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Research Article

Heating effect of Ginger (*Zingiber officinale* Rosc) in content of volatile oil and Oleoresin

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ABSTRACT

The influence of various heating treatments on the oleoresin and volatile oil content of ginger rhizome had been studied. The heating treatments employed included heating in an air oven at 60°C, 120°C, 180°C and burning in a charcoal fire for 15 minutes. Heating at above 60°C and burning reduced the total volatile oil content. All heating treatments reduced gingerol and shogaol content of ginger rhizome. Heating at 180°C gave highest concentration of the major oil components of ginger oil such as camphene, phellandrene, E-citral, Z-citral, ar-curcumene, zingiberene, β-bisabolene and β-sesquiphellandrene.

Keywords: Ginger; *Zingiber officinale;* heating; volatile oil; oleoresin

INTRODUCTION

Ginger is widely used as traditional medicine due to its volatile oil and oleoresin content with hot or pungent taste. It is also widely used as seasoning in cooking. The oil can be obtained through a steam distillation and widely used in perfumery and aromatherapy. The oleoresin with two main components gingerol and shogaol are used to prevent nausea and peripheral analgesic. Traditional medicines containing ginger extract to treat cold are leading in the traditional medicine market in Indonesia. A number of pharmacological activity antiemetic, antitussive, antiinflammation, analgesic, antihypertention, antiarthritis, antigenotoxic, antimicrobe and anticancer have been reported (Singh et al., 2012; Wang et al., 2012). The water extract of ginger was active as anti-inflammatory and anti-thrombotic agent but less effective in reducing cholesterol and triglyceride (Thomson et al*.,* 2002). The clinical study found that ginger was more effective than placebo in preventing nausea and vomiting (Chaiyakunapruk et al., 2006). Ginger was also safe and effective for treating pregnancy that induce nausea and vomiting (Borrelli et al., 2005; Ding et al., 2013; Thomson et al. 2014).

Maximum yield of ginger oil could be obtained from fresh rhizomes. Storage that longer than two weeks would decrease the oil content and also change the composition of the oil components. Drying and grinding would also substantially reduce the oil content (Sukrasno et al., 2000). Some Indonesian traditional manufacturers that using ginger as the major ingredient adopted the traditional practicing to prepare traditional medicine. Ginger was burnt on fire then further processed to prepare the final product. The aim of burning process was to improve the flavor and reduce the bitter taste (Purnomo et al., 2008). Heating and drying can induce the transformation of gingerol to shogaol (Ali et al., 2008; Bhattarai et al., 2001). Ginger oil from Nigeria contained 54 constituents with the major components geranial, neral, 1.8-cineole, zingiberene, β-bisabolene and β-sesquiphellanderene (Ekundayo et al., 1988). While the ginger oil from Cuba consisted of ar-curcumene, zingiberene, β-bisabolene and cadina-1,4-diene as the major components (Pino et al., 2004). Ginger oil from three different places in India was reported that zingiberene as the highest component, followed by E-citral, Z-citral, camphene and ocimene (Raina et al., 2005).

This research was aimed to evaluate the impact of heating at various temperatures and burning of ginger on the volatile oil and oleoresin content.

MATERIALS AND METHODS

Plant materials

Ginger rhizomes was obtained from Caringin market, Bandung, Indonesia. The rhizomes was determined at the Herbarium Bandungense, School of Biological Science and Technology and identified as *Zingiber officinale* Rosc. (Zingiberaceae). The ginger rhizomes was thoroughly washed with tap water, wet sortation and dried.

Heat treatment

Respectively 100 g of fresh ginger was heated in an oven at 60°C, 120°C and 180°C for two hours. Another

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100 g was burnt on the fire of charcoal for 15 minutes. Analysis was done in triplicate for each treatments. Fresh ginger (untreated) was used as control.

Isolation of ginger oil

Ginger rhizomes were crushed in a blender by adding 200 mL water and then strained to separate the marc and filtrate. Filtrate was left to settle and starch will precipitate. The supernatant together with the marc were transferred to Stahl distillation flask. Ginger oil distillation was conducted for two hours after the condensation taken place.

Analysis of ginger oil component

Qualitative analysis of ginger oil was performed by TLC on pre-coated silica gel (Merck) using toluene-ethyl acetate (93:7) as mobile phase and visualized with vanillin sulfate. The components of ginger oil were analyzed by GC-MS (Shimadzu QP 2010 Ultra) with DB-5 column, eluted with nitrogen at 1.32 mL/minutes, injection temperature 270°C, gradient temperature elution starting from 60°C to 280°C with the increase 8°C/minute. Quantitative analysis was performed by GC (Shimadzu GC 2010) with FID as the detector. The other condition was the same but the nitrogen flow rate was at 0.99 mL/minutes.

Determination of gingerol and shogaol

Oleoresin from ginger was extracted by crushing 10 g rhizome in 50 mL methanol then filtered and the volume was adjusted to 50 mL with methanol. The gingerol and shogaol content was separated by applying 4 μL extract at 6 mm width using applicator (Linomat) on 0.1 mm pre-coated silica gel (Merck) and developed using toluene-methanol (80:5). Gingerol and shogaol spots were visualized and the area measured using TLC densitometer (Camag) at 282 nm.

Statistical Analysis

Statistical analysis was conducted using one way ANOVA-Student Newman Keuls (SNK) with SPSS.

RESULT AND DISCUSSION

Ginger oil content was remain constant upon heating at 60°C, however the content significantly decreased when heated at 120°C and upon heating at 180°C. After heating at 120°C and 180°C the oil present in the ginger were 77% and 64% respectively compared to the fresh rhizome. Heating of ginger rhizome changed the composition of essential metabolites present in the rhizome. Burning of ginger rhizome that is traditionally used to prepare herbal medicine from ginger decreased the oil content compared to fresh ginger and the decrease was even higher compared to heating at 180°C. The decrease of the oil content upon heating might be due to the evaporation of volatile oil components with lower boiling point. The decrease of the oil content was also observed when sliced ginger rhizome was dried under the sun and the remaining oil was only 30% compared to fresh ginger (Sukrasno et al., 2000).

Table 1: Volatile oil content of ginger after treatments

Ginger	Oil content (% v/b)
Fresh	0.44 ± 0.08
Heated at 60°C	0.43 ± 0.05
Heated at 120°C	0.34 ± 0.05*
Heated at 180°C	0.28 ± 0.04*
Burned	0.26 ± 0.02*

*significantly different with fresh ginger at $p < 0.05$

Heat treatment also decreased the oleoresin content of ginger. Both gingerol and shogaol decreased upon heating even at 60°C. However, upon heating at 120°C, the amount of gingerol was higher compared to heating at 60°C, but the level was still lower compared to fresh ginger. Higher decrease of oleoresin at 60°C may be dominated by polyphenoloxidase activity that has optimum activity at 55°C (Prabha et al., 1982). Heating at 180°C decreased the gingerol and shogaol content compared to fresh and heating at lower temperature. Burning did not increase gingerol nor shogaol content compared to fresh ginger. This experimental results suggest that heating and burning of ginger rhizome did not improve the quality of ginger rhizome in the term of volatile oil content or oleoresin content.

Table 2: Gingerol and shogaol content of ginger after treatments

Ginger	Gingerol (mg/g)	Shogaol (mg/g)
Fresh	2,90 ±0,19^{a}	0,14±0,03^{a}
Heated at 60°C	1,85±0,03^{b}	0,09±0,01^{b}
Heated at 120°C	2,26±0,11^{c}	0,08±0,02^{b}
Heated at 180°C	1,17±0,05^{d}	0,05±0,01^{bc}
Burned	1,19±0,11^{d}	0,04±0,00^{c}

a –d = means within a column with the same letter were not significantly different (p=0.05)

Volatile oil component of ginger oil was analyzed by separating oil from fresh ginger by GC-MS and 46 components were separated. The major components of the oil are shown in Table 3. The components identified were similar to that of reported by Raina et al. (2005) with zingiberene as the highest component followed by E-citral, β-sesquiphellandrene, phellandrene, camphene, ar-curcumene, α-farnesene, β-bisabolene, Z-citral, cineol, α-pinene and β-pinene.

Changes in the composition of ginger oil components after various heating treatments were analyzed by GC with FID detector. Under the used GC-system, phellandrene and cineol were not separated and appeared as one peak, neither with β-bisabolene and α-farnesene. Therefore the 10 major peaks of the chromatograms were presented as α-pinene, camphene, β-pinene, 1-

phellandrene, E-citral, Z-citral, ar-curcumene, zingiberene, β-sesquiphellandene and α-farnesene.

Table 3: Major components of ginger oil separated on GC-MS

No	Rt	M	Peak Area (%)	Compound
1	4.003	136	3.72	α-Pinene
2	4.236	136	8.45	Camphene
3	4.743	136	2.04	β-Pinene
4	4.546	136	8.76	1-Phellandrene
5	5.460	154	4.16	1,8-Cineol
6	8.994	152	4.61	Z-Citral
7	9.512	152	8.98	E-Citral
8	12.961	202	6.45	Ar-Curcumene
9	13.190	204	16.61	Zingiberene
10	13.301	204	6.13	α-Farnesene
11	13.365	204	5.25	β-Bisabolene
12	13.621	204	8.91	β-Sesqui phellandrene

From the area under curve (AUC), camphene, phellandrene, citral and zingiberene can be considered as the four dominating components of the oil. Heating of ginger at 60°C and 120°C did not significantly change the composition of the ginger oil components. Increasing in intensity of some peaks with Rt 15 to 16 minutes was observed in the chromatogram of oil obtained from ginger heated at 180°C (Fig 1). Gas chromatogram of oil obtained from burnt ginger rhizome gave similar pattern to that of heated at 180°C.

The oleoresin of ginger consisted of mainly gingerol and shogaol that are responsible for the pungent taste and identified as the active compound for ginger usage as anti-inflammation, anti-emetic and anti- nausea (Borrelli et al., 2005). Due to the presence of phenolic moiety in the oleoresin of ginger, it may susceptible to phenoloxidase and might explain the high decrease of oleoresin content when ginger rhizome was heated at 60°C. The decrease of ginger oleoresin was higher when the ginger was heated at 60°C compared to 120°C.

The ginger oil components seem varies among varieties and the area of growth. The major components of ginger oil were geranial, neral, 1.8-cineole, zingiberene, β-bisabolene and β-sesquiphellanderene (Ekundayo et al., 1988). While ginger oil from Cuba consists of ar-curcumene, zingiberene, β-bisabolene and cadina-1,4-diene as the major components (Pino et al., 2004). Ginger oil from India contains zingiberene as the highest component followed by E-citral, Z-citral, camphene and ocimene (Raina et al., 2005). Similar to that of from India, zingiberene constitute as the highest component in the isolated oil in these experiments with approximately 16.8%, followed by E-citral (8.98%), β-sesquiphellandrene (8.91%), phellandrene (8.76%), camphene (8.45%), ar-curcumene (6.45%), α-farnesene (6.13%), β-bisabolene (5.25%), Z-citral (4.61%), cineol (4.16%), α-pinene (3.72%) and β-pinene (2.04%).

Fig. 2 showed that the change of each major components upon various heating treatments. The content of α-pinene and β-pinene did not significantly change upon various heating treatments. Heating of ginger at 60°C and 120°C did not change the content of camphene in the oil. However, upon burning, the camphene content was higher compared to the fresh ginger although the increase was not significant ($p < 0.05$). Heating ginger at 180°C significantly increase the camphene content ($p<0.05$). Similar observations were observed with phellandrene, E-citral, Z-citral, ar-curcumene, zingiberene, bisabolene and sesquiphellandrene. Compared to the other treatments, heating at 180°C gave highest concentration of the major components in ginger oil. In addition, this treatment also gave the least variation in the concentration of the major oil components.

Burning of ginger rhizome in traditional method to prepare beverage from ginger is intended to improve the flavor and reducing bitter taste (Purnomo et al., 2005). However, experimental results showed the decrease of volatile oil content upon burning or heating at 120 ºC or at higher degrees. The higher concentrations of major oil components in the obtained oil showed the change of oil quality upon heating treatments. Such increase might be due to the evaporation

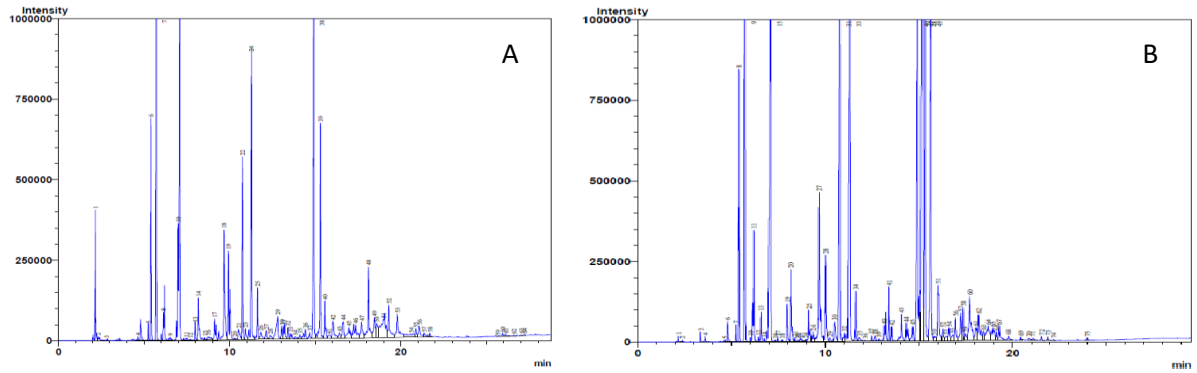

Figure 1: Gas chromatogram of volatile oil obtained from fresh ginger rhizome (A) and ginger rhizome heated at 180 °C (B)

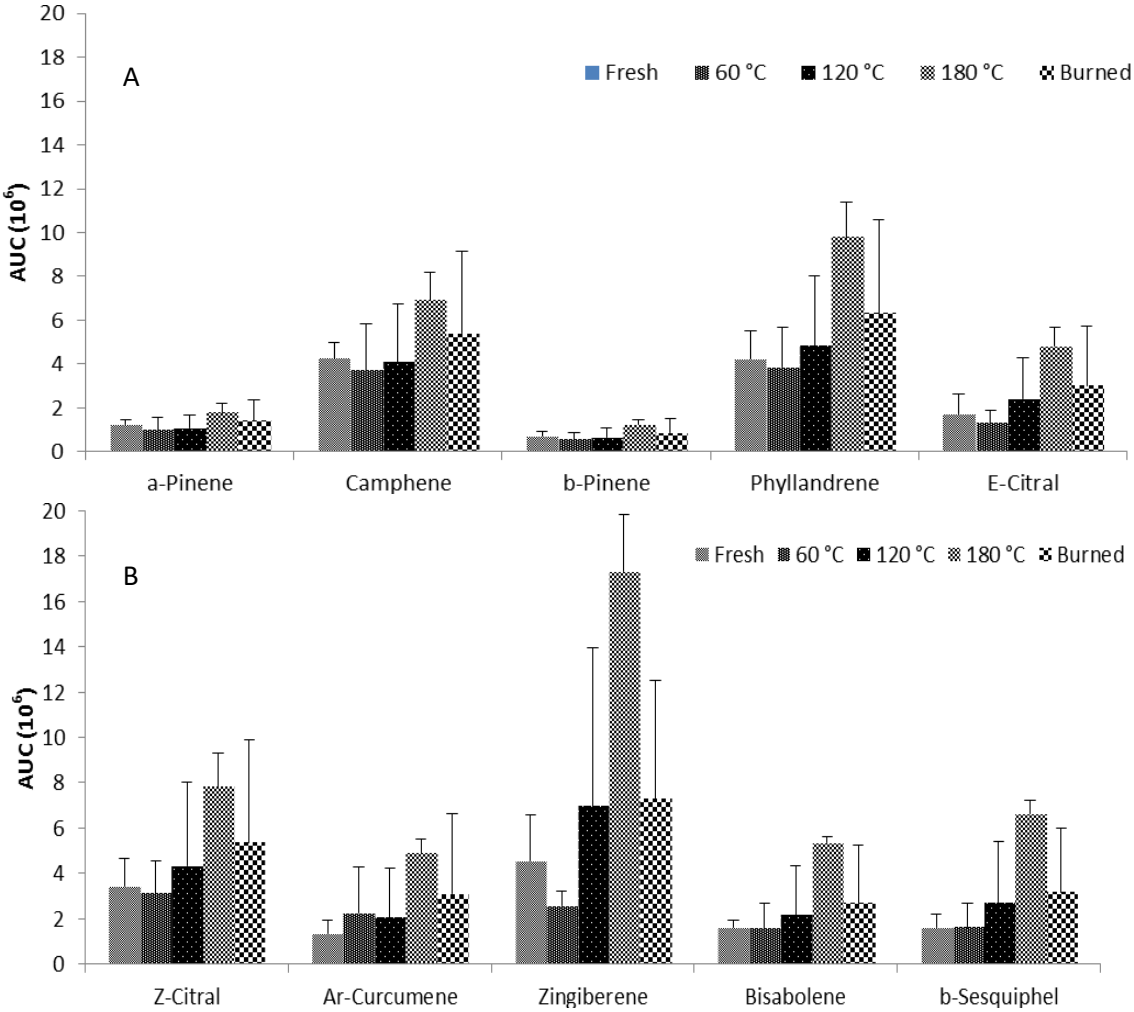

Figure 2: Changes of ginger oil components after various heating treatments of ginger rhizomes (A and B)

of oil components with lower boiling points and responsible in the improvement of the ginger flavor. Compared to the other treatments, heating at 180°C gave highest concentration of the major components in ginger oil. In addition, this treatment also gave the least variation in the concentration of the major oil components. Therefore, for industrial purpose it was recommended to heat the ginger using an air oven at 180°C rather than burning, in order to produce more reproducible product.

In this experiment, heating period employed was two hours. It was expected by heating for two hours, the rhizome had been thoroughly exposed to the heat. Optimization on heating period was also needed in order to produce better performance product and efficient production process.

CONCLUSION

Heating of ginger at above 60°C including burning would decrease the volatile oil and oleoresin contents. Composition of volatile oil components change upon heating and the increase of almost all major oil components occurred upon burning and heating at 180°C.

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