JMI
Jurnal Multidisiplin Indonesia

Volume 3 Number 8 Auguts 2024
E-ISSN: 2963-2900 | P-ISSN: 2964-9048
https://jmi.rivierapublishing.id/index.php/rp

Effectiveness of Some Concentrations of Rambutan Wood Liquid Smoke to Inhibit The Growth of Cercospora sp. Secara in Vitro

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Abstract

Cercospora sp. is a fungus that causes leaf spot disease in oil palm plants, potentially affecting productivity and harming oil palm cultivation. Long-term use of synthetic fungicides can lead to resistance, resurgence, and leave harmful residues in the environment. As an alternative solution, the utilization of liquid smoke from rambutan wood offers a cost-effective, environmentally friendly, and antifungal option to inhibit the growth of leaf spot disease. This study aims to determine the effective concentration of rambutan wood liquid smoke in inhibiting the growth of Cercospora sp. Vitro. The research was conducted from December to March 2024 at the Laboratory of Pathology, Entomology, Microbiology, and Soil Science, Faculty of Agriculture and Animal Husbandry, Sultan Syarif Kasim State Islamic University Riau. The experimental method used was a completely randomized design with six treatments (0%, 1%, 2%, 3%, 4%, and 5%), each repeated four times, resulting in 24 experimental units. Observed parameters included total phenol content analysis of liquid smoke, macroscopic observations, growth rate (cm/day), and inhibition rate (%) of Cercospora sp. The results showed a total phenol content of 1.76%. Liquid smoke from rambutan wood at a concentration of 2% was highly effective in inhibiting the growth of Cercospora sp., completely stopping the growth rate to 0 cm/day and categorizing it as a highly effective fungicide with an effectiveness percentage of 100%.

Keywords: Liquid Smoke, Cercospora Sp., Oil Palm, Rambutan Wood

INTRODUCTION

Background

Cercospora sp. is one type of fungus that causes leaf spot disease in oil palm plants. This fungus has the potential to affect crop productivity and harm the palm oil industry. As a result of damage to leaf tissue so that there is a decrease in the amount of chlorophyll that can interfere with the photosynthesis process, Infection in oil palm plants usually spreads through fungal spores carried by the wind or through infected plants (Roeswitawati and Sukorini, 2022). Based on research conducted by Roy (2015), the intensity of leaf spot disease caused by Cercospora sp. reached 71.81%. This can have a very negative impact on the growth of oil palm seedlings to death. Therefore, it is necessary to take appropriate measures to address this issue. (Elsa, 2023)

The use of synthetic fungicides is the most dominant way to control fungal diseases due to their ease of use and effectiveness, but their long-term use without adhering to the principles of Integrated Pest Control (IPR) can lead to resistance, resurgence, and leave residues that are harmful to environmental sustainability. As an alternative solution, the use of liquid smoke from rambutan wood can be a cheap, environmentally friendly, and antifungal option to inhibit the growth of leaf spot disease. (Angraini, 2017) (Lantiunga, 2022) (Sari, 2018)

Liquid smoke is a condensation or condensation of steam from direct or indirect combustion from materials that contain a lot of lignin, cellulose, hemicellulose and other carbon compounds. In the agricultural industry, Liquid smoke functions effectively to control pests and diseases without damaging the surrounding ecosystem. Its environmentally friendly and free nature of harmful chemicals makes liquid smoke or biopesticides one of the products recommended by the Ministry of Agriculture of the Republic of Indonesia to be used in the agricultural industry because its use is considered to be able to increase food production in a sustainable manner. (Ratmawati, 2022)

Liquid smoke has an antifungal effect, which is caused by the components contained in it, namely organic acids, phenols, and carbonyl compounds. Phenolic compounds cause the denaturation of proteins that make up part of the structure of the cytoplasmic membrane of fungi. Damage to the cytoplasmic membrane and cell wall can cause an increase in the permeability of the fungal plasma membrane, resulting in the loss of the contents of the fungal cell, which eventually leads to lysis and death of fungal cells. Carbonyl compounds play a role in inhibiting (inhibiting the movement) fungal growth by penetrating the fungal cell wall and inactivating enzymes in the cytoplasm and cytoplasmic membrane, while organic acid compounds work by affecting the overall pH and forming an undissociated acid, which ultimately results in impaired fungal metabolism (Wibowo et al., 2016).

Based on research conducted by Rahmawati (2022), One of the alternative ways to control agricultural pests is the use of natural materials that have the potential to be fungicides, namely liquid smoke. So that it can kill diseases in plants. One alternative is the use of rambutan wood liquid smoke. Liquid smoke is a product of wood pyrolysis that contains various chemical compounds. Rambutan wood, as a source of liquid smoke, is chosen because it is abundant and easy to obtain in Indonesia. In addition, rambutan wood contains certain compounds that have the potential to be antifungal, so it is expected to be effective in inhibiting the growth of Cercospora sp. However, the effectiveness of rambutan wood liquid smoke in inhibiting the growth of Cercospora sp. In vitro research is still needed.

Research Objectives

This study aims to obtain a concentration of rambutan wood liquid smoke that is effective in inhibiting the growth of Cercospora sp. in vitro.

Research Benefits

The benefits of this study can provide information related to the inhibition of rambutan wood liquid smoke on the growth of Cercospora sp. Causes of oil palm leaf spot disease in vitro.

Research Hypothesis

The hypothesis of this study is that rambutan wood liquid smoke with a concentration of 5% or as much as 2 ml is very effective in controlling Cercospora sp.

RESEARCH METHODS

Place and Time

This research has been carried out at the Laboratory of Pathology, Entomology, Microbiology and Soil Sciences (PEMTA) of the Faculty of Agriculture and Animal Husbandry, Sultan Syarif Kasim State Islamic University, Riau, as well as the Smoked Catfish Business House in Kampar Regency. The research was carried out from December to March 2024.

Materials and Tools

The materials used in this study were catfish, rambutan wood, Cercospora sp. isolate, Potato Dextrose Agar (PDA) media, aquades, 0.2 μm filter membrane, spirits, aluminium foil, 70% alcohol, cotton, tissues, liquid smoke, HCl, gallic acid, Folin-Ciocalteau reagent, NaOH, plastic wrap, and label paper.

The tools used in this study were knives, analytical scales, droppers, hot plates, Ph indicators, condensers, stoves, gas, bimetal thermometers, funnels, vial bottles, 20 ml syringes, spray bottles, measuring cups, Erlenmeyer, spatula, smoked fish smoking ovens, magnetic stirrers, autoclaves, stopwatches, hand sprayers, laminar air flow cabinets, Petri dishes, Ose needles, incubators, test tubes, borer corks, micropipettes, bunsen lamps, tweezers, markers, rulers, cameras and stationery.

Research Design

This study was carried out as a laboratory experiment with a complete random design (RAL) consisting of 6 liquid smoke concentration treatments. Each treatment was repeated 4 times so that 24 experimental units were obtained. Where the level of treatment concentration refers to the research of Mahmud et al. (2021).

A0 = 0% (0 ml liquid smoke + 20 ml PDA + Cercospora sp.)
A1 = 1% (0.2 ml liquid smoke + 19.8 ml PDA + Cercospora sp.)
A2 = 2% (0.4 ml liquid smoke + 19.6 ml PDA + Cercospora sp.)
A3 = 3% (0.6 ml of liquid smoke + 19.4 ml of PDA + Cercospora sp.)
A4 = 4% (0.8 ml of liquid smoke + 19.2 ml of PDA + Cercospora sp.)
A5 = 5% (1 ml liquid smoke + 19 ml PDA + Cercospora sp.)

1. Test for Phenol Content and pH Levels

Analysis of phenol content in rambutan wood liquid smoke was carried out to determine the level of phenol presence in the smoke. Phenol has antifungal properties that can help inhibit the growth of the Cercospora sp. on smoked fish smoking products. Research shows that the phenolic components in liquid smoke have an antibacterial function. A quantitative analysis method is needed to measure the phenol content in liquid smoke. The method used is Folin-Ciocalteau. In this process, a standard solution of gallic acid is made with various concentrations ranging from 0 to 100 mg/L. From each standard solution and blank, 0.5 ml is taken and mixed with 2.5 ml of 10% Folin-Ciocalteau reagent. The mixture is left for 4 minutes. Then, 2 ml of 7.5% Na_2CO_3 solution was added, and incubation was carried out for 30 minutes at room temperature. The absorbance of the solution was measured at a wavelength of 765 nm using a UV-Vis Spectrophotometer. A similar process was also applied to liquid smoke samples from palm fronds with a concentration of 100 mg/L. (Oktarina et al., 2017) (Appendix 8).

Testing the pH level in rambutan wood liquid smoke is carried out to determine the acidity level of the liquid smoke, which can affect its effectiveness. The right pH level is crucial in the smoking process, as low pH (acidic) can increase the growth inhibition properties of microorganisms. The pH measurement procedure is carried out as follows: first, the liquid smoke to be tested is pre-filtered to remove any solid particles that may be present. Screening is carried out using filter paper or microfilters to ensure that the tested sample is completely clean of physical contaminants. Second, before use, the pH meter is calibrated using a standard buffer solution with a known pH, such as pH buffers 4, 7, and 10. This calibration is important to ensure the accuracy of the instrument over a wide pH range. After calibration, the pH meter electrode is dipped into the liquid smoke sample. The pH meter will then automatically read the pH value, and the result will be displayed on the screen. The measurement process is carried out at room temperature to maintain the consistency of the results. The pH value read from the instrument is recorded, and measurements are usually taken several times to obtain a more accurate average value and reduce the possibility of measurement errors. Precise and consistent pH testing is essential because the pH of liquid smoke can affect the quality and safety of the final product. The high acidity level (low pH) in liquid smoke usually indicates better potential in inhibiting the growth of fungal microorganisms (Appendix 8).

Based on the National Standards Agency, in SNI 8985; 2021 The classification of liquid smoke is divided into 2 parts of quality requirements that are used as reference standards that can be used for the provision of industrial raw materials, including the agricultural industry. The categorization of liquid smoke quality is in Table 1.

Table 1. Liquid Smoke Quality Requirements

Characteristic	Unit	Quality 1	Quality 2
Colour	-	Yellow to brown	Yellow to brown
Ph	-	1,50 - 2,75	2,76 - 4,50
Phenol	%	Maximum 2.0	Maximum 2.0

2. Macroscopic Characteristics of Cercospora sp.

Macroscopic observations were carried out with the naked eye by checking the colony morphology of Cercospora sp. In petri dishes with different compositions, each petri dish was not treated, and the other dishes were treated with liquid smoke. Macroscopic observations of the observed characters include colony colour, colony shape, colony surface, colony growth pattern, and colony diameter (Yolan et al., 2014) (Appendix 12).

3. Growth Rate of Cercospora sp.

Observation of the growth rate of Cercospora sp. starting from the beginning of the laying of Cercospora sp. in the PDA media until the end of the observation day; this was done until the colony of Cercospora sp. filled the entire untreated petri dish and measuring using a Bar (Appendix 12). To determine the growth rate of the colony, a formula referring to Mahmud et al. (2020) is used as follows:

$$\mu = \frac{X}{T}$$

Information
μ = Growth Rate of Cercospora sp.
X = Increase in Diameter of Cercospora sp.
T = Observation Time

4. Inhibitory Effectiveness

To observe the inhibitory effect of liquid smoke on the growth of Cercospora sp. It was done by measuring the colony growth diameter of Cercospora sp. Colony measurements using a ruler (Appendix 12). Measurements can be made if the growth in the colony control has met all parts of the surface of the PDA media. The calculation of the effectiveness of the inhibition of the use of rambutan wood liquid smoke on the growth of the colony can be done using the formula stated by Oramahi et al. (2018) as follows:

$$DH = \frac{!}{K} \times 100\%$$

Information
DH = Percentage of resistance
K = Growth diameter of Cercospora sp. on the controls
P = Growth diameter of Cercospora sp. on the treatment

Assessment of the effectiveness of rambutan wood liquid smoke in inhibiting the growth of Cercospora sp. based on the category of effective fungicides contained in Table 2.

Table 2. Categories of Effective Fungicides

Percentage of Effectiveness (%)	Category
0	Ineffective
> 0-20%	Very ineffective
> 21-40%	Less effective

> 41-60%	Quite effective
> 61-80%	Effective
> 81%	Highly Effective

Source: Martyrs and Subekti (2019)

Data Analysis

Macroscopic data was analyzed descriptively, while quantitative data that had been obtained from each treatment was then processed using multi-fingerprint analysis (ANOVA).

Yij = μ + Ţi + ßj + €ij

Information:

I = 1, 2, 3,......... t

J = 1, 2, 3,......... r

Yij = Observation on the First Treatment with the j Repeat

μ = General average

Ţi = Influence of the i-th treatment

ßj = Effect of the j treatment

€ij = Effect of Error on the First Treatment and the Jth Repeat

Diversity fingerprint analysis is commonly used in scientific research, industrial data analysis, and other fields that require measuring data consistency and accuracy. A fingerprint analysis table is a statistical tool that is useful for measuring variations or differences between several data in a sample. In Table 3. There are instructions about the data needed to use fingerprint analysis.

Table 3. Fingerprint Analysis

Sources of Diversity	Degree of Freedom (DB)	Number of Quadrants (JK)	Central Quadrant (KT)	F Calculate
Treatment	T-1	JKP	Id card	KTP/KTG
Error	(tr-1) – (t-r)	JKG	KTG	
Total	(p-1)	JKT		

Information:

Correction Factor (FK) = Yij2/r-t

Sum of Total Squares = ∑ Y ijk2 – FK

Sum of Factor Squares = $\frac{\sum Y.^2}{r}$ – FK

Number of Squares of Error (JKG) = JKT-JKP-JKK

If there is a difference in treatment, it is continued with the Duncan Multiple Range Test (DMRT) test at the level of 1% and 5%. Data analysis was carried out using SPSS software version 22.0.

RESULTS AND DISCUSSION

Total Phenol Content and pH Levels

The results of total phenol analysis by the Folin-Ciocalteu method using UV-Vis spectrophotometer (Appendix 3) showed that the liquid smoke of oil palm fronds had a phenol content of 17.65 mg GAE/ml sample (1.76%). Brief information about the results of phenol analysis can be found in Table 4.

Table 4. Total Phenols and pH Levels of Rambutan Wood Liquid Smoke

Test Sample	Total Phenols (%)	pH level
Grade 2 Rambutan Wood Liquid Smoke	1,76	4,19

Description: Results are an average of three repetitions

Based on Table 4. The phenolic compound content of 1.76% in liquid smoke comes from the pyrolysis process of rambutan wood, the pyrolysis process is an incomplete combustion process of rambutan wood in a cylinder with minimal oxygen that produces hot steam which is then condensed into liquid smoke. The hot steam contains various chemical compounds formed from the breakdown of large molecules of organic matter into small molecules (Riadi, 2020).

According to Wibowo et al. (2016), the chemical compounds formed in rambutan wood liquid smoke generally consist of 3 main components, namely phenols, acid compounds, and carbonyl compounds. Based on a review conducted by Salindeho et al. (2017), phenolic compounds in liquid smoke are formed from the breakdown of lignin molecules, and organic acid compounds in liquid smoke are formed from the breakdown of cellulose and hemicellulose molecules, and carbonyl compounds in liquid smoke are formed from the breakdown of carbohydrate, protein, and fat molecules which are sources of carbon and nitrogen.

The liquid smoke of rambutan wood has a fungicidal effect, which can kill fungi. This happens because rambutan wood liquid smoke contains compounds that are toxic to fungi so that they can damage cell membranes, cell walls, and the cell nucleus of fungi, so fungi cannot survive (Silitonga and Hendarti, 2019).

Based on Table 4.1. The pH level in rambutan wood liquid smoke of 4.19 indicates that the liquid is acidic. The acidic condition in this liquid smoke is mainly caused by organic acid compounds formed during the pyrolysis process of rambutan wood. According to Wibowo et al. (2016), these acid compounds come from the breakdown of cellulose and hemicellulose molecules. In the context of this study, the pH level of 4.19 is very relevant because an acidic environment can inhibit the growth and enzymatic activity of Cercospora sp. because many enzyme systems in fungi are unstable or inactive at low pH. Organic acids in liquid smoke can also damage cell membranes and fungal cell walls, causing cell death (Aisyah, 2019).

Based on the National Standards Agency, in SNI 8985, In 2021, the pH value in Quality 1 is 1.5-2.75, while Quality 2 is 2.76-4.5, and the phenol value in Quality 1 and 2 has the same maximum value range of 2. Based on existing standards, the pH value of rambutan wood liquid smoke that has been analyzed is included in Quality 2, and for the value of phenol content, the phenol value of rambutan wood liquid smoke is included in Quality 2.

Macroscopic Cercospora sp.

Based on the results of the research conducted, it can be seen that the application of rambutan wood liquid smoke has caused changes in the macroscopic characteristics of the Cercospora sp. From observations at 15 HSI (Days After Incubation) on the control treatment of Cercospora sp., it was found that it has been able to fill the Petri dish. In contrast to the condition experienced in the treatment of 1% liquid smoke, there is an inhibition in the growth of the colony so that it cannot meet the Petri dish at 15 HSI, while in the 2-5% treatment there is no sign of colony growth marked by the size of the colony diameter that does not increase, this proves that the use of rambutan wood liquid smoke has a significant impact in inhibiting the growth of Cercospora sp colonies. (Figure 1.).

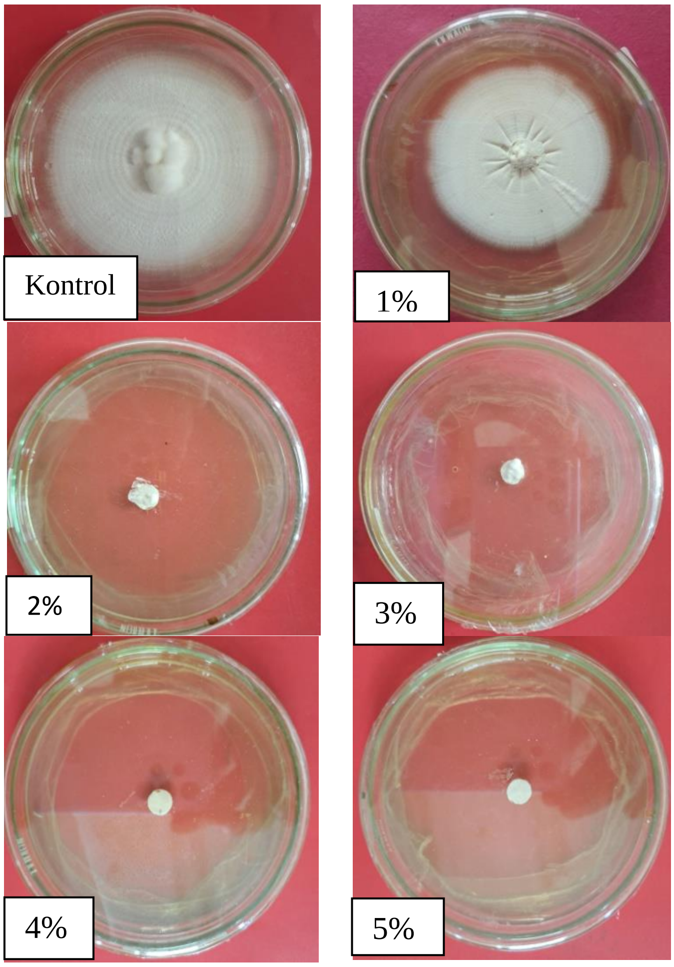

Figure 1. Macroscopic Colony Cercospora sp. Each Treatment is on 15 HSI.

Mycelium is a thin thread structure that forms the body of the fungus in Cercospora sp. The mycelium grows radially from the centre of the colony, has a white, grey, to greyish-white colour, and is textured smooth and hairy (Tondok, 2020).

The macroscopic physical shape of the mycelium on Cercospora sp. with control treatment grows well and fills the entire surface of the media within 15 HSI. The mycelium has a dense but smooth cotton-like texture, is white, and forms evenly distributed colonies. In contrast to the treatment with a concentration of 1%, the growth of mycelium is inhibited and unable to grow optimally, covering the entire surface of the medium within 15 HSI; the mycelium tends to be greyish-white. At concentrations of 2% to 5%, mycelium growth is completely inhibited until the 15th day of HSI, with mycelium tending to be white.

According to research conducted by Mahmud et al. (2021), active ingredients such as phenols, organic acids, and, carbonyl in rambutan wood liquid smoke interact with each other as a result of the application of liquid smoke concentration by the food poisoning method on PDA media, so that Cercospora sp. cannot grow normally. Based on the statement submitted by Sulaiman (2022), phenol compounds contained in liquid smoke can interfere with the metabolic process of Cercospora sp. and damage the ability of hyphae as food absorbers and reproductive organs. Wibowo et al. (2016) stated that phenol compounds contained in rambutan wood liquid smoke cause protein denaturation, which is a change in protein structure that causes loss of biological function; this denaturation affects part of the cytoplasmic membrane structure of Cercospora sp. Damage to the cytoplasmic membrane and cell wall can lead to increased plasma membrane permeability, which is the membrane's ability to allow certain substances to enter or exit the cell. As a result, it can trigger stunted cell growth. As for organic acid compounds, they work by affecting the overall pH so that the growing environment is acidic, which eventually results in the metabolism of Cercospora sp. annoyed. In addition, carbonyl compounds that are also found in liquid smoke play a role in inhibiting their growth by means of penetration, namely liquid smoke entering the cell wall with the aim of inactivating the enzymes in it, namely the cessation of the activity of enzymes in the cytoplasm and cytoplasmic membrane in Cercospora sp cells.

Growth Rate of Cercospora sp.

Measurement of the growth rate of Cercospora sp. began at observation 1 HSI until observation 15 HSI (Appendix 5). Average growth rate of Cercospora sp. during the 15 HSIs can be seen in Table 5. It shows that the application of rambutan wood liquid smoke is very different in inhibiting the growth rate of Cercospora sp. colonies in petri dishes.

Table 5. Growth Rate of Cercospora sp. For 15 HSI

Treatment	Growth Rate (cm/day)
0% Liquid Smoke	0.58A
1% Liquid Smoke	0.30b
2% Liquid Smoke	0.00c
3% Liquid Smoke	0.00c
4% Liquid Smoke	0.00c
5% Liquid Smoke	0.00c

Remarks: Different superscripts on the same row or column show a noticeable difference according to Duncan's follow-up test (P<0.05)

Based on Table Table 4.2. The application of rambutan wood liquid smoke has an effect in inhibiting so as to reduce the growth rate of Cercospora sp. with several concentrations that have been carried out. At a concentration of 0%, the growth rate reached 0.58 cm/day, in contrast to the concentration of 1%, which only reached 0.30 cm/day. Treatment with a concentration of 2% - 5% showed a very significant difference compared to 0% control, where no growth or growth rate of 0.00 cm/day occurred in Cercospora sp. The control showed the highest growth because there were no growth inhibitor compounds in Cercospora sp. on PDA media. Meanwhile, at a concentration of 1%, although there was a growth inhibition, there was still a slight growth. Concentrations of 2% - 5% indicate stunted growth, as seen from the absence of an increase in the growth rate of Cercospora sp. up to 15 HSI, According to Ton et al. (2020). This occurs as a result of compounds such as phenols, organic acid compounds, and carbonyl compounds contained in the liquid smoke of rambutan wood mixed with PDA media so that it affects its growth. According to Silitonga and Hendarti (2019), these active compounds in rambutan wood liquid smoke are compounds that are antifungal, which can damage cell membranes, cell walls, and the cell nucleus of fungi by disrupting the process of forming reproductive structures and metabolic processes.

Inhibition of Liquid Smoke Against the Growth of Cercospora sp.

Results of testing the inhibition of liquid smoke against the growth of Cercospora sp. in vitro on PDA media until the 15th day after incubation (Appendix 6). Based on Table 6. It can be seen that in the control treatment, there is no growth inhibition of Cercospora sp.; in the treatment with a concentration of 1% liquid smoke, there is a growth inhibition of the diameter of Cercospora sp. by 38.85%, while in the treatment with a concentration of 2-5% liquid smoke, it was seen to be effective by inhibiting 100% of the growth of the diameter of Cercospora sp. until the 15th day after incubation. This proves the statement submitted by Mahmud et al. (2022) that phenolic compounds in liquid smoke have strong anti-microbial properties, in line with the report submitted by Salindeho et al. (2017) that phenols in liquid smoke have bactericidal and anti-microbial or killing powers by damaging the cytoplasmic membrane in fungi.

Table 6. Inhibition of Rambutan Wood Liquid Smoke Against Cercospora sp.

Treatment	Percentage of Obstacles (%)
0% Liquid Smoke	0c
1% Liquid Smoke	38.85B
2% Liquid Smoke	100A
3% Liquid Smoke	100A
4% Liquid Smoke	100A
5% Liquid Smoke	100A

Remarks: Different superscripts on the same row or column show a noticeable difference according to Duncan's follow-up test (P<0.05)

Based on data from Table 6. The concentration of rambutan wood liquid smoke between 2% and 5% shows very high effectiveness in inhibiting the growth of Cercospora sp., reaching 100% when compared to a concentration of 0%. A concentration of 1% is considered less effective in inhibiting the growth of Cercospora sp. with an effectiveness rate of 38.85%, while the concentration of 0% (control) was considered ineffective with 0% effectiveness because there was no application of rambutan wood liquid smoke to the control PDA medium. According to the fungicide effectiveness criteria by Syahidah and Subekti (2019), the effectiveness of >81-100% is categorized as very effective in inhibiting fungal growth. This may be due to the high level of active ingredient at a 2% concentration of rambutan wood liquid smoke, which makes Cercospora sp. unable to grow on PDA media and even affects its existence. This indicates the antifungal properties of rambutan wood liquid smoke, i.e. the ability of the substance (fungicide) to stop mycosis and fungal growth.

According to the fungicide effectiveness criteria set by Syahidah and Subekti, (2019) an ingredient is categorized as very effective in inhibiting fungal growth if its effectiveness reaches 81-100%. In this context, liquid smoke from rambutan wood at a concentration of 2% has been shown to have a very high level of active ingredient. This results in Cercospora sp. unable to grow on PDA media.

Liquid smoke, especially those derived from rambutan wood, has a strong antifungal effect. This effect is caused by various active components, such as organic acid, phenol, and carbonyl compounds (Malvini and Nurjasmi, 2019). In line with the statement submitted by Wibowo et al. (2016), phenol compounds in liquid smoke from rambutan wood cause protein denaturation, which changes the structure of proteins and eliminates their biological function. This denaturing affects part of the cytoplasmic membrane structure of Cercospora sp. Damage to the cytoplasmic membrane and cell wall increases the permeability of the plasma membrane, allowing certain substances to enter or exit the cell, thus making it necessary for the growth of Cercospora sp. from the PDA medium not to enter normally. As a result, cell growth is inhibited. The organic acid compounds in liquid smoke work by changing the pH of the environment, making it acidic and disrupting the metabolism of Cercospora sp. In addition, carbonyl compounds in liquid smoke inhibit growth by penetrating cell walls and inactivating enzymes in the cytoplasm and cytoplasmic membrane in Cercospora sp. cells. Based on research conducted by Mahmud et al. (2021), the application of liquid smoke from palm fronds to Cercospora sp. can inhibit its growth. Its use with a concentration treatment of 4% is very effective in inhibiting growth with an effectiveness of 100% Cercospora sp. If viewed from the large concentration required to stop the growth of Cercospora sp., it can be seen that the liquid smoke from rambutan wood has the potential as a more effective antifungal agent against Cercospora sp.; this is evidenced at a lower concentration, which is 2%, the liquid smoke of rambutan wood is able to provide the same inhibitory effect of 100%.

CONCLUSION

Based on the results and discussion of the research, it can be concluded that liquid smoke from rambutan wood at a concentration of 2% is very effective in inhibiting the growth of Cercospora sp., by stopping the growth rate completely up to 0 cm/day and can be categorized as a highly effective fungicide with an effectiveness percentage of 100%.

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