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Antifungal Activities Of Cinnamon Leaf Extracts Against Sigatoka Fungus (*Pseudocercospora Fijiensis*)

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Abstract. Efforts to reduce the negative impacts caused by the use of synthetic fungicides need to be done in implementing environmentally sustainable agriculture. The use of biofungicides should be done. The acetone extract of cinnamon leaves has the potential as a biofungicide. Based on this, a series of experiments were carried out: crude cinnamon extract test against the test fungus, i.e. the fungus causing Sigatoka disease in banana plants, MIC (Minimum Inhibiting Concentration) extract, effectiveness test of extract on colony, biomass, spore formation, and identification of cinnamon leaf extract content based on partition, column chromatography and GS-MS analysis. The rough extract of cinnamon leaves inhibited the growth of the Sigatoka fungi (*P. fijiensis*) in-vitro on PDA media with a diameter of 30 mm which means that this extract has a very strong inhibitory activity, with a MIC value of 0.5% (w/v). Treatment of extracts with concentrations between 0.1 and 0.5% significantly ($P < 0.05$) inhibited the growth of fungal colonies, fungal biomass and fungal spore formation. There were 16 compounds found in the active fraction of cinnamon leaf extracts and 3 dominant compounds that are anti-fungal compounds, namely 1.2-Benzenedicarboxylic acid, mono 2-ethyl (29%), 2H-I-Benzopyran-2-one (CAS) Coumarin (11.9%) and 2,6-Dimethyl-6-nitro-2-hepten-4-one (11.5%).

1. Introduction

One of the diseases that attack banana plant is Sigatoka disease. This disease is very effective to attack the leaves of banana plants. Sigatoka disease is caused by ascomycetes fungi group that is *Pseudocercospora fijiensis* type. This type of pathogen is part of a larger cause of Sigatoka disease comprising *P. fijiensis*, *P. musae* (the cause of jaundice Sigatoka) and *P. eumusae* (the cause of eumusae leaf spot disease) [1,2]. Symptoms of this disease contain spots on the leaves of banana parallel to the leaf veins, round to elongated round spots, yellowish to blackish brown in color. According to Blackish yellowish to dark brown spots consists of sporodokium that produces acrospores and conidia [3].

Disease control in plants using synthetic fungicides can have a negative impact on the environment. Efforts to reduce the negative impacts caused by the use of synthetic fungicides need to be done in implementing environmentally sustainable agriculture. One way to reduce the impact of synthetic fungicide use is the use of biofungicides, i.e. the use of plant extracts that have potent antifungal active compounds [4].

Plant extracts obtained from various parts of plants contain many compounds with antimicrobial properties. These compounds can be obtained from roots, skins, seeds, buds, leaves, flowers and fruit. Several studies have reported that the anti-fungal properties of awar-awar leaf extracts or *Ficus septica* can control the growth of colonies, biomass and the formation of fungal spores *Colletotrichum acutatum* causes anthracnose disease that affects chili plants [5]. The extract of forest chili pepper known in Latin as *Piper caninum* can control the growth of *Pyricularia oryzae* fungus, the cause of Blast disease in rice



plants [6]. The utilization of matoa leaf extracts (*Pometia pinnata*) to control leaf blight disease in potato plants [7].

Cinnamon or known in Latin as *Cinnamomum burmanni* Blume is a plant whose height can reach 50 meters. Cinnamon bark listed in Pharmacopoeia Herb England can be used as a special medicine for disturbed digestion. While the cinnamon bark oil listed Phytomedicine Europe is used in tea for anti-bacterial and killing fungus [8]. Cinnamon has antifungal properties against *Candida albicans* in vitro [9]. The antibacterial activity of essential oil of cinnamon bark is the strongest against *Bacillus subtilis* with minimum inhibitory concentration of 0.62% while the strongest antifungal activity against *Candida albicans* with a minimum inhibitory concentration of 1%. Cinnamon leaf extract can significantly inhibit the growth of fungal colonies, fungal biomass and spore formation of fungi that attack tomato plants in-vitro. At concentrations of 1%, 1.25%, 1.50%, 1.75% and 2% can significantly inhibit the growth of fungal colonies of *Fusarium oxysporum* f.sp. *lycopersici* when compared to control with inhibitory respectively equal to 41.66%, 78.11%, 88.33%, 91.11%, and 100% [10].

Type *Guiera senegalensis* J.F. Gmel in Western African ethno medicine is used to treat diarrhea, dysentery, malaria, cough and other microbial infections. The methanol extract and ethyl acetate roots of *G. senegalensis* are effective against diarrhea and have antibacterial activities. Once analyzed on the basis of GC-MS (Gas Chromatography-Mass Spectroscopy), it was identified to contain n-Hexadecanoic acid (46.6%) as the highest content of the compound followed by other compounds such as 9-Hexadecenoic acid (20.93%), methyl ester (7.75%), 7-Octadecenoic acid- methyl esters, and 1, 2-benzene dicarboxylic acid - diisooctyl ester each (6.97%); 2-pentanone-4-hydroxy-4-methyl acid and diethyl phthalate respectively (2.32%), Decane-6-ethyl-2-methyl and nonane, 3-7-dimethyl respectively (1.55%) [11].

2. Methodology

2.1. Extraction of Cinnamon Leaves

Leaves of Cinnamon (*Cinnamomum burmanni* Blume) used in this study originates from the village Bedugul Baturiti District of Tabanan Bali Province, Indonesia. The cinnamon leaf used is the fourth leaf from the tip to the ninth leaf that has been green in color. The active ingredients of cinnamon leaves were extracted. The extraction was done by slicing small leaves of the plant that had been dried and blended. The blended leaf was then macerated in methanol at a ratio of 1:10 for 48 hours in order to attract the active substance on the material to be used as a vegetable pesticide. The filtrate was obtained by filtration through 4 layers of gauze and Whatman filter paper. No. 2 then evaporated by using vacuum rotary evaporator at 40°C, so the rough extract was then obtained.

The crude extract was weighed, recorded by weight and calibrated by the weight of methanol in the same volume as the leaf crude extract of the plant. Dilution of the extract was done by adding water of Tween-80 10% as emulsifier.

2.2. Anti-fungal Activity Test of Rough Extract of Cinnamon Leaf on PDA Media against Fungal Colony

The test was conducted by testing the anti-fungal activity of roughly cinnamon leaf extract, against the fungus *Sigatoka*. Petri dishes containing 10 ml of PDA (Potato Dextrose Agar) medium and 200 µl of the fungus *Sigatoka* suspension were allowed to solidify. After solid, diffusion wells with a diameter of 0.7 mm were made each of 2 pieces on each Petri dish by using cork borer. Each of the diffusion well was filled with 20 µl of roughly cinnamon leaf extract at 100% concentration. If the diameter of the resistance zone is ≥ 20 mm (very strong inhibitory), 10-20 mm (strong inhibitory power), 5-10 mm (inhibitory power), and <5 mm (inhibitory activity is less or weak) [12].

The testing to know Minimum Inhibitory Concentration (MIC) was also done by diffusion well method with some extract concentration, that is: 0.1%, 0.2%, up to 5% and control 0%.

2.3. Test the Percentage of Inhibitory Activity of Rough Extract of Cinnamon Leaves on PDA Media against Fungal Colony

The percentage of inhibitory activity using Completely Randomized Design with six concentration of extract, namely: 0%, 0.1%, 0.2%, 0.3%, 0.4%, and 0.5%. The concentration was obtained by pouring a concentration of 10% concentration into a Petri dish. For example to obtain a medium with a concentration of 0.5% extract, 10 ml PDA medium added 500 µl of extract 10%. Waiting for a few minutes until the mixture of PDA and extracts became solid then *Sigatoka* fungus that had been cultured on Petri dishes were taken and separated by cork borer diameter 5 mm, then using the fungal isolation needle placed right in the center of the Petri dish. Each concentration of the extract was prepared with four replications. Fungal culture without extracts was prepared as a control. Next it was incubated at room temperature for several days until the fungus on the control fully filled the Petri dish.

Observations were made daily by measuring the diameter of the fungal colony in each treatment. The percentage of inhibitory activity was calculated by comparing the growth of the fungus on the extracted medium with the fungus on the control medium. According to Rai [13], the inhibitory activity is calculated after the fungus on the control fully fills the Petri dish, using the formula:

$$\text{Inhibitory activity (\%)} = \frac{\text{Control Colony Diameter} - \text{Treatment Colony Diameter}}{\text{Control Colony Diameter}} \times 100\%$$

2.4. Mechanism of Inhibition of Rough Extract of Cinnamon Leaves on the Growth of Mold Spores of *Sigatoka*

Spore-formation testing used CRD. Testing was done by inoculating 200 µl of spore suspension on 10 ml of Potato Dextrose Broth (PDB) medium then each added with cinnamon leaf extract so that each contain variation of extract concentration 0,1%, 0,2%, 0,3 %, 0,4%, and 0.5%. Controls are made by adding fungal suspension in PDB media without extract. Each treatment was performed four replications. After incubation for 5 days at room temperature, spore count is calculated with haemasitometer [14]. The inhibitory activity of the extract on the growth of mold fungus spores was calculated by the following formula:

$$\text{Inhibitory activity (\%)} = \frac{\text{number of sporecontrol} - \text{number of spore treatment}}{\text{number of sporecontrol}} \times 100\%$$

2.5. Determining the Inhibitory Activity of Cinnamon Leaf Extracts against Biomass of *Sigatoka* Fungus

The inhibitory activity of cinnamon extracts against fungal biomass was tested using CRD. Testing was done by growing spores on PDB media. The fungal suspension was filtered by Whatman No 2 filter paper, so only the spores that passed the filter and were accommodated in a beaker glass.

One ml of the fungus *Sigatoka* spore suspension and cinnamon leaf extract were inserted into PDB media which had been placed in Erlenmeyer glass. The concentration of each extract given was 0.1%; 0.2%; 0.3%; 0.4%, 0.5% and extract less controls. The final volume of the solution which already contains the suspension of fungal spores *Sigatoka* cinnamon leaf extract and PDB is 100 ml. Each treatment was repeated four times.

Incubation is done for eight days. After eight days, the solution was centrifuged at 5,000 rpm for 3 minutes. The obtained precipitate was dried at 60°C until the constant weight. The biomass was weighed and the weight compared to the weight of the fungal biomass on the control/without treatment. The inhibitory activity of biomass formation was calculated by using the formula:

$$\text{Inhibitory activity (\%)} = \frac{\text{weight of biomass control} - \text{weight of biomass treatment}}{\text{weight of biomass control}} \times 100\%$$

2.6. GC-MS Analysis

The identification of active compounds that have fungicide activity against the *Sigatoka* (*Pseudocercospora fijiensis*) fungicidal disease-causing bacteria in banana plants was made using GC-MS. The most active and pure fraction snippets were analyzed by GC-MS. By applying the molecular

weight and fragment pattern of the compound isolated to the compound in the Library (WILEY or NIST) in the GC-MS system, the isolated compound can be identified by the name of the compound, the formula and the molecular weight. The GC-MS test was conducted at the Joint Laboratory of the Faculty of Mathematics and Natural Sciences Udayana University, Jl. Bukit Jimbaran Campus, Badung-Bali-Indonesia. The GC-MS tool used is GCMS-QP2010 Ultra SHIMADZU. The column temperature was programmed between 1000C and 2500C at a level of 1.16 mL / min. Temperature in injector and detector was respectively 2500C and 2200C.

3. Results and Discussions

3.1. Minimum Resistance Concentration of Cinnamon Leaf Extracts

The rough extract of cinnamon leaves can inhibit the growth of the Sigatoka fungus (*Pseudocercospora fijiensis*) in-vitro on PDA media by forming a resistance zone with a diameter of 30 mm (Figure 1). The rough extract of cinnamon leaves has a very strong inhibitory effect on the growth of Sigatoka fungus in vitro by 30mm. According to Ardiansyah [12], if the diameter of the resistance zone is ≥ 20 mm (this relates to very strong inhibitory activity), 10-20 mm (strong inhibitory activity), 5-10 mm (medium inhibitory activity), and <5 mm (inhibitory activity is less or weak). MIC of cinnamon leaf extract to the growth of *F. fijiensis* fungus on PDA media is 0.5% (w/v). The smaller the MIC value of a substance or extract the higher the activity of the fungicide is or vice versa [15]. Research on minimum inhibitory concentration by plant extracts has been done by some researchers such as Rathod et al. [16] who point out that water extract and acetone extracts of 2 types of plants that are anti-fungal against the fungus *Aspergillus niger*. MIC of aloe plant extract (Aloe vera) against *A. niger* is 50 μ L and MIC of Peepal plant bark extract is 70 μ L. Zakaria et al. [17] examines MIC of some Malaysian herbs against test bacteria i.e. *Staphylococcus aureus* ATCC 25923 (Gram positive) and *Escherichia coli* ATCC 25922 (Gram negative). The plant water extract has MIC resistance to each test bacteria namely *Tinospora crispa* and *Anacardium occidentale* 227.27 mg / mL, *Hibiscus cannabinus* of 113.64 mg / ml, and *Garcinia atroviridis* plant of 56.82 mg / ml.

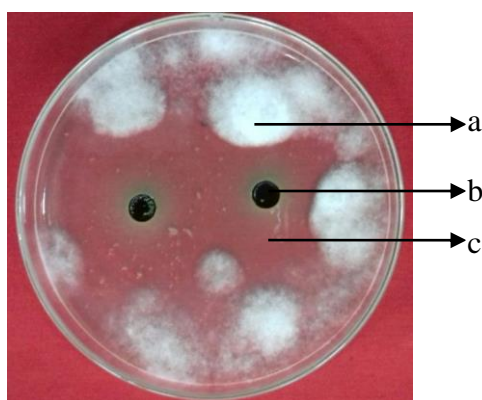


Fig. 1: Photographic inhibition of cinnamon leaf extract against Sigatoka (*Pseudocercospora fijiensis*)

3.2. Resistance Extracts to the Growth of Fungal Colonies

Growth of fungal colonies *Pseudocercospora fijiensis* on untreated PDA media (control) and 0.1% concentration had begun to appear on day 1 after inoculation. The growth of fungal colony with treatment of extract with 0.2% concentration, was only seen on day 3 and treatment with 0.3% concentration was only seen on day 5 (Figure 2).

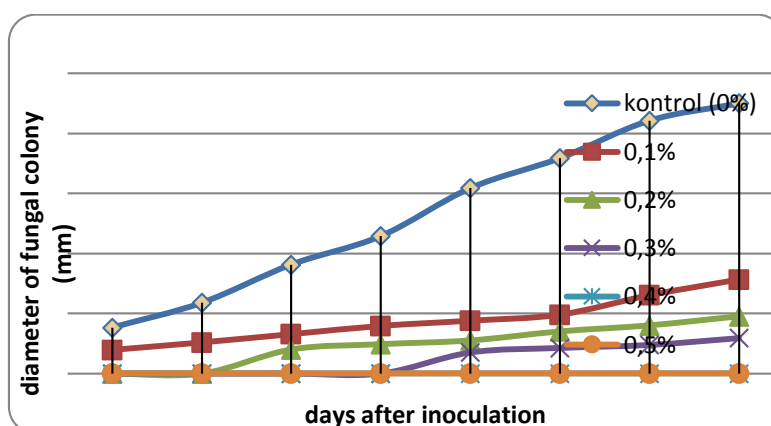


Fig. 2: Graph of effect of cinnamon leaf extract treatment on the growth of fungal colonies of *P. fijiensis* in PDA media

Cinnamon leaf extracts effectively inhibited the growth of fungal colonies in vitro on PDA media. Treatment of cinnamon leaf extract significantly ($P < 0.05\%$) inhibited the growth of the fungal colonies of *P. fijiensis* (Table 1 and Figure 3). Treatment with a concentration of 0.1% (w / v) could inhibit the growth of fungal colonies by 65.28%, whereas in treatment with 0.4% no fungal colony growth occurred. The treatment of 0.1 to 0.3% concentration of cinnamon leaf extract is fungistatic and the concentration of 0.4% cinnamon leaf extract serves as a fungicide. Damage caused by antifungal compounds contained in plant extracts can inhibit the growth of fungal colonies (fungi static) and can kill fungi (fungicide) (Table 1). An antimicrobial can be fungi static or fungicidal. Fungi static is a condition that describes the work of a material or a compound that inhibits the growth of fungi. This can happen because the antimicrobial concentration is too low while the fungicide is a condition that describes the work of a substance or compound that stops the growth or kills the fungus. Fungi static can be converted into fungicides by raising the concentration of an antimicrobial to a critical point, where the fungus can be killed by a fungicide. On the contrary, decreasing the effect of fungicide to fungi static level is obtained by reducing the concentration of fungicide given [18]. Research on the inhibitory effect of plant extracts on fungal colonies is also reported by Ghani [19] who claims that the extract of methanol leaf *Juniperus procera* plant can inhibit the growth of *Aspergillus flavus* and *Fusarium oxysporum* fungal colonies. The concentrations of 150 mg / mL and 200 mg / mL can inhibit the growth of both test fungi with the percentage of inhibitory activity of 16.55%, 48.54% and 48.64%, 59.86% respectively. Perelo et al. [20] also report that garlic bulb extracts could inhibit the growth of the *Bipolaris sorociniana* fungus colony. The concentration of garlic bulb extract 13.3 μ g; 26.5 μ g; 53.0 μ g gives inhibitory against the growth of testicular colony of 57.74%; 59.12%, and 63.10%.

Table 1: Inhibitory activity of cinnamon leaf extracts against growth of *Sigatoka* fungus colony (*Pseudocercospora fijiensis*) 8 days after inoculation, abbreviation: DC= Diameter of fungal colony, IA = Inhibitory Activity

Treatment (%)	DC (mm)	IA (%)
0	90a*	-
0.1	31.25b	65.28
0.2	19c	78
0.3	11.75d	86.94
0.4	0e	100
0.5	0e	100

*The numbers followed by the same letters show no significant difference based on Duncan's Multiple Range Test at the level of 5%

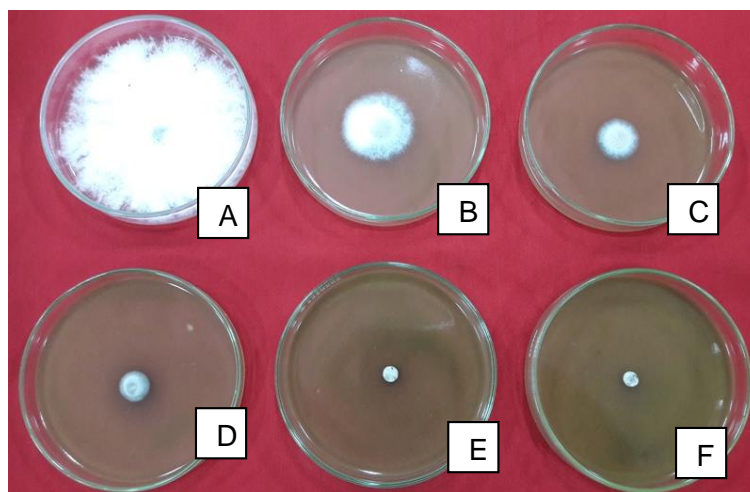


Fig. 3: Photo of *Pseudocercospora fijiensis* colonies on PDA media without and with treatment of cinnamon leaf extract at several concentrations. a. control (0%), b. 0.1%, c. 0.2%, d. 0.3%, e. 0.4%, f. 0.5%

3.3. Extract Resistance to Spore Formation

Treatment of cinnamon leaf extract effectively inhibits the growth of fungal spores *P. fijiensis*. All tested extract concentrations (0.1% - 0.5%) significantly ($P < 0.05$) inhibited the formation of fungal spores. Treatment at 0.1% concentration can inhibit spore formation of 52.63%, while treatment with 0.4% concentration can kill fungi or with 100% inhibitory activity (Table 2). Extract of cinnamon leaf acetone can inhibit spore formation (Tables 2). This is because the cinnamon leaf extract contains phytochemical compounds that serve as anti-fungal compounds. Cinnamon leaf acetone extract contains anti-fungal phytochemical compounds: steroids, flavonoids, phenolates, and tannins. Anti-fungal compounds can inhibit the formation of fungal spores *Fusarium oxysporum* f.sp. *lycopersici*. The fungus causes wilt disease in tomato plants found in Bali [10]. There are some plants that can inhibit the germination of conidia (spores) of the *Fusarium* fungus. Some plants from the *Brassicaceae* family contain glucosinolate compounds that serve as antifungal compounds. Alixin compounds are widely found in plants of *Alliaceae* family are also anti-fungal. The effectiveness of the antioxidant terpenoid compounds found in plants from the *asteraceae* family may result in damage to the mycelia structure and morphology of the hype fungus. *Lythraceae* family plants contain several phenolic compounds such as punicalagin can inhibit the growth of mycelia fungus [21]. *Acacia albida* leaf methanol extract, *Dovalis abyssinica* and *Prosopis juliflora* are very effective as antifungal compounds in the fungus *Colletotrichum musae* causes anthracnose disease in bananas. All three of these extracts can decrease germination of spores (conidia) from the fungi each up to 0.3, 0.2, and 0.5%. When compared with the synthetic fungicide Carbendazim which can decrease germination of testicular spores by 1.2% which is not statistically different significantly [22]. The most compound components present in cinnamon leaf extract is cinnamaldehyd which serves as an antifungal compound. Cinnamaldehyd compounds can inhibit the biosynthesis of fungal cell walls, cell membrane function and enzyme activity [23]. The essential oil of leaf and bark of *Cinnamomum zeylanicum* has the strongest resistance to all test fungi with a MIC value of 0.04 to 0.63 $\mu\text{g } \mu\text{L}^{-1}$. Essential oils from other plants that provide strong inhibitory activity are essential oils of *C. cordatum* leaf, bark essential oil and twigs of *C. pubescens* and *C. impressicostatum* inhibit the growth of test fungi i.e. dermatophytes (*Trichophyton rubrum*, *T. mentagrophytes*, *T. tonsurans*, *Microsporum canis*, *M. gypseum*, and *M. audouini*), a filamentous fungus (*Aspergillus fumigatus*), and five yeast fungi (*Candida albicans*, *C. glabrata*, *C. tropicalis*, *C. parapsilosis*, and *Cryptococcus neoformans*). The content of cinemaldehyde is the most abundant component in the *C. zeylanicum* plant which has the property of an antifungal compound [24].

Table 2. Inhibitory of cinnamon leaf extract to spore formation of *Sigatoka* fungus (*P. fijiensis*), abbreviation: NS= Number of spores, IA= Inhibitory Activity

Treatment (%)	N S ($\times 10^4 \text{mL}^{-1}$)	IA (%)
0	9.5a*	-
0.1	4.5b	52.63
0.2	3c	68.42
0.3	1d	89.47
0.4	0e	100
0.5	0f	100

* The numbers followed by the same letters show no significant difference based on Duncan Multiple range test at the level of 5%

3.4. Extracts Resistance to Fungal Biomass Growth

Treatment of cinnamon leaf extract at concentrations of 0.1-0.5% significantly ($P < 0.05$) inhibited the growth of fungal biomass on PDB media. Treatment with a concentration of 0.1% can inhibit the growth of fungal biomass by 17.97%, while at concentration 0.5% produce inhibitory equal to 68.36% (Table 3). Research on the inhibitory effect of plant extract on the growth of biomass of plant pathogenic fungi has been reported by some researchers such as El-Mohamedy and Abdallah [25] who claim that *Moringa oleifera* seed extract can reduce the dry weight of some plant pathogenic fungi. 20 % and 25% concentration treatments can decrease the biomass of test fungi i.e. *Fusarium oxysporum*, *Fusarium solani*, *Alternaria solani*, *Alternaria alternate*, *Rhizoctonia solani*, *Sclerotium rolfsii* and *Macrophomina phaseolina* up to 100%. According to Mohana and Raveesha [26], the extract of *Caesalpinia coriaria*, *Decalepis hamiltonii*, *Euphorbia tirucalli* and *Leucas aspera* can inhibit *Fusarium solani* biomass of 9.0%, 55.3%, 12.6% and 3.0% respectively.

Table 3: Inhibitory of cinnamon leaf extract to growth of fungal biomass of *Sigatoka* fungus (*Pseudocercospora fijiensis*), abbreviation: DW= Dry weight of fungal biomass, IA= Inhibitory Activity

Treatment (%)	DW(mg)	IA (%)
0	640a*	-
0.1	525b	17.97
0.2	487.5c	23.83
0.3	437.5d	31.64
0.4	312.5e	51.17
0.5	202.5f	68.36

*The number followed by the same letter indicates insignificant difference based on Duncan's Multiple Range Test at the level of 5%

3.5. Result of Identification of Active Compound with Gas Chromatography-Mass Spectroscopy (GC-MS)

The chromatographic column results in the greatest obstacle to the bioassay test and then the components of the compounds contained therein were analyzed by using GC-MS (QP 2010 Ultra SHIMADZU). The gas chromatogram of the fraction analysis showed 20 peaks. Each peak was further identified by mass spectroscopy, in which each compound had a specific pattern of mass fragmentation (Fig. 4 and Table 4). The GC-MS analysis results show that the dominant compound that comprises cinnamon acetone extract obtained in Bedugul Tabanan Bali Regency is 1.2-Benzenedicarboxylic acid, mono 2-ethyl (29%), 2H-1-Benzopyran-2-one (CAS) Coumarin (11.9%), and 2.6-Dimethyl-6-nitro-2-hepten-4-one (11.5%). According to Akpuaka et al., [27], the mono (2-ethyl exhyl pthalate) compound, also known as the 1.2-Benzenedicarboxylic acid compound found in *Azadirachta indica* A. Juss (Neem) is an antifungal compound. Compounds of 1.2-Benzenedicarboxylic acid, mono (2-ethylexyl ester) isolated from *Streptomyces* sp. VITSJK8 shows cytotoxic activity against cancer cells HepG2 and MCF-7 [28]. The coumarin derivative of 7-Hydroxy-6-nitro-2H-1-benzopyran-2-one is an antifungal compound. This

compound can inhibit the growth of mycelia and germination of conidia *Aspergillus* spp fungus. This compound can damage the cell wall structure of the test fungus [29]. the compound 2,6-Dimethyl-6-nitro-2-hepten-4-one is also present in the *Cenchrus ciliaris* plant. This compound is bioactive and has drug content. According to Dhawale and Ghyare [30], the acetone extract of *Blepharis repen* seed also contains the compound 2,6-Diethyl-6-nitro-2-heptene-4-one. These compounds may be antimicrobial [31].

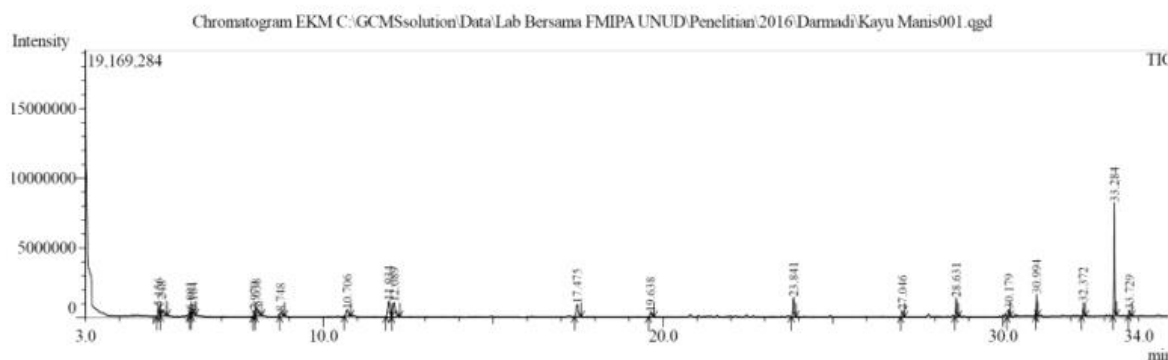


Fig.4. Chromatogram of GC-MS analysis

Table 4: Compounds of each peak on chromatogram active fraction antifungal cinnamon leaf

ID #	Compound	RT (min)	PA (%)	MF	MW
1	2,6-Dimethyl-6-nitro-2-hepten -4-one	5.156	699691	C ₉ H ₁₅ NO ₃	185
2	2,6-Dimethyl-6-nitro-2-hepten -4-one	5.249	1369408	C ₉ H ₁₅ NO ₃	185
3	Guanidine, monothiocyanate	6.091	225905	C ₂ H ₄ N ₄ S	116
4	2,4-Pentanediol, 2-methyl-(CAS)2-Methyl-2	6.161	274629	C ₆ H ₁₄ O ₂	118
5	2-Propenal, 3-phenyl-	7.978	244541	C ₉ H ₈ O	132
6	2-Propenal, 3-phenyl-	8.037	996450	C ₉ H ₈ O	132
7	2-Propen-1-ol, 3-phenyl-(CAS) Cinnamyl	8.747	247154	C ₉ H ₁₀ O	134
8	1-Tetradecene	10.708	246503	C ₁₄ H ₂₈	196
9	2H-1-Benzopyran-2-one (CAS) Coumarin	11.934	1405717	C ₉ H ₆ O ₂	146
10	2-Propen-1-ol, 3-phenyl-, acetate	12.091	819863	C ₁₁ H ₁₂ O ₂	176
11	1-Hexadecene (CAS) Cetene	17.477	347334	C ₁₆ H ₃₂	224
12	5-Methyl-3-phenylcyclopent-2-en-1-one	19.637	174909	C ₁₂ H ₁₂ O	172
13	1-Nonadecene	23.841	332848	C ₁₉ H ₃₈	266
14	Hexadecanoic acid, methyl ester	27.045	245458	C ₁₇ H ₃₄ O ₂	270
15	1-Nonadecene	28.631	262511	C ₁₉ H ₃₈	266
16	Phytol isomer	30.179	129999	C ₂₀ H ₄₀ O	296
17	n-Tetracosanol-1	30.994	189795	C ₂₄ H ₅₀ O	354
18	1-Heptacosanol	32.372	134649	C ₂₇ H ₅₆ O	396
19	1,2-Benzenedicarboxylic acid, mono(2-ethyl	33.284	3439668	C ₁₆ H ₂₂ O ₄	278
20	1-Heptacosanol	33.728	74499	C ₂₇ H ₅₆ O	396

RT= Retention Time, PA=Peak area, MF=Molecular Formula, MW=Molecular Weight

4. Conclusion

Based on the results and discussion, it can be concluded that cinnamon leaf acetone extract can inhibit the growth of the fungus *Sigatoka* caused by *Pseudocercospora fijiensis* fungus that cause disease in banana plants with inhibitory activity 30 mm, with MIC value of 0.5%. Treatment of cinnamon leaf extract at concentrations of 0.1% - 0.5% can significantly inhibit colony growth, spore formation, and growth of testicular biomass. The 0.1% concentration can inhibit the growth of fungal colony with inhibitory activity 65.28%. The concentration 0.4% can inhibit the growth of fungal colony with inhibitory activity 100%. The cinnamon leaf extract consists of 16 compounds which are dominated by

3 compounds namely 1,2-Benzenedicarboxylic acid, mono (2-ethyl (29%), 2H-I-Benzopyran-2-one (CAS) Coumarin (11.9%) and 2, 6- dimethyl-6-nitro-2-hepten-4-one (11.5%) of an antifungal nature.

Reference

- [1] Marin D.H., R.A. Romero, M. Guzman and T.B. Sutton, 2003. Black sigatoka: an increasing threat to banana cultivation. *Plant Dis.*, 87: 208–222
- [2] Bellaire L de L, E. Fouré, C. Abadie and J. Carlier, 2010. Black leaf streak disease is challenging the banana industry. *Fruits*. 65: 327–342.
- [3] Henderson, J., J. A. Pattemore, S. C. Porchun, H. L. Hayden, S. Van Brunschot, K. R. E. Grice, R. A. Peterson, S. R. Thomas-Hall and E. A. B. Aitken, 2005. Black Sigatoka disease: new technologies to strengthen eradication strategies in Australia. *Australasian Plant Pathology*, 2: 181-193
- [4] Kagale S., T. Marimuthu, B. Thayumanavan, R. Nandakumar, and R. Samiyappan, (2004). Antimicrobial activity and induction of systemic resistance in rice by leaf extract of *Datura metel* against *Rhizoctonia solani* and *Xanthomonas oryzae* pv. *oryzae*. *Physiological and Molecular Plant Pathology*, 65: 91–100
- [5] Sudirga, S.K., D.N. Suprpta, I M. Sudana and G.N.A.S. Wirya, 2014. Antifungal activity of leaf extracts of *Ficus septica* against *Colletotrichum acutatum* the cause of anthracnose disease on chili pepper. *Journal of Biology Agriculture and Healthcare*, 28: 47-52
- [6] Suriani, N.L., D.N. Suprpta, I M. Sudana and I G.R.M. Temaja, 2015. Antifungal activity of *Piper caninum* against *Pyricularia oryzae* Cav. the cause of rice blast disease on rice. *Journal of Biology, Agriculture and Healthcare*, 8: 72-78
- [7] Suprpta, D.N., I G.A.N.A. Swari, N. Arya and K. Ohsawa, 2002. *Pometia pinnata* leaves extract to control light blight disease in potato. *Journal of ISSAAS*, 8: 31-36
- [8] Dao, K.N., T. Hop and J.S. Siemonsma, 1999. *Cinnamomum schaefferi*. In: *Prosea (Plant Resources Of South-East Asia) No 13. Spices*. de Guzman, C.C. and J.S. Siemonsma (Eds.). Backhuys Publishers, Leiden, the Netherlands.
- [9] Rachma, L.N, 2012. Antifungal activity *Cinnamomum burmanni* against *Candida albicans* in vitro. *El-Hayah*, 1: 29-34 (in Indonesian language)
- [10] Darmadi, A.A.K., D.N. Suprpta, I G.R.M. Temaja and I M.D. Swantara, 2015. Leaf extract of *Cinnamomum burmanni* Blume effectively suppress the growth of *Fusarium oxysporum* f.sp. *lycopersici* the cause of fusarium wilt disease on tomato. *Journal of Biology Agriculture and healthcare*, 4: 131-137
- [11] Shettima, A.Y., Y. Karumi, O.A. Sodipo, H. Usman and M.A. Tijjani, 2013. Gas Chromatography–Mass Spectrometry (GC-MS) analysis of bioactive components of ethyl acetate root extract of *Guiera senegalensis* J.F. Gmel. *Journal of Applied Pharmaceutical Science*, 3: 146-150
- [12] Ardiansyah, 2005. Daun beluntas sebagai bahan anti bakteri dan anti oksidan.[Cited on 27 October 2007]. Available from: http://www.berita_iptek.com
- [13] Rai, I G.A, 2006. Fungicide activity saba leaf extract (*Piper majusculum* Blume) against *Fusarium oxysporum* f.sp. *vanilla* causes of stem rot disease in vanilla (tesis). Udayana University, Denpasar, Bali, Indonesia (in Indonesian language).
- [14] Subrata, I.M. 2006. Fungicide Activity of Betle Leaf Extract (*Piper betle* L) cultivar “Beleng” against *Fusarium* spp (Thesis). Udayana University. Bali, Indonesia. (in Indonesian language).
- [15] Suprpta, D.N., 2014. Biopetecides, potential and development prospects. Pelawa Sari, Denpasar, Bali, Indonesia (In Indonesian language).
- [16] Rathod, M.C., V.J. Godhani and D.A. Dhale, 2015. Antifungal activity of some medicinal plant material extracts against fungus *Aspergillus niger*. *World Journal of Pharmacy and Pharmaceutical Sciences*, 10: 1323-1332
- [17] Zakaria , Z.A., M. L. Zakaria , Z. Amom and M. N. M. Desa . 2011. Antimicrobial activity of the aqueous extract of selected Malaysian herbs *African Journal of Microbiology Research* Vol. 5(30), pp. 5379-5383; DOI: 10.5897/AJMR11.874

- [18] Banihashemi, Z. and C. Abivardi, 2011. Evaluation of fungicidal and fungi static activity of plant essential oils towards plant pathogenic and saprophytic fungi, *Phytopathol. Mediterr.*, 50: 245-256
- [19] Ghany, T.M.A., 2014. Eco-friendly and safe role of *Juniperus procera* in controlling of fungal growth and secondary metabolites. *J. Plant Pathol. Microbiol.*, 3:1-9.
- [20] Perello, A., U. Noll and A.J. Slusarenko, 2013. In vitro efficacy of garlic extract to control fungal pathogens of wheat. *J. Med. Plants Res.*, 24:1809-1817.
- [21] Rongai, D., F. Milano and E.Scio, 2012. Inhibitory effect of plant extracts on conidial germination of the phytopathogenic fungus *Fusarium oxysporum*. *American Journal of Plant Sciences*, 3: 1693-1698
- [22] Bazie, S., A. Ayalew and K. Woldetsadik, 2014. Antifungal activity of some plant extracts against (*Colletotrichum Musae*) the cause of postharvest banana anthracnose. *J Plant Pathol Microb*, 2: 1-4.
- [23] Shreaz, S., W.A. Wani, J.M. Behbehani, V. Raja, M. Irshad, M. Karched, I. Ali, W.A. Siddiqi and L.T. Hun, 2016. Cinnamaldehyde and its derivatives, a novel class of antifungal agents. *Fitoterapia*, 112: 116-131
- [24] Jantan, I.B., B.A.K. Moharam, J. Santhanam and J.A. Jamal, (2008) Correlation between chemical composition and antifungal activity of the essential oils of eight *Cinnamomum*. *Species, Pharmaceutical Biology*, 6: 406-412
- [25] El-Mohamedy, R.S.R. and A.M. Abdallah, 2014. Antifungal activity of *Moringa oleifera* oil and seed extract against some plant pathogenic fungi. *Middle East Journal of Agriculture Research*, 2: 242-249
- [26] Mohana, D.C. and K.A. Raveesha, 2007. Anti-fungal evaluation of some plant extracts against some plant pathogenic field and storage fungi. *Journal of Agricultural Technology*, 1: 119-137
- [27] Akpuaka, A., M.M. Ekwewchi, D.A. Dashak and A. Dildar, 2012. Gas Chromatography-Mass Spectrometry (GC/MS) analysis of phthalate isolates in n-hexane extract of *Azadirachta indica* A. Juss (Neem) leaves. *Journal of American Science*, 12: 146-155.
- [28] Krishnan K, Mani A, Jasmine S. 2014. Cytotoxic Activity of Bioactive Compound 1, 2- Benzene Dicarboxylic Acid, Mono 2- Ethylhexyl Ester Extracted from a Marine Derived *Streptomyces* sp. VI2TSJK8. *Int J Mol Cell Med*. 2014 Fall;3(4):246-54.
- [29] Guerra, F.Q.S., R.S.A. de Araújo, J.P. de Sousa, F. de Oliveira Pereira, F.J.B. Mendonça-Junior, J.M. Barbosa-Filho and E. de Oliveira Lima, 2015. Evaluation of antifungal activity and mode of action of new coumarin derivative, 7-Hydroxy-6-nitro-2H-1-benzopyran-2-one, against *Aspergillus* spp. *Evidence-Based Complementary and Alternative Medicine*, 1-8
- [30] Dhawale, P. G. and B. P. Ghyare, 2016. Determination of phytoconstituents of *Blepharis Repens* (Vahl.) Roth. leaves and fruit through GC-MS. *World Journal of Pharmaceutical Research*, 3: 883-889
- [31] Singariya, P., K.K. Mourya and P. Kumar, 2015. Gas Chromatography-Mass Spectrometric analysis of acetone extract of *Cenchrus ciliaris* (Dhaman Grass). *I.J.S.N.*, 4: 652-661

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