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Pressurized Hot Water Extraction of *Zingiber officinale* Fresh Rhizome

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Pressurized hot water extraction of fresh rhizome of ginger was investigated as a novel and alternative technology in separation of various active component of ginger. The pressurized hot water extraction was carried out at pressure of 2 bar and temperature of 120 and 140 °C. The extraction process was conducted for 10 minutes. The components of the samples were determined by using GC-MS analysis. The results showed that pressurized hot water extraction of fresh rhizome zingiberene produced various active components of ginger. Ten and twelve constituents were identified in the pressurized hot water ginger extract performed at temperature of 120 and 140 °C, respectively. Zingiberene (38.23%); (+)-Beta-Funebrene (19.45%) and (−)-AR-Curcumene (11.58%) were found to be the major constituents found in pressurized hot water ginger extract performed at temperature of 120 °C. Meanwhile Zingerone (30.44%) was found to be the predominant constituent found in pressurized hot water ginger extract performed at temperature of 140 °C.

Keywords: Extraction, Fresh Rhizome, GC-MS, Ginger, Pressurized Hot Water.

1. INTRODUCTION

Ginger (Zingiber officinale Roscoe) is a tropical crop originally, especially from Southeastern Asia, which is consisting of more than 1200 plant species in 53 genera that produces a pungent aromatic underground rhizome. It is belongs to the Zingiberaceae family and namely as *Zingiber officinale* by William Roscoe (1753-1831), an English botanist, at 1807.[1] Zingiber, the name of the genus, was derived from a Sanskrit word denoting "horn-shaped" due to their protrusions on the rhizome.[2]

Ginger is valued worldwide as either spice and plays many main roles for various foods and beverages; or even on the application for traditional herbal medicine.[3] The utilization of ginger for health perspective is often attributed to its rich components of phytochemistry.[4] Nowadays, as one of ginger product, essential oil of ginger was already internatioally commercialized for use in food, beverages and pharmaceutical industry.[5,6] Various techniques have been employed in the extraction process of this valuable fraction. Soxhlet extraction, ultrasound assisted extraction, steam distillation, microwave assisted distillation were reported as the methods applied in the ginger oil separation process.[1,5]

Among the methods previously reported by several researches, pressurized hot water extraction (PHWE) is a promising alternative to the other extraction methods. PHWE is performed by involves heating water as the solvent above its boiling point but below its critical point (374 °C). The pressure was mainted elevated enough to make sure that the water remains in a liquid state. PHWE was stated and proven as an efficient and potential alternative to the other extraction methods.[7] It is caused by the specific characteristics of water that is used as solvent. This is a disproportionately of its high boiling point for its mass, high polarity and high dielectric constant. In the liquid phase and in an elevated temperature, water showes a sistematic decrease in the surface tension and its viscosity, decrease in permittivity, and also increase in the diffusion rate.[8–11] In this research, pressurized hot water extraction (PHWE) of fresh rhizome of ginger was investigated as a novel and alternative technology in separation of various active component of fresh ginger rhizome.

2. EXPERIMENTAL DETAILS

2.1. Materials

Fresh rhizome of ginger was obtanied from a local fresh market in Semarang, Central Java, Indonesia. The pressurized hot water extraction was performed by using distilled water. The PHWE was conducted by using pressurized extraction cell.[7] A stainless steel pipe connected into each five liter volume of two

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stainless steel (ss) vessels, containing extraction column and cooling cell.

2.2. General Procedure

Fresh rhizome was grinded in a laboratory grinder. 100 g of grounded fresh ginger was loaded into the PHW extraction cell, following by the addition of 4000 ml of distilled water. The ss lid cover of the PHW extraction cell was then securely covered the column. In order to purge out air from the PHW cell and also to keep the inside pressure of the chamber at 2 bar, N_2 gas was passed through the PHW cell for 2 min. The extraction was performed at temperature of 120–140 °C for 10 minutes. Due to the rapid cooling requirement after extraction process, the extract solution was removed into the cooling vessel at 1 MPa and 25 °C during 1 min.

2.3. Analytical Discussion

The samples of hot pressurized water ginger extract were determined the components by using GC-MS analysis. The GC-MS used was QP2010S-Shimadzu. The gas chromatograph was fitted with a Rtx-5MS column having 30 m length and inner diameter of 0.25 mm. The initial column temperature, final temperature, injector and detector temperature were 70 °C, 280 °C, 300 °C and 300 °C, respectively. The analysis was run with split mode, where the split ratio was of 72.6 and pressure of 14.0 kPa. Helium was used as the gas carrier at a linier velocity of 1.2 ml/min. 0.5 ml of hot pressurized water of fresh ginger rhizome extract was dissolved in CH_2Cl_2 and 1 μl of samples volume was directly injected into the chromatograph. Compounds were identified by comparing retention indices/comparing mass spectra of each compound with those of authentic samples and literature.

3. RESULTS AND DISCUSSION

The GC-MS analysis of ginger extract obtained by pressurized hot water extraction was carried out at temperature of 120 °C and 140 °C was shown on Figure 1. Figure 1(a) shows that Zingiberene (38.23%); (+)-Beta-Funebrene (19.45%) and (−)-AR-Curcumene (11.58%) were found to be the major constituents in pressurized hot water ginger extract performed at temperature of 120 °C. Sivasothy et al.[12] mentioned that a good ginger oil must be characterized by high sesquiterpene hydrocarbons such as alpha zingiberene, beta sesquiphelandrene, ar-curcumene and then follows by other constituents.[13] The zingiberene, (−)-AR-Curcumene and beta-bisabolene content of the PHWE extract of fresh ginger found in this research were higher than the zingiberene, (−)-ar-Curcumene. Buang et al.[14] investigated the chemical composition of ginger oil by using Clevenger apparatus for the hydrodistillation extract of ginger and found beta-bisabolene. The water ratio was set of 2660 mL water to 100 g dried ginger sample. The medium size particles of dried ginger was hydro distillated for 23.15 h. They found at that conditions, the oil constitute 33.49% of sesquiterpenes hydrocarbon. Among the sesquiterpenes hydrocarbon identified in the sample, alpha-zingiberene is the major compound which is constitute of 2.17%.[14] They also found that the (−)-ar-Curcumene and beta-bisabolene content was 0.90% and 1.04%.

Kamaliroosta et al.[1] also hydrodistilled the dried and grinded ginger rhizome in a Clevenger apparatus. The solid liquid ratio was of 1:5. The hydrodistillation process was set at the boiling point for 5 hours. The extract was then subjected to GC MS analysis. They found that the zingiberene, (−)-AR-Curcumene and beta-bisabolene content of the 5 hours hydrodistillation process were of 31.79%, 15.88% and 9.29%, respectively. Apparently, though the zingiberene and (−)-AR-Curcumene content of

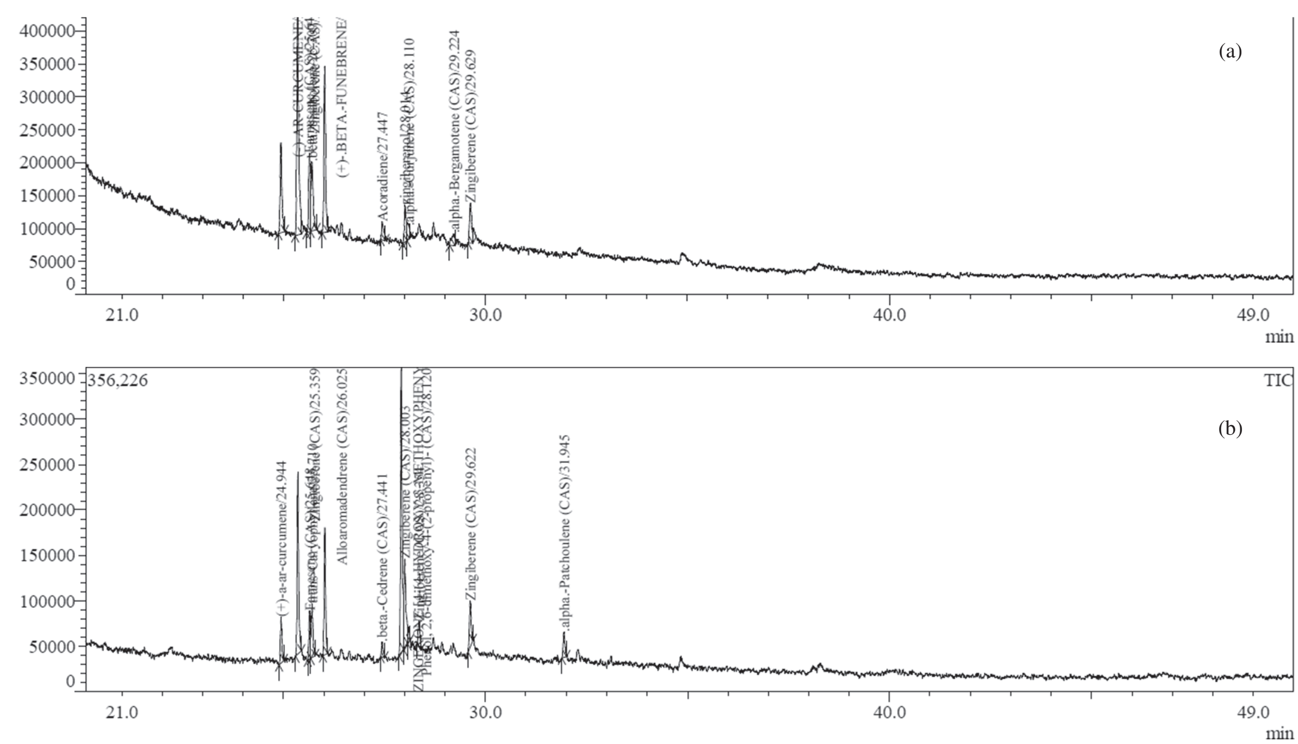

Fig. 1. GC-MS chromatogram of fresh ginger extract obtained by PHWE at temperature of 120 (a) and 140 (b) °C.

the hydrodistillation and PHWE were slightly differ, the PHWE process took shorter time than the hydrodistillation process. The short time needed in the PHWE might be due to the unique characteristic of pressurized hot water.

The zingiberene, (−)-AR-Curcumene and beta bisabolene content of PHWE extract found in this research were also higher than the zingiberene, (−)-AR-Curcumene and beta bisabolene content of the fresh ginger extract.[15] They reported that the zingiberene, (−)-AR-Curcumene and beta bisabolene content of the ginger extract obtained by blending fresh elephant ginger rhizome at a speed of 1800 rpm for 15–20 seconds were 33.50%, 4.91% and 4.41%, respectively.

The pressurized hot water extraction was also conducted at temperature of 140 °C. Figure 1(b) shows that zingerone (30.44%) was found to be the predominant constituent found in pressurized hot water ginger extract performed at temperature of 140 °C. Zingerone was not detected in the pressurized hot water ginger extract performed at temperature of 120 °C. It seems that zingerone was sinthesized due to the thermal process. Purnomo et al.[15] and Jolad et al.[16] mentioned that zingerone was the product of the thermal degradation of gingerol. Wolmuth[17] stated that gingerols is having the thermally unstable characteristic and can run into at least two reactions. Bae et al.[18] reported that zingerone is shown the strong anti-angiogenic activity. It could inhibited the MMP-2 and MMP-9 during tumor progression.

4. CONCLUSION

Pressurized hot water extraction of essential oil from fresh rhizome of ginger was proven to give a high content of sesquiterpenes hydrocarbon. Ten and twelve constituents were identified in the pressurized hot water ginger extract performed at temperature of 120 and 140 °C, respectively. Zingiberene (38.23%); (+)-Beta-Funebrene (19.45%) and (−)-AR-Curcumene (11.58%) were found to be the major constituents found in pressurized hot water ginger extract performed at temperature of 120 °C. Meanwhile Zingerone (30.44%) was found to be the predominant constituent found in pressurized hot water ginger extract performed at temperature of 140 °C.

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