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COMPARATIVE STUDY ON EXTRACTION, PHYTOCHEMICAL AND ANTIBACTERIAL ACTIVITY SCREENING ON THE FRESH AND DRIED LEAF EXTRACT OF THE MEDICINAL PLANT *ELATOSTEMA SESSILE*

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ABSTRACT

Elatostema sessile is a medicinal plant used for treating stomach disorders such as gastrointestinal, ulcers, indigestions. This work aimed to extract, qualitatively screen the phytochemicals and determine the antibacterial activity on fresh and dried leaf extracts of *Elatostema sessile* leaves in methanol and hexane solvents. Soxhlet extraction method was used for extraction, standard phytochemical testing procedure was used for phytochemical screening and well diffusion method was used in determining the antibacterial activity of the four selected bacterial strains *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*. Phytochemical analysis of fresh leaves from methanol solvent extract revealed presence of compound alkaloids, terpenoids, tannins, saponins, steroids, phenols and flavonoids, whereas terpenoids and steroids are found present in hexane solvent extract. From dried leaf extract, alkaloids, terpenoids, saponins, and flavonoids were found in methanol extract, while tannins were present in hexane dried leaf extract. The antibacterial activity screening was investigated at six different extract concentrations 300, 250, 200, 150, 100, 50 mg/ml in DMSO, the antibacterial activity was conducted in a triplicate. The best antibacterial activity was recorded on the fresh leaf methanol extract observed on bacteria *Staphylococcus aureus* at extract concentration 300 mg/ml with inhibition zone 19.66±0.57 mm. Ampicillin 2 mcg was used as a standard control. From this study, it gives a scientific justification of the traditional usage of *Elatostema sessile* leaves through phytochemical and antibacterial activity screening exhibited by *Elatostema sessile* leaves extracts as an affordable source of natural antibacterial agent to treat various pathogens.

Key words : Antibacterial activity, *Elatostema sessile*, Medicinal plants, Natural product.

Introduction

Nature has been an inexhaustible source of requirements for humans throughout the existence of life. One such important element is natural products, a substance originating biologically obtained from microorganisms, plants and animals (Cragg and Newman, 2013; Mishra and Tiwari, 2011; Siddiqui *et al.*, 2014). Natural products have been used in different fields, from ancient applications such as paper making, spices, perfumes to medicinal use for treating various human diseases (Lv Y *et al.*, 2024). Approximately 25% of every million natural products possess biological activity. Driven by their biological potential, 50% of present pharmaceuticals and nutraceuticals were derivatives of natural products (Demain, 2014; Katz and Baltz, 2016; Vaou *et al.*, 2021). Natural product continues to provide a main component for many pharmaceutical drugs, the pharmacological and economic value of natural product has not lost its significant impact till today (Ojiako, 2014). Remarkably medicines obtained from the plant-based have been the primary source for the treatment of illness since time immemorial (Renisheya *et al.*, 2011). The World Health Organization (WHO) reported that 80% of human population primarily on medicines obtained from natural source for healthcare, and recorded the names of over 20,000 of plant species as a potential source of drugs (Vaou *et al.*, 2021; EL-Kamali and EL-Amir, 2010; Raja *et al.*, 2011). The WHO suggested that medicinal plants are a safe option to make a difference for various pharmaceutical drugs for medication (Manandhar *et al.*,

2019). The significant advantage of using plant-based medicines is due to their safety and affordability over synthetic medicines (Hossaini *et al.*, 2021). The plants chemical composition provides an excellent substitute in medicinal therapy, particularly the phytochemicals which include alkaloids, terpenes, tannins, saponins, quinines, flavonoids, phenols, steroids, vitamins and other additional secondary metabolites (Sen and Batra, 2012; Mehmood *et al.*, 2022). 25% of these extracted bioactive compounds from plants are known to be major prescribed medication by a physician, Rao *et al.* (2023) as these compounds shows different biological applications such as antimicrobial, antiviral, anti-inflammatory, anticancer, antioxidant functions, etc (Mostafa *et al.*, 2023). Extract of medicinal properties from the plant source provides abundant antimicrobial activity, which is safe and readily biodegradable, this provides a persistent interest in screening the compounds from plants as an alternative treatment for microbial (Mickymaray, 2019 and Owusu *et al.*, 2021). There is a major setback in concern with the rise of the microbial resistance towards conventional antibiotic leading to major global health threats, the improper or extensive use of antibiotics results in antimicrobial resistance. This obligates the need to isolate new bioactive compounds and develop alternative antimicrobial drug to fight against microbial resistivity (Vaou *et al.*, 2021). Various strategies have been proposed, such as the production of combination therapies between natural products and antibiotics to enhance antibiotic activity, prevent bacterial resistance, and provide a significant pharmaceutical agent (Bazzaz *et al.*, 2016; Nasir *et al.*, 2015). Plants possess a bioactive compound that has natural protection against microbials, some of which compounds are toxic and are used as a whole for medicinal purposes (Wyk and Prinsloo, 2020). The chemical compound compositions vary in every medicinal plant and administering the right amount of dosage consumption is important (Kaur and Arora, 2009). Many herbal plants have claimed to possess the beneficial health effect against pathogenic microorganisms for thousands of years, however only few plants have been carried out for the scientific study of their effectiveness, and use of these medicinal plants are restricted locally. Hence scientific investigation of several medicinal plants becomes a necessity to get the information of their pharmacological activity (El-Desoukey *et al.*, 2022). *Elatostema sessile* is a plant which is found across Nagaland. It is locally called 'Rasi' in Chokri by Chakhesang tribe in Nagaland. *Elatostema sessile* is a medicinal plant that is used for the purposes of treatment of stomach disorders like gastrointestinal, ulcers, indigestion. The present study aims to extract the fresh and dried leaves of *Elatostema sessile* from methanol and hexane solvent and perform the phytochemicals and antibacterial activity screening.

Materials and Methods

Collection of *Elatostema sessile* plant sample

Elatostema sessile leaves are collected in Nagaland University Lumami, Nagaland, India. The plant was found in a river area, where there is no direct interaction with sunlight. Each leaf was thoroughly rinsed with water to remove the dirt's and carried out for the extraction process.

Preparation for extraction of *Elatostema sessile* leaves

The extraction of *Elatostema sessile* leaves was done using Soxhlet extraction method. The leaves have been carefully washed to remove the impurities, the extraction of *Elatostema sessile* leaves was done for both fresh and dried leaves in methanol and hexane solvents, 73.200 gm of fresh *Elatostema sessile* leaves were cut with knives into tiny pieces and was extracted in 180 ml of methanol solvent. Similarly, 54.200 gm of fresh *Elatostema sessile* leaves were extracted in 180 ml of hexane solvent. Further 13.350 gm of dried leaf of *Elatostema sessile* were extracted 180 ml of methanol and hexane solvent. The dried leaves were crushed to small sizes, the time taken for each leaf extraction was 72 hours. After the completion of extraction, each extract was then taken to rotatory evaporator to evaporate the solvents.

Fig. 1 : Photographic image of plant *Elatostema sessile.*

Phytochemical screening

The extracts of fresh and dried *Elatostema sessile* leaves from methanol and hexane solvents were phytochemically screened to detect the availability of the secondary metabolites following the standard procedure method. Screening of the compound alkaloids was determined from the procedure given by El-Desoukey *et*

al. (2022). Terpenoids, tannins, saponins, quinines and steroids test were tested following the procedure by Kabesh *et al.* (2015). For phenols test the procedure followed was given by Dauda *et al.* (2020) and flavonoids test was determined following the procedure given by the Sihotang *et al.* (2017).

Alkaloids tests

1 ml leaf extract was mixed with a few 2-3 drops of Marqus reagent (which was taken from 0.5 ml formaldehyde and 5 ml concentrated sulphuric acid). Turbidity formation showed that the compound alkaloid is present (El-Desoukey *et al.*, 2022).

Terpenoids tests

1 ml leaf extract was added to 1 ml of concentrated sulphuric acid and heated for approximately 2 minutes. Greyish colour formation determines that the compound terpenoids are present (Kabesh *et al.*, 2015).

Tannins tests

1 ml of ferric chloride was mixed to 1 ml of extract. Appearance of blue, green or black colour confirms presence of tannins (Kabesh *et al.*, 2015).

Saponins tests

2 ml of distilled water was taken and mixed to 1 ml of extract. Foam formation showed that the compound saponins are present (Kabesh *et al.*, 2015).

Quinines tests

1 ml of 1% sodium hydroxide was mixed to 1 mL leaf extract and shaken well. Blue, green or red formation confirms quinines are present (Kabesh *et al.*, 2015).

Steroids tests

1 ml of extract and 1 ml of chloroform and concentrated sulphuric acid are added carefully sidewise. With appearance of red colour at lower chloroform layer, it confirms presence of steroids (Kabesh *et al.*, 2015).

Phenols tests

Leaf extract of 1 ml was treated with 2 ml of distilled water and 2-3 of 10% ferric chloride. Blue or green colour appearance confirms that phenols is present (Dauda *et al.*, 2020).

Flavonoids tests

1 ml of leaf extract was added to the solution of 1 ml 10% lead acetate. Precipitate formation of yellow colour showed that is flavonoid present (Sihotang *et al.*, 2017).

Antibacterial activity of *Elatostema sessile* leaves extracts

Bacterial strains

Both fresh and dried leaves of *Elatostema sessile* extracted from methanol and hexane solvents were screened for antibacterial activity against the selected four bacteria i.e. two gram-positive bacteria (*Bacillus subtilis* and *Staphylococcus aureus*) and two gram-negative bacteria (*Escherichia coli* and *Klebsiella pneumoniae*).

Preparation of bacterial culture in agar

For preparation of four bacterial strains, 2.24 gm nutrient agar was taken and allowed to dissolved in 80 ml distilled water which was further autoclaved for 25 minutes at 121°C. 20 ml of nutrient agar was put to each sterilised petri plates and left for 20 minutes to solidify. From the mother culture a colony of bacteria was taken and scraped on the petri plates which contains nutrient agar, one bacterium was prepared at a time to avoid contamination. The plates were sealed which was further incubated at 37°C for 24 hours.

Preparation of bacterial culture in broth

For preparation of 4 broth bacterial strains, 0.96 gm of nutrient broth was weight and dissolved in 40 ml of distilled water. The prepare was autoclaved at 121°C for 25 minutes. 10 ml of prepared broth was poured into the sterilised vials. A colony of bacteria was taken from stock culture with a sterilised glass rod and stirred on vials containing nutrient. The broth cultures of bacteria were sealed and incubated at 37°C for 24 hours.

Antibacterial activity screening of *Elatostema sessile* leaves extracts

The screening of antibacterial activity of *Elatostema sessile* leaf extracts of fresh and dried leaves were tested against four selected bacterial strains, on six different concentrations extract ranging from 50, 100, 150, 200, 250, 300 mg/ml have been prepared by dissolving each extract in 1 ml DMSO (Dimethyl Sulfoxide). Four bacterial culture plate were prepared by allowing 2.24 gm of nutrient agar to be dissolved in 80 ml distilled water, which was autoclaved for 25 minutes at 121 °C. After completion of sterilization 20 ml of nutrient agar was taken to all sterile petri plate and allow it to solidify. The result was recorded by measuring inhibition zone in mm (millimetres) using HiAntibioticZoneScale-C. The antibacterial activity screening of fresh and dried extract of *Elatostema sessile* from methanol and hexane solvent was performed in triplicates.

Agar well diffusion method

For antibacterial activity screening of *Elatostema sessile* leaf extracts agar well diffusion method was carried out following the procedure by Balouiri *et al.*, (2016). From the solidified agar petri plates, 60 µL of bacteria broth was poured to petri plate and spread evenly

with the sterilized glass rod. Further 7 wells of size 6 mm have been made. 15 µL of different plant extract concentration was put to respective well. Ampicillin 2 mcg was used in antibacterial testing as a standard control and DMSO was used negative control. Inoculated bacterial plates were allowed to get incubated at 37 °C for 24 hours for the optimal growth.

Results

Yield of *Elatostema sessile* leaf extract

From the Soxhlet extraction of *Elatostema sessile* the result revealed that fresh extract of methanol solvent gives the yield 1.600 gm and the extract was dark green in colour and hexane solvent give the yield 0.480 gm with the extract yellow in colour. From the dried leaf extraction, the yield extract collected from methanol is 0.484 gm with a dark green colour extract. Whereas hexane solvent gives the yield 1.132 gm and the extract was dark green in colour (Table 1).

Phytochemical analysis of the of *Elatostema sessile* leaves extracts

Phytochemical screening is one fundamental method for detecting the availability of bioactive compounds in plant extracts. Determination of presence or absence of phytochemicals were taken by recording a change through visual observation in colour change or formation of precipitate when reagents are added. A qualitative phytochemical test of fresh leave extract from methanol solvent extract showed that the tested compounds like alkaloids, terpenoids, tannins, saponins, steroids, phenols, flavonoids were present and hexane extract solvent showed the presence of terpenoids. Whereas the dried leaf extract of methanol solvent showed that compound alkaloids, terpenoids, saponins, flavonoids were present and hexane solvent extract detect the presence of the compound tannins (Table 2).

Antibacterial activity of the *Elatostema sessile* leaves extract

The antibacterial activity obtained from the fresh and dried leaf extract of the plant *Elatostema sessile* from methanol and hexane solvent extract which was screened against the bacteria, *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumoniae* by using six different concentrations starting from 50 to 300 mg/ml DMSO exhibited the inhibition on all the bacteria that was screened (Table 3). The antibacterial activity varied with solvents and concentration used for antibacterial screening. Among the fresh and dried methanol solvent leaf extracts antibacterial testing, the fresh leaves extract exhibited the better antibacterial activity against all tested bacteria at the extract concentration 200 mg/ml for *Bacillus subtilis*, and 300 mg/ml for *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumoniae* with maximum inhibition zone 16±0 mm, 19.66±0.57 mm, 17.33±1.15 mm, 13.67±1.52 mm respectively. Among the fresh and dried leaf hexane extract the antibacterial activity of the fresh leaves extract exhibited the maximum antibacterial activity against the three bacteria *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumoniae* with the maximum inhibition zone 16±1.73 mm, 19.33±0.57 mm, 14.33±0.57 mm respectively, which was seen on the

Table 1 : The data employed of the *Elatostema sessile* leaves for the extraction.

Plant species	Vernacular name	Parts plant used	Condition of the leaves	Solvents used	Weight of leaf taken	Vol. of solvent used	Extract yield in gm	Colour of the extract
Elatostema sessile	Rasi	Leaves	Fresh	Methanol	73.200 gm	180 ml	1.600gm	Dark green
				Hexane	54.200 gm	180 ml	0.480 gm	Yellow
			Dried	Methanol	13.350 gm	180 ml	0.484gm	Dark green
				Hexane	13.350 gm	180 ml	1.132gm	Yellow

Table 2 : Phytochemical screening results of *Elatostema sessile* fresh and dried leaf extracts from methanol and hexane solvents.

Solvents	Extracts	Phytochemicals							
		Alkaloids	Terpenoids	Tannins	Saponins	Quinines	Steroids	Phenols	Flavonoids
Methanol	Fresh extract	+	+	+	+	-	+	+	+
	Dried extract	+	+	-	+	-	-	-	+
Hexane	Fresh extract	-	+	-	-	-	+	-	-
	Dried extract	-	-	+	-	-	-	-	-

Key (+) indicates the presence of a compounds, Key (–) indicates the absence of a compounds.

Table 3 : Antibacterial activity screening results and mean ± standard deviation values of *Elatostema sessile* leaf extracts against the selected bacteria.

Solvent	Concentration	*Bacillus subtilis*		*Staphylococcus aureus*		*Escherichia coli*		*Klebsiella pneumoniae*	
		Fresh leaves	Dried leaves	Fresh leaves	Dried leaves	Fresh leaves	Dried leaves	Fresh leaves	Dried leaves
Methanol	300mg	10.33±0.57	11±1	19.66±0.57	9.67±0.57	17.33±1.15	10±0	13.66±1.52	9.67±0.57
	250mg	16±0.57	10±0	17.33±0.0	9±0	16±0.57	10.33±0.57	12±0.57	10.33±0.57
	200mg	16±0	9.67±0.57	15.33±0.5	9±0	13.33±1.52	10±0	10±1	10±1
	150mg	14.66±0.57	9±0	15±1	8±0	12±0	9.33±0.57	9±0	8.67±0.57
	100mg	13±1	8±0	13±1	7.67±0.57	12.33±0.57	9±0	9±0	8±0
	50mg	10.33±0.57	7±0	11.66±1.52	7±0	13.66±0.57	9±0	9.33±0.57	7±0
	+ve	10±0	14.33±1.15	22.33±0.57	10±0	10±0	13.33±1.15	14±0.57	10.33±0.57
	-ve	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0
Hexane	300mg	9.33±0.57	10.33±0.57	16±1.73	9±0	19.33±0.57	9.33±0.57	14.33±0.57	7.03±0.57
	250mg	10±0.57	9±0	13.67±1.52	8.33±0.57	17±0.57	6.67±0.57	15.66±0.57	7±0
	200mg	9.67±0.57	9±0	16±0.57	8±0	13.66±1.52	6.33±0.57	14.33±0.57	7±0
	150mg	9.67±0.57	9±0	15±1.73	7.67±0.57	15.66±0.57	6.33±0.57	12.66±1.0	6.33±0.57
	100mg	9±0.57	9±0	14.33±0.57	7.67±0.57	15.6±1.52	6.33±0.57	11.66±0.57	6.66±0.57
	50mg	8±0.57	8.33±0.57	13±0.57	7±0	11.67±0.57	6±0	11.33±0.57	6.33±0.57
	+ve	8.33±0	15.33±0	16.67±1.52	10.68±0.57	21±1.73	12±0	18±0	10.33±0.57
	-ve	0±0	0±0	0±0	0±0	0±0	0±0	0±0	0±0

extract concentration 300 mg/ml for all the tested bacteria, whereas antibacterial activity of hexane dried extract showed better inhibition zone than the fresh leaf hexane extract against the bacteria *Bacillus subtilis* at the extract concentration 300 mg/ml DMSO with the inhibition zone 10.33±0.57 mm. The positive control ampicillin 2 mcg exhibited good antibacterial activity on all the tested bacteria for both fresh and dried leaf extract of *Elatostema sessile* from methanol and hexane solvent. However, negative control DMSO showed no antibacterial activity on all the bacteria.

Discussion

Medicines obtained from natural sources have been a primary treatment and preferred since time immemorial due to their safety and affordability, regardless of the extensive development of synthetic pharmaceutical drug, medicines obtained by natural source still hold an important stature (Wyk and Prinsloo, 2020). Considerable efforts have been put up by researchers for extracting and synthesizing the drug from the natural sources, particularly plants phytochemicals serve as a novel source of medicines alternative to synthetic medicines, despite the whole plant being known for medicinal purpose the leaves are the most favoured part for the therapeutic uses (Chanda and Kaneria, 2011). In the present study, both fresh and dried leaves of the *Elatostema sessile* plant was extracted from methanol and hexane solvent by Soxhlet extraction method and conducted the phytochemical screening and antibacterial activity screening. Phytochemical screening on fresh extract of methanol solvent showed the availability of significant compounds such as alkaloids, terpenoids, tannins, saponins, steroids, phenols and flavonoids, the fresh leaves extract of hexane solvent revealed the presence terpenoids, whereas the dried extract of methanol solvent exhibited the availability of the compound alkaloids, terpenoids, saponins, flavonoids, while tannins were found present in dried hexane solvent extract (Table 2). Alkaloids

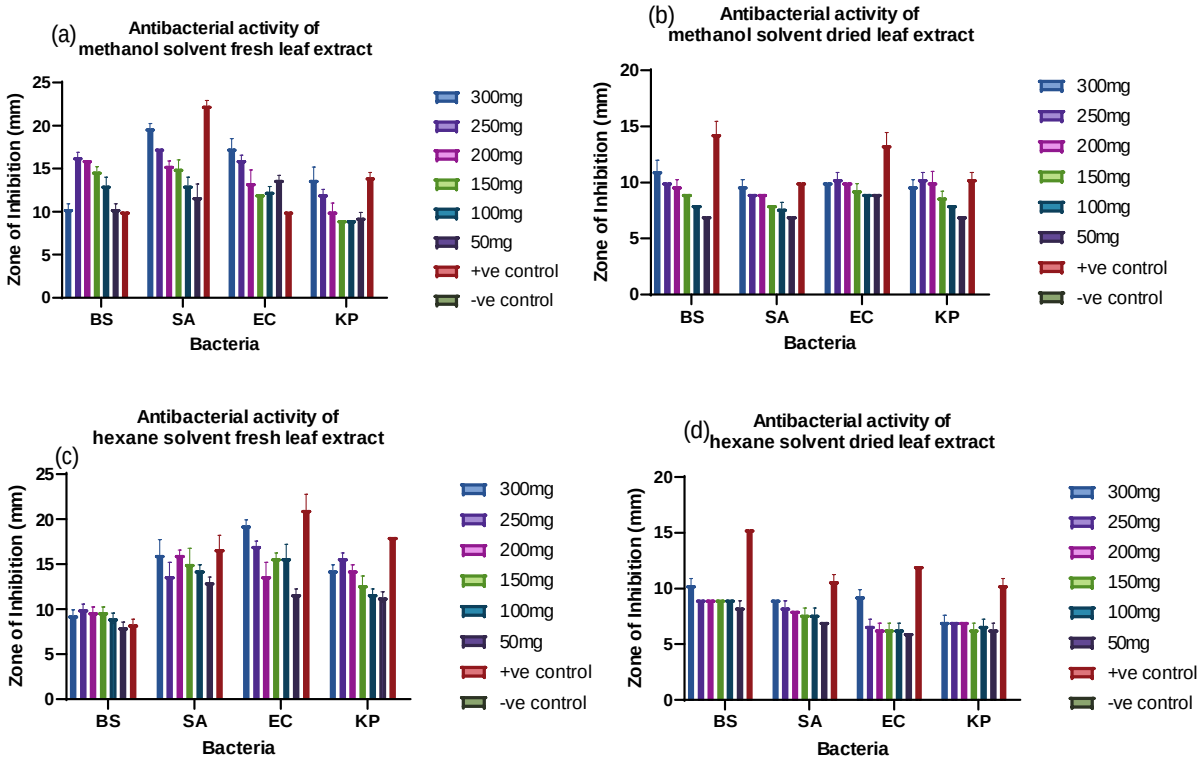

Fig. 2 : Antibacterial activity graph representation of *Elatostema sessile* leaf extracts on methanol and hexane solvents against the selected bacteria.

are one common bioactive compound that possess antioxidant and anti-inflammatory activities, terpenoids possess antimicrobial activity (Al-Tohamy *et al.*, 2018). The compound tannins are effective in treating intestinal disorders and possess and anticancer activity, steroidal compounds have been known to possess an antimicrobial activity (Igbinosa *et al.*, 2009). Quinines are an important compound that has remarkable antimalarial activity (Achan *et al.*, 2011). Saponins compounds are known to have defence mechanism of a plant by possessing an antimicrobial activity, flavonoids compounds have been known to exhibited antioxidant, anti-inflammatory, antimicrobial, anticancer and antiallergic reactions, phenolic groups are known to possess primary antioxidant activity (Alabri *et al.*, 2014). Additionally, all these phytochemicals were reported to effectively inhibit the bacteria growth. The global emergence of microbial resistance to medicines have raised major concern to treat infectious diseases. This raised an interest in use of natural medicines with minimal side effects and its ability to manage drug resistant microbes, to replace synthetic drugs researchers have conducted studies to identify possible solutions to these problems (Alrumman, 2022) (Settaluri *et al.*, 2014). Apart from the major disease treatments in hospitals, herbal plants have been documented as an integral part of home remedies in treating sickness such as headaches, stomach upsets and cold etc (Weli *et al.*, 2018). The antibacterial activity screening of the fresh and dried *Elatostema sessile* leaves by agar well diffusion method from methanol and hexane solvent has illustrated different range of the antibacterial activity. Fresh leaves extracts showed significantly better inhibition zone on three bacterial strains *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumoniae* as compared to dried extract. Whereas the dried extracts showed better inhibition zone on the bacteria *Bacillus subtilis* as compared to the fresh leaf extract, this was observed both in methanol and hexane solvent extract of *Elatostema sessile* leaves.

From fresh leaf extract of methanol solvent, the highest zone inhibitions observed on gram-positive bacteria *Bacillus subtilis* was seen on the extract concentration 200 mg/ml with the inhibition 16±0 mm, *Staphylococcus aureus* 19.66±0.57 mm at leaf extract concentration of 300 mg/ml. From fresh leaf extract of hexane solvent, the maximum inhibition zone observed on gram-positive bacteria *Escherichia coli* was at the concentration 300 mg/ml with the inhibition zone 17.33±1.15 mm, *Klebsiella pneumoniae* with the inhibition zone 13.66±1.52 mm at the leaf extract concentration of 300 mg/ml. Antibacterial activity graph representation from fresh leaf extract of methanol and hexane solvent is presented in the Fig. 2 (a) and (c).

Whereas from dried leaf methanol solvent extract, the maximum inhibition zone observed on gram-positive bacteria *Bacillus subtilis* was seen on the extract concentration 300 mg/ml with the inhibition 10.33±0.57 mm, *Staphylococcus aureus* 16±1.73 mm at extract concentration of 300 mg/ml. Maximum inhibition zone of fresh leaf extract on hexane solvent was observed on gram-positive bacteria *Escherichia coli* at extract concentration 300 mg/ml with the inhibition zone 9.33±0.57 mm, *Klebsiella pneumoniae* with the inhibition zone 7.03±0.57 mm at extract concentration of 300 mg/ml. From the present study it was observed that both the fresh and dried from methanol and hexane solvent extract of *Elatostema sessile* leaves can inhibit microbes effectively, hence this study confirms the traditional role in treating infections and can use as a potential lead product as a safe antibacterial agent. Similarly, the bar graph representation of the antibacterial activity which was obtained from the dried leaf extract of methanol and hexane solvent is presented in the Fig. 2 (b) and (d).

Conclusion

From our study, the fresh and dried leaves of *Elatostema sessile* was extracted from methanol and hexane solvent through Soxhlet extraction method. All the extracts of *Elatostema sessile* leaves were taken for phytochemicals and antibacterial activity screening against the selected bacteria. The results from our study exhibited the effective medicinal purpose served by *Elatostema sessile* leaves extracts. The extracts from methanol and hexane solvents taken for phytochemical screening revealed the availability of significant compounds such as alkaloids, terpenoids, tannins, saponins, steroids, phenols, flavonoids. The antibacterial activity showed by *Elatostema sessile* leaf extracts shows good antibacterial activity against all the four tested bacteria with the most effective antibacterial activity seen on the bacteria *Staphylococcus aureus* at 300 mg/ml concentration with inhibition zone 19.66±0.57 mm. Our work provides scientific justification for the traditional use of *Elatostema sessile* leaves with various phytochemical constituents and effectively works as a good natural antibacterial agent in treating against various pathogens.

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References

Achan, J., Talisuna A.O., Erhart A., Yeka A., Tibenderana J.K., Baliraine F.N. and D'Alessandro U. (2011). Quinine, an old anti-malarial drug in a modern world: role in the treatment of malaria. *Malaria J.*, **10**, 1-12. DOI: 10.1186/1475-2875-10-144

Alabri, T.H.A., Al Musalami A.H.S., Hossain M.A., Weli A.M. and Al-Riyami Q. (2014). Comparative study of phytochemical screening, antioxidant and antimicrobial capacities of fresh and dry leaves crude plant extracts of *Datura metel* L. *J. King Saud Univ.-Sci.*, **26(3)**, 237-243. https://doi.org/10.1016/j.jksus.2013.07.002

Alrumman, S.A. (2022) Antimicrobial activities and phytochemical analysis of leaf extracts of *Echinops abuzinadianus* Chaudhary growing in Abha City, Saudi Arabia. *Indian J. Traditional Knowledge* (*IJTK*), **21(4)**, 802-807. DOI: 10.56042/ijtk.v21i4.31795

Al-Tohamy, R., Ali S.S., Saad-Allah K., Fareed M., Ali A., El-Badry A. and Rupani P.F. (2018). Phytochemical analysis and assessment of antioxidant and antimicrobial activities of some medicinal plant species from Egyptian flora. *J. Appl. Biomed.*, **16(4)**, 289-300. DOI:10.1016/j.jab.2018.08.001

Balouiri, M., Sadiki M. and Ibnsouda S.K. (2016). Methods for in vitro evaluating antimicrobial activity: A review. *J. Pharmaceut. Anal.*, **6(2)**, 71-79. https://doi.org/10.1016/j.jpha.2015.11.005

Bazzaz, B.S.F., Sarabandi S., Khameneh B. and Hosseinzadeh H. (2016). Effect of catechins, green tea extract and methylxanthines in combination with gentamicin against *Staphylococcus aureus* and *Pseudomonas aeruginosa*:-combination therapy against resistant bacteria. *J. Pharmacopuncture*, **19(4)**, 312. doi: 10.3831/KPI.2016.19.032

Chanda, S. and Kaneria M (2011). Indian nutraceutical plant leaves as a potential source of natural antimicrobial agents. *Science against microbial pathogens: communicating current research and technological advances*, **2**, 1251-1259.

Cragg, G.M. and Newman D.J. (2013). Natural products: a continuing source of novel drug leads. *Biochimica et Biophysica Acta (BBA)-General Subjects*, **1830(6)**, 3670-3695. https://doi.org/10.1016/j.bbagen.2013.02.008

Dauda, H., Uba G. and Ali U. (2020). Preliminary Phytochemical Screening, Quantitative Analysis of Flavonoids from the Stem Bark Extract of *Commiphora africana* (Burseraceae). *Bull. Environ. Sci. Sust. Manage.* (e-ISSN 2716-5353), **4(1)**, 25-27. DOI:10.54987/bessm.v4i1.529

Demain, A.L. (2014) Importance of microbial natural products and the need to revitalize their discovery. *J. Indust. Microbiol. Biotechnol.*, **41(2)**, 185-201. DOI: 10.1007/s10295-013-1325-z

El-Desoukey, R.M., Albarakaty F.M., Alzamel N.M. and AlZain M.N. (2022) Ethnobotanical, phytochemical and antimicrobial activity of Halexylon salicornicum (Ramth) as a graze and promising shrub against selected animal microbes. *Saudi J. Biological Sci.*, **29(7)**, 103328. doi: 10.1016/j.sjbs.2022.103328.

EL-Kamali, H.H. and EL-Amir M.Y. (2010). Antibacterial activity

and phytochemical screening of ethanolic extracts obtained from selected Sudanese medicinal plants. *Curr. Res. J. Biological Sci.*, **2(2)**, 143-146.

Hossaini, F., Das N.C., Hossaini F., Acharjee M. and Munshi S.K. (2021). Antimicrobial traits of different medicinal plants locally available in Bangladesh. *Biomed. Biotechnol. Res. J.* (BBRJ), **5(1)**, 1-6. DOI:10.4103/bbrj.bbrj_198_20

Igbinosa, O.O., Igbinosa E.O. and Aiyegoro O.A. (2009) Antimicrobial activity and phytochemical screening of stem bark extracts from *Jatropha curcas* (Linn). *Afr. J. Pharma Pharmacol.*, **3(2)**, 058-062.

Kabesh, K., Senthilkumar P., Ragunathan R. and Kumar R.R. (2015). Phytochemical analysis of *Catharanthus roseus* plant extract and its antimicrobial activity. *Int. J. Pure App. Biosci.*, **3(2)**, 162-172.

Katz, L. and Baltz R.H. (2016). Natural product discovery: past, present and future. *J. Indust. Microbiol. Biotechnol.*, **43(2-3)**, 155-176. DOI: 10.1007/s10295-015-1723-5

Kaur, G.J. and Arora D.S. (2009). Antibacterial and phytochemical screening of *Anethum graveolens*, *Foeniculum vulgare* and *Trachyspermum ammi*. *BMC Complementary and Alternative Medicine*, **9**, 1-10. DOI: 10.1186/1472-6882-9-30

Lv, Y., Li W., Liao W., Jiang H., Liu Y., Cao J. and Feng Y. (2024). Nano-Drug Delivery Systems Based on Natural Products. *Int. J. Nanomed*., **2024**, 541-569. DOI: 10.2147/IJN.S443692

Manandhar, S., Luitel S. and Dahal R.K. (2019). *In vitro* antimicrobial activity of some medicinal plants against human pathogenic bacteria. *J. Trop. Med.*, 2019. DOI: 10.1155/2019/1895340

Mehmood, A., Javid S., Khan M.F., Ahmad K.S. and Mustafa A. (2022). *In vitro* total phenolics, total flavonoids, antioxidant and antibacterial activities of selected medicinal plants using different solvent systems. *BMC Chemistry*, **16(1)**, 64. DOI:10.1186/s13065-022-00858-2

Mickymaray, S. (2019). Efficacy and mechanism of traditional medicinal plants and bioactive compounds against clinically important pathogens. *Antibiotics*, **8(4)**, 257. DOI:10.3390/antibiotics8040257

Mishra, B.B. and Tiwari V.K. (2011). Natural products: an evolving role in future drug discovery. *Europ. J. Medicinal Chem.*, **46(10)**, 4769-4807. DOI: 10.1016/j.ejmech.2011.07.057

Mostafa, A.A., Al-Askar A.A., Almaary K.S., Dawoud T.M., Sholkamy E.N. and Bakri M.M. (2018). Antimicrobial activity of some plant extracts against bacterial strains causing food poisoning diseases. *Saudi J. Biological Sci.*, **25(2)**, 361-366. DOI: 10.1016/j.sjbs.2017.02.004

Nasir, B., Fatima H., Ahmed M. and Haq I.U. (2015). Recent trends and methods in antimicrobial drug discovery from plant sources. *Austin J Microbiol.*, **1(1)**, 1-12.

Ojiako, E.N. (2014). Phytochemical analysis and antimicrobial screening of *Moringa oleifera* leaves extract. *The Int. J. Engg Sci.*, **3(3)**, 32-35.

Owusu, E., Ahorlu M.M., Afutu E., Akumwena A. and Asare G.A. (2021). Antimicrobial activity of selected medicinal plants from a sub-Saharan African country against bacterial pathogens from post-operative wound infections. *Medical Sciences*, **9(2)**, 23. doi: 10.3390/medsci9020023.

Raja, R.D.A., Jeeva S., Prakash J.W., Antonisamy J.M. and Irudayaraj V. (2011). Antibacterial activity of selected ethnomedicinal plants from South India. *Asian Pac. J. Trop. Med.*, **4(5)**, 375-378. DOI: 10.1016/S1995-7645(11)60107-7

Rao, H., Ahmad S., Aati H.Y., Basit A., Ahmad I., Ghalloo B.A. and Nasim M.J. (2023). Phytochemical screening, biological evaluation and molecular docking studies of aerial parts of *Trigonella hamosa* (branched Fenugreek). *Arabian J. Chem.*, **16(7)**, 104795. DOI:10.1016/j.arabjc.2023.104795

Renisheya, J.J.M.T., Johnson M., Mary U.M. and Arthy A. (2011). Antibacterial activity of ethanolic extracts of selected medicinal plants against human pathogens. *Asian Pac. J. Trop. Biomed.*, **1(1)**, S76-S78. DOI:10.1016/S2221-1691(11)60128-7

Sen, A. and Batra A. (2012). Evaluation of antimicrobial activity of different solvent extracts of medicinal plant: *Melia azedarach* L. *Int J Curr Pharm Res.*, **4(2)**, 67-73. DOI:10.4081/vsd.2015.6080

Settaluri, V.S., Al Anbari T.M., Al Shukaili S.K., Al Rawahi R.M., Azmi S.N.H., Sah P. and Mahmood S. (2024). Phytochemical screening and in vitro evaluation of antioxidant and antimicrobial efficacies of *Pteropyum scoparium* (Jaub. & Spach) Sidaf crude extracts. *J. King Saud Univ.-Sci.*, **36(1)**, 102995. DOI:10.1016/j.jksus.2023.102995

Siddiqui, A.A., Iram F., Siddiqui S. and Sahu K. (2014). Role of natural products in drug discovery process. *Int J Drug Dev Res.*, **6(2)**, 172-204.

Sihotang, Y.M., Windiasfira E., Barus H.D.G., Herlina H. and Novita R.P. (2017). Hepatoprotective effect of ethanol extract of matoa leaves (*Pometia pinnata*) against paracetamol-induced liver disease in rats. *Sci. Technol. Indonesia*, **2(4)**, 92-95. https://doi.org/10.26554/sti.2017.2.4.92-95

van, Wyk A.S. and Prinsloo G. (2020). Health, safety and quality concerns of plant-based traditional medicines and herbal remedies. *South Afr. J. Bot.*, **133**, 54-62. DOI:10.1016/j.sajb.2020.06.031

Vaou, N., Stavropoulou E., Voidarou C., Tsigalou C. and Bezirtzoglou E. (2021). Towards advances in medicinal plant antimicrobial activity: A review study on challenges and future perspectives. *Microorganisms*, **9(10)**, 2041. doi: 10.3390/microorganisms9102041

Weli, A.M., Al-Salmi S., Al Hoqani H. and Hossain M.A. (2018). Biological and phytochemical studies of different leaves extracts of *Pteropyrum scoparium*. *Beni-Suef Univ. J. Basic Appl. Sci.*, **7(4)**, 481-486. DOI:10.1016/j.bjbas.2018.05.001