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Original Article

GC-MS analysis and antimicrobial activity of the aqueous extract from the bulbs of *Allium chinense* G. Don. cultivated in North Sumatra, Indonesia

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Abstract

Chemical constituents of the aqueous extract of the Chinese shallot, *Allium chinense* G. Don. grown in North Sumatra, Indonesia was determined through gas chromatography-mass spectrometry (GC-MS). The aqueous extract was obtained from maceration in distilled water and concentrated using rotavapor (yield: 38%, w/v). The antimicrobial activity of the aqueous extract displayed broad-spectrum inhibition against *Bacillus subtilis, Candida albicans, Staphylococcus aureus* and *Escherichia coli*. The most potential bioactivity was its antifungal activity against *Candida albicans* with a minimum inhibitory concentration (MIC) of 62.5 µg/mL. The results also displayed a distinct composition in North Sumatran cultivar, *Allium chinense,* which previously reported to be dominated by organosulfur compounds in the Chinese shallot. Furan compounds and their derivatives dominated the composition of aqueous extract. The major components identified were 5-(hydroxymethyl)-2-furancarboxaldehyde (26.65%), 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one (14.64%), lactic acid (12.70%), 3,5-dihydroxy-2-methyl-5,6-dihydropyran (10.42%) and other furan derivatives (<2%) which may be responsible for its antimicrobial activity due to its furan cocktails in the extract. The major compound, 5-(hydroxymethyl)-2-furancarboxaldehyde is then revealed as a potential antioxidant based on literature reviews.

Keywords: *Allium chinense*, Antimicrobial, *Candida albicans*, Furan, Gas Chromatography Mass Spectrometry

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Introduction

Allium spp. is a tropical plant species commonly used as spices, food preservatives, and medicinal ingredients (Keusgen et al., 2006; Sharma, 2004; Satyal et al., 2017). Its bioactive compounds have been intensively evaluated, explaining its oldest and global cultivation for many centuries (Benkeblia and Lanzotti, 2007). There are about >280 species of *Allium* with the most notable species, such as *Allium sativum, A. cepa, A. tuberosum, A. ascalonicum, A. minutiflorum, A. schoenoprasum,* etc (Rabinowitch and Currah, 2002).

A phytochemical study from their bioactive extracts showed a composition of essential oil and organosulfur compounds such as allicin, alliin, di-allyl tri-sulfide, ajone, di-allyl di-sulfide, methyl methanethiosulfinate, which may contribute to their health and medical properties (Putnik et al., 2019). Reports regarding the potential bioactivities of *Allium* extract grew the attention of researchers as they have been described as anti-inflammation, antioxidative, antihistamine, insecticidal, anticancer, antibacterial, and antifungal agents (Bah et al., 2012; Bakht et al., 2011; Safari et al., 2014; Meriga et al., 2012; Najjaa et al., 2009).

Bioactive compounds of *Allium* expressing antibacterial activity is the most common preliminary study in recognizing their valuabilities. The source of the antibacterial compounds may be obtained by extraction from bulbs, flowers, leaves, and roots. Antibacterial activity from *Allium* species showed a broad spectrum inhibition against bacterial pathogens, such as *Vibrio cholerae, Staphylococcus aureus, Escherichia coli, Streptococcus mutans, Pseudomonas aeruginosa,* and *Candida albicans* (Bakht et al., 2013; Bakht et al., 2014; Deresse, 2010; Fani et al., 2007; Hannan et al., 2010; Lemar et al., 2005).

The traditional use of *Allium* species has been documented in some ethnobotanical studies in Indonesia. The tuber or bulbs of *Allium cepa* L. mixed with water were used as a cleaning solution to treat cataract in the local community of Ranggawulung, East Java, Indonesia (Putri et al., 2016). The consumption of raw *A. sativum* bulbs by local community of Turgo, Yogyakarta, Indonesia was perceived as a herbal medicine in lowering high blood pressure and cholesterol levels (Nahdi et al., 2016). The *Batak Karo* tribe in North Sumatra, Indonesia purposively grew many medicinal plants in their home garden, for example *A. tuberosum* or *Gundara belang* for daily consumption as herbal medicine ingredients (Silalahi and Nisyawati, 2018). In a more recent study, both *A. cepa* and *A. sativum* bulbs were reported to be practically used as oral and topical medicine to treat various ailments, e.g fever, high blood pressure, injury, and abdominal pain by the *Batak Toba* tribe in North Sumatra, Indonesia (Silalahi et al., 2019).

Bawang Batak is one of local *Allium* species, cultivated in North Sumatra, Indonesia and identified as *Allium chinense* G. Don, originating from Chinese region. In North Sumatra, the shallot is primarily used as food ingredient or eaten raw in traditional cuisine namely *arsik ikan mas*. Meanwhile, no health properties have been reported so far. A laboratory investigation reported that *A. chinense* organic extracts (MeOH, EtOAc, hexane) displayed notable antifungal and antimicrobial activities against human clinical pathogens (Naibaho et al., 2015).

Regarding its future application, the present study investigated the antimicrobial activity of aqueous extract of *A. chinense* bulbs obtained through the decoction technique as one of many traditional processing of herbal ingredients. Besides, differences in chemical composition are suspected between the Chinese and North Sumatran *A. chinense* which may imply the impacts of geographical and cultivation conditions on the phytochemical investment among intraspecific organisms.

Material and Methods

Plant material

Allium chinense G. Don. or *bawang batak* (Ind.) was purchased from local farmer in Sidikalang district, Dairi regency, North Sumatra, Indonesia. The duplicate specimen was authenticated in Herbarium Bogoriense, Indonesian Institute of Sciences, Cibinong, Indonesia for species identification and confirmation.

Preparation of aqueous extract

Fresh *Allium chinense* bulbs were sliced to a thickness of ± 5 mm then the decoction technique was adopted to yield the aqueous extract (Ennaifer et al., 2018). Approximately 25 g of simplicia in 250 mL distilled water (1:10, w/v) was boiled in 500 mL flask at 100°C for 15-20 min or until the water volume was halved. Filtrate was concentrated using rotavapor *in vacuo* at temperature below 60°C to yield crude aqueous extract of *A. chinense*. Decoction process may be repeated in

an additional batch until adequate volume of aqueous extract is obtained. The crude extract was stored in refrigerator (4°C) prior experimentation.

Preliminary phytochemical screening

The aqueous extract was qualitatively screened for the presence of phytochemical constituents, i.e., alkaloids, flavonoids, organosulfur, saponins, steroids, tannins, and terpenoids based on color-forming reactions (Harborne, 1996).

Antimicrobial activity assay

The crude aqueous extract was tested for its antimicrobial activity using the agar well diffusion method (Balouiri et al., 2016). In this study, clinical pathogens were *Bacillus subtilis*, *Escherichia coli*, *Salmonella typhii*, *Staphylococcus aureus*, and *Candida albicans* retrieved from Laboratory of Bacteriology, Faculty of Veterinary Medicine, Bogor Institute of Agricultural Sciences, Bogor, Indonesia. Bacterial inoculum was initially grown in tryptone soya agar (TSA) (Oxoid™, UK) while *C. albicans* was grown in potato dextrose agar (PDA) (Difco™, USA) at 37°C for 24 hr. Bacteria and yeast colonies were picked up using sterile cotton swab and dipped into 0.85% physiological saline (NaCl) solution to obtain OD_{600} = 0.08-0.10 ≈ 1.5-2 $\times 10^8$ CFU/mL for bacteria or 1-5 $\times 10^6$ CFU/mL for *C. albicans*. An aliquot of 0.1 mL microbial suspensions were mixed with 20 mL of molten (45°C) Mueller-Hinton agar (MHA) and inoculated into sterile plates upon solidification. Five wells were made by punching a hole using a cork borer with a diameter of 6 mm. The crude aqueous extract was prepared in a 10% dimethyl sulfoxide (DMSO, v/v) at a concentration of 1000 µg/mL. 50 µL of each solution was pipetted into well. Chloramphenicol and Nystatin (60 µg/mL) were used as standard antibiotics or positive controls. 10% DMSO was used as negative control. Plates were incubated at 37°C for 24 hr. Clear zones around wells were measured using digital caliper (mm). All experiments were performed in three replicates.

Determination of minimum inhibitory concentration (MIC)

The MIC value was obtained by testing different concentration of aqueous extract of *A. chinense* by 2-fold dilution in 10% DMSO (v/v), yielding concentration at 500-1.95 µg/mL. The procedure in testing MIC was similar to that previously mentioned in antimicrobial activity assay. Plates were incubated at 37°C for 24 hr. Clear zones around wells were measured using digital caliper (mm). All experiments were performed in three replicates.

GC-MS (Gas Chromatography-Mass Spectrometry) analysis

The phytochemical constituents of aqueous extract of *A. chinense* G. Don. were analyzed with GC-MS equipment (Shimadzu type GCMS-QP2010, Japan). Experimental conditions of GC-MS system were as follows: Rtx-5MS (fused silica) capillary column, flow rate of mobile phase (carrier gas: He) was set at 1.50 mL/min, column oven temperature was set to rise from 50°C to 250°C at 5°C/min with velocity of 45.1 cm/sec and injection volume was 1 µL. The analysis was run at a range of 40–600 *m/z* and the results were compared based on database in Wiley Spectral library (WILEY7.LIB). A representative of major compounds was re-drawn in chemical structure using ChemDraw online tool.

Results and Discussion

Phytochemical screening of aqueous extract of *Allium chinense*

The existence of antibiotic-resistant pathogens has increased in the last decades, which demands a development and discovery of new drugs, especially those derived from natural products (Cowan, 1999). The main focus of discovering new antibiotics is by exploitation and exploration of various medicinal plant species followed by laboratory testing of their efficacies. (Newman and Cragg, 2012). Based on the qualitative screening results of phytochemicals, *A. chinense* may be considered as a prominent source of antimicrobial agents. The results showed that *A. chinense* aqueous extract contained organosulfurs, saponins, steroids, and triterpenoids although no presence of alkaloids, flavonoids, and tannins were detected in the extract (Table 1).

The presence of organosulfurs, saponins, steroids, and triterpenoids in *A. chinense* have been documented in previous studies. However, most studies reported the bioavailability of phytochemicals occurring in organic extracts and essential oils from *A. chinense* cultivated in the Chinese region.

Table-1. Phytochemical screening of aqueous extract of *Allium chinense* G. Don.

Phytochemical constituents	Test/Reagents	Result
Alkaloids	Dragendorf test	–
	Mayer test	–
	Wagner test	–
Flavonoid	Shinoda test	–
Organosulfur	Silver Nitrate test	+
Saponin	Foam test	+
Steroid	Liebermann-Burchardt test	+
Tannin	Braemer test	–
Triterpenoid	Liebermann-Burchardt test	+

+ , Present; – , Absent

Also, the steroidal saponins and sapogenins are among the well-studied phytochemicals in *A. chinense* and gaining recent focuses (Sobolewska et al., 2016). The steroidal saponins from MeOH fraction of *A. chinense*, was reported to inhibit the cellular activities of cyclic AMP phosphodiesterase and Na^+K^+ ATPase (Kuroda et al., 1995). The isoliquiritigenin and laxogenin, derived from saponins of *A. chinense* showed a significant anti-tumor promoting activity to HeLa cells (Baba et al., 2000). Moreover, three saponins isolated from *A. chinense* showed a protective effect to the stress-induced cardiac damage in the cultured rat cells (Ren et al., 2010). The essential oil or triterpenoids of *A. chinense* which contained majority of organosulfurs (allyl sulfides) was also as an insecticide, being effective against booklice in the field of post-harvest preservation (Liu et al., 2014). On the contrary, the hyperlipidemic properties of fresh *A. chinense* bulbs were attributed to its flavonoid contents, undetected in the present result (Lin et al., 2016). By considering the bioactivities reported from previous laboratory studies, it may seem promising to evaluate the native *A. chinense* from North Sumatra especially as herbal medicine or pesticide ingredients in the future.

Antimicrobial test

Antimicrobial activity of *A. chinense* aqueous extract was found to be most effective against Gram positive bacteria and yeast (Table 2). The largest inhibition zone (mm) was observed against *Candida albicans* reaching >16 mm (Figure 1). Minor antibacterial activities were observed from the test against Gram negative bacteria, *E. coli* and *S. typhii*, indicating their insensitivity to the aqueous extract.

Table-2. Inhibition zones (mm) of aqueous extract of *Allium chinense* G. Don.

Sample	Microorganism[a]				
	B. subtilis	***E. coli***	***S. aureus***	***S. typhii***	***C. albicans***
Aqueous extract	10.31 ± 0.58	+ / –	10.41 ± 0.53	+ / –	16.38 ± 0.32
Chloramphenicol	11 ± 0.0	18 ± 0.0	13 ± 0.0	12 ± 0.0	–
Nystatin	–	–	–	–	15 ± 0.0
DMSO 10% (v/v)	–	–	–	–	–

– , No inhibition; + / – , slight inhibition (< 7 mm).
[a]Inhibition zones are presented as means (three replicates) ± SE.

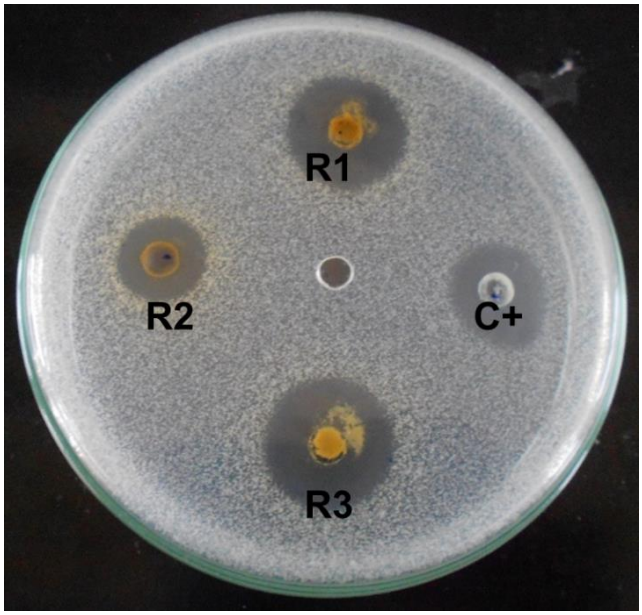

Figure-1. Inhibition zone of aqueous extract of *Allium chinense* G. Don. (1000 µg/mL) against *Candida albicans*. R: Replicate 1,2,3; C+: Nystatin (60 µg/mL)

On the contrary, Bakht et al. (2011) reported that water extracts showed antibacterial activities against tested Gram negative bacteria e.g *Escherichia coli, Salmonella typhii, Klebsiella pneumoniae,* and *Erwinia carotovora*. In general, plant materials extracted with organic solvents may display a more significant antibacterial activities than using only water as solvent (Koohsari et al., 2015).The first investigation using macerated *A. chinense* simplicia in ethyl acetate extract showed a more potent result against bacteria (Naibaho et al., 2015). However, the use of decoction technique in metabolite extraction, showed an increase in anti-*Candida albicans* activity in this study (previously <15 mm). A similar result

was also reported in which fresh garlic extract exhibited a stronger anti-*Candida* than simplicia-based extracts (Lemar et al., 2002). Hence, the bioactivity of *Allium* species may vary regarding the extraction and processing methods (Farag et al., 2017). The decoction technique is considered the oldest and simplest preparation method of herbal medicines, yet the effectiveness is still under evaluation in different plant species or formulation (Yang et al., 2015). Besides, the decoction technique is the best practice or preferably used by the local community in preparing herbal medicine for daily uses and treatments of ailments. Since the best results was observed against *C. albicans*, a further test of MIC determination was performed, revealing the value of >62.5 µg/mL (Figure 2). By determining the MIC of plant extracts, we may use the extract in a more effective concentration while exhibiting the best bioactivity.

The more sensitivity of Gram positive than gram–negative bacteria to herbal extracts has also been documented in past investigations. An antibacterial study of 25 Australian herbs revealed that *Bacillus cereus* and *B. subtilis* were more susceptible to the herbal extracts than *Pseudomonas aeruginosa* and *Aeromonas hydrophila* based on the disk diffusion method (Cock, 2008).The antibacterial test of different herbal extracts native to India and Nepal against human pathogenic bacteria revealed that the most sensitive bacteria were *B. subtilis* and *S. aureus*. In contrast, most Gram negative bacteria produced an insignificant inhibition based on agar well diffusion method (Joshi et al., 2009).

Gram positive bacteria are more sensitive than Gram negative bacteria because of the differences in the cell wall composition and membrane permeability. In Gram negative bacteria, the cell envelope and composition is more complex than in Gram positive bacteria. With its impermeable feature, the lipopolysaccharide layer may hinder the input of bioactive metabolites into the interior of cells yet reducing the effectivity of antibiotics (Hodges, 2002). The antibacterial activity by herbal extracts, must be initiated through a hydrophilic-lipophilic balance between soluble drugs and cell environment (Kanazawa et al., 1995). The herbal drugs or extracts must be soluble in the aqueous environment to make a contact with the target bacteria. The contact of a more lipophilic extract will initiate the interaction with the cell wall of Gram negative bacteria, leading to various solubilization, leakage, disruption or even direct passage into cell interior (Branen and Davidson, 2005). Moreover, the aqueous extract of *A. chinense* was subjected to GC-MS analysis to provide hints on the composition of bioactive phytochemicals, explaining the general mechanism of antimicrobial activity.

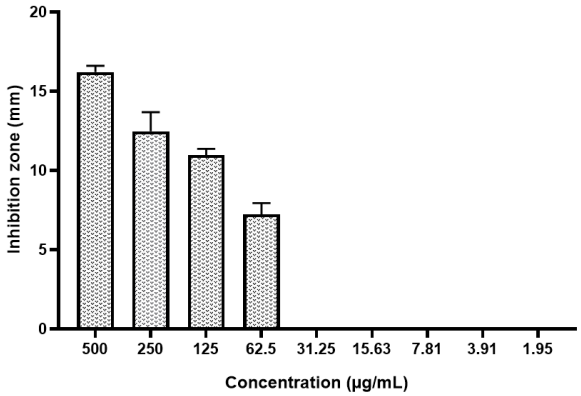

Figure-2. Minimum inhibitory concentration (µg/mL) of aqueous extract of *Allium chinense* G. Don. Data are presented as means of three replicates.

Phytochemical constituents of *A. chinense* aqueous extract by GC-MS analysis

The composition of the aqueous extract of *Allium chinense* G. Don. Bulbs grown in North Sumatra was determined by GC-MS as shown in Table 3. In this study, we identified the major components based on spectral database in library. The highest portion of phytochemicals in the extract was found to be 5-(hydroxymethyl)-2-furancarboxaldehyde (26.65%), followed with 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one (14.64%), L-(+)-lactic acid (12.70%), 3,5-Dihydroxy-2-methyl-5,6-dihydropyran (10.42%) (Figure 3).

The presence of 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one was detected again during a retention time of 9.515, suggesting an unequal distribution of sample or unidentified derivatives based on the library database. In general, the significant compounds detected were furan, furfural and its derivatives in the aqueous extract. The rest of the extract contained either minor components of alcohol compounds or organic acids. It can be seen that no aromatic terpenoids or volatile compounds detected in the bulbs, while the volatile oils along with organosulfurs were reported previously as the most dominant phytochemicals in *A. chinense* (Bah et al., 2012). Prior investigation using GC-MS analysis to identify the chemical composition

of the EtOAc extract of North Sumatran *A. chinense* also revealed dominant furan and furfural compounds (Naibaho et al., 2015).

Table-3. Compounds identified in the aqueous extract of *Allium chinense* G. Don.

RT	Compound	% Conc.
5.581	L-(+)-lactic acid	12.70
5.667	2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one	14.64
6.005	Cyclohexanone	0.70
6.273	1,2:3,4-Diepoxycyclopentane	0.60
6.826	Butyrolactone	1.19
6.993	2(5H)-Furanone	1.70
7.442	2-Methylpentane	0.37
7.895	Hyacinthin	1.24
8.583	Piperidine	0.12
8.941	2,5-Dimethyl-4-hydroxy-3(2H)-furanone	2.55
9.515	2,3-Dihydro-5-hydroxy-6-methyl-4H-pyran-4-one	2.82
10.416	2-Acetoxy-5-methylpyrazine	0.44
11.191	3,5-Dihydroxy-2-methyl-5,6-dihydropyran	10.42
12.607	Levulinic acid	1.96
13.342	2H-Pyran-2-one, tetrahydro-4,6-dimethyl-	0.35
13.874	Isosorbid	1.11
14.122	3-Methyl-furan-2-carboxylic acid	1.89
15.443	5-(hydroxymethyl)-2-furancarboxaldehyde	26.65
16.380	7-Oxo-octanoid acid	0.27
16.967	5-(2-hydroxyethylidene)	0.21
17.317	cis-dimethyl morpholine	0.17
18.246	n-Heptyl acetate	0.65
19.024	Vinyl 2,2-Dimethylpentanoate	0.46
19.367	6-Undecanol	0.31
20.289	Tri-n-butylborane	0.81
21.672	Tetradecyl alcohol	0.23
22.323	Ethyl phthalate	0.53
24.251	1,4-Anhydro-d-mannitol	4.15
27.247	2-Deoxy-D-ribose	3.69
29.530	Oleic acid	2.90
31.617	D-Mannitol	0.51
33.142	1-Hexanol, 4-methyl-, acetate	0.44
34.717	2,2,3,3-Tetramethylcyclopropanemethanol	0.32
35.817	1-Methyl-trans-2-ethylcyclohexane	0.26
Total		100.00

RT: Retention time

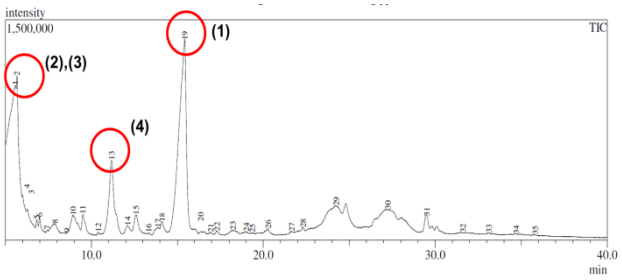

Figure-3. GC-MS chromatogram of aqueous extract of *Allium chinense* G. Don. The highest detected compounds are: (1) 5-(hydroxymethyl)-2-furancarboxaldehyde, (2) 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one, (3) lactic acid, (4) 3,5-dihydroxy-2-methyl-5,6-dihydropyran

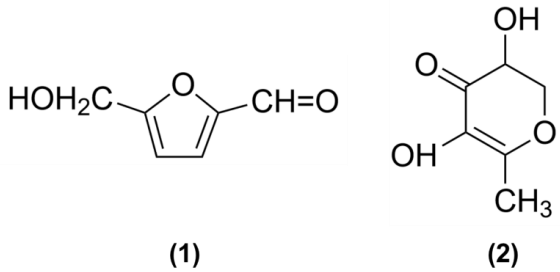

Figure-4. Chemical structure of representative furan compounds: (1) 5-(hydroxymethyl)-2-furancarboxaldehyde, (2) 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one

However, the concentration of 5-(hydroxymethyl)-2-furancarboxaldehyde in aqueous extract was higher than in the previous finding (18.23%). Besides, the presence of 5-(hydroxymethyl)-2-furancarboxaldehyde was also detected in other *Allium* species. Some phenols, organosulfurs, and a 5-(hydroxymethyl)-2-furancarboxaldehyde compound were present in the aged garlic (*A. sativum*) extract based on GC-MS and UPLC analysis (Wang et al., 2016). We also pointed out that the detection of 5-(hydroxymethyl)-2-furancarboxaldehyde was considered a rare finding within *Allium* members. Simultaneously, it was also found to be suitable as a strong oxidant along with other phytochemical constituents in *A. sativum.* Supporting evidence also came from the furfural compound or 5-hydroxymethylfurfural (HMF) derived from honey and other food products, which were claimed to possess beneficial health effects to human primarily as antioxidative agents (Shapla et al., 2018). Another reason for the detection of furfural compounds may be

due to the product of thermal decomposition of sugar (Liu et al., 2018).

Meanwhile, obtaining furfural in standard extraction of *Allium*, in the case of *A. cepa*, was achieved during the inactivation of allinase along with decreasing level of volatile organosulfur compounds within increased temperature. Therefore, the heated environment therefore permitted the availability of furfural compounds which may also contribute to the sweetness in the plant material (Crowther et al., 2005). However, it is also noteworthy that both organic and aqueous extract of North Sumatran *A. chinense* are distinctive compared to the China cultivar through abundant 5-(hydroxymethyl)-2-furancarboxaldehyde and 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one compounds (Figure 4). The differences may be the results of different environmental conditions, playing essential roles in the biosynthesis of secondary metabolites between two cultivars. Environmental conditions such as altitude, climate, light intensity, precipitation, soil nutrients, and temperature of cultivation area as geographical consequences may affect the accumulation of secondary metabolites (Sampaio et al., 2016; Kumar et al., 2017).

The natural composition of dominant furan and furfural compounds in the bulbs may contribute to its future use as natural preservative agents and potential antimicrobial components (Zanatta et al., 2007; Chai et al., 2013). Prior this investigation, the bioactivity of heterocyclic compounds such as furan and furfural, has been reported to exhibit a significant pharmacological activities while possessing anti-depressant and anti-inflammatory properties (Burch et al., 1980; Ahmad et al., 2013). Despite its potential as antifungal agent in our study, furan derivatives were notably known as antibacterial agent, especially in the form of synthesized nitrofuran and nitrofurfural compounds (El-Obeid et al., 1985; Lukevits and Demicheva, 1993; Malladi et al., 2017).

Regarding its antifungal properties, other furan derivative such as Dinaphtho[2,1-b]furan-2-yl-methanone also showed inhibitory activities against *C. albicans* with MIC values from 128 to 512 µg/mL (Kirilmis et al., 2009). Further investigation on antifungal activity against *C. albicans* has been reported from 4-(furan-2-yl)-1-(pyridine-4-yl)-azetidine-2-one based on disk diffusion method (>30 mm) (Sen et al., 2011). Recent investigation reported two furan derivatives namely 5-(undeca-3′,5′,7′-trien-1′-yl)furan-2-ol and 5-(undeca-3′,5′,7′-trien-1′-yl)furan-2-carbonate which displayed significant activities against phytopathogenic fungi, *Fusarium oxysporum* and *Rhizoctonia solani* with MIC values from 3.1 to 50 µg/mL (Wu et al., 2017). The prospect of developing antifungal drugs based on these furan constituents may be investigated further in the future, especially those extracted from North Sumatran cultivar containing furan cocktails as potential drugs. The results may also promote its initial use as one of the oral medicine ingredients as shown in its promising anti-*Candida* activity. This study supported the evidence of decoction technique used in extracting *A. chinense* for local community as the most straightforward method in preparing herbal medicine in Indonesia.

Conclusion

The phytochemical composition of aqueous extract of *Allium chinense* from North Sumatra, Indonesia displayed significant compared to the China cultivar. The aqueous extract obtained from the decoction revealed the presence of organosulfurs, saponins, steroids, and triterpenoids. The extract exhibited potential antibacterial activities against Gram positive bacteria and notable antifungal activity against *Candida albicans*. The major constituent of the aqueous extract is furan, furfural, and other minor compounds such as alcohols and organic acids. The presence of the abundant 5-(hydroxymethyl)-2-furancarboxaldehyde and 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one are considered as the major components responsible for its antimicrobial activity specific to its potent anti-*Candida* activity with a MIC value of 62.5 µg/mL. This is the first report in revealing the distinct phytochemicals in the North Sumatran cultivar of *A. chinense* with possible future utilization prospects.

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