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Herbal plants used in anti-microbial activity- A review

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Abstract
Several traditional plants have the medicinal benefits from many years and are included in the Rasayana category. An ayurvedic preparation used in the Indian traditional health care system (Ayurveda), which have been advocated for their intriguing antimicrobial properties. Rasayanas are a class of non-toxic polyherbal medicinal preparations that stimulate the immune system, preventing sickness and promoting health and life. They are studied for their chemical constituents, therapeutic properties, and antimicrobial properties. Antimicrobials have been shown to prevent microbial infections and may also protect the body from a variety of microbes-related disorders such as tuberculosis, gonorrhoea, syphilis, plague, cholera, botulism, pneumonia, also in infections and periodontitis, etc. The hunt for these effective non-toxic natural chemicals with antimicrobial action has accelerated in recent years which has been very productive and acquire. So here is the brief overview of a study report on plants with antibacterial potentials and medicinal properties are included in this review.

Keywords: antimicrobial activites, plant extract, infections

Introduction
Plants are continually threatened by a diverse range of harmful microbes. Disease control is a significant issue in plant production [1]. Bacterial infections caused by pathogens have wreaked havoc on various plants, that is basically resulting in significant losses in harvest productivity and quality. Chemical compounds can be used quickly and easily to address plant diseases and microbiological contamination, spraying copper-based chemicals has a negative influence on the environment and yield, due to their general toxicity and the establishment of resistant strains [2]. Antibiotics are forbidden in many countries due to their high acute toxicity, food chain build-up, and long breakdown times. Different plant chemicals have been studied for their antimicrobial action as an alternate strategy for plant protection and disease dissemination. Several research have been undertaken in recent years also found indications that several aromatic plants may be a possible source of natural insecticides. Secondary metabolism is produced in specific cells or groups of cells, which could be employed as antimicrobial agents in disease control [3]. Medicinal plants have been shown to be preferable replacements for synthetic antibiotics because they are more systematic and easily biodegradable in nature. Small terpenoids and phenolic chemicals, which have antimicrobial action when evaluated independently, are amenable for the antimicrobial/antibacterial activity of herbal plants [4]. The purpose behind this work was to learn more about antimicrobials movement of varieties of plants and several of their components contrary to the causative agents.

Medicinal plants with anti-bacterial properties
1. Terminalia arjuna
Family- Combretaceae
Chemical constituents- Saponins (arjungenin and, arjunetin, arjunolic acid, arjun glycoside), flavonoids (arjunone, arjunolone, luteolin) and proanthocyanidins [5].
Medicinal properties- T. arjuna's leaves and bark contain glycosides with cardioprotective properties, flavonoids with anti-inflammatory, antimicrobial (luteolin), anti-cancerous, and hypo-lipidemic properties [6].
Anti-microbial activity - Acetone, methanol, ethanol, hot and cold aqueous T. arjuna leaf and bark extracts were tested for antibacterial action was assessed by the method of agar well diffusion [6, 7]. Staphylococcus aureus, Proteus mirabilis, Acinetobacter sp and Pseudomonas aeruginosa were shown to be the most effective against the acetonic leaf extract. The methanolic and ethanolic extracts showed restraint zones against S. aureus and P. mirabilis. S. aureus and P. mirabilis were viewed extreme susceptible microorganisms, surviving at various concentrations, with MICs of 4.05 mg/ml and 7.25 mg/ml. All (organic and aqueous) extracts inhibited S. aureus, with the hot aqueous extract having the largest zone of inhibition of zone. The creation of inhibitory zones of both Gram positive and Gram-negative bacteria was observed in this review, indicating about Organic

extracts of T. arjuna's leaves and bark have widespread antimicrobial activity against ear infections. Surprisingly, all organic compounds of the plants had significantly higher activity [8].

2. Tamarindus indica

Family- Fabaceae

Chemical constituents- T. indica indicate the presence constituents, like Naringenin, Lupeol, Eriodectin, Catechin, Epicatechin, Procyanidin dimer, Procyanidin trimer [9].

Medicinal properties- T. indica used in healing of wound, anti-microbial diseases, stomach aches, diarrhoea, fever, malaria and respiratory diseases [10].

Anti-microbial Activity- The paper disc diffusion technique method was followed to assess the antimicrobial movement of the watery and natural concentrates [11]. The zone of inhibition around every paper disc was assessed to evaluate antimicrobial activity. The most active were the acetone extracts of stem bark against Proteus mirabilis, while the water extracts had minimal development against Staphylococcus aureus. In comparison to the stem bark extracts, leaf extracts had reduced efficacy against the test organisms. Extracts of acetone had strongest action against the organisms under test out of the three solvents used for extraction [12]. Because many traditional medicine men have created their decoctions in water, antimicrobial movement by water extricates gives the logical reason for involving these plants in the customary treatment of illnesses. Antimicrobial activity is also used to identify malarial microbes. Plasmodium falciparum and Plasmodium vivax inoculated plates were incubated at 37°C for 1 day. A definite zone of inhibition around the application location demonstrated the antibacterial activity of the tested drugs. Seven tamarind leaf methanolic extracts were compared to hydro chloroquine, which was employed as a control. Fluid extracts were given at a rate of 10l/plate. Positive controls were Hydro chloroquine (30 μg), while solvents were employed as negative control [13].

3. Allium Sativum

Family- Alliaceae

Chemical constituents- allicin and phytoncide, allinin, riboflavin, thiamine, proteins [14].

Medicinal properties- Garlic has pharmaceutical properties and to cure a variety of ailments for example, high blood pressure and cholesterol, cancer, hepatoprotective, healing of wound, arthritis, respiratory disorders, malaria, skin disease such as leukoderma, and itching [15].

Anti-microbial activity- The antimicrobial action of solvent extracts of Allium sativum on harmful microorganisms was investigated (Pseudomonas, Shigella, Bacillus and Salmonella). Methanol and chloroform extracts had demonstrated antibacterial activity at most bacterial concentration at most bacterial concentration against all bacterial cultures. The Allium sativum extract was found to have wide-spectrum action contrary to all of the Gram-positive and Gram-negative microorganisms tried in this examination might be attributed to contrasts in their cell wall organization [16]. Cancer prevention agent and microbial prevention exercises of new garlic outgrowth separated with various solvents were viewed as successful against Bacillus cereus in a review. The dissolvable concentrates of garlic showed a decent antimicrobial potential against every one of the chose contaminations [17].

4. Manilkara zapota

Family- Sapodillaceae

Chemical constituents- sapotin, saponin, achras saponin and the bitter sapotinine, tannins, apigenin-7-O-α-L-rhamnoside, flavonoids, alkaloids, phenols, steroids, glycosides and saponins, myricetin-3-O-α-L-rhamnoside and caffeic acid [18].

Medicinal properties- Many phytoconstituents in this plant that are named for a variety of biological properties, including in treatment of redness and swelling, rheumatoid arthritis, anti-microbial, anti-fungal, anti-cancer, and hypoglycaemic properties [18,19].

Anti-microbial Activity- Antimicrobial activities of M. zapota utilizing antibacterial activity of ethyl acetate leaf and stem bark extracts against a few pathogens was investigated, and it was observed that the ethyl acetate extract of stem bark demonstrated antimicrobial activity against each of the pathogenic microbes tested (Bacillus subtilis, Bacillus megaterium, Sarcina lutea, Escherichia coli, and Salmonella typhi). When investigating the antifungal activity of M. zapota, researchers discovered that an ethyl acetic acid derivation concentrate of stem bark had good effects against various fungal strains such as Aspergillus flavus, Fusarium sp, and Vasian factum sp, with inhibition of zone ranging from 08-13 mm. Leaf extracts in ethyl acetate demonstrated little antifungal action. According to these investigations, the antibacterial components in M. Zapota bark and leaves are found in relatively low quantities and so have antibacterial activity at high doses [20].

5. Rumex Acetosa

Family- Polygonaceae

Chemical constituents- anthraquinones, polyphenols, naphthalene's, flavan-3-ols, catechin nepodin, Rhein geraniin, carilagin, epicatechin-3-O-gallate.

Medicinal properties- Rumex acetosa is an herb that grows year after year with anti-inflammatory, diuretic, antiviral, antifungal, antibacterial, and anticancer effects in traditional medicine [21]. In both *in vivo* and in vitro

investigations, antioxidant scans were found to have antibacterial, anti-aging, anti-inflammatory, and anti-cancer capabilities, stomach ulcer, cramp, diarrhoea have all been treated with the plant's decoction, while the seeds have been used as an astringent in haemorrhages [22].

Anti-microbial activity - R. acetosa extracts have been shown to have antibacterial activity on Porphyromonas gingivalis, the primary causative factors of periodontitis has been demonstrated. The virulence effects of P. gingivalis, Arg gingipain and Lys-gingipain, are critical for the development of this illness. When evaluated in vitro, the proanthocyanidins-rich acetone–water extract of Rumex acetosa L. was revealed to be highly vital when tested in vitro[23].These substances effects on Kgp and Rgp activities were examined by using the disc diffusion method, the antibacterial action of n-hexane, aqueous fractions, and chloroform of methanol extracts made from varieties of portions of R. acetosa against Streptococcus pyogenes, Moraxella catarrhalis, S. pneumoniae, S. agalactiae Staphylococcus epidermidis, S. aureus, MRSA, Bacillus subtilis. The antibacterial movement of chloroform and n-hexane concentrates of these restorative plants' underlying roots was high [24].

6. Physalis angulata

Family- Solanaceae

Chemical constituents- P. angulata has the detachment of five new physalins E, F, H, I and K. Two novel physalins, physalins U and V, were isolated from a methanol concentrate of P. angulata, with seven identified ergostane-type steroidal combinations revealed the detachment of another minor physalin, physalin W [25].

Medicinal properties- Antimalarial, anti-inflammatory, anti-microbial and post-partum treatment characteristics are all documented for P. angulata [26].

Anti-microbial activity- The antimicrobial capabilities of the volatile oils recovered by hydro distillation of the air-to-air portion and roots against Klebsiella pneumoniae and Bacillus subtilis. Antifungal activity, have been proven in agar using the diffusion technique against Candida albicans, Candida stellatoidea, at all concentration, the ethanolic concentrate of P. angulata blossoms have action against Streptococcus mutans, which causes caries risk, has a lot of antimicrobial activity [27]. The pathogenic findings indicated that methanol concentrations from P. angulata eradicated S. mutans· in a short period of time at concentrations of 50 mg/ml. In comparison, the conventional antibiotic chloramphenicol had an average inhibition of zone size of 80.2 mm at 100 mg dosage, with zones of inhibition differing from 35.7 to 50.7 mm of natural antimicrobial agents from the plant. Additionally, 30 g/ml of physalin-containing portions and 600 g/ml of physalin-containing portions were sufficient to eliminate M. TB and M. avium completely. The MIC value of pure physalin B against M. tuberculosis H37 Rv strain was 33 gram per ml [28].

7. Piper betel

Family- Piperaceae

Chemical constituents- pentatriacontane, stearic acid and chavicol hentriacontane, γ-sitosterol, n-triacontanol Phenolic compounds eugenol and hydroxychavicol [29].

Medicinal properties- Anthelmintic action was found in essential oil isolated from P. betle leaves. Aqueous, ethanolic, and methanolic extracts of the leaves have cancer prevention, peptic ulcers, hypoglycaemic, antifungal, antimalarial, antibacterial, and also healing of wounds [29, 30].

Anti-microbial Activity- The method of disc diffusion was assessed to test the antimicrobial action of ethyl alcohol extracts of betel leaf against bacteria for example, Staphylococcus aureus, Staphylococcus epidermidis, Bacillus cereus, Escherichia coli & Salmonella typhimurium, as well as four oral isolates that were possibly recognized as Staphylococcus sp. and Pseudomonas sp. using biochemical tests [31]. The maximum inhibition zone was reported in S. epidermidis when using an ethanol extract. The ethanol extraction of betel leaf has the maximum efficacy against Staphylococcus sp. Gram-positive microbes were demonstrated to be more delicate than Gram-negative microorganisms, with a bigger inhibition zone in Gram positive microscopic organisms [32, 33].

8. Areca nut

Family- Aceraceae

Chemical constituents- Articaine, propylmalonic acid, 1-acetyloxydodecyl acetate, carbromal, arecoline, arecaine, choline, guvacoline, arecaidine and guvacine [34].

Medicinal properties- Mental disorientation, enlarged eyes, pus formation, and chronic urinary distress are all treated with it in Ayurveda. It's also utilised as an aphrodisiac and nervine tonic. Chewing areca nut strengthens the gums, reduces sweating, eliminates bad breath and anthelmintics [35].

Antimicrobial Activity- The technique of disc diffusion was employed to analyse the antimicrobial effectiveness of areca nut ethanol extracts against six foods borne bacteria. Bacillus cereus, S. aureus, S. epidermidis, Salmonella typhimurium, Escherichia coli. The maximum inhibition zone was obtained in S. aureus and the In the instance of areca nut ethanol extract, Bacillus cereus had the lowest inhibitory zone [36]. The areca nut ethanol extract had no effect on S. typhimurium or E. coli. Both extracts zones of inhibition against food-borne infections are shown. The least action was recognized against oral strains of Staphylococcus and Pseudomonas with the most elevated movement against Staphylococcus. Inhibition zones of both extracts against oral microbes: the areca nut of ethanol extract had the most elevated MIC value and the elevated MBC value against,

Bacillus cereus, S. aureus, S. epidermidis, and. Interestingly, against Staphylococcus the best MIC value of areca nut of ethanol extract with the elevated MBC value was observed [37].

9. Cinnamomum tamala

Family- Lauraceae

Chemical constituents- Tetrahydroxy flavone, quercetin, kaempferol-3-O- rhamnoside and myricetin [38].

Medicinal properties- Dried leaves and bark of C. tamala used for diarrhoea or cough, bronchitis, colds, and cough, and circulatory system, anti-microbial and anti-inflammatory activity [39].

Antimicrobial Activity- In comparison to gram-positive bacteria, antimicrobial action on gram-negative pathogens (Salmonella typhimurium and Escherichia coli) has been demonstrated. The ethanolic concentrate of new leaves had more grounded antibacterial action against Escherichia coli while the methanolic concentrate of new leaves would be beneficial to antibacterial movement against Salmonella typhimurium. It was also shown that several solvent extracts of C. tamala leaves, Gram-positive and gram-negative bacteria were suppressed to a higher amount by water, dichloromethane, n-hexane and isobutanol extract. Cinnamaldehyde and eugenol, are antimicrobial components in Cinnamomum extracts. Gram-negative microorganisms were fewer vulnerable to the impacts of cinnamaldehyde because it has an outside layer that surrounds the cell barrier and prevents hydrophobic chemicals from diffusing through the lipopolysaccharide coating. Gram-negative bacteria, on the other hand, were more susceptible because C. tamala extracts may contain particular ingredients that allow the extract to bypass the obstacles in gram-negative bacteria. Aside from these factors, the existence of distinct microbial prevention components in new leaves could explain the differences in antibacterial activity [39].

10. Eucalyptus Globulus

Family- Myrtaceae

Chemical constituents- E. globulus oil revealed α-pinene and D-limonene, 1,8-cineole, α-pinene, and linalool acetic acid derivation [40].

Medicinal properties- These essential oils have many medicinal properties such as anaesthetic, anodyne, antiseptic, astringent, deodorants, tumor, diabetes, diphtheria, diarrhoea, fever, flu, inflammation, laryngoplegia, trachalgia, worms, and wounds [41]. Antimicrobial Activity - The antibacterial action of essential oils varied dependent on the length of the inoculums and the essential oil proportion. The inhibitory zone's diameter ranged from 8 to 26 mm.

E. coli (10-3 dilution) had the biggest zone of inhibition with 100% concentration of E. globulus essential oils while S. aureus (10-1 dilution) had the smallest zone of inhibition with 25% concentration of essential oils. A higher concentration of essential oils resulted in a more significant inhibition. The concentration of essential oil leaves is growing. In compared to controls, a very modest inhibitory effect on microorganism growth was detected at low concentrations. However, when essential oil concentrations increased, there was a clear inhibitory impact on the development of and S. aureus. Except at dilution 10-3, when the gramme (-) bacteria E. coli was known to be extreme susceptible to the oil than the gramme (+) bacterium S. aureus, the essential oil of E. globulus leaves inhibits both pathogens [42].

11. Momordica charantia L.

Family- Cucurbitaceae

Chemical constituents- Kaempferol-3-O-rutinoside, Kaempferol-O-acetylhexoside, Quercetin-O-pentosylhexoside, Rutin, Momordicine I Momordicine II, Charantal, Charantin [43, 44].

Medicinal properties - Momordica charantia plant includes a wide range of primary and secondary metabolites with antiulcer, antioxidant, antibacterial, anthelmintic, antidiabetic, antiinflammatory, antihyperglycemic, and anticancer activities, as well as nutritional qualities such as antilipolytic [44].

Antimicrobial properties- M. charantia leaf and stem extracts in methanol have remarkable antimicrobial action against Staphylococcus aureus, Bacillus subtilis, Escherichia coli, Pseudomonas aeruginosa and Klebsiella pneumonia, whereas leaf extracts in ethanol showed antimicrobial activity against Trypanosoma cruzi, as well as enhancing the antifungal effect of metronidazole, E. coli, M. charantia leaves extract have antibacterial action against S. typhi and may help with hepato-inflammatory symptoms. Fresh fruit extracts showed antibacterial efficacy against Saccharomyces cerevisiae, Pseudomonas aeruginosa, and Bacillus subtilis, as well as E. coli, Staphylococcus, Pseudomonas, Salmonella, and Streptobacillus, in a manner comparable to hydrophilic extracts of leaves and Aspergillus Niger. Fruit extracts outperformed leaf extracts and seeds in terms of antibacterial activity, with methanol extracts having the greatest result [45, 46].

12. Pistacia khinjuk

Family- Anacardiaceae

Chemical constituents- Myrcene, Limonene, phellandrene and α-Pinene [47].

Medicinal properties- Useful in the treatment of dermatitis, respiratory diseases, anti-diarrheal, antipyretic, antibacterial, antiviral, pectoral, and stimulant in traditional medicine [47].

Antimicrobial activites- P. khinjuk extracts at three different strengths of 30, 55 and 80 mg/ml were compared to antibiotics, and antibacterial activity increased as the concentration is elevated from 30 to 80 mg/ml. Except for 80 mg/ml hydroalcoholic extract of P. khinjuk fruit derm on E. coli, which is better than Tobramycin and the

similar as Gentamicin and Kanamycin, and 80 mg/ml water concentrate of P. khinjuk derm product on S. epidermidis, which is higher than Gentamicin and the same as Gentamicin and Kanamycin, the antibacterial activity of P. khinjuk concentrates against microorganisms is of natural product derm of P. khinjuk on S. aureus, which is significantly greater than Tobramycin and the same as Kanamycin and Gentamicin [48].

13. Cassia auriculata

Family- Caesalpiniaceae

Chemical constituents- Cassia auriculata for the presence of phytoconstitutents (resorcinol, alpha-tocopherol-beta-mannosidase, O-methyl-d-glucose) [49].

Medicinal properties- The leaves are anthelmintic and can help with ulcers, leprosy, and skin conditions. Urinary discharges, diabetes, and throat infections are all treated with the flowers. The fruit can help with thirst and vomiting. Diabetes, diarrhoea, and chronic conjunctivitis are all treated with the seed. The bark has astringent properties [50].

Antimicrobial activites- The antibacterial activity was resolved using the inhibition of zone method. In total, three bacterial strains were used in this experiment one gram (-) (E. coli) and two grams (+) (S. aureus, B. subtilis). The ethanolic concentrates of CALE and CAFE were so dynamic in gram negative microscopic organisms in an antibacterial trial (E. coli). Gram-positive microbes were more impervious to anti-infection agents (S. aureus, B. subtilis). At 4 mg, CALE repressed the improvement of S. aureus, B. subtilis, and E. coli When compared to CALE, the CAFE had lower activity against test microbes with increasing concentrations, the extract's inhibitory action increased (0.5 to 4 mg) [50].

14. Punica granatum L.

Family- Punicacea

Chemical constituents- Tannins (Punicalin and punicafolin) and flavones glycosides [51] including luteolin and apigenin, ellagitannin [52].

Medicinal properties- Pomegranate has great astringency and it is the second primary attribute used in folk medicine, making a common therapy for dysentery and diarrhoea, as well as stomatitis in the form of an aqueous decoction. It can be consumed, also used as a mouthwash, douche, or enema. To prevent fertility, root extract is taken orally and intravaginally. Snakebite, diabetes, burns, and leprosy have all been treated with these materials in the past [53,54].

Antimicrobial activites- P. granatum extracts were evaluated in vitro for antibacterial action against human pathogenic microbes by the disc diffusion agar and the microdilution techniques. P. granatum leaves extracts revealed varying ranges of antibacterial efficacy against In vitro antibacterial research was conducted on all examined bacterial strains against conventional and resistant S. aureus and E. coli strains. This extract had a high MIC of 0.625 mg/mL against Gram-positive and Gram-negative standard strains, also the MIC of 2.5 mg/mL against penicillin-resistant pathogens. It also showed promising results against methicillin-resistant S. aureus a prominent bacterial infection. The ethanol extract was strong against all S. aureus strains and normal E. coli bacteria. The aqueous extract was particularly efficacious against the standard strains of E. coli. Phytoconstituents present in P. granatum leaves extract are responsible for this antibacterial action [55].

15. Cissus quadrangularis

Family- Vitaceae

Chemical constituents- onocer-7-ene-3a,21-b-diol and b-carotene, linoleic acid [56, 57].

Medicinal properties- This plant has been utilised for centuries. In rats, the plant's alcoholic extract has been proven to aid in the repair of shattered bone. C. quadrangularis has also been shown to have pain relief, antibacterial/antimicrobial and cancer prevention properties [58].

Antimicrobial activites- The diffusion well technique of agar was tested for antimicrobial action of several extractables from C. quadrangularis. For 24-hour incubated suspension cultures of bacterium inoculation were used to make agar spread plates [59]. Ethyl acetate, methanol, and watery extracts were diluted in to appropriate solvents at a specified concentration (1.0 mg/ml), and each ml was placed into the wells. An equal quantity of solvent was used individually as a control. After 1-2 days of incubation at 37.61°C, the zone of inhibition was calculated from the well's border to the inside border of the encircling bacterial invasion. Tetracycline (50 mg) was employed as a reference. The bacteria were not inhibited by the solvent at any point during the experiment. Gram-positive bacteria (B. cereus, B. subtilis, Staphylococcus aureus) were very vulnerable to the plant extract, while Gram-negative bacteria (E. coli and P. aeruginosa) were highly resistant. The findings of this research have ramifications for C. quadrangularis's usage as an antibacterial agent [60].

Conclusion

Several plant species assessed are presently utilized in traditional medicine to treat microbial diseases. The favourable results of this study give a scientific foundation for the traditional usage of the plants discussed in the overview. Antibacterial action has been observed for flavonoids and saponins, which may be due to their capacity to form complexes with extracellular proteins, soluble proteins, and the bacterial cell wall. Finally, the findings of this study demonstrate that these plants have antibacterial properties and provide evidence to justify their usage in folk medicine.

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