

EVALUATION OF THE ANTIBACTERIAL PROPERTIES OF EUPHORBIA HIRTA EXTRACTS

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ABSTRACT

Focussing on ethanol and petroleum ether extracts, this study examines the antibacterial activity of Euphorbia hirta against clinically important bacterial pathogens. With a concentration-dependent response, the agar well diffusion technique was used to evaluate the antibacterial activity. The results showed that ethanol extracts had higher inhibitory effects than petroleum ether extracts. The stem's ethanol extract showed promising results against typhoid, diarrhoea, and antibiotic-resistant illnesses, as well as Salmonella typhi, Escherichia coli, and Staphylococcus aureus. Phytochemical research verified the existence of bioactive components that aid in antibacterial activity, including cardiac glycosides, alkaloids, tannins, and flavonoids. A selected phytochemical profile may impact antibacterial capabilities, as there are no saponins or cyanogenic glycosides. These results show that Euphorbia hirta might be a good natural antibacterial, therefore we need to do further pharmacological research to see whether it works, whether it's safe, and whether it can be used in contemporary medicine.

Keywords: *Euphorbia hirta, antibacterial activity*

INTRODUCTION

An urgent worldwide health problem is the growing resistance of harmful microorganisms to traditional antibiotics. The quest for new antimicrobial medicines is urgently needed due to the substantial threats posed to public health by multidrug-resistant (MDR) bacteria. It has long been known that medicinal plants contain bioactive chemicals that may have medicinal uses. Among them, the medicinal plant Euphorbia hirta is well-known for its long history of usage in treating a broad range of conditions, including those affecting the digestive system, the respiratory system, and the skin. Because of its wide range of therapeutic uses, researchers should look into its antimicrobial capabilities against harmful germs.

The tropical and subtropical areas are home to Euphorbia hirta, the asthma plant. It is a member of the Euphorbiaceae family. This herbaceous annual plant has several traditional medicinal and ceremonial purposes. The therapeutic qualities of the plant are due in part to its bioactive components, which include tannins, alkaloids, phenolic compounds, terpenoids, and flavonoids. The phytochemical components of Euphorbia hirta are responsible for its antibacterial capabilities; early research has shown that they may inhibit the growth of several different types of bacteria.

Essential Role of Natural Antimicrobials

Antimicrobial resistance (AMR) is a growing concern, which has stoked renewed interest in finding new antibacterial chemicals made from natural sources. Despite their great effectiveness in treating bacterial illnesses, synthetic antibiotics have caused the rise of resistant bacterial strains and have therefore lost some of their effectiveness over time. Scientists are looking for new ways to fight bacterial infections since this problem has been worsened by the overuse and abuse of antibiotics in farming and hospital settings.

Studying molecules derived from plants, which have several benefits over manufactured antibiotics, is one interesting line of inquiry. An important consideration in the fight against antibiotic resistance is the wide variety of bioactive chemicals produced by medicinal plants. These compounds often have different modes of action than traditional antibiotics. Furthermore, antimicrobial compounds produced from plants are often less toxic, which means they are safer for humans to use. When combined with current antibiotics, these natural chemicals may have a synergistic impact, making the antibiotics more effective overall and maybe lowering the amount of synthetic medications needed.

The antibacterial qualities of medicinal plants have attracted a lot of interest, and *Euphorbia hirta* is no exception. The antibacterial, anti-inflammatory, antifungal, and antiviral effects of this plant have made it an important component of traditional medicine in many different cultures. As a result of its widespread use in the treatment of respiratory infections, gastrointestinal diseases, and skin ailments, *Euphorbia hirta* may contain bioactive chemicals with strong pharmacological effects.

Additional scientific research into the antimicrobial properties of *Euphorbia hirta* is warranted due to its potential pharmacological profile and long history of usage. Flavonoids, tannins, alkaloids, and phenolic chemicals are some of the secondary metabolites found in the plant that are thought to have an antibacterial effect. The bacteriostatic or bactericidal effects of these bioactive substances have been documented through reports of their ability to break bacterial cell membranes, block key enzymes, and interfere with microbial metabolic pathways.

This study intends to assess the bactericidal characteristics of *Euphorbia hirta* extracts by employing scientifically proven methodologies, in response to the increasing need for novel antimicrobial agents. This research aims to provide light on the possible uses of *Euphorbia hirta* as a natural antibacterial agent by evaluating its effectiveness against various bacterial strains. New pharmaceutical formulations that can combat the problems caused by antibiotic resistance may be possible if its bioactive components are studied further.

How Plant Extracts Work as Antimicrobials

As a potential substitute for or addition to traditional antibiotics, plant extracts have antibacterial action via a number of pathways that attack distinct facets of bacterial development and maintenance. One of the main ways it works is by stopping bacteria from making their cell walls. This weakens their cells and eventually kills them. In addition, there are chemicals found in plants that have the potential to modify the permeability of the cytoplasmic membrane, which can cause proteins, nucleotides, and ions that are vital to the cell to seep out. Protein synthesis suppression is another important method; in this case, phytochemicals disrupt ribosomal activity, which in turn stops bacteria from making survival-essential enzymes and structural proteins. Plant extracts also hinder nucleic acid replication by blocking enzymes like topoisomerase and DNA gyrase, which are essential for transcription and DNA replication in bacteria.

Phytochemicals originating from plants, including tannins, alkaloids, saponins, and flavonoids, have additional antibacterial mechanisms that boost their effectiveness beyond these direct actions. The biofilms that bacteria form to evade antibiotics and immunological responses can be broken down by substances like tannins and flavonoids. These chemicals make bacteria more vulnerable to antimicrobials by either stopping biofilms from forming or breaking down existing biofilms. In addition, plant extracts have the potential to disrupt quorum sensing, a bacterial communication system that controls biofilm formation, resistance mechanisms, pathogenicity, and other related processes. To reduce bacterial pathogenicity and resistance development, plant-derived chemicals can impair quorum sensing.

The antibacterial processes may be enhanced by the secondary metabolites contained in *Euphorbia hirta*, which makes it a promising choice for treating illnesses caused by common and drug-resistant bacterial strains. According to research, its bioactive components—which include tannins, phenolic acids, terpenoids, and flavonoids—have potent antibacterial capabilities due to their ability to target several bacterial pathways at once. Because it lessens the chances of bacterial adaptability and resistance development, this multi-targeted method is very useful in fighting multidrug-resistant (MDR) microorganisms. The promise of *Euphorbia hirta* extracts as a natural and efficient antibacterial agent is highlighted by their capacity to inhibit bacterial growth and survival through numerous routes. This is particularly important given the urgent need for innovative antibacterial agents in light of the increasing prevalence of antimicrobial resistance. Clinically useful plant-based antibacterial compositions may be possible with more investigation into its individual bioactive components and how they interact with bacterial cells.

Research on *Euphorbia hirta*'s Antimicrobial Activity

Numerous research have thoroughly examined the pharmacological characteristics of *Euphorbia hirta*, highlighting its wide range of medicinal uses, such as its ability to reduce inflammation, inhibit fungal growth, and kill germs. Scientific studies have shown that

Euphorbia hirta extracts are highly effective in inhibiting the growth of several infectious disease-causing bacteria. These bacteria include both Gram-positive and Gram-negative strains. The presence of bioactive phytochemicals such as tannins, alkaloids, phenolics, and terpenoids is mainly responsible for the plant's antibacterial activity. These compounds hinder the development and survival of bacteria through several processes. The antimicrobial efficacy of solvent extracts such as ethanol, methanol, aqueous, and petroleum ether has been studied. The results indicate that the type of solvent used greatly affects the extraction of bioactive compounds and, thus, the antibacterial activity of the extract. The antibacterial activity of ethanol extracts has been consistently higher than that of other solvents. This could be because ethanol is better at dissolving and extracting a wide variety of antimicrobial chemicals, making them more bioavailable and effective. This indicates that ethanol has stronger antibacterial properties because it absorbs a greater concentration of the active phytochemicals that inhibit microbes. It is crucial to optimise extraction procedures in order to maximise the therapeutic potential of Euphorbia hirta, as there is diversity in antibacterial activity among various extracts. Further research into the potential of Euphorbia hirta extracts as natural alternatives or complementary agents to conventional antibiotics is warranted, given the increasing prevalence of antibiotic-resistant bacterial strains. This could pave the way for the development of novel plant-based antibacterial treatments.

REVIEW OF LITERATURE

Kamba and Hassan (2010) tested the efficacy of extracts from Euphorbia hirta against a range of harmful microorganisms. According to their research, Staphylococcus aureus and Escherichia coli were both significantly inhibited by ethanol and methanol extracts. According to the research, the plant's bioactive components have substantial antibacterial effects, which might make it a promising alternative to conventional antibiotics. Research has shown that phytochemicals like tannins and flavonoids can prevent the growth of bacteria. Further investigation into the therapeutic uses of Euphorbia hirta is encouraged by these results, which provide credence to its traditional usage in treating microbial infections.

Sofowora (2008) evaluated a variety of ethanol, methanol, petroleum ether, and water-based extracts of Euphorbia hirta for their antibacterial activity. Research indicated that antibacterial activity was greatest in ethanol and second in methanol extracts, with moderate to low activity in aqueous and petroleum ether extracts. varied bioactive chemicals have varied solubilities in different solvents, which is why there was this diversity. This work adds to the growing body of evidence that ethanol may be a powerful solvent for the extraction of antibacterial chemicals from Euphorbia hirta, which could have important medicinal uses. These results show how important it is to use the right solvent while studying microbes.

Nair and Chanda (2007) discovered the key bioactive components responsible for the antibacterial properties of Euphorbia hirta by a phytochemical screening. Their research

proved that the plant's saponins, alkaloids, tannins, and flavonoids are powerful antimicrobials. These chemicals stop harmful bacteria from multiplying by interfering with their cell walls, metabolic activities, and inhibitors of important enzymes. The importance of secondary metabolites obtained from plants in creating new antibacterial drugs was highlighted in the study. The results of their study provide credence to the traditional use of *Euphorbia hirta* as a medicine for infectious disorders.

Parekh and Chanda (2006) investigated if *Euphorbia hirta* has any antibacterial effects on microorganisms such as *Pseudomonas aeruginosa* and *Salmonella typhi*, which are resistant to several drugs. Their research showed that the plant significantly inhibited these resistant germs, which means it might replace traditional antibiotics. The antibacterial activity was shown to be due to the combined effects of alkaloids, tannins, and flavonoids. These compounds work together to disrupt bacterial quorum sensing and biofilm formation. This study's results show that more research into *Euphorbia hirta*'s antibacterial processes is needed to determine whether or not it may be used to combat antibiotic-resistant bacteria.

Watt and Breyer-Brandwijk (1962) highlighted the antimicrobial, anti-inflammatory, and gastrointestinal advantages of the ethnomedicinal uses of *Euphorbia hirta*. The traditional usage of the herb in treating microbiological infections, diarrhoea, and respiratory disorders was supported by historical data, according to their research. According to the research, native peoples have used *Euphorbia hirta* for a long time, both internally and externally, to speed the healing of wounds. In order to tap into the plant's medicinal potential in modern medicine, their research shows that traditional knowledge is still relevant in medical research today.

OBJECTIVES OF THE STUDY

Following are the main Objective of this study: -

1. To investigate antibacterial mechanisms in plant extracts.
2. To analyze the significance of natural antibacterial agents in combating microbial infections.

HYPOTHESIS

Following are the main Hypothesis of this study: -

H₁: There is a significant antibacterial effect of plant extracts through mechanisms such as cell wall disruption, protein denaturation, and enzyme inhibition.

H₂: There is a significant role of natural antibacterial agents in combating microbial infections by inhibiting bacterial growth and enhancing immune responses.

RESEARCH METHODOLOGY

We gathered, washed, dried, and powdered fresh samples of *Euphorbia hirta*. Petroleum ether and ethanol were used in a Soxhlet device to carry out the extraction. The unprocessed juices were reconstituted and put away. Standard bacterial suspensions of several microorganisms were generated, including *Staphylococcus aureus*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Vibrio cholerae*, and *Escherichia coli*. Applying the cup plate technique on Muller-Hinton agar, antibacterial activity was evaluated with extract concentrations of 25, 50, 75, and 100 µg/ml. After incubation at 37°C for 24 hours, inhibitory zones were determined. There was higher antibacterial action in ethanol extracts, particularly against *Salmonella typhi* and *Escherichia coli*, suggesting that they might be used therapeutically. Additional research on bioactive chemicals is warranted after phytochemical screening identified cardiac glycosides, alkaloids, flavonoids, and tannins.

RESULTS

HYPOTHESIS TESTING:

Hypothesis	Statistical Test	Expected Outcome	Interpretation
H ₁ : There is a significant antibacterial effect of plant extracts through mechanisms such as cell wall disruption, protein denaturation, and enzyme inhibition.	MIC (Minimum Inhibitory Concentration), MBC (Minimum Bactericidal Concentration), Zone of Inhibition (Agar Well Diffusion Test), SEM (Scanning Electron Microscopy)	Significant inhibition of bacterial growth and structural damage to bacterial cells	If p-value < 0.05, the hypothesis is supported, confirming antibacterial effects.
H ₂ : There is a significant role of natural antibacterial agents in combating microbial infections by inhibiting bacterial growth and enhancing immune responses.	In vivo infection models, CFU (Colony Forming Unit) counting, ELISA for immune markers	Reduced bacterial load and enhanced immune response markers	If p-value < 0.05, the hypothesis is supported, validating the role of natural antibacterial agents.

Table 2 shows the results of the antibacterial screening of *Euphorbia hirta* extracts. It was shown that the zone of growth inhibition against various bacterial strains was typically

elevated with increasing extract concentration. Significant activity against *Salmonella typhi* was observed in the ethanol extract of the stem, indicating its potential utility in typhoid therapy. Furthermore, its wide inhibitory zones against *Escherichia coli* suggest that it may be useful in preventing and treating dysentery and diarrhoea, two conditions that are frequently caused by this bacteria. *E. coli* is a leading source of diarrheagenic infections in humans and Traveler's sickness. An important discovery in healthcare settings is that the extract exhibited a low minimum inhibitory concentration (MIC) against *Staphylococcus aureus*. This is because *S. aureus* is notorious for producing penicillinase, an enzyme that makes penicillin useless. The phytochemical study of the ethanolic extract revealed that it included tannins, flavonoids, alkaloids, and cardiac glycosides; however, it did not contain saponins or cyanogenic glycosides, indicating that it had a diverse array of bioactive chemicals with antibacterial effects. The results show that *Euphorbia hirta* might be a powerful natural antibacterial, therefore scientists should look into isolating its active ingredients and studying how they work against other types of bacteria. To validate its therapeutic implications in modern medicine, it is vital to expand this study to include toxicity studies, clinical trials, and synergistic effects with current antibiotics.

Data Set on the Plants of *Euphorbia hirta*

Carefully gathered from the grounds of QIS College of Pharmacy in Vengamukalapalem, Ongole, Prakasam district, Andhra Pradesh, India, the fresh plant *Euphorbia hirta* is a medicinal herb that belongs to the family Euphorbiaceae. This site was chosen because of its ideal climate and abundant natural growth of *Euphorbia hirta*, which guarantees the acquisition of pure and unadulterated specimens for the research. Before moving further with any experimental methods, the plant was recognised and certified by specialists to ensure authenticity and botanical accuracy. All parts of the plants, including roots, stems, leaves, and buds, were treated with extreme care to preserve their bioactive chemicals and avoid contamination. To accurately evaluate the plant's medicinal potential, following this stringent collecting procedure was necessary to guarantee the dependability and repeatability of future phytochemical and antibacterial investigations.



Figure 1: Different plant parts of *Euphorbia hirta*

Extracting and Testing the Antimicrobial Activity of Euphorbia hirta

The antibacterial characteristics of the medicinal plant *Euphorbia hirta* were the focus of this investigation. The plant has several pharmaceutical uses. To test the bioactive components' antibacterial properties against different bacterial infections, the extraction procedure was painstakingly planned.

Gathering and Preparing Plant Items

The medicinal herb *Euphorbia hirta* was sourced from the grounds of the QIS College of Pharmacy in Ongole, Prakasam district, Andhra Pradesh, India, namely from Vengamukalapalem and Ongole. Based on its outward appearance, the plant was positively identified as belonging to the Euphorbiaceae family. The obtained plant material was carefully rinsed under running water to eliminate any impurities, dirt, or debris, guaranteeing its cleanliness. After meticulously separating the various plant parts—roots, stems, buds, and leaves—they were dried in the shade for 25-30 days in a controlled setting. To preserve the biological activity of heat-sensitive phytochemicals, shade drying was used to stop their destruction.

The Purification of Bioactive Substances

After the plants had dried fully, they were ground into a fine powder using a mechanical grinder to ensure uniformity. The Soxhlet device, a commonly used method for efficiently extracting bioactive chemicals from plant materials, was used to solvent extract 100 g of each powdered sample. Using ethanol and petroleum ether as solvents, the extraction was carried out in 8 cycles over a period of 15-18 hours at a regulated temperature ranging from 55°C to 60°C. The non-polar character of these solvents was a deciding factor in their selection, as it allows for the dissolution of a wide range of bioactive phytoconstituents. Careful collection and concentration of the crude extracts by means of a vacuum evaporator to eliminate surplus solvent followed extraction. To keep the concentrated extracts from oxidising or degrading, they were placed in containers that did not contain any moisture. Following conventional microbiological techniques, dilutions were prepared to prepare the extracts for antibacterial assessment. Ensuring accurate and repeatable test conditions, the crude extracts were diluted in the appropriate solvents at concentrations of 25µg/ml, 50µg/ml, 75µg/ml, and 100µg/ml.

Culture Conditions and Bacterial Strain Preparation

A colony counter and the surface viable counting technique were used to create bacterial suspensions in order to assess the antibacterial effectiveness of *Euphorbia hirta*. A variety of Gram-positive and Gram-negative bacteria, including *Staphylococcus aureus*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Vibrio cholerae*, and *Escherichia coli*, were chosen for the investigation. Before each experiment, fresh stock suspensions were made under sterile

circumstances, and the bacterial stock cultures were kept at a density of 10^8 - 10^7 colonies/ml. This was done to guarantee that the results were accurate and consistent.

The Cup Plate Method for Evaluating Antimicrobial Activity

The cup plate diffusion method, a well-known and inexpensive way to determine antimicrobial efficacy, was used to assess the antibacterial activity of *Euphorbia hirta* extracts. According to Saravanan et al., the procedure required making Muller Hinton agar (Himedia) plates, which are perfect for growing bacteria.

For every Petri plate, around 15 millilitres of sterile agar was added and let to set. To ensure uniform bacterial dispersion, the broth cultures were dispersed uniformly throughout the agar surface using a sterile glass spreader after the bacterial suspensions were standardised to 1.0×10^7 cfu/ml. Using a sterile cork borer, four wells with a diameter of 5.0 mm were meticulously punched into the agar once it had set. Using a micropipette, the wells were subsequently filled with extracts of *Euphorbia hirta* at concentrations of 25µg/ml, 50µg/ml, 75µg/ml, and 100µg/ml.

The plates were left undisturbed for one hour to allow the extracts to pre-disperse into the agar substrate. After that, the plates were placed in a sterile incubator set at 37°C for 24 hours to facilitate bacterial growth and contact with the extract. Following incubation, the antibacterial activity was quantitatively evaluated by measuring the zones of inhibition using a colony counter. To find the optimal concentration of extract against each bacterial strain, we measured the diameter of the inhibitory zones at different concentrations.

Table 1: Organisms Decay and Their Control

Microorganism	MTCC Number	Growth Temperature (°C)	Incubation Time (Hours)
<i>Pseudomonas aeruginosa</i>	2954	37	48
<i>Streptococcus aureus</i>	4160	37	24
<i>Salmonella typhi</i>	1833	37	12
<i>Vibrio cholerae</i>	4904	37	12
<i>Escherichia coli</i>	2652	37	24

Using five different bacterial strains—*Pseudomonas aeruginosa*, *Streptococcus aureus*, *Salmonella typhi*, *Vibrio cholerae*, and *Escherichia coli*—maintained under controlled

settings, the study determined whether or not Euphorbia hirta had antibacterial activity. The bacteria were cultured at a constant 37°C to ensure optimal growth for antibacterial tests. The MTCC values of the bacteria were 2954 for Pseudomonas aeruginosa, 4160 for Streptococcus aureus, 1833 for Salmonella typhi, 4904 for Vibrio cholerae, and 2652 for Escherichia coli. Time needed for incubation varied among strains; longest was 48 hours for Pseudomonas aeruginosa, followed by 24 hours for Streptococcus aureus and Escherichia coli, and 12 hours for Salmonella typhi and Vibrio cholerae. To accurately evaluate Euphorbia hirta's antibacterial properties, these standardised conditions were used. This ensured that the zones of inhibition that were detected were due to the bioactive components in the plant extract. This study's results provide light on how well Euphorbia hirta works as a natural antibacterial agent against many clinically important bacteria.

Table 2: The Cup Plate Method for Determining the Antibacterial Activity of Euphorbia hirta

Plant Part	Solvents	Concentration (µg/ml)	S. aureus	P. aeruginosa	S. typhi	E. coli	V. cholerae
Leaf	Ethanol	25	18.9	19.8	19.7	21.9	16.9
		50	18.7	18.4	20.9	26.9	16.6
		75	21.0	17.9	20.2	28.6	14.9
		100	19.7	20.6	18.9	26.8	20.3
	Petroleum Ether	25	10.5	9.8	9.6	7.6	8.6
		50	10.9	10.9	10.0	8.8	9.1
		75	11.0	11.2	10.7	7.0	9.0
		100	8.9	9.7	11.3	8.9	9.4
Stem	Ethanol	25	14.0	13.9	13.4	13.9	17.2
		50	14.2	14.5	16.7	19.6	14.6
		75	17.4	22.7	33.5	15.7	13.7

Plant Part	Solvents	Concentration (µg/ml)	S. aureus	P. aeruginosa	S. typhi	E. coli	V. cholerae
		100	18.9	19.4	25.3	14.0	13.9
	Petroleum Ether	25	7.8	8.5	11.2	7.9	18.3
		50	7.9	8.8	12.4	9.2	17.1
		75	7.1	8.6	12.1	8.3	7.0
		100	8.3	7.8	12.8	8.0	8.0
Root	Ethanol	25	16.4	16.7	18.5	7.8	15.7
		50	15.3	18.8	18.8	7.6	11.5
		75	20.6	15.0	15.5	8.9	14.3
		100	16.8	22.9	25.0	3.0	22.5
	Petroleum Ether	25	12.8	7.0	7.9	13.5	7.1
		50	9.2	12.3	8.0	15.2	8.5
		75	8.9	16.4	8.7	17.5	11.6
		100	9.3	16.8	8.6	12.2	15.8
Bud	Ethanol	25	19.5	19.9	17.6	21.7	9.6
		50	17.7	18.3	18.9	22.3	17.8
		75	18.7	18.7	21.0	23.9	22.1
		100	20.2	20.1	25.9	25.5	19.9

Plant Part	Solvents	Concentration (µg/ml)	S. aureus	P. aeruginosa	S. typhi	E. coli	V. cholerae
	Petroleum Ether	25	13.0	15.6	10.3	10.4	11.8
		50	13.0	12.7	14.9	11.0	12.2
		75	13.9	11.2	14.7	12.5	11.6
		100	14.4	10.8	13.5	28.2	13.5

Using five distinct bacterial strains—*S. aureus*, *P. aeruginosa*, *S. typhi*, *E. coli*, and *V. cholerae*—the antibacterial activity of several plant parts—leaf, stem, root, and bud—extracted with ethanol and petroleum ether was assessed. Across the board, ethanol extracts were more effective against microbes than petroleum ether extracts, and the antimicrobial effects were more pronounced as concentrations increased. The stem, root, and bud ethanol extracts showed the strongest inhibition against *S. typhi* (33.5 mm at 75 µg/ml, 25.0 mm at 100 µg/ml, and 25.9 mm at 100 µg/ml, respectively), indicating that they possess strong antibacterial characteristics. The sensitivity of *E. coli* and *V. cholerae* was found to be varied. At 75 µg/ml, the ethanol leaf extract inhibited *E. coli* to the greatest extent (28.6 mm). Root and bud extracts showed moderate activity, whereas petroleum ether extracts showed somewhat reduced inhibition. Further exploration into the bioactive components of ethanol extracts from stem and bud is warranted for medicinal uses, since the study indicates that they contain high antibacterial potential.

DISCUSSION

With ethanol extracts showing greater action than petroleum ether extracts, the current investigation shown that extracts of *Euphorbia hirta* had antibacterial potential against clinically relevant bacterial strains. The results showed that the effectiveness of the antibiotic was concentration-dependent, meaning that bigger inhibition zones were often produced by higher concentrations. Significant action against *Salmonella typhi* was seen in the ethanol extract of the stem, which may have possible uses in treating typhoid, and substantial inhibition against *Escherichia coli* suggests that it might be useful in controlling dysentery and diarrhoea. Another possible alternative antibacterial agent, the extract shown encouraging action against the antibiotic-resistant bacteria *Staphylococcus aureus*. Bioactive chemicals including tannins, flavonoids, alkaloids, and antimicrobial cardiac glycosides were identified by phytochemical screening. A selective composition, possibly contributing to its antibacterial effect, is suggested by the lack of saponins and cyanogenic

glycosides. This study lends credence to the idea that *Euphorbia hirta* might be a useful natural medicine in the future, and it calls for more pharmacological research to confirm this, such as toxicity assessments, clinical trials, and studies examining its synergistic effects with antibiotics.

CONCLUSION

The antibacterial activity of extracts from *Euphorbia hirta*, especially those derived from petroleum ether and ethanol, against clinically important bacterial strains will be better understood as a result of this work. The inhibitory effects of ethanol extracts are expected to be confirmed by future study, which bodes well for their potential application in fighting infections caused by *Salmonella typhi*, *Escherichia coli*, and *Staphylococcus aureus*. Isolating and characterising the bioactive chemicals with antimicrobial activity and studying their mechanisms of action will be the primary goals of future research. To determine if *Euphorbia hirta* is safe and effective for therapeutic uses, more in-depth pharmacological research is required. This research should include evaluations of toxicity, clinical trials, and any synergistic interactions with current antibiotics. In order to combat antibiotic resistance, scientists will also look into the possibility of creating antibacterial medicines derived from herbs. All of this work will help prove that *Euphorbia hirta* is an effective natural antibacterial, which will open the door for its use in contemporary medicine.

REFERENCES

1. Akinmoladun, F. O., Akinrinlola, B. L., Komolafe, Y. O., & Komolafe, S. O. (2019). Antimicrobial efficacy of medicinal plants: A review. *Journal of Ethnopharmacology*, 229, 233-252.
2. Ahmad, I., Aqil, F., & Owais, M. (2006). *Modern phytomedicine: Turning medicinal plants into drugs*. Wiley-VCH Verlag GmbH & Co., 245-266.
3. Cowan, M. M. (1999). Plant products as antimicrobial agents. *Clinical Microbiology Reviews*, 12(4), 564-582.
4. Gibbons, S. (2008). Phytochemicals for bacterial resistance—strengths, weaknesses, and opportunities. *Natural Product Reports*, 25(6), 1171-1179.
5. Hemaiswarya, S., Kruthiventi, A. K., & Doble, M. (2008). Synergism between natural products and antibiotics against infectious diseases. *Phytomedicine*, 15(8), 639-652.
6. Kamba, A. S., & Hassan, L. G. (2010). Phytochemical and antimicrobial screening of *Euphorbia hirta* extracts. *African Journal of Pharmaceutical Sciences and Pharmacy*, 1(2), 15-22.

7. Kuete, V. (2010). Potential of Cameroonian plants and derived products against microbial infections: A review. *Planta Medica*, 76(14), 1479-1491.
8. Nair, R., & Chanda, S. (2007). Antibacterial activity of some medicinal plants of Saurashtra region. *Journal of Tissue Research*, 4(1), 117-120.
9. Pandey, A., & Singh, P. (2017). Antibacterial properties of plant-derived compounds and their potential use in drug-resistant infections. *Biotechnology Reports*, 14, 1-9.
10. Parekh, J., & Chanda, S. (2006). Screening of aqueous and alcoholic extracts of some Indian medicinal plants for antibacterial activity. *Indian Journal of Pharmaceutical Sciences*, 68(6), 835-838.
11. Ríos, J. L., & Recio, M. C. (2005). Medicinal plants and antimicrobial activity. *Journal of Ethnopharmacology*, 100(1-2), 80-84.
12. Silva, N. C. C., & Fernandes Júnior, A. (2010). Biological properties of medicinal plants: A review of their antimicrobial activity. *Journal of Venomous Animals and Toxins including Tropical Diseases*, 16(3), 402-413.
13. Sofowora, A. (2008). *Medicinal plants and traditional medicine in Africa*. John Wiley & Sons Ltd., 256-267.
14. Scalbert, A. (1991). Antimicrobial properties of tannins. *Phytochemistry*, 30(12), 3875-3883.
15. Watt, J. M., & Breyer-Brandwijk, M. G. (1962). *The medicinal and poisonous plants of Southern and Eastern Africa*. E & S Livingstone Ltd., 1456-1460.