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A Review on Antimicrobial Activity of Medicinal Plant Extracts

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A B S T R A C T

Infectious infections are a major concern in both developing and developed countries. Because of their high antibacterial activity and inexpensive cost, traditional medicinal plants are commonly utilized to treat microbial infections. Different solvents were used to extract different plant parts, such as seeds, fruit, roots, bark, stems, leaves, and even the entire plant, including ethanol, methanol, chloroform, acetone, petroleum ether, alcohol, and ethyl acetate. To determine their antibacterial activity, these extracts were tested using a diffusion method against gram positive, gram negative bacteria, and fungi. This review provides extensive information on nearly 50 traditional medicinal plants that have antimicrobial action, providing the basis for more research into medicinal plant extracts in order to generate effective antimicrobial therapeutics.

Keywords: Medicinal plants, Flavonoids, Fungi, Antimicrobial activity, WHO

1. INTRODUCTION

Medicinal plants are generally used in the pharmaceutical profession for the extensive range of ingredients found in plants that have been used to treat chronic and infectious disorders. Long before civilization realized the existence of germs, it was widely known that certain plants had healing properties, and that they included what we now call antimicrobial principles. Plants have long been used to treat common infectious diseases, and some of these ancient medicines are still utilized to treat a variety of ailments. Antimicrobial agents are abundant in medicinal plants [1,2]. According to the World Health Organization (WHO), medicinal plants are the best source of a range of medications, and 80 percent of the world's population relies on traditional medicine, which includes the use of plant extracts or active ingredients in traditional therapies. However, determining their antibacterial active components in a scientific investigation is a relatively new concept [1,3].

Infectious diseases are widespread, especially skin and mucosal infections. Fungi and bacteria are a significant group of these skin infections [4]. Dermal inflammation, folliculitis, skin abuses, acne, dermatitis, rosacea, and other infectious dermatological disorders are frequent. Multidrug-resistant bacteria have become a major reason for the increased usage of skincare products [5]. The indiscriminate use of commercial antimicrobial medications routinely employed in the treatment of infectious disease has resulted in the development of multiple drug resistance. Skin infections are common in immunocompromised people, and they can be difficult to treat [6]. A novel antimicrobial agent with a different method of action against germs offers an appealing alternative to multidrug-resistant bacteria. Drug safety is still a huge global issue, thus the medications already in use to treat infectious diseases are a source of concern [5]. The majority of synthetic medications have negative side effects. Antimicrobial substances from promising plants should be investigated to help solve this problem. These plant-based medications are less toxic, have less side effects, and are also more cost-effective. They are helpful in the treatment of infectious disorders while also avoiding many of the negative effects that synthetic antimicrobial are known for [1]. Topical

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drug administration is a localized drug delivery system anywhere in the body through ophthalmic, rectal, vaginal, and skin as topical routes. Skin is one of the most accessible organ of the human body for topical administration and the main route of topical drug delivery system. The amount of medicinal substances applied to the skin or mucous membrane that either improves or restores a basic skin function or pharmacologically a ffects an action in the highlighted tissues. Topical or dermatological products are the terms for these kinds of items. Drug molecules come into contact with cellular debris, bacteria, and other things near the skin's surface, affecting penetration. The applied medicinal material has three routes to viable tissue: 1) hair follicles, 2) through sweat ducts, and 3) between the appendages (hair follicles, sebaceous glands, eccrine, apocrine glands, and nails) via the continuous stratum corneum. Because it avoids the first-pass impact, gastrointestinal irritation, and metabolic degradation associated with oral administration, this mode of drug delivery has grown in favour. The topical route of administration has been used to produce either a local or systemic effect in the treatment of skin disorders [7].

Plant-based antimicrobials represent a massive untapped source of medications, and further research into them is urgently needed. Plant-derived antimicrobials have significant therapeutic promise. Antimicrobials derived from plants have a long history of offering much-needed new therapies. Hundreds of plant and animal species have been examined for antibacterial capabilities, but the majority have not been thoroughly studied. Given the great potential of plants as antimicrobial drug sources, the present research is based on a review of such species [2].

2. ANTIMICROBIAL ACTIVITY OF MEDICINAL PLANTS

Antimicrobial of plant origin have great therapeutic potential. They are beneficial in the treatment of a variety of ailments. But also reducing the spread of infectious diseases several of the side effects that are commonly linked to antimicrobial that are synthesized. The pharmacological benefits usually caused by the mixture of secondary compounds produced by the plant. Secondary metabolites in plants, such as alkaloids, steroids, tannins and phenol compounds, flavonoids, steroids, resins, fatty acids gums, and flavonoids, steroids, resins, and fatty acids gums, are capable of producing distinct physiological action on the organism. Compounds isolated from various plant parts can be used to treat diarrhoea, dysentery, cough, cold, cholera, fever, bronchitis, and other ailments.

Chandra analyzed the antibacterial activity of leaf extracts from two medicinally important plants, *Lagerstroemia indica* and *Annona reticulata,* against *Klebsiella pneumoniae, Staphylococcus auerus, Salmonella typhi, Proteus vulgaris,* and *Pseudomonas aeruginosa*. The disc diffusion method was used to test antibacterial activity against microorganisms using methanol and aqueous extracts. It shows that the medicinal plants studied are potentially good sources of antibacterials against infections such as *K. Pneumoniae, S. aureus, K.pneumoniae, S. typhi P. vulgaris* and *P. aeruginosa*. Phytochemical screening revealed the presence of terpenoids, tannins, deoxy sugars, saponins, phenolic compounds, and flavonoids, all of which could contribute to the medicinal plant's antibacterial potential [8].

Nitha *et al*., tested the antibacterial activity of ten plants (Artocarpus heterophyllus Lam., Berberis aristata DC, Chromolaena odorata L., Embelia ribes Burm.f., Jasmine angustifolia L., Mahonia leschenaultii Wall.ex.wt & Arn, Pluchea lanceolata DC., Plumbago indica L., Terminalia chebula Retz, Vitex nigundo L.) using aqueous and ethanol extract. Each belonging to different families was evaluated against medically important bacteria viz. S. aureus (MTCC3160), B. subtilis (MTCC441), E. coli (MTCC40), K . pneumoniae (MTCC3384), P.mirabilis (MTCC425), P.aeruginosa (MTCC741). Agar disc diffusion and agar well diffusion were used to test antibacterial activity in vitro. The bacteria *P. mirabilis* was the most resistant, whereas S. aureus was the most susceptible. *Terminalia chebula* has the best antibacterial activity of all the plant species studied [9].

Tahir Javid et al., Screened the antimicrobial activity of *Artemisia indica, Medicago falcata* and *Tecoma stans* using chloroform, butanol, ethyl acetate and n-hexane extracts. Antibacterial activity was tested against four pathogenic bacterial strains including *Escherichia coli, Pseudomonas aeruginosa, Salmonella typhi* and *Staphylococcus aureus* while antifungal activity was tested against four fungal strains including *Aspergillus flavus, Aspergillus niger, Aspergillus fumigatus* and *Fusarium solani.* Extracts of *Artemisia indica, Medicago falcata,* and *Tecoma stans* in chloroform, butanol, and ethyl acetate showed high inhibitory activity (between 15-20 mm) against *E. coli, P. aeruginosa,* and *S. aureus*. However, all *Artemisia indica* extracts had inhibitory activity against *Salmonella typhi* (12-14 mm). The n-Hexane and chloroform extracts of *Artemisia indica* have totally inhibited the development of *Aspergillus flavus* and *Fusariun solani,* respectively, as antifungal activity. *Fusarium solani* and *Aspergillus fumigate*s were fully inhibited by ethyl acetate and butanol extract of *Medicago falcata,* respectively [10].

Morus alba extract was found to be more efficient against *Candida albicans, Aspergillus niger, Pseudomonas aeroginosa, Streptococcus mutans, Staphylococcus aureus,* and *Escherichia col*i than conventional antibiotics. Plant-based antibiotics will be a boon to society, therefore the plants investigated can be used to develop antibiotics. *Morus alba* extracts' antibacterial activity was also compared to that of conventional antibiotics in the study by *Madhuri and Sarasamma* [11].

Dutta and Aich assessed antibacterial and anti fungal activities of *Colocasia esculenta* by disc diffusion method. *Staphylococcus aureus, Klebsiella, Escherichia coli, Pseudomonas aeruginosa,* and *Candida albicans* were the organisms tested. In a dose-dependent manner, an ethanolic extract of *Colocasia esculenta* demonstrated antibacterial action against *S. aureus, P. aeruginosa, E.coli, Kleibsiella*, and antifungal activity against *Candida albicans* [12].

Dereje Nigussie et al., revealed agar well diffusion and colorimetric microdilution techniques have been used to determine the antibacterial activity of methanol extracts of the three medicinal plants. They were tested against *Staphylococcus aureus, Streptococcus pyogenes, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, Shewanella alage*, methicillin-resistant *S. aureu,* and Staphlactone. The extract of *L. inermis* leaf showed high activity in opposition to all bacteria species, which turned into corresponded to the usual drugs. But, the extract of *A. aspera* leaf showed low activity even though it was found to be at better concentration [13].

Uddin et al., studied to assess the antibacterial activity of various traditional medicinal herbs against a variety of pathogenic bacteria that can cause human disease. Thirty-four medicinal plants from twenty-four families were chosen based on indigenous people's medical practises and tested for antibiotic activity. The fruit extracts of *O. sactum* produced the biggest inhibition zones (22 mm in diameter) against *S. dysenteriae* and *B. cereus*. This could lead to the development of novel antibiotics [14].

Srikacha et al., investigated the antibacterial activity of five different plants against four different harmful microorganisms. The antimicrobial compounds were extracted from the plants using a maceration process using three solvents with various polarity. The antibacterial activity were predominantly tested using the agar-disc diffusion technique. The minimal inhibitory concentration was determined using a broth-dilution experiment. The ethanol extract of *Piper betle* Linn has the maximum antibacterial activity against Gram-positive and Gram-negative bacteria of all the extracts tested. The ethanol extract of *Piper betle* Linn had the same MIC and MBC against *Salmonella typhimurium* (1 562.50 mg/L), but had the greatest MIC and MBC against *Pseudomonas aeruginosa* (6 250 mg/L and 12 500 mg/L, respectively. The bacteria *Salmonella typhimurium* is the most sensitive to the ethanol extract of *Piper betle* Linn, whereas *Pseudomonas aeruginosa* is the most resistant. *Piper betle* contains chemicals that may have antibacterial activity and could be used to treat infectious disorders as an alternative [15].

*Artur et al., t*ested 13 common flavonoids (flavones, flavonols, flavanones) and 6 organic acids for antibacterial activity (aliphatic and aromatic acids). The micro-dilution method was used to evaluate the minimum inhibitory concentrations (MICs) of chosen plant components using clinical strains of four pathogenic bacteria species.Although all of the chemicals examined have antibacterial characteristics, their biological activity was modest to low. Salicylic acid (MIC = 250–500 g/mL) was shown to be the most effective inhibitor of bacterial growth. Gram-negative bacteria, such as *Escherichia coli* and *Pseudomonas aeruginosa*, were found to be more active than Gram-positive bacteria, such as *Enterococcus faecalis* and *Staphylococcus aureus*. The presence of hydroxyl groups in the phenyl rings A and B had no effect on the level of antibacterial activity of flavone, chrysin, apigenin, and luteolin, according to research. Only S. aureus showed a significant increase in flavone hydroxy derivative activity. MIC values were not affected by the presence or position of the sugar group in flavone glycosides [16].

The Hydromethanolic extracts of *Berberis vulgaris, Cassia angustifolia, Cinnamomum cassia, Cistus monspeliensis, Nigella sativa, Punica granatum, Rhus tripartata, Withania frutescens,* and *Zingiber officinale* were tested against Gram-positive and Gram-negative reference bacterial strains. The disc diffusion method was used to assess antibacterial activity and determine the lowest inhibitory concentration for distinct extracts of each plant (MIC) The plant extracts had zones of inhibition ranging from 06.0 to 23.0 mm against one or more of the microorganisms tested. Their MICs ranged from 0.1 to 12.8 mg/mL. In comparison to the other plant extracts, the extracts of *B. vulgaris* showed comparatively high efficacy against *S. aureus, E. faecalis,* and *E. cloacae* [17].

Samayeh et al., tested the antibacterial activity of *Baeckea frutescens* L. ethanol extract against MRSA clinical isolates, studied the putative antibacterial ingredient, and evaluated the extract's cytotoxicity in tissue culture. *Baeckea frutescens* L. leaves were shade dried, ground, and extracted using ethanol as the solvent. The crude extracts contained alkaloids, flavonoids, steroids, terpenoids, phenols, and carbohydrates, according to preliminary phytochemical screening. The antibacterial action of the plant is linked to the presence of certain bioactive components. The disc diffusion approach demonstrated a high level of antimicrobial activity. The findings support the usage of *Baeckea frutescens* L [18].

Mohamed et al., studied disc diffusion that was used to test antimicrobial activity against six pathogenic microorganisms, four bacteria and two fungus. The crude extracts were extracted using maceration. All of the microbes were susceptible to the extracts, according to the findings. The primary compounds in the essential oil of *P. crispa* were 1,4-ditert butylbenzene (22.81%), caryophyllene (13.19%), carvone (11.80%), and neryl(s)-2-methylbutanoate (10.33%), while the main constituents in *P. undulata* were camphor (44.48%) and thymyl acetate (11.80%). The findings of this study could be used to generate natural bioactive compounds to help people live healthier lives [19].

Ashraf et al., **s**tudied using the agar disc diffusion technique, the antimicrobial activity of five plant extracts against *Bacillus cereus, Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa,* and *Salmonella typhi.* At a dosage of 10 mg/ml, ethanolic extracts of *Punica granatum, Syzygium aromaticum, Zingiber officinales,* and *Thymus vulgaris* were possibly useful with variable efficacy against the tested bacterial strains, although *Cuminum cyminum* extract was only efficient against S. aureus. The most effective plant extracts were *P. granatum* and *S. aromaticum* ethanolic

extracts, which showed bacteriostatic and bactericidal activities against highly susceptible strains of food borne pathogenic bacteria (*S. aureus* and *P. aeruginosa*) with MICs ranging from 2.5 to 5.0 mg/ml and MBC of 5.0 and 10 mg/ml, except for *P. aeruginosa*, which was less sensitive and its MBC reached 12.5 mg/ml of *S. aromaticum*. These plant extracts, which have been shown to be potentially useful, can be utilised as natural alternatives to chemically antimicrobial agent applications to treat food poisoning diseases and preserve food [20].

Four plant extracts inhibited *Listeria monocytogenes, Salmonella enteritidis,* and *Escherichia coli* for 24 hours were measured using broth microdilution. *Agrimonia pilosa Ledeb, Iris domestica* (L.) *Goldblatt* and *Mabb, Anemone chinensis Bunge,* and *Smilax glabra Roxb* all had MICs of 62.5 mg/L and MBCs of 500 mg/L against one pathogen, respectively. With the exception of *S. enteritidis*, for which *A. chinensis Bunge* was the most effective, *A. pilosa Ledeb* was the most effective against *L. monocytogenes* and *E. coli*. The bactericidal activity of *A. pilosa Ledeb* and *A. chinensis Bunge* was determined using time–kills against *L. monocytogenes, E. coli,* and *S. enteritidis* incubated in poultry cecum. Within 6 hours, *A. chinensis Bunge* reduced *S. enteritidis* by 99.99 percent. Within 4 hours, *A. pilosa Ledeb* showed substantial bactericidal action against *L. monocytogenes* and *E. coli*. The potential of these plant extracts to suppress infections often seen in the gastrointestinal tract of chickens is highlighted in this research [21].

Ramdan Btissam et al., studied agar-well diffusion method, minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC), and IC50 were used to assess the antibacterial properties of ethanolic extracts (EE). *L. nobilis* and *O. europaea* extracts have the most antibacterial activity. In ethanol, the active components were soluble. The antibacterial properties of *L. nobilis* and *O. europaea* may help researchers better understand how they're used in pharmaceuticals and traditional medicine to combat a variety of microbial illnesses [22].

Nicotiana tabacum L. was extracted in seven organic solvents after being obtained in Western Ethiopia. Extracts based on ethyl acetate had better antibacterial properties. Uropathogens that generate biofilms were the most susceptible, but clinical isolates were quite resistant to biofilm forming bacteria. The ethyl acetate extract of *N. tabacum* showed high antimicrobial effects against biofilm-forming bacteria, while clinically isolated bacteria were the most resistant. Pyridine, 3-(1-methyl-2-pyrrolidinyl)-(S), which has a broad spectrum of activity, could be responsible for the antibacterial feature observed [23].

Elisha et al., studied acetone was used to extract leaves from nine medicinal plant species with excellent antibacterial activity against *Escherichia coli*. A microplate serial dilution approach was used to establish their minimum inhibitory concentration (MIC). All pathogens were active against the extracts, with MICs ranging from 0.02 to 0.52 mg/ml on average. With mean MICs of 0.07 and 0.09, *Cremaspora triflora* and *Maesa lanceolata* demonstrated better activity against Gram-positive and Gram-negative pathogens than the other extracts. Selectivity indices >1 showed that the activity of the extracts on the test microorganisms was not always connected with cytotoxicity. This suggests that antibacterial compounds were unlikely to be the cause of cellular damage [24]. By using the agar well diffusion method, the antimicrobial efficiency of Hexane, Ethyl acetate, and Ethanolic extracts of herbal plants (*Anthocephalus cadamba, Allium sativum, Origanum vulgare, Ocimum sanctum*) against human pathogens like *Staphylococcus aureus* (MTCC-3160), *Escherichia coli* (MTCC-1652), and fungi *Aspergillus niger* (MTCC-282). All of the plants had considerable antimicrobial action against all pathogens, however the alcoholic extract of *Ocimum sanctum* had the highest zone of inhibition and the lowest inhibitory concentration. In hexane and ethanolic extracts, the minimal zone of inhibition and comparatively higher inhibitory concentration were determined. The broad spectrum action of these plants' alcoholic extracts could be a source for developing new and effective herbal medicines to treat a variety of infectious disorders [25].

The antibacterial activity of six Indian plant extracts commonly used in traditional medicine against standard *Streptococcus mutans* strains. The agar well diffusion method was used to assess the antibacterial activity of six plant extracts. The agar well diffusion method was used to estimate the minimum inhibitory concentration (MIC) for the crude (raw), organic solvent based, aqueous extracts. Organic solvent-based and aqueous extracts of all six extracts tested had significant antibacterial activity against the oral pathogen. The crude extract of garlic had the largest zone of inhibition (24.62 mm) against *Streptococcus mutans*, followed by the aqueous extract of Amla (19.47 mm) and the organic solvent based extract of Ginger (18.76 mm). Antimicrobial responses were obtained despite the fact that the extracts were not pure substances. This refers to the extracts' efficiency [26].

Sumaya Sulthana et al., investigated gram-positive organisms were used to test the antibacterial activity of methanol and aqueous extracts of *Barleria cristata* leaves. Gram-negative bacteria and *Streptococcus pyogenes* The methanolic Extracts of *Barleria cristata* were effective against the test microorganisms, according to *Escherichia coli* NCTC 10418, who used an effective diffusion method. Methanolic extract and aqueous extract inhibit *E. coli* by 77.06 and 64.2 percent, respectively, and methanolic extract and aqueous extract inhibit *Streptococcus* by 78.5 and 68.8 percent, respectively. The study's findings give a strong basis for using the plant extract to treat wounds and skin problems [27].

Antibacterial activity of extracts of *A. vera, C. officinalis,* and *M. recutita* combined into bacterial cellulose membrane (BCM) was tested against bacterial strains usually seen in wounds and burns by *Batain et al.* The minimum inhibitory concentration (MIC) for *S. aureus, E. coli,* and *P. aeruginosa* was determined using agar-dilution susceptibility testing. *A. vera, M. recutita,* and *C. officinalis* standardized extracts were employed at 3.25 percent total polysaccharides, 1 percent apigenin 7-O-glucoside, and 0.084 percent total flavonoids expressed in quercetin, respectively. The BCM combined with *A. vera* extract was effective in inhibiting *P. aeruginosa* and S. aureus growth. *S. aureus* growth was suppressed by BCM containing *C*

officinalis. The BCM containing *A. vera* and *C officinalis* extract had superior antibacterial activity against *P. aeruginosa* and *S. aureus*, as well as characteristics to prevent infectious disease induced by these bacteria in wounds or burns [28].

Masoumian and Zandi investigated the antibacterial activities of selected plant extract evoked by two different solvents on *S. aureus, E. coli, P. aeruginosa* and *S. enteric*. The most active extracts evaluated for antibacterial properties against various four bacteria as tested species were the hydro-alcoholic extract of *Myrtus communis* (myrtle) and the water extract of *Cinnamomum zeylanicum* (cinnamon). The diameter of the zone of inhibition ranges from 23 to 28 mm. The comparison of the antibacterial effects of plant extracts and commercially available drugs shows that the size of the inhibitory area of penicillin on *Staphylococcus aureus* is larger than that of the plant extract. However, compared with other extracts and even penicillin, myrtle extract showed stronger antibacterial activity at a minimum inhibitory concentration (MIC) of 30 mg/mL. It was found that *Petroselinum crispum* (cilantro), *Nerium oleander* (Oleander) and *Glycyrihiza glabra* (licorice) had the least impact on the tested bacteria[29].

Atikya Farjana et al.**,** evaluated water, oil, and methanol extracts of guava, green tea, neem, and marigold. They tested for antibacterial activity against *Pseudomonas* spp., *Vibrio cholerae, Vibio parahaemolyticus, Escherichia coli, Staphylococcus aureus,* and *Klebsiella* spp. The maximum zone of inhibition (22 mm) against *V. parahaemolyticus* was found in boiled water extracts of Guava leaf. Green tea leaf demonstrated 17.5 mm and 19 mm zones of inhibition against *E. coli* (10 mm) Neem leaf extract had antibacterial action against *Klebsiella* spp (16 mm) and *Vibiro cholerae* (14 mm) Marigold leaf extract showed antibacterial activity against *S. aureus* (18 mm) at both boiling and room temperature [30].

Elumalai et al., investigates *Merremia emarginata* leaf extracts in aqueous, methanol, and petroleum ether extracts for antibacterial efficacy and phytochemical screening (*M. emarginata*). The antibacterial activity of *M. emarginata* leaf extracts against four different bacteria species was tested using the agar well diffusion method. Tannins, flavonoids, amino acids, starch, glycosides, and carbohydrates were found in the distinct leaf extracts. *Bacillus cereus* and *Escherichia coli* were more susceptible to the methanol extract, but *Staphylococcus aureus* and *Pseudomonas aeruginosa* were more susceptible to the aqueous extract. The findings indicate that *M. emarginata* leaves can be utilised to treat disorders caused by the species studied [31].

The in vitro antibacterial activities of *H. diversifolia* ethanolic leaf extract were tested against numerous Gram positive and Gram negative bacteria. The antibacterial research was conducted utilising a disc diffusion experiment to identify the pattern of inhibition zones as well as the least inhibitory concentration (MIC). A disc diffusion technique was used to assess the antibacterial study's pattern of inhibition zones, as well as the least inhibitory dose (MIC). Methicillin-resistant *Staphylococcus aureus, Escherichia coli,* and *Bacillus cereus* have all been demonstrated to be inhibited by the extract. At 24 and 48 hours of incubation, the lowest MIC values of extract were 25 mg/mL for *MRSA* and *E. coli,* and 100 mg/mL for *B. cereus*. The plant had the potential to be used as an antibacterial agent in the pharmaceutical and cosmetic industries [32].

The antimicrobial activity of ethanol, methanol, acetone, and water extracts of 11 plant species used in folk medicine against six antibiotic-resistant clinical infections using the agar-well diffusion method. The results show that the majority of the extracts had antibacterial activity. The aqueous extract of *A. discoridis* leaves had the greatest impact, with the lowest MIC and MMC. It produced a broad spectrum of antibacterial activity after methanol leaf extraction. Curiously, the most effective antibacterial agent extraction method was discovered to be methanol extraction. *S. pneumonia* was the least sensitive of the pathogenic bacteria examined. However, the antibiotic MIC and MMC values are greater than the antibacterial values, implying that *C. albicans* is less sensitive to plant leaf extracts. Finally, aqueous extracts of *A. discoridis* leaves were found to be the most effective against all infections tested. As a result, this research validates the effectiveness of several plant extracts as natural antimicrobials and proposes that they could be employed in medications to treat infectious diseases caused by the pathogens studied [33].

The bactericidal activity of aqueous and ethanolic extracts of *Punica granatum* L. bark prepared by decoction and maceration. The disc diffusion method was used to investigate the antibacterial activity of several *Punica granatum* L. (Lythraceae) bark extracts against Gram-positive (*Staphylococcus aureus, Bacillus stearothermophilus*)and Gram-negative bacteria *(Escherichia coli, Pseudomonas aeruginosa*). With a zone inhibition of 24.4 mm, the ethanolic macerate extract showed high in vitro antibacterial activity against *Pseudomonas aeruginosa*. The disc diffusion method, on the other hand, demonstrated that the ethanolic decoctate was efficient against Gram-positive bacteria (*Staphylococcus aureus and Bacillus stearothermophilus*), with a diameter zone of inhibition ranging from 21.1mm to 23.75mm, respectively [34].

Shegute et al., characterized *Agave americana* contains alkaloids, saponins, tannins, polyphenols, and flavonoids. Antibacterial activity of *A. americana*'s crude and solvent fractions is equivalent to that of gentamycin with zones of inhibition ranging from 17 mm to 40 mm and MICs of 2.5 mg/ml for *S. aureus, P. aeruginosa, Klebsiella pneumoniae, Salmonella* species, and *Escherichia coli* strains. Phytochemical components of *Agave americana* were determined using standard methods of analysis [35]. *NINO, Jaime et al.,* investigated the agar well diffusion method to test 75 crude n-hexanes, dichloromethane, and methanol extracts from the aerial parts of 25 plants belonging to four botanical families (Asteraceae, Euphorbiaceae, Rubiaceae, and Solanaceae) for antibacterial and antifungal activity. The same plant extracts were also tested against *Candida albicans, Aspergillus fumigatus,* and *Fusarium solani*. Overall, the plant extracts studied were more effective as bactericides than fungicides [36].

Bishnu Thapa et al., extracted gram negative bacteria from diverse clinical samples and used the modified Kirby-Bauer disc diffusion method to determine antibiotic susceptibility. The antibacterial activity of methanol extracts of six different medicinal plants, including *Acorus calamus* (bojho), *Ocimum sanctum* (tulsi), *Azadirachta indica* (neem), *Cinnamomum tamala* (tejpatta), *Aloe vera,* and *Zanthoxylum alatum* (timur) was tested using the agar

well diffusion method against the selected MDR bacteria. Antibacterial medicinal herbs could be a viable alternative to antibiotics for MDR Gram negative bacteria [37].

Gonelimali et al., investigated the antibacterial activity of ethanolic and aqueous extracts of *Rosmarinus officinalis* (rosemary), *Syzygium aromaticum* (clove), and *Thymus vulgaris (*thyme) against a variety of food pathogens and spoilage microorganisms. The results showed that plant extracts had a tremendous impact on Gram-positive and Gram-negative bacteria's cell membranes, as revealed by a decrease in pH and cell membrane hyperpolarization. Plant extracts are effective natural antimicrobials that can be used as food preservatives [38].

Ana Morales et al., analysed and assessed the hydroalcoholic extract of Croton draco's antibacterial activity in vitro against microorganisms of sanitary importance. Hydroalcoholic maceration was used to get the extract. The extract was characterised qualitatively and chemically, and the antibacterial activity was assessed using the Minimum Inhibitory Concentration (MIC) and the Minimum Bacterial Concentration (MBC). The hydroalcoholic extract of Croton draco yielded phenolic components, terpenes, saponins, and alkaloids, according to qualitative characterization studies. The presence of thymol and carvacrol was determined by gas chromatography at quantities of 0.5340 mg/ml and 0.4206 mg/mL, respectively. The bacteria were sensitive to the hydroalcoholic extract in varying degrees. However, Gram positive bacteria like Listeria monocytogenes, *Staphylococcus aureus*, and *Bacillus subtilis* showed higher activity [39].

The antibacterial activity of essential oils found in the leaves of two medicinal and fragrant plants, *Eucalyptus gobulus a*nd *Rosmarinus officinalis.* Hydrodistillation was used to extract the oil, however the output was disappointing (0.132 percent for *Eucalyptus globulus* and 0.004 percent for *Rosmarinus officinalis*). Using the aromatogramme approach, essential oil extracts from the two plants were utilised to highlight antibacterial activity of three pathogenic bacterial strains, *S. aureus, P. aeruginosa*, and *E. coli.* The results revealed that all of the strains tested had antibacterial activity. The most vulnerable bacteria were *E. coli* and *P. aeruginosa*, whereas *S. aureus* was the most resistant.The solid dilution method was used to find the minimal inhibitory doses. The tests conducted yielded almost negative findings [40].

Disc diffusion assay was used to test the antibacterial activity of crude extracts and flavonoids from Tridax procumbens L. (Asteraceae) and Cardiospermum halicacabum L. (Sapindaceae) leaves against two Gram positive and five Gram negative bacteria. Antimicrobial activity was observed in both plants throughout a broad spectrum.The flavonoids of C. Halicacabum and T. Procumbens were found to be the most powerful of the five extracts examined. The findings of this study suggest that T. Procumbent and C. Halicacabum could be used to develop future antimicrobial medicines [41].

Kumari Pushpa Rani et al., studied *Myristica fragrans* Houtt (Nutmeg) seed extract for antibacterial efficacy against a lower respiratory infection. *Acinetobacter baumannii* isolates were tested against the seed extract. According to the findings, secondary metabolites found in plants can be a valuable source of antibacterial chemicals [42]. *Mohd. SayeedAkthar et al.,* studied disc diffusion method was used to test antibacterial activity. The serial dilution method was used to obtain the minimum inhibitory concentration (MIC), minimum bactericidal, and fungicidal concentrations. The antibacterial activity of methanol leaf extract from test plants was higher against the selected bacterial and fungal species. This research implies that test plants could be great choices for creating novel antimicrobial medications that are effective against a wide spectrum of pathogenic bacteria and fungi [43].

3. CONCLUSION

Finally, many research on the antimicrobial activity of medicinal plant extracts revealed that solvent extracts have promise antibacterial action against bacterial and fungal human diseases. Scientific studies on therapeutic plants with traditional claims of effectiveness, according to the findings of many herbal specialists, may yield successful results. These plants might be a good place to look for novel antimicrobial agents.

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