



Effectiveness of *Aloe Vera Extract (Aloe vera L.)* Against *Colletotrichum capsici* Fungi and Its Use as a Learning Media

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ABSTRACT

This study aims to determine the effectiveness of aloe vera extract (Aloe vera L.) against Colletotrichum capsici fungus and determine the optimal concentration of aloe vera extract that effectively inhibits the growth of Colletotrichum capsici fungus and is used as a learning medium. This study used a laboratory experiment method using a Complete Random Design (RAL) with 5 treatments and 4 replicates. The treatment consisted of a concentration of 0% as a negative control, a concentration of aloe vera extract of 25%, 50%, 75% and 100%. The observed parameter is the diameter of the formed inhibition zone. The results of the study used Variant Analysis (ANOVA) and continued with the smallest real difference (BNT) test. The results showed that the administration of aloe vera extract (Aloe vera L.) could inhibit the growth of Colletotrichum capsici fungus at a maximum concentration of 100%. The higher the concentration of aloe vera extract, the higher its ability to inhibit the growth of Colletotrichum capsici fungus. The results of this study are feasible to be implemented in the form of a digital flipbook as a learning medium with a feasibility of 83.2%.

INTRODUCTION

Chili is an important type of horticultural crop and can be cultivated by farmers. Curly chili plant (*Capsicum annum* L.) is one of the horticultural crops whose results are in demand by the community. Red chili has high economic and nutritional value. The nutritional content contained in the red chili plant makes it a commodity needed by the community for cooking ingredients (Rindani, 2015). Every year, the demand for chili continues to increase in line with the growth of the population and the development of industries that require chili as a raw material. However, chili production by farmers is still low. One of the main causes of low chili production in Indonesia is the attack of diseases in chili peppers (Ropalia & Kusmiadi, 2023).

Anthraxnose disease caused by the fungus *Colletotrichum* sp. is a type of disease that often attacks chili plants and reduces their production. The fungus invades the plant's tissues and forms blackish-brown patches, which can then spread and cause complete decay. Fungi of the genus *Colletotrichum* cause anthracnose diseases, such as *Colletotrichum capsici*, *Colletotrichum acutatum*, *Colletotrichum dematium*, and *Colletotrichum gloeosporioides*. More than 90% of anthracnose diseases that infect chili peppers are caused by the fungus *Colletotrichum capsici* (Ropalia & Kusmiadi, 2023). During this time, the application of fungicides can be used to stop fungal diseases in plants. However, continuous administration of fungicides can lead to the restitution of pathogens, damage the environment, and be harmful to the environment. Disease control of this natural fungicide plant is carried out with *the plant Aloe vera* L. and will not harm the environment (Nazir, 2015; Selvianita et al., 2024).

According to Maryam (2013), aloe vera plants (*Aloe vera* L.) is known to have various benefits, such as its ability as an anti-inflammatory, antifungal, antibacterial, and stimulating cell regeneration. The aloe vera plant also belongs to the category of functional plants, since all parts of this plant have beneficial values both for body care and the treatment of various diseases. Many studies have been conducted on fungal growth *Colletotrichum capsici* by using a variety of natural plants. Aloe vera (*Aloe vera* L.) is known as a plant that has many benefits because all parts of this plant can be utilized both for body care and to treat various diseases. Aloe vera fronds can be grouped into 3 parts that can be used for treatment, including leaves, exudates and gels can be used either directly or in the form of extracts. Then exudate is the sap that comes out from the inside when cutting, this exudate is thick yellow in shape, and tastes bitter. Then the gel is the slimy part obtained by slashing the inside of the leaf (Handayani, 2019).

Anthraxnose disease caused by the fungus *Colletotrichum capsici* can be detrimental to farmers. The disease is controlled by the application of synthetic functionalities. The use of synthetic functionalides is not good to use if used for a long time, as a result of the use of fungicides used can damage the quality of chili. Therefore, to overcome the negative impact of the use of synthetic fungicides, another alternative to prevent anthracnose disease is to use natural plant-based remedies. Natural treatment using plant extracts that are more environmentally friendly and safe to use for a long period of time, one of which is using aloe vera plants that are relatively resistant to various environmental conditions so that they are easy to obtain. In this study, we look at the influence of alternative ingredients that will be used in this study using aloe vera extract on the growth of *Colletotrichum capsici* fungi.

The results of this research will be used as scientific information that is poured into learning media in the form of *digital flipbooks*. Learning media made using *digital flipbook* applications is a relatively easy process of making teaching materials as an alternative to help users in learning in the current era, with many variations and interesting models in terms of appearance both visually and audiovisually (Amanullah, 2020; Supriyatman et al., 2024). *Digital flipbooks* are chosen as a medium because they are suitable for use in learning. Based on previous research, the use of *digital flipbooks* as a learning medium can increase learning motivation (Anandari, et al. 2019).

METHOD

This study was carried out by the laboratory experiment method with the Lengkap Random Design

(RAL), using 5 (five) treatments with 4 (four) replicates, so that there were a total of 20 experimental units used (Rahman et al., 2021). The analysis of the research results used variant analysis (ANOVA), followed by the Smallest Real Difference Test (BNT). Research on the effectiveness of Aloe Vera Extract (*Aloe vera* L.) against Fungi *Colletotrichum capsici* carried out at the Laboratory of the Biology Education Study Program, Tadulako University and held in March-July 2024.

Research Procedure

The tools and materials to be used in the research are physically sterilized using autoclaves. First put enough water into the vessel, then add enough aquades, and put in the tools and materials (media) to be sterilized, set the temperature to 121 °C, and set the time for 15 minutes, close the autoclave tightly and make sure the steam hole is closed, then pull the power lever to ON (Utami et al., 2018). The preparation of the sample to be extracted is carried out first by separating dirt or other foreign objects. The cleaned and then dried aloe vera is aired for \pm 2 days and then mashed using a blender, then the maceration process is carried out by weighing 250 grams of aloe vera juice and putting it in an erlenmeyer flask and soaked with a 1000 ml 70% alcohol solvent incubated for 3 x 24 hours at room temperature. The maceration results were filtered using a filter funnel stored on the erlenmeyer to separate the filtrate and residue. Furthermore, the evaporation of the solution from the maceration results is carried out using a rotary evaporator at a temperature of 50°C so that a thick extract is obtained (Badaring et al., 2020).

Large chili fruits showing the presence of *Colletotrichum capsici* fungus were rejuvenated on the oblique PDA medium. The mushrooms are taken as much as 1 ose then scratched on an oblique medium in the garnish, after which they are incubated in an incubator at a temperature of 37°C for 2 x 24 hours, leave until the fungal hyphae grow on the culture medium. The mushrooms that grow are then rejuvenated and purified. (Rahmawati, 2019). The results of the mushroom rejuvenation were then continued to make mushroom suspensions. The suspension is made by making physiological NaCl 0.8% by weighing 0.8 grams of NaCl then dissolving it in 100 ml of sterile aquades and homogenizing it. Put the physiological solution into a test tube as much as 10 ml and take 1 ose of the rejuvenated *Colletotrichum capsici* mushroom into the test tube and homogenize it (Misna and Khusnul, 2016).

The culture medium for mushrooms was using PDA powder (Potato dextrose agar) which was weighed as much as 20.3 grams and dissolved in 500 ml of sterile aquades. PDA and aquades are stirred until the powder dissolves, then heated over a bath to a boil (the solution looks clear). Next, take a 1 ml mushroom suspension using a micropipette and pour it into a petri dish. Pour 20 ml of medium into a petri dish containing mushroom suspension and then homogenize, wait for it to harden and continue with the process of making a well (hole) on the medium (Jamilatun et al., 2020).

The concentration of aloe vera extract was made in 5 concentration variants, namely 0%, 25%, 50%, 75% and 100%. (Mendrofa et al., 2019). The test was carried out by the agar diffusion method (Idis Diffusion Method) the medium used was a sterile PDA. This method is done by making 5 wells or holes each on one petri dish with a hole diameter of 5mm. The hole in the medium is then dripped with aloe vera extract as much as 1 ml or until it covers the well hole using a micropipette. The treatment used 0% concentrations as negative controls of 25%, 50%, 75%, and 100%, respectively. Then let the petri dish sit for 10 minutes to carry out the diffusion process, then incubate the medium at 37°C for 3 x 24 hours (Dimova & Stirk, 2019). The observed parameter was the length of the diameter of the growth inhibition zone of *Colletotrichum capsici*. The measurement of the inhibition zone was carried out to determine the strength of the inhibition of aloe vera extract against the growth of *Colletotrichum capsici* fungus. The measurement of the inhibition zone was carried out using a caliper (Alfiah et al., 2015).

RESULTS AND DISCUSSION

Structure of the fungus *Colletotrichum capsici*

This study used a sample in the form of *Colletotrichum capsici* mushroom obtained directly from red chili and purified for use in this study. The mushroom was first cultivated in PDA (*Potato Dextrose*

Agar) medium, then observed using a 1000x magnification microscope and simple safranin dye to see the shape of the fungus *Colletotrichum capsici*.

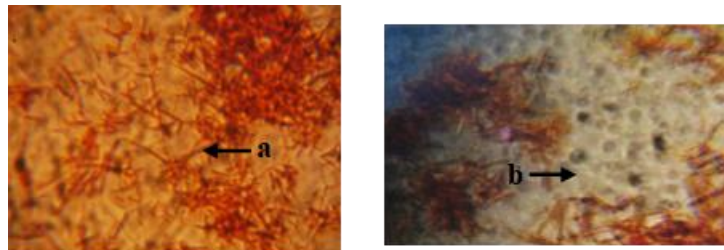


Fig 1. (a) Mycelium and (b) Spore *Colletotrichum capsici*.

Antifungal Effectiveness Testing with Well Technique

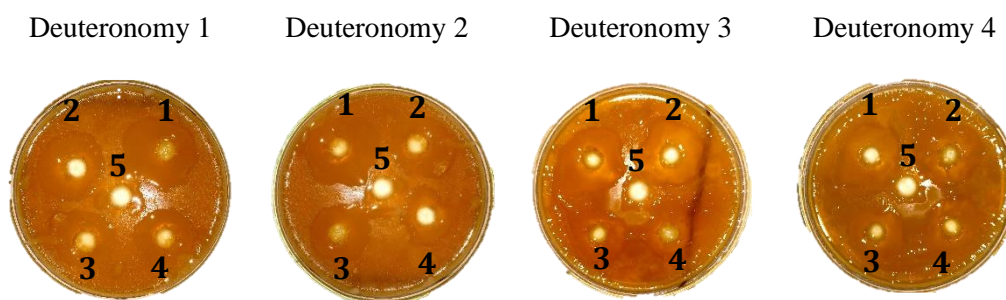


Fig 2. Growth Inhibition Zone of *Colletotrichum capsici*.

Information:

1. Aloe vera extract concentration 100%
2. Aloe vera extract concentration 75%
3. Aloe vera extract concentration 50%
4. Aloe vera extract concentration 25%
5. Concentration of 0% sterile aquades (without aloe vera extract)

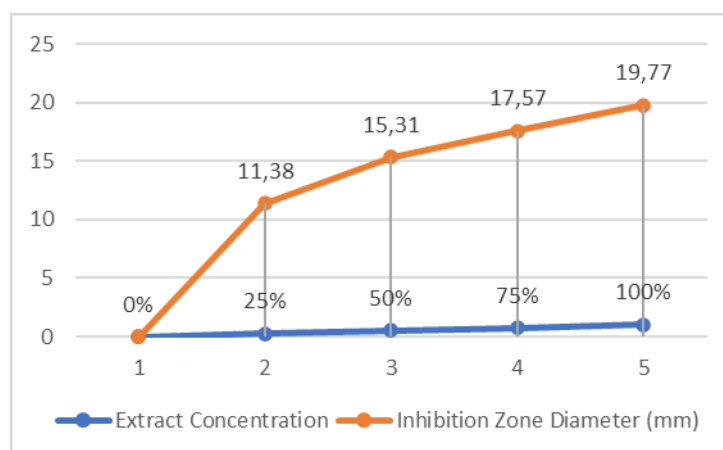


Fig 3. Graph of Average Diameter of Resistance Zones

Table 1. Results of the diameter of the inhibition zone from each concentration

Repetition	Inhibition Zone Diameter (mm) of Each Concentration %				
	0	25	50	75	100
1	0	11,25	16,1	18,45	20,85
2	0	10,65	16,65	15,75	19,25
3	0	11,1	13,15	17,35	18,95
4	0	12,5	15,35	18,75	20,1
ΣY	0	45,5	61,25	70,3	77,65
Ȳ	0	11,38	15,31	17,57	19,77

Statistical Test Results

The results of the analysis of the diameter variant of the growth inhibition zone of *Colletotrichum capsici* due to antimicrobial aloe vera extract, were obtained as shown in Table 2.

Table 2. Analysis of Various Inhibition Zones of Aloe Vera Extract

Sources of Diversity	Free Degree	Total Diversity	Middle Square	F count	F table 0,05
Treatment	4	975,23	243,080	219,64	3,06
Error	15	16,65	1,11		
Total	19	991,888			

Description*: Significantly different in level ($\alpha = 0,05$)

Results of the Assessment of the Feasibility of Learning Media in the Form of Digital Flipbooks

The assessment of the feasibility of learning media in the form of a digital *flipbook* was carried out by a team of 3 experts, namely content experts, media experts, and design experts. The validation team was carried out by three lecturers discussing and testing 40 Biology Education students.

Table 3. Average Data Analysis of Digital *Flipbook* Teaching Materials Assessment

Valuation	Score	Percentage (%)
Contents Member	3,9	78,3
Design Expert	4,09	81,8
Media Members	4	80
Small Group Trial (15 students)	4,41	88,2
Large Group Trial (25 Students)	4,42	88,4
Sum	20,82	416
Average	4,164	83,2

Based on the observation results in the well technique, the diameter of the inhibition zone formed around the well varies according to the difference in the concentration of aloe vera extract given. The concentration given consecutively is 100% concentration which is the highest concentration, 25%, 50%, 75% concentration and 0% concentration as a negative control by using aquades solvent which is a neutral compound that does not contain substances that can inhibit fungal growth *Colletotrichum capsici*, where water functions to help the metabolism take place. Aquades (water) is a neutral compound, does not contain toxins or substances that can inhibit and kill fungal growth *Colletotrichum capsici*. This is because water does not have antimicrobial power but is an essential need of every living

thing. Aquades as a negative control does not form a clear zone in the well. Therefore, aquades is a comparison to see whether or not solvents have an effect on microbial growth (Anatje et al., 2022).

The existence of inhibition zones that are formed varies due to the difference in the concentration of aloe vera extract given. In Table 1, the average inhibition zone formed at each concentration is 11.38 mm for 25% concentration, 15.31 mm for 50% concentration, 17.57 mm for 75% concentration and 19.77 mm for 100% concentration. The results obtained can be interpreted that the higher the concentration of the extract, the wider the inhibition zone formed. This is in accordance with the opinion of Lestari & Susanti (2021) that the diameter of the inhibition zone is formed differently due to the presence of different concentrations of the given extract. This is also supported by the statement of Obistoiu, et al. (2014) that a low concentration of antimicrobial compound components will reduce their antimicrobial activity. The concentration of aloe vera as an antifungal is one of the determining factors in the size of its ability to inhibit fungal growth.

There was a difference in the average inhibition zone from a concentration of 25%, to a concentration of 50%, a concentration of 75%, to a concentration of 100%, which was carried out 4 times. The cause of the inhibition zones forming with different diameters is thought to be due to the difference in concentrations given. The higher the concentration, the wider the inhibition zone formed due to the content of the active substances in the extract, the higher and better the effectiveness in inhibiting fungal growth. This happens due to the increase in the content of phytochemicals that are antimicrobial at the highest concentrations. The results of this study are in accordance with the results of Alouw (2022) which stated that the increase in the concentration of the extract is directly proportional to the increase in the diameter of the inhibition zone, because the more active compounds in the extract increase the ability to inhibit fungal growth.

Different inhibition zones occur on each repeat of each given concentration. At a concentration of 25%, the inhibition zone formed was in the range of 11.25 mm to 12.5 mm, for the concentration of 50% of the inhibition zone formed was in the range of 13.15 mm to 16.65 mm and for the concentration of 75% of the inhibition zone was formed 15.75 mm to 18.75 mm. For 100% concentration, the inhibition zone formed is 18.95 mm to 20.85 mm. The difference in the area of the inhibition zone formed in each replicate from the concentrations of 25%, 50%, 75% and 100% was relatively the same. The difference in the wide range of inhibition zones can be affected by the difference in the diffusion speed of the active compounds present in the agar medium. Over a certain period of time, the speed of diffusion will increase so that the potential for fungal colonies to develop will occur faster if the thickness of the medium exceeds the normal limit, then the diffusion of active compounds will occur more slowly, causing less fertile fungal growth (Aprilia et al., 2017).

Antimicrobial testing of aloe vera extract on the growth of *Colletotrichum capsici* fungus through the well technique, showed that aloe vera extract belongs to the category with "strong" inhibition power having an average area of inhibition zones formed at concentrations of 100%, 75%, 50%, and 25%. The results of the study are in accordance with the opinion of Alioes et al., (2019), if the diameter of the resistance area is less than 10 mm, it is categorized as weak, the resistance area of 10-15 mm is categorized as moderate, the resistance area of 16-20 mm is categorized as strong and if the diameter of the resistance is more than 20 mm, it is categorized as very strong.

Zeniusera et al., (2019) stated that there are several factors that affect the size of the area of the inhibition zone, namely (1) the turbidity of the suspension, (2) the incubation temperature, to obtain optimal growth, the incubation is carried out at 35°C, because sometimes there are less fertile bacteria to grow, (3) the thickness of the agar medium, The thickness of the agar medium is about 4 mm, if it is less than the thickness, then the diffusion of drugs will be slower, and (4) lack of diffusion power into the media.

The findings in this study are strengthened by the results of statistical test analysis such as in Table 2 obtained is $F_{\text{Count}} \geq F_{\text{Table}}$ at the level of 5% with the F_{Count} value of 219.64 greater than F_{Table} 5% which is 3.06. This means that the results of this study received H_1 , which is aloe vera extract, which is effective in inhibiting the growth of *Colletotrichum capsici* fungus. Based on the research, $F_{\text{Count}} \geq F_{\text{Table}}$, then the BNT test was continued, where in Table 3 the results obtained showed the most optimal concentration in inhibiting the growth of *Colletotrichum capsici* fungus. The results of the BNT test show that the most optimal concentration is 100% concentration. This concentration is said to be the most effective in inhibiting because the average difference between treatments is greater than the

difference between other concentrations, which is 19.77 mm. The difference between a concentration of 100% and a concentration of 0% differs significantly or significantly.

Based on the average analysis of data on the assessment of digital *flipbook* teaching materials, it is included in the category of very suitable for use as a learning medium with an overall average score of 83.2%, according to the percentage stated by Adhisa et al., (2022). Learning media in the form of digital *flipbooks* is also in accordance with the opinion of Sugiyono (2015) with an average percentage of eligibility based on the rating scale, which is 75%-100% of the category is very feasible.

CONCLUSION AND SUGGESTION

Based on the results of the research, it can be concluded that Aloe vera extract is effective in inhibiting the growth of *Colletotrichum capsici* fungus, Aloe vera extract is most effective at inhibiting the growth of *Colletotrichum capsici* fungus at a concentration of 100% and the results of this research are very feasible to be used as a biology learning medium in the form of a digital *flipbook*. It is necessary to conduct further tests related to the content of this study using dilution techniques and colony count on the growth of *Colletotrichum capsici* fungi.

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