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Antibacterial Activity of Dayak Onion (*Eleutherine Bulbosa* [*syn. E. palmifolia*]) Against *Escherichia coli*: A Systematic Review of Evidence (2020-2025)

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A R T I C L E I N F O

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A B S T R A C T

Dayak onion (*Eleutherine palmifolia*), a herbal plant native to Kalimantan, is rich in natural compounds such as alkaloids, glycosides, flavonoids, phenolics, steroids, and tannins that have potential antibacterial properties. To determine the inhibitory effect of *Eleutherine palmifolia* extract on the growth of *Escherichia coli*. This study employed a systematic literature review design. Quantitative data in the form of inhibition zone diameters were found in seven studies, indicating that Dayak onion extract was able to inhibit the growth of *Escherichia coli* with a strong category. Meanwhile, three studies reported that *Eleutherine palmifolia (L.) Merr.* showed weak effectiveness against *Escherichia coli*. Differences in inhibitory activity at each concentration occur because higher concentrations of Dayak onion leaf extract result in wider inhibition zones. Increasing the concentration enhances the amount of active compounds responsible for antibacterial activity.

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INTRODUCTION

Currently, Escherichia coli bacteria that are resistant to antibiotics are a big problem in the world of health. The spread of immune genes causes this to be recognized as a serious threat globally.(1) In Indonesia the presence of E. coli bacteria which produce the ESBL (Extended-Spectrum Beta-Lactamase) enzyme is a quite serious problem. The Ministry of Health's sentinel network report shows that cases of resistance to ESBL-producing Escherichia coli in Indonesia are still very high. In 2022, around 68% of isolates from 20 sentinel hospitals were identified as resistant, and this figure even rose to 70.75% in 2023 with coverage of 24 hospitals. This finding emphasizes the severity of the burden of resistance at the national level and also shows the need to expand the scope of monitoring on an ongoing basis. (2) This is in line with the results of GLASS analysis and regional surveillance which also shows the same pattern, namely high resistance to β-lactam antibiotics, especially third generation cephalosporins and fluoroquinolones. This condition encourages the development of local antibacterials, such as Dayak onion extract, as an alternative to help control resistance.(3) The high resistance of *E. coli* to β-lactam antibiotics makes treating infections caused by this bacteria increasingly difficult. Therefore, more effective alternative strategies are needed to help control the spread of this infection. In the midst of increasing cases of antibiotic resistance, natural ingredients from plants are starting to be looked at as promising alternative options because of their ability to fight bacteria. Plants contain various natural compounds such as flavonoids, alkaloids, tannins and phenolics which are known to have the ability to fight microorganisms, including E. coli bacteria which can cause disease.(4)(5) Increasing bacterial resistance to antibiotics encourages the use of natural ingredients as alternatives. Several types of plants are known to be able to damage E. coli cell walls and inhibit biofilm formation by up to 50%.(5) Antibacterial testing of plant extracts is usually carried out in the laboratory in vitro. One method that is often used is the disc diffusion method (Kirby–Bauer), where a paper disc that has been given an extract is placed on agar media that has been planted with bacteria, then observed to see whether a clear zone forms around it after incubation, which indicates antibacterial activity. Apart from that, the bioautography method using thin layer chromatography (TLC) was also used to find out which compounds in the extract had antibacterial properties. In this method, compounds are separated on a thin layer chromatography (TLC) plate, then exposed to bacteria to see their inhibitory effect. These two methods are often used as a first step to evaluate the antimicrobial potential of natural ingredients before they are further developed as drug candidates.(6)(7) Dayak onions (Eleutherine palmifolia), a native herbal plant from Kalimantan, are rich in natural compounds such as alkaloids, glycosides, flavonoids, phenolics, steroids and tannins. Various studies conducted by Nuryanti et al and Ni Made et al show that these compounds are able to inhibit the growth of bacteria, including Escherichia coli and Salmonella. This makes Dayak onions have great potential to be used as a natural antibacterial source. (4)(8) The traditional way to make Dayak onion water extract is to boil Dayak onion simplicia in water at a temperature of 90°C for 15 minutes. Pure Dayak onion infusion is reported to be

able to inhibit the growth of disease-causing E.coli bacteria, with an inhibition zone of around 0.94 mm at the highest concentration.[9] Research recently conducted by Sirajuddin et al shows that the ethanol extract of Dayak onions (Eleutherine palmifolia) effectively inhibits the growth of Salmonella spp. and Escherichia coli. The results of the Kirby–Bauer test show that the largest zone of inhibition appears when the highest extract concentration is used.[10] The antibacterial effect of Dayak onion extract is believed to come from the content of active compounds such as flavonoids and phenolics. These two compounds are known to be able to damage bacterial cell walls and disrupt the function of the transpeptidase enzyme that bacteria need to survive.[10] Dayak onion water extract is also reported to be able to inhibit bacteria that cause skin infections,such as P. aeruginosa, S. aureus, and S. epidermidis, through thin layer chromatography (TLC) bioautography tests. These findings further strengthen the potential of Dayak onions as a natural antibacterial. [4] Based on the title of this research and various studies that have been conducted, it confirms that there is a relationship between Dayak onions and Escherichia coli infections, where diseases caused by Escherichia coli bacterial infections require the discovery or use of effective antibacterial agents. Dayak onions, which are known to contain phytochemicals with antibacterial potential, are a natural resource that is worth researching. In line with this research it relates to HR. Ahmad no. 18405, Al-Bukhari in Al-Adab Al-Mufrad no. 291, Ibn Majah no. 3436, authenticated by Al-Albani as follows:

إِنَّ اللَّهَ لَمْ يُنْزِلْ دَاءً إِلَّا أَنْزَلَ لَهُ دَوَاءً، عَرَفَهُ مَنْ عَرَفَهُ، وَجَهِلَهُ مَنْ جَهِلَهُ، غَيْرَ السَّام

Meaning: "Allah does not send down a disease but He also sends down the medicine. There are those who know it and there are those who do not know it, except as-sām." This hadith emphasizes that every disease has a cure that Allah has provided, except death (as-sām). In Tafsir Al-Misbah, M. Quraish Shihab interprets this hadith as an encouragement for humans to use reason, knowledge and research to find unknown medicines. Islam teaches a balance between trust and endeavor; Surrendering oneself to Allah must be accompanied by real efforts through research and scientific development. Every creation of God has benefits and works according to the law of cause and effect which can be studied scientifically. Therefore, health research efforts including the exploration of natural materials as sources of medicine are part of scientific responsibility as well as a form of worship in carrying out the mandate as caliph on earth.

THEORETICAL REVIEW

Taxonomy and morphology of Dayak onions

Figure 1. Bawang Dayak (*Eleutherine palmifolia)*

Dayak onion (Eleutherine palmifolia) is a traditional plant from Kalimantan which has long been used as a herbal medicine. This plant is known to have antibacterial abilities, especially against Escherichia coli. Several studies conducted by Rani et al in 2025 reported that ethanol extract from Dayak onion bulbs was able to significantly suppress the growth of Escherichia coli, with a minimum inhibitory concentration (MIC) value of around 1.37 mL/L. This finding strengthens the potential of Dayak onions as a natural antibacterial source which has the opportunity to be developed as an alternative to inhibit the growth of Escherichia coli on agar media.[12]

Active Compounds of Dayak Onions

Dayak onions (Eleutherine palmifolia) contain various active substances such as eleutherine, iso eleutherine, eleutherol, as well as naphthoquinone compounds such as hongconin and eleutheroside B. These substances are known to have antioxidant and antibacterial effects, which are even stronger thanks to the content of flavonoids and phenolic acids, including quercetin, routine, gallic acid, chlorogenic acid, epicatechin gallate, and myricetin. Research conducted by Kamaruddin et al, Aprianti et al, and Muthia et al showed that the methanol fraction from these tubers was able to inhibit the growth of bacteria such as Escherichia coli, Staphylococcus aureus, Streptococcus mutans, and Vibrio cholerae with a minimum inhibitory concentration (MIC) as low as 0.0125%. [13][14][15]:

1. Eleutherine as antibacterial and antioxidant. The mechanism disrupts bacterial cell membranes, inhibits protein synthesis, captures free radicals through electron donation [16]
2. Isoeleutherine as an antibacterial. The mechanism inhibits the growth of gram-positive and gram-negative bacteria by damaging membrane permeability [17]
3. Hongconin as an antibacterial. The mechanism of naphthoquinone compounds that inhibit bacterial enzymes and trigger oxidative stress [18]
4. Eleuthoside B as antibacterial, anti-inflammatory. The mechanism inhibits biofilm formation and suppresses the inflammatory response [19]

5. Quercetin as an antioxidant and antibacterial. Mechanisms capture free radicals, disrupting bacterial membrane integrity [20]
6. Rutin as an antioxidant. Mechanism of scavenging free radicals and inhibiting lipid oxidation [21]
7. Gallic acid as an antioxidant and antibacterial. The mechanism inhibits bacterial enzymes and acts as a free radical scavenger [22]
8. Chlorogenic acid as an antioxidant and antibacterial. The mechanism disrupts bacterial metabolism, protecting cells from oxidative stress [23]
9. Epicatechin gallate as an antibacterial. The mechanism disrupts bacterial cell walls and inhibits biofilm formation[24]
10. Myricetin as an antioxidant and antibacterial. Mechanisms disrupt bacterial respiration and ward off free radicals [25]

Traditional and Scientific Use of Dayak Onions

Traditional Use: Dayak people in Kalimantan have long used Dayak onions (Eleutherine palmifolia) as a natural medicine to treat various diseases. The tubers of this plant are believed to be useful in treating diabetes, breast cancer, high blood pressure and digestive problems. Apart from that, Dayak onions are also often used to help heal wounds. Its antimicrobial and anti-inflammatory properties help prevent infection and reduce inflammation, so it is believed to speed up the skin healing process. Scientific use: Research conducted by Ni Made et al stated that Dayak onion extract has the potential to inhibit the growth of resistant E. coli (ESBL) bacteria. The MIC test results show that the higher the extract dose, the stronger the antibacterial effect. However, several sources state that this effect is still classified as weak to moderate.

Antibacterial Activity of Dayak Onion Extract

When tested in more detail, both require higher concentrations to inhibit E. coli than S. aureus, so it can be concluded that these Gram-negative bacteria tend to be more resistant to this content. However, several newly identified phenolic compounds from Eleutherine bulbosa tubers were able to inhibit the growth of E. coli in laboratory tests, although the effect was classified as moderate. MIC values in the range of 15.6–250 μg/mL indicate that high enough levels are needed for bacterial growth to stop.If seen from a form that is closer to the use of the original ingredient, Dayak onion bulb ethanol extract can indeed inhibit the growth of E. coli, and its inhibitory power increases as the concentration increases. Even so, compared with standard antibiotics, the effect is still considered weak to moderate. Dayak onions have the potential as a natural antibacterial which can be developed as an alternative to suppress the growth of Escherichia coli on agar media.

Commonly used antibacterial activity test methods

Assessment of antibacterial activity in vitro is usually carried out in several ways:

1. Disc diffusion (Kirby-Bauer): This method looks at the zones of inhibition that form on Mueller-Hinton agar, using the latest interpretation

standards. This method is still popular because it is simple and cost effective.

2. MIC (Minimum Inhibitory Concentration) test via broth dilution or microdilution: Used to determine the lowest concentration of an extract or compound that can stop bacterial growth, thereby providing a quantitative picture of its antibacterial strength.
3. Determination of MBC (Minimum Bactericidal Concentration): This is done if you want to know the concentration that can kill bacteria, not just stop their growth.[32]

To ensure proper practice and following the latest standards such as appropriate media, inoculum density of 0.5 McFarland, incubation conditions, quality control using ATCC strains, as well as determining breakpoints it is best to refer to the latest CLSI guidelines (M02/M07/M100). In addition, open-access publications are available that discuss the application and adaptation of the disc diffusion method and RAST, which can serve as a guide to current methodology.

Escherichia coli

Morphology and characteristics

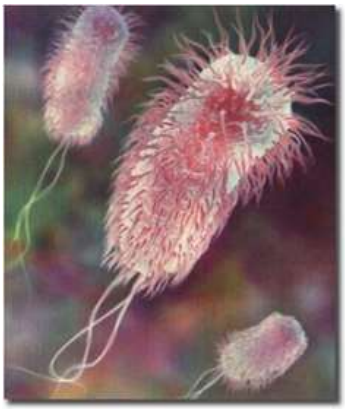

Figure 2. Macroscopic Image of Escherichia coli

Figure 3. Microscopic Image of Escherichia coli

Escherichia coli is a Gram-negative rod bacterium that is facultatively anaerobic, measuring approximately 0.4 µm × 2–3 µm. Some strains have a capsule, and generally move using a flagellum that spreads around the cell. The surface is coated with lipopolysaccharide (LPS) on the outer membrane, which functions as a barrier as well as a virulence factor. These bacteria also have attached structures such as pili or fimbriae, which help attach to epithelial cells

and form a biofilm. In uropathogenic E. coli (UPEC), flagella, type 1 fimbriae, and curli play an important role in colonization and invasion of the urinary tract.

Role as a bacterial pathogen

Escherichia coli has various types of intestinal pathogens, such as enterotoxigenic (ETEC), enteropathogenic (EPEC), enterohemorrhagic/Shiga toxin producing (EHEC/STEC), enteroaggregative (EAEC), enteroinvasive (EIEC), and diffusely adherent (DAEC). Each type can cause diarrhea in different ways, for example ETEC produces hot (LT) and stable (ST) toxins, while STEC produces Shiga toxin. Some types also damage the intestinal mucosal layer, so that the process of absorbing ions and water is disrupted.[38] Apart from the intestinal pathotype, Escherichia coli also has an extra-intestinal pathogenic Escherichia coli (ExPEC) type, for example Uropathogenic Escherichia coli (UPEC), which can cause urinary tract infections, sepsis and meningitis in newborn babies. Uropathogenic Escherichia coli (UPEC) attaches to neuroepithelial cells using fimbriae, forming bacterial communities within the cells, and this plays a role in the recurrence of infections.[35][39]

Antibiotic resistance and the urgency of natural alternatives

Antibiotic resistance in Escherichia coli is now a global problem. According to WHO GLASS data, many Escherichia coli isolates from blood in various countries show resistance to third-generation cephalosporins.[40] Global analysis shows that E. coli producing extended-spectrum β-lactamase (ESBL), especially those carrying the bla_{CTX-M} gene, is quite frequently found in human isolates.[41][42] In addition, plasmid-triggered colistin resistance (mcr gene) still appears in isolates from humans and animals[43]. This emphasizes the importance of seeking alternative treatments to overcome the limitations of conventional antibiotics.[44]

Medication as an alternative antibacterial

The use of medicinal plants as a source of antibacterials is increasingly relevant in the era of antibiotic resistance. Extracts from plants that are rich in compounds such as terpenoids, phenols, alkaloids and flavonoids have been proven to be effective against various WHO priority bacteria. Apart from that, this extract can also inhibit biofilm formation, regulate bacterial communication, and increase the effectiveness of antibiotics through synergistic cooperation. These findings support the development of phytotherapy or phytobiotics as an alternative or complement to antibacterial treatment.[45][46] In QS. Ar-Ra'd:11,

ۡإِنَّ اللَّهَ لَا يُغَيِّرُ مَا بِقَوْمٍ حَتَّىٰ يُغَيِّرُوا مَا بِأَنْفُسِهِم

Meaning: "Indeed, Allah does not change the condition of a people unless they change what is within themselves." In Tafsir Al-Misbah explains that this verse emphasizes the importance of efforts, both individually and collectively, to change the situation from bad to better. This principle is relevant in the health sector, including scientific research. Efforts to study the antibacterial potential of Dayak onions (Eleutherine palmifolia) against Escherichia coli are a real form of change through science. Research is a form of human endeavor in finding solutions, while the final results remain within the will of Allah. In addition, the

awareness that every action is monitored and accounted for encourages research to be carried out ethically, responsibly and oriented towards the benefit. Thus, scientific activity not only has academic value, but also has moral and spiritual dimensions.

METHODOLOGY

This research design uses the form of a systematic literature review (SLR), namely a structured and transparent literature review for its use, value, plus a summary of scientific evidence from relevant main studies. By choosing the SLR method, it facilitates in-depth analysis of a special topic, namely the antibacterial effect of Dayak onion extract on Escherichia coli bacteria, with a focus on variations in bacterial growth on agar media. In contrast to narrative reviews which are more descriptive, SLR follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) standard protocol so that bias is minimized and the results can be repeated. This research did not collect primary data directly, but summarized secondary literature published in the last 5 years (2020-2025), in order to obtain the latest developments regarding antimicrobial resistance and plant-based medicine.

RESULTS

After searching for references using the PRISMA method, data was obtained with the keywords Eleutherine palmifolia, Dayak onions, Escherichia coli, and antibacterial outcome. In a literature search with the keyword "Effectiveness of Dayak Onion Extract (Eleutherine Palmifolia) on the Growth of Escherichia Coli", 560 articles were found from the Google Scholar, PubMed (PMC), and Science Direct databases. Articles that were incomplete or whose information could not be retrieved were 104 articles, while 20 articles used languages other than Indonesian and English. Next, articles were filtered based on the type of scientific article and year of publication between 2020 and 2025, namely 436 articles were obtained. Articles that are not used and removed are articles that are not original or research articles.

Articles were filtered based on full text, namely there were 414 articles. The literature that was removed were articles that did not have full text and could not be opened, namely 10 articles. Articles were filtered based on completeness of research data, namely 394 articles. The literature that was removed were research articles that were not relevant to the effectiveness of Dayak onion (Eleutherine Palmifolia) extract on the growth of Escherichia Coli, namely 384 articles. The results obtained were 10 articles used in the research, which were described using the PRISMA method.

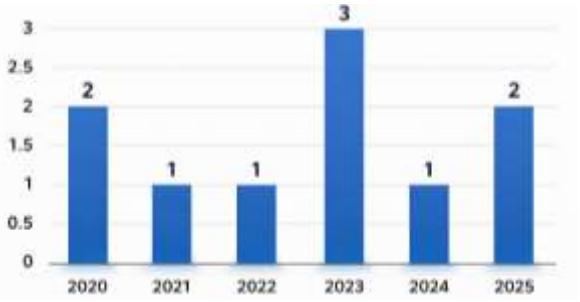

Figure 3. Number of Literature Related to the Effectiveness of Dayak Onions on the Growth of E.Coli Bacteria

The percentage results of the number of related literature related to the effectiveness of Dayak onions on the growth of E. Coli bacteria from 2020-2025, namely in 2020 there were 2 journals, in 2021 there was 1 journal, in 2022 there was 1 journal, in 2023 there were 3 journals, in 2024 there was 1 journal and in 2025 there were 2 journals.

Results of Publication Bias Analysis

Publication bias analysis was carried out using funnel plots and Egger's test. Based on visual observation of the funnel plot, the distribution of studies was relatively symmetrical and did not show strong visual indications of publication bias. The funnel plot results are supported by the Egger test results which show that the constant (intercept) is not statistically significant (B = −19.881; p = 0.357; CI95%: −66.784 – 27.021), so there is no significant evidence of publication bias or small-study effects.

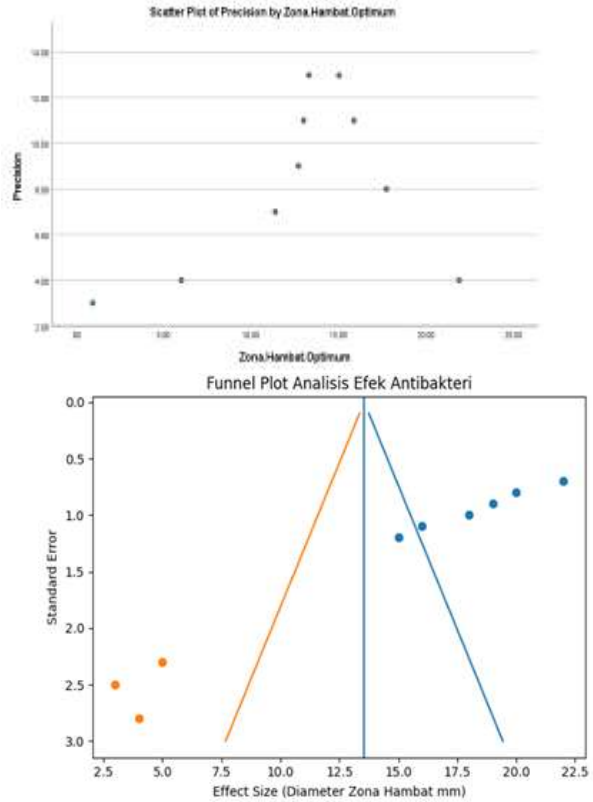

Figure 4. Funnel plot of optimum inhibition zone against study precision

Table 1. Results of the Egger test for detection of publication bias

Variable	*B*	*SE*	*t*	*p-value*	CI 95%
Konstanta (*Intercept*)	-19.881	20,339	-0,977	0,357	-66,784-27,021

DISCUSSION

Based on a study of 10 pieces of literature, it was found that quantitative data in the form of the diameter of the inhibition zone was found in 7 pieces of literature which stated that Dayak onion extract was able to stop the growth of Escherichia coli bacteria in the strong category, while in 3 of them the results showed that Dayak onion (Eleutherine palmifolia (L.)Merr.) had weak effectiveness against Escherichia coli bacteria based on the antibacterial strength classification according to Davis and Stout (1971), where the resistance area of 20 mm or more was classified as very strong, the resistance area 10-20 mm is classified as strong, an obstacle area of 5-10 mm is classified as moderate and an obstacle area of 5 mm or less is classified as weak[47].

Based on research by Kumalasari et al in 2020, Dayak leek extract has the ability to inhibit the growth of Escherichia coli bacteria. The average zone of inhibition of Dayak leek extract differs depending on the concentration used. At 100% concentration, the barrier zone reaches 21.88 mm, 80% concentration is 19.88 mm, 60% concentration is 17.68 mm, 40% concentration is 9.81 mm, and 20% concentration is 3.32 mm. Analysis using SPSS shows that the results for each concentration are significantly different. The higher the concentration of the extract used, the wider the inhibition zone formed. The greater the concentration of the substance, the more active compounds there are and the stronger the ability to inhibit bacteria[48].

Research conducted by Romadhon et al in 2023 shows that extracts from Dayak onions can inhibit the growth of Escherichia coli in chicken meat. The decrease in the number of E. coli occurred after 12 hours of storage because this bacteria had passed its peak growth phase. E. coli experiences its permanent growth phase after an incubation period of 5 hours at 37°C and after 12 hours at 25°C. Other findings also reported that the growth of E. coli decreased after 10 hours of storage at 37°C[49]. Factors that influence the speed at which antibacterial compounds diffuse include the number of microbes, medium composition, temperature, and incubation time. Apart from that, the size of the inhibition zone is also influenced by the type of bacteria and the ability of the antibacterial compounds produced by each bacterial species. The formation of an inhibitory zone is likely caused by contact between bioactive compounds produced by endophytic bacteria and disease bacterial cells, thereby affecting cell wall formation and disrupting the permeability of the disease bacterial cell membrane[50].

The test results carried out by Harlita in 2025 showed antibacterial activity from a combination of Dayak onion bulb ethanol extract with a ratio of 1:1, 1:2, and 2:1 at a concentration of 75 mg/mL against the test bacteria. These results include the size of the inhibition zone as well as the level of inhibition ability. This antibacterial activity is influenced by several things, such as the type of

antibacterial compound contained, the ability of the extract to spread, the type of bacteria being inhibited, and the concentration level of the extract used. Because Dayak onion extract contains more complex antibacterial compounds, its inhibitory activity tends to be stronger. Escherichia coli is a gram-negative bacterium that has a fairly complex cell wall, consisting of three parts, namely lipoproteins, phospholipids and lipopolysaccharides. The ability of bacterial cell walls to allow the entry of molecules depends on the presence of porin proteins. The porin protein in the outer membrane of gram-negative bacteria tends to like water, so it is difficult for molecules from the extract components to enter the bacterial cell(52).

The antibacterial properties of Dayak onions are related to their rich content of various secondary metabolites, such as alkaloids, saponins, phenolics, flavonoids and terpenoids. The efficacy of Dayak onion extract in suppressing the activity of pathogenic bacteria. Shallots contain bioactive components that can effectively suppress bacterial proliferation(53).

Islamic Studies

As for the Islamic review, as based on QS. An-Nahl: 11,

۝١١ يُنۢبِتُ لَكُمْ بِهِ الزَّرْعَ وَالزَّيْتُوْنَ وَالنَّخِيْلَ وَالْاَعْنَابَ وَمِنْ كُلِّ الثَّمَرٰتِۗ اِنَّ فِيْ ذٰلِكَ لَاٰيَةً لِّقَوْمٍ يَّتَفَكَّرُوْنَ

It means:

"With the rainwater He makes plants grow for you, olives, dates, grapes, and all kinds of fruit. Indeed, in this there really are signs (of Allah's power) for a people who think." Allah explains that various plants that grow because of rainwater are proof of His power and a sign for people who think. In Ibn Kathir's Tafsir, this verse is understood as an affirmation that plants were created with various benefits for human life, both as a source of food and other uses that are not yet fully known. Therefore, humans are commanded to reflect, think and explore knowledge in order to understand the benefits of God's creation.

In the context of research, this verse is relevant to the study of medicinal plants as alternative treatments. Dayak onions (Eleutherine palmifolia) are an example of a plant that is traditionally used and scientifically proven to contain active compounds with potential antibacterial properties. Research on herbal plants, especially in the midst of increasing antibiotic resistance, can be understood as a form of implementing the Al-Qur'an's command to think and research nature. Thus, the scientific study of medicinal plants not only has health value, but also has a spiritual dimension as a reflection of the signs of God's greatness. Apart from that, in QS. Al-An'am: 99

وَهُوَ الَّذِيْٓ اَنْزَلَ مِنَ السَّمَاۤءِ مَاۤءً فَاَخْرَجْنَا بِهٖ نَبَاتَ كُلِّ شَيْءٍ فَاَخْرَجْنَا مِنْهُ خَضِرًا نُّخْرِجُ مِنْهُ حَبًّا مُّتَرَاكِبًاۚ وَمِنَ النَّخْلِ مِنْ طَلْعِهَا قِنْوَانٌ دَانِيَةٌ وَّجَنّٰتٍ مِّنْ اَعْنَابٍ وَّالزَّيْتُوْنَ وَالرُّمَّانَ مُشْتَبِهًا وَّغَيْرَ مُتَشَابِهٍۗ اُنْظُرُوْٓا اِلٰى ثَمَرِهٖٓ اِذَآ اَثْمَرَ وَيَنْعِهٖۗ اِنَّ فِيْ ذٰلِكُمْ لَاٰيٰتٍ لِّقَوْمٍ يُّؤْمِنُوْنَ ۝٩٩

It means:

"It is He who sends down water from the sky and with it We make all kinds of plants grow. So, from it We bring out green plants. From it We bring out grains that are piled up (many). From the date palms (untangle) the stalks that hang down. (We grow) vineyards. (We also grow) olives and pomegranates which are similar and which are not similar. Look at the fruit when it bears fruit and becomes ripe. Verily in that there really are signs (of power) Allah) for the

believers." Allah SWT explains that various types of plants originate from water sent down from the sky and humans are commanded to pay attention to their growth process and their benefits. In Tafsir Al-Misbah by M. Quraish Shihab, this verse emphasizes the importance of scientific observation of plants as a form of appreciation for the greatness of Allah as well as their use for life, both as food and medicine.

Dayak onions (Eleutherine palmifolia) are an example of a herbal plant that is used traditionally and has been scientifically proven to have antibacterial compounds. Thus, the Al-Qur'an's command to research plants can become a theological basis for the development of herbal plant research as an alternative treatment amidst increasing antibiotic resistance.

CONCLUSIONS AND RECOMMENDATIONS

The results of a literature review of 10 research articles show that the extract from Dayak onions (Eleutherine palmifolia) has antibacterial activity against the growth of Escherichia coli bacteria, which is in the strong category from the 7 literature that has been reviewed. The difference in inhibitory power at each concentration is because the greater the concentration of Dayak leek extract used, the wider the inhibition zone formed. Increasing the concentration of substances increases the content of active compounds that function to inhibit bacteria.

· Extracts from Dayak onions (Eleutherine palmifolia) have bioactive compounds that play a role in antibacterial activity.

Variations in extraction methods (water, ethanol, and methanol fractionation) influence the size of the antibacterial activity of Eleutherine palmifolia extract against Escherichia coli, where ethanol extract and certain fractions tend to show higher inhibitory power than water infusion.

·The antibacterial activity of Dayak onion extract is not only influenced by concentration, but also by methodological factors such as media type, incubation time, inoculum density, as well as differences in the characteristics of the bacterial strains used in each study.

Islamic studies, that confirms the verses that Allah SWT says in QS. Ar-Ra'd:11,

ٱإِنَّ اللَّهَ لَا يُغَيِّرُ مَا بِقَوْمٍ حَتَّىٰ يُغَيِّرُوا مَا بِأَنْفُسِهِم

Meaning: "Indeed, Allah does not change the condition of a people unless they change what is within themselves."

Tafsir Al-Misbah views that change occurs through various forms of effort, both individually and collectively, which are able to bring a situation from a bad condition to a better one. This principle is very relevant to the world of health, for example in research on the efficacy of Dayak onions as an inhibitor of the growth of Escherichia coli bacteria. In this context, researchers play an active role as agents of change, trying to find solutions through research and development of alternative medicines in line with the message of the verse which emphasizes the important role of humans in improving the situation. Simply put, this verse teaches that humans need to make efforts, and scientific research is one form of this. The discovery of the antibacterial properties of Dayak onion extract is a clear example of the application of this principle. Humans use their

knowledge and abilities to find solutions, while the final result still depends on the will of Allah SWT.

It is hoped that in the future further research can be carried out regarding extracts from Dayak onions (Eleutherine palmifolia) which can experimentally inhibit variations in the growth of Escherichia coli bacteria so that they can be used for modern medicine.

FURTHER STUDY

Further research needs to be carried out to determine the specific compounds that have antibacterial properties in extracts from Dayak onions (Eleutherine palmifolia) that can inhibit variations in bacterial growth and their antibacterial activity on other pathogenic bacteria. Further research is also recommended to evaluate the potential of combining Dayak onion extract with conventional antibiotics to see the possible synergistic effect in treating infections caused by resistant bacteria.

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