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ANTIMICROBIAL ACTIVITY OF FIVE SOUTH INDIAN MEDICINAL PLANTS AGAINST CLINICAL PATHOGENS

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ABSTRACT

The antimicrobial activity of leaves of five South Indian medicinal plants *Adhatoda vasika, Bacopa monnieri, Carica papaya, Cissampelos pareira* and *Cynodon dactylon* , collected from regions of Kulathoor and Malayadi were investigated against ten clinical pathogens (*Bacillus subtilis, Enterobacter aerogenes, Escherichia coli, Klebsiella pneumoniae, Proteus vulgaris, Pseudomonas aeruginosa, Salmonella typhi, Shigella* sp., *Staphylococcus aureus and Streptococcus* sp.) using agar well diffusion method and broth dilution method. The plant extracts were prepared using the solvents – acetone, ethanol and propanol. It is clear from the results that, the extract of five plants used in this study acts as a good source of antibiotics against various bacterial pathogens tested and exhibited a broad spectrum of antimicrobial activity. The phytochemical analysis revealed the presence of alkaloids in all plants selected and other secondary metabolites like tannins, glycosides and saponins were also observed in all the extracts. The MIC values ranges between 3.175µg/ml and 12.5µg/ml, whereas MBC values ranges between 6.25µg/ml and 12.5µg/ml. The results of this study support the use of all the selected five medicinal plants to discover bioactive natural products that may serve as leads in the development of new pharmaceuticals that address unmet therapeutic needs.

Keywords: **medicinal plants, well diffusion method, broth dilution method, MIC, MBC**

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INTRODUCTION

In India, infectious diseases accounts for high proportion of health problems. Morbidity and mortality due to these infections continues to be a major problem, especially amongst children. Infections due to a variety of bacterial etiologic agents, such as pathogenic *Escherichia coli, Staphylococcus aureus, Shigella* sp*., Salmonella* sp*., Enterobacter* sp. are most common (Mukherjee *et al.,* 1998). In the present time multiple drug resistance in microbial pathogens become a serious health problem to humankind worldwide (Peng *et al.,* 2006). It is aroused due to indiscriminate and repetitive use of antimicrobial drugs (Shariff, 2001). Synthetic drugs are not only expensive and inadequate for the treatment of diseases but also often associated with adulterations and side effects. Therefore, there is need to search new infection fighting strategies to control microbial infections. However, the past record of rapid, widespread emergence of resistance to newly introduced antimicrobial agents indicates that even new families of antimicrobial agents will have a short life expectancy while there are some advantages of using medicinal plants, such as often fewer side effects, better patient tolerance, relatively less expensive, acceptance due to long history of use and being renewable in nature. For these reasons, researchers are increasingly turning their attention to herbal products, looking for new leads to develop better drugs against multiple drug resistant microbial strains (Benkeblia, 2004). Herbal medicine is still the mainstay of about 75-80% of the whole population, and the major part of traditional therapy involves the use of plant extract and their active constituents (Akerele, 1993). According to the report of the World Health Organization, 80% of the world's population relies mainly on traditional therapies which involve the use of plant extracts or their active substances. Following the advent of modern medicine, herbal medicine suffered a setback, but during last two or three decades advances in phytochemistry and in identification of plant compounds effective against certain diseases have renewed the interest in herbal medicines. In the recent years, research on medicinal plants has attracted a lot of attentions globally. Scientific experiments on the antimicrobial properties of plants and their components have been documented in the late 19th century. Large body of evidence has accumulated to demonstrate the promising potential of medicinal plants used in various traditional, complementary and alternate systems of treatment of human diseases. Traditionally used medicinal plants produce a variety of compounds of known therapeutic properties (Chopra *et al.,* 1992). This revival of interest in plant derived drugs is mainly due to the current widespread belief that "green medicine is safe".

Adhatoda vasika (Atalodakam), *Azadirachta indica* (Veppu), *Bacopa monnieri* (Brahmi), *Cassia fistula* (Kanikonna), *Carica papaya* (Papaya), *Oscimum sanctum* (Tulasi), *Cissampelos pareira* (Malathaangi), *Mangifera indica* (Mavu), *Cynodon dactylon* (Karugapul) and *Emblica officinalis* (Nelli) are some of the common traditionally used medicinal plants. The present study has been designed to determine the antimicrobial activity of five traditionally used medicinal plants – *Adhatoda vasika* (Atalodakam), *Bacopa monnieri* (Brahmi), *Carica papaya* (Papaya), *Cissampelos pareira* (Malathaangi) and *Cynodon dactylon* (Karugapul) against ten clinical pathogens (*Bacillus subtilis, Enterobacter aerogenes, Escherichia coli, Klebsiella pneumoniae*, *Proteus vulgaris, Pseudomonas aeruginosa*, *Salmonella typhi, Shigella* sp*., Staphylococcus aureus* and *Streptococcus* sp.). The profile of five medicinal plants and the clinical pathogens used in this study was shown in table 1 and 2, respectively.

Table 1
Different types of medicinal plants used in the present study

No:	Common name	Botanical name	Family	Traditional uses
1.	Atalodakam	*Adhatoda vasika*	*Acanthaceae*	Cough, bronchitis, tuberculosis, typhus fever, diphtheria, bleeding gums
2.	Brahmi	*Bacopa monnieri*	*Scrophulariaceae*	Brain tonic, tuberculosis, syphilis, dysentery, skin diseases, wounds, ulcers
3.	Karugapul	*Cynodon dactylon*	*Poaceae*	Urinary tract infections, syphilis, tooth ache, dysentery, prostatitis
4.	Malathaangi	*Cissampelos pareira*	*Menispermaceae*	Urinary tract infections, kidney stones, cough, snakebites, dysentery, skin diseases, ulcers, wounds
5.	Papaya	*Carica papaya*	*Caricaceae*	Digestive problems, cuts, rashes, stings, burns

Table. 2
Profile of Clinical pathogens used in this study

S.No	Test pathogens	Infections
1.	*Bacillus subtilis*	Causes wound infections and often isolated from lesions.
2.	*Enterobacter aerogenes*	causes respiratory tract infections and septicemia
3.	*Escherichia coli*	causes urinary tract and wound infections, also problems after surgery
4.	*Klebsiella pneumoniae*	Causes pneumonia, urinary tract infection, septicemia and diarrhea.
5.	*Proteus vulgaris*	causes urinary tract infections
6.	*Pseudomonas aeruginosa*	Causes severe infections in burn victims, cancer patients, and cystic fibrosis.
7.	*Salmonella typhi*	causes food poisoning and typhoid
8.	*Shigella sp.*	causes dysentery
9.	*Staphylococcus aureus*	causes skin and tissue infections
10.	*Streptococcus sp.*	causes sore throats, upper respiratory infections and pneumonia

Methodology

Collection of plant material

Five different medicinal plants free from diseases were collected from the regions of Kulathoor, Kerala (*Adhatoda vasika, Bacopa monnieri* and *Cynodon dactylon*) and Malayadi, Tamilnadu (*Carica papaya* and *Cissampelos pareira*), South India. The leaves of the

collected plants were removed, washed thoroughly with running tap water and again washed with sterile distilled water to remove dirt prior to drying process. The leaves were shade dried at room temperature for a week to remove the moisture content and powdered using mixer grinder.

Preparation of plant extract

The air dried finely ground leaves (10 gm) were taken separately in air tight bottles and 50 ml of different solvents (acetone, ethanol and propanol) were added and kept under dark. After 2 days, the contents were stirred well and filtered using Whatmann no: 1 filter paper. The filtrate was collected and stored in sterile glass beakers for further study.

Collection of test organisms

Ten pathogenic microbial cultures were used in this study namely, *Bacillus subtilis, Enterobacter aerogenes, Escherichia coli, Klebsiella pneumoniae*, *Proteus vulgaris, Pseudomonas aeroginosa*, *Salmonella typhi, Shigella* sp*., Staphylococcus aureus* and *Streptococcus* sp. Microorganisms were provided by Modern Laboratories, Neyyattinkara, Kerala, South India. Pathogenic cultures were confirmed in our laboratory using selective media. The pathogenic cultures were grown in nutrient broth at 37°C, maintained in nutrient agar slants, and stored at 4°C for determining the antimicrobial activity of these selected medicinal plants.

Antimicrobial activity assay

The antimicrobial activity of selected medicinal plants against clinical pathogens was determined by using agar well diffusion method. 20 ml of sterilized Muller Hinton agar was poured into Petri dishes and allowed for solidification. After solidification, 24 h nutrient broth grown pathogenic cultures were swabbed on the respective agar plates using sterilized cotton swabs. Wells of 6 mm diameter were punched over the agar plates using a sterile gel puncher. 50 µl of each extract were poured into the wells and the plates were incubated at 37°C for 24 h. After incubation, the diameter of inhibition zones formed around each wells were measured and expressed in millimeter (mm) to evaluate the antimicrobial activity. Inhibition zones of 8 to 10 mm were considered to be significant when testing plant extracts for antimicrobial activity (Tepe *et al.,* 2005).

Phytochemical analysis

Phytochemical analysis for major phytoconstituents of the plant extracts was performed by the method of Kemp 1991.

Determination of minimum inhibition concentration (MIC)

The MIC value was studied for the test pathogens, which are determined as most sensitive to each plant extract in well diffusion assay. The inoculum of microorganisms was prepared from 18 h nutrient broth cultures. In this method, the broth dilution technique was utilized where the plant extract was prepared to the highest concentration of 100 mg/ml (stock concentration) in propanol and serially diluted (two-fold) to a working concentration ranging from 100 mg/ml to 0.18 mg/ml using Mueller Hinton broth and later inoculated with 1 ml suspension of the test organisms. The positive control was Mueller Hinton broth with standard reference antibiotics (Gentamycin) and inoculums and negative control was the Mueller Hinton broth and inoculums as described by Kuete *et al.,* (2008). After 18 h of incubation at 37ºC, the test tubes were observed for turbidity. The least concentration where no turbidity observed was noted as the MIC value. The test tubes were vortex gently to mix the content and incubated at 37ºC for 24 h. MIC is defined as the lowest concentration where no visible turbidity is observed in the test tube (bacteriostatic concentration).

Determination of minimum bactericidal concentration (MBC)

The MBC is defined as the lowest concentration where no bacterial growth is observed (bactericidal concentration). This was determined from the broth dilution resulting from the MIC tubes by sub culturing to antimicrobial free agar as described in Reuben *et al.* (2008). In this technique, the contents of the test tubes resulting from MIC was streaked using a sterile wire loop on agar plate free of bacteria and incubated at 37ºC for 24 h for bacteria. The lowest concentration of the extract which showed no bacterial growth was noted and recorded as the MBC.

RESULT

The antimicrobial activity of acetone, ethanol and propanolic extracts of five South Indian medicinal plants were investigated against the selected clinical pathogens such as *Bacillus subtilis, Enterobacter aerogenes, Escherichia coli, Klebsiella pneumonia, Proteus vulgaris, Pseudomonas aeruginosa, Salmonella typhi, Shigella* sp.*, Staphylococcus aureus* and *Streptococcus* sp. by agar well diffusion method. All the examined plant extracts showed varying degrees of antimicrobial activities against the clinical pathogens tested.

The antimicrobial activity of acetone extracts of selected medicinal plants against tested pathogens was shown in table 3. The acetone extract of *Adhatoda vasika* showed maximum zone of inhibition (18 mm) against *Streptococcus* sp. The minimum inhibitory zone (11 mm) was exhibited against *Pseudomonas aeruginosa and Shigella* sp. Acetone extracts of *Cynodon dactylon* showed maximum zone of inhibition (14 mm) against *Enterobacter aerogenes* while minimum inhibitory zone (10 mm) was shown against *Staphylococcus aureus*, *Bacillus subtilis and Shigella* sp. Acetone extracts of *Bacopa monnieri*, *Cissampelos pareira and Carica papaya* showed no zone of inhibition against any of the tested pathogens.

Table. 3
Antimicrobial activities of acetone extracts of five South Indian medicinal plants

S.No	Test organisms	*Adhatoda vasika*	*Bacopa monnieri*	*Carica papaya*	*Cissampelos pareira*	*Cynodon dactylon*
1.	*Bacillus subtilis*	–	–	–	–	10
2.	*Enterobacter aerogenes*	–	–	–	–	14
3.	*Escherichia coli*	–	–	–	–	–
4.	*Klebsiella pneumoniae*	15	–	–	–	–
5.	*Proteus vulgaris*	–	–	–	–	–
6.	*Pseudomonas aeruginosa*	11	–	–	–	–
7.	*Salmonella typhi*	–	–	–	–	–
8.	*Shigella* sp.	11	–	–	–	10
9.	*Staphylococcus aureus*	14	–	–	–	10
10.	*Streptococcus* sp.	18	–	–	–	–

The antimicrobial activity of ethanol extracts of selected medicinal plants against tested pathogens was shown in table 4. The ethanol extract of *Adhatoda vasika* showed maximum zone of inhibition against *Staphylococcus aureus* (23 mm) while minimum inhibitory zone was observed against *Enterobacter aerogenes* (10 mm). *Bacopa monnieri* exhibited maximum zone of inhibition against *Streptococcus* sp. (19 mm) while minimum inhibitory zone was observed against *Salmonella typhi* (11 mm). *Carica papaya* and *Cissampelos pareira* inhibits *Proteus vulgaris* (maximum zone of inhibition- 25 mm) and *Shigella* sp. (maximum zone of inhibition- 20 mm), respectively. *Cynodon dactylon* showed maximum zone of inhibition against *Pseudomonas aeruginosa* (18 mm), while exhibiting minimum zone of inhibition against *Escherichia coli* (10 mm).

Table. 4
Antimicrobial activities of ethanolic extracts of five South Indian medicinal plants

S.No	Test organisms	*Adhatoda vasika*	*Bacopa monnieri*	*Carica papaya*	*Cissampelos pareira*	*Cynodon dactylon*
1.	*Bacillus subtilis*	11	17	20	14	15
2.	*Enterobacter aerogenes*	10	−	18	15	18
3.	*Escherichia coli*	12	13	17	19	10
4.	*Klebsiella pneumoniae*	20	−	11	16	15
5.	*Proteus vulgaris*	−	−	25	−	−
6.	*Pseudomonas aeruginosa*	15	15	14	15	18
7.	*Salmonella typhi*	12	11	10	−	11
8.	*Shigella* sp.	20	17	14	20	13
9.	*Staphylococcus aureus*	23	17	11	15	−
10.	*Streptococcus* sp.	19	19	22	19	−

The antimicrobial activity of propanolic extracts of selected medicinal plants against tested pathogens was shown in table 5. The propanol extract of *Adhatoda vasika* showed maximum zone of inhibition against *Staphylococcus aureus* (26 mm) while minimum inhibitory zone was observed against *Bacillus subtilis,* (10 mm). *Bacopa monnieri* exhibited maximum zone of inhibition against *Streptococcus* sp. (26 mm) while minimum inhibitory zone was observed against *Shigella* sp (15 mm). The most susceptible pathogen was *Proteus vulgaris* (25 mm maximum zone of inhibition) and *Shigella sp.* (20 mm maximum zone of inhibition) for *Carica papaya* and *Cissampelos pareira*, respectively. *Cynodon dactylon* showed maximum zone of inhibition against *Pseudomonas aeruginosa* (20 mm), while showing minimum inhibitory zone against *Streptococcus* sp. (10 mm).

Table. 5
Antimicrobial activities of propanolic extracts of five South Indian medicinal plants

S.No	Test organisms	*Adhatoda vasika*	*Bacopa monnieri*	*Carica papaya*	*Cissampelos pareira*	*Cynodon dactylon*
1.	*Bacillus subtilis*	12	20	15	−	11
2.	*Enterobacter aerogenes*	20	20	21	15	19
3.	*Escherichia coli*	18	18	17	21	13
4.	*Klebsiella pneumoniae*	20	22	20	20	17
5.	*Proteus vulgaris*	−	16	33	19	15
6.	*Pseudomonas aeruginosa*	17	24	23	12	20
7.	*Salmonella typhi*	18	16	21	18	14
8.	*Shigella* sp.	20	15	29	25	18
9.	*Staphylococcus aureus*	26	20	15	−	11
10.	*Streptococcus* sp.	22	26	15	20	10

The propanolic extract showed highest antimicrobial activity of the three solvent extracts. Thus the phytochemical analysis of propanolic extracts of five plants was showed in table 6. From the analysis, the presence of alkaloids was observed in all the plants. Flavonoids, phenols and reducing sugars were absent in all the plants tested. Saponins, tannins and glycosides were observed in *Adhatoda vasika, Carica papaya* and *Cissampelos pareira.* Carbohydrates, resins and diterpenes are present in *Cynodon dactylon.*

Table. 6
Phytochemical analysis of the propanolic extracts of five South Indian medicinal plants

S.No	Phytochemical tests	*Adhatoda vasika*	*Bacopa monnieri*	*Carica papaya*	*Cissampelos pareira*	*Cynodon dactylon*
1.	Alkaloids	+	+	+	+	+
2.	Carbohydrates	−	+	−	−	+
3.	Saponins	+	−	+	+	−
4.	Phytosterols	−	+	+	+	−
5.	Phenols	−	−	−	−	−
6.	Flavonoids	−	−	−	−	−
7.	Proteins and amino acids	−	+	−	−	+
	Glycosides	+	−	+	+	−

8.						
	Oils and fats	+	+	−	+	−
9.						
	Resins	−	−	−	−	+
10.						
	Tannins	+	−	+	+	−
11.						
	Diterpenes	+	−	+	−	+
12.						
	Reducing sugars	−	−	−	−	−
13.						

MIC and MBC was also performed for propanolic extracts of *Adhatoda vasika, Bacopa monnieri, Carica papaya, Cissampelos pareira* and *Cynodon dactylon* against *Staphylococcus aureus, Streptococcus* sp., *Proteus vulgaris, Shigella* sp. and *Pseudomonas aeruginosa,* respectively (table 7). The extracts of *Adhatoda vasika* and *Cissampelos pareira* were effective against *Staphylococcus aureus and Shigella* sp, respectively at 6.25 µg/ml, whereas MIC of *Bacopa monnieri and Pseudomonas aeruginosa* was observed at 12.5 µg/ml. *Carica papaya* showed ffective inhibition against *Proteus vulgaris* at 3.75 µg/ml (table 7). The MBC values ranges between 6.25 µg/ml and 12.5 µg/ml (table 7).

Table. 7
MIC and MBC values of propanolic extracts of five medicinal plants

S.No	Plant used	Most sensitive pathogen	MIC(µg/ml)	MBC(µg/ml)
1.	*Adhatoda vasika*	*Staphylococcus aureus*	6.25	6.25
2.	*Bacopa monnieri*	*Streptococcus* sp.	12.5	12.5
3.	*Carica papaya*	*Proteus vulgaris*	3.175	6.25
4.	*Cissampelos pareira*	*Shigella* sp.	6.25	6.25
5.	*Cynodon dactylon*	*Pseudomonas aeruginosa*	12.5	12.5

DISCUSSION

Infectious diseases are a major cause of morbidity and mortality in India. The number of multiple drug resistant strains and the appearance of the strains with reduced susceptibility to antibiotics are continuously increasing. This situation provided the impetus to the search for new antimicrobial substances from various sources like medicinal plants. It is important to investigate scientifically these plants which have been used in traditional medicines as potential source of novel antimicrobial compounds. The first step towards this goal is the *in vitro* antibacterial activity assay. In the present study, the leaf extracts of five medicinal plants *Adhatoda vasika, Bacopa monnieri, Carica papaya, Cissampelos pareira and Cynodon dactylon* were tested against clinical pathogens *Bacillus subtilis, Enterobacter aerogenes, Escherichia coli, Klebsiella pneumonia, Proteus vulgaris, Pseudomonas aeruginosa, Salmonella typhi, Shigella* sp., *Staphylococcus aureus and Streptococcus* sp. All of these plants showed antibacterial activity against the pathogens tested (table 3-5). The tested pathogens were sensitive to *Adhatoda vasika* leaf extracts, agreed with those reported in literature (Karthikeyan *et al.,* 2009). On the other hand,

Proteus vulgaris was found highly resistant to *Adhatoda vasika* leaf extracts, an observation contrary to the above cited reference. From the present work, it is estimated that these extracts contains alkaloids, tannins, glycosides, etc and the antimicrobial activity may be a result of individual or combination of these bioactive compounds. It can be a source of newer useful drugs and of greater pharmacological importance. Despite many published reports dealing with treatment for neurological disorders, little was known about antimicrobial activity of *Bacopa monnieri* prior to this study. Propanolic extracts of *Bacopa monnieri* was found to possess inhibitory effects against both Gram positive and Gram negative organisms tested, than acetone and ethanolic extracts. The result agreed with literature cited (Ayyappan *et al.,* 2010). The antibacterial activity may be due to the presence of phytochemicals such as alkaloids, phytosterols, proteins, etc., which warrants *Bacopa monnieri* could be subjected to extensive experimental studies in future to treat certain diseases caused by studied bacteria.

The results of this study showed that the propanolic extracts of *Carica papaya* were more effective than the ethanol extracts demonstrated the highest activity. Among the Gram-positive and Gram-negative bacteria tested against the leaf extract of *C. papaya*, the Gram-negative bacteria were more susceptible especially *Proteus vulgaris* to the extracts. This result, however, is at disparity with an earlier report indicating that plant extracts are more active against Gram-positive bacteria than Gram-negative bacteria while that of the leaf extract of *C. papaya* was next to the most sensitivity with the Gram-negative bacteria especially *Proteus mirabilis* (Jigna and Sumitra, 2006). The fact that the extracts were active against both Gram-negative and Gram-positive bacteria tested may indicate a broad spectrum of activity and the phytochemical analysis revealed the presence many phytoconstituents. This observation is very significant because of the possibility of developing therapeutic substances that will be active against multidrug-resistant organisms. Literature representing the studies on antimicrobial activities of *Cissampelos pareira* was scanty. The present work showed the ethanolic and propanolic extracts of *Cissampelos pareira* leaf possess antibacterial activity against most of the tested pathogens. The most sensitive organism was *Shigella* sp. This may be due to the presence of bioactive compounds like alkaloids, phytosterols, tannins, etc. leading to the broad spectrum of activity. The present study revealed a controversy report that gram-negative bacteria were more susceptible to the alcoholic extracts than gram positive bacteria (Chaudhari *et al.,* 2011). It may be due to the presence of broad spectrum of antibiotic compounds such as alkaloids, proteins, etc present in the leaves of *Cynodon dactylon.* The most sensitive pathogen was *Pseudomonas aeruginosa*. Ethanolic and propanolic extracts of *Cynodon dactylon* showed wide range of antibacterial activity. So it can be used and administered in the ethno medical practice. Further research needs to be carried out for effective utilization of this plant. The MIC values ranges between 3.175 µg/ml and 12.5µg/ml whereas MBC values ranges between 6.25µg/ml and 12.5µg/ml (Table 7). The most promising broad spectrum of antimicrobial activity was exhibited by *Carica papaya* followed by *Cissampelos pareira*, *Adhatoda vasika, Cynodon dactylon* and *Bacopa monnieri.* The low MIC and MBC values observed was a good indication of high efficacy of these plants against the tested pathogens and the outcome is remarkable.

Results from the susceptibility study with the plant extracts indicate that *Adhatoda vasika, Bacopa monnieri, Carica papaya, Cissampelos pareira* and *Cynodon dactylon* could be beneficial for people suffering from certain infections caused by the studied pathogens. The demonstration of antimicrobial activity against both gram negative and gram-positive bacteria was an indication that these plants were potential source for production of

drugs with a broad spectrum of activity. The results of the study also support the traditional application of the plants and suggest that these plant extracts possess compounds with antibacterial properties that can be used as antibacterial agents in novel drugs. These compounds have previously been reported to possess antimicrobial activity (Elisabetsy, 2006). It is not surprising that there are difference in the antimicrobial effects of plant species, due to their phytochemical properties and difference among plant species. Further research is necessary to determine the identity of extract antibacterial compounds from within these plants and also to determine their full spectrum of efficacy. The potential for developing antimicrobials from higher plants appears rewarding as it will lead to the development of phytomedicines to act against pathogens. Plant based antimicrobials have enormous therapeutic potential as they can serve the purpose with lesser side effects that are often associated with synthetic antimicrobials (Iwu *et al.,*1999). The result of present study offer a scientific basis for traditional use of solvent extracts of the selected medicinal plants and ascertains the value of these plants to be a possible source to obtain new and effective herbal medicines to treat infections caused by MDR microbes. Further pharmacological evaluations, toxicological studies and possible isolation of the therapeutic drugs from these plants are the future challenges.

CONCLUSION

In conclusion, the results of this study have provided scientific justification for the use of *Adhatoda vasika, Bacopa monnieri, Carica papaya, Cissampelos pareira and Cynodon dactylon* extracts as antimicrobial agents. The extracts of these medicinal plants possess a broad spectrum of activity against a panel of bacteria responsible for the most common bacterial diseases. These promissory extracts open the possibility of finding new clinically effective antibacterial compounds, thereby decreasing the burden of drug resistance and cost of management of diseases. However, the effect of these plants on more pathogenic organisms, toxicological investigations and further purifications, needs to be carried out.

REFERENCE

1. Mukherjee PK, Saha K, Murugesan T, Mandal SC, Pal M. and Saha BP, Screening of anti-diarrheal profile of some plant extracts of a specific region of West Bengal, India. *J Ethnopharmacol,* 60: 85-89, (1998).
2. Peng Y, Rakowskim SA and Filutowiez M, Small deletion variants of the replication protein Pi and their potential for over-replication-based antimicrobial activity. *FEBS Microbiol Lett.,* 261(2):245-252. (2006).
3. Shariff ZU, Modern Herbal Therapy for Common Ailments. *Nature Pharmacy*, 1:9-84, (2001).
4. Sieradzki K, Wu SW and Tomasz A, Inactivation of the resistant genes in MDR strains. *Micro. Drug resist,* 5(4): 253- 257, (1999).
5. Benkeblia N, Antimicrobial activity of essential oil extracts of various onions (*Allium cepa*) and garlic (*Allium sativum*). *Lebensm-Wiss u-Technol,* 37: 263-268, (2004).
6. Akerele, O. Summary of WHO Guidelines for the Assessment of Herbal Medicines, 22:13-28, (1993).
7. Acharyya S, Patra A and Bag K, Evaluation of the antimicrobial activity of some medicinal plants against enteric bacteria with Particular reference to MDR *Vibrio cholerae*. *Tropical Journal of Pharmaceutical Research*, 8(3):231-237, (2009).

8. Agarry OO, Olaleye MT and Michael CO, Comparative antimicrobial activity of *Aloe vera* gel and leaf. *American Journal of Biotechnology*, 4(12): 1413─1414, (2005).
9. Chopra RN, Nayer SL, Chopra IC, Glossary of Indian Medicinal Plants, Council of Scientific and Industrial Research, New Delhi, 7–246, (1992).
10. Tepe B, Daferera D, Sokmen A, Sokmen M and Polissiou M, Antimicrobial and antioxidant activities of the essential oil and various extracts of *Salvia tomentosa* Miller (Lamiaceae). *Food Chem*, 90:333-340, (2005).
11. Kemp W, Organic Spectroscopy. 3rd Edn., Macmillan Education Ltd., London. (1991)
12. Kuete V, Mbaveng AT, Tsaffack M, Beng VP, Etoa FX, Nkengfack AE, Marion Meyer JJ and Lall N, Antitumor, antioxidant and antimicrobial activities of *Bersama engeleriana* (Melianthaceae).*Journal of Ethno pharmacology,* 115: 494–501, (2008).
13. Reuben KD, Abdulrahman FI, Akan JC, Usman H, Sodipo OA and Egwu GO Phytochemical Screening and *In Vitro* Antimicrobial Investigation of the Methanolic Extract of *CrotonZambesicus* Muell ARG. Stem Bark, *European Journal of Scientific Research,* 23: 134–140, (2008).
14. Karthikeyan A, Shanthi V. and Nagasathaya A. Preliminary phytochemical and antibacterial screening of crude extract of the leaf of *Adhatoda vasika*. L. *Int. J. Green Pharm.,* 3: 78-80, (2009).
15. Ayyappan S R, Srikumar R and Thangaraj R, Phytochemical and antibacterial activity of *Bacopa monnieri* against bacterial isolates from humans. *International Journal of Microbiological Research*, 1(2):67-71, (2010).
16. Jigna P and Sumitra C *In vitro* antimicrobial activity of medicinal plants. *Afr. J. Biomed*, 9(2):89-93, (2006).
17. Chaudhari Y, Mody H and Acharya B, Antibacterial activity of *Cynodon dactylon* on different bacterial pathogens isolated from clinical samples. *International Journal of Pharmaceutical Studies and Research*, 2: 16-20, (2011).
18. Elisabetsy E, A review of pharmacological properties. *ECAM*, 3: 39-48, (2006).
19. Iwu MM, In: Therapeutic Agents from Ethnomedicine. Ethnomedicine and Drug Discovery. *Elsevier Science*, 11: 21-23, (1999).