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SURAT TUGAS

Nomor : 63 /LPPM-UMJ/V/2022

Assalamualaikum wr. wb.

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2. Anwar Ilmar Ramadhan, ST, MT, dosen Fakultas Teknik UMJ

berperan aktif sebagai penulis artikel berjudul "The effect of varous essential oil and solvent additives on the botanical pesticide of *Piper aduncum* essential oil on formulation antifungi activity" dalam jurnal Results in Engineering..

Demikian Surat Tugas ini dibuat untuk dilaksanakan sebagaimana mestinya.

Wabillahittaufiq walhidayah,
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Jakarta, 26 Mei 2022
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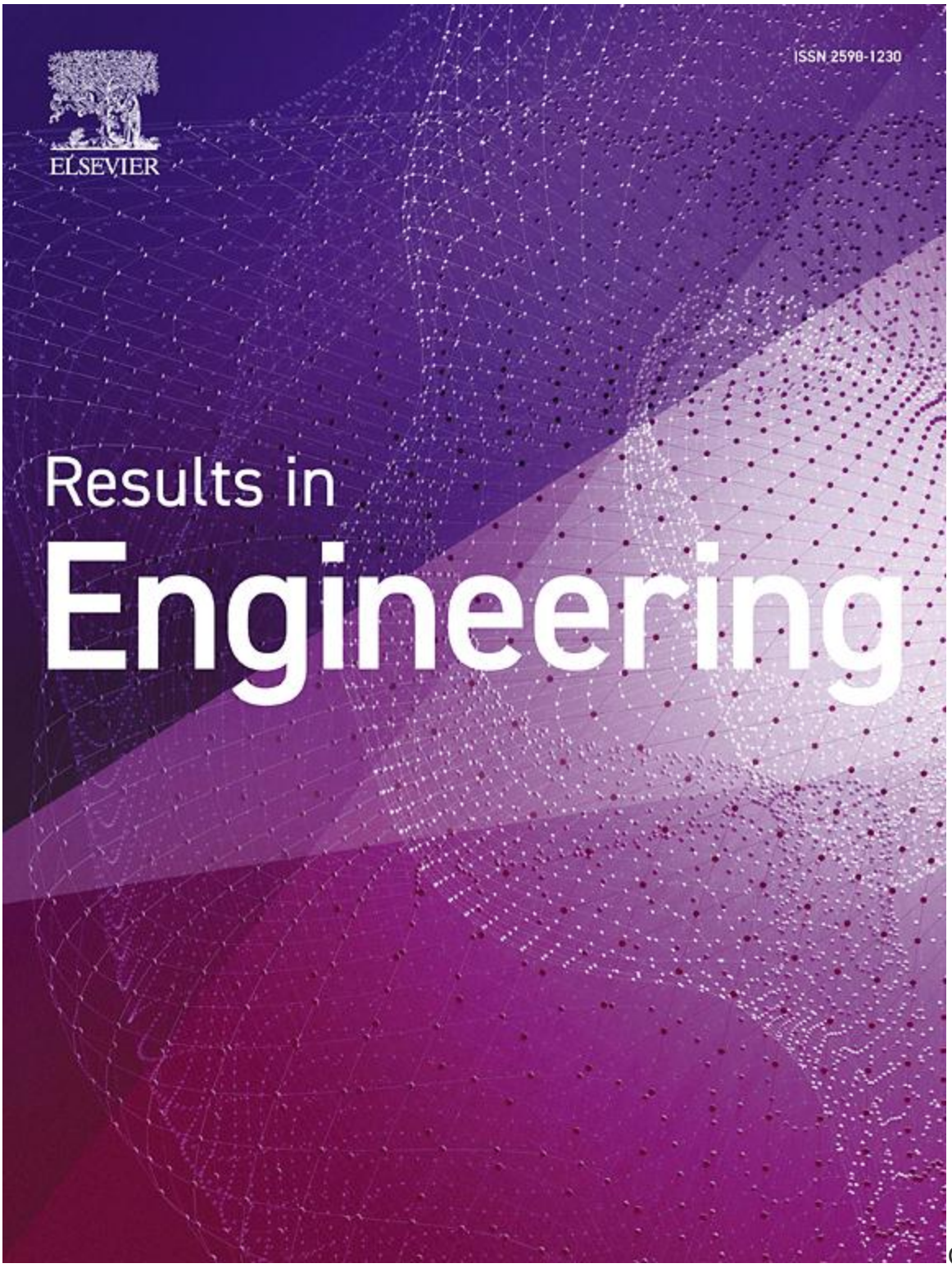

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The effect of various essential oil and solvent additives on the botanical pesticide of *Piper Aduncum* essential oil on formulation antifungal activity

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ABSTRACT

This study aims to obtain a formulation of the botanical pesticide *P aduncum* with additives and the right type of solvent. The research was arranged in a completely randomized design in factorial, the first factor being essential oil additives; citronellagrass oils (*Andropogon nardus*), lemongrass oils (*Cimbopogon flexiosus*), Ceylon cinnamon leaf oils (*Cinnamomum zeylanicum*), Padang cinnamon leaf oils (*Cinnamomum burmanii*), clove leaf oils (*Eugenia aromatica*) and wild ginger leaf oils (*Elettariopsis slahmong*), both types of solvent (ethanol, methanol and turpentine). The experiment was carried out at the Laing Solok IPPTP parasitology laboratory. The results showed that all additive materials had a positive effect in increasing the antifungal activity of the botanical pesticide *P aduncum* essential oil with different effectiveness against the test fungi. Citronella oil showed the highest antifungal effectiveness compared to other additives, especially against *S. rolfsii* and *Pestalotia* sp, with diameter and biomass inhibition of fungal colonies tested *S rolfsii* 92.15% and 92.70%, *Pestalotia* sp 84.82% and 86,34% and *F. oxysporum* 43.87 and 47.17%. All solvents can be used for the formulation of the botanical pesticide *P aduncum*, ethanol solvent is better than methanol and turpentine with the highest inhibition capacity of the diameter and biomass of the fungus colonies tested *S rolfsii* 91.28% and 92.05%, *Pestalotia* sp 83.56% and 86.02% and for *F. oxysporum* 40.31 and 48.36%, respectively.

1. Introduction

Piper aduncum, also known as sirih sirihan, forest betel, monkey piper, bamboo piper and others, is a wild plant from the Piperaceae family in the form of a shrub with a height ranging from 3 to 7 m. This plant is usually considered a nuisance plant that can grow at various elevations ranging from lowlands to highlands, on fertile soils to the most critical soils and can even thrive on rocky hills [1].

Although *P. aduncum* has been considered only as a nuisance plant, it turns out that this plant has many benefits after exploring its potential because it produces bioactive substances including phenylpropanoids, lignoids and flavonoids. Phenylpropanoid compounds are pesticides, especially dimethoxy-4,5-methylenedioxy-allylbenzene compounds or known as dillapiole [2]. The main components of *P. aduncum* oil research results in Havana Cuba [3] are piperiton 23.7%, camphor 17.1% and viridiffloral 14.5%. Furthermore, he said that there were many variations in the composition of *P. aduncum* essential oil including dillapiole chemotype, 1,8 Cineol chemotype, €-neurolidol chemotype, Linalool chemotype, -caryophyllene chemotype, €-β-ocimene chemotype, camphor chemotype, piperitone/terpinene, and the asaricin chemotype.

With the increasing price of pesticide materials today, while the community's need for it is increasing, it is necessary to conduct a bioprospect study for raw materials for botanical pesticides. Meanwhile, *P. aduncum* grows wild, cosmopolitan, grows quite fast and dominates degraded forest areas and abandoned lands that have the potential as natural plant resources. In the long term, the development and utilization of germplasm through molecular harvesting technology for bioactive substances (molecular harvesting). *P.aduncum* has the potential as one of the economic resources in areas that have depended on forests for their livelihoods [4].

Extracts and essential oils from the *P aduncum* plant have antifungal activity and have potential if developed as a source of raw material for botanical pesticides, to control the pathogenic fungus *Colletotrichum*

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musae that causes post-harvest banana fruit rot disease [5]. *Sclerotium rolfsii* causes stem rot disease in peanut plants [6,7], *Phytophthora palmivora* [8]. In addition, botanical pesticides *P. aduncum* are also insecticidal against *Cerotoma tingomarianus* with LC50 0.06 ml/cm2 and LD50 0.002 ml/mg insects [9], *Periplaneta americana* [11], *Crocidolomia pavonana* in cabbage [12,13] and *Helopeltis antonii* on cocoa plants [14,15]. *P aduncum* oil was able to inhibit the hatchability of the nematode *Haemanchus contortus* and kill *Aedes agypti* larvae at concentrations of 500 and 1000 ppm after 24 h the larval mortality rate reached 100% [16,17], *P aduncum* oil is also effective against the golden snail *Pomacea canaculiculata* [18,19].

Purpose this study is to increase the effectiveness of the botanical pesticide *P. aduncum*, it is necessary to add appropriate additives and use the right type of solvent, in order to obtain an effective formula from the botanical pesticide *P. aduncum*.

2. Methods

The research was carried out in the Postharvest and Parasitology Laboratory of Indonesian Spices and Medicinal Crops Research Institute Assessment Installation of Agricultural Technology Laing, Solok, West Sumatra, from January 2020 to December 2020. With the following work steps:

2.1. Essential oil distillation

Essential oil of bamboo piper leaf (*P. aduncum*), citronellagrass (*Andropogon nardus*), lemongrasss (*Cymbopogon flexuosus*), Seilon cinnamon leaf (*Cinnamomum zeylanicum*), Padang cinnamon leaf (*Cinnamomum burmanii*), clove leaf (*Eugenia aromatica*), and ginger leaf wild, (*Elettariopsis slahmong*). The material was distilled in the Laing Solok IPPTP Post-Harvest laboratory, using the Balittro-type prototype (steam system). Analysis of the chemical components of *P aduncum* essential oil, citronella and Seilon cinnamon leaves oils were carried out by GC-MS in the laboratory of the Faculty of Animal Science, Andalas University, Padang.

2.2. Formulation

The pesticide formulation was made in the form of an emulsifier concentrate (EC 25%), as the main ingredient of *P aduncum* leaf essential oil (25%), added additives (Citronella essential oil, Lemongrass essential oil, Seilon cinnamon leaf essential oil, Cinnamon laef essential oil, Clove leaf essential oil, and Wild ginger leaf essential oil) according to treatment as much as 5% in the formulation, then added solvent (58%) (ethanol, methanol and turpentine) according to treatment and added tween emulsifier (10%) and typol (2%) material agent until 100%, then stirred until smooth for 30 min using a stirrer.

2.3. Isolation pathogenic fungi

Pathogenic fungi *S. rolfsii, Pestalotia* sp and *F. oxysporum* isolated from peanut plants belonging to farmers infected with stem rot disease and *Pestalotia* sp isolated from sick banana plants and *F. oxysporum* isolated from chili plants infected with *Fusarium* wilt disease from farmers' gardens Solok district. Isolates from diseased plants were isolated and the growing pathogens were purified, identified using [5]. Furthermore, it was propagated on Potato Dektrose Agar (PDA) medium. The pathogen isolates used for testing were one week old.

2.4. Antifungal activity test

2.4.1. A. Colony diameter growth suppression

The test was carried out by mixing until homogeneous the formulation of botanical pesticides (0.04 ml) into each test tube according to treatment into 20 ml sterile medium PDA medium, before freezing (45 °C), then poured into petridishes and allowed to harden, Furthermore, pure culture of fungal were inoculated, in the form of pieces of fungal mycelia (*S. rolfsii*, *Pestalotia* sp, and *F.oxysporum*) which were sliced using sterile corkbore with a diameter of 6 mm, placed in the middle of the treated medium, then incubated in an incubator at 28 °C for four days *S rolfsii* and seven days for *Pestalotia* sp and *F. oxysporum* [7].

2.4.2. b. Colony biomass suppression

Testing using Potato Dektrose Broth (PDB) liquid medium, as much as 25 ml of medium was inserted into each test tube, and then sterilized in an autoclave, after which the media was cooled, and the botanical pesticide formula was added according to the concentration treatment to be tested (0.05 ml/25 ml medium). Furthermore, pure culture of fungal were inoculated, in the form of pieces of fungal mycelia *(S. rolfsii, Pestalotia* sp, and *F.oxysporum*) which were sliced using sterile corkbore with a diameter of 6 mm, then incubated in an incubator at 28 °C for seven days. Furthermore, the fungal colonies that grew were taken and dried in an oven at 80 °C for 48 h, then the biomass was weighed [10].

The tests were arranged in a completely randomized design (CRD) in factorial, with 21 treatments (formulations), each with four replications, the treatments being additives for essential oil of citronella leaf oil (*A. nardus*), lemongrass leaf oil (*Cy. flexiosus*), Seilon cinnamon leaf oil (*C. zeylanicum*), cinnamon leaf oil (*C. burmanii*), clove leaf oil (*E. aromatica*) and wild ginger laef oil (*E slahmong*), as the first factor, the type of solvent (Ethanol, methanol and turpentine) as the second factor, the concentration level of the main ingredients used in the test was 500 ppm). For more details it consists of F1 = *Piper aduncum* leaf oil without additives with ethanol solvent, F2 = *Piper aduncum* leaf oil without additives with methanol solvent, F 3 = *Piper aduncum* leaf oil without additives with turpentine solvent, F4 = *Piper aduncum* leaf oil with Citronelal grass leaf oil additive + methanol solvent, F5 = *Piper aduncum* leaf oil with Citronelal grass leaf oil additive + ethanol solvent, F 6 = *Piper aduncum* leaf oil with Citronelal grass leaf oil additive + turpentine solvent, F 7 = *Piper aduncum* leaf oil with lemongrass leaf oil additive + methanol solvent, F 8 = *Piper aduncum* leaf oil with oil additive lemongras leaf oil + ethanol solvent, F 9 = *Piper aduncum* leaf oil with lemongrass leaf oil additive + turpentine solvent, F 10 = *Piper aduncum* leaf oil with seilon leaf oil additive + ethanol solvent, F 11 = *Piper aduncum* leaf oil with seilon leaf oil additive + methanol solvent, F 12 = *Piper aduncum* leaf oil with seilon leaf oil additive + turpentine solvent, F 13 = *Piper aduncum* leaf oil with cinnamon leaf oil additive + ethanol solvent, F 14 = Piper aduncum oil with min additive cinnamon leaf oil + methanol solvent, F 15 = Piper aduncum oil with additive cinnamon leaf + turpentine solvent, F 16 = *Piper aduncum* leaf oil with clove leaf oil additive + ethanol solvent, F 17 = *Piper aduncum* leaf oil with clove leaf oil additive + methanol solvent, F 18 = *Piper aduncum* leaf oil with clove leaf oil additive + turpentine solvent F 19 = *Piper aduncum* leaf oil with wild ginger leaf oil additive + ethanol solvent, F 20 = *Piper aduncum* leaf oil with wild ginger leaf oil additive + methanol solvent, F21 = *Piper aduncum* leaf oil with wild ginger leaf oil additive wild + solvent turpentine.

To calculate the inhibition of growth of colony diameter and colony biomass calculated by the formula [12]:

$$I = \frac{C - T}{C} \quad x\ 100\ \% \tag{1}$$

where:

I = Inhibition of colony growth/efficacy.
C = Colony diameter/colony biomass in the control.
T = Colony diameter/colony biomass in the treatment.

3. Results and discussion

3.1. Colony diameter suppression

The results showed that the botanical pesticide *P. aduncum* essential oil with additive ingredients of citronella grass leaf essential oil (*A. nardus*), lemongrass leaf essential oil (*Cy. flexiosus*), Seilon cinnamon leaf essential oil (*C. zeylanicum*), essential oil of Padang cinnamon leaf (*C. burmanii*), clove leaf essential oil (*E. aromatica*) and wild ginger leaf essential oil (E slahmong), showed positive results to increase the antifungal activity of botanical pesticide essential oil *P. aduncum*. All solvents can be used for the manufacture of botanical pesticide formulations, *P aduncum* essential oil and ethanol solvents showed the best, followed by methanol and turpentine (Table 1).

The results of statistical analysis showed that there was an interaction between additives and the type of solvent, the addition of citronella grass essential oil with ethanol as a solvent showed the highest antifungal activity of *P. aduncum* botanical pesticides, namely by suppressing growth. from the diameter of the test fungus colonies *S. rofsii* of 92.75%, *Pestalotia* sp. 86.85% and *F.oxysporum* 47.26%. Overall, the addition of citronellagrass essential oil showed the best effectiveness as an additive to the botanical pesticide *P. aduncum*, and was better than the addition of Seilon cinnamon leaf essential oil, Padang cinnamon leaf essential oil, clove leaf essential oil, lemongrass essential oil and leaf essential oil. wild ginger. The Botanical pesticide *P aduncum* without additives with turpentine as a solvent showed the lowest inhibid of fungal colony diameter growth respectively for the test fungus *S. rofsii* at 88.51%, *Pestalotia* sp. 81.09% and *F.oxysporum* 35.99%. Statistically there was no significant difference between the types of solvents tested in suppressing the growth of the diameter of the fungal colonies *S. rolfsii, Pestalotia* sp and *F.oxysporum*. The effect of different types of solvents is seen after the addition of additives, this means that the solubility of the additives used is strongly influenced by the different types of solvents used.

3.2. Colony biomass suppression

Parameters determining the effectiveness of additive and solvent effects in the formulation of botanical pesticides are not only determined by suppression of colony diameter, but can also be seen in suppression of colony biomass. Treatment with citronellagrass essential oil additive also showed the highest suppression of fungal colony biomass growth against the test fungi *S. rolfsii* and *Pestalotia* sp, but not for the test fungus *F. oxysporum*, where the highest suppression of colony biomass was found in the treatment with citronellagrass essential oil additives, leaf oil. cloves and not significantly different from the additive treatment of Seilon cinnamon and Padang cinnamon leaf oil.

The treatment with lemongrass oil and wild ginger leaf essential oil additives still showed an increase in suppression of the lowest colony biomass growth for the three test mushrooms (Table 2). According to (Harni. R., et al., 2013), the high power of suppression of the citronella essential and clover leaf essential oils additives, because the content of eugenol and citronella in the two essential oils belongs to the terpenoid group and monoterpenes are antifungal compounds. Both of these groups are able to inhibit the metabolic process of fungi so that it interferes with the growth of pathogenic fungi.

From the results above, it shows that the formulation with the additive treatment of citronella essential oil (*A. nardus*) and ethanol or methanol solvents, showed the best in increasing the antifungal effectiveness of the botanical pesticide *P aduncum* with the highest inhibition on the growth of colony diameter and fungal colony biomass. *Pestalotia* sp. For the fungus *F. oxysporum*, the formulation with clover leaf essential oil additive (*E aromatica*), Ceylon cinnamon leaf essential oil (*C. zeylanicum*) and Padang cinnamon leaf essential oil (*C. burmanii*) showed the best effectiveness. From these results it can be read that the response of each pathogen to pesticides is different. From [14] reported that a mixture of *P. aduncum* essential oil and lemongrass essential oil (*Cy. flexuosus*) at a dose of 1000 ppm was able to control the growth of *Phytopthora palmivora* colonies. 100%, higher than *P. aduncum* and *Cy. flexuosus* essential oils alone. The results of the study reported [15] that citronella oil, Padang cinnamon leaf oil and clove leaf oil at a concentration level of 500 ppm were able to suppress the growth of the fungus *Microsporum canis*. Clove leaf essential oil had the highest antifungal effect (89.17%), followed by citronella oil (80.98%) and Padang cinnamon leaf essential oil at 77.07%. Citronella oil (*Cy citratus*) with antimicrobial content of geraniol and neral is also capable of inhibiting the development of the fungus *Malassezia furfur* that causes tinea versicolor (M.Yusdar., *et al* 2015.). Wild ginger oil at a concentration level of 500 ppm was able to inhibit the growth of the fungus *S rolfsii* by 81.74% [16]. Eugenol which is the main component of clove essential

Table 1
Effect of additives and solvents on the pesticide formulation of *P aduncum* essential oil on growth of colony diameter of *S. rolfsii, Pestalotia* and *F. oxysporum*.

Treatments		Colony Diameter (mm)			Colony Inhibition (%)		
Additive	Solvents	*S.rolfsii*	*Pestalotia* sp	*F. oxisporum*	*S.rolfsii*	*Pestalotia* sp	*F. oxisporum*
Without Additive	Ehtanol	9.25	14.50	44.50	88.82 gh	81.41 ij	35.27 i
	Methanol	9.00	14.50	43.50	89.12 gh	81.41 ij	36.72 ghi
	Turpentine	9.50	14.75	44.00	88.51 h	81.09 j	35.99 hi
Citronelal grass leaf	Ethanol	6.00	10.25	36.25	92.75 a	86.85 a	47.26 a
oil (A. nardus)	Methanol	6.75	11.75	39.00	91.85 ab	84.93 b	43.27 b
	Turpentine	6.75	13.50	40.50	91.84 ab	82.69 efgh	41.09 c
Lemonggrass leaf oil	Ethanol	7.75	13.75	41.75	90.63 cde	82.37 fghi	39.27 cde
(Cy flexuosus)	Methanol	7.50	14.25	42.25	90.93 bcd	81.73 hij	38.54 def
	Turpentine	9.00	14.50	42.50	89.12 gh	81.41 ij	38.18 efg
Seilon leaf oil	Ethanol	6.00	12.00	40.75	92.75 a	84.60 bc	40.72 c
(C. zeylanicum)	Methanol	7.75	13.25	40.75	91.24 bcd	83.01 defg	40.72 c
	Turpentine	8.50	14.25	41.25	89.72 efg	81.73 ghi	39.99 cd
Padang Cinnamon leaf	Ethanol	7.00	12.50	40.75	91.54 bc	83.97 bcd	40.72 c
Oil (C burmanii),	Methanol	7.25	13.00	40.50	91.24 bcd	83.33 cdef	41.09 c
	Turpentine	9.00	14.50	41.50	89.12 gh	81.41 hi	39.63 cde
Clove leaf oil	Ethanol	6.75	12.75	40.75	91.84 ab	83.65 cde	40.73 c
(E. aromatica)	Methanol	7.00	13.25	40.50	91.54 bc	83.01 defg	41.09 c
	Turpentine	8.50	14.75	43.50	89.72 efg	81.09 j	36.73 ghi
Wild ginger leaf oil	Ehtanol	7.75	14.00	42.50	90.63 cde	82.05 ghij	38.18 efg
(*E slahmong*)	Methanol	8.00	14.00	43.00	90.33 def	82.05 ghij	37.45 fgh
	Turpentine	8.75	14.50	43.75	89.42 fgh	81.41 ij	36.73 ghi
CV/%					1.01	1.08	2.93

Note. The numbers followed by the same letter are not significantly different according to DMRT. Test at 5% level.

Table 2
Effect of additives and solvents on the pesticide formulation of *P aduncum* essential oil on growth of colony biomass of *S. rolfsii, Pestalotia* sp and *F. oxysporum.*

Treatments		Colony Biomass/mm			Biomass Inhibition/%		
Additive	Solvents	*S.rolfsii*	*Pestalotia* sp	*F. oxisporum*	*S.rolfsii*	*Pestalotia* sp	*F. oxisporum*
Without Additive	Ehtanol	13.25	5.75	51.33	90.39 fgh	84.02 def	45.95 defg
	Methanol	14.50	6.00	52.66	89.49 ijk	83.33 ef	44.55 efgh
	Turpentine	15.00	6.75	53.33	89.13 k	81.24 g	43.85 fgh
Citronelal grass leaf oil (A. nardus)	Ethanol	8.50	4.00	48.00	93.83 a	88.88 a	49.46 abcd
	Methanol	10.00	4.25	48.67	92.79 bc	88.19 a	48.90 bcde
	Turpentine	11.00	6.25	54.00	91.30 de	82.63 fg	43.15 fgh
Lemonggrass leaf oil (Cy flexuosus)	Ethanol	13.50	5.25	56.67	90.21 gh	85.41 cd	41.05 hi
	Methanol	13.50	5.25	56.00	90.21 gh	85.41 cd	40.35 hi
	Turpentine	14.75	6.75	58.66	89.28 jk	81.24 g	38.25 i
Seilon leaf oil (C. zeylanicum)	Ethanol	9.50	4.50	45.33	93.11 b	87.50 ab	52.24 abc
	Methanol	10.75	4.50	49.16	92.20 c	87.50 ab	47.71 cdef
	Turpentine	11.00	6.00	53.00	91.30 de	83.33 ef	44.21 efgh
Padang Cinnamon leaf oil (C burmanii),	Ethanol	9.25	5.00	44.66	93.29 ab	86.11 bc	52.96 ab
	Methanol	9.50	5.25	44.00	93.11 b	85.41 cd	53.66 a
	Turpentine	12.75	6.25	54.66	90.76 efg	82.64 fg	42.45 ghi
Clove leaf oil (E. aromatica)	Ethanol	9.75	5.00	45.00	92.93 b	86.11 bc	52.63 ab
	Methanol	10.75	4.50	45.66	92.20 c	87.50 ab	51.93 abc
	Turpentine	12.50	6.00	52.33	90.94 def	83.33 ef	44.91 defgh
Wild ginger leaf oil (*E slahmong*)	Ethanol	13.00	5.50	52.33	90.58 fg	84.72 def	44.91 defgh
	Methanol	13.00	6.00	54.33	90.58 fg	83.33 ef	42.80 ghi
	Turpentine	14.00	6.25	56.67	89.85 hij	82.64 g	40.35 hi
CV/%					1.02	1.34	5.46

Note. The numbers followed by the same letter are not significantly different according to DMRT. Test at 5% level.

oil is very effective for the control of fungi Penicillium, Aspergillus and *Fusarium* sp, administration of 150 mg/lt eugenol *F. oxysporum* growth was completely inhibited [10]. Padang cinnamon oil (*C burmanii*), the results of previous reports showed quite good antifungal activity against *Fusarium sambucinum* [11].

The increase in antifungal activity in the botanical pesticide *P aduncum* essential oil due to the additives given, especially citronella essential oil, Padang cinnamon oil, Ceylon cinnamon oil and clove leaf essential oil indicates a synergistic collaboration, between the *P. aduncum* essential oil content and the components contained in it the additives given. The main component contained in *P aduncum* essential oil is a compound dimethoxy-4,5-methylenedioxy-allylbenzene or known as dillapiole [2,9,13]. The main component of citronella oil is citronellal ranging from 41.61 to 49.56% [14]. The main component in Padang cinnamon leaf oil (*C burmanii*) is cinnamaldehyde 63.61% (Fajar., et al., 2019). The main component of clove leaf oil is [7], among them are eugenol (76.8%), -caryophyllene (17.4%), alpha-humulene (2.1%), and eugenyl acetate (1.2%).The main components in lemongrass oil (*Cy flexuosus*) Chowdhury SR., et al.*l*, 2010, 2010, were citral-a (33.1%), citral-b (30.0%), geranyl acetate (12.0%) and linalool (2.6%). Wild ginger (*E. slahmong*) the main component contained in it is 2-decanoic acid 48.04%, followed by nonanoic acid 9.18% and octenal 8.97% [16]. The chemical components contained in *P. aduncum* oil, citronellagrass (*A. nardus*) and Ceylon cinnamon leaf oil (*C. zeylanicum*) were the results of GC-MS analysis in this study (Table 3).

As for the other 4 oil components (lemongras leaf oil, cinnamon leaf oil, clove leaf oil and wild ginger leaf oil, no analysis was carried out based on literature studies only).

Table 3
Main components of *P. aduncum* oil, Citronella and Ceylon cinnamon leaves GC-MS analysis results.

Botanical Pesticide Raw Materials	Main components
Bamboo piper (*P aduncum*) leaves oils	*Trans*-isodillapiole 32.96%, trans β-caryophyllene 7.31%, piperitone 4.79%, g-terpinen 3.90, terpinene-4-ol 3.75%, 2-pinene 3.13%, limonen 3.35%, a-cymene 2.18%, a humulene 4.32%, pentadecane 3.20%, farnesene 3.56%, d-cadinene 3.22%, copaene 2.94%, petandecene 3.20%, dan 36 each other component <2%
Ceylon cinnamon (*C zeylanicum*) leaves oils	Eugenol 91.76%, cinnamaldehyde 0.53%, acetogenol 4.66%, transcaryophylin 0.90%, cinnamyl acetat 0.87%dan linalool 0.25%, and 32 each other component <0.20%
Citronellagrass (*A nardus*) leaves oils	Citronellal 41.74%, graniol 14.89%, citronellol 9.86%, naphthalenol 4.83%, limonene 2.88%, cyclohexan 3.30%, germacrene 2.46%, citral 1.06% and 43 other components
Cinnamon leaf oil (C burmanii)	Cinnamaldehyde 63.61%
Lemongrass leaf oil (Cy flexuosus	Citral-a (33.1%), citral-b (30.0%), geranyl acetate (12.0%) and linalool (2.6%).
Clove leaf oil	Eugenol (76.8%), -caryophyllene (17.4%), alpha-humulene (2.1%), and eugenyl acetate (1.2%).
Wild ginger leaf oil (E. slahmong)	2-decanoic acid 48.04%, followed by nonanoic acid 9.18% and octenal 8.97%

4. Conclusion

The results of the study concluded that all additive materials had a positive effect in increasing the antifungal activity of the botanical pesticide *P aduncum* essential oil with different effectiveness against the test fungi, the best being citronella essential oil (*A. nardus*), then Ceylon cinnamon leaf essential oil (*C. zeylanicum*), Padang cinnamon leaf essential oil (*C. burmanii*) and clove leaf essential oil (*E. aromatica*) while lemongrass (*Cy. flexuosus*) essential oil and wild ginger (*E. slahmong*) essential oil had low effect. . All solvents can be used for the formulation of botanical pesticides of *P aduncum* essential oil, ethanol and methanol solvents are better than turpentine.

Credit author statement

Nurmansyah: Data curation, Writing-Original draft preparation. **Herwita Idris:** Supervision, Methodology. **Erma Suryani:** Investigation, Conceptualization. **Helfi Gustia:** Project administration. **Anwar Ilmar Ramadhan:** Resources, Writing-Reviewing and Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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