PHYTOCHEMICAL PROFILE OF CINNAMON EXTRACT (*Cinnamomum Burmanii Blume*) FROM THREE REGIONS OF SUMATRA ISLAND USING GCMS

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Abstract : This study aims to determine the phytochemical components of different extracts of Cinnamomum burmanii B. from different regions in Indonesia by GC-MS using ethanol, distilled water and isopropyl alcohol as solvents. The analysis showed that the ethanol extract of cinnamon from the Aceh region, which contains five compounds with biological activity and the main compound was 59.77% coumarone. Meanwhile, the distilled water extract contains four compounds with biological activity, and the main chemical compound was 37.01% coumarin. For the extract of isopropyl alcohol, contains four compounds with biological activity and the main compound was coumarin at 41.55%. The ethanol extract of cinnamon from Jambi region contains three compounds with its biological activity and the main compound was coumarin at 28.31%, while the extract using distilled water contains four compounds with biological activity and the main compound was 1-phenyl-4- carboxy-4,5 at 33.50%. Furthermore, for the isopropyl alcohol extract, there are five compounds with biological activity, and the most important chemical compound was 2-propanol at 45.89%. Meanwhile, the ethanol extract of cinnamon from West Sumatra contains six compounds that were identified as biological activity and the main compound was 2-propanol at 14.97%, while the distilled water extract contains four compounds with biological activity and the main compound was 17.49% for 1-phenyl -4-carboxy-4,5. For the extract of isopropyl alcohol, four compounds with biological activity were obtained, and the main compound was 9.96% coumarin. This study confirms the existence of different bioactive compounds and biological activities in each original region of cinnamon in Indonesia.

Keywords: cinnamon, ethanol, distilled water, isopropyl alcohol, GC-MS

Introduction

The latest trend in disease control and treatment is the use of natural substances, such as antioxidants, which are used to control DM and has a role to play in managing oxidative stress. Various studies were conducted on over 1,050 antidiabetic plants to examine the positive benefits against the inhibition of antioxidant stress (Plumeriastuti et al., 2019). The main phytochemical groups with antidiabetic activity are polyphenols, terpenoids, and steroids, glycosides (saponins), alkaloids, and non-starch polysaccharides. Several

polyphenol antioxidants (flavonoids, anthocyanins, xantones, stilbenes, quinines, and tannins), are beneficial for people with diabetes mellitus by reducing lipid peroxidation, protein glycation, and oxidative stress.

One type of plant that contains bioactive components and is useful as a functional food for controlling diabetes mellitus is cinnamon. Indonesia is one of the countries with the largest biodiversity in the world, and cinnamon is a type existing in the country. According to (Sangal, 2011) and (Anggriawan et al., 2015), cinnamon is an Indonesian medicinal plant that has traditionally been used to treat diabetes mellitus due to its ability to control blood sugar (antihyperglycemia). It has a procyanidin compound that act similarly to insulin by increasing glucose uptake (Chen et al., 2014) and (Kumar et al., 2012).

The active substances such as cinnamaldehyde, cinnamate acid, cinnamic acid, and eugenol in *Cinnamomum burmannii* B. have various therapeutic effects. This plant helps in the correction of various aspects of the metabolic syndrome, including hyperglycemia, dyslipidemia, obesity, and high blood pressure. Furthermore, several studies on cinnamon have shown that this plant is a cardiovascular protective agent and has potential effects in reducing metabolic syndrome complications due to its antidiabetic effect, antioxidant, anti-inflammatory, and beneficial in lipid profiles (Al-Dhubiab, 2012) and (Plumeriastuti et al., 2019).

Cinnamon reduces the risk of hyperglycemic and inflammation by slowing the process of gastric emptying, decreasing the activity of the α-glycosidase enzyme, limiting glucose absorption and increasing glycogen synthesis (Kirkham et al., 2009). Furthermore, cinnamon polyphenols also increase the activity of SOD (Super Oxide Dismutase) and GSH-Px (Glutathione Peroxidase) and also reduce malondialdehyde (MDA) in the pancreatic glands of diabetic rats (Liang et al., 2019).

The main mechanism of cinnamon as an antidiabetic is focused on the ability of the water-soluble of this extract that helps the insulin signaling process. It increases the autophosphorylation of insulin receptors and decreases the activity of tyrosine phosphatase (an enzyme that *in vitro* activates insulin receptors). The impact of the aboce two results is an increase in insulin sensitivity (Rafehi et al., 2012). In addition, it has a phenolic component, which act an antioxidant but also helps inhibit the formation of the end product of the glycation process related to its ability in trapping reactive oxygen (ROS) and reactive carbonyl species (RCS) (Kasim et al., 2014).

Generally, GC-MS is used to analyze compounds directly in medicinal plants. In recent years, this study was applied to medicinal plants in analyzing non-polar compounds and volatile essential oils, fatty acids, lipids and alkaloids. The result identified different compounds in the test sample, and it is a good technique for identifying bioactive long-chain hydrocarbons, alcohols, acids, esters, etc. (Sharmila et al., 2017), (Kalsum et al., 2016), and (Balamurugan et al., 2012).

Therefore, this study aims to examine the bioactive compounds reported in several solvent extracts in all parts of the *Cinnamomum burmanii* B. plant using the GC-MS technique.

Materials and Methods

Research Materials

Cinnamon (*Cinnamomum Burmanii* B.) was collected from different provinces of the Sumatra island, such as Aceh, Jambi and West Sumatra. Furthermore, different solvents were also used such as distilled water (aquades), ethanol (Merck) and isoproyl alcohol (Merck).

Cinnamon Extracts

The sampling point of cinnamon were Aceh, Jambi and West Sumatra. The plant's part taken was the bark, and a representative sample was then cut into small pieces, dried, and made into a powder with a particle size of 100 mesh. Extraction of powder sample was carried out by maceration using distilled water, ethanol and isopropyl alcohol solvents with the sonication process using an ultrasonic device (Suryowati et al., 2015). The extraction results were collected and stored in a vial for further analysis.

GC-MS Analysis

A certain number of extracts were analyzed to determine the volatile compounds using Gas Chromatography-Mass Spectroscopy (GC-MS). The GC-MS used was the Shimadzu GCMS-QP 2010 equipped with pyrolysis accessories. As soon as the condition is stable, about ± 1 µg / 1 drop of cinnamon extract is injected into the pyrolycer and the GCMS works automatically, and the determination process takes 50 minutes.

Data Analysis

Currently, research on organic compounds in plants and their activity has increased. The combination of the best separation (GC) and identification (MS) technique makes GC-MS an ideal technique for the qualitative analysis of volatile and semi-volatile bioactive compounds (Kanthal et al., 2014) and (Arts & Nadu, 2013). Furthermore, the determination was carried out based on the name, molecular weight and formula, as well as area below the peak of the components of the test material. The prediction of the biological activity of the compound is based on Dr. Dukes Phytochemical and Ethnobotanical Databases made by Dr. Jim Duke of the Agricultural Research Service/USDA. In addition, the data presented have a similarity index of ≥ 90% according to WILEY and NIST library ver. 3.0.

Results and Discussions

Analysis of the GC-MC chromatogram on the ethanol extract of cinnamon originating from Aceh, Jambi and West Sumatra (Figures 1, 2 and 3) shows peaks indicating the presence of dozens of phytochemicals with different retention times and percentage area. By comparing the mass spectra of the compounds with the library from WILEY and NIST version 3.0, dozens of phytochemicals were characterized and identified based on their retention time (RT), molecular weight (MW), formula and properties concentration (% of peak area).

Seven GC-MS chromatograms of Aceh cinnamon ethanol extract have a similarity index ≥ 90%, and contains different bioactive compounds, which includes 2-Propanamine,1-methoxy- (6.25%), dihydrocarvyl acetate (1.87%), 3-methylbenzofuran (3.13%), cis,cis,trans-3,3,6,6,9,9-hexamethyl-tetracyclo [6.1.0.0(2,4).0(5,7)] nonane (1.55%), 1-phenyl-4-carboxy-4,5 (23.91%), cinnamyl acetate (0.39%) and coumarone (59.77%). Five of these compounds were reported to have biological activity, such as dihydrocarvyl acetate ($C_{12}H_{20}O_2$), 3-methylbenzofuran (C_9H_8O), 1-phenyl-4-carboxy-4,5 ($C_9H_9N_3O_2$), cinnamyl acetate ($C_{11}H_{12}O_2$) and coumarone (C_8H_6O). The results of GC-MS analysis on the ethanol extract of cinnamon from Jambi show five peaks with a similar index of ≥90%. The compunds of carbon dioxide (1.26%), 2-propanamine,1-methoxy- (9.90%), 2-propanol (14.33%), 3-methylbenzofuran (27. 73%) and coumarin (28.31%) have different bioactive compounds. Furthermore, three compounds were reported to have biological activity, such as 3-methylbenzofuran (C_9H_8O), 2-propanol (C_3H_8O) and coumarin ($C_9H_6O_2$). The GC-MS chromatogram analysis on the ethanol extract of cinnamon from West Sumatra resulted to six peaks, including a similarity index of ≥90%. From the six bioactive compounds, the compounds detected were acetaldehyde (2.37%), L-alanine (14.67%), 2-propanol (14.97%), 3-methylbenzofuran (8.83%), 1-phenyl,-4-carboxy-4,5 (10.44%), and cinnamyl acetate (8.12%). Among these compounds, six compounds were reported to have biological activity, which includes acetaldehyde (C_2H_4O), L-alanine ($C_5H_{11}NO_2$), 2-propanol (C_3H_8O), 3-methylbenzofuran (C_9H_8O), 1-phenyl-4-carboxy-4,5 ($C_9H_9N_3O_2$), and cinnamyl acetate ($C_{11}H_{12}O_2$). Phytochemical compounds of cinnamon from three regions in Sumatra that provide biological activity are shown in Table 1.

A total of six GC-MS chromatogram peaks of cinnamon distilled water extract originating from Aceh region had an estimated similarity index of ≥90, which have different bioactive compounds, including carbon dioxide (19.23%), ethylic acid (2.94%), 3-furanone,2,3-dihydro-4-hydroxy (5.68%), 3,5-dihydroxy-2-methyl-5,6- (9.34%), 1-phenyl-4-carboxy-4,5 (17.01%) and coumarin (37.01%). Four compounds have been reported to have biological activity, namely ethylic acid ($C_2H_4O_8$), 3,5-dihydroxy-2-methyl-5,6- ($C_6H_8O_4$), 1-phenyl-4-carboxy-4,5 ($C_9H_9N_3O_2$) and coumarin ($C_9H_6O_2$). The results of GC-MS analysis on

cinnamon distilled water extract from Jambi have six peaks with similarity index of ≥90%. Furthermore, different bioactive compounds includes carbon dioxide (8.04%), glycerose (18.13%), acetyl monoglyceride (3.11%), 1-phenyl-4-carboxy-4,5 (33,50%), coumarin (21.21%), and bis (2-ethylhexyl) phthalate (1.39%). Four compounds are reported to have biological activity, namely acetyl monoglyceride (C5H10O4), 1-phenyl-4-carboxy-4,5 ($C_9H_9N_3O_2$), coumarin ($C_9H_6O_2$), and bis (2-ethylhexyl) phthalate ($C_{24}H_{38}O_4$). GC-MS chromatogram analysis of cinnamon distilled water extract from West Sumatra is known to have five peaks with similarity index of ≥90%. The compounds detected were carbon dioxide (24.99%), ethylic acid (6.39%), itaconic anhydride (7.21%), 1-phenyl-4-carboxy-4,5 (17. 49%), and phthalazinone (12.13%). Among these compounds, four compounds are reported to have biological activity, including ethylic acid ($C_2H_4O_8$), itaconic anhydride ($C_5H_4O_3$), 1-phenyl-4-carboxy-4,5 ($C_9H_9N_3O_2$), and phthalazinone ($C_8H_6N_2O$). Phytochemical compounds of cinnamon from three regions in Sumatra that provide biological activity are shown in Table 2.

A total of six GC-MS chromatogram peaks of cinnamon isopropyl alcohol extract originating from Aceh region had a similarity index ≥90% that contains different bioactive compounds, which includes Bicyclo[2.2.1]heptane,-5-(ethyl-1-amine) (4.33%), 2-Propanol (37.93%), 6,6-dimethyl-2-(3-oxo-butyl)-bicyclo[3.1.1]heptan-3-one (0.29%), Cis,cis,trans-3,3,6,6,9,9-hexamethyl-tetracyclo[6.1.0.0(2,4).0(5,7)]nonane (0.69%), 1-phenyl-4-carboxy-4,5 (15.04%) and coumarin (41.55%). Furthermore, five compounds were reported to have biological activity, such as Bicyclo[2.2.1]heptane,-5-(ethyl-1-amine) ($C_9H_{17}N$), 2-Propanol (C_3H_8O), 6,6-dimethyl-2-(3-oxo-butyl)-bicyclo[3.1.1]heptan-3-one ($C_{13}H_{20}O_2$), Cis,cis,trans-3,3,6,6,9,9-hexamethyl-tetracyclo[6.1.0.0(2,40(5,7)]nonane ($C_{15}H_{24}$), 1-phenyl-4-carboxy-4,5 ($C_9H_9N_3O_2$) and coumarin ($C_9H_6O_2$). The results of GC-MS analysis on the isopropyl alcohol extract of cinnamon from Jambi have six peaks with similarity index of ≥90%. The compounds that have different bioactive compounds are 2-Propanol (45.89%), 3-Methylbenzofuran (14.50%), Cis,cis,trans-3,3,6,6,9,9-hexamethyl-tetracyclo[6.1.0.0(2,4).0(5,7)]nonane (2.64%), trans-Caryophyllene (1.44%), 1-phenyl-4-carboxy-4,5 (4.55%), and Coumarin (23.86%). Among these, five compounds were reported to have biological activity such as 2-Propanol (C_3H_8O), 3-Methylbenzofuran (C_9H_8O), trans-Caryophyllene ($C_{15}H_{24}$), 1-phenyl-4-carboxy-4,5 ($C_9H_9N_3O_2$), and Coumarin ($C_9H_6O_2$). GC-MS chromatogram analysis on the isopropyl alcohol extract of cinnamon from West Sumatra have five peaks withsimilarity index of ≥90%. The bioactive compounds tested were Bicyclo[2.2.1]heptane,-5-(ethyl-1-amine) (3.53%), 1,3-Butylene glycol (68.68%), 3-Methylbenzofuran (2.91%), 1-phenyl-4-carboxy-4.5 (7.69%), and coumarin (9.96%). Among these, four compounds were reported to have biological activity, including Bicyclo[2.2.1]heptane,-5-(ethyl-1-amine) ($C9H_{17}N$), 3-Methylbenzofuran (C_9H_8O), 1-phenyl-4-carboxy-4,5 ($C_9H_9N_3O_2$), and coumarin ($C_9H_6O_2$). Phytochemical compounds of cinnamon from three regions in Sumatra that provide biological activity are shown in Table 3.

According to (Kumar et al., 2012), the main volatile components of cinnamon oil are cinnamaldehyde, trans cinnamyl acetate, Ascabin, Hydro cinnamyl acetate, Beta-caryophyllene. Meanwhile, (Plumeriastuti et al., 2019) that conducted an analysis on cinnamon from Karang Anyar, Padang and Jambi, reported that the potential for cinnamon essential oil are used as an antidiabetic because it contains high cinnamaldehyde. Volatile components are also reported in all parts of this plant and are broadly classified into monoterpenes, sesquiterpenes, and phenylpropene (Sangal, 2011). According to (Liang et al., 2019), proanthocyanidin is a natural compound commonly reported in cinnamon bark, especially in *C. wilsonii* and *C. burmannii*. Coumarin and cinnamyl alcohol are also the main compounds, and (E)-cinnamaldehyde and (Z)-cinnamaldehyde are the most important compounds in ethanol extract. Research by (Fajar et al., 2019), reported that Proanthocyanidin type-A isolated from *Cinnamomum burmannii* may have insulin-like biological activity.

In short, this study provides evidence that *Cinnamomum burmanii* B. contains bioactive compounds from three production centers in Sumatra that are expected to have antihyperglycemic effects.

CONCLUSIONS

This study showed that *Cinnamomum burmanii B.* from three production centers in Sumatra is a reliable source of bioactive compounds such as coumarone, coumarin, 1-phenyl-4-carboxy-4,5, and 2-propanol. This shows a simple, fast and reliable analytical method that makes it possible to distinguish the three different origins of cinnamon production centers from Sumatra island.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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Table 1. The activity components identified in the ethanol extract samples of the cinnamon originating from three regions in Indonesia

No	Component Name	Retention Time	Peak Area (%)	Molecular Formulas	Origin of Cinnamon			Biological Activity*)
					Aceh	Jambi	West Sumatera	
1	2-Propanamine, 1-methoxy-	4.112	6.25	$C_4H_{11}NO$	x	x		No activity reported
2	Dihydrocarvyl acetate	15.876	1.87	$C_{12}H_{20}O_2$	x			Antioxidant, strong α-glucosidase inhibitor, anticancer activity
3	3-Methylbenzofuran	16.390	3.13	C_9H_8O	x	x	x	Antibacterial, antifungal, anti-inflammatory, analgesic, antidepressant, anticonvulsant, antitumor, anti-HIV, antidiabetic, antitubercular, antioxidant activity
4	Cis,cis,trans-3,3,6,6,9,9-hexamethyl-tetracyclo[6.1.0.0(2,4).0(5,7)]nonane	16.749	1.55	$C_{15}H_{24}$	x			No activity reported
5	1-phenyl-4-carboxy-4,5	17.253	23.91	$C_9H_9N_3O_2$	x		x	Antibacterial, antifungal, antitubercular, anticancer, anticonvulsant, analgesic, anti-inflammatory, antiviral,

								antioxidant, antihypertensive, antiparkinsonian activity
6	Cinnamyl acetate	17.542	0.39	$C_{11}H_{12}O_2$	x		x	Antibacterial, antifungal activity
7	Coumarone	17.924	59.77	C_8H_6O	x			Antihelminthic, anti-inflammatory, anti-diarrhea activity
8	Carbon dioxide	3.811	1.26	CO_2		x		No activity reported
9	2-Propanol	4.315	14.33	C_3H_8O		x	x	Antibacterial, antifungal activity
10	Coumarin	18.269	28.31	$C_9H_6O_2$		x		Antimicrobial, antiviral, antidiabetic, anticancer, antioxidant, antiparasitic, antihelmintic, antiproliferative, anticonvulsant, anti-inflammatory, antihypertensive activity
11	Acetaldehyde	3.975	2.37	C_2H_4O			x	Antibacterial activity
12	L-Alanine	4.104	14.67	$C_5H_{11}NO_2$			x	Antioxidant, antimicrobial activity

Table 2. The activity components were identified in samples of cinnamon distilled water extract from three regions in Indonesia

No	Component Name	Retention Time	Peak Area (%)	Molecular Formulas	Origin of Cinnamon			Biological Activity*)
					Aceh	Jambi	West Sumatera	
1.	Carbon dioxide	4.046	19.23	CO_2	**X**	**X**	**X**	No activity reported
2.	Ethylic acid	6.323	2.94	$C_2H_4O_2$	**X**		**X**	Antimicrobial, antioxidant activity
3.	3-furanone, 2,3-dihydro-4-hydroxy	14.455	5.68	$C_6H_8O_3$	**X**			No activity reported
4.	3,5-dihydroxy-2-methyl-5,6-	15.180	9.34	$C_6H_8O_4$	**X**			Antimicrobial, antioxidant activity
5.	1-phenyl-4-carboxy-4,5	17.360	17.01	$C_9H_9N_3O_2$	**X**	**X**	**X**	Antibacterial, antifungal, antitubercular, anticancer, anticonvulsant, analgesic, anti-inflammatory, antiviral, antioxidant, antihypertensive, antiparkinsonian activity
6.	Coumarin	18.112	37.01	$C_9H_6O_2$	**X**	**X**		Antimicrobial, antiviral, antidiabetic, anticancer, antioxidant, antiparasitic, antihelmintic, antiproliferative, anticonvulsant, anti-inflammatory, antihypertensive activity
7.	Glycerose	14.359	18.13	$C_3H_6O_3$		**X**		No activity reported
8.	Acetyl monoglyceride	14.950	3.11	$C_5H_{10}O_4$		**X**		Hypoglycemic activity

9.	Bis(2-ethylhexyl) phthalate	26.168	1.39	$C_{24}H_{38}O_4$	**X**	**X**	Antimicrobial and cytotoxic activity
10.	Itaconic anhydride	12.977	7.21	$C_5H_4O_3$		**X**	Antioxidant, antimicrobial activity
11.	Phthalazinone	18.305	12.13	$C_8H_6N_2O$			Antitumor, PARP-1 inhibitor, antimicrobial, antiviral, antihistamine, antiallergic rhinitis, antifungal, anti-inflammatory, antiproliferative, antidiabetic activity

Table 3. The activity components identified in samples of isopropyl alcohol extract of cinnamon from three regions in Indonesia

No	Component Name	Retention Time	Peak Area (%)	Molecular Formulas	Origin of Cinnamon			Biological Activity*)
					Aceh	Jambi	West Sumatera	
1.	Bicyclo [2.2.1] heptane,-5-(ethyl-1-amine)	3.961	4.33	$C_9H_{17}N$	**X**		**X**	Antifungal activity
2.	2-Propanol	4.322	37.93	C_3H_8O	**X**	**X**		Antibacterial, antifungal activity
3.	6,6-dimethyl-2-(3-oxo-butyl)-bicyclo [3.1.1]heptan-3-one	15.895	0.29	$C_{13}H_{20}O_2$	**X**			Antifungal activity
4.	Cis,cis,trans-3,3,6,6,9,9-hexamethyl-tetracyclo[6.1.0.0(2,4).0(5,7)]nonane	16.759	0.69	$C_{15}H_{24}$	**X**	**X**		No activity reported
5.	1-phenyl-4-carboxy-4,5	17.283	15.04	$C_9H_9N_3O_2$	**X**	**X**	**X**	Antibacterial, antifungal, antitubercular, anticancer, anticonvulsant, analgesic, anti-inflammatory, antiviral, antioxidant, antihypertensive, antiparkinsonian activity
6.	Coumarin	17.954	41.55	$C_9H_6O_2$	**X**	**X**	**X**	Antimicrobial, antiviral, antidiabetic, anticancer, antioxidant, antiparasitic, antihelmint

							ic, antiproliferative, anticonvulsant, anti-inflammatory, antihypertensive activity
7.	3-Methylbenzofuran	16.225	14.50	C_9H_8O	**X**	**X**	Antibacterial, antifungal, anti-inflammatory, analgesic, antidepressant, anticonvulsant, antitumor, anti-HIV, antidiabetic, antitubercular, antioxidant activity
8.	trans-Caryophyllene	17.212	1.44	$C_{15}H_{24}$	**X**		Anti-inflammatory, antibiotic, antioxidant, anticarcinogenic, local anesthetic activity
9.	1,3-Butylene glycol	4.336	68.68	$C_4H_{10}O_2$		**X**	No activity reported