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by Muhammad Asfar

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Characteristics of simplicia ginger (*Zingiber officinale*) and lemongrass (*Cymbopogon citratus*) powder by different drying method

Khaerunnisa¹, M Mahendradatta² and M Asfar²

¹Food Science and Technology Master Program, Hasanuddin University, Makassar, 90245, South Sulawesi, Indonesia

²Food Science and Technology Study Program, Department of Agricultural Technology, Hasanuddin University, Makassar, 90245 South Sulawesi, Indonesia

E-mail: metamahendradatta@gmail.com

Abstract. This study aimed to produce qualified simplicia of ginger and lemongrass powder by determining water content, antioxidant activity, and the characteristic of color and aroma. Two stages of drying were conducted, namely, the conventional method using open-air sun drying and the oven method with a temperature of 50°C for 24 hours. The method used to determine water content was based on SNI 01-2891-1992, and antioxidant activity was determined using the UV-VIS spectrophotometry method. The data were analyzed according to descriptive analysis. The results indicated that the simplicia ginger and lemongrass powder in the oven drying method resulted in lower moisture content, higher antioxidant activity, stronger aroma quality, and lighter color compared to the conventional drying. The water content of ginger and lemongrass powder was 6.75% and 7.2% in oven drying, while the conventional methods were 7.25% and 10.15%, respectively. The antioxidant activity of ginger and lemongrass powder in oven drying was 65.12% and 51.63%, while the conventional methods were 62.41% and 50.05%, respectively. Based on this study, it can be concluded that the simplicia of ginger and lemongrass powder indicated the better characteristics and quality with the oven drying method at 50°C for 24 hours compared to the conventional method using open-air sun drying.

1. Introduction

Indonesia is one of the countries rich in agricultural and plantation products that have the potential to be used as a natural functional food. Ginger and lemongrass are export commodities that play an important role in Indonesia's foreign exchange earnings. In 2005-2010, ginger exports increased along with the increasing demand for world ginger products [1].

Exported ginger rhizomes often experience problems with wrinkling, germination, and contamination by microbes. The shelf life in fresh form is very short and impractical for transportation and distribution, so that it does not meet the quality requirements of export ginger. In addition, the condition of fresh ginger and lemongrass is prone to changes in chemical components due to the changes in texture, less strong aroma due to broken rhizomes in ginger, and damaged parts of ginger. Likewise, lemongrass is susceptible to damage to the stem due to impact and large volume when its distribution is not optimal. Therefore, the quality is low, and there are still few exports of spices in the processed form [2].



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One of the alternatives to get the benefits and improve the quality of ginger and lemongrass is to convert it into dry and powdered simplicia form. Ginger and lemongrass in these forms have higher economic value, are easy to distribute, and are of high quality in the market, locally, nationally, and internationally. The processed form of dry and powdered simplicia can be processed through drying and powdering methods which will produce long-shelf-life product, practicality, easy to distribute, and no preservatives needed [3].

Ginger (*Zingiber officinale*) and lemongrass (*Cymbopogon citratus*) are agricultural plants in the spices category that have many benefits. According to Mao et al. (2019), ginger contains phenolic components, namely gingerol, shogaol, paradol, zingeron and terpenic components, which have biological activity and have several bioactivities such as antioxidants, anti-fungal, antiviral and antimicrobial properties [4]. The main chemical structure of ginger is gingerol, shogaol and zingeron which are phenolic compounds (figure 1) [5].

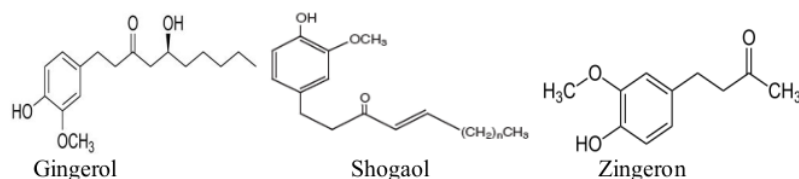


Figure 1. The chemical structure of gingerol, shogaol, and zingeron [6].

Lemongrass belongs to the *Cymbopogon* genus of aromatic grasses and contains essential oils with a lemon flavor and strong flavor. Lemongrass is commonly used in traditional medicine for the treatment of gastrointestinal disorders and as an antispasmodic, analgesic, antipyretic, anti-inflammatory, diuretic, and sedative [7]. Some of the compounds contained in lemongrass include citronellal, stonellol, geraniol, and limonene which have high antioxidant activity. The structure of citronellal compounds, geraniol, and citronellol can be seen in figure 2.

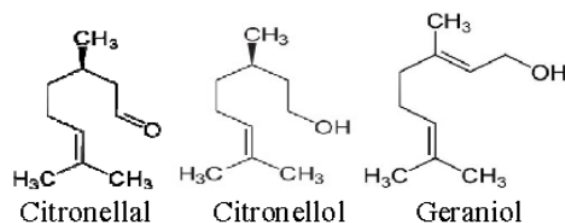


Figure 2. The chemical structure of citronellal, citronellol, and geraniol [7,8].

Based on the research of Shadri et al. (2018) regarding the quality of lemongrass powder with a combination of temperature and drying time, the best treatment was obtained, namely 48 hours and drying temperature of 60°C with flavonoid levels of 7.03% and antioxidant activity of 46.67% [3]. Berry (2014) also reported that lemongrass tea could be used to treat fever, colds, coughs, and stomach aches and with its wide use as an ingredient in cooking [9]. Ando et al. (2019) stated that lemongrass as a natural ingredient is still very trendy and is still very popular in the herbal world, has the characteristics of a strong taste and aroma, which adds to the appeal of food and beverages [10].

One of the methods to change the form of fresh materials into dry simplicia powder, which is more durable, can be done using conventional and modern drying processing. Drying is defined as the process of removing or separating a relatively small amount of water from a material using heat. Drying can extend the shelf life of a material, increase practicality and reduce space for storage [10]. Processing ginger and lemongrass in the form of dry simplicia powder is an effort to improve the quality of

simplicia. Simplicia is a natural material that is used as a medicine that has not undergone certain processing and is in the form of dried material, with the quality standardization of the simplicia so that the raw material becomes uniform and can guarantee the pharmacological effect of the plant [11].

Drying methods are classified into direct and indirect drying. Direct drying is characterized by direct contact between the fresh material and the heating medium. The liquid in the fresh material will evaporate and be carried away by the heating medium, namely hot air or gas (convection drying). Equipment used in direct drying such as tray dryers, rotary dryers, spray dryers, fluid bed dryers. Oven drying is a direct drying type. Indirect drying is carried out by transferring heat to the dividing wall, so the drying rate depends on the contact area between the fresh material and the heating plane (conduction drying). Equipment used in indirect drying includes drum dryers, agitated pan dryers, freeze dryers, vacuum rotary dryers, and vacuum tray dryers [12].

The purpose of this study was to produce quality ginger and lemongrass simplicia powder, containing high antioxidants and meeting standards using conventional methods (drying under the sun) and oven drying methods.

2. Material and methods

The research was conducted in the cocoa processing engineering laboratory of BBIHP Makassar and the chemical laboratory of BBIHP Makassar. The ginger and lemongrass ingredients were collected in the Malino area, South Sulawesi, Gowa Regency, Indonesia, with a plant age of approximately 6 months on lemongrass and ginger which is 10 months after harvesting.

2.1. Material and equipment

The main materials used in this research were white ginger/elephant ginger (*Zingiber officinale*), lemongrass (*Cymbopogon citratus*), aquadest, white cardboard, glass covers, and chemicals for analysis of antioxidant activity. Equipment used were Memmert ovens, analytical balance, 60 mesh sieve, Madato blender, Shimadzu UV-Vis Spectrophotometer, stainless knives, cutting boards, trays, stainless rectangular gutters, white paper/cardboard, and glass tools.

2.2. Analytical method

This research was conducted using an experimental method with the treatment of drying materials (ginger and lemongrass), namely drying methods under sunlight and oven drying at 50°C. Data were processed using experimental methods and descriptive analysis. The measurement parameters were moisture content, antioxidant activity, and visual observation of color and aroma/odor.

2.3. Drying experiments of ginger and lemongrass

The ginger rhizome was almost equal in size, weighing the ingredients, washing the ingredients to remove dirt that sticks to the ingredients. Furthermore, the peeling was done by thinly scraping the ginger skin, rinsing one time, draining to remove the rinse water, cutting thinly and crosswise with a thickness of approximately 0.5 cm. Then the material was divided into two, namely for drying in an oven at a temperature of 50°C and for drying in the sun on a tray of woven bamboo. The resulting dry ginger rhizome is called dried ginger simplicia. The process of pulverization was done by crushing the dry ginger simplicia in a blender for 3 minutes, sieving with a 60-mesh sieve until the ginger powder was obtained [2,6]. The ginger simplicia powder was put into a closed glass container for further analysis.

The lemongrass stems were sorted, which was almost the same size. After sorting and weighing, the materials were washed to remove any dirt that still sticks to the materials. Next, the two pieces of the outer skin of the stem were peeled. Then, the stem was cut along 20 cm and slicing with a thickness of approximately 0.5 cm. Furthermore, the materials were dried using two drying methods under the sun and oven drying at 50°C for 24 hours. The dried materials were powdered using a blender and sieved with a 60 mesh sieve [3]. Lemongrass simplicia powder was put into a closed glass container for further analysis.

2.4. Quality analysis

2.4.1. Moisture content determination (SNI 01-2891-1992), oven method. A clean cup along with the lid was heated in the oven for 3 hours, and then the cup was closed then cooled in a desiccator for 15 minutes. Subsequently, the cup was weighed as empty weight. Sample of ginger and lemongrass powder simplicia were weighed as much as 1-5 grams, then placed in the cup and weighed with the lid. The samples were then heated in an oven at 105°C for 3 hours then cooled in a desiccator and then weighed again. The water content was calculated using the following equation:

$$\text{Water content (\%)} = (\text{weight loss} / \text{initial sample weight}) \times 100\% \quad (1)$$

2.4.2. Antioxidant Activity IC₅₀ using DPPH method [14]. Preparation of DPPH solution was done by weighing as much as 1.97 mg DPPH and dissolving in ethanol to 25 mL. The obtained solution has a concentration of 0.2 mM. Ethanol extracts were diluted according to a series of concentrations (25, 50, 75, 100, 125 and 150 mg/L). Each concentration of the solution as much as 1.5 mL was pipetted and added 0.75 mL of 0.2 mM DPPH. The mixture was homogenized and allowed to stand in the dark for 30 minutes. Uptake was measured by UV-Vis spectrophotometer at a maximum wavelength is 517 nm. The measurement was performed three fold for each concentration of the sample solution. The reference solution used was BHT, and ascorbic acid at a concentration of 2, 4, 6, 8, and 10 mg / L. Percentage of inhibition was calculated using the formula:

$$\% \text{ Inhibition} = (Abs_{blank} - Abs_{sample}) / Abs_{blank} \times 100\% \quad (2)$$

2.4.3. Observation of color and odor [10]. Observation of the color and aroma/odor of the simplicia of ginger and lemongrass powder was carried out by subjective test with direct observation of the color of the simplicia powder and the aroma/odor that visible to the human senses.

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3. Result and discussion

3.1. Determination of moisture content [13]

Water content affects the shelf life of a product. Powder products of simplicia generally have a relatively long shelf life because they have low moisture content. Based on SNI 01-3709-1995, the quality of spice powder has a maximum moisture content of 12%.

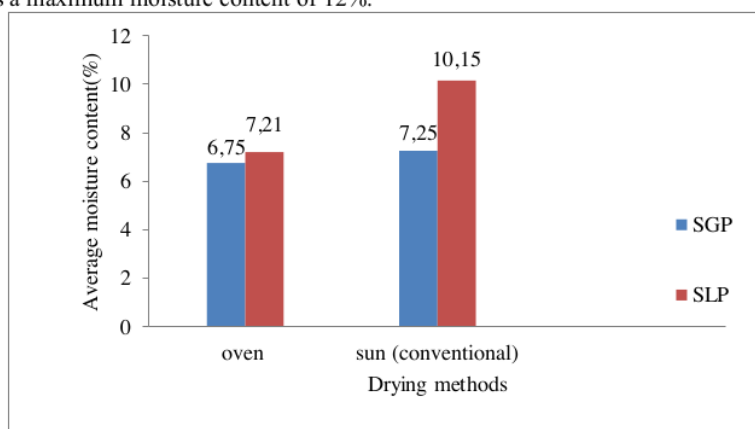


Figure 3. Average moisture content of simplicia ginger powder (SGP) and simplicia lemongrass powder (SLP) in different drying methods.

Data from the analysis of moisture content showed that the moisture content of ginger and lemongrass simplicia powder obtained from the two drying methods ranged from 6.75 to 10.15% (figure 3). The moisture content of ginger powder (SGP) with oven drying was 6.75%, while sun drying was 7.25%. Likewise, the moisture content of lemongrass simplicia powder (SBS) by oven drying was 7.21% and sun-drying 10.15%. The water content of SGP powder products and SBS products by oven drying method was smaller than sun drying. This was due to the drying methods used. In the oven drying process, the mass and heat transfer process were more homogeneous so that drying occurred better. In the conventional drying process under the sun, there was no additional heat and the quality of drying depending on the weather, temperature, and humidity of the environment. It took longer, so it was not optimal, resulting in higher moisture content that was not constant [12].

3.2. Antioxidant activity IC_{50} (DPPH method) [14]

Antioxidant activity is the ability of anti-radical compounds to scavenge free radicals. The role of antioxidants is very important to maintain the quality of food products. Antioxidants can inhibit various damages such as rancidity, changes in nutritional value, changes in color and aroma, and other physical damage to food products [16]. The results of the average antioxidant activity in the simplicia of ginger and lemongrass powder can be seen in figure 4.

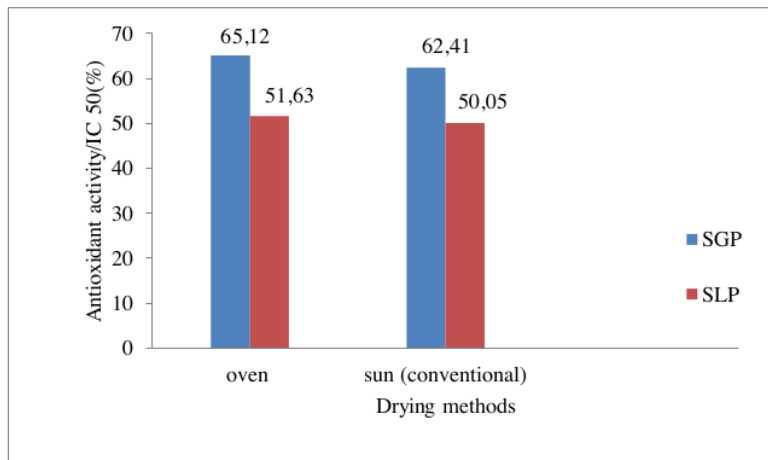


Figure 4. Average antioxidant activity/ IC_{50} of simplicia ginger powder (SGP) and simplicia lemongrass powder (SLP) in different drying methods.

The results of the analysis of antioxidant activity showed differences in the value of antioxidant activity between simplicia ginger powder (SGP) and lemongrass (SBS) by oven drying method and sun temperature (figure 4). The antioxidant activity of ginger and lemongrass simplicia powder by oven drying was in the range of 50.05-65.12%. Figure 4 showed that the value of antioxidant activity in ginger simplicia powder was higher than that of lemongrass powder, where the value of antioxidant activity in ginger powder simplicia both with oven drying and sun drying was 65.12% and 62.41%, respectively. That was greater than the simplicia of lemongrass powder, namely 51.63% and 50.05%. The high antioxidant activity in ginger compared to lemongrass was due to the many antioxidant compounds in ginger, such as phenolic or polyphenolic compounds, which can be in the form of flavonoids, cinnamic acid derivatives, coumarin, tocopherols, and polyfunctional organic acids. The higher the IC₅₀ value, it shows that the higher and stronger the antioxidant activity of the material. In ginger, there is a gingerol compound that is active compared to vitamin E, and lemongrass has flavonoid compounds, citral, limonene, licochalcone A, and b, which have more active antioxidant activity compared to vitamin E and vitamin C [15]. Antioxidants in ginger and lemongrass can be powerful antioxidants in vegetable

and animal products, and components that play an active role as antioxidants are phenol components (gingerol and shogaol) and flavonoids found in ginger oleorrsin. [16]. The flavonoid group, which has antioxidant activity, included flavones, flavonols, isoflavones, catexins, and chalcones. While cinnamic acid derivatives included caffeic acid, ferulic acid, chlorogenic acid, and others. The natural polyphenolic antioxidant compounds in ginger were multifunctional and can react as reducers, free radical scavengers, metal chelating agents, reducing singlet oxygen formation [17]. Likewise, in lemongrass, there are compounds that function as antioxidants, including citral, geraniol, linalool, limonene, geraniol citronella, terpinolene, myrcene and terpinol, and in lemongrass contain phenolic components, which also play an important role in increasing antioxidant activity [18].

3.3. Observation of color and odor

The color of processed food or food ingredients is the first quality parameter evaluated by consumers and is very important in product acceptance [19]. Based on the observations of the macroscopic test, the color difference between the simplicia and the ginger-lemongrass simplicia powder using the oven and sun drying method was shown in figure 5 and figure 6.



Figure 5. Observation of the color of dried ginger simplicia (A) and dried lemongrass (B) from the oven drying method, and dried ginger simplicia (C) and dried lemongrass (D) from the sun drying method



Figure 6. Observation of simplicia ginger powder (E) and lemongrass powder (F) from the oven drying method and simplicia ginger powder (G) and lemongrass powder (H) from the sun drying method

The difference in color and aroma of the two ingredients (lemongrass and ginger), either by oven drying or sun drying, was caused by heating of the ingredients, which causes a change in the color and aroma of the foodstuff [20]. The macroscopic observations of dry simplicia and ginger-lemongrass powder are presented in table 1.

Table 1. Macroscopic observation of dry simplicia of ginger and lemongrass.

| Sample | Observation of the color | Observation of the odor |
|---------------------|--------------------------|----------------------------------|
| Ginger/Oven (A) | Light yellow | Typical ginger (very strong) |
| Ginger/sun (C) | Reddish yellow | Typical ginger (less strong) |
| Lemongrass/Oven (B) | Brownish red | Typical lemongrass (very strong) |
| Lemongrass/Sun (D) | Green brown | Typical lemongrass (less strong) |

Table 2. Macroscopic observation of ginger and lemongrass powder simplicia.

| Sample | Observation of the color | Observation of the odor |
|---------------------|---------------------------|----------------------------------|
| Ginger/Oven (E) | Dark yellow | Typical ginger (very strong) |
| Ginger/sun (G) | Light yellow | Typical ginger (less strong) |
| Lemongrass/Oven (F) | Brownish red | Typical lemongrass (very strong) |
| Lemongrass/Sun (H) | little faded brownish red | Typical lemongrass (less strong) |

The difference in the color of ginger and lemongrass powder simplicia was due to the formation of singlet oxygen and the influence of light during the solar drying process, and in the oven drying process, the material was not directly exposed to light, but heat transfer to the material so that the color of the material can be preserved [20]. In line with the study Suhendra (2017), that the color change was related to the sugar component in food during the heating process, which causes a non-enzymatic browning process, namely the Maillard reaction [6]. The odor of both products showed stronger in ginger and lemongrass powder so that the simplicia product of ginger and lemongrass powder from the oven drying method produced a stronger odor and brighter color compared to conventional drying under the sun.

15 4. Conclusion

Based on this research, it can be concluded that the best drying was by using the oven drying method at a temperature of 50 °C for 24 hours which produced simplicia of ginger and lemongrass powder with higher antioxidant activity, lower water content, meets quality standards, odor, and color, brighter than conventional drying under the sun.

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