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SCREENING OF TRADITIONALLY USED MEDICINAL PLANTS IN INDIA FOR POTENTIAL ANTIBACTERIAL, ANTIFUNGAL AND ANTIOXIDANT ACTIVITY

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ABSTRACT

The goal of the current study is to test a variety of herbs used in Indian folk medicine for their potential antibacterial, antifungal, and antioxidative properties. The study's objective was to identify an active plant extract that would be helpful in the development of new lead chemicals to treat fatal diseases **[1]**. Nine herbs, including *Emblica officinalis, Withania somnifera, Aegle marmelos, Bacopa monnieri, Tinospora cordifolia, Plantago ovate, Garcinia indica, Glycyrrhiza glabra,* and *Ocimum sanctum,* were chosen for preliminary screening for their antibacterial, antifungal, and anti-oxidant potentiality. Methanol extracts were more powerful than aqueous extracts, according to the results of the initial screening experiment. Gram-positive bacteria were more susceptible to the effects of the plant extracts than gram-negative bacteria. The bacterias *K. pneumoniae* and *E. coli* were the most sensitive and resistant, respectively. The antibacterial activity of *Bauhinia variegata* L. was astounding. In the modern world, fungi infections are a substantial cause of illness and mortality, particularly in people with impaired immune systems **[14]**. Aqueous and dichloromethane extracts of nine plants historically used to treat fungus infections. Results confirm the likelihood that commonly used plants could serve as a source of novel medications for the treatment of fungus diseases. In addition, the 2,2-diphenyl-1-picrylhydrazyl radical and linoleic acid peroxidation were tested against the antioxidant activity **[29]** and radical scavenging activity of methanolic extracts of specific plant materials historically utilized by Indians as folk treatments.

Keywords: antibacterial, antifungal, antioxidative, Methanol extracts, gram-positive bacteria, gram-negative bacteria, immune systems, linoleic acid peroxidation and folk treatments

INTRODUCTION

Plants have been utilized as medications and treatments for a variety of ailments for ages. New antimicrobial chemicals have been sought for from a variety of sources, including soil, microbes, animals, and plants. Folk remedies are one such resource, and systematically screening them may lead to the identification of brand-new, powerful molecules **[2]**. The goal of interest in recent years has been to improve the efficacy, safety, and affordability of antibacterial medication therapy. Several plant extracts have been reported to have antibacterial action in many investigations. In light of the aforementioned factors, an effort has been made to screen many herbs utilized in Indian folk medicine for preliminary antibacterial activity. For further investigation, the most potent plant extract was chosen. The study's objective was to identify an active plant extract that would be helpful in the development of new lead chemicals to treat fatal diseases **[3]**.

Invasive fungal infections have gained popularity as a leading global source of morbidity and mortality during the past 20 years. Fungal infections, particularly Candida infections, are exceedingly prevalent and significantly increase patient morbidity in India. Fungal infections frequently require extensive chemotherapy, are persistent, and pose special hazards to those with impaired immune systems **[15]**. *Candida albicans, Aspergillus species*, and *Cryptococcus neoformans* are the most common fungi that cause fungal infections, but the advent of new fungi is broadening the range of the illness. The majority of common fungal infections are typically challenging to treat with topical medications and may necessitate long-term systemic medication use. There is still no effective treatment for several fungal infections, and nearly all synthetic anti-fungals are linked to substantial side effects **[16]**.

Hence, the advent of resistant fungal strains and adverse effects linked to the majority conventional antifungal medications, such as polyenes (amphotericin B) and the azoles, have hindered effective therapy of fungal infections (itraconazole and fluconazole). There is a propensity for the pathogen to shift in some circumstances, particularly for Candida, from more sensitive species like *C. albicans* to less sensitive species like *C. glabrata* and *C. krusei*, which reduces the number of readily available, efficient antifungal medicines. Antifungal medications are also too expensive for the bulk of the population in underdeveloped nations like India, where resources are few **[17]**.

New antifungal treatments must be developed due to the challenges involved in treating fungus infections. The bulk of India's rural people had no choice but to treat their infections with locally accessible plant treatments. Plants that are frequently used in Indian traditional medicine could be a source of new, secure medications for the treatment of fungi. Determining the antifungal activity of various plants used in Indian traditional medicine to treat fungus infections was the purpose of the current investigation **[18]**.

A number of chronic and degenerative diseases, such as atherosclerosis, ischemic heart disease, ageing, diabetes mellitus, cancer, immune-suppression, neurological diseases, and others have been linked to oxidative stress as one of the main initiating causes. Antioxidants are the most efficient means of eradicating the free radicals responsible for oxidative stress. Exogenous and endogenous antioxidants, synthetic or natural, can scavenge free radicals or promote their decomposition and decrease such illnesses, preventing the production of new ones **[30]**. The use of herbal resources' natural antioxidants is currently gaining popularity. The hypothesis that plant elements with antioxidant activity are capable of exerting protective effects against oxidative stress in biological systems was substantially supported by epidemiological and in vitro investigations on medicinal plants and vegetables **[31]**.

We looked at 9 plant extracts as part of our ongoing screening effort to look for antioxidant potential in common Iranian medicinal herbs. In this paper, the antioxidant and radical-scavenging properties of various plant extracts against linoleic acid peroxidation and 2, 2-diphenyl-1-picrylhydrazyl (DPPH) were examined. Trolox and quercetin were utilised as antioxidant reference chemicals **[32]**.

METHODS AND METHODOLOGY

Collection and identification of plant materials

The practitioners were employed as tour guides for field trips to gather plant material during the same time as ethnobotanical surveys. Ethno-pharmacological surveys served as the foundation for the collection of plant materials **[4]**. The material was gathered in the form of powdered and dried components, which were then sealed in bottles. Plant materials were divided into little pieces and allowed to air dry for ten days at room temperature while being shaded. The dried plant materials were then ground in a grinder. The crushed materials were divided into two portions, each weighing around 600 g. About 300 g of the material was extracted

using a maceration method in dichloromethane, while the other portion was extracted entirely with water. Using a rotary evaporator and a temperature below 40°C, the organic crude extracts were concentrated in vacuo. Using a freeze dryer, the aqueous extracts were lyophilized. The organic and aqueous extracts were both diluted in dimethyl-sulfoxide (DMSO) and stored in the refrigerator before use. The yield of extraction for organic crude extracts varied between 7.8 and 16.51 g, whereas that for aqueous extracts varied between 2.6 and 9.3 g **[33]**.

Anti-Bacterial Activity Analysis

Distilled water was used to extract 10 grammes of plant material over the course of 6 hours at a low heat. It was centrifuged at 5000 g for 5 minutes after being filtered through eight layers of muslin cloth at intervals of 2 hours. One-fifth of the original volume of the supernatant was concentrated. The extract was autoclaved and kept at 4°C for storage. This produced an aqueous extract of the plant material **[5]**. 10 g of plant material were extracted with 100 ml of methanol and left on a rotary shaker overnight to create a methanol extract. After filtering, the extract was centrifuged at 5000 g for five minutes. The filtrate was concentrated to one-fifth of its original volume and kept at 4°C. The test organisms comprised the gram-positive *Bacillus cereus* (ATCC11778), *Staphylococcus aureus* (ATCC25923), and gram-negative *Klebsiella pneumoniae* (NCIM 2719), *Escherichia coli* (ATCC25922), and *Pseudomonas pseudoalcaligenes* (ATCC17440). The bacteria were kept alive on nutrient agar slants at 4°C while being cultured in nutrient broth at 37°C **[6]**.

The aqueous and methanol extracts were examined for possible antibacterial activity using the agar disc diffusion method with a disc size of 7 mm (HiMedia) and the agar well diffusion method with a cup borer of size 8.5 mm, respectively. For the inoculation of the agar plates, overnight cultures of all the bacterial strains cultured in nutrient broth were adjusted to an inoculum size of 108 cells/ml **[7]**. The Mueller Hinton agar No. 2 medium was heated up, and an aliquot of inoculum (0.2 ml) was added (HiMedia). For both techniques, 0.1 ml of the aqueous and methanol extracts were added to the wells and discs. Controls included pure water and methanol. By counting the regions where bacterial growth was stopped after 24 hours of incubation at 37 degrees, antibacterial activity was determined. (The average of the three replicates was taken into account). The entire microbiological assay was run three times under rigorous aseptic conditions **[8]**. The

screening result is shown in the graph **(Figures 1 and 2)**. All of the details regarding the plants evaluated in this study are shown in **Table 1**. We looked for potential antibacterial activity in 24 extracts (aqueous and methanol) from 12 different plant species in 9 different families **(Figures 1 and 2)**.

Anti-Fungal Activity Analysis

Test microorganisms and preparation of the inoculum

The in vitro anti-fungal experiments utilised three different fungi: *Candida albicans* (ATCC 90028), *Cryptococcus neoformans* (ATCC 90112), and *Aspergillus niger* (AZN 8240). According to the manufacturer's instructions, malt extract broth (MEB) was produced, dispensed (10 mL) in sealed test tubes, autoclaved, and allowed to sit for an entire night.[19] Pure isolates of subcultured fungal colonies were then aseptically added to the broth and adjusted to a turbidity comparable to 0.5 McFarland standard with an approximate cell concentration of 1 106 CFU/mL. The inoculated soup was moved to an incubator that was shaken at 150 rpm orbital throughout the duration of the next day **[20]**.

Media preparation and antifungal activity tests

The in vitro antifungal activity of crude extracts was assessed using the Kirby-Bauer disc and agar well diffusion methods. Pure substances and semi-purified fractions were only examined using the agar well diffusion method. The manufacturer's recommendations were followed for making the malt extract agar. A sterile Drigalski spatula was used to spread 0.2 mL of the broth culture evenly on the agar surface before being added to the molten media **[21]**. Equidistant wells were created in the plates using a sterilised cork-borer for the agar well diffusion procedure. The plant extracts, semi-purified fractions, or pure chemicals, as well as their controls, were added to the wells in amounts of around 75 microliter. For the disc diffusion procedure, sterile 5 mm Whatman No. 1 filter paper discs were saturated with 75 L of the test crude extracts and controls, allowed to dry, and then placed on the top layer of the seeded agar plates. In both cases, the treatment plates were pre-incubated in a refrigerator at 4°C for 4-6 hours to allow the extracts and controls to diffuse into the agar while halting the development of the test microorganisms. They were then placed in an incubator for 24 hours at 30°C. The tests were conducted in pairs **[22]**.

Determination of minimum inhibitory concentration (MIC) and minimum fungicidal concentration (MFC)

The minimal inhibitory concentration (MIC) of crude extracts, semi-purified fractions, and pure substances was calculated using a broth microdilution technique. The test was conducted in sterile, 96-well microplates with flat bottoms. For crude extracts and semi-purified fractions, solutions of extracts and compounds were prepared in DMSO at concentrations between 50 and 0.4 g/mL, and for pure compounds and the positive control fluconazole, at concentrations between 0.5 and 0.0078 g/mL. Fluconazole was administered into columns 11 and 12, while serial dilutions of 100 L of the test extracts and compounds were dispensed in duplicate into columns 1–10 **[23]**. From rows A to G, serial dilutions were made vertically.

In row H, negative controls of inoculated and uninoculated broth were created. For each well containing the test medications, an inoculum of roughly 106 CFU/ mL (100 L) was added to create a volume of 200 L. Thereafter, 40 L of 0.2% iodonitrotetrazolium chloride was added, and the plates were incubated at 30 2°C for 24 hours. When the indicator changed from colourless to purple, indicating a lack of extract or chemical action, fungal growth was seen in the plates. When the indicator's colour remained clear, showing the extracts' or compounds' continued activity, the MIC end-point was recorded. To ascertain the fungicidal properties of the extracts, the contents of the microplate wells with no discernible fungal growth were grown onto malt extract agar plates. The plates were incubated for an additional 24-48 hours. The lowest concentration of the extract that did not result in any fungal growth on the solid agar medium was noted as the minimum fungicidal concentration **[24]**.

Anti-oxidant Activity Analysis

A technique was used to assess the antioxidant activity of plant extracts against the peroxidation of linoleic acid. Trolox and quercetin were employed as standards. Each extract was produced as a 0.002, 0.02, and 0.2 mg/ml dilution in methanol. For a typical experiment, 20 l of each dilution was combined with 20 l of ethanol containing 2 mg/ml linoleic acid and incubated at 80 °C for 60 min. After cooling the incubated samples in an ice bath, 200 l of 20 mM BHT, 200 l of 8% SDS, and 400 l of distilled water were added **[34]**. After combining, 3.2 ml of 12.5 mM DETBA in sodium phosphate buffer (0.125 M, pH 3.0) was added. The mixture was then heated to 50 °C. After mixing, the tubes were heated for 15 minutes at 95 °C before being chilled in an ice bath. The pink adduct was then removed from the aqueous phase by vortexeing each tube with 4 ml of ethyl acetate for 10 minutes at 700 g. (F1). A

control with linoleic acid and other additions but no antioxidants that represented 100% lipid peroxidation was also created (F2). In a spectrofluorimeter, the fluorescence intensities of the ethyl acetate layer of the sample (F1) and control solution (F2) were assessed in comparison to their blanks (F3 and F4, respectively), which were made as described above but without linoleic acid. The antioxidant activity was calculated as the percent of peroxidation inhibition using the following equation:

Percent of peroxidation inhibition= [1- (F1 - F3) / (F2 - F4)]×100

All extracts and reference materials were tested at least three times, and the findings were averaged. A percent inhibition versus concentration curve was plotted using the XLfit 4 programme, and the sample concentration necessary for 50% inhibition was calculated using linear interpolation and presented as the IC50 value.

DPPH free radical scavenging activity

The Okada & Okada technique was used to evaluate the DPPH free radical scavenging activity. 40 l of an extract solution with various strengths (0.02-2 mg/ml) were mixed with a 300 l ethanolic DPPH (0.05 mM) solution. The freshly made DPPH solution was maintained at 4°C in the dark. After adding 2.7 ml of 96% ethanol, the liquid was forcefully shaken. After 5 minutes, the mixture was allowed to stand, and the absorbance at 517 nm was measured with a spectrophotometer **[35]**.

The spectrophotometer was zeroed using ethanol. The same amount of ethanol and DPPH were also used to prepare a blank sample. All determinations were made in triplicate. The following equation was used to determine the radical scavenging activities of the investigated samples, expressed as a percentage of inhibition:

Percent of DPPH inhibition= [(AB-AA)/AB]× 100

Where AA and AB are the absorbance values of the test sample and the blank sample, respectively. The concentration of the sample necessary for 50% inhibition was calculated and reported as the IC50 value using a percent inhibition versus concentration curve.[36]

RESULT AND DISCUSSION

K. pneumoniae and *E. coli* were the most susceptible and resistant bacterial strains, respectively, of the five examined strains. The test results demonstrated that some of the plants' use in folklore is appropriate. The nine plant species examined in this study were discovered to treat one or more of the following fungal illnesses during the ethnobotanical surveys: skin rashes, oral candidiasis, ringworm, aspergillosis,

cryptococcal meningitis, general skin eruptions, and skin lesions. Eight of the nine plant extracts examined have antifungal properties against one or more of the three tested fungi **(Table 2)**.

The dichloromethane extracts generally showed action. Dichloromethane extracts were fractionated, and 23 fractions with larger growth inhibition zones than their initial crude extracts showed a relative increase in antifungal efficacy **(Table 2)**. Only dichloromethane crude extracts were fractionated since they performed better than water extracts during the preliminary screening. Three fractions, CE 1, CE 2, and CE 3, were extracted from *C. erythrocarpos*, with CE 3 being the most effective against all three fungi. The C. arborea extract yielded five fractions, CA 1–5, of which CA 5 was the most potent and inhibited the growth of the three fungi.

The *D. steudneri* dichloromethane extract produced five fractions, DS 1–5, and DS 3 was the most active against the three fungi, with high activity against A. niger. None of the L. schimperi LS 1-4 fractions had more effectiveness than the crude extract against all three fungus. The *S. ellipticum* dichloromethane extract yielded six fractions, SE 1–6, all of which had higher activity than the original extract, with SE 3 being the most effective against all three fungi. The dichloromethane extract of C. arborea contained only one inactive fraction, CA 3.

Overall, CE 3, CA 5, DS 3, and SE 3 were the frac- tions that were effective against all three fungus species. The current study suggests that the studied plants' extracts may be used to treat fungus infections. This is supported by the fact that the majority of the extracts were effective against one or more of the three tested fungi. Most water extracts showed little to no activity, most likely because the active ingredients are soluble in organic solvents rather than water. The agar well diffusion method was used exclusively to analyse semi-purified fractions and pure substances since it outperformed the disc assay method in screening tests.

Antioxidant activity

Table 3 displays the inhibitory impact of methanolic extracts of the investigated plants on linoleic acid peroxidation, given as IC50. The IC50 showed a significant variance, ranging from 1.28 ng/ml to 63.48 ng/ml. All plant materials displayed IC50 values smaller than Trolox, while seven plant materials displayed IC50 values that were lower (2–30 times) than quercetin.

Radical scavenging activity

The test compounds' capacity to scavenge free radicals was assessed using the change in

absorbance caused by reduced DPPH. The extract of Salix sp. had the highest IC50 value, with values of 1.14, 1.55, 1.80, and 1.89 g/ml, respectively, according to the results of the DPPH test. Compared to Trolox (IC50, 8.64 g/ml) and quercetin (IC50, 5.22 g/ml), these plant extracts demonstrated greater radical scavenging activity.

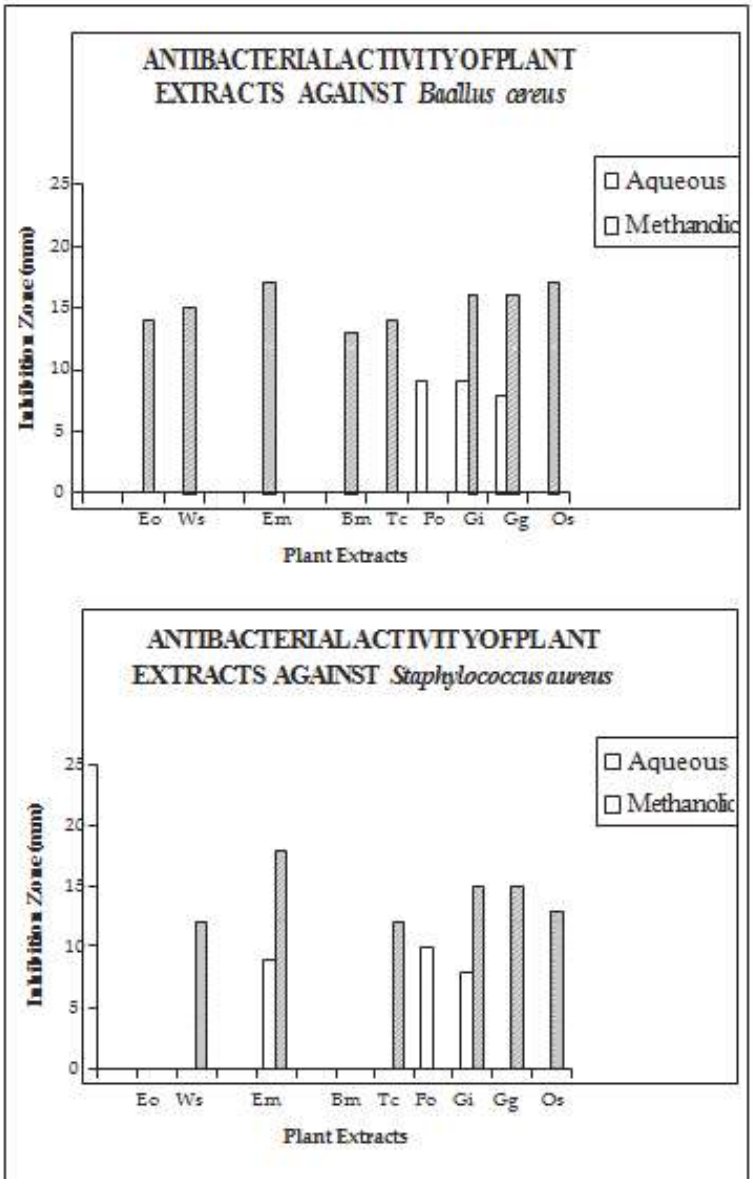

Figure 1: Evaluation of antibacterial activity of aqueous and methanol plant extracts against gram-positive bacteria *Bacillus cereus* and *Stephylococcus aureus*; Eo: *Emblica officinalis, Ws: Withania somnifera, Am: Aegle marmelos, Bm: Bacopa monnieri, Tc: Tinospora cordifolia, Po: Plantago ovate, Gi: Garcinia indica, Gg: Glycyrrhiza glabra,* and Os: *Ocimum sanctum*

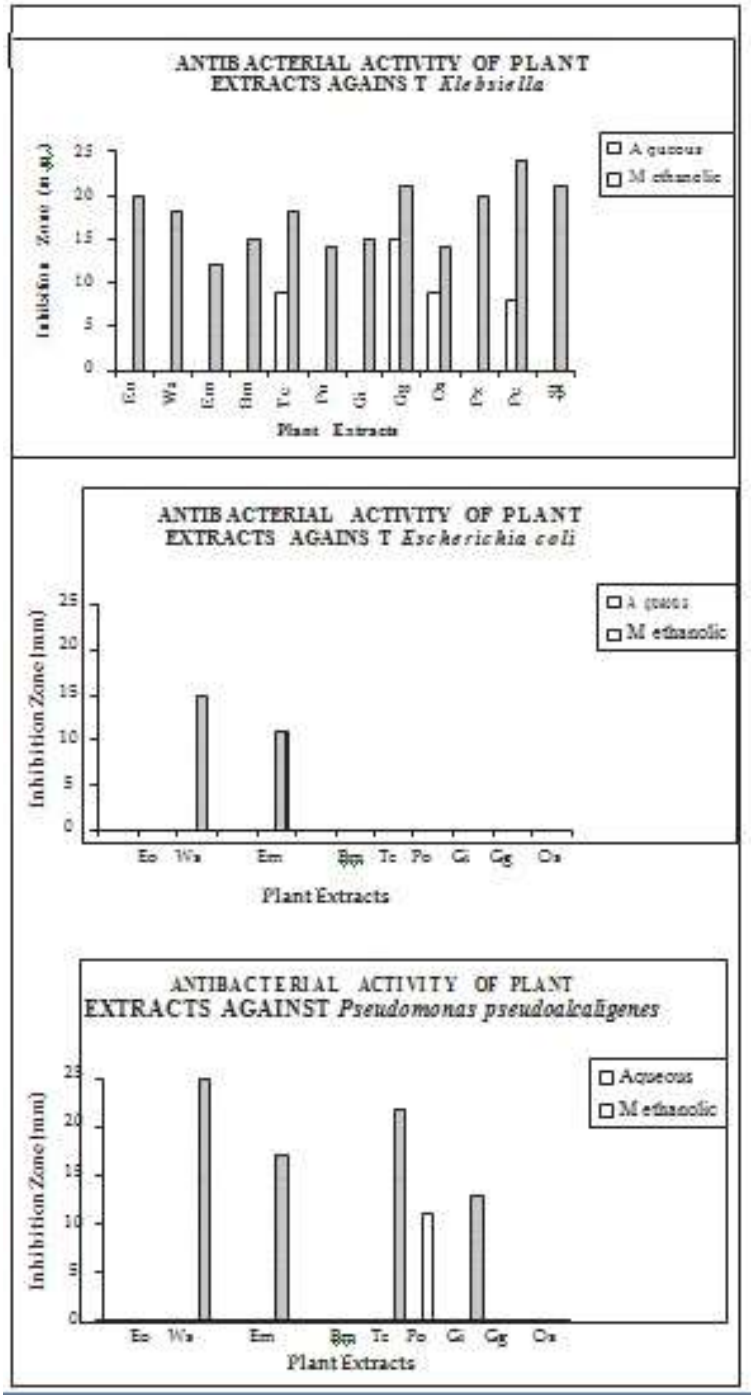

Figure 2: Evaluation of antibacterial activity of aqueous and methanol plant extracts against gram-negative bacteria *Klebsiella pneumoniae, Escherichia coli and Pseudomonas pseudoalcaligenes*; Eo: *Emblica officinalis, Ws: Withania somnifera, Am: Aegle marmelos, Bm: Bacopa monnieri, Tc: Tinospora cordifolia, Po: Plantago ovate, Gi: Garcinia indica, Gg: Glycyrrhiza glabra,* and Os: *Ocimum sanctum*

Table 1: Ethnobotanical Information of Some Traditionally Used Indian Medicinal Plant Species Selected for Antibacterial Activity

Plant species	Family	Common name	Habitat	Part used
Emblica officinalis	Phyllanthaceae	Amla	tree	Fruits
Withania somnifera	Solanaceae	Ashwagandha	shrub	Rhizomes
Aegle marmelos	Rutaceae	Bael	tree	Fruits
Bacopa monnieri	Plantaginaceae	Brahmi	tree	Leaf
Tinospora cordifolia	Menispermaceae	Giloy	shrub	Stem
Plantago ovate	Plantaginaceae	Ispaghol	shrub	seed
Garcinia indica	Guttiferae	Kokum	tree	Leaf
Glycyrrhiza glabra	Fabaceae	Liquorice	shrub	Root
Ocimum sanctum	Lamiaceae	Tulsi	shrub	Leaf

Table 2: Antifungal activity of crude extracts observed in the agar well and disk diffusion methods

Plant name	Part	Extract	Conc. (mg/mL)	Inhibition Zone Diameter (mm)					
				Agar Well Method			Disk Diffusion Method		
				C. albicans	*C. neoformans*	*A. niger*	*C. albicans*	*C. neoformans*	*A. niger*
Emblica officinalis	Fruits	DM	250	6.50 ± 1.41	14.00 ± 0.00	20.50 ± 3.05	6.50 ± 1.41	—	—
		W	250	12.00 ± 0.00	—	—	—	12.00 ± 0.00	—
Withania somnifera	Root	DM	100	—	17.00 ± 1.53	16.00 ± 0.00	6.00 ± 0.00	—	—
		W	100	—	—	16.00 ± 5.67	—	—	—
Aegle marmelos	Fruits	DM	200	12.50 ± 0.71	—	—	11.00 ± 2.83	13.50 ± 2.12	10.50 ± 0.71
		W	250	15.00 ± 0.00	12.00 ± 0.00	—	—	5.00 ± 1.41	—
Bacopa monnieri	Leaf	DM	100	—	16.5 ± 1.53	9.00 ± 0.00	7.00 ± 0.00	8.00 ± 0.00	—
		W	100	—	—	—	—	—	—
Tinospora cordifolia	Stem	DM	250	—	—	19.00 ± 5.67	5.00 ± 0.71	6.5 ± 0.71	—
		W	250	—	—	—	—	11.00 ± 2.83	—
Plantago ovate	seed	DM	250	—	—	—	—	—	—
		W	170	—	—	—	—	—	—
Garcinia indica	Leaf	DM	130	—	—	17.00 ± 0.00	—	—	12.00 ± 0.71
		W	165	—	—	—	—	—	—
Glycyrrhiza glabra	Root	DM	250	—	18.00 ± 0.00	24.00 ± 7.19	8.00 ± 1.41	—	10.00 ± 0.71
		W	200	—	—	—	—	—	—
Ocimum sanctum	Leaf	DM	200	—	—	—	4.5 ± 0.71	—	—
		W	250	—	10.00 ± 0.00	—	—	—	—

Table 3: Results of antioxidant and free radical scavenging activities of the plant extracts

IC50 (µg/ml)[a]	IC50(Linoleic acid peroxidation) (ng/ml)[a]	Scientific Name
8.64±0.03	97.34 ± 0.66	Trolox
5.22±0.13	40.83±3.39	Quercetin
1.89±0.05	39.71±1.72	*Achillea tenuifolia* Lam.
187.88 ±60.40	30.67±4.35	*Allium hirtifolium* Boiss.
32.36 ±4.43	7.65±1.07	*Astragalus hamosus* L.
37.14 ± 3.23	1.28±0.14	*Biebresteinia multifida* DC.
74.41±12.67	24.85±2.15	*Citrulus colocynthis* (L.) Schrad.
24.63 ±1.02	39.77±4.67	*Colchicum speciosum* Stev.
10.60 ±1.53	3.77±0.51	*Curcuma zedoaria* Rosc.
1.14 ± 0.10	4.16±0.11	*Mentha spicata* L.
2.14 ± 0.08	63.48±6.89	*Polypodium vulgare* L.
1.03 ± 0.05	21.57±3.11	*Salix sp.*
37.19± 6.00	52.35±1.28	*Salvadora persica* L.
1.55 ± 0.09	2.50±0.42	*Salvia hydrangea* DC.
1.80 ± 0.17	3.23±0.12	*Zataria multiflora* Boiss.

CONCLUSION

Methanol extract was shown to be more powerful than aqueous extracts in the initial screening experiment. The plant extracts were more effective against gram-positive bacteria than gram-negative bacteria. *E. coli* and *K. pneumoniae* were the most resistant and susceptible microorganisms, respectively. According to a study, knowledge gained from traditional healers may help develop therapeutically effective drugs. The discovery of antifungal activity in almost all of the investigated plant species lends great credibility to the claims made by traditional healers regarding the treatment of fungal infections. This plant material's antioxidant activity has not previously been documented. This plant's anti-inflammatory and analgesic properties have been researched, and there may be a connection between these two outcomes.

With an IC50 value of 1.03 g/ml, *Salix sp.* was the most effective radical-scavenging plant material in our investigation. Some of the examined species in this article demonstrated low radical scavenging activity in comparison to positive controls but moderate antioxidant activity against linoleic acid peroxidation, or vice versa.

Several investigations that used other testing on plant materials came to the same conclusion. Several antioxidant components including phenolics, ascorbate, and carotenoids may contribute to different antioxidant and radical scavenging activity. Moreover, there are two categories of antioxidants: those that prevent free radicals from starting oxidation and those that prevent free radical chain reaction propagation. The disparity of these results was caused by the varied mechanisms of action and kinetics of the inhibitory effect of these antioxidants employing distinct techniques. Due to the complexity of antioxidant materials and their mechanisms of action, it is evident that a combination of testing techniques is required to obtain a complete picture of the antioxidant profile of the analysed samples. DPPH or linoleic acid peroxidation approaches can be useful for primary screening and the discovery of new antioxidants, despite these drawbacks.

The findings of this study indicate that the investigated plant materials exhibit moderate to strong antioxidant activity and/or free radical scavenging activity, respectively. Nevertheless, we are unsure of which plant extract ingredients are responsible for these actions. To describe the plant extracts as biological antioxidants, more in-depth research on their chemical make-up as well as other in vivo tests are required, which is outside the purview of this study. It should also be noted that in vitro measurements of antioxidant activity may not accurately represent in vivo effects of antioxidants. Several more elements, including metabolism and absorption, are also significant. The results of this study provide credence to the idea that some medicinal plants can act as effective antioxidant sources and disease preventatives. The information provided will only add to the wealth of information already available about the antioxidant activity of plant materials.

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