



Received on 23 February, 2015; received in revised form, 09 April, 2015; accepted, 08 June, 2015; published 01 September, 2015

PRELIMINARY SCREENING OF ETHNOMEDICINAL PLANTS FOR ANTIBACTERIAL ACTIVITY

Rekha Sharanappa and G. M. Vidyasagar *

Medicinal Plants and Microbiology Research Laboratory, Department of Post-Graduate Studies and Research in Botany, Gulbarga University, Kalaburagi-585 106, Karnataka, India.

Keywords:

Preliminary screening,
Ethnomedicinal plants,
Escherichia coli, *Bacillus subtilis*,
Hyderabad Karnataka region

Correspondence to Author:

G. M. Vidyasagar

Medicinal Plants and Microbiology
Research Laboratory, Department of
Post-Graduate Studies and Research
in Botany, Gulbarga University,
Kalaburagi-585106, Karnataka, India.


E-mail: gmvidyasagar@rediffmail.com

ABSTRACT: Based on the ethno botanical survey and the related literature, 285 solvent extracts from 57 ethno medicinal plants belonging to 55 genera and 34 families were subjected to preliminary screening for antibacterial activity against *Escherichia coli* and *Bacillus subtilis* using agar well diffusion method at concentrations of 5 & 2.5 mg/ml. Among 285 plant extracts, some exhibited very effective activity, some exhibited effective activity, some exhibited moderate and some exhibited weak activity and no activity was observed in some extracts against *E. coli* and *B. subtilis*. Among the plants tested, maximum activity was observed in all the solvents extracts of *Argemone mexicana*, *Allium sativum*, *Lantana camara*, *Tephrosia purpurea* and *Withania somnifera*. The results of the present study indicate that the extracts of different parts of 57 ethnomedicinal plants have more potential of antibacterial activity and are concentration dependent. The demonstration of broad spectrum of the above said 5 plants may help to discover new chemical classes of antibiotic substances that could serve as selective agents for infectious disease chemotherapy and control.

INTRODUCTION: Microorganisms are frequently developing resistance to common drugs and antibiotics and this pose an enormous threat to the treatment of a wide range of serious infections^{1, 2}. In the present scenario of emergence of drug resistance to human pathogenic organisms; this has necessitated a search for new antimicrobial substances from other sources including plants. In all regions of the World, history shows that medicinal plants have always held an important Place. Plants are rich in a wide variety of secondary metabolites such as tannins, alkaloids and flavonoids, which have been found in vitro to have antimicrobial properties³.

A number of phytotherapy manuals have mentioned various medicinal plants for treating infectious diseases due to their availability, fewer side effects and reduced toxicity⁴. There are several reports on the antimicrobial activity of different herbal extracts⁵⁻⁷. The activity of plant extracts on bacteria and fungi has been studied by a very large number of researchers in different parts of the world^{8,9}.

Antimicrobial properties of certain Indian medicinal plants were reported based on folklore information¹⁰⁻¹⁷, and a few attempts were made on inhibitory activity against certain pathogenic bacteria and fungi. As a result, antibacterial therapy is playing a greater role in health care and the screening of traditional plants in search of novel antibacterials are now more frequently performed. The selection of crude plant extracts for screening programs has the potential of being more

| | |
|---|--|
| QUICK RESPONSE CODE  | DOI: 10.13040/IJPSR.0975-8232.6(9).3928-35 |
| | Article can be accessed online on: www.ijpsr.com |
| DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.6(9).3928-35 | |

successful in initial steps than the screening of pure compounds isolated from natural products¹⁸.

In the present study, 57 ethno medicinal plants of Hyderabad Karnataka Region have been selected for antibacterial screening against human pathogens namely *E. coli* and *B. subtilis*. Among the tested plants, *A. mexicana*, *W. somnifera*, *T. purpurea*, *L. camara* and *A. sativum* showed profound antibacterial activity. The demonstration of broad spectrum of the above said five plants may help to discover new chemical classes of antibiotic substances that could serve as selective agents for infectious disease chemotherapy and control.

MATERIAL AND METHODS:

Collection of plant material:

Based on the ethno botanical survey and the related literature, 57 ethno medicinal plants belonging to 55 genera and 34 families were collected in fresh bags from different localities of Hyderabad Karnataka region during the month of June, July, August and late September and brought to laboratory. The different plant parts like, leaves, roots, flowers, fruits and stem bark collected were initially rinsed with distilled water to remove soil and other contaminants, shade dried using tray under controlled temperature at 37°C for week.

Extraction of plant material by Soxhlet apparatus:

All these parts of plants were powdered using mechanical pulverize and powdered materials were preserved in the sterilized polythene bags until further use. For extraction of crude drugs, 250g of shade dried powdered plant material was weighed and subjected to successive Soxhlet extraction with different solvents such as Petroleum ether, Chloroform, Ethyl acetate, Methanol and Distilled water (Aqueous) in the order of increasing polarity of solvents for a period of 18-22 h. The extracts obtained were concentrated to dryness in evaporating dish at 40°C and stored the dried extract at 4°C in the refrigerator until further use.

For preparing drug solution, Petroleum ether, Chloroform, Ethyl acetate, Methanol and Aqueous crude extracts were dissolved in DMSO to a final concentration (5mg/ml and 2.5 mg/ml. And for preparation of standard drug, Streptomycin

dissolved in DMSO and used as a reference compound (Positive control-500µg/ml) for bacterial activity. DMSO was used as negative control. These solutions were preserved at 4°C until further use. The *in vitro* antibacterial (*E. coli* and *B. subtilis*) activity of 57 ethno medicinal plants was carried out by adopting the agar well diffusion technique¹⁹.

Test microorganisms and preparation of inoculums:

The pure axenic cultures of bacteria viz., *E. coli*, *B. subtilis* were procured from the stock culture of Department of Botany, Gulbarga University, Kalaburagi, and were further maintained on nutrient agar slants at 4°C until further use. For preparation of inoculums, 48 h old bacterial culture grown in nutrient broth (Himedia, M002) at 37°C and maintained on nutrient agar slants at 4°C was used for experimental studies.

Antibacterial activity:

The assay was conducted by agar well diffusion method. About 15 to 20 ml of nutrient agar medium was poured in the sterilized Petri dishes and allowed to solidify. Bacterial lawn was prepared using 5 days old culture strain. The bacterial strains were suspended in a saline solution (0.85% NaCl) and adjusted to a turbidity of 0.5 Mac Farland standards (10⁸ CFU/ml). 1 ml of bacterial strain was spread over the medium using a sterilized glass spreader. Using flamed sterile borer, wells of 4mm diameter were punctured in the culture medium. Required fractions of extracts were added to the wells. The plates thus prepared were left for diffusion of extracts into media for one hour in the refrigerator and then incubated at 37°C. After incubation for 18 h, the plates were observed for zones of inhibition.

The diameter of zone of inhibition was measured and expressed in millimeters. Dimethyl Sulphoxide (DMSO) was used as a negative control. Streptomycin for bacteria was used as positive control (500µg/ml). The experiments were conducted in triplicates.

RESULTS:

Preliminary screening of ethno medicinal plants for antibacterial activity: 285 solvent extracts from

57 ethno medicinal plants were subjected to antibacterial screening against two bacteria namely, *E. coli* and *B. subtilis* using agar well diffusion method at concentrations of 5 & 2.5 mg/ml. The results are given in **Table 1**.

Screening against *Escherichia coli* and *Bacillus subtilis*: Among the 285 plant extracts, 77 and 48 extracts exhibited very effective activity against *E. coli* and *B. subtilis*. 67 and 68 extracts exhibited effective activity. 63 and 58 extracts exhibited moderate activity and 67 and 95 extracts exhibited weak activity against *E. coli* and *B. subtilis*. No activity was observed in 11 and 16 extracts against

E. coli and *B. subtilis* (**Table 2**). Among the plants tested, maximum activity was observed in all the solvents extracts of five medicinal plants namely, *A. mexicana*, *A. sativum*, *L. camara*, *T. purpurea* and *W. somnifera*. The effectivity was also observed in different solvent extracts of other plants also but the above mentioned five plants showed strong antibacterial activity against both the test strains in all the solvent extracts. There was no inhibition recorded from the negative control (DMSO), while the standard drug, Streptomycin, significantly inhibited (21.00±0.00 to 31.00±0.00mm) the growth of the test organism. (**Table 1**).

TABLE 1: PRELIMINARY ANTIMICROBIAL (ANTIBACTERIAL) SCREENING OF ETHNO MEDICINAL PLANTS OF HYDERABAD KARNATAKA REGION

| Sl. No. | Plant name, Family & Part used | Test strains | Zone of inhibition in different solvents (mm) | | | | | | | | | | | | Control (DMSO) | S |
|---------|---|--------------|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----|--------------|----------------|---|
| | | | P | | C | | E | | M | | A | | | | | |
| | | | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | | | | |
| 01. | <i>Abelmoschus ficulneus</i> (L.). Malvaceae (Root). | a | 12.33 ± 1.15 | 11.33 ± 1.15 | 10.33 ± 1.15 | 09.66 ± 1.57 | 10.33 ± 1.15 | 09.66 ± 1.57 | 08.33 ± 1.15 | 07.66 ± 0.57 | 06.33 ± 1.52 | NA | NA | 22.00 ± 1.00 | | |
| | | b | 11.33 ± 1.15 | 10.33 ± 1.15 | 08.33 ± 1.15 | 07.66 ± 0.57 | 09.66 ± 1.57 | 08.33 ± 1.15 | 07.66 ± 0.57 | 06.33 ± 1.52 | 05.33 ± 1.52 | NA | NA | 23.00 ± 0.00 | | |
| 02. | <i>Acacia ferruginea</i> DC. Fabaceae (Leaf). | a | 09.66 ± 1.57 | 09.00 ± 0.00 | 09.66 ± 1.57 | 08.33 ± 1.15 | 11.00 ± 1.15 | 10.33 ± 1.15 | 09.66 ± 1.57 | 08.33 ± 1.15 | 07.66 ± 0.57 | NA | NA | 25.66 ± 1.15 | | |
| | | b | 07.66 ± 0.57 | 08.00 ± 0.00 | 08.33 ± 1.15 | 07.66 ± 0.57 | 10.33 ± 1.15 | 09.66 ± 1.57 | 08.33 ± 1.15 | 07.66 ± 0.57 | 06.33 ± 1.52 | NA | NA | 28.00 ± 0.00 | | |
| 03. | <i>Achyranthus aspera</i> L. Amaranthaceae (Root). | a | 12.33 ± 1.15 | 11.33 ± 1.15 | 11.33 ± 1.15 | 10.33 ± 1.15 | 19.66 ± 1.57 | 17.66 ± 0.57 | 10.33 ± 1.15 | 09.66 ± 1.57 | 08.33 ± 1.15 | 07.66 ± 0.57 | NA | 26.33 ± 1.52 | | |
| | | b | 11.33 ± 1.15 | 10.33 ± 1.15 | 10.33 ± 1.15 | 09.66 ± 1.57 | 16.33 ± 1.57 | 14.66 ± 1.57 | 09.66 ± 1.57 | 08.33 ± 1.15 | 07.66 ± 1.52 | 06.33 ± 1.52 | NA | 28.33 ± 1.52 | | |
| 04. | <i>Aerva lanata</i> (L.) Juss. Amaranthaceae (Leaf). | a | 06.33 ± 1.52 | 05.33 ± 1.52 | 11.33 ± 1.15 | 11.00 ± 0.00 | 12.33 ± 1.15 | 11.00 ± 1.00 | 08.33 ± 1.15 | 06.33 ± 1.52 | 05.33 ± 1.52 | NA | NA | 27.33 ± 1.52 | | |
| | | b | 05.66 ± 0.57 | 05.33 ± 1.52 | 10.33 ± 1.52 | 09.66 ± 1.57 | 11.00 ± 1.00 | 10.33 ± 1.15 | 07.66 ± 0.57 | 06.33 ± 1.52 | NA | NA | NA | 29.00 ± 0.00 | | |
| 05. | <i>Alangium salvifolium</i> (L.f.) Wang. Alangiaceae (Stem bark). | a | 12.33 ± 1.15 | 11.33 ± 1.15 | 11.00 ± 0.00 | 10.66 ± 1.57 | 13.33 ± 1.15 | 11.33 ± 1.15 | 10.33 ± 1.15 | 08.33 ± 1.15 | 07.66 ± 0.57 | 05.33 ± 1.52 | NA | 29.66 ± 0.57 | | |
| | | b | 11.33 ± 1.15 | 10.66 ± 1.57 | 10.66 ± 1.57 | 09.66 ± 1.57 | 11.33 ± 1.15 | 10.66 ± 1.57 | 08.33 ± 1.15 | 07.66 ± 0.57 | 05.33 ± 1.52 | NA | NA | 31.00 ± 0.00 | | |
| 06. | <i>Allium sativum</i> L. Liliaceae (Clove). | a | 18.66 ± 0.57 | 17.66 ± 0.57 | 15.00 ± 0.00 | 14.66 ± 1.57 | 17.33 ± 1.15 | 16.33 ± 1.15 | 18.66 ± 1.52 | 14.66 ± 1.57 | 13.33 ± 1.15 | 12.66 ± 1.57 | NA | 21.00 ± 0.00 | | |
| | | b | 17.33 ± 0.57 | 16.33 ± 1.52 | 15.66 ± 0.57 | 13.66 ± 1.57 | 16.33 ± 1.52 | 15.33 ± 1.15 | 17.33 ± 0.57 | 13.33 ± 1.52 | 12.66 ± 1.57 | 12.33 ± 0.57 | NA | 24.00 ± 0.00 | | |
| 07. | <i>Amaranthus spinosus</i> L. Amaranthaceae (Whole plant). | a | 09.00 ± 0.00 | 08.33 ± 1.15 | 10.33 ± 1.15 | 09.66 ± 1.57 | 12.33 ± 1.15 | 11.00 ± 0.00 | 09.66 ± 1.57 | 08.33 ± 1.15 | 07.66 ± 0.57 | 06.33 ± 1.52 | NA | 26.33 ± 1.52 | | |
| | | b | 08.33 ± 1.15 | 07.66 ± 0.57 | 09.66 ± 1.57 | 09.00 ± 0.00 | 11.33 ± 1.15 | 10.66 ± 0.57 | 08.33 ± 1.15 | 07.66 ± 0.57 | 07.00 ± 0.00 | 05.33 ± 1.52 | NA | 23.00 ± 0.00 | | |
| 08. | <i>Argemone mexicana</i> L. Papaveraceae (Root). | a | 21.00 ± 0.00 | 20.00 ± 0.00 | 20.33 ± 1.52 | 19.66 ± 1.15 | 21.33 ± 1.52 | 20.00 ± 1.00 | 20.33 ± 1.52 | 19.00 ± 0.00 | 19.66 ± 1.57 | 17.33 ± 1.15 | NA | 27.66 ± 1.15 | | |
| | | b | 21.00 ± 0.00 | 19.33 ± 1.52 | 19.66 ± 0.57 | 18.00 ± 0.00 | 19.66 ± 1.15 | 19.33 ± 1.52 | 20.00 ± 0.00 | 18.66 ± 0.57 | 18.66 ± 1.57 | 16.33 ± 1.15 | NA | 28.00 ± 0.00 | | |
| 09. | <i>Aristolochia bracteolata</i> Lam. Aristolochiaceae (Stem). | a | 13.66 ± 1.57 | 12.33 ± 1.15 | 11.33 ± 1.15 | 11.00 ± 0.00 | 13.33 ± 1.15 | 12.33 ± 1.15 | 11.33 ± 1.15 | 10.66 ± 0.57 | 10.00 ± 0.00 | 08.33 ± 1.15 | NA | 21.00 ± 0.00 | | |
| | | b | 11.33 ± 1.15 | 10.66 ± 1.57 | 10.66 ± 1.57 | 10.00 ± 0.00 | 12.33 ± 1.15 | 11.33 ± 1.15 | 10.66 ± 0.57 | 10.00 ± 0.00 | 08.33 ± 1.15 | 07.66 ± 0.57 | NA | 23.33 ± 1.52 | | |
| 10. | <i>Asparagus racemosus</i> Willd. Liliaceae (Whole plant). | a | 07.66 ± 0.57 | 06.33 ± 1.52 | 09.66 ± 1.57 | 08.33 ± 1.15 | 14.66 ± 1.57 | 13.33 ± 1.15 | 12.33 ± 1.15 | 11.33 ± 1.15 | 07.66 ± 0.57 | 06.33 ± 1.52 | NA | 25.00 ± 0.00 | | |
| | | b | 07.33 ± 1.52 | 06.33 ± 1.52 | 08.33 ± 1.15 | 07.66 ± 0.57 | 13.33 ± 1.15 | 11.33 ± 1.15 | 11.33 ± 1.15 | 10.66 ± 0.57 | 06.33 ± 1.52 | 06.00 ± 0.00 | NA | 24.33 ± 1.52 | | |
| 11. | <i>Azadirachta indica</i> A. Juss. Meliaceae (Root, Stem bark). | a | 15.66 ± 1.57 | 14.33 ± 0.57 | 13.33 ± 1.15 | 16.33 ± 1.52 | 14.33 ± 1.52 | 12.33 ± 1.15 | 09.66 ± 1.57 | 08.33 ± 1.15 | 09.66 ± 0.57 | 07.66 ± 1.15 | NA | 24.00 ± 0.00 | | |
| | | b | 14.33 ± 0.57 | 13.33 ± 1.15 | 12.33 ± 1.15 | 14.33 ± 1.52 | 12.33 ± 1.15 | 11.33 ± 1.15 | 08.33 ± 1.15 | 08.00 ± 0.00 | 06.33 ± 1.52 | 05.00 ± 0.00 | NA | 21.66 ± 1.15 | | |
| 12. | <i>Barleria prionitis</i> L. Acanthaceae (Leaf). | a | 10.66 ± 1.57 | 09.66 ± 1.57 | 12.33 ± 1.15 | 11.33 ± 1.15 | 14.66 ± 1.57 | 12.33 ± 1.15 | 07.66 ± 0.57 | 07.00 ± 0.00 | 06.33 ± 1.52 | NA | NA | 27.33 ± 1.52 | | |
| | | b | 09.66 ± 1.57 | 09.00 ± 0.00 | 11.33 ± 1.15 | 10.66 ± 1.57 | 12.33 ± 1.15 | 11.33 ± 1.15 | 07.00 ± 0.00 | 06.33 ± 1.52 | 05.33 ± 1.52 | NA | NA | 31.50 ± 0.00 | | |
| 13. | <i>Boerhavia diffusa</i> L. Nyctaginaceae (Whole plant). | a | 11.33 ± 1.15 | 10.33 ± 1.15 | 11.33 ± 1.15 | 10.66 ± 1.57 | 18.66 ± 0.57 | 17.33 ± 0.57 | 09.66 ± 0.57 | 08.33 ± 1.52 | 07.00 ± 0.00 | 06.33 ± 1.52 | NA | 22.00 ± 0.00 | | |
| | | b | 12.33 ± 1.15 | 11.33 ± 1.15 | 10.66 ± 1.57 | 10.00 ± 0.00 | 16.33 ± 1.57 | 14.66 ± 0.57 | 07.66 ± 0.57 | 07.00 ± 0.00 | 06.33 ± 1.52 | 05.33 ± 1.52 | NA | 24.33 ± 1.52 | | |
| 14. | <i>Bryophyllum pinnatum</i> (Lamk.) Kurz. | a | 10.66 ± 1.57 | 10.00 ± 0.00 | 09.66 ± 0.57 | 08.33 ± 1.15 | 08.00 ± 0.00 | 07.66 ± 0.57 | 06.33 ± 1.52 | 06.00 ± 0.00 | 05.33 ± 1.52 | NA | NA | 28.33 ± 1.52 | | |
| | | b | 10.66 ± 1.57 | 10.00 ± 0.00 | 09.66 ± 0.57 | 08.33 ± 1.15 | 08.00 ± 0.00 | 07.66 ± 0.57 | 06.33 ± 1.52 | 06.00 ± 0.00 | 05.33 ± 1.52 | NA | NA | 28.33 ± 1.52 | | |

| | | | | | | | | | | | | | | |
|-----|--|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----|--------------|
| | Crassulaceae (Leaf). | b | 10.00 ± 0.00 | 09.66 ± 0.57 | 08.00 ± 0.00 | 07.66 ± 0.57 | 07.66 ± 0.57 | 07.00 ± 0.00 | 06.33 ± 1.52 | 05.33 ± 1.52 | NA | NA | NA | 27.33 ± 1.52 |
| 15. | <i>Butea monosperma</i> (Lam.) Taub. Fabaceae (Stem bark, Seed, Flower). | a | 11.00 ± 0.00 | 10.66 ± 1.57 | 13.33 ± 1.15 | 11.33 ± 1.15 | 15.66 ± 1.57 | 14.66 ± 1.57 | 09.66 ± 0.57 | 08.66 ± 0.57 | 07.66 ± 0.57 | 06.66 ± 0.57 | NA | 22.00 ± 0.00 |
| | | b | 10.66 ± 1.57 | 10.00 ± 0.00 | 11.33 ± 1.15 | 10.66 ± 1.57 | 13.33 ± 1.15 | 12.33 ± 1.15 | 08.33 ± 1.52 | 07.66 ± 0.57 | 06.33 ± 1.52 | 05.66 ± 1.15 | NA | 21.33 ± 1.52 |
| 16. | <i>Calotropis gigantean</i> (L.) R.Br. Asclepiadaceae (Root, Latex). | a | 10.66 ± 0.57 | 09.66 ± 0.57 | 11.66 ± 0.57 | 11.00 ± 0.00 | 13.33 ± 1.15 | 11.33 ± 1.15 | 08.33 ± 1.52 | 08.00 ± 0.00 | 06.33 ± 1.52 | 05.33 ± 1.52 | NA | 21.50 ± 0.00 |
| | | b | 08.66 ± 0.57 | 08.00 ± 0.00 | 10.66 ± 0.57 | 10.00 ± 0.00 | 12.33 ± 1.15 | 11.00 ± 0.00 | 07.66 ± 0.57 | 07.00 ± 0.00 | 05.33 ± 1.52 | 05.00 ± 0.00 | NA | 22.66 ± 1.15 |
| 17. | <i>Capparis zeylanica</i> L. Capparaceae (Root). | a | 08.33 ± 1.52 | 07.66 ± 0.57 | 09.66 ± 0.57 | 09.00 ± 0.00 | 11.66 ± 0.57 | 11.00 ± 0.00 | 10.66 ± 1.57 | 10.00 ± 0.00 | 06.66 ± 0.57 | NA | NA | 26.66 ± 0.57 |
| | | b | 07.66 ± 0.57 | 07.00 ± 0.00 | 08.33 ± 1.52 | 08.00 ± 0.00 | 11.33 ± 1.57 | 10.66 ± 1.57 | 09.66 ± 0.57 | 07.66 ± 0.57 | 05.33 ± 1.52 | NA | NA | 24.33 ± 1.52 |
| 18. | <i>Cassia auriculata</i> L. Fabaceae (Leaf). | a | 11.66 ± 0.57 | 11.33 ± 1.15 | 12.33 ± 1.15 | 11.66 ± 0.57 | 15.66 ± 1.15 | 13.66 ± 1.15 | 10.33 ± 1.15 | 09.33 ± 1.15 | 08.33 ± 1.52 | 06.33 ± 1.52 | NA | 24.00 ± 0.00 |
| | | b | 11.33 ± 1.15 | 10.66 ± 1.57 | 11.66 ± 0.57 | 10.66 ± 1.57 | 15.66 ± 1.15 | 11.66 ± 1.15 | 08.33 ± 1.52 | 07.33 ± 1.52 | 06.33 ± 1.52 | 05.33 ± 1.52 | NA | 22.00 ± 0.00 |
| 19. | <i>Cassia fistula</i> L. Fabaceae (Leaf). | a | 09.66 ± 0.57 | 08.33 ± 1.52 | 10.33 ± 1.15 | 09.66 ± 0.57 | 12.33 ± 1.15 | 12.00 ± 0.00 | 07.33 ± 1.52 | 06.33 ± 1.52 | 06.00 ± 0.00 | 05.33 ± 1.52 | NA | 24.50 ± 0.00 |
| | | b | 07.66 ± 0.57 | 06.33 ± 1.15 | 09.66 ± 0.57 | 08.66 ± 0.57 | 11.00 ± 0.00 | 10.00 ± 0.00 | 06.33 ± 1.52 | 06.00 ± 0.00 | 05.00 ± 0.00 | NA | NA | 27.33 ± 1.52 |
| 20. | <i>Cassipourea filiformis</i> L. Lauraceae (Stem). | a | 10.33 ± 1.52 | 09.33 ± 1.52 | 12.66 ± 1.15 | 11.00 ± 0.00 | 13.33 ± 1.52 | 11.33 ± 1.52 | 08.66 ± 1.15 | 07.66 ± 1.15 | 06.00 ± 0.00 | NA | NA | 24.66 ± 0.57 |
| | | b | 09.33 ± 1.52 | 08.33 ± 1.52 | 11.00 ± 0.00 | 09.00 ± 0.00 | 11.33 ± 1.52 | 10.33 ± 1.52 | 08.33 ± 1.52 | 07.33 ± 1.52 | 05.66 ± 1.15 | NA | NA | 28.00 ± 0.00 |
| 21. | <i>Crotalaria prostrata</i> Rottl. Fabaceae (Whole plant). | a | 07.66 ± 1.15 | 06.66 ± 1.15 | 08.66 ± 1.15 | 08.00 ± 0.00 | 12.33 ± 1.52 | 11.66 ± 1.15 | 10.33 ± 1.52 | 09.66 ± 0.57 | 06.33 ± 1.52 | NA | NA | 20.33 ± 1.52 |
| | | b | 06.66 ± 1.15 | 05.66 ± 1.15 | 08.00 ± 0.00 | 07.66 ± 1.15 | 11.00 ± 0.00 | 10.00 ± 0.00 | 08.33 ± 1.52 | 07.33 ± 1.52 | 05.33 ± 1.52 | NA | NA | 28.00 ± 1.00 |
| 22. | <i>Cissus quadrangularis</i> L. Vitaceae (Stem). | a | 05.33 ± 0.33 | 05.00 ± 0.00 | 06.66 ± 0.33 | 05.66 ± 0.33 | 09.66 ± 0.33 | 08.66 ± 0.33 | 06.33 ± 0.33 | 05.33 ± 0.33 | 05.66 ± 0.33 | NA | NA | 21.00 ± 0.00 |
| | | b | 05.00 ± 0.00 | NA | 05.66 ± 0.33 | NA | 08.66 ± 0.33 | 07.66 ± 0.33 | 05.33 ± 0.33 | 05.00 ± 0.00 | 05.00 ± 0.00 | NA | NA | 28.66 ± 1.15 |
| 23. | <i>Citrus medica</i> L. Rutaceae (Fruit). | a | 09.33 ± 0.66 | 08.33 ± 0.66 | 10.33 ± 0.66 | 09.33 ± 0.66 | 13.33 ± 0.66 | 11.33 ± 0.66 | 07.50 ± 0.50 | 06.50 ± 0.50 | 05.33 ± 0.33 | NA | NA | 30.33 ± 1.52 |
| | | b | 07.33 ± 0.66 | 06.33 ± 0.66 | 09.33 ± 0.66 | 08.66 ± 1.15 | 12.33 ± 0.66 | 10.33 ± 0.66 | 06.50 ± 0.50 | 05.50 ± 0.50 | NA | NA | NA | 29.33 ± 1.52 |
| 24. | <i>Coccinea grandis</i> . Cucurbitaceae (Leaf). | a | 08.50 ± 0.50 | 08.20 ± 1.00 | 10.50 ± 0.50 | 09.50 ± 0.50 | 12.66 ± 1.15 | 10.66 ± 1.15 | 08.20 ± 1.00 | 07.20 ± 1.00 | 06.00 ± 0.00 | 05.66 ± 1.15 | NA | 29.66 ± 1.15 |
| | | b | 07.33 ± 1.52 | 06.33 ± 1.52 | 09.50 ± 0.50 | 08.50 ± 0.50 | 11.00 ± 0.00 | 09.00 ± 0.00 | 08.00 ± 0.00 | 06.00 ± 0.00 | 05.66 ± 1.15 | NA | NA | 32.66 ± 1.15 |
| 25. | <i>Coriandrum sativum</i> L. Apiaceae (Leaf). | a | 14.00 ± 0.00 | 13.33 ± 1.52 | 14.33 ± 1.52 | 12.33 ± 1.52 | 14.66 ± 1.15 | 13.66 ± 1.15 | 09.50 ± 0.50 | 08.50 ± 0.50 | 07.50 ± 0.50 | 06.50 ± 1.00 | NA | 29.00 ± 0.00 |
| | | b | 13.33 ± 1.52 | 11.33 ± 1.52 | 13.33 ± 1.52 | 11.33 ± 1.52 | 12.66 ± 1.15 | 11.66 ± 1.15 | 08.50 ± 0.50 | 07.50 ± 1.00 | 07.20 ± 1.00 | 06.20 ± 1.00 | NA | 28.20 ± 1.00 |
| 26. | <i>Cucumis collosus</i> L. Cucurbitaceae (Seed). | a | 09.33 ± 1.52 | 08.33 ± 1.52 | 10.33 ± 1.52 | 09.50 ± 0.50 | 13.66 ± 1.15 | 11.66 ± 1.15 | 08.50 ± 0.50 | 07.20 ± 1.00 | 06.50 ± 0.50 | 06.00 ± 0.00 | NA | 27.33 ± 1.52 |
| | | b | 06.33 ± 1.52 | 05.33 ± 1.52 | 09.50 ± 0.50 | 07.50 ± 0.50 | 10.50 ± 0.50 | 09.50 ± 0.50 | 07.20 ± 1.00 | 06.20 ± 1.00 | 05.66 ± 1.15 | NA | NA | 25.33 ± 1.52 |
| 27. | <i>Curcuma longa</i> L. Zingiberaceae (Rhizome). | a | 12.66 ± 1.15 | 11.33 ± 1.52 | 13.66 ± 1.15 | 12.50 ± 0.50 | 16.33 ± 1.52 | 15.33 ± 1.52 | 11.66 ± 1.15 | 10.20 ± 1.00 | 09.50 ± 0.50 | 07.50 ± 0.50 | NA | 28.20 ± 1.00 |
| | | b | 11.33 ± 1.52 | 10.50 ± 0.50 | 11.66 ± 1.15 | 10.50 ± 0.50 | 15.66 ± 1.15 | 13.66 ± 1.15 | 10.33 ± 1.52 | 09.33 ± 1.52 | 08.50 ± 0.50 | 06.50 ± 0.50 | NA | 27.33 ± 1.52 |
| 28. | <i>Delonix elata</i> (L.) Gamb. Fabaceae (Leaf). | a | 09.66 ± 0.88 | 08.66 ± 0.88 | 10.66 ± 0.88 | 09.66 ± 0.88 | 12.00 ± 1.52 | 10.66 ± 0.88 | 11.33 ± 1.52 | 09.66 ± 0.88 | 08.00 ± 0.00 | 07.00 ± 0.00 | NA | 29.00 ± 0.00 |
| | | b | 08.50 ± 0.50 | 07.66 ± 0.88 | 07.00 ± 0.00 | 06.50 ± 0.50 | 11.00 ± 1.52 | 09.00 ± 1.52 | 09.00 ± 0.00 | 08.33 ± 1.52 | 07.66 ± 0.57 | 05.66 ± 0.57 | NA | 29.00 ± 0.00 |
| 29. | <i>Dichanthium annulatum</i> (L.) Poaceae (Root). | a | 07.66 ± 1.33 | 06.66 ± 1.33 | 09.00 ± 1.52 | 07.00 ± 1.52 | 09.66 ± 0.88 | 08.66 ± 0.88 | 07.66 ± 0.57 | 06.66 ± 0.57 | 05.33 ± 1.45 | NA | NA | 25.33 ± 1.52 |
| | | b | 05.66 ± 0.57 | 05.33 ± 1.52 | 08.66 ± 0.57 | 06.66 ± 0.57 | 08.66 ± 0.88 | 07.66 ± 0.88 | 05.33 ± 1.45 | 04.33 ± 1.45 | NA | NA | NA | 29.66 ± 0.57 |
| 30. | <i>Dichrostachys cinerea</i> (L.) Wight & Arn. Fabaceae (Leaf). | a | 09.00 ± 1.00 | 08.00 ± 1.00 | 09.66 ± 1.15 | 09.00 ± 1.00 | 14.33 ± 1.52 | 12.33 ± 1.52 | 07.66 ± 0.88 | 07.00 ± 0.00 | 06.50 ± 0.50 | NA | NA | 27.66 ± 1.15 |
| | | b | 08.00 ± 1.00 | 06.00 ± 1.00 | 09.00 ± 1.00 | 08.00 ± 1.00 | 12.50 ± 1.50 | 11.50 ± 1.50 | 07.00 ± 0.00 | 06.33 ± 1.52 | 05.50 ± 0.50 | NA | NA | 25.33 ± 1.52 |
| 31. | <i>Ficus religiosa</i> L. Moraceae (Stem bark, Leaf). | a | 11.00 ± 1.52 | 10.33 ± 1.52 | 12.00 ± 1.52 | 10.00 ± 1.52 | 13.66 ± 1.15 | 12.50 ± 1.50 | 09.50 ± 0.50 | 08.50 ± 1.00 | 07.20 ± 1.00 | 06.20 ± 1.00 | NA | 24.00 ± 0.00 |
| | | b | 09.66 ± 1.15 | 08.50 ± 0.50 | 10.00 ± 1.52 | 09.66 ± 0.88 | 12.66 ± 1.15 | 09.50 ± 0.50 | 08.50 ± 1.00 | 07.20 ± 1.00 | 06.20 ± 1.00 | 05.50 ± 0.50 | NA | 29.00 ± 0.00 |
| 32. | <i>Goniogyna hirta</i> L. Fabaceae (Whole plant). | a | 09.50 ± 0.50 | 08.50 ± 0.50 | 10.33 ± 1.52 | 12.50 ± 1.50 | 11.50 ± 1.50 | 10.50 ± 1.50 | 09.50 ± 0.50 | 07.00 ± 0.00 | 06.00 ± 0.00 | NA | NA | 28.33 ± 1.52 |
| | | b | 08.50 ± 0.50 | 07.50 ± 0.50 | 10.00 ± 1.52 | 11.50 ± 1.50 | 11.00 ± 1.52 | 09.50 ± 0.50 | 08.50 ± 0.50 | 06.50 ± 0.50 | NA | NA | NA | 28.00 ± 0.00 |
| 33. | <i>Gymnema sylvestre</i> Retz. Schulte. Asclepiadaceae (Leaf). | a | 14.50 ± 0.50 | 13.50 ± 0.50 | 12.50 ± 0.50 | 11.50 ± 0.50 | 15.33 ± 1.52 | 14.00 ± 0.00 | 12.66 ± 1.15 | 10.66 ± 1.15 | 09.66 ± 0.88 | 08.66 ± 0.88 | NA | 28.33 ± 1.52 |
| | | b | 12.66 ± 1.15 | 11.66 ± 1.15 | 11.00 ± 0.00 | 10.00 ± 0.00 | 11.50 ± 1.50 | 10.50 ± 1.50 | 09.66 ± 0.88 | 08.66 ± 0.88 | 07.20 ± 1.00 | 06.20 ± 1.00 | NA | 24.33 ± 1.52 |
| 34. | <i>Hibiscus rosa-sinensis</i> L. Malvaceae (Flower). | a | 11.50 ± 1.50 | 10.50 ± 1.50 | 12.00 ± 1.52 | 11.00 ± 1.52 | 13.66 ± 1.15 | 12.66 ± 1.15 | 09.33 ± 1.52 | 08.66 ± 0.88 | 07.50 ± 0.50 | 06.50 ± 0.50 | NA | 29.33 ± 1.52 |
| | | b | 10.50 ± 1.50 | 09.50 ± 1.50 | 11.00 ± 1.52 | 10.00 ± 1.52 | 12.66 ± 1.15 | 11.66 ± 1.15 | 08.66 ± 0.88 | 07.20 ± 1.00 | 06.50 ± 0.50 | 05.50 ± 0.50 | NA | 29.66 ± 1.15 |
| 35. | <i>Hybanthus enneaspermus</i> (L.) F.V. Muell. Violaceae (Seed). | a | 07.20 ± 1.00 | 06.20 ± 1.00 | 09.66 ± 0.88 | 08.66 ± 0.88 | 12.66 ± 1.15 | 10.00 ± 0.00 | 08.66 ± 0.88 | 07.66 ± 0.88 | 07.20 ± 1.00 | 06.20 ± 1.00 | NA | 25.66 ± 1.15 |
| | | b | 06.20 ± 1.00 | 05.50 ± 0.50 | 08.66 ± 0.88 | 07.66 ± 0.88 | 11.00 ± 1.52 | 10.66 ± 1.15 | 07.20 ± 1.00 | 06.50 ± 0.50 | 05.20 ± 1.00 | NA | NA | 28.00 ± 0.00 |

| | | | | | | | | | | | | | | |
|-----|---|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----|--------------|
| 36. | <i>Ipomea batatas</i> (L.) Lamk. Convolvulaceae (Root). | a | 11.33 ± 1.52 | 10.33 ± 1.52 | 11.00 ± 0.00 | 10.50 ± 1.50 | 12.50 ± 1.15 | 11.66 ± 0.50 | 08.50 ± 1.00 | 07.20 ± 1.00 | NA | NA | NA | 21.00 ± 0.00 |
| | | b | 11.20 ± 1.00 | 10.20 ± 1.00 | 10.50 ± 1.50 | 09.66 ± 0.88 | 11.50 ± 1.50 | 10.50 ± 1.50 | 06.20 ± 1.00 | 05.20 ± 1.00 | NA | NA | NA | 29.66 ± 1.15 |
| 37. | <i>Jatropha glandulifera</i> Roxb. Euphorbiaceae (Rhizome). | a | 08.50 ± 0.50 | 07.50 ± 0.50 | 09.33 ± 1.52 | 08.33 ± 1.52 | 08.66 ± 0.88 | 07.66 ± 0.88 | 06.20 ± 1.00 | 05.20 ± 1.00 | NA | NA | NA | 28.33 ± 1.52 |
| | | b | 07.20 ± 1.00 | 06.20 ± 1.00 | 08.33 ± 1.52 | 07.33 ± 1.52 | 06.50 ± 1.50 | 05.50 ± 1.50 | 05.20 ± 1.00 | 05.00 ± 1.52 | NA | NA | NA | 26.33 ± 1.52 |
| 38. | <i>Lagascea mollis</i> Cam. Asteraceae (Leaf). | a | 07.66 ± 0.88 | 06.66 ± 0.88 | 08.33 ± 1.52 | 07.33 ± 1.52 | 09.33 ± 1.52 | 08.33 ± 1.52 | 07.33 ± 1.52 | 06.33 ± 1.52 | 05.00 ± 0.00 | NA | NA | 24.00 ± 0.00 |
| | | b | 06.66 ± 0.88 | 05.66 ± 0.88 | 07.33 ± 1.52 | 06.33 ± 1.52 | 08.33 ± 1.52 | 07.33 ± 1.52 | 06.33 ± 1.52 | NA | NA | NA | NA | 27.33 ± 1.52 |
| 39. | <i>Lantana camara</i> L. Verbenaceae (Leaf). | a | 16.66 ± 1.57 | 15.33 ± 0.57 | 17.33 ± 0.57 | 16.00 ± 0.00 | 21.33 ± 1.52 | 21.33 ± 1.15 | 19.66 ± 0.57 | 18.00 ± 0.00 | 16.33 ± 0.57 | 14.66 ± 1.15 | NA | 29.00 ± 0.00 |
| | | b | 14.66 ± 1.52 | 13.33 ± 0.57 | 15.66 ± 1.57 | 14.33 ± 0.57 | 21.00 ± 0.00 | 20.33 ± 1.52 | 18.00 ± 0.00 | 18.00 ± 0.00 | 16.33 ± 0.57 | 13.66 ± 0.57 | NA | 26.33 ± 1.52 |
| 40. | <i>Lawsonia inermis</i> L. Lythraceae (Leaf). | a | 08.50 ± 0.50 | 07.50 ± 0.50 | 08.00 ± 0.00 | 07.33 ± 0.57 | 12.20 ± 1.00 | 11.20 ± 1.00 | 09.33 ± 0.57 | 07.33 ± 0.57 | 06.66 ± 1.15 | 05.33 ± 0.57 | NA | 25.33 ± 1.52 |
| | | b | 07.50 ± 0.50 | 06.50 ± 0.50 | 07.33 ± 0.57 | 06.50 ± 0.50 | 11.20 ± 1.00 | 09.20 ± 1.00 | 07.33 ± 0.57 | 06.33 ± 0.57 | 06.20 ± 1.00 | 05.20 ± 1.00 | NA | 29.66 ± 0.57 |
| 41. | <i>Malvastrum coromandelianum</i> (L.) Garck. Malvaceae (Leaf). | a | 08.66 ± 1.15 | 07.66 ± 1.15 | 07.33 ± 0.57 | 06.66 ± 1.15 | 11.20 ± 1.00 | 10.20 ± 1.00 | 07.66 ± 0.57 | 07.00 ± 0.00 | 06.00 ± 0.50 | 05.50 ± 1.00 | NA | 28.33 ± 1.52 |
| | | b | 07.66 ± 1.15 | 06.66 ± 1.15 | 06.66 ± 1.15 | 05.66 ± 1.15 | 10.20 ± 1.00 | 09.33 ± 0.57 | 07.00 ± 0.00 | 06.00 ± 0.00 | 05.50 ± 0.50 | 05.20 ± 1.00 | NA | 28.20 ± 1.00 |
| 42. | <i>Mangifera indica</i> L. Anacardiaceae (Leaf). | a | 12.66 ± 1.15 | 11.33 ± 0.57 | 11.66 ± 0.57 | 10.66 ± 0.57 | 13.66 ± 1.57 | 11.66 ± 0.57 | 11.33 ± 0.57 | 10.66 ± 0.57 | 07.33 ± 1.52 | 06.33 ± 1.52 | NA | 25.33 ± 1.52 |
| | | b | 12.33 ± 0.57 | 11.66 ± 0.57 | 10.66 ± 0.57 | 10.00 ± 0.00 | 10.00 ± 0.00 | 09.00 ± 0.00 | 10.66 ± 0.57 | 09.33 ± 1.52 | 06.33 ± 1.52 | 05.33 ± 1.52 | NA | 29.00 ± 0.00 |
| 43. | <i>Maytenus senegalensis</i> (Lam.) Excell. Celastraceae (Root). | a | 10.66 ± 0.57 | 09.66 ± 0.57 | 11.00 ± 0.00 | 09.66 ± 0.57 | 12.33 ± 0.57 | 11.33 ± 0.57 | 09.66 ± 0.57 | 08.66 ± 1.00 | 07.20 ± 1.00 | 06.20 ± 1.00 | NA | 28.33 ± 1.52 |
| | | b | 09.66 ± 0.57 | 08.00 ± 0.00 | 09.66 ± 0.57 | 08.66 ± 0.57 | 11.33 ± 0.57 | 10.33 ± 0.57 | 08.66 ± 0.57 | 07.66 ± 0.57 | 07.00 ± 0.00 | 06.00 ± 0.00 | NA | 29.00 ± 0.00 |
| 44. | <i>Musa paradisiaca</i> L. Musaceae (Stem, Fruit). | a | 11.33 ± 0.57 | 10.33 ± 0.57 | 10.66 ± 0.57 | 09.66 ± 0.57 | 11.33 ± 0.57 | 11.00 ± 0.00 | 10.66 ± 0.57 | 09.66 ± 0.57 | 07.33 ± 1.52 | 06.33 ± 1.52 | NA | 25.33 ± 1.52 |
| | | b | 09.66 ± 0.57 | 08.66 ± 0.57 | 09.66 ± 0.57 | 08.00 ± 0.00 | 11.00 ± 0.57 | 10.66 ± 0.57 | 07.33 ± 1.52 | 07.00 ± 0.00 | 05.33 ± 1.52 | 05.00 ± 1.52 | NA | 26.33 ± 1.52 |
| 45. | <i>Nelumbo nucifera</i> Gaertn. Nelumbonaceae (Rhizome). | a | 11.66 ± 0.57 | 11.00 ± 0.00 | 10.66 ± 1.15 | 09.66 ± 0.57 | 12.33 ± 1.15 | 11.33 ± 1.15 | 09.00 ± 0.00 | 07.66 ± 0.57 | 07.00 ± 0.00 | NA | NA | 28.33 ± 1.52 |
| | | b | 11.00 ± 0.00 | 10.66 ± 1.15 | 09.66 ± 0.57 | 08.33 ± 1.15 | 10.33 ± 1.15 | 09.00 ± 0.00 | 07.00 ± 0.00 | 06.00 ± 0.00 | 05.66 ± 0.57 | NA | NA | 29.66 ± 1.15 |
| 46. | <i>Phyllanthus emblica</i> L. Euphorbiaceae (Fruit). | a | 12.33 ± 1.15 | 10.33 ± 1.15 | 12.33 ± 1.15 | 11.33 ± 1.15 | 14.66 ± 0.57 | 12.66 ± 0.57 | 11.33 ± 1.15 | 09.33 ± 1.15 | 07.66 ± 0.57 | 06.66 ± 0.57 | NA | 27.33 ± 1.52 |
| | | b | 11.66 ± 0.57 | 09.66 ± 0.57 | 09.66 ± 0.57 | 08.66 ± 0.57 | 13.20 ± 1.00 | 11.20 ± 1.00 | 11.00 ± 0.00 | 09.00 ± 0.00 | 06.66 ± 0.57 | 06.00 ± 0.00 | NA | 25.66 ± 1.15 |
| 47. | <i>Phyllanthus niruri</i> L. Euphorbiaceae (Leaf). | a | 09.33 ± 1.15 | 09.00 ± 0.00 | 08.66 ± 0.57 | 07.66 ± 0.57 | 11.33 ± 1.15 | 10.33 ± 1.15 | 09.66 ± 0.57 | 07.33 ± 1.52 | 06.66 ± 0.57 | 05.00 ± 0.00 | NA | 24.00 ± 0.00 |
| | | b | 08.66 ± 0.57 | 08.00 ± 0.00 | 08.00 ± 0.00 | 07.00 ± 0.00 | 10.33 ± 1.15 | 09.66 ± 0.57 | 07.66 ± 0.57 | 06.66 ± 0.57 | 05.00 ± 0.00 | NA | NA | 26.33 ± 1.52 |
| 48. | <i>Ricinus communis</i> L. Euphorbiaceae (Seed). | a | 09.00 ± 0.00 | 08.66 ± 0.57 | 07.66 ± 0.57 | 07.33 ± 1.52 | 10.66 ± 1.15 | 09.66 ± 0.57 | 07.33 ± 1.52 | 06.66 ± 0.57 | 06.66 ± 0.57 | 05.66 ± 0.57 | NA | 21.00 ± 0.00 |
| | | b | 08.66 ± 0.57 | 07.66 ± 0.57 | 06.33 ± 1.52 | 05.66 ± 0.57 | 12.33 ± 1.15 | 11.20 ± 1.00 | 09.33 ± 1.15 | 08.00 ± 0.00 | 05.66 ± 0.57 | 05.00 ± 0.00 | NA | 25.33 ± 1.52 |
| 49. | <i>Semecarpus anacardium</i> L.f. Anacardiaceae (Fruit). | a | 07.66 ± 0.57 | 06.66 ± 0.57 | 06.66 ± 0.57 | 06.20 ± 1.00 | 10.20 ± 1.00 | 09.66 ± 0.57 | 08.66 ± 0.57 | 07.66 ± 0.57 | 06.66 ± 0.57 | NA | NA | 27.33 ± 1.52 |
| | | b | 06.66 ± 0.57 | 06.00 ± 0.00 | 06.33 ± 1.52 | 05.20 ± 1.00 | 09.66 ± 0.57 | 08.66 ± 0.57 | 07.66 ± 0.57 | 06.66 ± 0.57 | 05.66 ± 0.57 | NA | NA | 24.33 ± 1.52 |
| 50. | <i>Sida cordifolia</i> L. Malvaceae (Leaf). | a | 11.00 ± 0.00 | 09.33 ± 1.15 | 11.20 ± 1.00 | 10.66 ± 0.57 | 13.66 ± 1.15 | 13.66 ± 1.15 | 10.66 ± 0.57 | 09.66 ± 0.57 | 08.33 ± 1.52 | 07.33 ± 1.52 | NA | 26.33 ± 1.52 |
| | | b | 09.33 ± 1.15 | 08.33 ± 1.15 | 10.66 ± 0.57 | 10.20 ± 1.00 | 12.33 ± 1.15 | 11.33 ± 1.15 | 09.66 ± 0.57 | 08.33 ± 1.52 | 07.33 ± 1.52 | 05.33 ± 1.52 | NA | 28.20 ± 1.00 |
| 51. | <i>Solanum nigrum</i> L. Solanaceae (Fruit). | a | 13.66 ± 1.15 | 12.33 ± 1.15 | 11.33 ± 1.15 | 11.00 ± 0.00 | 16.66 ± 0.57 | 15.66 ± 0.57 | 12.33 ± 1.15 | 11.33 ± 1.15 | 09.66 ± 0.57 | 07.66 ± 0.57 | NA | 29.66 ± 1.15 |
| | | b | 12.33 ± 1.15 | 11.33 ± 1.15 | 11.00 ± 0.00 | 09.33 ± 1.52 | 15.66 ± 0.57 | 14.66 ± 0.57 | 11.33 ± 1.15 | 11.00 ± 0.00 | 07.66 ± 0.57 | 06.66 ± 0.57 | NA | 25.33 ± 1.52 |
| 52. | <i>Tephrosia purpurea</i> (Del.) Pers. Fabaceae (Leaf). | a | 19.66 ± 1.15 | 18.33 ± 1.52 | 21.33 ± 1.52 | 20.00 ± 0.00 | 21.66 ± 1.15 | 19.33 ± 1.52 | 20.33 ± 1.52 | 19.33 ± 1.52 | 16.66 ± 0.57 | 15.00 ± 0.00 | NA | 24.66 ± 0.57 |
| | | b | 18.66 ± 0.57 | 17.33 ± 1.52 | 20.33 ± 1.52 | 20.66 ± 1.15 | 20.33 ± 1.52 | 18.66 ± 0.57 | 20.33 ± 1.52 | 18.66 ± 0.57 | 15.66 ± 0.57 | 14.66 ± 0.57 | NA | 29.00 ± 0.00 |
| 53. | <i>Terminalia chebula</i> Retz. Combretaceae (Fruit). | a | 12.33 ± 1.15 | 11.33 ± 1.15 | 14.33 ± 1.52 | 12.33 ± 1.15 | 15.66 ± 0.57 | 14.33 ± 1.52 | 13.66 ± 1.15 | 12.33 ± 1.15 | 11.33 ± 1.15 | 10.33 ± 1.52 | NA | 27.20 ± 1.00 |
| | | b | 11.33 ± 1.15 | 10.33 ± 1.52 | 10.33 ± 1.52 | 09.33 ± 1.52 | 14.33 ± 1.15 | 13.66 ± 1.15 | 12.33 ± 1.15 | 10.00 ± 0.00 | 10.33 ± 1.52 | 09.66 ± 1.15 | NA | 25.33 ± 1.52 |
| 54. | <i>Tribulus terrestris</i> L. Zygophyllaceae (Fruit). | a | 11.33 ± 1.15 | 10.33 ± 1.52 | 12.33 ± 1.15 | 11.33 ± 1.15 | 14.33 ± 1.52 | 13.66 ± 1.15 | 10.33 ± 1.52 | 10.00 ± 0.00 | 09.33 ± 1.52 | 08.33 ± 1.52 | NA | 29.66 ± 1.15 |
| | | b | 10.33 ± 1.52 | 10.00 ± 0.00 | 11.33 ± 1.15 | 11.00 ± 0.00 | 13.66 ± 1.15 | 11.33 ± 1.15 | 10.00 ± 0.00 | 09.33 ± 1.52 | 08.00 ± 0.00 | 07.33 ± 1.52 | NA | 23.00 ± 0.00 |
| 55. | <i>Tridax procumbens</i> L. Asteraceae (Whole plant). | a | 11.33 ± 1.15 | 11.00 ± 0.00 | 07.33 ± 1.52 | 09.33 ± 1.52 | 08.66 ± 1.15 | 15.66 ± 0.57 | 14.33 ± 1.52 | 13.66 ± 1.15 | 12.33 ± 1.15 | 06.33 ± 1.52 | NA | 28.00 ± 0.00 |
| | | b | 11.00 ± 0.00 | 10.33 ± 1.52 | 08.00 ± 0.00 | 08.66 ± 1.15 | 07.66 ± 0.57 | 14.33 ± 1.15 | 13.66 ± 1.15 | 12.33 ± 1.15 | 11.33 ± 1.15 | 05.33 ± 1.52 | NA | 28.00 ± 0.00 |
| 56. | <i>Withania somnifera</i> L. Solanaceae (Root). | a | 20.33 ± 1.52 | 20.66 ± 0.57 | 19.66 ± 1.15 | 18.00 ± 0.00 | 21.00 ± 0.00 | 21.66 ± 1.15 | 19.00 ± 0.00 | 18.00 ± 0.00 | 16.33 ± 1.52 | 14.33 ± 1.52 | NA | 27.33 ± 1.52 |
| | | b | 19.66 ± 1.15 | 19.66 ± 1.15 | 18.00 ± 0.00 | 21.66 ± 1.15 | 19.66 ± 0.00 | 18.00 ± 1.15 | 19.66 ± 0.00 | 18.00 ± 0.00 | 15.66 ± 0.57 | 14.66 ± 1.15 | NA | 24.66 ± 0.57 |
| 57. | <i>Woodfordia fruticosa</i> (L.) Kurz, J.Asiat. | a | 11.33 ± 1.15 | 10.33 ± 1.52 | 12.33 ± 1.15 | 11.33 ± 1.15 | 14.33 ± 1.52 | 12.33 ± 1.15 | 11.00 ± 0.00 | 10.33 ± 1.52 | 10.00 ± 0.00 | 09.66 ± 1.15 | NA | 28.20 ± 1.00 |
| | | b | 11.33 ± 1.15 | 10.33 ± 1.52 | 12.33 ± 1.15 | 11.33 ± 1.15 | 14.33 ± 1.52 | 12.33 ± 1.15 | 11.00 ± 0.00 | 10.33 ± 1.52 | 10.00 ± 0.00 | 09.66 ± 1.15 | NA | 28.20 ± 1.00 |

| | | | | | | | | | | | | | |
|-------------------------|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----|-----------------|
| Lythraceae (Flower). | b | 11.00 ± 0.00 | 10.33 ± 1.52 | 11.33 ± 1.15 | 11.00 ± 0.00 | 13.66 ± 1.15 | 11.33 ± 1.15 | 10.33 ± 1.52 | 10.00 ± 0.00 | 09.66 ± 1.15 | 07.33 ± 1.52 | NA | 27.33 ± 1.52 |
|-------------------------|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----|-----------------|

P= Petroleum ether extract, C= Chloroform extract, E= Ethyl acetate extract, M= Methanol extract, A= Aqueous extract, C= Control (DMSO), S= Streptomycin, NA= No Activity, 1= 5 mg⁻¹, 2 = 2.5 mg⁻¹. a= *Escherichia coli*, b= *Bacillus subtilis*.

TABLE 2: ANTIBACTERIAL FREQUENCY OF 57 ETHNOMEDICINAL PLANTS

| Sl. No. | Test strains | Very effective | Effective | Moderate | Weak | No activity |
|---------|--------------------------|----------------|-----------|----------|------|-------------|
| 01 | <i>Escherichia coli</i> | 77 | 67 | 63 | 67 | 11 |
| 02 | <i>Bacillus subtilis</i> | 48 | 68 | 58 | 95 | 16 |

DISCUSSION: In the present study, Petroleum ether, ethyl acetate and methanol extracts of *A. sativum* showed very effective activity against all the tested strains. However, Seema Bhadauria and Padma Kumar²⁰ reported effective activity in aqueous extract. A study by Esimone *et al.*,²¹ reported that it is worthy to note that in most cases of infection, a combination of antimicrobial activity and one or more other biological effects, such as immunomodulation, could be responsible for overall effect of a natural product. It is therefore likely that a combination of these biological effects of garlic and ginger and the demonstrated antimicrobial effect may explain its usefulness in the management of oropharyngeal infections.

Some *in-vitro* studies confirmed anti-bacterial activity of garlic extract^{22, 23}. A study by Ankari *et al.*,²⁴ reports the garlic extract for anti-bacterial, antifungal, anti-parasitic and anti-viral activities. It has been reported that the use of fresh garlic is more effective for antimicrobial activity than that from old garlic^{22, 25}. The antibacterial properties of crushed garlic have been known for a long time. Various garlic preparations have been shown to exhibit a wide spectrum of antibacterial activity against the species of *Escherichia*, *Streptococcus*, *Klebsiella*, *Proteus*, *Bacillus* and *Clostridium*. Analysis of steam distillations of crushed garlic cloves performed over a century ago showed a variety of allyl sulfides compounds responsible for antibacterial activity of crushed garlic cloves^{24, 26-28}.

In the present study, all the five solvent extracts of *A. mexicana* root at 5mg/ml concentration showed effective activity against both the tested strains with strong activity especially in ethyl acetate extracts. The inhibition zones against bacterial and fungal strains were comparable to those elicited by streptomycin.

However, a study by Yashwant Bais *et al.*,²⁹ reported that the methanolic leaf extracts of *A. mexicana* did not show inhibitory action against bacteria, but was found to be very good against *C. albicans* as compared to other yeast strain.

In the present study, the leaf extracts of *L. camara* in all the solvent extracts especially in ethyl acetate showed potent antibacterial activity against both the tested strains. However, in another study by Parivuguna *et al.*,³⁰ reports that the extract of flower, leaf, stem and root of *L. camara* showed antibacterial activity against *E. coli*, *P. aeruginosa*, *S. aureus* and *S. saprohiticus*. The antibacterial activity was determined by disc diffusion method³¹, tube dilution technique³², agar well diffusion method, micro distillation method³³. It was observed that strains of *E. coli* & *S. aureus* were more susceptible to essential oil. *L. camara* flower extract possess strong antibacterial activity of all few types, yellow lavender, red and white *L. camara*. *L. camara* leaves evaluated for antimicrobial & antifungal activity³⁴.

The essential oil of *L. camara* tested against 7 bacteria & 8 fungi, showed wide spectrum of antifungal activities³⁵. An investigation of acetone extracts of leaves of *L. camara* and *L. rugosa* showed growth inhibitory effects against (*E. coli*, *P. aeruginosa*, *E. faecalis* and *S. aureus*) bacteria, with MIC values varying from 0.39 mg/mL to 6.3 mg/mL³⁶. The essential oil of the leaves of *L. camara* has been examined for antibacterial activity by the microdilution test³⁷. The inhibitory activity was seen against the multiresistant strains *E. coli* (MIC 512 µg/mL) and *S. aureus* (MIC 256 µg/MI). In the present study, the leaf extracts of *T. purpurea* in all the solvent extracts at 5mg/ml concentration showed significant antibacterial activity against all the test organisms.

A study by Thetwa *et al.*,³⁸ tested the seed extracts of *T. purpurea* for their antimicrobial properties against some human, animal and plant pathogenic organisms and reported that the seed extract showed good results.

In another study, Kumar *et al.*,³⁹ evaluated antimicrobial activity of ethanolic extract of *T. purpurea* roots by disc diffusion and broth dilution methods and reported the significant activity. Ethanolic extract showed better antibacterial activity against *S. aureus*, *E. coli*, *P. aeruginosa* and *B. subtilis*⁴⁰. However, Sachin Parashram Venkatraman⁴¹ reported potent activity in pet ether seed extracts of *T. purpurea*.

The present study reports the potent antibacterial activity of root extracts of *W. somnifera* in ethyl acetate solvent extracts against both the test strains used in the study and the inhibitory effect was comparable with that of streptomycin. However, in another study, Ethanol, acetone, Iso propyl alcohol, toluene and hexane extract of different aerial parts (leaf and flower) of *W. somnifera* was evaluated by Premlata Singariya *et al.*,⁴² and reported that the extract of *W. somnifera* significantly inhibited 6 important bacteria and two fungi (*C. albicans* and *A. flavus*) to varying degrees. Leaf extracts of *W. somnifera* in different polar solvents showed highest activity in terms of inhibition zone, activity index, MIC, MBC/MFC and total activity.

The inhibitory effect was very identical in magnitude and comparable with that of standard antibiotics Gentamycin. Pranay Jain and Rishabh Varshney⁴³ reported the antimicrobial activity of aqueous and methanolic extracts of *W. somnifera* (Ashwagandha) with highest in aqueous extract against *E. coli*, *P. aeruginosa*, *S. aureus*, *S. mutans* and *C. albicans*. The present study also revealed very effective antibacterial activity in *M. indica* against *E. coli* and *B. subtilis* in petroleum ether and ethyl acetate extract. Similarly, *C. longa* was found effective in petroleum ether and ethyl acetate extracts.

CONCLUSION: Since plants produce a variety of compounds with antibacterial properties, it is expected that screening programs for some under-represented target such as antibacterial activity may yield candidate compounds for developing new

antibacterial drugs. In the present study, the extracts of total 57 plant species belonging to 55 genera and 34 families were screened for their antibacterial activity, among which ethyl acetate extracts of *A. mexicana*, *W. somnifera*, *T. purpurea* and *L. camara* and Petroleum ether and methanolic extract of *A. sativum* showed significant antibacterial potential against test microbes.

The demonstration of broad spectrum of all the five plants may help to discover new chemical classes of antibiotic substances that could serve as selective agents for infectious disease chemotherapy and control. The extracts that showed strong antibacterial activity are worth of further investigation in order to isolate and identify the active compounds.

ACKNOWLEDGEMENT: First author would like to thank Gulbarga University, Kalaburagi, for providing financial assistance through University Research Studentship to meritorious students pursuing Ph.D. course.

REFERENCES:

1. Taylor PW, Stapleton PD, Luzio JP: New ways to treat bacterial infections. *Drug Discov Today* 2002; 7(21): 1086-1091.
2. Sibanda T, Okoh AI: The Challenges of overcoming antibiotic resistance: Plants extracts as potential sources of antimicrobial and resistance modifying agents. *Afr J Biotechnol* 2007; 6(25): 2886-2896.
3. Lewis K and Ausubel FM: Prospects of plant derived antibacterials. *Nat Biotechnol* 2006; 24:1504-1507.
4. Lee SB, Cha KH, Kim SN, Altantsetseg S, Shatar S, Sarangerel O and Nho CW: The antimicrobial activity of essential oil from *Dracocephalum foetidum* against pathogenic microorganisms. *J Microbiol* 2007; 45: 53-57.
5. Bonjar S: Evaluation of antibacterial properties of some medicinal plants used in Iran. *J Ethnopharmacol* 2004; 94: 301-305.
6. Islam B, Khan SN, Haque I, Alam M, Mushfiq M and Khan AU: Novel Anti-adherence activity of mulberry leaves: Inhibition of *Streptococcus mutans* Biofilm by 1-Deoxynojirimycin isolated from *Morus alba*. *J Antimicrob Chemother* 2008; 62: 751-757.
7. Boer HJ, Kool A, Broberg A, Mziray WR, Hedberg I and Levenfors JJ: Antifungal and antibacterial activity of some herbal remedies from Tanzania. *J Ethnopharmacol* 2005; 96: 461-469.
8. Vuuren SFV, Naidoo D: An antimicrobial investigation of plants used traditionally in Southern Africa to treat sexually transmitted infections. *J Ethnopharmacol* 2010; 130: 552-558.
9. BhengrajAR, Dar SA, Talwar GP, Mittal A: Potential of a novel polyherbal formulation BASANT for prevention of *Chlamydia trachomatis* infection. *Int J Antimicrob Agents* 2008; 32: 84-88.
10. Tharkar PR, Tatiya AU, Shinde PR, Surana SJ, Patil UK: Antifungal activity of *Glycyrrhiza glabra* Linn. and *Emblca*

- officinalis* Gaertn. by direct bio autography method. Int J Phar Tech Res 2010; 2: 1547-1549.
11. Gupta SK, Banerjee AB: Screening of selected West Bengal plants for antifungal activity. Econ Bot 2008; 26(3): 255-259.
 12. Suresh M, Rath PK, Panneerselvam A, Dhanasekaran D, Thajuddin N: Antifungal activity of selected Indian medicinal plant salts. J Global Pharma Technol 2010; 2(4): 71-74.
 13. Parekh J, Chanda S: *In vitro* antifungal activity of methanol extracts of some Indian medicinal plants against pathogenic yeast and moulds. African J Biotechnol 2008; 7(23): 4349-4353.
 14. Patel M, Coogan MM: Antifungal activity of the plant *Dodonaea viscosa* var. *angustifolia* on *Candida albicans* from HIV-infected patients. J Ethnopharmacol 2008; 118(1): 173-176.
 15. Govindachari TR, Suresh G, Gopalakrishnan G, Balaganesan B, Masilamani S: Identification of antifungal compounds from the seed oil of *Azadirachta indica*. Phytoparasitica 1998; 26(2): 109-116.
 16. Srinivasan D, Nathan S, Suresh T, Lakshmana Perumalsamy P: Antimicrobial activity of certain Indian medicinal plants used in folkloric medicine. J Ethnopharmacol 2001; 74: 217-220.
 17. Duraipandiyar V, Ignacimuthu S, Gnanasekaran M: Antifungal activity of triterpenoid isolated from *Azima tetraacantha* leaves. Folia Histo chem Cytolbia 2010; 48: 311-313.
 18. Mekkiy SE, Meselhy MR, Kusumoto IT, Kadota S, Hattori M, Namba T: Inhibitory effects of Egyptian folk medicines on human immunodeficiency virus (HIV) reverse transcriptase. Chem Pharm Bull 1995; 43: 641-648.
 19. Indian Pharmacopoeia: Test for specified microorganisms. Volume II. The controller of publications, New Delhi 1996: 115.
 20. Seema Bhaduria and PadmaKumar: *In vitro* antimycotics activity of some medical plants against human pathogenic dermatophytes. Indian Journal of Fundamental and Applied Life Sciences 2011; 1(2): 1-10.
 21. Esimone Co, Adikwu Mu, Nworu Cs, Okoye Fbc, Odimegwu Dc: Adaptogenic potential of *Camellia sinensis* leaves, *Garcinia kola* and *Kola nitida* seeds. Sci Res Essays 2008; 2(7): 232-237.
 22. Sasaki J, Kita T, Ishita K, Uchisawa H, Matsue H: Antibacterial activity of garlic powder against *Escherichia coli* O-157. J Nutr Sci Vitaminol (Tokyo) 1999; 45(6): 785-90.
 23. Tsao SM, Hsu CC, and Yin MC: Garlic extract and diallylsulphides inhibit methicillin-resistant *Staphylococcus aureus* infection in BALB/cA mice. J Antimicrob Chemother 2003; 52: 974-80.
 24. Ankari S, Mirelman D: Antimicrobial properties of allicin from garlic. Microbes and Infection 1999; 1(2): 125-9.
 25. Lemar KM, Turner MP, Lloyd D: Garlic (*Allium sativum*) as an anti-*Candida* agent: a comparison of the efficacy of fresh garlic and freeze-dried extracts. J Appl Microbiol 2002; 93(3): 398-405.
 26. Benkeblia N: Antimicrobial activity of essential oil extracts of various onions (*Allium cepa*) and garlic (*Allium sativum*). Lebensm. -Wiss. U. -Technol 2004; 37: 263-268.
 27. Yin MC, Cheng WS: Antioxidant and antimicrobial effects of four garlic-derived organosulfur compounds in ground beef. Meat Science 2003; 63: 23-28.
 28. Tsao SM, Yin MC: *In-vitro* antimicrobial activity of four diallylsulphides occurring naturally in garlic and Chinese leek oils. J. Med. Microbiol 2001; 50: 646-649.
 29. Yashwant Bais, Sunil B Chaudhari, SujitBelani and Arvind R Umakar: Evaluation of antimicrobial activity of plant leaf *Argemone mexicana*. International Journal of Pharmacy and Biological Sciences 2013; 3(1): 41-45.
 30. Parivuguna V, Doss A and Abhitha B: Anticandidal activity of the leaf extracts of *Fragaria virginiana* Duchense. and *Lantana camara* Linn. International Journal of Bio-Technology and Research 2013; 3(2): 21-26.
 31. Mary Kensa V: Studies on phytochemical screening and antibacterial activities of *Lantana camara* Linn. Plant Science Feed 2011; 1(5): 74-79.
 32. Smaranika Pattnaik and Banita Pattnaik: A study of *Lantana camara* Linn. Aromatic oil as an antibacterial agent. Intr J Pharma sci 2010; 01(01): 32.
 33. Deepak Ganjewala, Silviya Sam, Kishwar Hayat Khan: Biochemical compositions and antibacterial activities of *Lantana camara* plants with yellow, Lavender, red and white flowers. Eur Asia J Biosci 2009; 3: 69-77.
 34. Vidya SS Dharmagadda, MamtaTandonb and Padma Vasudevan: Biocidal activity of the essential oils of *Lantana camara*, *Ocimum sanctum* and *Tagetes*. Journal of Scientific & Industrial Research 2005; 64: 53-56.
 35. Deena MJ, Thoppil JE: Antimicrobial activity of the essential oil of *Lantana camara*. Fitoterapia 2000; 71: 453-455.
 36. McGaw LJ, Eloff JN: Screening of 16 poisonous plants for antibacterial, anthelmintic and cytotoxic activity *in vitro*. S Afr J Bot 2005; 71: 302-306.
 37. Sousa EO, Silva NF, Rodrigues FFG, Campos AR, Lima SG, Costa JGM: Chemical composition and resistance modifying effect of the essential oil of *Lantana camara* Linn. *Phcog Mag* 2010b; 6: 79-82.
 38. Thetwa LK, Shrivastava Alka, ShrivastavaSeema, Deshmukh NC, Angor MR and Tandon RC: Antimicrobial efficacy of successive seed extracts of *Tephrosia purpurea*. Asian Journal of Chemistry 2006; 18(1): 745-746.
 39. Kumar GS, Jayaveera KN, Ashok Kumar CK, Umachigi P Sanjay, Vrushabendra Swamy BM, Kishore Kumar DV: Antimicrobial effects of Indian medicinal plants against acne-inducing bacteria. Tropical Journal of Pharmaceutical Research 2007; 6(2): 717-723.
 40. Dev Prakash, Srinivasan KK, Subburaju T, Sachin Kumar Singh: Antimicrobial activity of alcoholic and aqueous extracts of *Tephrosia purpurea*. Asian Journal of Biochemical and Pharmaceutical Research 2011; 2(1).
 41. Sachin Parashram Venkataraman: Phytochemical evaluation and antimicrobial activity of seeds of *Tephrosia purpurea* Linn. Imperial J Pharmaceutics & Cosmetology 2011; 1(1): 38-46.
 42. Premlata Singariya, Padma Kumar and Krishan K, Mourya: Estimation and bio activity of arial parts of *Withania somnifera* against the bacterial and fungal microbes. Int J Pharm Pharm Sci 2012; 4(3): 553-557.
 43. Pranay Jain and Rishabh Varshney: Antimicrobial activity of aqueous and methanolic extract of *Withania somnifera* (Ashwgandha). J Chem Pharm Res 2011; 3(3): 260-263.

How to cite this article:

Sharanappa R and Vidyasagar GM: Preliminary Screening of Ethnomedicinal Plants for Antibacterial Activity. Int J Pharm Sci Res 2015; 6(9): 3928-35. doi: 10.13040/IJPSR.0975-8232.6(9).3928-35.