THE ACTIVITY TEST OF BIDARA LEAF ETHANOL EXTRACT (ZIZIPHUS MAURITIANA) TOWARDS *ESCHERICHIA COLI* BACTERIA

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ABSTRACT

This research aims at investigating the antibacterial activity and optimum concentration of the ethanol extract of bidara leaves (Ziziphus mauritiana) against Escherichia coli bacteria. The method used in this research is a completely randomized design (CRD) consisting of 7 treatments and 4 replicates. The treatments are: P1 (negative control Aquades), P2 (10% concentration), P3 (12.5% concentration), P4 (15% concentration), P5 (17.5% concentration), P6 (20% concentration), and P7 (positive control Ciprofloxacin). The findings reveal that the concentration of ethanol extract of bidara leaves (Ziziphus mauritiana) has activity in inhibiting the growth of Escherichia coli bacteria. From the results of Kruskall-Wallis statistical analysis with a significant value of 0.003 or < 0.05, it appears that there is a dose of ethanol extract of bidara leaves (Ziziphus mauritiana) that affects the growth of Escherichia coli bacteria. After further testing (Duncan test), it was found that there was no significant difference between one concentration and another, so it can be said that the optimum concentration of bidara leaf ethanol extract treatment (Ziziphus mauritiana) in inhibiting the growth of Escherichia coli bacteria is at a concentration of 10%.

Keywords: Bidara leaf ethanol extract (Ziziphus mauritiana), Antibacterial Activity, and Escherichia coli Bacteria

INTRODUCTION

Infectious disease is a condition caused by pathogenic microorganisms with or without clinical symptoms. In some developing countries such as Indonesia, infectious diseases are one of the most important health problems. Based on the Indonesian Health Profile (2019), infectious diseases are a contributor to death in children aged 29 days to 11 months. Infections are caused by microorganisms such as bacteria, viruses, fungi, or parasites [15].

The cause of infection is influenced by several factors, one of which is unhealthy environmental conditions such as lack of public awareness of the importance of maintaining environmental cleanliness, poor environmental conditions can trigger various diseases. Epidemiologically, the spread of infectious diseases due to adverse environmental conditions includes dengue fever, diarrhea, intestinal worms, and acute respiratory infections [11].

The spread of the disease can be caused by groups of pathogenic bacteria. According to Jayanti (2020), the most frequent cause of infection is *Escherichia coli* bacteria. *E. coli* bacteria are gram-negative bacteria that normally live in the digestive tract but will be pathogenic if they leave their habitat. Escherchia coli ranks first in the Enterobacteriaceae group and is therefore responsible for increased treatment costs,

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morbidity, and mortality [21]. Based on research conducted by Cho (2018) E. coli bacteria are classified as dangerous bacteria, which can cause various diseases such as diluted diarrhea, bloody diarrhea, urinary tract infections, meningitis and up to death.

Giving antibiotics is one of the therapies in dealing with infectious diseases. The selection of the right antibiotic during the recovery period contributes to the improvement of the patient's clinical condition and vice versa inappropriate antibiotic selection will potentially cause antibiotic resistance [18].

The existence of antibiotic resistance, causing a decrease in the ability of these antibiotics to treat infections and diseases in humans, animals and plants. It can also lead to problems such as increased morbidity rates and death, increased cost and length of treatment, and increased side effects [32]. To overcome this, the development of the use of traditional medicinal plants can be carried out. According to Botalaha (2021), traditional medicinal plants have relatively smaller side effects and relatively cheaper prices. One plant that has potential as traditional medicine is the bidara plant (*Ziziphus mauritiana*).

The bidara plant (*Ziziphus mauritiana*) is a shrub or small, thorny tree that grows in tropical regions such as Indonesia. In Tutulo Village, Boalemo Regency, this plant grows a lot and is used by the local community as a febrifuge, antihypertensive drug and can overcome digestive problems such as diarrhea. In some research, bidara plants (*Ziziphus mauritiana*) are plants that have various health benefits including antibacterial, antipyretic, and anti-inflammatory [28]. The content of chemical compounds such as flavonoids, saponins, tannins and phenols can act as antibacterial [2]. Based on previous research, this plant has antibacterial activity because it can inhibit the growth of bacteria such as *Staphylococus aureus* and *Staphylococus muntas* bacteria. In *Staphylococus aureus* bacteria, the diameter of the resulting inhibitory zone is 11 mm, while in *Staphylococus muntas* bacteria it is 12-16 mm [10,19].

This study aims to determine the antibacterial activity and optimum concentration of ethanol extract of bidara leaves (*Ziziphus mauritiana*) in inhibiting the growth of *Escherichia coli* bacteria.

RESEARCH METHODS

2.1 Tools and Materials

The tools used in this study are autoclaves, ovens, incubators, Laminar Air Flow (LAF), spectrophotometers, shakers, stirrers, analytical scales, hot plates, calipers, analytical scales, micropipettes, petri dishes, beakers, erlemeyers, measuring cups, split funnels, tube racks and test tubes, bottle containers, jar containers, bunsen, tweezers, drip pipettes.

The ingredients used in this study were ethanol extract of bidara (*Ziziphus mauritiana*), magnesium (Mg) and hydrochloric acid (concentrated HCl), FeCl3, aquadest, Muller Hinton Agar (MHA), ethanol 96%, aniseptic 70%, Ciprofloxacin, *Escherichia coli* bacterial culture, aluminum foil, plastic wrapping, cotton, tissue, filter paper, disc paper.

2.2 Work Procedure

2.2.1 Sample Setup

a. Raw Material Picking

Bidara leaf raw material (*Ziziphus mauritiana*) is obtained from Tutulo village, Botumoito District, Boalemo Regency. The part of the bidara plant (*Ziziphus mauritiana*) taken is the fresh (non-diseased) leaf part [24].

b. Simplisia Processing

The processing technique of bidara leaf simplisia (*Ziziphus mauritiana*) consists of wet sorting, washing, drying, dry sorting and storage. Then the simplisia is weighed wet weight and dry rice and then calculated the moisture content of the simplisia using the following formula.

$$\% \text{ Water content} = \frac{wet\ simplisia - dry\ simplisia}{wet\ simplisia} \text{x} 100\%$$

c. Extraction

Bidara leaf simplisia (*Ziziphus mauritiana*) was extracted using the maceration method (soaking), where bidara leaf powder (*Ziziphus mauritiana*) was weighed as much as 400 grams, put in a maceration container, soaked with a 96% ethanol filter solution as much as 2 liters. Then the maceration container is closed with a container cover covered with aluminum foil and soaked for 3x24 hours at room temperature without being exposed to direct sunlight, (while stirring using a digital overhead stirrer) so that an extract is still mixed with solvent. Next, the extract is filtered using filter paper which produces mafiber I and residue. Then the residue is added with 2 L of solvent and soaked for 3x24 hours, then filtered with filter paper and produces maserat II. Maserat I and II are mixed and filtered with a strained rice. The extract obtained is then concentrated using a shaker to remove the solvent contained in the extract so that a thick extract is obtained. A shaker is a liquid mixer or shaker used in laboratories to homogenize a material or solution [12]. Next, the extract is weighed and then the yield is calculated with the following formula:.

$$\%\text{Rendemen} = \frac{\text{Amount of weight of viscous extract}(g)}{amount\ of\ dry\ weight\ (g)} \text{x} 100\%$$

d. Phytochemical Screening

Phytochemical screening testing was carried out on 4 compounds, namely flavonoids, saponins, tannins and phenols.

Flavonoid testing was carried out by reacting a solution of ethanol extract of bidara leaves (*Ziziphus mauritiana*) with concentrated magnesium and HCl powder reagents. If red, yellow, orange colors are formed in the mixture indicates the presence of flavonoid compounds [9].

Saponin testing was carried out by reacting a solution of ethanol extract of bidara leaves (*Ziziphus mauritiana*) with hot aquades that were strongly coated for 10 seconds. If foam forms that do not disappear for 10 minutes, it indicates the presence of saponin compounds [25].

Tannins and phenol tests were carried out by reacting a solution of ethanol extract of bidara leaves (*Ziziphus mauritiana*) with FeCl3 reagents. If there is a change in color to a blackish-green color, it positively contains tannins and phenol compounds [17].

e. Determination of Bidara Leaf Extract (*Ziziphus mauritiana*) Concentration 10%, 12.5%, 15%,17.5% and 20%

The use of this concentration is based on the fact that it still uses viscous extracts. Making a concentration of 10% was carried out weighing 1 g of bidara leaf extract dissolved with 10 mL of aquades. For a concentration of 12.5%, 1.25 g of bidara leaf extract was weighed dissolved with 10 mL of aquade. A concentration of 15% weighed 1.5 g of bidara leaf extract dissolved with 10 mL of aquade. The concentration of 17.5% weighed 1.75 g of bidara leaf extract dissolved with 10 mL of aquade. While the concentration of 20% weighed 2 g of bidara leaf extract dissolved with 10 mL of aquades.

2.2.2 Antibacterial Activity Test

a. Sterilization Of Tools And Materials

The tools to be used are first washed with detergent and then rinsed with aquades. Tools made of glass are wrapped in white hvs paper and sterilized using an oven with a temperature of 170 ° C for 1 hour. Ose needles and tweezers are sterilized using a spritus lamp for 30 seconds. Rubber and plastic tools (not resistant to high-temperature heating) were sterilized by autoclave at 121°C for 15 minutes. Laminar Air Flow (LAF) is cleaned of dust then sprayed with 70% ethanol left for 15 minutes and sterilized with a UV lamp for 5 minutes before use.

b. Manufacture of Bacterial Suspension

The test bacteria are rejuvenated first by being taken using an ose needle, then implanted in the media to tilt it by scratching in a zigzag manner. Then it is opened at a temperature of 37ºC for 18-24 hours. The rejuvenated test bacteria were each specimated in a sterile 0.9% w/v NaCl solution. Bacterial suspensions are measured for transmittance value or Optical Density (OD) using a spectrophotometer. Optical density measurement using a spectrophotometer aims to calculate the population density of Escherichia coli bacteria or to determine the number of surviving *Escherichia coli* bacteria, based on the number of colonies that grow. The bacterial culture is inserted into the cuvette to the limit mark and inserted into the spectro then measured the transmittance value using a spectrophotometer at 580 nm until a 25% transmittance is obtained equal to 1x106 (1,000,000) bacterial colonies.

c. MHA Media Creation

The media used in this study was Muller Hinton Agar (MHA). The MHA media to be used is weighed as much as 2.28 gr then poured into 100 ml erlemeyer and then dissolved with 60 ml aquadest stir until dissolved. After dissolving, the media is heated using a hot plate at a temperature of 200ºC. Then the media is sterilized using an autoclave at a temperature of 121ºC for 15 minutes. This medium will be used in antibacterial testing.

d. Antibacterial Testing

This antibacterial test uses the pour plate method. The activity testing using the pour plate method is as follows.

1) Prepared tools and materials to be used
2) Paper disc is prepared then the disc paper is soaked into ethanol extract of bidara leaves that have been dissolved with concentration variations of 10%, 12.5%, 15%, 17.5% and 20% for 30 minutes
3) Poured cultures of *Escherichia coli* bacteria using micropipettes as much as 1 ml into sterilized petri dishes
4) Put the sterilized MHA media into a dish containing cultures of *Escherichia coli* bacteria and then let it stand until it solidifies.
5) Paper discs that have been soaked in positive control (ciprofloxacin), negative control (aquaades) and ethanol extract of bidara leaves (*Ziziphus mauritiana*) are taken and then attached to the surface of MHA media
6) Incubated each petri dish for 1x24 hours at 37°C.
7) The diameter of the inhibitory zone of each resulting treatment is measured using a caliper.
8) Recorded measurement results from each treatment

2.2.3 Data Analysis

Data analysis in this study used the SPSS Statistical test. If the data meets the requirements of the parametric test, Wet Weight (Simplisia)the One Way Anova test is used. If the data does not meet the

parametric requirements (homogeneous and normally distributed) then proceed with a non-parametric alternative test, namely Kruskal Wallis.

RESEARCH RESULTS

3.1 Descriptive Analysis

The results of the research that has been carried out will be described as follows.

a. Simplisia Water Content Results

The moisture content results from weighing the wet weight and dry weight of bidara leaf simplisia (*Ziziphus mauritiana*) obtained a high percentage result, while the complete data can be seen in Table 1.

Table 1. Moisture Content Results of Bidara Leaf Simplisia (*Ziziphus mauritiana*)

Wet Weight (Simplisia)	Dry Weight (Simplisia)	Water Content
440 grams	400 grams	9%

Source: Processed Data, 2023

Based on the data in Table 1, it can be seen that the results of weighing wet weight and dry weight of bidara leaf simplisia (*Ziziphus mauritiana*) were obtained respectively weighing 440 grams of wet simplisia and 400 grams of dry simplisia with a moisture content value of 9%.

b. Extract Yield Results

The extraction process of ethanol extract of bidara leaves (*Ziziphus mauritiana*) is carried out using maceration method. The maceration results are then calculated the yield value to determine the percentage of the remaining amount of material. The yield of angel leaf ethanol extract (*Ziziphus mauritiana*) can be seen in Table 2

Table 2. Yield Results of Bidara Leaf Ethanol Extract (*Ziziphus mauritiana*)

Dry Weight (Simplisia)	Weight of Viscous Extract	Rendemen
400 grams	79,8 grams	19,95 %

Source: Processed Data, 2023

Based on Table 2 shows the yield of ethanol extract of bidara leaves (*Ziziphus mauritiana*) from 400 grams of dried simplisia maceration then obtained a thick extract weight of 79.8 grams so as to produce a yield value of 19.95%.

c. Phytochemical Screening Results

Phytochemical screening of angel leaf ethanol extract (*Ziziphus mauritiana*) was tested on 4 secondary metabolite compounds using appropriate reagents. The results of phytochemical screening can be seen in Table 3

Table 3. Phytochemical Screening Results of Bidara Leaf Ethanol Extract (*Ziziphus mauritiana*)

Phytochemical Screening Test	Reagents	Picture	Ket
Flavonoid	Mg and HCL		+
Saponin	Aquades		+
Tannin	$FeCl_3$		+
Fenol	$FeCl_3$		+

Source: Processed Data, 2023

Table 3 shows testing of 4 secondary metabolite compounds as antibacterial

from ethanol extract of bidara leaves (Ziziphus mauritiana) including flavonoids, saponins, tannins and phenols. Testing each secondary metabolitt compound using the appropriate reagents as shown in the table. From the four tests, positive results were obtained which were characterized by the occurrence of reactions in each test of metabolite compounds.

d. Antibacterial Test Results

Observation of the activity of angel leaf ethanol extract (*Ziziphus mauritiana*) against Escherichia coli bacteria was carried out by measuring each clear zone formed in each treatment using a caliper with the results obtained can be seen in Table 4.

Table 4. Results of Measurement of the Inhibition Zone of Bidara Leaf Ethanol Extract (*Ziziphus mauritiana*) Against the Growth of *E. coli* Bacteria

Treatment	Average Diameter of the Inhibitory Zone (mm)	
	E coli	Category
Nrgative Control	-	-
10%	9,55	Keep
12,5%	10,77	Keep
15%	10,85	Keep
17,5%	11,10	Strong
20%	12,76	Strong
Positive Control	28,67	Very Powerful

Source: Processed Data, 2023

Table 4 shows the activity of ethanol extract of bidara leaves (*Ziziphus mauritiana*) against *Escherichia coli* bacteria can be seen in the average diameter of the inhibitory zone of Flavonoids Flavonoids formed. In this study consisted of 7 treatments including negarif control (Aquades), concentration of 10%, 12.5%, 15%, 17.5%, 20% and positive control (Ciprofloxacin). The average value of diameter is categorized based on the criteria of inhibitory zones i.e. weak, medium, strong and very strong.

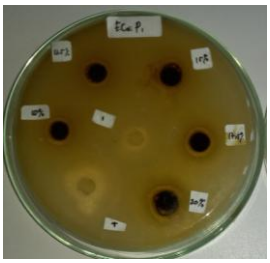

Figure 1. Inhibition zone of angel leaf ethanol extract against the growth of *E. coli* bacteria

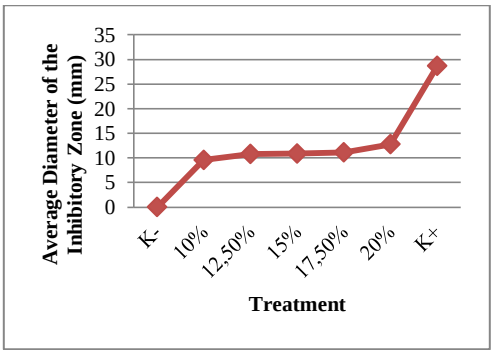

Figure 2. Average diamtere zone inhibition of ethanol extract of bidara leaves (*Ziziphus mauritiana*) against the growth of *E. coli* bacteria

The results obtained in measuring the diameter of the inhibitory zone of each control solution and the concentration of ethanol extract of bidara leaves (*Ziziphus mauritiana*) showed average values at concentrations of 10% of 9.55 mm (medium), 12.5% of 10.77 (medium), 15% of 10.85 mm (medium), 17.5% of 11.10 mm (strong), 20% of 12.76 (strong) and positive control (Ciprofloxacin) of 28.67 mm (very strong). While in the negative control using Aquades no clear zone was formed. Based on Figure 4.1 that the

average diameter of the inhibitory zone against 7 treatments has increased [26].

3.2 Statistical Analysis

Based on non-parametric statistical tests using wallis crucials with a level of 5% or 0.05, it was found that hypothesis 1 was accepted, namely the presence of a dose of ethanol extract of bidara leaves (Ziziphus mauritiana) against the large inhibitory zone in Escherichia coli bacteria, then further tests were carried out using Duncan's analysis test. The results obtained from the wallis crucial test obtained asymp value. Pig 0.003 or <0.05, it can be said that there is a dose of ethanol extract of bidara leaves (Ziziphus mauritiana) against the large inhibitory zone in Escherichia coli bacteria or which means that the conclusion of the hypothesis, namely H0, is rejected and H1 is accepted. Furthermore, the Duncan test was carried out to see the optimum concentration of ethanol extract of bidara leaves (Ziziphus mauritiana) against the growth of Escherichia coli bacteria. The results of Duncan's analysis test can be seen in Table 5.

Table 5. Duncan Test Results of Bidara Leaf Ethanol Extract (*Ziziphus mauritiana*) Against *Escherichia coli* Bacteria

Treatment	*Escherichia coli*	
	Average	Symbol
Negative Control	0,00	a
10%	9,55	b
12,5%	10,77	b
15%	10,85	b
17,5%	11,10	b
20%	12,76	b
Positive Control	28,67	c

Source: Processed Data,2023

Ket. Numbers followed by the same letter in the same column do not differ markedly, whereas different letters in different columns show a marked difference according to Duncan's test at a confidence level of 5% or 0.05.

Based on the results of Duncan's test analysis on negative controls differed markedly with concentrations of ethanol extract of bidara leaves (*Ziziphus mauritiana*) concentrations of 10%, 12.5%, 15%, 17.5%, 20% and positive controls. The concentration of 10% did not differ markedly from concentrations of 12.5%, 15% and 17.5% and 20% but differed markedly from the positive control. While positive controls differ markedly from negative controls, concentrations of 10%, 12.5%, 15%, 17.5% and 20%.

DISCUSSION

From the drying of 440 grams of bidara leaves (*Ziziphus mauritiana*) obtained 400 grams of bidara leaf powder (*Ziziphus mauritiana*) and obtained a moisture content value of 9%. These results show that the moisture content value in bidara leaf simplisia (*Ziziphus mauritiana*) has met the minimum requirements set by SNI. According to traditional SNI, the allowable moisture content is 10%. Water content can affect physical properties (hardness and dryness) and physico-chemical properties, chemical changes (enzyme browning, microbiological damage, and enzymatic changes) [29].

Based on Table 4.2, the yield value of angel leaf ethanol extract (*Ziziphus mauritiana*) obtained was 19.95%. The yield percentage describes the many bioactives attracted from the bidara plant (*Ziziphus mauritiana*). Senduk (2020) states that the higher the yield value of the extract, the higher the content of the substance attracted. Good yield value if the value is more than 10%. The length of maceration time can affect the yield results to be obtained. This is

because the longer extraction time causes a longer heating effect and longer contact between solids and solvents which will increase the number of cells that break and the active ingredient dissolved [7].

The phytochemical screening results in Table 4.3 showed that the ethanol extract of bidara leaves (*Ziziphus mauritiana*) tested positive. The color change formed in the flavonoid test shows an interaction between the ethanol extract of bidara leaves (*Ziziphus mauritiana*) with magnesium powder and concentrated HCl, where the reagent will reduce the benzopiron core contained in the flavonoid structure so that red or orange flavilium salts are formed [20].

The formation of foam or foam in the saponin test indicates an interaction between the ethanol extract of bidara leaves (*Ziziphus mauritiana*) with hot aquades during the shaking process where glycosides in saponins will form foam in hydrolyzed water to produce aglycone and glucose [30].

In the tannin test, the blackish-green color change is caused by the reaction of adding $FeCl^3$ with one of the hydroxyl groups present in the tannin compound. The addition of $FeCl^3$ that causes discoloration indicates the presence of condensed tannins [17]. $FeCl^3$ is also used to determine if a sample contains phenol groups. The presence of phenol groups is indicated by a blackish-green color. This color change occurs because the ethanol extract of bidara leaves (*Ziziphus mauritiana*) contains polyphenolic compounds which are thought to be tannin compounds. The formation of complex compounds between tannins and FeCl3 due to the presence of Fe^3+ ions as the central atom and tannins have an O atom that has a lone pair of electrons that can coordinate to the central atom as its ligand. The Fe^3+ ion in the above reaction binds three tannins that have 2 donor atoms, namely the O atom at the 4' and 5' dihydroxy positions, so that there are six lone pairs of electrons that can be coordinated to the central atom. The O atoms at positions 4' and 5' of the dihydroxy have the lowest energy in the formation of complex compounds, making it possible to become a ligand [17].

The results of measuring the inhibitory zone of angel leaf ethanol extract (*Ziziphus mauritiana*) against the growth of *Escherichia coli* bacteria can be seen in Table 4.4. Based on the results obtained in measuring the diameter of the inhibitory zone, each concentration of ethanol extract of bidara leaves (*Ziziphus mauritiana*) showed a concentration of 10% of 9.55 mm, a concentration of 12.5% of 10.77 mm, a concentration of 15% of 10.85 mm, a concentration of 17.5% of 11.10 mm, a concentration of 20% of 12.76 mm. Variations in various concentrations have shown inhibition of the growth of *Eschericia coli* bacteria. If grouped in the inhibitory zone category, concentrations of 10%, 12.5% and 15% fall into the medium category because the diameter obtained ranges from 6-10 mm. The inhibitory effect is stronger at concentrations of 17.5% and 20% because it has an inhibitory zone diameter between the range of 10-20 mm (strong).

The positive control using Ciprofloxacin with the diameter of the inhibitory zone showed the greatest value among all treatments with an average value of 28.67 mm. This positive control is categorized as very strong because it has an average value of more than 21 mm [32]. Ciprofloxacin belongs to the Floroquinolone group which is a broad-spectrum antibiotic widely used in the treatment of antibacterial infections [1]. For negative controls using Aquades in this study did not form a clear

zone because aquades do not have antibacterial abilities. According to Suciarti in Anggraini (2022), aquades are not able to affect bacterial growth because aquades are neutral compounds.

Based on the results described above, it was found that the concentration of ethanol extract of bidara leaves (*Ziziphus mauritiana*) which showed the lowest inhibitory zone was at a concentration of 10% while the highest zone was at a concentration of 20%. This indicates that there is an increase in the inhibitory effect of each addition of the concentration value. Therefore, the concentration and the inhibitory zone have a relationship, where the higher the concentration of the extract, the greater the inhibitory zone formed, meaning that antibacterial compounds in the ethanol extract of bidara leaves (*Ziziphus mauritiana*) at higher concentrations have a strong inhibitory power in inhibiting *Escherichia coli* bacteria [26].

In the results of statistical analysis using the Kriskall Wallis test showed a significant value of 0.003 or <0.05, it can be said that there is a dose of bidara leaves (*Ziziphus mauritiana*) and the use of negative and positive controls on the size of the inhibitory zone in *Esccherichia coli* bacteria or which means the conclusion of the hypothesis that H0 is rejected and H1 is accepted. Then after further tests using the Duncan test, the results obtained were that there was no significant difference between one concentration and another concentration but significantly different between negative control and positive control, it can be said that the optimum concentration of bidara leaf extract treatment (*Ziziphus mauritiana*) in inhibiting the growth of *Escherichia coli* bacteria is at a concentration of 10%.

The presence of antibacterial activity in each concentration treatment due to the antibacterial compounds contained in bidara leaves (*Ziziphus mauritiana*). Antibacterial compounds owned are the result of metabolites from plants stored in these plant parts. The content of secondary metabolites of a plant depends on the environment in which the plant lives [13]. According to Aisyah, et al. (2020) in their research explained that in bidara plants (*Ziziphus mauritiana*) there are antibacterial compounds that have the ability to inhibit bacterial growth including flavonoids, saponins, tannins and phenols.

Flavonoids constitute the largest group of phenolic compounds in nature. Based on several studies, it is reported that flavonoids can function as antibacterials. According to Wahyuni &; Karim (2020), flavonoids as antibacterial can damage bacterial cell wall permeability and inhibit bacterial motility.

According to Ravelliani (2021), saponins are glycosides of aglycone which are included in the triterpene and sterol glycoside groups. Saponins have many uses for health including, as antiviral, antitumor, anti-inflammatory, antifungal, antibacterial. The mechanism of saponins as antibacterial where saponins have molecules that can attract water (hydrophilic) and moleul that can dissolve fat (lipophilic) so that it can reduce cell surface tension which eventually causes the destruction of bacteria [31].

Tannin compounds have antibacterial activity because they can constrict the cell wall so that it interferes with cell wall permeability, consequently inhibiting bacterial growth or even death [22].

According to Volk & Wheleer in Anuzar (2022), phenol can interfere with peptidoglycan in the cell wall so that cell wall synthesis will be disrupted. In addition, phenols can cause damage to bacterial cells, denature proteins, activate enzymes and cause cell leakage [5].

In general, the mechanism of inhibition of microorganisms carried out by antibacterial compounds can be caused by several factors, including disrupting cell membrane permeability compounds which can cause loss of cell components and inactivating enzymes [26;].

CONCLUSION

Based on the results of research and data processing that has been carried out by researchers, it can be concluded that:

1. There is antibacterial activity of angel leaf ethanol extract (*Ziziphus mauritiana*) against the growth of *Escherichia coli* bacteria
2. The optimum ethanol extract of bidara leaves (*Ziziphus mauritiana*) in inhibiting the growth of *Escherichia coli* bacteria is at a concentration of 10%

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