

Evaluation of Antimicrobial Activity of Some Traditional Medicinal Plants

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ABSTRACT

Antimicrobial activity of aqueous and solvent extracts of *Adina cordifolia*, *Careya arborea*, *Careya arborea*, *Hiptage benghalensis* and *Lannea coromandelica* were tested against different bacteria (*Bacillus cereus*, *Bacillus subtilis*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Enterobacter aerogenes*, *Escherichia coli*, *Proteus mirabilis*, *Klebsiella pneumonia*) and fungi (*Fusarium oxysporum*, *Aspergillus niger*, *Curvularia lunata* and *Alternaria alternata*). Out of the tested plants, *Cassia angustifolia* and *Adina cordifolia* were found effective in inhibiting the growth of test microorganisms. Ethanol extract of *C. angustifolia* exhibited the maximum antibacterial potential with 24.66 mm inhibition zone of against *S. aureus* followed by *E.coli* (22.62 mm), *B. subtilis* (21.63 mm), *E. aerogenes* (18.32 mm), *K. Pneumonia* (17.67 mm) and *B. cereus* with 15.00 mm of inhibition. Aqueous extract of *C. angustifolia* showed maximum growth inhibition against *B. cereus* with inhibition zone of 21.55 mm followed by *B. subtilis* (19.47 mm) and *E. coli* (16.32 mm). *A. cordifolia* was found effective against *B. cereus* (15.52 mm), *S. aureus* (10.49 mm) and *E.coli* (11.32 mm). Against test fungi, *C.angustifolia* was found potent against *F. oxysporum* with 60 % of mycelial inhibition followed 13.16 % of inhibition against *A. alternate*. Ethanol extract of *C. angustifolia* exhibited the strong antifungal potential against *C. lunata* with 22.93 mm zone of inhibition.

KEY WORDS: ANTIBACTERIAL, ANTIFUNGAL, CASSIA ANGUSTIFOLIA, ADINA CORDIFOLIA, AQUEOUS EXTRACT, ETHANOL EXTRACT.

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INTRODUCTION

Mankind is blessed with medicinal plants, an expensive gift from nature. Medicinal plants have been used widely as alternative therapeutic tools for the prevention or treatment of many diseases (Cartea et al., 2010, Nagavani and Rao, 2010). The active principles present in the medicinal plants are unknowingly exploited in traditional methods for the treatment of numerous ailments (Adebajo et al., 1983). Researchers are gradually increasing their attention towards the natural products and looking for new active principles, which lead to develop better drugs against microbial infections (Lopez et al., 2001, Ibrahim, 1997, Philip et al., 2009). The antimicrobial compounds obtained from plants have more preventive and curative effect than the commercial antibiotics, hence antimicrobial compounds of plants have more clinical value than the commercial ones against the infectious strains of resistant microorganisms, (Jamshiya, 2017). About 800 plants have been in use in Ayurveda, whereas Siddha system of medicine makes use of 600 plants in different formulations and Unani and Amchi system together are practicing about 700 plants in their various preparations. Development of resistance by microbes against the available antibiotics has deepened the concerns for the identification of new and natural antibiotics.

Plants are considered as the rich sources of secondary metabolites and have been reported to have potential therapeutic values (Farnsworth, 1973, Farnsworth and Soejarto, 1985). Medicinal plants are gradually gaining more priority and interest from microbiologists, pharmacologists and drug developing institutions/industries of India and abroad for last few decades owing to their vast medicinal values. Antimicrobial activity of medicinal plants have been reported by several workers from in India and other parts of the world, (Bhawasari et al., 1965, Shah and Qadry, 1971, Radhakrishnan et al., 1976, Rastogi et al., 1990, Asolkar et al., 1992, Mehmood et al., 1997, Ahmad et al., 1998, Grainger Bisset, 2000, Behl and Srivastava, 2002, Sofowora et al., 2013 and Gaudillière, 2019). In the present investigation, five medicinal plants viz. *Adina cordifolia*, *Careya arborea*, *Cassia angustifolia*, *Hiptage benghalensis* and *Lanneacoro mandelica* have been selected based on their traditional medicinal properties like chronic cough, jaundice, stomach ache, swelling in stomach, antiamebic, anti-inflammatory, antifertility, antityphoid,

anticholera, anti anaemia, in treating burning sensation of the body, rheumatism, hyperdipsia, obesity, intrinsic hemorrhage, elephantiasis, inflammation, neuralgia, sprains and bruises as reported by many researchers, (de Saravia and Gaylarde, 1998, Arya et al., 2003, Costa et al., 2009, Sharma et al., 2009, Siddique et al., 2010a, Parveen and Shahzad, 2011). Hence the above plants were evaluated for their antibacterial and antifungal activity against both gram positive and gram negative bacteria and phyto-pathogenic fungi.

MATERIALS AND METHODS

Collection of plant material: Leaves of the selected plants were used for antimicrobial activity. The selected plant materials were collected from in and around region of Mysore. The samples were collected freshly in the air tight clean polythene bags and brought to laboratory, washed under running water to remove the dust and debris.

Microorganisms used in study: Bacteria: *Bacillus cereus*, *Bacillus subtilis*, *Staphylococcus aureus*, *Streptococcus pyogenes*, *Enterobacter aerogenes*, *Escherichia coli*, *Proteus mirabilis*, *Klebsiella pneumoniae*. Fungi: *Fusarium oxysporum*, *Aspergillus niger*, *Curvularia lunata* and *Alternaria alternata*.

Preparation of extracts: Aqueous extraction: Fresh and washed samples were used for the aqueous extraction and extraction was made at 1:1 volume. About 50 gm of sample was weighed and macerated with 50 ml of distilled water in the mortar and pestle. The macerate was kept overnight for exudation of bio chemicals and were filtered through double layered muslin cloth followed by Whatman No. 1 filter paper. Obtained aqueous extracts were stored at 4 °C for further use. Solvent extraction: The test plants which gave effective results against tested pathogens in aqueous extracts were subjected to solvent extraction with the help of Soxhlet apparatus. Shade dried samples of test plant leaf materials were coarse powdered. The plant materials were exhaustively extracted by solvents with an increasing polarity. The solvent series which are used in extraction based on increasing polarity are as follows; Petroleum ether, chloroform, ethyl acetate and ethanol. The extracted solvents were kept for evaporation and obtained extracts were stored at 5 °C for further use.

Antibacterial Assay: Agar well diffusion method: This method was carried out in-vitro with nutrient agar medium (HiMedia, Mumbai). About 25 ml of sterilized, autoclaved nutrient agar medium was poured on to the sterilized petri-plates in a laminar air flow to avoid contamination. The spore suspension was uniformly spread over the sterilized media in Petri-plates with the help of 'L' shaped glass rod. The 6 mm of wells were made on the media with the help of stainless steel cork borer. The wells were filled with the extracts of 100 µl each. Plates were incubated at 27 ± 2°C, three replicates were maintained for each treatment. Inhibition zone was observed after 24 h of inoculation and inhibition zone was measured with zone scale. The results were tabulated. **Agar disc diffusion method:** In this method, Sterilized disks were impregnated with extracts solutions of the substances to be examined, the test compound at a known concentration.

About 20 ml of sterilized, autoclaved Muller Hinton agar (Hi Media, Mumbai) media was poured into sterile petri-plates and were allowed to solidify inside laminar air flow. About 100 µl of bacterial cultures were spread over solidified, media using 'L' shaped glass rod. The test extracts of 100 µl (100 mg/ml) was impregnated onto a sterile disc. Each test plates contained a disc impregnated with extract, one disc as positive control (Gentamicin) and one disc served as negative control (solvent), all discs were placed at equidistant from each other. The inoculated plates were incubated at 37°C for 24 h. The experiment was carried out in triplicates and the zone of inhibition was recorded with zone scale.

Antifungal Assay: Poison Food Technique: Antifungal activity was carried out In-vitro at 10% of concentration. About 2 ml of 100% extract from the prepared stock solution (100%) was added to 20 ml of sterilized, autoclaved Potato Dextrose Agar (PDA) (HiMedia, Mumbai) media to bring up 10% of concentration, poisoned media in the plate were allowed to solidify. A 5 mm diameter of actively growing mycelium disc of the pathogen of 7 days old culture was placed in the center of the Petri plates containing poisoned media plates. And plates were incubated at 27 °C. Three replicates were maintained for each treatment. Radial growth of mycelium was measured after seven days after inoculation. The percent inhibition of the fungus in treatments was calculated using following formula

$$\% \text{ of growth inhibition} = \frac{dc - dt}{dt} \times 100 \quad (1)$$

Where;

dc= Average increase in mycelial growth in control, dt= Average increase in mycelial growth in treatment.

Agar disc diffusion method: In this method, sterilized disks impregnated with extracts of the substances to be examined, the test compound at a known concentration. About 20 ml of sterilized, autoclaved Potato Dextrose Agar (PDA) media was poured into sterile petri-plates and were allowed to solidify in laminar air flow. About 100 µl of fungal cultures were spread over solidified media using 'L' shaped glass rod. The test extracts of 100 µl (100 mg/ml) was impregnated onto a sterile disc. The inoculated plates were incubated at 27°C for 7 days. The experiments were carried out in triplicates and the zone of inhibition was recorded with zone scale.

Statistical analysis: All the experiments were carried out in triplicates and the data were subjected to one- way analysis of variance (ANOVA), followed by Tukey's post test at P≤0.05 level of significance using Graph pad prism 5 software.

RESULTS AND DISCUSSION

Antibacterial activity of aqueous extracts: In the present study five medicinal plants have been screened for antibacterial activity. Out of tested plants *Cassia angustifolia* has effectively inhibited growth of the pathogenic bacteria *B. cereus* with inhibition zone of 21.55 mm, *B. subtilis* (19.47 mm), *S. aureus* (15.76 mm), *E. coli* (16.32 mm) as compared to others followed by *Adina cordifolia* *B. cereus* (11.52 mm), *S. aureus* (10.49 mm) and *E. coli* (11.32 mm). The plant *Lanneacoromandelica* was effective against *B. subtilis* (11.66 mm) only. Whereas *Careyaarborea* and *Hiptagebenghalensis* has shown no activity on any bacterium (Table1, Fig. 1).

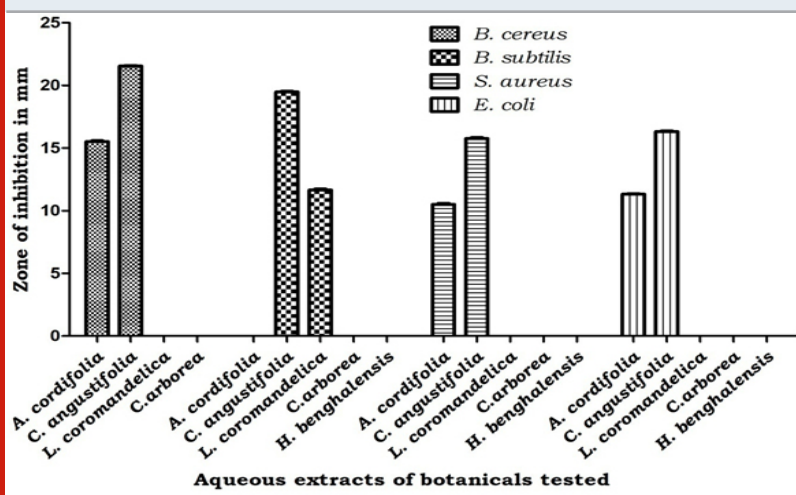
Antifungal activity of aqueous extracts: Antifungal activity was carried out by poisoned food technique at 10%. The results revealed that *Cassia angustifolia* with percentage inhibition of 60% (*Fusarium oxysporum*), 13.16% (*Alternaria alternata*), 11.20% (*Aspergillusniger*) and 09% (*Curvularialunata*) was the only plant which inhibited the growth of the tested fungi and whereas least inhibition was observed in

Table 1. Antibacterial activity of aqueous plant extracts against bacteria

Sl. No	Name of the plant	Parts used	Inhibition of Bacteria in mm				Gram negative Bacteria			
			Gram Positive Bacteria							
			B. cereus	B. subtilis	S. aureus	S. pyogenes	E. aerogenes	E. coli	P. mirabilis	K pneumonia
1	<i>Adina cordifolia</i>	Leaves	11.52 ± 0.06*	0.00 ± 0.0	10.49 ± 0.08*	0.00 ± 0.0	0.00 ± 0.0	11.32 ± 0.04*	0.00 ± 0.0	0.00 ± 0.0
2	<i>Careyaarborea</i>	Leaves	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
3	<i>Cassia angustifolia</i>	Leaves	21.55 ± 0.04**	19.47 ± 0.06**	15.76 ± 0.07**	0.00 ± 0.0	0.00 ± 0.0	16.32 ± 0.05**	0.00 ± 0.0	0.00 ± 0.0
4	<i>Hiptagebenghalensis</i>	Leaves	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
5	<i>Lanneacoromandela</i>	Leaves	0.00 ± 0.0	11.65 ± 0.04*	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0

Note: Asterisk marks *, **, *** indicate significance of values at P 6 0.05 level according to ANOVA, Tukey's post test.

Figure 1. Graphical representation of antibacterial activity of aqueous extracts of plants



Lanneacoromandela with 7% inhibition of *Aspergillusniger*, *Hiptagebenghalensis* is showed inhibition of *Fusarium oxysporum* and *Aspergillusniger* with inhibition percentage of 6% and 2.22% respectively. *Adina cordifolia* showed least inhibition against *Fusarium oxysporum* (2.22%) only. Whereas no inhibition was observed in the *Careyaarborea* for all the tested fungi (Table 2, Fig. 2).

Antibacterial activity of solvent extracts: Based on the results obtained from the aqueous extracts two medicinal plants were selected for further activity. *Adina cordifolia* and *Cassia angustifolia* have been selected for further studies as they

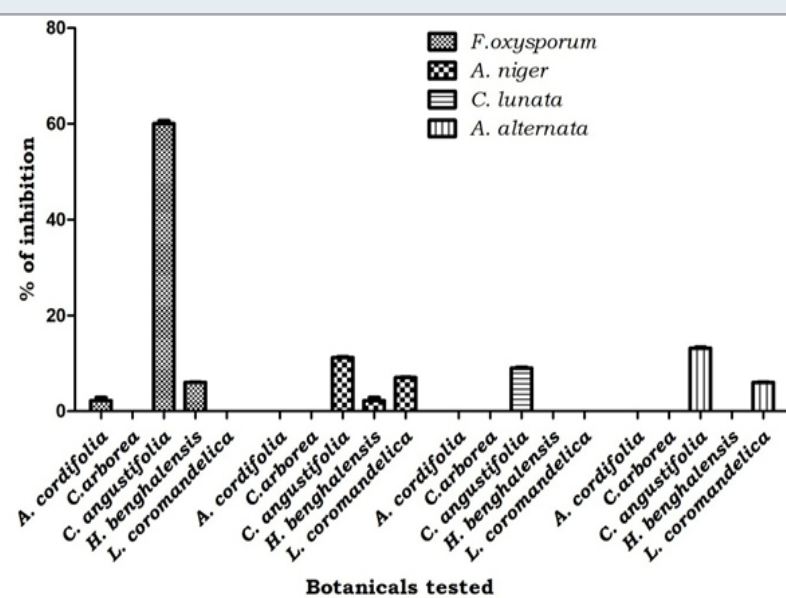
shown good activity against both bacteria and fungi as compared to others. These two plants were subjected to solvent extraction and the obtained extracts of solvents were examined for antibacterial activity. The results revealed that, both Petroleum ether and Chloroform of both plants shown no activity on all tested pathogenic bacteria. Ethyl acetate extract of *Adina cordifolia* effective only on *S. aureus* with inhibition zone of 15.31mm. Whereas ethanol extract of *Adina cordifolia* has shown inhibition of *S. aureus*, *B. Cereus* and *E. coli* with inhibition zone of 23.61 mm, 15.33 mm and 14.63 mm respectively. Ethyl acetate extract of *Cassia angustifolia* was effective on *S. aureus* and *E. coli* with inhibition

Table 2. Antifungal activity of aqueous plant extracts against fungi

Sl. No	Name of the plant	Parts used	Fusarium oxysporum	Percentage inhibition of Fungi		
				Aspergill usniger	Curvulari alunata	Alternaria alternata
1	<i>Adina cordifolia</i>	Leaves	2.22 ± 0.64	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
2	<i>Careyaarborea</i>	Leaves	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
3	<i>Cassia angustifolia</i>	Leaves	60.00 ± 0.60***	11.20 ± 0.15	09.00±0.14	13.16 ± 0.16*
4	<i>Hiptagebenghalensis</i>	Leaves	06 ± 0.11	2.22 ± 0.64	0.00 ± 0.0	0.00 ± 0.0
5	<i>Lanneacoromandelica</i>	Leaves	0.00 ± 0.0	07.00 ± 0.08	0.00 ± 0.0	0.00 ± 0.0

Note: Asterisk marks *, **, *** indicate significance of values at P 6 0.05 level according to ANOVA, Tukey'spost test.

Figure 2. Graphical representation of antifungal activity of aqueous extracts of plants



zone of 22.31 mm and 13.65 mm respectively while ethanol extract shown effective inhibition of pathogenic bacteria *B.cereus*, *B. subtilis*, *S. aureus*, *E. aerogenes*, *E. coli*, and *K. pneumonia* with inhibition zone of 15 mm, 21.63 mm, 24.66 mm, 18.32 mm, 22.62 mm, 17.67 mm respectively (Table 3, Fig. 3).

Antifungal activity of solvent extracts: Results of antifungal activity revealed that solvent extracts of *Cassia angustifolia* was more effective than

Adina cordifolia. Out of tested four solvent extractions ethyl acetate and ethanol extractions were effective against tested pathogens whereas petroleum ether and chloroform not shown any inhibition against any tested pathogens. Ethanol extract of *Cassia angustifolia* was more effective with inhibition zone of 14.33 mm (*Fusarium oxysporum*), 20.63 mm (*Aspergillusniger*), 22.93 mm (*Curvularialunata*) and 10.16 mm (*Alternaria alternata*) and ethyl acetate extract shown that 9.2 mm (*Fusarium oxysporum*), 15.43 mm

(*Aspergillusniger*), 17.53 mm (*Curvularialunata*) and 14.26 mm (*Alternaria alternata*). Ethanol extract of *Adina cordifolia* has shown inhibition zone of 8.9 mm (*Fusarium oxysporum*), 10.00 mm (*Aspergillusniger*) and 8.00 mm (*Curvularialunata*) whereas ethyl acetate extract of *Adina cordifolia*

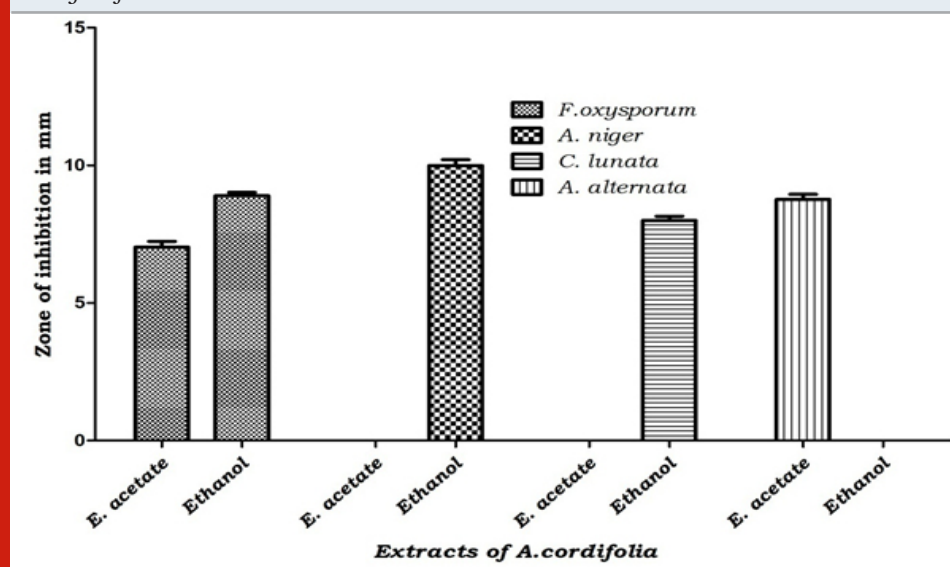
was effective only against *Fusarium oxysporum* and *Alternaria alternata* with inhibition zone of 7.03 mm and 8.76 mm respectively (Table 4, Fig. 4, 5). Natural products such as botanical extracts have bioactive principles which are produced as secondary metabolites; their main function is to

Table 3. Antibacterial activity of solvent plant extracts against bacteria

Sl. No	Name of the plant	Solvent extracts	Inhibition of Bacteria in mm				Gram negative Bacteria			
			Gram Positive Bacteria		Gram negative Bacteria		Gram negative Bacteria		Gram negative Bacteria	
			B. cereus	B. subtilis	S. aureus	S. pyogenes	E. aerogenes	E. coli	P. mirabilis	K. pneumonia
1	Adina cordifolia	Petroleumether	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
		Chloroform	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
		Ethyl acetat	0.00 ± 0.0	0.00 ± 0.0	15.31 ± 0.02**	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
		Ethanol	15.33 ± 0.02**	0.00 ± 0.0	23.61 ± 0.02**	0.00 ± 0.0	0.00 ± 0.0	14.63 ± 0.05**	0.00 ± 0.0	0.00 ± 0.0
2	Cassia angustifolia	Petroleumether	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
		Chloroform	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
		Ethyl acetate	0.00 ± 0.0	0.00 ± 0.0	22.31 ± 0.02**	0.00 ± 0.0	0.00 ± 0.0	13.65 ± 0.03*	0.00 ± 0.0	0.00 ± 0.0
		Ethanol	15 ± 0.17**	21.63 ± 0.05**	24.66 ± 0.06***	00.00	18.32 ± 0.03**	22.62 ± 0.06**	0.00 ± 0.0	17.67 ± 0.07**
3	Gentamycin		28.60 ± 0.11***	24.29 ± 0.09***	27.26 ± 0.07***	21.60 ± 0.11**	25.59 ± 0.08***	26.53 ± 0.06***	22.21 ± 0.09**	28.21 ± 0.10***

Note: Asterisk marks *, **, *** indicate significance of values at P 6 0.05 level according to ANOVA, Tukey'spost test.

Figure 3. Graphical representation of antibacterial activity of solvent extraction *C.angustifolia*



protect host plants from pathogenic microbial invaders which affect the health of the host plants. As science and research has progressed, the scientific community has found to be aware of antimicrobial activity of botanicals and started to explore active principles of secondary metabolites from the plants. As a result of this huge number of plants around the world found to have antimicrobial properties, (Bhawasar et al., 1965, Behl and Srivastava, 2002, Chopra and Chopra, 1969, Iyengar, 1981, Mehmood et al., 1997, Grainger Bisset, 2000, Radhakrishnan et al., 1976, Shah and Qadry, 1971, Zafar, 1994

and Dahanukar and Hazra, 2009). In the present investigation in vitro study was carried out to evaluate the aqueous and solvent extractions five medicinal plants against pathogenic bacteria and fungi. In aqueous extracts significant result was observed in *C. angustifolia*, it has inhibited *B. cereus* with 21.55 mm of inhibition zone followed by *B. subtilis* (19.47 mm), *E. coli* (16.32 mm), *S. aureus* (15.76 mm), another plant *A. cordifolia* has shown inhibition of *B. Cereus* (15.52 mm), *S. aureus* (10.49 mm) and *E. coli* (11.32 mm) and *L. coromandelica* was effective only against *B. subtilis* (11.65 mm). Whereas, *C. arborea* and

Table 4. Antifungal activity of solvent plant extracts against fungi

Sl. No	Name of the plant	Solvent extracts	Fusarium oxysporum	Percentage inhibition of Fungi		
				Aspergillusniger	Curvularialunata	Alternaria alternata
		Petroleumether	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
01	<i>Adina cordifolia</i>	Chloroform,	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
		Ethyl acetate	7.03 ± 0.20*	0.00 ± 0.0	0.00 ± 0.0	8.76 ± 0.18*
		Ethanol	8.9 ± 0.11*	10.00 ± 0.18*	08 ± 0.15*	0.00 ± 0.0
		Petroleumether	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
2	<i>Cassia angustifolia</i>	Chloroform,	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
		Ethyl acetate	9.2 ± 0.17*	15.43 ± 0.20**	17.53 ± 0.20**	14.26 ± 0.12**
		Ethanol	14.3 ± 0.20**	20.63 ± 0.17**	22.93 ± 0.14***	10.16 ± 0.17*

Note: Asterisk marks *, **, *** indicate significance of values at P 6 0.05 level according to ANOVA, Tukey'spost test.

Figure 4. Graphical representation of antifungal activity of solvent extraction *A. cordifolia*

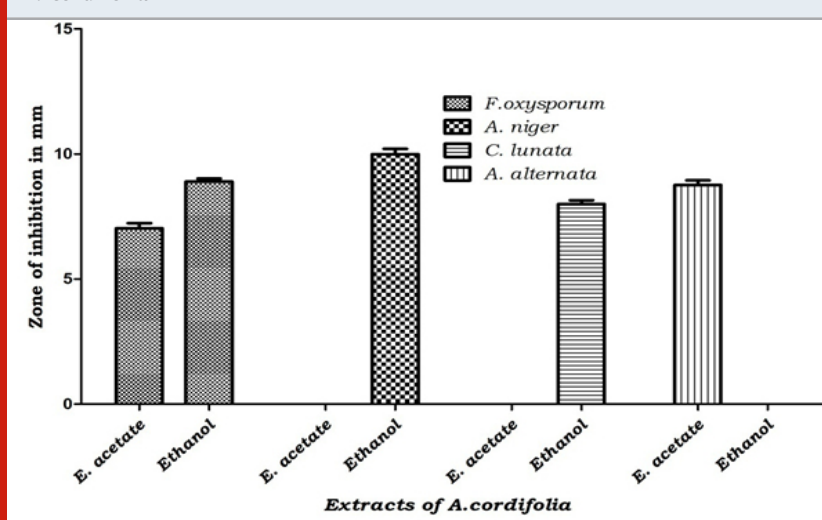
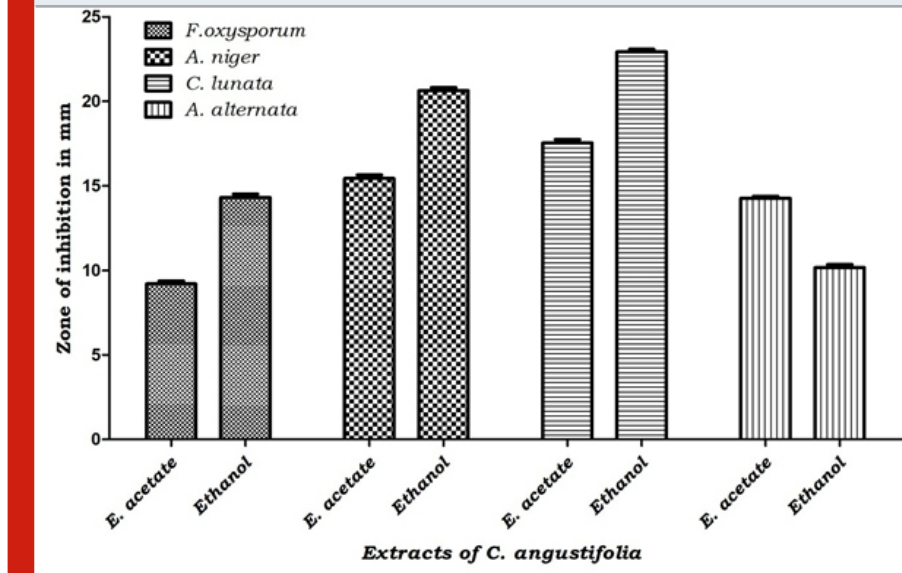


Figure 5. Graphical representation of antifungal activity of solvent extraction *C.angustifolia*



H. benghalensis not shown any activity against any bacteria. When aqueous extracts of plants tested against fungi only *C. angustifolia* shown effective results against *F. oxysporum* with inhibition percentage of 60%. Among solvent extracts ethyl acetate extraction of *A. cordifolia* was effective against *S. aureus* with inhibition zone of 15.31 mm and *C. angustifolia* against *S. aureus* and *E. coli*, with inhibition zone of 22.31 mm and 13.65 mm respectively. Ethanol extract of *A. cordifolia* was effective against *B. cereus*, *S. aureus* and *E. coli* with inhibition zone of 15.33 mm, 23.61 and 14.63 mm and *C. angustifolia* against *S. aureus* 24.66 mm. whereas against *A. niger*, *C. lunata* and *A. alternata* not shown much inhibition, inhibition percentage are 11.20 %, 9.00% and 13.16% respectively. Some of the earlier reports corroborates with antibacterial and antifungal activity of extracts of the botanicals (Chen and Dai, 2012, de Saravia and Gaylarde, 1998, Goussous et al., 2013).

Also, other studies also confirms the antimicrobial capability of *C. angustifolia* of various extracts against *S. mercenscens*, *A. junni*, *E. cloacae*, *Aspergillus niger*, *Aspergillus terreus*, *Aspergillus flavus*, and *Aspergillus fumigates*, (Al-Marzoqi et al., 2016, Ahmed et al., 2016). Based on the results of the aqueous extracts the plants which given significant results, two plants were selected for further solvent extraction, the results revealed

that only ethyl acetate and ethanol solvent extraction showed activity where as others not shown any activity on any tested pathogens either on bacteria or fungi. Ethyl acetate extraction of *A. cordifolia* was only effective against *S. aureus* with inhibition zone of 15.31 mm whereas ethyl acetate extraction of *C. angustifolia* was effective against *S. aureus* and *E. coli*, with inhibition zone of 22.31 mm and 13.65 mm. Ethanol extract of *A. cordifolia* was effective against *B. cereus*, *S. aureus* and *E. coli* with inhibition zone of 15.33 mm, 23.61 and 14.63 mm whereas ethanol extract of *C. angustifolia* was effective against maximum tested bacteria except *S. pyogenes* and *P. mirabilis* and shown maximum inhibition zone of 24.66 mm against *S. aureus* and 22.62 mm, 21.63 mm 18.32 mm, 17.67 mm and 15.00 mm against *E. coli*, *B. subtilis*, *E. aerogenes*, *K. pneumonia* and *B. cereus* respectively. There are earlier reports that solvent extracts of botanicals has antibacterial activity, (Abas et al., 2006,

Shan et al., 2007, Kang et al., 2011, Hosamath, 2011, Parveen and Shahzad, 2011). In the antifungal activity of solvent extraction against ethyl acetate and ethanol extractions shown activity whereas petroleum ether and chloroform not shown any activity against all tested phytopathogenic fungi. Ethyl acetate extraction of *A. cordifolia* shown inhibition of *F. oxysporum* and *A. alternata* with inhibition zone of 7.03 mm

and 8.76 mm whereas ethyl acetate extraction of *C. angustifolia* was effective against all the tested fungi with inhibition zone of 17.53 mm (*C. lunata*), 14.26 mm (*A. alternata*) and 9.2 mm (*F. oxysporum*). Ethanol extraction of both plants shown effective inhibition of the phytopathogenic fungi. Ethanol extraction of *A. cordifolia* was effective against *F. oxysporum* with inhibition zone of 8.9 mm, *A. niger* (10.00 mm) and *C. lunata* (8.00 mm). Ethanol extract of *C. angustifolia* has shown more effective than any other tested solvents with inhibition zone of 22.93 mm against *C. lunata*, *A. niger* (20.63 mm), *F. oxysporum* (14.3 mm) and *A. alternata* (10.16 mm). The present investigation came out with medicinal plant *C. angustifolia* which was effective against both tested bacteria and fungi in both aqueous extracts and solvent extractions. There were many reports of medicinal values of *C. angustifolia* from various researchers. The plant has been in use as traditional medicine, (Wu et al., 2009), the plant is also used in the treatment of amoebic dysentery, typhoid, cholera, anemia (Siddique et al., 2010b, Wu et al., 2009, Parveen and Shahzad, 2011).

CONCLUSION

The study confirms the antimicrobial potential of leaf extracts of *Adina cordifolia*, *Careya arborea*, *Cassia angustifolia*, *Hiptage benghalensis* and *Lannea coromandelica* and thereby confirms their traditional medicinal use. Bioprospection of ethnomedicinal plants paves a way for the identification of natural and novel drugs. Further identification and characterization of biologically active principles needs to be done which may lead to the discovery of potent antimicrobial agents.

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Authors' Contribution: Kh. Tahamtan and M.S Sharada developed ideas and drafted

the manuscript. Dr.M.S Sharada provided the required facilities. Kh. Tahamtan conducted the experiments. Kh. Tahamtan and Dr. M.S Sharad had contributed to the design and analysis of data. Authors contributed to revise the manuscript and approved the final version for publication.

REFERENCES

- Abas, F., Lajis, N. H., Israf, D., Khozirah, S. & Kalsom, Y. U. 2006. Antioxidant And Nitric Oxide Inhibition Activities Of Selected Malay Traditional Vegetables. *Food Chemistry*, 95, 566-573.
- Adebajo, A., Adewumi, C. & Esseini, E. Anti-Infective Agents Of Higher Plants. *International Symposium Of Medicinal Plants*. 5th Ed. University Of Ife, Nigeria, 1983. 152-158.
- Ahmad, I., Mehmood, Z. & Mohammad, F. 1998. Screening Of Some Indian Medicinal Plants For Their Antimicrobial Properties. *Journal Of Ethnopharmacology*, 62, 183-193.
- Ahmed, S. I., Hayat, M. Q., Tahir, M., Mansoor, Q., Ismail, M., Keck, K. & Bates, R. B. 2016. Pharmacologically Active Flavonoids From The Anticancer, Antioxidant And Antimicrobial Extracts Of *Cassia angustifolia* Vahl. *Bmc Complementary And Alternative Medicine*, 16, 460.
- Al-Marzoqi, A. H., Hadi, M. Y. & Hameed, I. H. 2016. Determination Of Metabolites Products By *Cassia angustifolia* And Evaluate Antimicrobial Activity. *Journal Of Pharmacognosy And Phytotherapy*, 8, 25-48.
- Arya, R., Lehman, D., Hunt, K. J., Schneider, J., Almasy, L., Blangero, J., Stern, M. P. & Duggirala, R. Evidence For Bivariate Linkage Of Obesity And Hdl-C Levels In The Framingham Heart Study. *BMC Genetics*, 2003. Biomed Central, S52.
- Asolkar, L., Kakkar, K., Chakre, O., Chopra, R. N., Nayar, S. & Chopra, I. C. 1992. *Glossary Of Indian Medicinal Plants*, Publications & Information Directorate.
- Behl, P. N. & Srivastava, G. 2002. *Herbs Useful In Dermatological Therapy*, CBS Publishers & Distributors.
- Bhawasari, G., Guru, L. & Chadda, A. 1965. Antibacterial Activity Of Some Indigenous Medicinal Plants. *Medicine And Surgery*, 5, 11-14.

- Cartea, M., Francisco, M., Lema, M., Soengas, P. & Velasco, P. 2010. Resistance Of Cabbage (*Brassica oleracea Capitata* Group) Crops To Mamestra Brassicae. *Journal Of Economic Entomology*, 103, 1866-1874.
- Chen, Y. & Dai, G. 2012. Antifungal Activity Of Plant Extracts Against *Colletotrichum lagenarium*, The Causal Agent Of Anthracnose In Cucumber. *Journal Of The Science Of Food And Agriculture*, 92, 1937-1943.
- Chopra, R. N. & Chopra, R. N. 1969. Supplement To Glossary Of Indian Medicinal Plants.
- Costa, R. M., Magalhães, A. S., Pereira, J. A., Andrade, P. B., Valentão, P., Carvalho, M. & Silva, B. M. 2009. Evaluation Of Free Radical-Scavenging And Antihemolytic Activities Of Quince (*Cydonia oblonga*) Leaf: A Comparative Study With Green Tea (*Camellia sinensis*). *Food And Chemical Toxicology*, 47, 860-865.
- Dahanukar, S. & Hazra, A. 2009. Heal With Herbs.
- De Saravia, S. G. G. & Gaylarde, C. C. 1998. The Antimicrobial Activity Of An Aqueous Extract Of *Brassica Negra*. *International Biodeterioration & Biodegradation*, 41, 145-148.
- Farnsworth, N. 1973. Importance Of Secondary Plant Constituents As Drugs. Miller, Lawrence Peter. *Phytochemistry*.
- Farnsworth, N. R. & Soejarto, D. D. 1985. Potential Consequence Of Plant Extinction In The United States On The Current And Future Availability Of Prescription Drugs. *Economic Botany*, 39, 231-240.
- Gaudilliere, J.-P. 2019. From Crisis To Reformulation: Innovation In The Global Drug Industry And The Alternative Modernization Of Indian Ayurveda. *Innovation Beyond Technology*. Springer.
- Goussous, S., Mas' Ad, I., Abu El-Samen, F. & Tahhan, R. 2013. In Vitro Inhibitory Effects Of Rosemary And Sage Extracts On Mycelial Growth And Sclerotial Formation And Germination Of *Sclerotinia sclerotiorum*. *Archives Of Phytopathology And Plant Protection*, 46, 890-902.
- Grainger Bisset, N. 2000. *Max Wichtl Herbal Drugs And Phytopharmaceuticals*. Boca Raton: Crc Press.
- Hosamath, P. 2011. Evaluation Of Antimicrobial Activity Of *Litsea glutinosa*. *Int J Pharm Appl*, 2, 105-114.
- Ibrahim, M. 1997. Anti-Microbial Effects Of Extract Leaf, Stem And Root Bark Of *Anogeissus leiocarpus* On *Staphylococcus aureus*, *Streptococcus pyogenes*, *Escherichia coli* And *Proteus vulgaris*. *J. Pharma. Devpt*, 2, 20-30.
- Iyengar, M. A. 1981. Study Of Crude Drugs, Manipal College Of Pharmaceutical Sciences.
- Jamshiya, S. 2017. Formulation And Evaluation Of Herbal Skin Cream For Wound Healing. Rvs College Of Pharmaceutical Sciences, Coimbatore.
- Kang, C.-G., Hah, D.-S., Kim, C.-H., Kim, Y.-H., Kim, E. & Kim, J.-S. 2011. Evaluation Of Antimicrobial Activity Of The Methanol Extracts From 8 Traditional Medicinal Plants. *Toxicological Research*, 27, 31.
- Lopez, A., Hudson, J. & Towers, G. 2001. Antiviral And Antimicrobial Activities Of Colombian Medicinal Plants. *Journal Of Ethnopharmacology*, 77, 189-196.
- Mehmood, Z., Ahmad, S. & Mohammad, F. 1997. Antifungal Activity Of Some Essential Oils And Their Major Constituents. *Indian Journal Of Natural Products*, 13, 10-13.
- Nagavani, V. & Rao, T. R. 2010. Evaluation Of Antioxidant Potential And Qualitative Analysis Of Major Polyphenols By Rp-Hplc In *Nymphaea nouchali* Burm Flowers. *International Journal Of Pharmacy And Pharmaceutical Sciences*, 2, 98-104.
- Parveen, S. & Shahzad, A. 2011. A Micropropagation Protocol For *Cassia angustifolia* Vahl. From Root Explants. *Acta Physiologiae Plantarum*, 33, 789-796.
- Philip, K., Malek, S. N., Sani, W., Shin, S. K., Kumar, S., Lai, H. S., Serm, L. G. & Rahman, S. N. 2009. Antimicrobial Activity Of Some Medicinal Plants From Malaysia. *American Journal Of Applied Sciences*, 6, 1613.
- Radhakrishnan, N., Hamsveni, R., Uma, R. & Thyagarajan, R. 1976. Antifungal Activity Of Medicinal Plants. *J. Res. Ind. Med. Yoga And Homoeopathy*, 11, 70-74.
- Rastogi, R. P., Mehrotra, B., Sinha, S., Pant, P. & Seth, R. 1990. *Compendium Of Indian Medicinal Plants: 1985-1989*, Central Drug Research Institute And Publications & Information Directorate
- Shah, C. & Qadry, J. 1971. *A Textbook Of*

- Pharmacognosy, Messrs BS Shah.
- Shan, B., Cai, Y.-Z., Brooks, J. D. & Corke, H. 2007. The In Vitro Antibacterial Activity Of Dietary Spice And Medicinal Herb Extracts. *International Journal Of Food Microbiology*, 117, 112-119.
- Sharma, R., Singh, B. & Singh, D. 2009. Ethnomedicinal, Pharmacological Properties And Chemistry Of Some Medicinal Plants Of Boraginaceae In India. *Journal Of Medicinal Plants Research*, 3, 1153-1175.
- Siddique, A., Nair, G., Alam, M., Sack, D. A., Huq, A., Nizam, A., Longini, I., Qadri, F., Faruque, S. & Colwell, R. 2010a. El Tor Cholera With Severe Disease: A New Threat To Asia And Beyond. *Epidemiology & Infection*, 138, 347-352.
- Siddique, I., Anis, M. & Aref, I. 2010b. In Vitro Adventitious Shoot Regeneration Via Indirect Organogenesis From Petiole Explants Of *Cassia angustifolia* Vahl.—A Potential Medicinal Plant. *Applied Biochemistry And Biotechnology*, 162, 2067-2074.
- Sofowora, A., Ogunbodede, E. & Onayade, A. 2013. The Role And Place Of Medicinal Plants In The Strategies For Disease Prevention. *African Journal Of Traditional, Complementary And Alternative Medicines*, 10, 210-229.
- Wu, Q. P., Wang, Z. J., Tang, L. Y., Fu, M. H. & He, Y. 2009. A New Flavonoid Glucoside From *Cassia angustifolia*. *Chinese Chemical Letters*, 20, 320-321.
- Zafar, R. 1994. *Medicinal Plants Of India*, CBS Publishers & Distributors.