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Effect of Different Drying Methods on the Characteristics of *Curcuma zedoaria* rhizome

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Abstract:
Curcuma zedoaria is one of the plants that has the potential to be developed as raw material for making traditional medicine. The results of the study showed that white ginger has diverse pharmacological activities such as antihyperglycemia, antihyperlipids, antihypercholesterol, antiviral, anticancer / antitumor, immunomodulators, analgetics, anti-inflammatory, antipyretic and antioxidants. In the production process of traditional medicines, the quality of simplicia used as raw materials must meet quality standards in order to provide a good therapeutic effect. The quality of white intersection simplicia can be influenced by several factors, one of which is the drying method. The purpose of this study was to determine the effect of drying method on the characteristics of white intersection simplicia. The drying methods studied are drying direct sunlight, greenhouse drying, wind and oven. The characteristics tested are organoleptis test, microscopic test, water soluble juice test, ethanol soluble juice, water content, total ash content, acid insoluble ash content, microbial and fungal contamination. The results showed that the drying method can affect the characteristics of *Curcuma zedoaria* simplicia. The greenhouse drying method produces simplicia with the highest levels of ethanol marine essence and watersoluble essence, respectively 10.97±0.013% and 13.86±0.110%. The lowest water content of simplicia using a 50^{o}C oven is 5.48%. The lowest total ash content was with the hybrid method, namely 7.006±0.018%.

Keywords: Curcuma zedoaria, rhizome characteristics, drying, simplicia

1. Introduction

Curcuma zedoaria is one of the medicinal plants that are easily bred in Indonesia. The part of the plant that is often used is its rhizome. White rhizome is rich in beneficial chemical compounds, including sesquiterpenes which include curcumin, ethyl p-metoxynamate, β-turmerone, β-eudesmol, zingiberene, dihydrocurcumin, furanodiene, α-phellandrene, 1,8 cineole, β-elemene and germacrone [1][2]. White ginger has biological and pharmacological activities such as antimicrobial, antitoxic, antihypertensive, antiinsect, antihyperglycemic, antihyperlipid, antihypercholesterol, antiviral, anticancer/antitumor, immunomodulatory, analgetic, anti-inflammatory, antipyretic and antioxidant [3].

The quality of white metre simplicia can be influenced by several factors such as where it grows, how and when to harvest, as well as the drying method used [4]. Previous research has found that differences in drying methods can affect antioxidant and microbiological activity in ginger rhizome. Heating using an oven at temperatures above 100oC; direct sunlight at a temperature of 25-30 oC for 3 days; and hot-air drying at 60oC will decrease the antioxidant and biological activity of ginger rhizome. While heating using an oven temperature of 60 and 70oC and solar drying 44-58oC can increase its biological and chemical activity [5]. Different drying methods can also affect the yield of medicinal plant extracts to be produced. The method of drying chamomile extract using an oven at 45oC has better physicochemical characteristics than spray-drying 140oC and freeze drying 50oC [6]. However, other studies have also proven that the method freeze drying resulting in higher phenolic and antioxidant content in Curcuma aeruginosa Leave extract compared to using an oven [7].

In addition to the method, the difference in drying temperature causes a difference in the yield of essential oil in Anethum graveolens. Drying using an oven temperature of 40oC yields greater than 60oC [8]. Variations of drying methods have been done by researchers on simplicia herba patikan kebo (Euphorbia hierta L.) by the method of sunlight covered with a black cloth and aerated way. The results proved that the aerated method resulted in higher flavonoid levels [9].

Post-harvest processes such as drying factors can affect the quality of white tea as a raw material for medicinal products. Therefore, this study intends to study the effect of several drying methods on the characteristics of white intersection simplicia. The drying methods used are direct sunlight, wind method, oven and greenhouse drying.

2. Research Method

2.1. Sample Preparation

Curcuma zedoaria rhizome was obtained from farmers in Karangpandan, Karanganyar, Central Java, Indonesia. Fresh rhizomes are washed under running water until clean and there is no foreign organic matter, then slicing and reducing the size is carried out by cutting rhizomes with a thickness of 2-3 mm.

2.2. Drying Method

The drying process was carried out by four methods. First, **direct sunlight drying**. The place used is away from sources of dust or pollution. Drying was done at 7.00 a.m – 4.00 p.m (when conditions did not rain and not cloudy). Secondly, **drying with greenhouse drying**, the rhizomes were dried in the sun in a special room made of transparent material, so as to get indirect sunlight. Third, **drying with an oven at 50^{o}C**. Fourth, **aerated method**, rhizomes were in a room with a non-transparent roof that blocks the entry of sunlight. Simplicia only gets wind circulation that enters the room.

2.3. Organoleptic and Microscopic Test

Organoleptic examination was carried out by observing the shape, smell, taste, color of the simplicia *Curcuma zedoaria*. This examination is to determine the morphological characteristics of *Curcuma zedoaria*. Microscopic tests were carried out using a microscope whose magnification degree is adjusted to the needs. The simplicia tested is in the form of a transverse incision or in the form of a powder. In microscopic tests are sought typical tissue anatomical elements. From this test, the type of simplicia will be known based on the fragment identifier specific to each simplicia [10].

2.4. Ethanol Soluble Essence Content

Weigh carefully approximately 5g of simplicia (powder form). Put in a stopper flask, add 100 mL of ethanol, shake many times during the first 6 hours, leave for 18 hours. Strain quickly to avoid ethanol evaporation, steam 20 mL of filtrate dry in a shallow, flat-bottomed dish that has been heated to 105°C, heat the remainder at 105°C to a fixed weight [11]. The ethanol soluble essence content was calculated using the formula:

$$Ethanol\ Soluble\ Essence\ Content\ (\%) = \frac{A1 - A0}{B} \times 100\%$$

Information:
A1 : Container + residue after heating (g)
A0 : Empty container (g)
B : Sample weight (g)

2.5. Water Soluble Essence Content

Weigh carefully approximately 5 grams of simplicia (powder form). Put in a stopper flask, add 100 mL of chloroform saturated water, shake repeatedly during the first 6 hours, leave for 18 hours. Then filtered, steam 20 mL of filtrate dry in a shallow flatbed dish that has been heated to 105°C, heat at 105°C to a fixed weight [12]. The water soluble juice content is calculated using the formula:

$$Water\ soluble\ content = \frac{A1 - A0}{B} \times 100\%$$

Information:
A1 : container + residue after heating (g)

A0 : empty container (g)
B : Sample weight (g)

2.6. Moisture Content

Measurement of moisture content is carried out using *Moizture Analyzer* OHAUS Type MB95.

2.7. Total Ash Content

Bring the obtained ash to a boil at the determination of total ash content with 25 mL of diluted hydrochloric acid for 5 minutes. Collect the insoluble parts, strain through ash-free paper, wash in hot water, incandescent with crutches until the weight remains at 800±25°C. The acid insoluble ash content is calculated against the weight of the test material, expressed in % w/w (Ministry of Health, 2017). Calculation using the formula:

$$Total\ ash\ content = \frac{W1 - W2}{W} \times 100\%$$

Information
W1 : Weight of container and ash (g)
W2 : Weight of empty container (g)
W : Sample weight (g)

2.8. Insoluble Acid Ash Content

Bring the obtained ash to a boil at the determination of total ash content with 25 mL of diluted hydrochloric acid for 5 minutes. Collect the insoluble parts, strain through ash-free paper, wash in hot water, incandescent with crutches until the weight remains at 800±25°C. The acid insoluble ash content is calculated against the weight of the test material, expressed in % w/w [14]. Calculate the acid insoluble ash content by the formula:

$$Acid\ insoluble\ ash\ content = \frac{W1 - W2}{W} \times 100\%$$

Information:
W1 : Weight of container and ash (g)
W2 : Weight of empty container (g)
W : Sample weight (g)

2.9. Fungal Contamination Rate

A total of 10 grams of simplicia samples were dissolved in 90 mL of sterile aquades then vortex (dilution 10^{-1}). From the solution is taken as much as 1 mL and dissolved in 9 mL sterile aqueous and divortex until homogeneous (dilution 10^{-2}). Next is made a dilution of 10^{-3} and 10^{-4}. Each sample is made 3 repetitions. Testing of mold contamination is carried out by the spread cup technique (*Spread Plate Method*). A total of 1 mL of suspension from dilution of the sample is poured into the surface of the media and flattened with a glass spread. Then incubated for 5-7 days at a temperature of 20°C-25°C [15].

2.10. Microbial Contamination Rate

A total of 10 grams of simplicia samples were dissolved in 90 mL of sterile aquades then vortex (dilution 10^{-1}). From the solution is taken as much as 1 mL and dissolved in 9 mL sterile aqueous and divortex until homogeneous (dilution 10^{-2}). Next is made a dilution of 10^{-3} and 10^{-4}. Each sample is made 3 repetitions. Pipettes l mL from each dilution into a sterile petri dish, using a different and sterile pipette for each dilution. Each petri dish is poured 10 mL of TSA media that has been melted, then the petri dish is shaken to form a figure eight, let it solidify. Incubation at 30°C-35°C for 3-5 days [15].

3. Result And Discussion

The drying process of Curcuma zedoaria as a medicinal raw material is carried out to reduce the moisture content so that the shelf life becomes longer. The drying process in this method uses four different methods. Each method shows a different temperature as in Table 1. The duration of heating also varies due to the influence of temperature. Warming is carried out until the rhizome is completely dry and can be crushed.

Table 1. Methods, Temperature and Drying Time of Curcuma zedoaria

Method	Temperature	Heating Duration
Direct sunlight	± 33^{o}C	3 days
Indirect sunlight (hybrid)	± 50^{o}C	2 days
Oven	± 50^{o}C	2 days
Wind	± 33^{o}C	18 days

The results of the simplicia organoleptic are flattened, light, almost round to oblong or irregular, the outer surface is uneven, wrinkled, flat fracture marks, fibrous middle, lighter in color than the outer surface, thicker and rougher edges, light yellowish brown to gray brown, light yellow middle, brownish, distinctive smell and has a bitter taste. The difference in drying results from the four methods can be seen from the paler color of the rhizome in the direct sunlight and indirect sunlight drying methods. This can be caused by higher temperatures during the drying process and exposure to UV rays from the sun causing degradation of color compounds such as curcumin, so that the color becomes paler or slight, while drying without sunlight has a darker color [16]. The selection of conventional drying methods using sunlight causes a decrease in color intensity, while non-sun methods such as vacuum drying, microwaves can enhance or maintain the natural color of plants [17].

(A) (B) (C) (D)

Figure 1. The effect of the drying method on the color of Curcuma *zedoaria simplicia*: sunlight (A); Hybrid (B); Oven (C); Wind (D)

Microscopic observations are made to determine the arrangement of tissues *Curcuma zedoaria*. The test was carried out by simplicia made powder first then observed in a microscope with the addition of immersion oil. The results of microscopic observations obtained the results of parenchyma fragments with oil drops, amylum and fibers, idioblasts in the form of oil cells, and periderm as Figure 2.

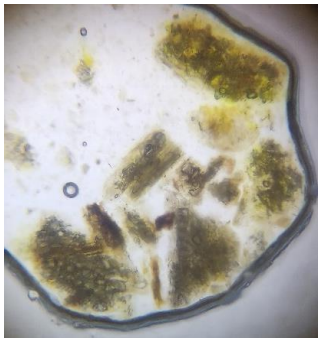

Figure 2. Microscopic observations of Curcuma *zedoaria simplicial*

Water and ethanol soluble essence content was done to give an initial idea of how much of the compound in white matter can dissolve in ethanol solvents and water solvents. In measuring ethanol soluble juice, 70% and 96% ethanol are used. The data in Table 2 show that the selection of solvent has an effect on the level of juice obtained. The more polar solvent used (the more water), the cider *Curcuma zedoaria* What is obtained is getting more and more. This result will differ from one plant to another, depending on the content of the compound. In other plants, the opposite can happen, namely more ethanol content produces greater yields [7]. Table 2 shows that the hybrid method can produce the most juice compared to other methods.

Table 2. Results Of Measuring Water And Ethanol Soluble Essence Content

Drying Method	Essence Content (%)		
	Ethanol 96%	Ethanol 70%	Water
Direct sunlight	7.96±0.040	9.97±0.011	11.96±0.014
Hybrid	8.96±0.018	10.97±0.013	13.86±0.110
Oven	2.99±0.005	6.99±0.016	5.98±0.008
Wind	2.33±0.578	7.00±0.008	7.66±0.568

Water content is a parameter to determine the remaining water contained in simplicia after the drying process. Determination of moisture content aims to express the content of substances in plants as percent dry matter and to determine the resistance of a material in storage. The moisture content value is related to the temperature at the time of the drying process. Oven and hybrid drying uses a higher temperature than the other two methods, allowing more water to evaporate and not remain in the simplicia.

Table 3. Water Content Measurement Results

Drying Method	Water Content (%)
Direct sunlight	8,28
Hybrid	6,48
Oven	5,48
Wind	7,30

The purpose of determining the total ash content is to provide an idea of the total amount of material remaining in the massage, consisting of physiological ash derived from the plant tissue itself, and non-physiological ash which is residue from extraneous compounds (such as sand and soil) attached to the plant surface. High and low ash content indicates a high mineral content in the white rhizome itself. The higher the ash content obtained, the mineral content in the material is also higher. High levels of ash insoluble in acid indicate the presence of silicate content derived from soil or sand, can also indicate the presence of heavy metal elements. Table 4 data show that the drying method does not exert a significant effect on the total ash content and the acid insoluble ash content.

Table 4. Water Content Results

Drying Method	Total ash content (%)	Ash content is not acid soluble (%)
Direct sunlight	7,060±0,040	3,155±0.003
Hybrid	7,006±0.018	3,105±0.013
Oven	7,301±0.014	3,982±0.008
Wind	7,301±0.014	3,319±0.006

The growth of fungal and microbial contamination is a quality parameter of medicinal raw materials. The high growth of fungal and microbial contamination in simplicia can reduce the quality and quantity of extracts or products that will be produced, such as disrupting product stability, inactivating active substances and shortening their shelf life. The allowable value of fungal growth is not more than 10^4 CFU/g and microbial contamination no more than 10^6 cfu/g. The high growth of fungal and microbial contamination can be caused by moisture content in simplicia or contamination during the washing and drying process in the open air.

Table 5. Testing Results of Mold Growth and Microbial Contamination

Drying Method	Fungal Growth Rate (cfu/g)	Microbial Contamination Rate (cfu/g)
Direct sunlight	$>10^4$	$>10^6$
Hybrid	$>10^4$	$>10^6$
Oven	$>10^4$	$>10^6$
Wind	$>10^4$	$>10^6$

4. Conclusion

The results showed that the drying method can affect the characteristics of Curcuma *zedoaria* simplicia. The method of drying sunlight results in the color of the simplicia becoming paler. The indirect sunlight drying

method (hybrid) produces simplicia with the largest water soluble juice content and ethanol soluble juice content and produces simplicia with low water content.

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