

ANTIMICROBIAL ACTIVITY TEST OF ALOE VERA PLANT EXTRACT: A REVIEW ARTICLE

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ABSTRACT:

Introduction: One of the nutritious medicinal plants is *Aloe vera*. *Aloe vera* has various benefits such as the manufacture of commercial products, such as food products and cosmetics. *Aloe vera* contains chemical compounds such as flavonoids, tannins, saponins, terpenoids, acemannan, anthraquinone, aloin, and aloe-emodin which are known to have antimicrobial effects.

Objective: To summarize the latest shreds of evidence through full-length studies performed during the last ten years on the antipathogenic activity of *Aloe vera* L.

Methodology: The literature available was searched on the online media using keywords, “antimicrobial and *Aloe vera*”. The main reference searches in this review article were through Google Scholar, ScienceDirect, ResearchGate, and other articles published in different journals.

Results: It was found that *aloe vera* (*Aloe vera*) has antimicrobial activity that can inhibit the growth of several pathogenic microbes. In the reviewed literature, there are extracts, gels, mucus, and sap from *aloe vera*, it is found that the higher the concentration used, the higher the levels of the active compounds present. The *Aloe vera* extracts caused the larger concentrations of the antimicrobial activity, the larger is the inhibition of pathogenic growth zone.

Keywords: *Aloe vera*, antimicrobial

INTRODUCTION

Indonesia has a wealth and diversity of plants. Most of these plants are useful as medicinal plants. Medicinal plants are plants in which one, several, or all parts of the plant contain active substances that are nutritious for health. In Indonesia, there are about 20,000 types of plants that can be used as medicinal plants [1]. The use of plants as medicine is also to reduce the level of resistance to antibiotics. Resistance in the use of antibiotics is a big problem, therefore the solution is by utilizing existing natural resources because the best source of medicine is medicinal plants derived from nature [2]. One of the plants commonly used as a medicinal plant is *Aloe vera* (*Aloe vera* L).

Aloe vera has been used by the Samaritans around 1875 BC and the ancient Egyptians around 1500 BC used as an herbal plant. The physical characteristics of this plant are green, large spiny leaves, and contain a lot of gel. The plant stems are short, have circular sap leaves. Leaves 40-90cm long, 6-13cm wide with a thickness of approximately 2.5cm [3].

Aloe vera has been used by all countries in the world as medicine in curing various diseases. *Aloe vera* contains about 75 active ingredients that have been identified and have therapeutic effects. The polysaccharide content in *Aloe vera* leaves is related to the biological activity of *Aloe vera*, supported by the synergistic effect of various other ingredients in the plant. *Aloe vera* meat has been used extensively in commercial products for example for food products and cosmetics [4].

Aloe vera has broad-spectrum antibacterial activity, both to inhibit gram-positive and negative bacteria. The antibacterial mechanism of *Aloe vera* is due to the synergistic effect of various plant ingredients such as anthraquinone, aloin, aloe-emodin, chromones, oleoresin D, and isoaloeresin D. Other

ingredients such as pyrocatechol, cinnamic acid which is a phenolic group, p-coumaric acid, ascorbic acid as well. supports as an antibacterial anti-bacterial. Identified phytochemicals such as saponins, glycosides, alkaloids, and tannins are active ingredients that have the potential to be antibacterial [5].

As an antibacterial, *aloe vera* contains campesterol, sitosterol, and lupeol. *Aloe vera* also has useful ingredients including tannins, amino acids, anthraquinones, which are phenolic compounds found in *Aloe vera* sap. *Aloe vera* is also used as a medicinal ingredient such as to treat burns, hair loss, and pain in the digestive tract [6].

Kingdom:	Plantae
Sub Kingdom:	Tracheobionta
Super Division:	Spermatophyta
Division:	Magnoliopsida
Class:	Liliopsida
Order:	Asparagales
Genus:	Aloe
Species:	<i>Aloe vera</i> L

METHODOLOGY

Literature Search Strategy

In writing, this review article using literary study techniques were used by finding literature in the form of official books, national journals, and international journals in the last ten years (2010-2020). A literature search in writing this review article also uses online media with keywords, namely antimicrobial and *Aloe vera*. The main reference searches in this review article were through Google Scholar, ScienceDirect, ResearchGate, and other published articles published in different journals.

RESULT AND DISCUSSION

A total of forty publications on the Antimicrobial Activity Test of *Aloe vera* were found, from the initial forty studies, after screening these studies twenty studies which met the criteria those who met the criteria were selected for the final analysis.



Figure 1. *Aloe vera* [7]

Scientific Classification

Table 1. Search results of the published articles in relevant Journals.

NO	JOURNAL TITLE	MICROBES TESTED	METHODs	SEARCH RESULTS FROM THE JOURNAL	REF:
1	Activity Test of <i>Aloe Vera</i> (<i>Aloe vera</i>) Leaf Ethanol Extract Against <i>Staphylococcus aureus</i> and <i>Candida albicans</i> Growth Inhibition	<i>Staphylococcus aureus</i> <i>Candida albicans</i>	Diffusion	The antimicrobial activity of ethanol extract against <i>Staphylococcus aureus</i> showed the highest inhibition zone diameter at a concentration of 3.5%, namely 10.8 mm, and the highest inhibition zone diameter against <i>Candida albicans</i> at a concentration of 12%, namely 18.87 mm.	[8]
2	The Antimicrobial Effect of <i>Aloe vera</i> (<i>Aloe vera</i>) Extract Against Bacterial Isolates That Cause Acne Vulgaris In Vitro	<i>Staphylococcus aureus</i> <i>Propionibacterium acne</i>	Diffusion	The highest diameter of inhibition resulted in the test of ethanol extract of <i>Aloe vera</i> leaf bark against <i>Staphylococcus aureus</i> test bacteria at a concentration of 75%, namely 9.14 mm, for <i>Propionibacterium acne</i> at a concentration of 75%, namely 15.8 mm.	[9]
3	Inhibition of <i>Aloe vera</i> (<i>Aloe barbadensis</i> Miller) Leaf Bark Extract Against the Growth of <i>Staphylococcus aureus</i> ATCC 25923 and <i>Escherichia coli</i> ATCC 25922	<i>Staphylococcus aureus</i> <i>Escherichia coli</i>	Kirby-Bauer	The highest diameter of inhibition resulted from the methanol extract of <i>Aloe vera</i> leaf bark against <i>Staphylococcus aureus</i> and <i>Escherichia coli</i> at a concentration of 100%, the diameter of the inhibition zone, respectively, 11.58 mm and 6.81 mm.	[10]

4	The Effect of <i>Aloe vera</i> (<i>Aloe vera</i> L) Leaf Extract on <i>Candida albicans</i> Fungal Growth Bacteria by In Vitro	<i>Candida albicans</i>	Diffusion	The antimicrobial activity of the ethanol extract of <i>Aloe vera</i> leaves at concentrations of 100%, 50%, and 25% can form an inhibition zone in <i>Candida albicans</i> fungi with an average diameter of 13.4 mm, 6.4 mm, and 5.4 mm.	[11]
5	Testing the Antibacterial Activity of Liquid Soap from <i>Aloe vera</i> Leaf Bark Extract	<i>Staphylococcus aureus</i> <i>Staphylococcus epidermidis</i> <i>Bacillus subtilis</i> <i>Bacillus cereus</i> <i>Salmonella typhimurium</i> <i>Proteus mirabilis</i> <i>Pseudomonas aeruginosa</i> <i>Escherichia coli</i>	Diffusion	The antibacterial activity of the ethanol extract of <i>Aloe vera</i> leaf bark on liquid soap showed the highest average diameter of the inhibition zone in gram-negative bacteria <i>Pseudomonas aeruginosa</i> of 11.59 ± 0.27 mm, and the highest average diameter of the inhibition zone in gram-positive bacteria <i>Bacillus subtilis</i> of 11.08 ± 0.47 mm.	[12]
6	Inhibition of <i>Aloe vera</i> (<i>Aloe barbadensis</i> Miller) Extract Against The Growth of <i>Staphylococcus aureus</i> Bacteria In Vitro	<i>Staphylococcus aureus</i>	Diffusion	Testing the inhibition of <i>Aloe vera</i> ethanol extract against <i>Staphylococcus aureus</i> bacteria with the highest inhibition zone diameter at a concentration of 100% with an average inhibition zone of 9.00 ± 0.40 mm.	[13]
7	Antibacterial activity and phytochemical analysis of <i>Aloe vera</i> against Clinical Isolates	<i>Escherichia coli</i> <i>Klebsiella pneumonia</i> <i>Pseudomonas aeruginosa</i> <i>Staphylococcus aureus</i> <i>Streptococcus pyogens</i>	Diffusion	The test results of <i>Aloe vera</i> extract methanol in a concentration of 1000 μ l, the highest inhibition zone was for <i>Klebsiella pneumonia</i> bacteria, namely 20 mm, and methanol extract on <i>Staphylococcus aureus</i> bacteria with an inhibition zone of 11 mm.	[14]
8	Antimicrobial activity of <i>Aloe vera</i> leaf extract	<i>Staphylococcus aureus</i> <i>Klebsiella pneumonia</i> <i>Escherichia coli</i> <i>Aspergillus Niger</i> <i>Candida albicans</i>	Diffusion	Antimicrobial activity of methanol extract, petroleum ether, and chloroform of <i>Aloe vera</i> leaves showed the highest inhibition zone diameter in methanol extract of 22 mm at a concentration of 20 mg against <i>Escherichia coli</i> , petroleum ether extract at a concentration of 40 mg against <i>Staphylococcus aureus</i> , and <i>Klebsiella sp</i> , chloroform extract of 20 mm at a concentration of 40 mg against <i>Candida albicans</i> .	[15]
9	Determination of FICI Value Combination of <i>Aloe vera</i> (<i>Aloe vera</i> L) Leaf Bark Extract and Gentamicin sulfate against <i>Staphylococcus aureus</i> bacteria	<i>Staphylococcus aureus</i>	Kirby-Bauer	The test results of the combination of 2.5 mg/ml <i>Aloe vera</i> leaf ethanol extract and 5 μ g/ml gentamicin sulfate showed an average inhibition of 7.63 mm against <i>Staphylococcus aureus</i> bacteria.	[16]
10	Antibacterial Activity of <i>Aloe vera</i> Against Skin Pathogens	<i>Staphylococcus aureus</i> <i>Staphylococcus epidermidis</i> <i>Escherichia coli</i> <i>Proteus Vulgaris</i> <i>Pseudomonas aeruginosa</i> <i>Klebsiella pneumonia</i> <i>Proteus mirabilis</i>	Diffusion	The antimicrobial activity of the zone of inhibition of <i>Aloe vera</i> methanol extract was highest in <i>Staphylococcus aureus</i> and <i>Staphylococcus epidermidis</i> with inhibition zone diameter of 12 mm and 11 mm, in <i>Escherichia coli</i> and <i>Proteus Vulgaris</i> that was 10 mm, and the lowest inhibition zone was in <i>Pseudomonas aeruginosa</i> 9 mm, <i>Klebsiella pneumonia</i> , and <i>Proteus mirabilis</i> 7 mm.	[17]
11	Inhibition of <i>Aloe vera</i> (<i>Aloe vera</i>) against the growth of <i>Streptococcus mutans</i> bacteria	<i>Streptococcus mutans</i>	Quasi eksperiment	The diameter of the inhibition zone formed from <i>Aloe vera</i> sap against <i>Streptococcus mutans</i> at concentrations of 100%, 75%, and 50% with inhibition of 20.7 mm, 10.26 mm, and 10.15 mm.	[18]
12	Antimicrobial Activity and Minimum Inhibitory Concentration Of <i>Aloe vera</i> Sap And Leaves Using Different Extracts	<i>Escherichia coli</i> <i>Pseudomonas aeruginosa</i> <i>Bacillus subtilis</i> <i>Staphylococcus aureus</i>	Diffusion	The average minimum inhibition zone of methanol extract from <i>Aloe vera</i> sap in a concentration of 50 (μ g/ml) in <i>Escherichia coli</i> was 36 mm, <i>Pseudomonas aeruginosa</i> 35 mm, <i>Bacillus subtilis</i> 30 mm, <i>Staphylococcus aureus</i> 36 mm, <i>Candida albicans</i> 30 mm, and	[19]

				<i>Aspergillus niger</i> 28 mm.	
13	Antimicrobial Activity of <i>Aloe vera</i> (<i>Aloe vera</i> L) Gel on acne vulgaris infected with <i>Staphylococcus sp</i> In Vitro	<i>Staphylococcus aureus</i>	Diffusion	The antimicrobial activity test of <i>Aloe vera</i> gel against <i>Staphylococcus aureus</i> showed the highest average was 9.50 mm and the lowest was 8.67 mm.	[20]
14	Antibacterial Activity of <i>Aloe vera</i> Gel against <i>Staphylococcus aureus</i>	<i>Staphylococcus aureus</i>	Diffusion	The results of the measurement of the inhibition zone for the antibacterial activity of <i>Aloe vera</i> gel against <i>Staphylococcus aureus</i> bacteria showed that the highest inhibition zone diameter was at a concentration of 70% with a diameter of 12.81 mm, and the lowest inhibition zone was at a concentration of 30% with a diameter of 4.75 mm.	[21]
15	Minimal concentration test of <i>Aloe vera</i> gel that can inhibit the growth of <i>Staphylococcus aureus</i>	<i>Staphylococcus aureus</i>	Dilution	The results of the observation of the minimum concentration test of <i>Aloe vera</i> gel against <i>Staphylococcus aureus</i> were at a concentration of 15%.	[22]
16	Antibacterial Effect of <i>Aloe vera</i> Gel against Oral Pathogens: An In-vitro Study	<i>Aggregatibacter actinomycetemcomitans</i> <i>Clostridium bacilli</i> <i>Streptococcus mutant</i> <i>Staphylococcus aureus</i>	Diffusion	The antibacterial effect of <i>Aloe vera</i> gel at concentrations of 100%, 50%, Ciprofloxacin (30 mcg), Ofloxacin (5 mcg), and against <i>Aggregatibacter actinomycetemcomitans</i> with inhibition zones of 6.9 mm, 5.8 mm, 7.4 mm, 4.6 mm, respectively. In <i>Clostridium bacilli</i> 6.3 mm, 5.4 mm, 7.1 mm, and 4.8 mm. In <i>Streptococcus mutans</i> with an average of 6.8 mm, 5.6 mm, 6.8 mm, 5.4 mm. In <i>Staphylococcus aureus</i> with a mean of 6.6 mm, 6.1 mm, 7.3 mm, 5.1 mm.	[23]
17	An evaluation Antimicrobial Activity of <i>Aloe barbadensis</i> Miller (<i>Aloe vera</i>) Gel Extract	<i>Staphylococcus aureus</i>	Diffusion	The highest antimicrobial activity of <i>Aloe vera</i> extracts Dimethyl Sulfate aloe vera gel in a concentration of 400 µg/ml against <i>Staphylococcus aureus</i> bacteria with an inhibition zone diameter of 16 mm.	[24]
18	Antibacterial Effect of <i>Aloe vera</i> Gel Extract on <i>Escherichia coli</i> and <i>Salmonella enterica</i> Isolated from the Gastrointestinal Tract of Guinea Fowls	<i>Escherichia coli</i> <i>Salmonella enterica</i>	Diffusion	Antibacterial test using ethanol extract of <i>Aloe vera</i> gel showed an inhibition zone in the concentration of 200 mg/ml, 100 mg/ml, 50 mg/ml, the mean inhibition zone was obtained in <i>Escherichia coli</i> 9.10 mm-12.23 mm, and in <i>Salmonella enterica</i> 5.5 mm-12.57 mm.	[25]
19	Antibacterial Effectiveness Test of Liquid Hand Soap Preparation from <i>Aloe vera</i> (<i>Aloe barbadensis</i> Miller) Slime Against <i>Escherichia coli</i> and <i>Staphylococcus aureus</i> Bacteria	<i>Escherichia coli</i> <i>Staphylococcus aureus</i>	Disc and Scratch	The test for the antimicrobial activity of liquid hand soap from <i>Aloe vera</i> mucilage against <i>Escherichia coli</i> bacteria showed that the inhibition zone diameter was very strong at a concentration of 9% and 6%, namely 21.45 mm and 21.09 mm. Whereas <i>Staphylococcus aureus</i> bacteria are categorized as strong at a concentration of 9% 13.72 mm, 6% 13.5 mm, 3% 13.25 mm.	[26]
20	Activity Test of <i>Aloe vera</i> (<i>Aloe vera</i> L) Leaf Infusion Against <i>Propionibacterium acne</i> Causes Acne	<i>Propionibacterium acne</i>	Diffusion	The testing activity of <i>Aloe vera</i> infusion against <i>Propionibacterium acne</i> showed the highest inhibition zone diameter at a concentration of 15% with an average inhibition zone of 23.13 mm, then at a concentration of 10% 17.00 mm and a concentration of 5% 12.65 mm.	[27]

DISCUSSION

The ethanol extract of *Aloe vera* showed antimicrobial activity against *Staphylococcus aureus* at concentrations of 2.5%, 3.5%, 4.5% with the formation of inhibition zone diameters of 8.6 mm, 9.98 mm, 10.8 mm, respectively. In *Candida albicans* at a concentration of 4%, 8%, 12% with each inhibition zone formed of 11.87 mm, 16.09 mm, 18.87 mm. The antimicrobial activity caused by the ethanol extract of *Aloe vera* can occur due to the presence of chemical compounds of saponins and acemannan which are antiseptic, antibiotic, anti-bacterial, and anti-fungal [8]. The antimicrobial activity of *Aloe vera* ethanol extract against *Staphylococcus aureus* and *Propionibacterium acne* bacteria with the highest inhibition diameter resulted in a concentration of 75% with an inhibition zone of 9.14 mm and 15.8 mm. Its activity is categorized as strong because this study using the whole extract of *Aloe vera*, both the skin and the gel, which as a whole contains anthraquinones and anthracuroneloin complex compounds [9].

The methanol extract of *Aloe vera* leaf bark has the highest antimicrobial activity at 100% concentration with an inhibition zone diameter of 11.58 mm against *Staphylococcus aureus*, 75% with inhibition zone diameter of 6.81 mm against *Escherichia coli*. There is a difference between the two concentrations because the diameter of the inhibition zone does not always increase in proportion to the increase in antibacterial concentration, it can be caused by several factors, such as the concentration of chemicals, the nature of the agar media used, and the rate of diffusion [10]. Testing the antimicrobial activity of the ethanol extract of *Aloe vera* leaves against the growth of *Candida albicans* fungi with a concentration of 100%, 50%, and 25% with an average diameter of 13.4 mm, 6.4 mm, and 5.4 mm, respectively. This is because the ethanol extract of *Aloe vera* leaves contains saponins and flavonoids which have antimicrobial and anti-fungal effects [11].

Testing the antibacterial effectiveness of liquid soap from the ethanol extract of *Aloe vera* bark leaves against gram-positive and negative bacteria, showed the average inhibition zone diameter against *Staphylococcus aureus* was 10.41 ± 0.60 mm, *Staphylococcus epidermis* 9.21 ± 0.36 mm, *Bacillus subtilis* 11.08 ± 0.47 mm, *Bacillus cereus* 10.38 ± 0.35 mm, *Salmonella typhimurium* 10.22 ± 0.35 mm, *Proteus mirabilis* 9.62 ± 0.60 mm, *Pseudomonas aeruginosa* 11.59 ± 0.27 mm, *Escherichia coli* 9.39 ± 0.51 mm. The antibacterial activity caused by the ethanol extract of *Aloe vera* leaf bark is due to the presence of secondary metabolite compounds in *Aloe vera*, namely saponins, flavonoids, terpenoids, tannins, and anthraquinones which have an antimicrobial effect [12].

Testing the inhibition of *Aloe vera* extract against *Staphylococcus aureus* bacteria at a concentration of 25%, 50%, 75%, 100% with the inhibition zone diameter 0 ± 0 mm, 7.12 ± 0.12 mm, 8.37 ± 0.23 mm, respectively. 9.00 ± 0.40 . At a concentration of 25%, it cannot inhibit bacterial growth because the average inhibitory power is still 0 ± 0 mm, this could be due to the lack of the number of active antibacterial compounds from the *Aloe vera* extract. At a concentration of 50%, 75%, 100% of the inhibitory activity is in the moderate category [13]. Antibacterial activity and phytochemical analysis of *Aloe vera* by diffusion method showed that the

Aloe vera methanol extract with the highest inhibition zone was at a concentration of 1000 μ l with an average inhibition zone of 11 mm against *Staphylococcus aureus*. In *Pseudomonas aeruginosa*, *Streptococcus pyrogens*, *Escherichia coli*, *Klebsiella pneumonia* with inhibition zones of 10 mm, 9 mm, 8 mm, 6 mm, respectively. The antimicrobial agent of *Aloe vera* gel effectively kills or reduces or eliminates the growth of *Staphylococcus aureus*, *Klebsiella pneumonia*, *Streptococcus pyrogens*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Propionibacterium acne*, *Helicobacter pylori*, and *Salmonella typhi* [14].

The antimicrobial activity of methanol extract, petroleum ether, chloroform of *Aloe vera* leaves using the diffusion method showed the highest inhibition zone diameter in methanol extract of 22 mm at a concentration of 20 mg against *Escherichia coli*, petroleum ether extract at a concentration of 40 mg against *Staphylococcus aureus* and *klebsiella sp*, chloroform extract of 20 mm at a concentration of 40mg against *Candida albicans*. The methanol extract showed maximum inhibitory activity against *Escherichia coli* and *Aspergillus*. Petroleum ether extract showed maximum inhibitory activity against *Klebsiella pneumonia* and *Staphylococcus aureus*. Chloroform extract showed maximum activity against *Candida albicans* [15].

The ethanol extract of *Aloe vera* leaves and gentamicin sulfate against *Staphylococcus aureus* at a concentration of 2.5 mg/ml, 5 mg/ml, 10 mg/ml resulted in an inhibition zone of 7.27 mm, 9.0 mm, 10.39 mm, respectively, while at a concentration of 1,25 mg/ml did not show growth inhibition against *Staphylococcus aureus* bacteria. Gentamicin sulfate at a concentration of 5 μ g/ml, 10 μ g/ml, 20 μ g/ml produced inhibition of 7.57 mm, 11.33 mm, 12.46 mm, respectively, at a concentration of 2.5 μ g/ml gentamicin sulfate showed no growth inhibition against *Staphylococcus aureus*. The combination of ethanol extract of *Aloe vera* leaves and gentamicin sulfate showed an average inhibition zone of 7.63 mm against *Staphylococcus aureus* because of the ethanol extract of *Aloe vera* leaf bark contains secondary metabolites which have antibacterial activity [16].

Antibacterial activity of *Aloe vera* against skin pathogens using the diffusion method obtained an antimicrobial activity in methanol extract with maximum effect on *Staphylococcus aureus* and *Staphylococcus epidermis* with inhibition zone diameters of 12 mm and 11 mm, in *Escherichia coli* and *Proteus Vulgaris* that is 10 mm, and the lowest inhibition zone in *Pseudomonas aeruginosa* 9 mm, *Klebsiella pneumonia*, and *Proteus mirabilis* 7 mm. In vitro analysis shows that traditional medicine can be as effective as modern medicine for fighting pathogenic microorganisms apart from being applied as cosmetics [17]. Testing the antibacterial activity of *Aloe vera* against *Streptococcus mutans* bacteria at a concentration of 100%, 75%, and 50% had an inhibition zone diameter of 20.7 mm, 10.26 mm, and 10.15 mm respectively, there was a large difference in the inhibition zone at a concentration of 100% and 75% with a difference of 10.44 mm, this happens because at 100% concentration using pure *Aloe vera* sap, while at concentrations of 50% and 75% there is the addition of aqua bikes so that the diameter of the inhibition zone at 100% concentration is greater [18].

The antimicrobial activity and minimum inhibitory concentration of *Aloe vera* extract by diffusion method using different extracts showed that the average inhibition zone with methanol extract from *Aloe vera* sap was the highest in a concentration of 50 ($\mu\text{g/ml}$) against *Escherichia coli* bacteria were 36 mm, *Pseudomonas aeruginosa* 35 mm, *Bacillus subtilis* 30 mm, *Staphylococcus aureus* 36 mm, *Candida albicans* 30 mm and *Aspergillus niger* 28 mm [19]. The results of measurements of the antimicrobial activity against *Staphylococcus sp* bacteria showed that the average inhibition zone of *Aloe vera* gel ranged from 8.67 mm to 9.50 mm. The resulting zone of inhibition is 8.67 mm, 8.83 mm, 9.17 mm, 9.50 mm, 9.33 mm, respectively. The antimicrobial activity of *Aloe vera* gel is due to the presence of saponins, anthraquinones, and salicylic acid compounds which can inhibit bacterial growth [20].

The results of measurements of the diameter of the zone of inhibition of *Aloe vera* gel against *Staphylococcus aureus* bacteria at a concentration of 30%, 40%, 50%, 60%, 70% with a diameter of inhibition of 4.75 mm, 5.92 mm, 7.22 mm, 9.59 mm, 12.81 mm, respectively. One of the determining factors in inhibiting bacteria is the diffusion ability of *Aloe vera* gel into the media and its interaction with the tested bacteria is a factor in the emergence of the inhibition zone, the faster the aloe vera gel diffuses into bacterial cells, the bacteria growth will be disrupted, *Aloe vera* also contains anthraquinone shown to have antimicrobial activity [21]. The results of the observation of the minimum concentration test of *Aloe vera* gel against *Staphylococcus aureus* were carried out at different times, namely 1 x 20 hours, 1 x 24 hours, 1 x 48 hours. In the observation time of 1 x 20 hours, there are no results because it cannot be determined at what concentration bacterial growth can be inhibited, this is because the time required is not optimal for bacteria to move in the media. At the observation time of 1 x 24 hours at the highest concentration of 10%, 5%, 3% there is bacterial inhibition. In observation 1 x 48 hours to determine the lowest concentration that can inhibit the growth of *Staphylococcus aureus* bacteria, namely at a concentration of 15% [22].

Antibacterial effect of *Aloe vera* gel on oral pathogens: An In-vitro study using the diffusion method obtained an antibacterial effect on 100%, 50% extract, Ciprofloxacin (30 mcg), Ofloxacin (5 mcg) antibacterial effect at a concentration of 100%, 50%, Ciprofloxacin (30 mcg), Ofloxacin (5 mcg) against *Aggregatibacter actinomycetemcomitans* with inhibition zones of 6.9 mm, 5.8 mm, 7.4 mm, 4.6 mm, respectively. The *Clostridium bacilli* are 6.3 mm, 5.4 mm, 7.1 mm, and 4.8 mm. In *Streptococcus mutants* were 6,8 mm, 5,6 mm, 6,8 mm, 5,4 mm. In *Staphylococcus aureus*, it was 6.6 mm, 6.1 mm, 7.3 mm, 5.1 mm. The test results showed antimicrobial activity because it contained Aloin and Aloemodin compounds, which inhibit bacterial protein synthesis, thus having antimicrobial activity [23].

Evaluation of the antimicrobial activity of the *Aloe barbadensis* Miller gel extract (*Aloe vera*) using the diffusion method showed that the results of the antibacterial and antifungal activity of the *Aloe vera* gel extract were the highest inhibition zone at a concentration of 100 $\mu\text{g/ml}$, 200 $\mu\text{g/ml}$, 400 $\mu\text{g/ml}$ with inhibition zone 8 mm, 12 mm, 15 mm

against *Escherichia coli*, respectively. *Klebsiella pneumonia* by 8 mm, 10 mm, 13 mm. *Proteus mirabilis* of 6 mm, 10 mm, 11 mm. *Pseudomonas aeruginosa* by 6 mm, 8 mm, 10 mm. *Staphylococcus aureus* by 12 mm, 14 mm, 16 mm, *Candida albicans* by 10 mm, 10 mm, 13 mm, *Penicillium sp* by 6 mm, 7 mm, 10 mm [24]. Antibacterial effect of ethanol extract of *Aloe vera* gel against *Escherichia coli* and *Salmonella enterica* isolated from the digestive tract of chickens using the diffusion method at concentrations of 200 mg/ml, 100 mg/ml, 50 mg/ml with inhibition zone diameters of 9.13 mm, 9.10 mm, 11.23mm (GIT1), respectively. 7.8 mm, 8.53 mm, 7.87 mm (GIT2), 7.43 mm, 14.43 mm, 9.2 mm (GIT3) against *Escherichia coli*. *Salmonella enterica* is 8.23 mm, 5.5 mm, 9.00 mm (GIT1), 0.00 mm, 4.3 mm, 7.13 mm (GIT2), 6.67 mm, 4.2 mm, 7.67 mm (GIT3) [25].

The test for the antibacterial activity of liquid hand soap from *Aloe vera* mucilage against the growth of *Escherichia coli* bacteria showed at a concentration of 3%, 6%, 9% with a diameter of the inhibition zone, respectively, 19.87 mm, 21.09 mm, 21.45 mm. Whereas in the *Staphylococcus aureus* bacteria at a concentration of 3%, 6%, 9% with the inhibition zone diameter respectively 13.25 mm, 13.5 mm, 13.72 mm. It can be concluded that the preparation of liquid handwashing soap from *Aloe vera* mucus is effective in inhibiting bacterial growth due to the presence of active antibacterial compounds contained in aloe vera mucus, namely saponins. The zone of inhibition was categorized as very strong in *Escherichia coli* at a concentration of 9% and 6%, whereas in *Staphylococcus aureus* at all concentrations was categorized as strong [26]. The results of activity testing against *Propionibacterium acne* from *Aloe vera* infusion at a concentration of 5%, 10%, 15% with inhibition zone diameters of 12.65 mm, 17.00 mm, 23.13 mm respectively. The inhibition zone formed on a paper disk containing *Aloe vera* infusion has an inhibitory power against *Propionibacterium acne*. The inhibition of aloe vera infusion at a concentration of 5%, 10%, 15% are categorized as strong inhibition [27].

CONCLUSION

Based on the literature review that has been described above, it was found that aloe vera (*Aloe vera*) has antimicrobial activity that can inhibit the growth of several pathogenic microbes. The strength of its antimicrobial activity depends on the concentration of the extract and the active compounds contained therein. The higher the extract concentration used, the higher the levels of the active compound dissolved in the extract which causes a larger inhibition zone formed.

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