DRYING CHARACTERISTICS AND PHYTOCHEMICAL RETENTION OF DIFFERENT ACCESSIONS OF KUNYIT HITAM (*KAEMPFERIA PARVIFLORA*)

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ABSTRACT

In Malaysia, one of the most promising medicinal plants with high phytochemical contents is kunyit hitam or Kaempferia parviflora. Kunyit hitam is typically consumed in dried form. Therefore, the study on effective drying technique for various accessions of kunyit hitam was conducted using a cabinet dryer at different operating temperatures of 50℃, 60℃ and 70℃ with a fixed air velocity of 2.5 m/s. The drying periods for each 5 kg of kunyit hitam were 5 hours (50℃), 4.5 hours (60℃) and 3.5 hours (70℃) for KH-THA 1 and KH-THA 2 respectively, while KH-THA10 took 3 hours (50℃), 2.5 hours (60℃) and 2 hours (70℃) when drying at the same temperatures. Despite the shorter drying time, KH-THA10 retained the most phytochemicals such as antioxidant activity based on ferric reduction mechanisms at a concentration of 2.07 µmol Fe/g with the highest retention of total phenolics (47.53 mg GAE/g) and flavonoids content (7.89 mg RE/g) were observed when dried at 60°C. It also retained more antioxidant content when dried at 70 ℃ as denoted by DPPH scavenging activity (IC50) of 84.89 mg/ml. The antioxidant content determined by ferric reduction assay also showing highest result at 2.89 µmol Fe/g. Drying at 70℃ also maximized the concentration of both total phenolics and flavonoids content which were at 48.68 mg GAE/g and 8.64 mg RE/g respectively. Consequently, drying at 60℃ is recommended for maximum phytochemical retention, and KH-THA 10 is the most heat stable accession to be domesticated for large scale planting in the future.

Keywords: Kunyit hitam, drying characteristics, phytochemical retentions

INTRODUCTION

Medicinal plants have been used in traditional medicine since antiquity. The plants were used for a variety of health-related purposes, including health promotion and wellness, disease prevention, and chronic disease management (Sofowora et al. 2013). People all over the world began to adopt healthy lifestyles by incorporating medicinal plants such as culinary herbs into their diets for health maintenance and disease prevention in order to reduce the risk of chronic diseases. Healthcare products derived from medicinal plants are becoming more popular due to their medicinal and health-beneficial properties. They are used as a dietary supplement to promote health and well-being, with over 80% of the world's population relying on them as primary healthcare to treat a variety of ailments (Ekor 2014). Medicinal plants have played an important role in the sustainable management of human health, sparking interest in alternative therapies and therapeutic applications derived from them. These plants are used in complementary and alternative medicine, gaining public attention and international recognition as a natural remedy. In Malaysia, one of the most promising medicinal plants with high phytochemical contents is kunyit hitam or *Kaempferia parviflora*. The plant is a member of the *Zingeberaceae* family, which includes 60 species found from India to Southeast Asia. These understory plants have short fleshy rhizomes, tuberous roots, erect or apprised leaves, and inconspicuous flowers that are usually white or violet (Catherine et al. 2014). Kunyit hitam is mostly consumed in dried form, as a tea or as a powdered ingredient in a variety of functional food. As a result, an effective drying technique for kunyit hitam is critical for safety, storability, and product development, as improper drying results in significant quality loss. Furthermore, dried products can withstand long-distance transportation with prolonged storage times before being distributed and marketed. Moreover, appropriate drying techniques for quality preservation of kunyit hitam are essential for high quality products. The quality of final products influences by cultivars, drying technique, process parameters and environmental conditions because all these factors contribute to different levels of quality retention. In this regard, different accessions of kunyit hitam namely KH-THA1, KH-THA2 & KH-THA10 were tested for the establishment of its drying characteristics, as different accession respond differently to drying treatments due to the diversity in microstructure and nutritional profiles which could impact heat and mass transfer during the drying process. Drying is the initial step for water removal in agricultural crops and the process is one of the most important postharvest operations of medicinal plant because reducing the water content to a safe level is required for storage stability. Furthermore, water is an essential component of medicinal plants, and it plays critical roles in chemical reactions that could affect the stability of the physical and bioactive constituents of the plants. In various pharmacopoeias around the world, a maximum value of final moisture content between 8%

and 12% is consider adequate to preserve the product after dried for various medicinal plant species. For this reason, drying of kunyit hitam is imperative for moisture reduction in order to prevent enzymatic and microbial activity, thereby preserving quality and extending the shelf-life of the final product. Drying of kunyit hitam can be accomplished through various modes of heat transfer, including convection, conduction, and radiation. Most crops such as kunyit hitam, are typically dried by conduction and convection modes because they are less expensive to operate than radiation. Therefore, this research focuses on drying of kunyit hitam using a cabinet dryer in convection mode at different operating temperatures of 50°C, 60°C, and 70°C with a fixed air velocity of 2.5 m/s. The influence of drying temperatures on drying time and phytochemical retention was discussed further.

MATERIALS AND METHODS

Harvesting of kunyit hitam

Different accessions of kunyit hitam namely KH-THA1, KH-THA2 & KH-THA10 were harvested manually at MARDI's farm in Jerangau, Terengganu, at an optimum maturity of 8 months after planting. The fresh rhizomes were cleaned and washed with chlorinated water before being sliced to a thickness of 3mm prior to drying treatments.

Drying of kunyit hitam

The sliced rhizomes of kunyit hitam were dried in a convectional hot air cabinet dryer at 50°C, 60°C, and 70°C with a constant air flow of 2.5 m/s. The quality of dried rhizomes was determined immediately following drying treatments.

Determination of moisture content

The moisture content of kunyit hitam was determined using the AOAC method (Association Official Analytical Chemists, 2019) by drying the sample in a 105 °C oven for 24 hours (ULM 400, Mermert GmbH, Germany). The initial moisture content was recorded to be around 75% on a wet basis.

Preparation of extracts for phytochemical analysis

The sliced rhizomes were washed with running tap water to remove any dirt and surface contaminants. Then, the dried samples were ground into a fine powder prior to extraction and sonicated for 1 hour while being extracted with 70% methanol (1:10). The samples were then centrifuged at 1000 rpm for 10 minutes to separate the supernatant from the sediment. The extraction was repeated three times under the same conditions. The supernatant was tested for DPPH radical scavenging activity, Ferric reducing antioxidant power (FRAP) assay, total phenolics and total flavonoids contents by following the method described by Salahuddin et al. (2020).

Determination of 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay

The scavenging activity of the dried rhizomes against 2,2-diphenyl-1-picrylhydrazyl (DPPH) radicals was carried out following the method reported by Salahuddin et al. (2020). The final concentration of 0.06 mM can be achieved by preparing various concentrations of extract in methanol to give a final volume of 7 µL before being mixed with 280 µL of a DPPH radical-containing solution. Then, the reaction mixture was vigorously shaken and allowed to stand for 30 minutes in the dark. Ascorbic acid (vitamin C) was used as a positive control, while the negative control contained all reagents without test samples, and methanol served as a blank. The DPPH radical scavenging activity was determined by measuring the absorbance at 517 nm with a microplate reader (Eon Biotek, VT, USA). The percentage of inhibition of the DPPH radicals was calculated as follows:

$$\text{Inhibition (\%)} = (\text{Absorbance of control} - \text{Absorbance of the test sample}) / (\text{Absorbance control}) \times 100\%$$

A graph of each sample's DPPH inhibition percentage against its concentration was projected. The results were reported as IC50 values, which are the inhibitory concentrations at which DPPH radicals were scavenged by 50%. All procedures were carried out in triplicate with minimal exposure to light.

Determination of total phenolic content

The total phenolic content of the test samples was estimated following the Folin-Ciocalteu colorimetric method, as described in our previous study (Salahuddin et al., 2020). In brief, a 50 µL test sample was mixed with 100 µL of Folin Ciocalteu's phenol reagent. After 3 minutes, 100 µL of 10% Na2CO3 was added to the reaction mixture and left to stand in the dark for 60 minutes. The analysis was carried out in triplicate with minimal light exposure. The resulting blue-colored complex was measured at 725 nm against a blank. The calibration curve used gallic acid as a reference standard and total phenol content was expressed in gallic acid equivalents (GAE) in milligrams per gram of dry weight samples (DW).

Determination of total flavonoid content

Determination of total flavonoids content was performed by adopting the method described by Salahuddin et al. (2020). The aluminium chloride assay was employed to determine total flavonoids by diluting 30 µL of extract with 120 µL of dH2O. Initially, 9 µL of 5% NaNO2 solution was added and allowed to react for 5 minutes, followed by the addition of 9 µL 10% of AlCl3 solution. Then, both 60 µL of NaOH and 72 µL of dH2O were incorporated into the solution and the mixture was mixed thoroughly using a vortex mixer. The total flavonoids in each triplicate sample were measured using a spectrophotometer at an absorbance of 510 nm against a blank. The total flavonoid content was calculated using a calibration curve with rutin as the standard reference. The findings were presented as rutin equivalents (RE) in milligrams per gram of dry weight samples.

Statistical analysis

The influence of process parameters on drying performance and quality of kunyit hitam were determined by ANOVA analysis (Duncan Multiple Range Test - DMRT) using Minitab 12 software (Minitab Inc., State College, PA, USA). All physicochemical analyses of the samples for each temperature were carried out in triplicate.

RESULTS AND DISCUSSION

Drying characteristics of kunyit hitam

Figure 1: Drying of kunyit hitam at 50°C

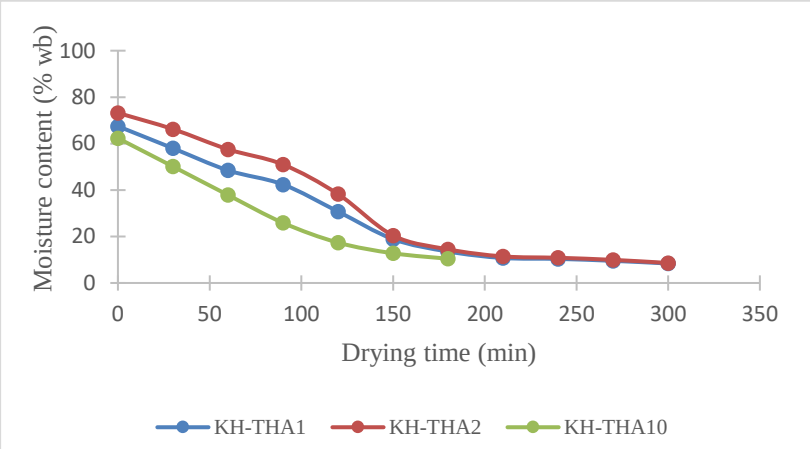

Figure 2: Drying of kunyit hitam at 60°C

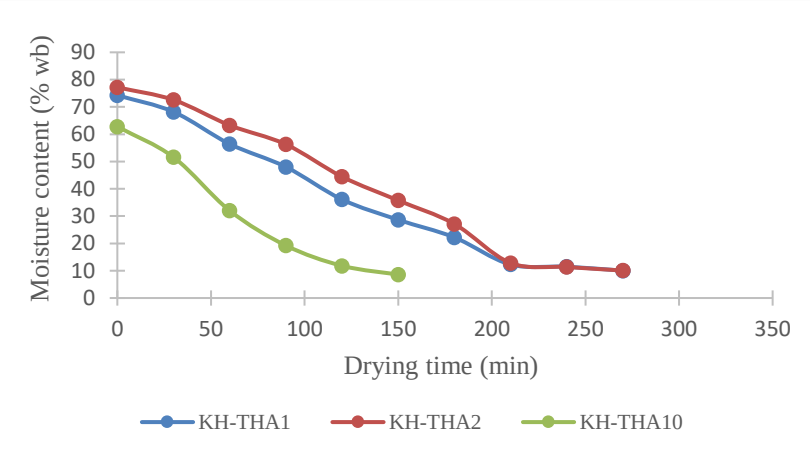

Figure 3: Drying of kunyit hitam at 70°C

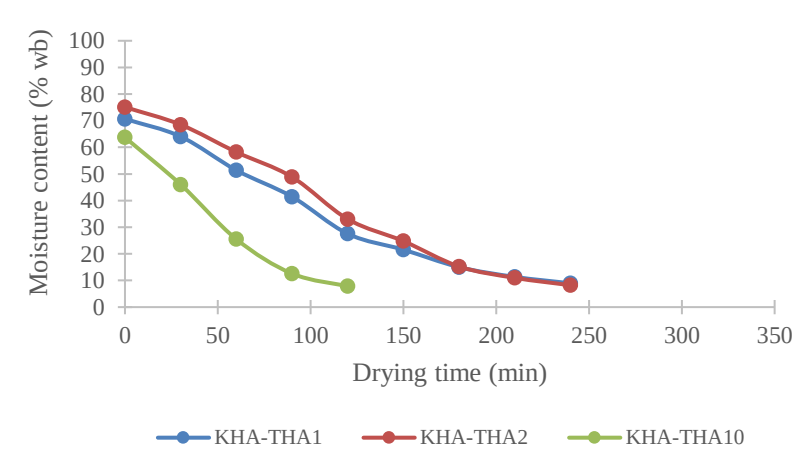

Figure 1 to 3 demonstrated that drying time of kunyit hitam is highly dependent on drying temperature and accessions to achieve the desired moisture content. For all tested temperatures, the moisture content decreased as drying progressed. These are well-known facts that other researchers have discovered to be true for a wide range of other crops, with varying outcomes depending on shape, dimension, drying methods, and parameter settings (Md Saleh et al., 2020). Drying time decreased as temperature increased for all accessions studied. When drying at the lowest temperature of 50°C, both KH-THA1 and KH-THA2 took 5 hours, while KH-THA10 took 3.5 hours at the same temperature. Drying at 60°C and 70°C resulted in shorter drying times of 4.5 hours and 3.5 hours for KH-THA1 and KH-THA10, whereas drying period for KH-THA10 was 2.5 hours and 2 hours when drying at 60°C and 70°C, respectively. The study found that different accessions of kunyit hitam possess different drying characteristics due to varying levels of initial moisture content in the fresh rhizomes, which significantly influenced the drying period. Moreover, different cultivars respond differently towards drying treatment (Pinar et al. 2021).

Influence of drying temperatures on phytochemical contents

Table 1: The effect of drying temperatures on phytochemical contents in different accession of kunyit hitam

Drying temperature	Accession	Antioxidant activity (DPPH IC_{50} mg/mL)	Antioxidant activity (Ferric reduction-µmol Fe/g)	Total phenolics content (mg GAE/g)	Total flavonoids content (mg RE/g)
50°C	THA-1	18.116 ^{a}	0.849 ^{d}	25.038 ^{c}	11.47 ^{a}
	THA-2	71.032 ^{f}	0.499 ^{e}	23.449 ^{cd}	6.548 ^{c}
	THA-10	41.549 ^{bc}	1.936 ^{c}	18.911 ^{d}	2.941 ^{g}
60°C	THA-1	17.187 ^{a}	0.043 ^{f}	28.281 ^{c}	3.841 ^{def}
	THA-2	58.933 ^{de}	0.029 ^{f}	33.679 ^{b}	3.401 ^{ef}
	THA-10	17.802 ^{a}	3.531 ^{a}	47.534 ^{a}	7.887 ^{bc}
70°C	THA-1	37.516 ^{bc}	0.086 ^{f}	25.109 ^{c}	4.219 ^{d}
	THA-2	47.856 ^{bcd}	0.046 ^{f}	17.397 ^{d}	3.209 ^{fg}
	THA-10	14.106 ^{a}	2.891 ^{b}	48.677 a	8.635 ^{b}

Table 1 depicted the influence of drying temperatures on phytochemical contents in different accessions of kunyit hitam. The results demonstrated varying degrees of quality retention in different accessions of kunyit hitam when subjected to different drying treatments. High retentions of antioxidant compounds by DPPH scavenging activity were observed for KH-THA1 at drying temperatures of 50°C and 60°C at the lowest amounts of 18.116 (IC_{50} mg/ml) and 17.187 (IC_{50} mg/ml) , while KH-THA10 showed high retentions when drying at 60°C (17.802 -IC_{50} mg/ml) and 70°C (14.106-IC_{50} mg/ml). The lowest value of IC_{50} indicates the more powerful antioxidant activity (Hue et al. 2012). The maximum antioxidant activities by Ferric reduction (FRAP) assay and highest retention of total phenolics compound were obtained by drying KH-THA10 at the drying temperatures of 60°C (3.531 µmol/g) and 70°C (2.891 µmol/g) for the antioxidant activity (FRAP), whereas the total phenolics were retained at 47.534 mg GAE/g (60°C) and 48.677 mg GAE/g (70°C). Drying at 50°C demonstrated high retention of total flavonoids content for KH-THA1 at 11.47 mg RE/g, while the concentrations were highest for KH-THA10 at the drying temperatures of 60°C and 70°C. The results revealed that, KH-THA2 was shown to be the most heat-sensitive accessions due to low phytochemical retention at all drying temperatures, whereas KH-THA10 was observed to be the most heat-stable accessions since it had the highest phytochemical retention after the drying process. According to the study, different cultivars or accessions react to heat treatment in different ways leading to various levels of quality retention (Coradi et al.2020).

CONCLUSION

The study demonstrates the complex relationship between accessions and drying temperatures on the quality retention of kunyit hitam. In this regard, determining the optimal drying temperature and identifying suitable accession of kunyit hitam prior to commercial cultivation is critical for ensuring the quality of the finished product. Therefore, the best drying temperature for quality maintenance is 60°C, and the most heat-stable accession is KH-THA10, with great commercialization potential for large scale planting towards the development of "speciality product" for economic benefits.

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