International Journal on Advanced Science Engineering Information Technology

Vol.7 (2017) No. 1
ISSN: 2088-5334

Product Standarization of Ginger (Zingiber officinale Rosc.) and Red Ginger (Zingiber officinale var. Rubrum) Simplicia through Washing Time, Slice Thickness and Raw Materials Drying Process Optimization

Nita Kusumawati[#], Mirwa Adiprahara Anggarani[#], Rusijono[*], Pirim Setiarso[#], Supari Muslim[1]

[#] *Department of Chemistry, Universitas Negeri Surabaya, Ketintang, Surabaya, 60231, Indonesia*
E-mail: nkusumawati82@yahoo.com

* *Department of Education, Universitas Negeri Surabaya, Lidah Wetan, Surabaya, 60231, Indonesia*
E-mail: rusijonorusijono@gmail.com

[1] *Department of Electrical Engineering, Universitas Negeri Surabaya, Ketintang, Surabaya, 60231, Indonesia*
E-mail: suparimuslim@gmail.com

***Abstract*— On this study has been conducted product standardization of ginger and red ginger simplicias as one of post-harvest processed form. To get ginger and red ginger simplicia product with high quality, has been done the optimization on the stage of washing, slicing, and drying process. Optimization has done in a range of 1-3 minutes washing time and raw material sliced thickness of 0.15 cm and 0.30 cm. In addition, the production of the entire simplicia has done with three drying methods, including sundried, sunlight through the intermediary of black fabric and dried by the oven. Specifically for the dried by the oven, has conducted optimization on the drying temperatures of 70° C; 85° C; 100˚C; and 115˚C. The analysis results of active compound content in the simplicia product indicates that the product of ginger and red ginger simplicia with optimum quality has obtained from the production process by washing time for 1 minute, slicing thickness of 0.15 cm, and oven drying method using temperature of 115° C. The ginger and red ginger simplicia product with optimum active compound content obtained by drying time, each for 310 minutes and 280 minutes. The ginger simplicia products contain essential oils, oleoresins, zingiberene in essential oils, gingerol and shogaol in the oleoresins, each by 1.7%; 0.86%; 56.90%; 42.50%; and 21.54%. Meanwhile, the red ginger simplicia products contain essential oils, oleoresins, zingiberene in essential oils, gingerol and shogaol in the oleoresins, each by 2.11%; 0.88%; 78.60%; 80.06%; and 8.02%. Thus, it can be said that, overall, red ginger simplicia product contains an active compound higher than the ginger simplicia product.**

***Keywords*— simplicia; ginger; red ginger; washing; slicing; drying**

I. INTRODUCTION

Material handling after harvesting time needs to be considered because it affects the quality of the processed products. The quality and safety of biofarm product, which one of which in the form of simplicia, determined by the quality of raw materials, post-harvest handling, and processing techniques. The post-harvest handling techniques consist of the stages of sorting, washing, drying/draining [1]-[3], sorting/grading, packaging, labeling, and storage, either before sold in fresh form or after further processing. However, until now there is no researcher who reported in detail about the standard operating procedures (SOP) for the manufacture of processed products after harvest, particularly in the form of simplicia, which are able to maintain active compound content in the raw materials.

Ginger (Zingiberofficinale (L.) Rosc) has a variety of benefits, both as herbs, essential oils, flavor concentrates, as well as the drug [4]. Traditionally, ginger is used to treat rheumatic diseases, asthma, stroke, tooth pain, diabetes, muscle pain, throat, cramps, hypertension, nausea, fever and infections [5]-[8]. Based on the shape, color, and size of the rhizome, there are three kinds of ginger known, namely the large white ginger/*gajah* ginger (Z. officinale var. Roscoe), small white ginger or *emprit* ginger (Z. officinale var. Amarum) and red ginger or *sunti* ginger (Z. officinale var.

Rubrum) [9]. In general, the three types of the ginger rhizome contained active compound content of which is divided into two group of compounds, namely: (1) the volatile compounds, which largely consist of sesquiterpene derivatives (> 50%) and monoterpenes. Two of these components provide the scent of ginger, with a relatively constant level, ie 1-3%. The sesquiterpene derivatives contained in the ginger rhizome include zingiberene (20-30%), ar-curcumene (6-19%), β-sesquiphelandrene (7-12%) and β-bisabolane (5-12%). Meanwhile, derivatives of monoterpenes contained α-pinene, bornyl acetate, borneol, camphene, ρ-cymene, cineol, citral, cumene, β-elemene, farnesene, β-phelandrene, geraniol, limonene, linalol, myrcene, β-pinene and sabinene; (2) non-volatile compounds, namely oleoresin (4.0 to 7.5%), with the content of gingerol, shogaol, gingediol, gingediasetat, gingerdion, and gingerenon. Those component has given a spicy flavor on the ginger [10].

Reference [8] shows that in general, the active compound in red ginger has a similarity with the active compounds contained in ginger. However, based on the reference [11], red ginger has essential oil content of (3.9%) and alcohol-soluble extract (9.93%) higher than *emprit* ginger which has a content of essential oil (3.5%) and alcohol soluble extracts of (7.29%), and *gajah* ginger containing essential oil (2.5%) and alcohol-soluble extract (5.81%).

Each element in ginger have their benefits and characteristics, such as: (1) anti-oxidants [13], including zingiberene essential oils, as well as gingerol and shogaol in oleoresin [14]; (2) inhibiting the growth of pathogenic bacteria by the essential oil [9], [15]-[16]; (3) antihepatotoxic against CCl_4 by gingerol and shogaol in oleoresin [17]; (4) reduced cardiotonic activity by gingerol in oleoresin [18]; (5) suppress intestinal contractions and antitussive properties by gingerol and shogaol in oleoresin [19]; and (6) the phitopharm deposit.

Based on its usefulness, on this research, the content of active compound in ginger include (1) essential oils; (2) oleoresin; (3) zingiberene essential oils; (4) gingerol, and (5) shogaol in oleoresin, become the nutritional content parameters of simplicia ginger products. Given the benefit magnitude of each active compounds contained in ginger, it is necessary to do a research about the effect of ginger simplicia producing stage process, which includes the washing process, slicing, and drying, to the content of active compounds in ginger simplicia.

II. Materials and Methods

A. Material

The main material used in this research is the *gajah* ginger (Z. officinalevar. Roscoe) and red ginger (Z. officinale var. Rubrum) rhizome. Meanwhile, to get the optimum quality of ginger and red ginger simplicia product, utilized a number of tools, including: washer (homemade) used in optimization stages of ginger raw material washing time by NESCO Lab MS-H280 Pro Magnetic Stirrer as a motor producing whirlpool which is used in order to remove contaminants attached to the raw materials that collected on the filter, as shown in Fig. 1; Bosch MUZ4DS3 slicer machine (Fig. 2) with slicing capacity of 60 g/min and the slicing thickness of 0.15 cm and 0.30 cm; and J-LabTech LDO-030E (Daihan LabTech Ltd. Co) drying machine which used at the optimization stage of the sliced thickness of ginger and red ginger with a range temperature of 50 °C - 250 °C and a drying time up to 60 minutes.

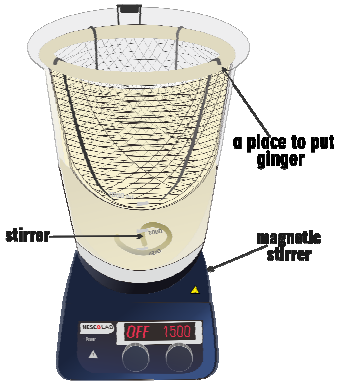

Fig. 1 Washing machine of ginger and red ginger

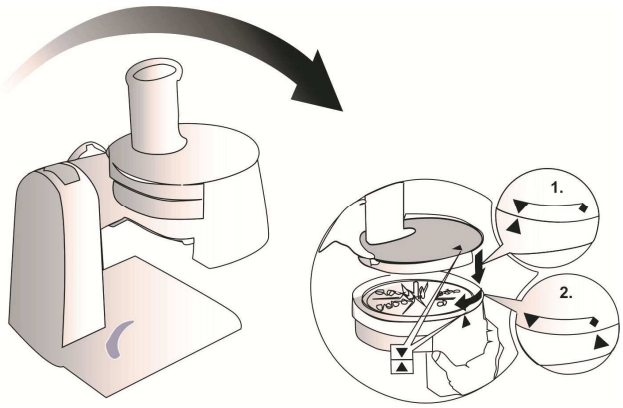

Fig. 2 Slicer machine of ginger and red ginger raw material

B. Manufacturing of Ginger and Red Ginger Simplicia

Generally, manufacturing process of ginger and red ginger simplicia at this stage used the same steps, covering the steps of washing, slicing, and drying of the material. In early stages of simplicia product manufacture, done the washing process of fresh raw materials for 1 minute. After being washed, raw materials dried in the sunlight for 24 hours. Raw materials that have been dried, then going through stages of slicing. The slicing process of raw materials is done with a thickness of 0.15 mm and 0.3 mm. Raw materials that have been sliced has ready for the drying process.

The drying process at this stage includes three methods, which was direct sunlight drying, sunlight drying with the utilize of black fabric as sample cover, and the drying process using an oven. Specifically for drying method with oven, the temperature used was 70 ° C; 85 ° C; 100 ˚C; and 115 ˚C. In addition, during the drying process has not performed samples reversing, and drying process is stopped as soon as constant mass is obtained.

C. *Water Content Testing of Ginger and Red Ginger Simplicia Product*

The testing procedure performed using the gravimetric method.

D. *Active Compound Content Testing of Ginger and Red Ginger Simplicia Product:*

The testing procedure of active compound content of simplicia products that performed on the stages includes essential oil content testing procedure using stahl distillation methods. Meanwhile, the testing procedure of oleoresins content, zingiberene content in essential oils, gingerol, and shogaol content in oleoresin, all four of them performed using Pharmaspec UV-1700 UV Visible Spectrophotometer.

III. Result and Discussion

A. *The Effect of Washing Time to Simplicia's Quality and Nutritional Content*

Appropriate washing time will make the ginger and red ginger simplicia has unsignificantly different on nutritional quality compared to the fresh ginger products. Thereby, the production of ginger simplicia will not only have longer shelf life but also has high nutritional content. At this stage, the active compound which acts as nutritional quality parameters of ginger and red ginger simplicia was (1) essential oils; (2) oleoresin; (3) zingiberene in essential oils; also (4) gingerol, and (5) shogaol in oleoresin. Fig. 1 shows the molecular structure of zingiberene, gingerol, and shogaol compounds contained in ginger.

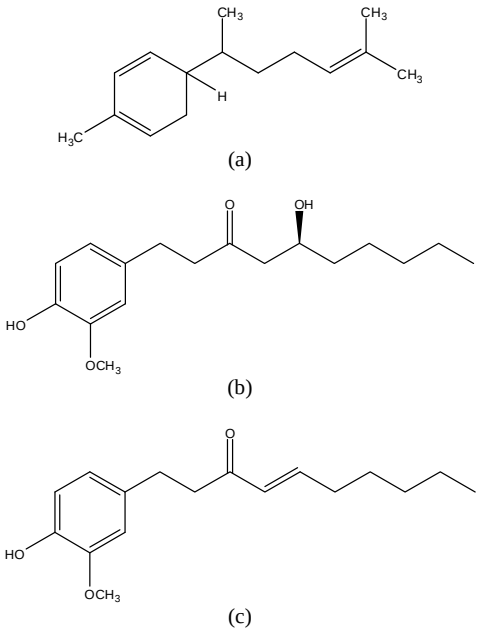

Fig. 1 A molecular structure of: (a) zingiberene; (b) gingerol; and (c) shogaol

Table 1 shows the data of drying time required and water content of dried simplicia generated from the washing stages application of raw materials for 1-3 minutes. Based on data in Table 1, note that duration of washing time applied in the production stage of ginger and red ginger simplisia greatly affect the drying time and water content on the simplicia products.

In the production process of ginger and red ginger material with washing time of 1 minute has produced simplicia with a drying time of 400 minutes and 380 minutes respectively. While washing time of ginger and red ginger material for 2 minutes and 3 minutes, each has produced ginger and red ginger simplicia with a drying time of 420 minutes and 560 minutes for the ginger simplicia product; and 390 minutes and 550 minutes for red ginger simplicia. Therefore, the ginger simplicia product has a water content higher than the red ginger simplicia product.

TABLE I
DRYING TIME OF GINGER AND RED GINGER SIMPLICIA RESULTED FROM WASHING TIME OPTIMIZATION

No	Simplicia's Type	Drying Time Resulted from Washing Time (minute)			Water Content (%) Resulted from Washing Time (minute)		
		1	2	3	1	2	3
1	Jahe	400	420	560	11.83	13.17	21.33
2	Jahe merah	380	390	550	12.83	21.17	23.00

Note :
1. Sliced thickness of 0,15 cm
2. Drying process using oven 100 °C
3. Drying chamber : 15cmx6.5cmx4cm
4. Simplicia's mass of 60 gram

Furthermore, in order to determine the optimum washing time in the production process of ginger and red ginger simplicia, has been analyzed the active compound content of simplicias products. Based on data in Table 2, was detected decreased levels of active compounds which include essential oils, oleoresins, zingiberene in essential oils, gingerol and shogaol in oleoresin, along with the duration of raw materials time washing.

TABLE II
ACTIVE COMPOUND CONTENT OF GINGER AND RED GINGER RED GINGER SIMPLICIAS RESULTED FROM WASHING TIME OPTIMIZATION

No	Simplicias Type & Washing Time (minute)	Active Compound Content (%)				
		Essential Oil	Oleoresins	Zingiberene	Gingerol	Shogaol
1	Jahe					
	1 minute	3.56	1.62	85.12	67.82	34.05
	2 minute	3.41	1.40	83.90	65.48	32.90
	3 minute	2.31	0.90	70.27	50.70	26.08
2	Jahe merah					
	1 minute	2.80	1.18	81.96	83.11	8.41
	2 minute	2.38	1.02	81.54	80.44	8.32
	3 minute	2.24	0.90	80.42	78.95	8.05

Zingiberene has the lowest decrease level of content in line with the duration of washing time compared to gingerol and shogaol. This is mainly due to the presence of carbon and hydrogen atoms in the molecular structure of zingiberene which has created hydrophobic characteristics so that it can inhibit the active compound's solubility in polar solvents like water. Meanwhile, on the molecular structure of gingerol and shogaol, there are some polar functional groups, such as -OH, which has been increasing the polarity of gingerol and shogaol compounds. The improved polarity of the compound has increased the solubility of these two types of active compounds in polar solvents like water. However, compared with shogaol, gingerol has a high solubility in the aqueous solvent, which is caused by the more presence of polar functional groups in their molecular structure.

The analysis results of active compounds in ginger simplicia showed significant decreased levels when ginger raw material has been washed for 3 minutes, which was observed the presence of (a) reduction in essential oil content, respectively of 4.21% and 35.11%; (b) decreased levels of oleoresin, respectively 13.58% and 44.44%; (c) decreased levels of zingiberene content in essential oil, respectively 1.43% and 17.45%; (d) decreased levels of gingerol content in oleoresin, respectively 3.45% and 25.24%; and (e) decreased levels of shogaol contenct in oleoresin, respectively 3.38% and 23.41% when the washing time is increased from 1 minute to 2 minutes and 3 minutes.

Meanwhile, the analysis results of the red ginger's simplicia active compounds showed a significant decline when the material has washed for 3 minutes, had observed the presence of (a) reduction in essential oil content, respectively 15% and 20%; (b) decreased levels of oleoresin content, respectively 13.56% and 23.73%; (c) decreased levels of zingiberene content in essential oil, respectively 0.51% and 1.88%; (d) decreased levels of gingerol content in oleoresin, respectively of 3.21% and 5.01%; and (e) decreased levels of shogaol content in oleoresin, respectively 1.07% and 4.28% when the material washing time has increased from 1 minute to 2 minutes and 3 minutes. Thereby, compared with ginger simplicia products, red ginger simplicia products experienced a lower decline when the washing process has carried out for 3 minutes.

B. The Effect of Slicing Thickness and Drying Method to Simplicia's Quality and Nutritional Content

The data in Table 3 indicate that the production process of ginger simplicia with a slice thickness of 0.3 cm, required drying time 25.30%; 8.21%; and 29.73% longer than the simplicias product manufactured with a slice thickness of 0.15 cm which each dried by direct sunlight, the sunlight with intermediaries of black fabric, and the oven on the temperature of 100 °C. Longer drying times have produced ginger simplicia with a water content of 32.35% - 59.15%. The water content of ginger simplicia with a thickness of 0.30 cm has equal to 56.34%; 59.15%; and 32.35% higher than the ginger simplicia product with a slice thickness of 0.15 cm with each drying method has direct sunlight, sunshine with intermediaries of black fabric and use an oven with temperature of 100 ° C.

Meanwhile, in the production process of red ginger simplicia with a thickness of 0.3 cm required drying time which 22.91%; 10.29%; and 5.41% longer than drying process of red ginger with a slice thickness of 0.15 cm and each has gone through the drying process using direct sunlight, sunshine with intermediaries black fabric, and the oven with temperature of 100 °C.

Longer drying times have produced red ginger simplicia with water content, respectively by 18.33%; 18.50%; and 18.00% for red ginger simplicia product which resulted from the drying method using direct sunlight, sunshine with intermediaries black fabric, and the oven with a temperature of 100 °C. The water content of red ginger simplicia with a thickness of 0.30 cm respectively by 23.60%; 14.43%; and 40.26% higher than the red ginger simplicia products with a slice thickness of 0.15 cm which each dried using direct sunlight, sunshine with intermediaries black fabric, and the oven with a temperature of 100 °C.

TABLE III
DRYING TIME OF GINGER AND RED GINGER SIMPLICIAS PRODUCT RESULTED FROM SLICES THICKNESS AND DRYING METHOD OPTIMIZATION

No	Simplisia's Type	Drying Time (minute)			Drying Time (minute)		
		Slice Thickness 0,15 cm			Slice Thickness 0,30 cm		
		Direct Sunlight	Sunlight, Black Fabric	Oven, T100 °C	Direct Sunlight	Sunlight, Black Fabric	Oven, T100 °C
1	Ginger	838	1,060	370	1,050	1,147	480
2	Red Ginger	838	1,040	370	1,030	1,147	390

TABLE IV
WATER CONTENT OF GINGER AND RED GINGER SIMPLICIA RESULTED FROM SLICES THICKNESS AND DRYING METHOD OPTIMIZATION

No	Simplisia's Type	Water Content (%)			Water Content (%)		
		Slice Thickness 0,15 cm			Slice Thickness 0,30 cm		
		Direct Sunlight	Sunlight, Black Fabric	Oven, T100 °C	Direct Sunlight	Sunlight, Black Fabric	Oven, T100 °C
1	Ginger	11.8	11.8	11.3	18.5	18.8	15.0
2	Red Ginger	14.8	16.2	12.8	18.3	18.5	18.0

The analysis results of active compound content in ginger and red ginger simplicia produced with variations in slice thickness and drying methods show that: (a) either at a slice thickness of 0.15 cm or 0.30 cm, a drying method using sunlight with a black fabric as intermediary has produced ginger and red ginger simplicia with the highest levels of active compound compared with those produced by drying using direct sunlight and oven with a temperature of 100 °C; (b) ginger and red ginger simplicia with a slice thickness of

0.30 cm had higher levels of active compounds compared to products with a slice thickness of 0.15 cm; and (c) the products of red ginger simplicia have higher levels of active compound compared with ginger simplicia products resulting from the production process with the same variety methods of drying and slicing thickness. Table 5 and 6 show the active compound content of simplicia products produced by the variation in the slice thickness and drying methods.

Water is a major component in foods that affect appearance, texture, and taste of ingredients. The water content in food ingredients also determines the acceptability of a food ingredient [20]. The sensitivity of a commodity against water losses due to evaporation depends on the deficit of atmospheric pressure in the vicinity as well as the structure of the surface layer of the commodity in question.

TABLE V
ACTIVE COMPOUND CONTENT OF GINGER SIMPLICIAS RESULTED FROM SLICES THICKNESS AND DRYING METHOD OPTIMIZATION

	Simplicias Type & Drying Method	Active Compound Content (%)				
		Essential Oil	Oleoresin	Zingiberene in Essential Oil	Gingerol in Oleoresin	Shogaol in Oleoresin
Direct Sunlight	0.15 cm	2.68	1.05	74.55	56.10	27.42
	0.30 cm	2.96	1.24	78.64	58.40	28.90
Sunlight, Black Fabric	0.15 cm	3.01	1.18	78.87	59.05	28.90
	0.30 cm	3.14	1.32	81.22	62.80	31.60
Oven, 100 ˚C	0.15 cm	1.80	0.98	58.52	42.70	21.82
	0.30 cm	1.88	1.03	58.66	43.10	22.35

TABLE VI
ACTIVE COMPOUND CONTENT OF RED GINGER SIMPLICIAS RESULTED FROM SLICES THICKNESS AND DRYING METHOD OPTIMIZATION

	Simplicias Type & Drying Method	Active Compound Content (%)				
		Essential Oil	Oleoresin	Zingiberene in Essential Oil	Gingerol in Oleoresin	Shogaol in Oleoresin
Direct Sunlight	0.15 cm	2.89	1.05	81.96	84.75	8.95
	0.30 cm	3.02	1.18	83.61	84.90	9.04
Sunlight, Black Fabric	0.15 cm	3.35	1.42	84.08	85.01	9.22
	0.30 cm	3.48	1.54	86.05	87.62	10.32
Oven, 100 ˚C	0.15 cm	2.26	0.91	78.98	80.26	8.06
	0.30 cm	2.62	0.96	83.43	80.52	8.86

Drying is a very important process in the manufacture of simplicia.The purpose of drying in the process of making simplicia is to lower the water content, so it is not easily covered with mold and bacteria, eliminates the activity of enzymes that can decipher the active compound content, facilitate further processing, so it can be more compact, durable and easily stored. The drying process, in addition, to extend the shelf life also determines the quality of the simplicia. Things to consider during the drying process is drying temperature, air humidity, air flow, the drying time and surface area materials. During the material drying process, these factors must be considered in order to obtain dried simplicia that is not easily damaged during storage.

Incorrect drying method can lead to a face hardening, which is a state where the outer material is dried while the inside is still wet. It can be caused by material sliced which too thick, the drying temperature which too high or by any other circumstances that led to the water evaporation of surface material are much faster than the diffusion of water from the inside to the surface, so the surface of the material becomes hard and inhibit to subsequent drying.

As shown by the active compound content of ginger and red ginger simplicia products in Table 5 and Table 6, it is known that the product of ginger and red ginger simplicia which dried using direct sunlight has lower active compound content than the one which dried using sunlight with intermediaries black fabric. This can happen because the drying process using a higher temperature on products that dried in direct sunlight. Drying method which has involved the use of a higher temperature in the manufacturing process of ginger and red ginger simplicia has resulted in the evaporation of volatile active compounds in the material.

Besides the drying method, slice thickness is also one of the variables that determine the quality of ginger and red ginger simplicias products. Based on data from the active compound content which shown in Table 7, it is known that the simplicia products with a slice thickness of 0.30 cm contain the higher active compound than the simplicia product manufactured with a slice thickness of 0.15 cm. This is caused by the lower slicing thickness (0.15 cm) which has resulted in higher damage to the matrix of the ginger material, making it easier to evaporate volatile active compounds in gingers simplicia along with the increasing of drying temperatures used. Likewise, if it thicker (0.30 cm), matrix damage that occurs in the raw material of gingers lower. The lower damage level matrix of ginger's raw materials will prevent the evaporation of volatile active compounds in the materials.

C. The Effect of Drying Temperature on Simplicia's Quality and Nutritional Content

Based on data in Table 7, it is known that the drying process by using an oven with a temperature of 70 ºC has produced ginger and red ginger simplicia with a water content of respectively 20.83% and 16.33% which obtained through the stages of drying using the oven, each for 1,610 minutes and 1,820 minutes.

The drying process with a higher temperature generates products with lower water content and shorter drying time. The minimum drying process capable of saving drying time by up to 80.75% in the production of ginger simplicia, and

84.52% in the production of red ginger simplicia, may occur when the drying has done at a temperature of 115 °C, respectively for 310 minutes and 280 minutes. The product of ginger and red ginger simplicia manufactured using a drying temperature of 115 ºC has a water content respectively by 11.17% and 12.50%. Water content data for each ginger and red ginger simplicia product produced using a temperature of 70 ºC; 85 ºC; 100 ºC; and 115 ºC appear in Table 8.

TABLE VII
DRYING TIME OF GINGER AND RED GINGER SIMPLICIA PRODUCT RESULTED FROM DRYING TEMPERATURE OPTIMIZATION

No	Simplicias Type	Drying Time (minute)			
		T 70 °C	T 85 °C	T 100 °C	T 115 °C
1	Ginger	1,610	1,540	370	310
2	Red Ginger	1,820	1,540	370	280

TABLE VIII
WATER CONTENT OF GINGER AND RED GINGER SIMPLICIA RESULTED FROM DRYING TEMPERATURE OPTIMIZATION

No	Simplicia Type	Drying Time (minute)			
		T 70 °C	T 85 °C	T 100 °C	T 115 °C
1	Ginger	20.83	12.83	11.33	11.17
2	Red Ginger	16.33	15.67	12.83	12.50

On the previous data has been shown that the lowest water content of ginger and red ginger simplicia can be obtained when dried at a temperature of 115 ºC. However, to obtain an optimum drying temperature in the production process of ginger and red ginger simplicia, at this stage also conducted an analysis of active compounds content in simplicia products which dried using an oven on temperature 70 °C; 85 ºC; 100 ºC; and 115 ºC. Based on data from the active compounds content of ginger and red ginger simplicia products which shown in Table 9, note that: (a) increasing the drying temperature from 85 °C to 100 °C caused a significant decrease in the active compounds content of ginger simplicia, which is 45.12% on the content of essential oils; 27.94% on the content of oleoresin; 28.99% on the content of zingiberene in essential oils; 33.33% on the content of gingerol in oleoresin; and 32.74% on shogaol content in oleoresin; (b) under the same conditions, the increase in drying temperature from 85 °C to 100 °C has not cause a significant reduction on the content of active compounds of red ginger simplicia, which is 35.43% on essential oil content; 18.75% on the content of oleoresin; 10.07% on the content of zingiberene in essential oils; 9.19% on the the content of gingerol in oleoresin; and 27.06% on the content of the oleoresin's shogaol. Thereby, it can be said that the red ginger material has higher stability towards drying temperature increased.

Furthermore, in order to know the manufacturing procedure of ginger and red ginger simplicia with an optimum quality, has been done an analysis using the ginger simplicia quality standard issued by Materia Med Indonesia (Table 10). Based on an optimization result which done in the production process of ginger and red ginger simplicia, includes the washing, slicing and drying stage, as well as the quality standard of gingers simplicia set by Materia Med Indonesia, it is known that the ginger simplicia products with optimum quality obtained from the production stage with (1) washing time for 1 minute; (2) slice thickness of 0.15 cm; (3) using the oven drying method; and (4) using a drying temperature of 115 ºC. An optimum ginger simplicia product has a water content of 11.17% with a 1.7% essential oil content; 0.86% oleoresin; 56.90% zingiberene content in essential oils; 42.50% gingerol content in oleoresin; and 21.54% shogaol content in oleoresin. Meanwhile, red ginger simplicia products with an optimum quality have a water content of 12.50% and 2.11% essential oil content; 0.88% oleoresin; 78.60% zingiberene content in essential oils; 80.06% gingerol content in oleoresin; and 8.02% shogaol content in oleoresin.

TABLE IX
ACTIVE COMPOUND CONTENT OF GINGER AND RED GINGER SIMPLICIA RESULTED FROM DRYING TEMPERATURE OPTIMIZATION

No	Simplicias Type & Drying Temperature (°C)	Active Compund Content (%)				
		Essential Oil	Oleoresin	Zingiberene in Essential Oil	Gingerol in Oleoresin	Shogaol in Oleoresin
1	Ginger					
	70 °C	3.52	1.53	84.05	66.32	33.81
	85 °C	3.28	1.36	82.41	64.05	32.44
	100 °C	1.80	0.98	58.52	42.70	21.82
	115 °C	1.7	0.86	56.90	42.50	21.54
2	Red Ginger					
	70 °C	3.62	1.68	87.82	88.92	11.07
	85 °C	3.50	1.12	87.82	88.38	11.05
	100 °C	2.26	0.91	78.98	80.26	8.06
	115 °C	2.11	0.88	78.60	80.06	8.02

TABLE X
QUALITY STANDARD OF GINGER SIMPLICIA ISSUED BY MATERIA AND MED INDONESIA [21]

Characteristic	Value
Water content	Max. 12%
Essential oil content	Max. 1.5%
Ash content	Max. 8.0%
Patogenic content	None
Foreign material (impurities)	Max. 2.0%

IV. CONCLUSIONS

The results showed that the washing time, the slicing thickness, drying method and drying temperature affect the water content and active compounds of ginger and red ginger simplicia products. These effects include an increase in washing time material which increases the water content of simplicia products with lower levels of active compounds, while the increased of slice thickness increase the water content as well as an active compound of simplicia products. Meanwhile, the optimization result shows that drying method using sunlight with a black fabric as intermediary produced ginger and red ginger simplicia with the highest water content. Lower water levels produced from the drying process with direct sunlight and the lowest water content obtained from products which have dried in the oven. Furthermore, the increase in drying temperatures has produced simplicia with lower water content and reaches the maximum when used drying temperature of 115 ° C.

Ginger and red ginger simplicia product with an optimum quality obtained from the production stage with: (1) the washing time of 1 minute; (2) slice thickness of 0.15 cm; (3) a method of drying in an oven; and (4) using drying temperature of 115 ºC. An optimum ginger simplicia product has a water content of 11.17% with a 1.7% essential oil content; 0.86% oleoresin; 56.90% zingiberene content in essential oils; 42.50% gingerol content in oleoresin; and 21.54% shogaol content in oleoresin. Meanwhile, red ginger simplicia products with an optimum quality have a water content of 12.50% and 2.11% essential oil content; 0.88% oleoresin; 78.60% zingiberene content in essential oils; 80.06% gingerol content in oleoresin; and 8.02% shogaol content in oleoresin.

ACKNOWLEDGMENT

We would like to thank *Direktorat Penelitian dan Pengabdian Masyakarat Kementrian Riset dan Teknologi Pendidikan Tinggi* Republik Indonesia which has provided financial support through National Priority Research Programme Masterplant of Acceleration and Expantion of Indonesia Economic Development.

REFERENCES

[1] R. Paramawati, Mardison, S. Triwahyudi, and R.Y.Gultom, "Design and testing of horizontal type of mechanical rhizome chopper," Indonesian Journal of Agriculture, vol. 3(1),pp. 39-44, 2010.

[2] M.L. Barek, M. Hasmadi, A.Z. Zaleha, and A.B.Mohd Fadzelly, "Effect of different drying methods on phytochemicals and antioxidant properties of unfermented and fermented teas from Sabah Snake Grass (Clinacanthus nutans Lind.) leaves,"International Food Research Journal, vol. 22(2), pp. 661-670, 2015.

[3] J.P. Pertiwi, "Evaluasi kinerja alat pengering simplisia menggunakan sumber panas sinar matahari dengan backup panas kompor biomassa untuk memenuhi standar kualitas simplisia jahe," Sarjana Teknik Industri, Universitas Sebelas Maret, Surakarta, Indonesia, Jan 2015.

[4] J. Bartley, and A. Jacobs, "Effects of drying on flavour compounds in Australian-grown ginger (Zingiber officinale)," Journal of the Science of Food and Agriculture, vol. 80, pp. 209–215, 2000.

[5] B.H. Ali, G. Blunden, M. O. Tanira and A. Nemmar. "Some phytochemical, pharmacological and toxicological properties of ginger (Zingiber officinale Roscoe): A review of recent research," Food and Chemical Toxicology. Vol. 46, pp. 409–420, 2008.

[6] W.H. Wang and Z.M. Wang, "Studies of commonly used traditional medicine-ginger," Zhongguo Zhong Yao Za Zhi, vol. 30, pp. 1569–1573, 2005.

[7] L.C. Tapsell, I. Hemphill, L. Cobiac, C.S. Patch, D.R. Sullivan, M. Fenech, S. Roodenrys, J.B. Keogh, P.M. Clifton, P.G. Williams, V.A. Fazio and K.E. Inge, "Health benefits of herbs and spices: the past, the present, the future," Med. J. Aust., vol. 185 (Suppl. 4), S4–S24.

[8] Hernani dan E. Hayani, " Identification of chemical components on red ginger (Zingiber officinale var. Rubrum) by GC-MS," in Proc. International Seminar on natural products chemistry and utilization of natural resources UI Jakarta-Unesco, 2001, p : 501-505.

[9] K.I.P. Sari, Periadnadi, and N. Nasir, "Uji antimikroba ekstrak segar jahe-jahean (Zingiberaceae) terhadap Staphylococcus aureis, Eschericia coli dan Candida Albicans, " J. Bio. UA, vol. 2 no. 1, pp. 20-24, March 2013.

[10] C.V. Denyer, P. Jackson, D.M. Loakes, M.R. Ellis and D.A.B. Yound, "Isolation of antirhinoviral sesquiterpenes from ginger (Zingiber officinale)," J Nat Products, vol. 57, pp. 658-662, 1994.

[11] N. Nwinuka, G. Ibeh and G. Ekeke, "Proximate composition and levels of some toxicants in four commonly consumed spices", J. Appl. Sci. Environ. Mgt, vol. 9, pp. 150-155, 2005.

[12] R.W. Kusumaningati, "Analisis kandungan fenol total jahe (Zingiber officinale Roscoe) secara in vitro," Medical Doctor thesis Universitas Indonesia, Jakarta, Indonesia, June. 2009.

[13] N. Aryaeian and H.Tavakkoli, "Ginger and its effect on inflammatory diseases," Advances in Food Technology and Nutritional Sciences, vol.1(4), pp. 97-101, 2015.

[14] M. Safithri, A. Kurniawati, and Syaefudin, "Formula of Piper crocatum, Cinnamomum burmanii, and Zingiber officinale extracts as a functional beverage for diabetics," International Food Research Journal, vol. 23(3), pp. 1123-1130, 2016.

[15] E.S. Kafu, and O. Adebisi, "Phytochemical and antibacterial activity of three medicinal plants found in Nasarawa State," International Journal of Scientific and Research Publications, vol. 5(1), pp. 164-168, 2015.

[16] E.Y. Sukandar, I. Fidrianny, and A. Kamil, " In situ antibacterial activity of Kaempferia Pandurata rhizomes against Staphylococcus aureus," International Journal of Pharmacy and Pharmaceautical Sciences, vol. 7(2), pp. 239-244, 2015.

[17] M.A. Al Khayat, and G. Blank, " Phenolic spice components sporostatik to Bacillus subtilis," J. Food Sci, vol. 50, pp.971-974, 1985.

[18] A. Shoji, T. Iwasa and Y. Takemoto, "Cardiotonic principles of ginger (Zingiber officinale Roscoe)," J Pharmac Sci., vol. 71, pp. 1174-1175, 1982.

[19] M. Suekawa, A. Ishige, K. Yuasa, K. Sudo, M. Aburada and E. Hosoya, "Pharmacological studies on ginger. I. Pharmacological actions of pungent constituents, (6)-gingerol and (6)-shogaol,", Pharmacobiodynamics, vol. 7, pp. 13-18, 1984.

[20] Winarno, Gizi dan makanan bagi bayi dan anak sapihan. Jakarta, Indonesia : Pustaka Sinar Harapan, 1990.

[21] B.S. Sembiring, S. Yuliani, "Penanganan dan pengolahan rimpang jahe," Balai Besar Penelitian dan Pengembangan Pascapanen Pertanian, Status Teknologi Hasil Penelitian Jahe, 2011.