E$) is a total difference of colour changes which combine all parameters such as $L^*$, $a^*$ and $b^*$. In this research, $\Delta E$ values were calculated for 10 weeks of storage period. In general, higher value of $\Delta E$ shows the greater colour change of the samples. Figure 3 exhibits that the values of $\Delta E$ increased after 10 weeks of storage period. The highest $\Delta E$ belonged to the high initial moisture content (20 %) with value of $2.63 \pm 0.15$, followed by medium (13 %) and low (8 %) initial moisture content with values of $0.90 \pm 0.46$ and $0.24 \pm 0.08$, respectively. The changes of $\Delta E$ might be affected by the content of moisture itself during storage. According to other study, they claimed that the change of $\Delta E$ is affected by absence water in the capillary voids [9].
Figure 3. The changes of delta E (ΔE) during storage.

The hue angles (h°) of low, medium and high initial moisture content samples after 10 weeks of storage period were recorded as 87.51±0.08°, 86.49±0.22° and 81.24±0.29°, respectively. It was reported that, the hue angle with range 90˚ may be change to reddish yellow colour [10]. From the both results of ΔE and h°, it can be expected that the colour of O. stamineus ground powder will turn to dark slowly when storage period is extended to another next 6 months.

Table 1. The changes of hue angle (h°) during storage

| Initial Moisture Content (%) | Storage Period (Week) |  |  |  |  |  |  |
|-----------------------------|----------------------|--|--|--|--|--|--|
|                             | 0                    | 2   | 4   | 6   | 8   | 10  |
| 8                           | 87.01 ± 0.05         | 86.57 ± 0.04 | 87.32 ± 0.10 | 87.24 ± 0.34 | 87.53 ± 0.11 | 87.51 ± 0.08 |
| 13                          | 86.70 ± 0.11         | 86.52 ± 0.10 | 86.35 ± 0.16 | 86.31 ± 0.13 | 86.77 ± 0.03 | 86.49 ± 0.22 |
| 20                          | 82.80 ± 0.27         | 81.81 ± 0.51 | 82.38 ± 0.50 | 82.65 ± 0.02 | 80.76 ± 0.33 | 81.24 ± 0.29 |

4. Conclusion
The moisture content, water activity, delta E (ΔE) and hue angle (h°) of the O. stamineus ground powder were affected by initial moisture content and storage period when the samples were stored under room temperature (±25 °C) with relative humidity ±60 % for 10 weeks. However, it is suggested to store the samples with initial moisture content of 13 % to sustain the quality of O. stamineus ground powder during short term storage. At this suggested point, the colour changes of the samples also can be controlled. In addition, by controlling the moisture content and water activity of the samples, the microbial growth can be prevented during short term storage. It is also expected that the shelf life of the O. stamineus ground powder can be prolonged at least for another 6 months.

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