Research Article

Antimicrobial Activity of Medicinal Oil Plants against Human Pathogens from Hyderabad Karnataka Region

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ABSTRACT

Plant essential oils are potential source of antimicrobials of natural origin. Oil extracted from twenty nine medicinal plants were screened for their antimicrobial activity against human pathogenic bacteria and fungi causing skin diseases. The antimicrobial activity of 29 oils were investigated against *Escherichia coli, Trichophyton rubrum* and *Candida albicans* by agar well diffusion method, Minimum inhibitory concentrations (MICs) of oil (%v/v) done by agar well diffusion method. Most of the essential oils showed a relatively high antimicrobial activity against all the tested organisms. Of the essential oils studied, The maximum antimicrobial activity was shown by *Calotropis gigantae* followed by *Semecarpus anacardium, Azadirachta indica, Datura stramonium, Coriandrum sativum, Luffa acutangula, Momordica cymbalaria, Gliricidia sepium, Hyptis sauveolens and Ocimum sanctum* are more inhibitory activity against tested bacteria and fungi. *C. gigantae* showed good antimicrobial activity against tested bacteria and fungi with MIC values ranging from 0.62 to 40 mg/mL using inhibitory zone estimation. The effects of the plant extract were compared with those of Ketoconazole for fungi and Streptomycin sulphate for bacteria. The results obtained suggest that *C. gigantae* has antimicrobial activity. These results support the plant oils can be used to cure skin diseases and plant oils may have role as pharmaceutical and preservatives.

Keywords: Medicinal plants, Antimicrobial activity, Essential oils, Skin diseases.

INTRODUCTION

Since the ancient times aromatic plants had been used for their preservatives and medicinal properties. The pharmaceutical properties of aromatic plants are partially recognized to essential oils[1]. Essential oils are complex mixtures of volatile secondary metabolites that mainly consist of mono- and sesquiterpenes including carbohydrates, alcohols, ethers, aldehydes, and ketones and are responsible for both the fragrant and biological effects of aromatic medicinal plants [2-6]. An important characteristic of essential oils and their constituents is their hydrophobicity, which enables them to partition in the lipids of bacterial cell membranes and mitochondria, thus disturbing the structures and rendering them more permeable[7,8]. A number of aromatic medicinal plants used for treating infectious diseases have been mentioned in different phytotherapy manuals due to their availability, fewer side effects, and reduced toxicity. Despite of tremendous progress in human medicines, infectious diseases caused by bacteria, fungi, viruses and parasites are still a major threat to public health[9]. Infectious diseases accounts for high proportion of health problems in the developing countries including India. Microorganisms have developed resistance to many antibiotics and as a result, immense clinical problem in the treatment of infectious diseases has been created[10]. Direct infection of the skin occurs by invasion of the epidermis, usually after damage to the skin, and infection may affect any anatomical layer. Microbial disease of the skin may also occur by haematogenous spread of bacteria[11]. Bacterial infections that cause a number of diseases depending on where the bacteria gains entry into the body. Gram negative bacteria *Escherichia coli* is one of the most common species of bacteria that leads to disease in humans. *E.coli* strains may cause various infections, including infections of the skin wounds[12-14]. *E. coli* was found to be the causative agent of cellulitis localized to lower or upper limbs[15-17]. Cellulitis is an acute spreading infection of the skin, extending more deeply than erysipelas to reach subcutaneous tissues. Although most cases of cellulitis are caused by group A *Streptococci*, a number of other microorganisms may be responsible for this disease, including other *Bhaemolytic streptococci, Staphylococcus aureus, Haemophilus influenzae* in children, *Capnocytophaga canimorsus*, following a dog or cat bite, and *Pseudomonas aeruginosa*[18]. Cellulitis due to *E. coli* is rare and less documented[19].

Human infections, particularly those involving the skin and mucosal surface constitute a serious problem, especially in tropical and subtropical developing countries; dermatophytes and *Candida* spp. being the most frequent pathogen. The cutaneous mycoses are superficial fungal infections of the skin, hair or nails. Essentially no living tissue is invaded, however a variety of pathological changes occur in the host because of the presence of the infectious agent and/or its metabolic products. The principle a etiological agents are dermatophytic moulds belonging to the genera *Microsporum, Trichophyton* and *Epidermophyton* which cause ringworm or tinea of the scalp, glabrous skin and nails.

Among dermatophytes, the species *Trichophyton rubrum* i s of particular clinical interest for man because is the mos t common agent of human dermatophytoses[20]. A few studies have suggested a potential therapeutic effect against infections due to *Trichophyton rubrum,* a human dermatophytic filamentous fungus[21] and *Candida albicans* and related species, causing candidiasis of skin, which resides as commensal in the mucocutaneous cavities of skin, vagina and intestine of humans[22], can cause infections under altered physiological and pathological conditions such as infancy, pregnancy, diabetes, prolonged broad spectrum antibiotic administration, steroidal chemotherapy as well as AIDS[23–29]. The usual approach to the management of cutaneous infections is to treat with topical agents. Nevertheless, very little information is available on its comparative antifungal activity on the growth and physiology of human pathogenic yeasts or filamentous fungi either in vitro or in vivo. Furthermore, its direct therapeutic use either in superficial or systemic infections due to bacteria or fungi has not been clearly established.

Therefore our aim was to study the antimicrobial properties of some selected oils against a diverse range of organisms comprising Gram-negative bacteria (*E.coli*), dermatophytic fungi (*Trichophyton rubrum*) and a yeast (*Candida albicans*). The purpose of this was to create directly comparable, quantitative, antimicrobial data and to generate data for oils for which little data exist.

MATERIALS AND METHODS

Collection and Extraction of plant material

For the present investigation 29 oil yielding medicinal plants parts was selected, growing around Gulbarga University, Gulbarga, Karnataka, India, were collected. The voucher specimens of all the species bearing numbers listed [Table 1] and deposited in herbarium of Gulbarga University, Gulbarga. The collected plant materials were initially rinsed with distilled water to remove soil and other contaminants and dried on paper towel in laboratory at 37°C for week. The dried seeds, leaves, flowers, kernals and fruit were ground to semi-powdered state and about 250g powdered plant part were extracted successively with non-polar to polar method i.e., hexane, petroleum-ether, chloroform, ethyl acetate, methanol (98% methanol) and aqueous in soxhlet extractor for 48h. The fractions obtained were combined into calibrated flasks, evaporated to dryness and weighted in order to determine the extraction's efficiency. The oils were solubilised in DMF (Dimethyl formamide) to a final concentration 5 mg/ml. The oils were stored in a sealed glass vial (bijoux bottle) in a refrigerator at 4 ^{0}C until required. These all oils of above plants were screened for their antimicrobial activity.

Table 1: Oils of Indian medicinal plants including the botanical name, common name, family and plant part use

Botanical name and HGUG voucher number	Common name	Family	Plant part used
1. *Celosia argentea* (8)	Cockscomb	Amaranthaceae	Seeds
2. *Mangifera indica* (15)	Mango	Anacardiaceae	Fruit peel
3. *Mangifera indica* (15)	Mango	Anacardiaceae	Seeds
4. *Semecarpus anacardium* (33)	Bilava	Anacardiaceae	Fruits
5. *Annona squamosa* (19)	Custard apple	Annonaceae	Seeds
6. *Coriandrum sativum* (22)	coriander	Apiaceae	Seeds
7. *Calotropis gigantea* (47)	Gaint milkweed	Asclepiadaceae	Seeds
8. *Cucurbita pepo* (NK)	pumpkin	Cucurbitaceae	Seeds
9. *Luffa acutangula* (NK)	ridged luffa	Cucurbitaceae	Seeds
10. *Luffa cylindrica* (NK)	sponge gourd	Cucurbitaceae	Seeds
11. *Momordica cymbalaria* (809)	bitter gourd	Cucurbitaceae	Seeds
12. *Jatropha curcus* (1295)	physic nut	Euphorbiaceae	Seeds
13. *Caesalpinia bonduc* (208)	bonduc nut	Fabaceae	Seeds
14. *Gliricidia sepium* (494)	gliricidia	Fabaceae	Seeds
15. *Tamarindus indica* (224)	Imli	Fabaceae	Kernals
16. *Mentha piperita* (NK)	Mint	Labiatae	Leaves
17. *Hyptis sauveolens* (536)	Mint weed	Lamiaceae	Seeds
18. *Ocimum scantum* (535)	Basil	Lamiaceae	Seeds
19. *Lawsonia inermis* (554)	Henna	Lythraceae	Seeds
20. *Hibiscus cannabinus* (NK)	Deccan hemp	Malvaceae	Seeds
21. *Azadirachta indica* (576)	Neem	Meliaceae	Seeds
22. *Eucalyptus globulus* (594)	Blue gum	Myrtaceae	Leaves
23. *Jasminum roxburgianum* (605)	Jasmine	Oleaceae	Flowers
24. *Sapindus laurifolia* (721)	Soapnuts	Sapindaceae	Seeds
25. *Datura stramonium* (738)	Thorn apple	Solanaceae	Seeds
26. *Solanum melongena* (NK)	Brinjal	Solanaceae	Seeds
27.*Withania somnifera* (734)	Winter cherry	Solanaceae	Seeds
28. *Duranta repens* (770)	Pigeon berry	Verbenaceae	Seeds
29. *Lantana indica* (253)	Wild sage	Verbenaceae	Leaves

HGUG Herbarium Gulbarga University Gulbarga; NK- not known.

Test Organisms

The isolate of *Escherichia coli*, *Trichophyton rubrum* and *Candida albicans* used for the present study were obtained from Microbiology Department, Gulbarga University, Gulbarga. Karnataka, India, The fungal cultures were maintained on Sabouraud Dextrose Agar (SDA) medium supplemented with Chloramphenicol (50 mg/ml) and Streptomycin sulfate (500 mg/ml) and sub cultured on Potato Dextrose Agar (PDA) every 15 days to prevent pleomorphic transformations. Bacterial cultures were grown in nutrient broth (Himedia, M002) at 37^{o}C and maintained on nutrient agar slants at 4^{o}C.

In vitro antimicrobial assay by agar well diffusion method

Oils were screened for their antimicrobial activity against tested organisms by agar well diffusion method. Fungal lawn was prepared using 5 days old culture strain. The fungal strains were suspended in a saline solution (0.85% NaCl) and adjusted to a turbidity of 0.5 Mac Farland standards (108 CFU/ml) and used for antimicrobial assay tests. Inocula(1ml) was spread over the potato dextrose agar medium using a sterilized glass spreader. Using flamed sterile borer, wells of 4 mm diameter were punctured in the culture medium. About 20 µl of 5 mg/ml of solubilised oils were added to the wells. The plates thus prepared were left for diffusion of extracts into media for one hour in the refrigerator. The test was performed in triplicate. These plates were incubated for 48 h at 28^{0}C. After incubation for 48h, the diameter zone of inhibition was measured and expressed in millimetres. DMF was used as a negative control. Standard antibiotics Ketoconazole were used in order to control the sensitivity of the tested fungi. Ketoconazole used as positive control (1000µg/ml) because Ketoconazole is an imidazole fungicidal agent with a very broad spectrum of activity against many fungal species that is used for treatment of superficial and systemic fungal infections. The zones of different oil were measured.

The same method was followed for testing antibacterial activity using nutrient agar medium incubated at 37^{0}C for 18h. Streptomycin sulphate used as positive control for bacteria.

Minimum Inhibitory Concentration (MIC)

The minimum inhibition concentration MICs were determined as the lowest concentration of oil inhibiting the visible growth of each organism on the agar plate. The MIC values were determined by agar well diffusion method. Fungal and bacterial lawn prepared were suspended in a saline solution (0.85% NaCl) and adjusted to a turbidity of 0.5 Mac Farland standards (108 CFU/ml) and required concentrations of serially diluted *C. gigantae* seed oil (0.6, 1.2, 2.5, 5, 10, 20 and 40mg/ml) were added to the wells. The least concentration of each oils showing a clear of inhibition was taken as the MIC.

Statistical analysis

Each experiment has three replicates and three determinations were conducted. Means and standard deviation were recorded.

RESULTS AND DISCUSSION

The antimicrobial activity of 29 plants oil obtained by the agar well diffusion method is shown in Table 2. All the oils tested exhibited different degrees of antimicrobial activity against tested strains. The essential oils from the different plant species studied showed activities, with the diameters of inhibition zone ranging from 4.83± 0.28mm to 16.16± 0.28 mm. Plants showed significant differences in the antimicrobial activities of extracts. Among the plants tested, the essential oil of *C. gigantae* showed the best antimicrobial activity of all extracts [Table 2] followed by *S. anacardium , A. indica, D. stromium, C. sativum, L. acutangula, M. cymbalaria, G. sepium, H. sauveolens and O. sanctum*. The oils of *L. cylindrical*, *J. curcas, M. spicata,* and *E. globules* exhibited moderate activity and the oils of *C. argentia, M. indica, A. squamosa, C. pepo, C. bonduc, T. indica, L. inermis, H. cannabinus, J. roxburgianum, S. mukrorie, S. molangianum, W. somnifera, D. repens and L. indica* showed comparatively low activity against tested strains. Subsequent experiment were conducted to determine minimum inhibitory concentration (MIC) of *C. gigantae* essential oil [Table 3].

Gram-negative bacteria *E.coli* appear to be least sensitive to the action of many other plants essential oils. By comparison, it was found to have more potent activity in antifungal than antibacterial action. The response of dermatophyte to treatment with various plants extracts varied, it was shown to be dose dependent as greater inhibition of growth was observed as the concentrations of the extracts increased[30, 31]. Hence, search for new, cheaper antimycotics from natural sources is an urgent need. The data obtained in the present investigation proves the antimicrobial activity of *C. gigantae* seed oil with varying MIC. The present findings demonstrated that various solvent extracts of *S. anacardium, A. indica, D. stromium, C. sativum, L. acutangula, M. cymbalaria, G. sepium H. sauveolens* and *O. sanctum* have concentration dependent activity against all the tested organisms, this might be due to the difference in the concentration of the phytocompounds of various secondary metabolites present in the extract as well as the extracting ability of the solvents. It was also observed that some solvent extracts (hexane, pet. ether, chloroform, ethyl acetate, methanol and aqueous) of few plants (*C. argentia, M. indica, A. squamosa, S. molangianum* and *W. somnifera*) could not inhibit completely or even 50% growth of the tested organisms. This could suggest that probably certain phytochemicals exhibit their antimicrobial action only with other phyto-constituents. After this experiment, further work should be performed to describe the antimicrobial activities in more detail as

well as their activity *in-vivo*. In addition, phytochemical studies will be necessary to isolate the active constituents and evaluate the activities against a wide range of microbial population.

Table 2: Antimicrobial activity of 29 oils of medicinal plants

Sl. No	Botanical name and part used	Test organisms	Zone of Inhibition					
			1	2	3	4	5	6
1.	*Celosia argentea* (Seeds)	*E. coli*	10.33±0.28	10.16±0.28	9.83±0.28	8.33±0.28	10.66±0.28	9.33±0.28
		T. rubrum	8.66±0.28	8.66±0.28	8.16±0.28	7.33±0.28	8.33±0.28	7.33±0.28
		C. albican	9.16±0.28	8.33±0.28	8.66±0.28	8.16±0.28	9.66±0.28	8.33±0.57
2.	*Mangifera indica* (Fruit peel)	*E. coli*	8.16±0.28	7.33±0.28	6.66±0.28	NA	NA	NA
		T. rubrum	6.16±0.28	5.33±0.28	5.16±0.28	NA	NA	NA
		C. albican	7.16±0.28	6.16±0.28	5.5±0.5	NA	NA	NA
3.	*Mangifera indica* (Seeds)	*E. coli*	7.5±0.5	7.16±0.28	6.16±0.28	NA	NA	NA
		T. rubrum	5.83±0.28	5.16±0.28	4.83±0.28	NA	NA	NA
		C. albican	6.33±0.28	6.16±0.28	5.83±0.28	NA	NA	NA
4.	*Semecarpus anacardium* (Fruits)	*E. coli*	15.33±0.57	15.33±0.28	15.16±0.28	14.83±0.28	14.16±0.28	13.83±0.28
		T. rubrum	12.66±0.28	12.33±0.28	12.16±0.28	11.66±0.28	11.33±0.57	10.33±0.28
		C. albican	14.16±0.28	13.83±0.28	13.16±0.28	12.83±0.28	12.16±0.28	11.83±0.28
5.	*Annona squamosa* (Seeds)	*E. coli*	7.66±0.57	NA	NA	NA	8.33±0.28	8.33±0.28
		T. rubrum	5.16±0.28	NA	NA	NA	7.16±0.28	6.16±0.28
		C. albican	6.16±0.28	NA	NA	NA	7.66±0.28	6.83±0.28
6.	*Coriandrum sativum* (Seeds)	*E. coli*	14.66±1.15	13.16±0.28	12.66±0.57	12.16±0.28	14.16±0.28	14.66±0.28
		T. rubrum	11.16±0.28	9.66±0.28	9.33±0.57	8.5±0.5	10.16±0.28	10.66±0.57
		C. albican	13.66±0.76	11.83±0.28	11.66±0.57	10.66±0.57	13.16±0.28	13.66±0.57
7.	*Calotropis gigantea* (Seeds)	*E. coli*	15.33±0.57	15.0±0.5	14.33±0.57	16.16±0.28	13.83±0.28	12.33±0.57
		T. rubrum	12.16±0.28	11.16±0.28	10.16±0.76	13.0±0.0	9.83±0.28	8.66±0.57
		C. albican	14.16±0.28	13.5±0.5	13.33±0.57	14.83±0.28	13.16±0.28	12.16±0.28
8.	*Cucurbita pepo* (Seeds)	*E. coli*	9.33±0.57	7.16±0.28	10.16±0.28	6.16±0.28	9.33±0.57	NA
		T. rubrum	7.16±0.28	6.16±0.28	8.16±0.28	5.5±0.5	7.66±0.57	NA
		C. albican	7.83±0.28	7.33±0.57	9.16±0.28	6.83±0.57	8.33±0.57	NA
9.	*Luffa acutangula* (Seeds)	*E. coli*	14.33±0.57	14.16±0.28	13.0±0.0	10.33±0.57	12.16±0.28	8.5±0.5
		T. rubrum	11.33±0.57	10.33±0.57	9.5±0.5	8.16±0.28	8.33±0.57	7.16±0.28
		C. albican	13.16±0.28	12.83±0.28	11.83±0.28	10.16±0.28	10.66±0.57	9.0±0.0
10.	*Luffa cylindrica* (Seeds)	*E. coli*	12.16±0.28	10.83±0.28	9.66±0.57	9.16±0.28	7.66±0.57	6.66±0.57
		T. rubrum	9.83±0.28	8.66±0.57	7.66±0.57	6.83±0.28	5.66±0.57	4.83±0.28
		C. albican	11.16±0.28	10.0±0.0	8.83±0.28	8.33±0.57	6.66±0.28	6.16±0.28
11.	*Momordica cymbalaria* (Seeds)	*E. coli*	13.83±0.28	13.16±0.28	12.16±0.28	10.5±0.5	9.33±0.57	9.16±0.28
		T. rubrum	11.16±0.28	10.66±0.57	10.16±0.28	8.16±0.28	7.0±0.0	6.16±0.28
		C. albican	13.0±0.0	11.66±0.57	11.16±0.28	9.5±0.86	8.16±0.28	6.33±0.57
12.	*Jatropha curcus* (Seeds)	*E. coli*	12.16±0.28	11.16±0.28	10.16±0.28	9.16±0.28	8.0±0.0	6.66±0.57
		T. rubrum	9.66±0.28	9.33±0.57	8.5±0.5	7.33±0.57	6.16±0.28	4.66±0.57
		C. albican	11.0±0.0	9.83±0.28	8.83±0.28	8.33±0.57	7.16±0.28	5.66±0.57
13.	*Caesalpinia bonduc* (Seeds)	*E. coli*	6.66±0.57	8.66±0.28	NA	NA	7.16±0.28	8.16±0.28
		T. rubrum	4.83±0.28	6.66±0.28	NA	NA	5.16±0.28	5.83±0.28
		C. albican	5.83±0.28	7.33±0.28	NA	NA	6.16±0.28	6.66±0.57
14.	*Gliricidia sepium* (Flowers)	*E. coli*	13.33±0.28	12.16±0.28	10.66±0.57	8.16±0.28	7.16±0.28	8.66±0.57
		T. rubrum	11.0±0.5	10.33±0.57	8.66±0.28	7.0±0.0	5.83±0.28	7.66±0.57
		C. albican	12.66±0.28	11.16±0.28	9.83±0.57	7.66±0.28	6.33±0.57	8.5±0.5
15.	*Tamarindus indica* (Kernal)	*E. coli*	9.16±0.28	10.0±0.0	6.83±0.28	5.83±0.28	4.83±0.28	7.83±0.28
		T. rubrum	6.83±0.28	7.83±0.28	5.5±0.5	4.83±0.28	4.33±0.28	6.33±0.57
		C. albican	7.5±0.5	8.66±0.28	6.0±0.0	5.16±0.28	4.66±0.28	6.66±0.57

Table 2: Antifungal activity of 29 oils of medicinal plants (continue).

Sl. No	Botanical name and part used	Test organisms	Zone of Inhibition					
			1	2	3	4	5	6
16.	*Mentha piperita* (Leaf)	*E. coli*	11.83±0.28	10.83±0.28	9.66±0.57	8.83±0.28	7.83±0.28	6.66±0.57
		T. rubrum	9.5±0.0	8.66±0.57	7.66±0.57	6.66±0.57	5.66±0.57	4.83±0.28
		C. albican	10.66±0.28	10.16±0.28	9.16±0.28	7.66±0.57	6.83±0.28	5.83±0.76
17.	*Hyptis sauveolens* (Seeds)	*E. coli*	13.0±0.0	11.83±0.28	10.83±0.28	9.33±0.57	8.5±0.5	7.66±0.57
		T. rubrum	10.66±0.28	9.33±0.28	8.0±0.0	6.33±0.57	5.5±0.5	5.0±0.0
		C. albican	11.83±0.28	10.66±0.57	9.83±0.28	8.66±0.57	7.83±0.76	6.66±0.57
18.	*Ocimum scantum* (Seeds)	*E. coli*	12.83±0.28	11.66±0.57	9.66±1.15	9.33±0.57	8.66±0.28	7.33±0.57
		T. rubrum	10.0±0.0	8.83±0.28	7.66±0.57	6.83±0.76	5.66±0.57	4.83±0.76
		C. albican	11.66±0.28	10.5±0.5	10.33±0.57	8.66±0.57	7.83±0.28	6.33±0.57
19.	*Lawsonia inermis* (Seeds)	*E. coli*	7.83±0.28	11.16±0.28	6.66±0.57	5.83±0.28	8.83±0.28	10.16±0.28
		T. rubrum	7.0±0.0	9.16±0.28	5.66±0.57	5.0±0.0	7.83±0.28	8.16±0.28
		C. albican	7.5±0.5	10.0±0.0	6.5±0.5	5.66±0.57	7.83±0.28	8.66±0.57
20.	*Hibiscus cannabines* (Seeds)	*E. coli*	9.83±0.28	8.66±0.57	8.33±0.57	10.83±0.28	7.5±0.5	7.0±0.0
		T. rubrum	7.5±0.5	6.66±0.57	5.66±0.57	9.0±0.0	5.33±0.28	5.0±0.0
		C. albican	9.16±0.28	7.83±0.28	7.16±0.28	9.83±0.28	5.66±0.57	5.16±0.28
21.	*Azadirachta indica* (Seeds)	*E. coli*	15.0±0.0	14.16±0.28	12.16±0.28	14.0±0.0	14.5±0.5	13.66±0.28
		T. rubrum	12.16±0.28	11.33±0.28	6.66±1.15	7.66±1.15	8.66±1.15	10.66±0.57
		C. albican	13.66±0.28	12.83±0.28	8.83±0.28	9.83±0.28	11.16±0.28	12.16±0.28
22.	*Eucalyptus globulus* (Leaf)	*E. coli*	11.66±0.28	9.0±0.0	8.33±0.28	6.66±0.57	6.16±0.28	10.33±0.57
		T. rubrum	9.33±0.28	8.16±0.28	7.16±0.28	6.0±0.0	5.16±0.28	9.0±0.0
		C. albican	10.33±0.28	9.33±0.57	7.66±0.57	6.33±0.57	5.66±0.28	9.5±0.5
23.	*Jasminum roxburgianum* (Flowers)	*E. coli*	12.16±0.28	14.16±0.28	11.33±0.57	10.66±0.57	12.83±0.76	14.0±0.0
		T. rubrum	9.16±0.76	12.66±0.28	9.16±0.28	7.83±0.28	11.16±0.28	12.16±0.28
		C. albican	10.66±0.57	13.66±0.28	10.0±0.0	8.16±0.76	12.0±0.0	12.66±0.57
24.	*Sapindus laurifolia* (Seeds)	*E. coli*	7.66±0.28	6.66±0.57	6.0±0.0	NA	NA	NA
		T. rubrum	5,83±0.28	4.83±0.28	4.83±0.28	NA	NA	NA
		C. albican	6.33±0.28	5.33±0.57	4.83±0.28	NA	NA	NA
25.	*Datura stramonium* (Seeds)	*E. coli*	14.83±0.28	12.33±0.57	11.66±0.57	14.33±0.57	12.66±0.57	9.83±0.28
		T. rubrum	12.0±0.0	9.66±0.57	9.0±0.0	11.16±0.28	9.33±0.57	6.33±0.57
		C. albican	13.33±0.57	9.5±0.5	8.5±0.5	10.66±1.15	10.0±0.0	8.16±0.28
26.	*Solanum melongena* (Seeds)	*E. coli*	7.33±0.28	6.16±0.28	NA	NA	NA	5.33±0.57
		T. rubrum	5.66±0.28	5.0±0.0	NA	NA	NA	4.66±0.28
		C. albican	6.16±0.28	5.16±0.28	NA	NA	NA	4.83±0.28
27.	*Withania somnifera* (Fruits)	*E. coli*	7.16±0.28	6.33±0.28	NA	NA	NA	6.0±0.0
		T. rubrum	5.33±0.57	5.16±0.28	NA	NA	NA	4.66±0.28
		C. albican	5.83±0.28	5.33±0.57	NA	NA	NA	4.66±0.28
28	*Duranta repens* (Seeds)	*E. coli*	8.66±0.57	8.33±0.28	8.0±0.0	9.66±0.28	9.66±0.57	9.16±0.28
		T. rubrum	6.83±0.28	6.0±0.0	5.16±0.28	7.66±0.28	6.66±0.57	6.0±0.0
		C. albican	7.16±0.28	7.33±0.57	6.16±0.28	8.16±0.28	9.0±0.0	7.5±0.5
29	*Lantana indica* (Leaf)	*E. coli*	9.33±0.57	8.5±0.5	8.33±0.57	9.16±0.28	8.83±0.28	7.66±0.57
		T. rubrum	7.0±0.0	6.33±0.57	5.66±0.57	6.66±0.28	6.0±0.0	5.16±0.28
		C. albican	8.33±0.57	8.66±0.57	7.66±1.15	7.83±0.28	6.66±0.57	6.16±0.28
30	Positive control	Streptomycin sulphate (Bacteria) 30.0±0.0 Ketaconazole (Fungi) 24.0±0.0						
31	Negative control	DMF NA						

1. Hexane extract, 2. Petroleum ether extract, 3. Chloroform extract, 4. Ethyle acetate extract, 5. Methanol extract and 6. Aqueous extract; NA- No activity

Table 3: Minimum Inhibitory Concentration of *Calotropis gigantea* seeds oil.

Botanical name and part used	Family	Zone of Inhibition							
		Test organisms	40mg/ml	20mg/ml	10mg/ml	5mg/ml	2.5mg/ml	1.25mg/ml	0.62mg/ml
Calotropis gigantea (Seeds)	Asclepiadaceae	*E. coli*	15.16±0.28	14.0±0.0	13.66±0.28	17.33±0.57	13.0±0.0	10.16±0.28	9.0±0.0
		T. rubrum	10.0±0.0	8.16±0.28	9.83±0.28	13.0±0.0	10.66±0.28	7.66±0.28	7.0±0.0
		C. albican	11.83±0.28	10.83±0.28	13.0±0.0	12.83±0.28	12.0±0.0	9.83±0.28	8.0±0.0
Positive control	Streptomycin sulphate (Bacteria) 30.0±0.0 Ketaconazole (Fungi) 24.0±0.0								
Negative control	DMF NA								

NA- No activity

CONCLUSION

As all the plants investigated in the present work are common in India, the recovery of their compounds is high and thus, these species may be exploited as potent herbal chemotherapeutics for skin diseases. The present study concluded that the essential oil of these plants is a potential source of natural antimicrobial agents.

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REFERENCES

1. Mumtaz J, Mohiuddin KW, Fehmeeda K: Studies on antibacterial property of *Eucalyptus* – The Aromatic plant. International Journal of Pharmaceutical Sciences Review and Research, 7(2), 2011, 86-88.
2. Salzer UJ: The analysis of essential oils and extracts (oleoresins) from seasonings-a critical review. *CRC Crit. Rev. Food Sci. Nutr,* 9, 1977, 345-373.
3. Angioni A, Barra A, Arlorio M, Coisson JD, Russo MT, Pirisi FM, Satta M, Cabras P: Chemical composition, plant genetic differences, and antifungal activity of the essential oil of *Helichrysum italicum*G. Don ssp. microphyllum (Willd) Nym. *J. Agric Food Chem*. 51, 2003, 1030-1034.
4. Senatore F, Arnold NA, Piozzi F: Chemical composition of the essential oil of *Salvia multicaulis* Vahl. var. simplicifolia Boiss. growing wild in Lebanon. *J. Chromatogr. A,* 1052, 2004, 237-240.
5. Vandendool H, Kratz PD: A generalization of the retention index system including linear temperature programmed gas liquid partition chromatography. *J. Chromatogr,* 11, 1963, 463-471.
6. Kalemba D, Kunicka A: Antibacterial and antifungal properties of essential oils. *Curr. Med. Chem*, 10, 2003, 813-829.
7. Sikkema J, De Bont JA, Poolman B: Interactions of cyclic hydrocarbons with biological membranes. *J. Biol. Chem.* 269, 1994, 8022-8028.
8. Sikkema J, De Bont JA, Poolman B: Mechanisms of membrane toxicity of hydrocarbons. *Microbiol. Rev.* 59, 1995, 201-222.
9. Saini NK, Singha IM, Srivastava B, Sachdeva K, Singh C: Antimicrobial activity of Tecomaria carpensis leaves extract. International Journal of Pharmaceutical Sciences Review and Research, 7(1), 2011, 121-124.
10. Davies J. Inactivation of antibiotic and the dissemination of resistance genes. Sci., 264, 1994, 375-382.
11. Matthew SD. Complicated skin and soft tissue infection. Antimicrob Chemother, 65(3), 2010, 35-44.
12. Cooper RA. The contribution of microbial virulence to wound infection, In: White RJ, ed.The Silver Book. Dinton, Salisbury, UK: Quay Books, 2003.
13. Edwards R and Harding KG. Bacteria and wound healing, Current Opinion Infect Dis, 17(2), 2004, 91–96.
14. Wassilew SW. Infection of the skin with Gram-negative bacilli infections of the toe webs, Microbiology Abstracts Section Bacteriology, 25(3), 1990, 117.
15. Brzozowski D, Ross DC: Upper limb *Escherichia coli* cellulitis in the immunocompromised. J. Hand Surg, 22, 1997, 678–680.
16. Corredoira JM, Ariza J, Pallares R, Carratala J, Viladrich PF, Rufi G, Verdaguer R, Gudiol F: Gram-negative bacillary cellulitis in patients with hepatic cirrhosis. Eur. J. Clin. Microbiol. Infect. Dis, 13, 1994, 19–24.
17. Yoon TY, Jung SK, Chang SH: Cellulitis due to *Escherichia coli* in three immunocompromised subjects. Br. J. Dermatol, 139, 1998, 885–888.
18. Stevens DL, Bisno AL, Chambers HF, Everett ED, Dellinger P, Goldstein EJC, Gorbach SL, Hirschmann JV, Kaplan EL: Practice guidelines for the diagnosis and management of skin and soft-tissue infections. Clin Infect Dis, 41, 2005, 1373–1406.
19. Sunder S, Haguenoer E, Bouvet D, Lissandre S, Bree A, Perrotin D, Helloin E, Lanotte P, Schouler C, Guillon A: Life-threatening Escherichia coli cellulitis in patients with haematological malignancies. Journal of Medical Microbiology, 61, 2012, 1324–1327.
20. John WR, Saunders Company WB, Harcourt B, Jovanich inc: *The Pathogenic Fungi and the Pathogenic Actinomycetes, 3rd edition*, Philadelphia, 1988. 797.
21. Adam K, Sivropoulou A, Kokkini S, Lanaras T, Arsenakis M: Antifungal activities of *Origanum vulgare* subsp. *Hirusutum, Mentha spicata, Lavanula angustifolia*, and *Salvia fruticosa* essential oils against human pathogenic fungi. J Agricul Food Chem, 46, 1998, 1739–1745.
22. Kaufman HK: Opportunistic fungal infections: Superficial and systemic candidiasis. Geriatrics, 52, 1997, 50–54.

23. Friedman S, Richardson SE, Jacobs SE, O'Brien K: Systemic infection in extremely low birth weight infants: Short term morbidity and neuro developmental outcome. Ped Infect Disease J, 19, 2000, 499–504.

24. Young GL, Jewell D: Topical treatment for vaginal candidiasis in pregnancy. Cochrane Datab System Rev 2: CD000225, 2000.

25. Rippon JW: Candidiasis and the pathogenic yeasts. In: J.W. Rippon (ed), Med Mycol, PA, 1988, 532–581.

26. Kennedy WA, Laurier C, Gautrin D, Ghezzo H, Pare MJL, Contandriopoulos AP. Occurrence of bad risk factors of oral candidiasis treated with oral antifungals in seniors using inhaled steroids. J Clin Epidem, 53, 2000, 696–701.

27. Sallah S: Hepatosplenic candidiasis in patients with acute leukemia: Increasingly encountered complication. Anticancer Res, 19, 1999, 757–760.

28. Jagarlamudi R, Kumar L: Systemic fungal infections in cancer patients. Trop Gastroenterol 21, 2000, 3–8.

29. Mackenzie DWR, Cauwenberg G, Van Cutsem J, Drouhet E, Dupont B. Mycoses in AIDS patients: An overview. In: H. Vanden Bossche (ed), Mycoses in AIDS Patients. New York, Plenum Press, 1990, 27–33.

30. Bharati H, Vidyasagar GM. A Comparative study: Differential antimycosis activity of crude leaf extracts of Calotropis Spp. International Journal of Pharmacy and Pharmaceutical Sciences, 4 (3), 2012, 705-708.

31. Kashari O, Aliyu GM, Jamilu BD. The effects of neem oil (*Azadirachta indica* oil) on pathogens isolated from adult skin. International Journal of Engineering and Social Science, 3(3), 2013, 90-95.

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