

Iraqi Medicinal Plants with Antibacterial Effect- A Review

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Abstract: Medicinal plants possessed antibacterial activities via many mechanisms, such as disruption of cytoplasmic membrane, inhibition of cell wall synthesis, inhibition of cell membrane synthesis, inhibition of nucleic acid synthesis, inhibition of energy metabolism, as well as inhibition of bacterial virulence factors, including quorum-sensing signal receptors, enzymes and toxins. Evidence of these molecular effects at the cellular level include inhibition of biofilm formation, inhibition of bacterial attachment to host ligands, and neutralisation of bacterial toxins. The current review highlighted the medicinal plants showed antibacterial activity with their spectrum and mechanisms of action.

Keywords: medicinal plant, pharmacology, antibacterial

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I. INTRODUCTION

The excessive use of antibiotics has contributed to the emergence and spread of antibiotic-resistant bacteria in communities [1-11]. Medicinal plants were used as an antimicrobial agents to avoid the development of multi-drug resistant bacteria [12-15]. Medicinal plants can exert antibacterial activities through multiple mechanisms, such as disruption of cytoplasmic membrane, inhibition of cell wall synthesis, inhibition of cell membrane synthesis, inhibition of nucleic acid synthesis, inhibition of energy metabolism, as well as inhibition of bacterial virulence factors, including quorum-sensing signal receptors, enzymes and toxins. Evidence of these molecular effects at the cellular level include inhibition of biofilm formation, inhibition of bacterial attachment to host ligands, and neutralisation of bacterial toxins [16-20]. The current review will discuss the medicinal plants with antibacterial activity with their spectrum and mechanisms of action.

II. MEDICINAL PLANT WITH ANTIBACTERIAL EFFECTS

Achillea santolina

Achillea santolina exerted antimicrobial activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa*. MICs of *Achillea santolina* extracts against these microorganisms were 40, 60 and 12 ppm respectively (Khalil *et al.*, 2009). Ahmadi *et al* found that the standard strains of *Staphylococcus aureus* presented the greatest sensitivity to the stem extract and leaf extract in MIC (mg/l) > 0.573 and MBC > 1.146, respectively and to the flower extract in MBC > 1.663 and MIC > 0.831, respectively. In addition, it presented an intermediate sensitivity to standard strains *E.coli* with MBC > 2.293 and MIC > 1.146, respectively to the stem and leaf extract and MBC > 6.650 and MIC > 3.325 respectively to the flower extract [21-22].

Adiantum capillus-veneris

The methanolic extracts of *Adiantum capillus-veneris* aerial part showed antimicrobial properties in concentrations between 0.5-2 mg/ml of the extract against *Bacillus*, *E. coli*, *Staphylococcus*, *Proteus* and *Pseudomonas* [23-24]. The methanolic extract of *Adiantum capillus-veneris* was also tested for its antimicrobial activity against five Gram positive (including multi-resistant *Staphylococcus aureus*) and six Gram negative bacteria. The extract showed broad antibacterial activity and a very low minimum inhibitory concentration value (0.48 µg/ml) against *Escherichia coli* [25].

Agrimonia eupatoria

Marked antibacterial activity against *Staphylococcus aureus* and α -haemolytic *Streptococci* has been reported for agrimony. Aqueous extracts inhibited *Mycobacterium tuberculosis*, including the strains resistant to streptomycin and p-aminosalicylate. Essential oil was antibacterial, it was active against *Bacillus subtilis* [26-27]. The antibacterial (against *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*) and wound healing effects of the extracts of *Agrimonia eupatoria* (aqueous and ethanolic) were studied. The results showed that the ethanolic extract was more effective on inhibiting the tested bacteria than the aqueous extract. *P. aeruginosa* was the most resistant bacteria, while highest inhibition zone appeared against *E. coli* (20 mm).

There was a moderate activity against *S. aureus* with inhibition zone of 15 mm[28]. Preparations of *Agrimonia eupatoria* L were screened for antimicrobial activity against selected Gram-positive and Gram-negative bacteria of relevance in wounds using a 96 well plate microdilution method (200, 40 and 8µg/ml). It exerted moderate antibacterial effects[29].

Agropyron repens

A post-marketing surveillance was designed to investigate the efficacy and tolerability of a fluid extract of *Agropyron repens* [*Elymus repens*] (Acorus drops) in patients with urinary tract infections or irritable bladder. Data for 313 patients with urinary tract infections or irritable bladder were analysed. The patients were treated on average for twelve days with 50-60 drops 3 times a day. The primary efficacy criterion was the change of urological symptoms during the course of therapy. Between 69% and 91% of the urological symptoms initially documented were relieved in the course of therapy. Depending on the underlying urological diagnosis, between 32% and 53% of the patients were completely free of symptoms following treatment. Acorus drops were tolerated very well. No adverse drug reactions occurred[30-31].

Ailanthus altissima

Metanolic extracts from leaves and hydrodistilled residues were efficient against gram-positive bacteria[32]. A new naturally occurring sterol and six known stigmaterols isolated from fruits of *Ailanthus altissima* showed potent activity against many bacterial isolates. However, two compounds exhibited moderate activity[33]. The antibacterial effects of methanolic extracts of *Ailanthus altissima* leaves were evaluated by agar disk diffusion method against 11 (six gram-positive and five gram-negative) foodborne bacteria. The methanol extract and its different polar subfractions inhibited significantly the growth of all six gram-positive bacteria: *Listeria monocytogenes* (ATCC 19116, ATCC 19118 and ATCC 19166), *Staphylococcus aureus* (ATCC 6538 and KCTC 1916) and *Bacillus subtilis* ATCC 6633 and two gram-negative bacteria: *Pseudomonas aeruginosa* KCTC 2004 and *Escherichia coli* ATCC 8739. The zones of inhibition of methanol extract and its derived different polar subfractions against the tested bacteria were found in the 12.1–23.2 mm range and the minimum inhibitory concentration values were recorded between 62.5 and 500 mg/ml. Anti-tuberculosis activity was conducted for quassinoids isolated from *Ailanthus altissima*, although the activities were low, the resulting data provided a picture of structure-activity relationships[34-36].

Alhagi maurorum

Aqueous extract of *Alhagi maurorum* in different concentrations had no antibacterial activity against both Gram negative (*Escherichia coli* and *Pseudomonas aeruginosa*) and Gram positive (*Staphylococcus aureus* and *Stroptococcus pyogenes*) bacteria. Antimicrobial activity of the leaves and flowers extracts was tested against [*Staphylococcus aureus* (ATCC 25923), *Bacillus subtilis* (ATCC 6633), *Pseudomonas aeruginosa* (ATCC 15523) and *Salmonella typhi-murium* (ATCC 13311) using disc diffusion method. Both extracts showed antibacterial activity. The minimum inhibitory concentrations of the leaves extract were 80.7±4.5, 68.8±4.6, 60.6±8.3 and 58.0±6.3 µg/ml, and of flowers extract were 84.0±0.0, 65.0±2.7, 65.2±6.2 and 62.4±5.0 µg/ml against the mentioned microorganisms, respectively[37-38]. The antibacterial activity of methanol extracts (6 mg/ml) of the fresh aerial parts of *Alhagi maurorum* were evaluated against gram positive microorganisms [*B cereus*, *C. perfringens* ATCC 13124, *L. innocua* ATCC 33090, *L. ivanovii* Li4 (pVS2), *L. monocytogenis* ATCC 19116, *S. aureus* 72, *S. aureus* 132, *S. aureus* 224 and *S. epidermis*]. It showed antibacterial activity against only *B cereus*, *L. ivanovii* Li4 (pVS2), *S. aureus* 72, *S. aureus* 132 and *S. aureus* 224 with diameter of inhibition of 10, 7, 5, 12 and 20 mm respectively. The extract at the same concentration was also evaluated against gram negative microorganisms [*E. coli*, *Y. Enterocolitica* ATCC 23715, *K. oxytoca*, *K. pneumonia*, *S. enterica* ATCC 25566]. It showed activity against only *K. pneumonia* with a diameter of inhibition of 7mm. Increase the concentration to 23 mg/ml gave antibacterial activity only against *K. oxytoca* and *K. pneumonia* with a diameter of inhibition of 18 and 7mm respectively. The antibacterial activity of hexane extracts (6 mg/ml) of the fresh aerial parts of *Alhagi maurorum* were evaluated against gram positive microorganisms [*B cereus*, *C. perfringens* ATCC 13124, *L. innocua* ATCC 33090, *L. ivanovii* Li4 (pVS2), *L. monocytogenis* ATCC 19116, *S. aureus* 72, *S. aureus* 132 and *S. aureus* 224]. It showed antibacterial activity against only *B cereus*, *L. ivanovii* Li4 (pVS2), *L. monocytogenis* ATCC 19116, *S. aureus* 72 and *S. aureus* 132, with diameter of inhibition of 7, 7, 10, 10 and 15 mm respectively. The extract at the same concentration was also evaluated against gram negative microorganisms [*E. coli*, *Y. Enterocolitica* ATCC 23715, *K. oxytoca*, *K. Pneumonia*, *S. enterica* ATCC 25566]. It showed activity against only *E. coli*, *Y. Enterocolitica* ATCC 23715, *K. oxytoca* and *K. pneumonia* with diameter of inhibition of 12, 13, 11 and 15 respectively[39]. The MIC of 90% methanolic extract of the leaves of *Alhagi maurorum* Medic, against *Escherichia coli*, *Moraxella lacunata*, *Proteus merabiles*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Micrococcus luteus*, *Sarcina ventricull*, *Streptococcus byogenes* and *Saccharomyces cerevisiae* were 3,2,3,3,4,4,4,5, 5 and 5 mg/ml[40].

However, Neamah found that all doses of aqueous extract have no antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Streptococcus pyogenes*, using Cup-plate diffusion method [41].

Allium cepa

The petroleum ether extract of Bulbus *Allium cepa* inhibited the growth of *Clostridium parapatrificum* and *Staphylococcus aureus*. The aqueous extract or the juice of *Allium cepa* inhibited the growth of *Escherichia coli*, *Serratia marcescens*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Streptococcus* species and *Lactobacillus odontolyticus*. The extracts of dried scale leaves of *Allium cepa* exerted antibacterial activities against Gram positive bacteria like *Staphylococcus aureus* and *Bacillus subtilis* and Gram negative bacteria like *Escherichia coli* and *Klebsiella pneumonia* [42]. Antimicrobial activity of different concentrations (50, 100, 200, 300 and 500 ml/l) of essential oil extracts of three type of onions (green, yellow and red) was investigated against *Staphylococcus aureus* and *Salmonella enteritidis*. The essential oil extracts of onions exhibited marked antibacterial activity, comparatively, 50 and 100 ml/l concentrations of onions extracts were less inhibitory than 200, 300 and 500 ml/l concentrations. However *S. enteritidis* was strongly inhibited by the red onion essential oil extract [43].

The effect of the ethanolic extracts of onion against *V. cholera* was investigated. All tested strains of *V. cholerae* were sensitive to onion (*Allium cepa*) extracts of two types (purple and yellow). Purple type of extract had MIC range of 19.2–21.6 mg/ml while, the extract of yellow type onion had an MIC range of 66– 68.4 mg/ml[44-45]. The antimicrobial effects have been attributed to the action of allicin (diallyldisulphide oxide) on the growth and respiration of microorganisms such as *Staphylococcus aureus* and *Escherichia coli*. *E. coli* seemed to be less sensitive than *Staphylococcus aureus*. The -SO-S- group was essential for the antibacterial action of allicin as it inhibited the -SH enzymes. It has been observed that the permeability of bacterial cells to allicin was greatly influenced by the lipid content of the microorganisms [46-47].

Allium porrum

All the *Allium* species possessed thiosulfinate contents. It reached 0.15 $\mu\text{mol/g}$ in leek (*A. porrum*). Thiosulfates are the best studied compounds arising from *Allium* species. The antibacterial activities against a variety of Gram-negative and Gram-positive bacteria were frequently recorded [48-49].

Allium sativum

Numerous reports indicate that garlic extract has broad spectrum antimicrobial activity against Gram positive and Gram negative microorganisms. The juice, aqueous and alcoholic extracts, and the essential oil of garlic inhibited the *in vitro* growth of *Staphylococcus aureus*, *Streptococcus faecalis*, *Bacillus* sp., *Clostridium*, *Escherichia coli*, *Shigella sonnei*, *Proteus* sp., *Pseudomonas aeruginosa*, *Erwinia carotovora*, *Pasteurella multocida* and *Mycobacterium tuberculosis* [50-54]. In 1982 Bolton *et al* mentioned that, around the turn of the century, Minchin, the head of the tuberculosis ward at a Dublin hospital, wrote that garlic had a remarkable cure rate for tuberculosis. It was used as an inhalant and taken internally. At the same time, McDuffie, in New York City, compared garlic with 55 other treatments for tuberculosis and concluded that it was the most effective[55]. 2 mg/ml of garlic extract was required to inhibit one *Mycobacterium tuberculosis* strain [56]. Thirty strains of mycobacterium, consisting of 17 species, were inhibited by various concentrations of garlic extract. The inhibitory concentration was ranged from 1.34 mg/ml to 3.35 mg/ml. *M.bovis* was the species most easily inhibited by the extract, requiring only a concentration of 1.34 mg/ml. The six strains of *M. tuberculosis* required only slightly more concentration, with a mean value of 1.67 mg/ml of media[57]. Garlic extracts can also prevent the formation of *Staphylococcus* enterotoxins A, B, and C1 and thermonuclease. Garlic extracts are also effective against *Helicobacter pylori* [58]. Pure allicin produced significant antibacterial effects against various bacterial isolates[59]. In general, the antimicrobial effects have been attributed to the action of thiosulfates. Inhibition of certain thiol-containing enzymes in the microorganisms by the rapid reaction of thiosulfates with thiol groups was assumed to be the main mechanism. Allicin also inhibited other bacterial enzymes such as acetate kinase and phosphotransacetyl -CoA synthetase. Allicin also inhibited the DNA and protein synthesis, the effect on RNA is suggesting that RNA could be a primary target of allicin[60-61].

Allium schoenoprasum

Diallyl sulfides (diallyl monosulfide, diallyl disulfide, diallyl trisulfide, and diallyl tetrasulfide) are believed to be responsible for the antimicrobial activity in *Allium* species. Chive oil was examined for its diallyl sulfide content and its antimicrobial activity against some strains of food-borne pathogenic bacteria. Chive oil had a low concentration of diallyl monosulfide in comparison with the other diallyl sulfides. They inhibited all the tested pathogenic bacteria with a different degree of inhibition. Chive oil was also shown to be able to inhibit *Escherichia coli* O157:H7 in a food model[62].

Alpinia galanga

The essential oils of rhizome of *A. galanga* showed antimicrobial activity [63]. Thomas *et al*, found that ether and ethyl acetate extract of *A. galanga* exerted antibacterial activity. Aqueous extract of *A. galanga* showed significant activity against *Klebsiella pneumonia*, *Escherichia coli*, *Pseudomonas aeruginosa*, *S. aureus* and *Streptococcus pyogenes* except *Staphylococcus epidermidis* [64]. Essential oil had shown significant activity against *Staphylococcus aureus*, *Streptococcus suis*, *Erysipelothrix rhusiopathiae*, *Pseudomonas aeruginosa*, *E. coli*, *Pasteurella multocida* and *Arcanobacterium pyogenes*, the effects were attributed to 1,8-cineole, 4-allylphenyl acetate and α -bisabolene [65]. Oven-dried ethanol extract from *Alpinia galanga* flower was the most effective against *S. aureus* with inhibition zone of about 26–31 mm and the minimum inhibitory concentration (MIC) ranging from 0.352–0.547 mg/mL. No antimicrobial activity was observed on *E. coli* O157:H7 and *Salmonella*. Overall antimicrobial activity of oven-dried samples extracted with ethanol was the highest with inhibition zone of 8.94 mm and MIC of 1.457 mg/mL. In contrast, freeze-dried samples extracted with ethanol exhibited the lowest overall antimicrobial activity (7.05 mm and 2.470 mg/ml) [66]. *Alpinia galanga* ethanolic extract had strong inhibitory effect against *S. aureus*. The minimum inhibitory concentration (MIC) of the galanga extract was 0.325 mg/ml and the minimum bactericidal concentration (MBC) was 1.3 mg/ml using the broth dilution method. Transmission electron microscopy demonstrated that the *Alpinia galanga* extract caused both outer and inner membrane damage, and cytoplasm coagulation. The disruption of the cytoplasmic membrane properties was determined by the releasing of cell materials including nucleic acids [67–68].

Althaea officinalis

A methanolic extract prepared by exhaustive extraction from marshmallow root has been shown to possess an inhibiting activity able to diminish significantly the periodontal pathogens resident in the oral cavity (*Porphyromonas gingivalis*, *Prevotella* spp., *Actinomyces odontolyticus*, *Veillonella parvula*, *Eikenella corrodens*, *Fusobacterium nucleatum*, *Peptostreptococcus* spp.). Antimicrobial activity against *Pseudomonas aeruginosa*, *Proteus vulgaris* and *Staphylococcus aureus* has been documented for chloroform and methanolic extracts of marshmallow roots. The hexane extracts of flower and root of *Althaea officinalis* exerted antimicrobial activity against Gram-positive and Gram-negative bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Bacillus subtilis*, *Enterococcus faecalis*, *Staphylococcus aureus* and *Staphylococcus epidermidis*) [69–71].

Althaea rosea

The antimicrobial activities of n-hexane, methanol, ethanol, ethyl acetate and water extracts of *Althaea rosea* L. flowers were reported against *Escherichia coli* ATCC 29998, *Escherichia coli* ATCC 25922, *Escherichia coli* ATCC 11230, *Staphylococcus aureus* ATCC 6538, *Staphylococcus aureus* ATCC 29213, *Staphylococcus epidermidis* ATCC 12228, *Salmonella thyphimurium* CCM 5445, *Enterobacter cloacae* ATCC 13047, *Enterococcus faecalis* ATCC 29212, *Pseudomonas aeruginosa* ATCC 27853 by disc diffusion method [72].

Ammannia baccifera

1,4-naphthoquinone and 4-hydroxy-1-tetralone extracted from the crude hexane and ethyl acetate extract of *Ammannia baccifera* showed significant antibacterial activity against *Staphylococcus aureus*, *Salmonella typhi* and *Pseudomonas aeruginosa* at MIC = 2.35, 2.35, 9.38 for hexane and 150, 150, 300 ppm for ethyl acetate extracts respectively. Alkyl rans-4-hydroxycinnamate which also extracted from the crude hexane and ethyl acetate extract of *Ammannia baccifera*, was found active against only *S. typhi* and *P. aeruginosa* at MIC 250 ppm [73–74]. Upadhyay and Thakur found that 4-hydroxyl –a-tetralone extracted from the ethanolic extract of *Ammannia baccifera*, and its semi synthetic compound, 4-O-myricitoyl- a –tetralone were active against *Mycobacterium tuberculosis*. Their MIC was 50 and 100 µg/ ml respectively [75]

Ammi visnaga

The antimicrobial effects of the ethanolic and aqueous extract of *Ammi visnaga* were tested against six pathogenic microorganisms: *Staphylococcus aureus*, *Leuconostic mesenteroides*, *Enterococcus faecalis*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. The most active extract against Gram-positive bacteria was ethanol extract with a minimal inhibitory concentration (MIC) value of (5mg/ml) against *Enterococcus faecalis*. In addition, the same extract exerted antimicrobial activity against the Gram-negative bacteria *Escherichia coli*, *Klebsiella pneumoniae* with an MIC value of 12.5mg/ml [76]. The essential oil of *Ammi visnaga* was tested against *Escherichia coli* ATCC 25922, *Escherichia coli*, *Staphylococcus aureus* ATCC 43300, *Staphylococcus aureus*, *Pseudomonas aeruginosa* ATCC 27853, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Klebsiella pneumoniae*, and *Morganella morganii*. The essential oil exhibited the best

antibacterial activity against *Escherichia coli* ATCC 25922, *Escherichia coli*, *Staphylococcus aureus* ATCC 43300 and *Pseudomonas aeruginosa* ATCC 27853, the diameter of the inhibitory zones were 29, 25, 25, 25 mm respectively [125]. Ethanol extract of *Ammi visnaga* fruits (at a dilution of 1:40) inhibited the growth of *Mycobacterium tuberculosis* H37RVTMC 102. The aqueous and hydroalcoholic extract of seed and stem of *Ammi visnaga* showed a good antibacterial activity against *Streptococcus mutans*, *Streptococcus salivarius* and *Streptococcus sanguis* oral pathogens [77-78].

Anagyris foetida

The methanolic extracts of *Anagyris foetida* was examined against sensitive and multidrug-resistant *E. coli* strain. It reduced the activity of amoxicillin against the sensitive strain but enhanced the activity against resistant strains [79-80].

Anchusa strigosa

The antibacterial activity of the extracted lipid constituents against different bacteria strains, has been investigated. This effect was significant at different concentrations of the extracted lipids (0.01-10mg/ml). It appeared that *Anchusa strigosa* lipids were more effective against Gram positive microorganisms in comparison with Gram negative. The antibacterial activity against Gram positive as follow: *Streptococcus faecalis* > *Staphylococcus aureus* > *Bacillus sp.*, while the effect against Gram negative was in the following sequence: *Pseudomonas aeruginosa* > *Proteus sp.* > *E. coli* > *Enterobacter sp.* > *Klebsiella sp.* The volatile oil of *Anchusa strigosa* Lab. exhibits potent antibacterial activity against both Gram positive and Gram negative bacteria, especially in a high concentrations (200 and 500µg/ml). On the other hand, the fixed oil showed good activity against *Klebsiella sp.*, *Proteus sp.* and *Pseudomonas aeruginosa* especially at higher conc. (500µg/ml). However, the volatile oil showed greater inhibitory activity when compared to fixed oil. The antibacterial activity of aqueous extracts of *Anchusa strigosa* was also studied on the following fish bacterial pathogens: *Aeromonas hydrophila*, *Photobacterium damsela* subspecies piscicida, *Streptococcus iniae*, and *Vibrio alginolyticus*. A high inhibitory effect (14-19.5 mm) was produced by *Anchusa strigosa* [81-82].

Anethum graveolens

The essential oil and different extracts of *Anethum graveolens* seeds exerted antimicrobial activity against wide range of microorganisms. The essential oils and acetone extracts shown antimicrobial activity against *Staphylococcus aureus*, *Bacillus cereus*, *Enterococcus faecalis*, *Listeria monocytogenes*, *Escherichia coli*, *Yersinia enterocolitica*, *Salmonella choleraesuis*, *S. typhimurium*, *Shigella flexneri*, *Salmonella typhi*, *Pseudomonas aeruginosa*, and *Mycobacterium*. *Anethum graveolens* seed extracts have also been reported to possess anti-ulcer activity, and have shown moderate activity against *Helicobacter pylori*. Aqueous and organic extracts of seeds have exhibited potent antibacterial activity [83-85].

Anthemis nobelis

The extract and essential oil of Roman chamomile flower head showed antibacterial activity against *P. gingivalis*. The antimicrobial effects were evaluated by disk diffusion method. The results indicated that the means of inhibition zone for chamomile extract and essential oil were 13.33±3.4 and 20.5±0.5 respectively [86-87]. Azulenes and bisabolol were anti-inflammatory and antispasmodic, reducing histamine-induced reactions, including hay fever and asthma. Flavonoids, especially anthemidin, were also antispasmodic. Valerianic acid and cyanogenic glycosides were sedative. Two hydroperoxides compounds isolated from *Anthemis nobilis* showed a medium antibacterial activity [88]. In a clinical study, *Anthemis nobelis* showed a good result in the treatment of recurrent aphthous stomatitis as estimated by the time of pain elimination and the duration of the healing [89].

Antirrhinum majus

The antimicrobial assay of different concentrations of plant extract and fractions was studied against selected microorganisms. The results showed that when the concentration of plant extract and fraction was increased the antimicrobial activity also increased. The plant samples exhibited considerable antimicrobial activity against most of the bacterial strains. Disc diffusion method measured in inhibition zone (IZ) indicated that absolute methanol extract has significant inhibitory activity at the concentration of 10 mg/mL against bacterial strains such as *S. aureus* (IZ = 33.60 mm), *B. subtilis* (IZ 31.40 mm), *P. multocida* (IZ 29.40 mm) and *E. coli* (IZ 30.50 mm). The *n*-hexane extract (extracted by soxhlet) showed less activity against all the tested bacterial strains. It was observed that when the concentration of plant extract and fraction increased to 5 mg/ml some of the strains also inhibited which were resistant at 1 mg/ml concentration. The *n*-butanol fraction was unable to inhibit the growth of *E. coli*. The chloroform fraction was also unable to inhibit the growth of *S.*

aureus, *B. subtilis*, *A. alternata* and *A. niger*. The ethyl acetate fraction showed significant activity as compared to the other fractions [90-91].

Apium graveolens

Essential oil and aqueous extract prepared from the aerial parts of *A. graveolens* were tested to determine their antibacterial activity. Essential oil of *A. graveolens* was strongly inhibitory against *Escherichia coli* and moderately inhibitory against *Pseudomonas aeruginosa* and *Staphylococcus aureus*[92]. *Apium graveolens* boiling water extract showed a wide zone of inhibition of *E.coli* growth in concentration of 5% [93]. The antimicrobial activity of the liquid carbon dioxide extracts of *Apium graveolens* were tested against *Escherichia coli*, *Listeria monocytogenes*, *Citrobacter freundii*, *Hafnia alvei*, *Salmonella typhimurium*, *Bacillus cereus*, *Enterococcus faecalis*, *Enterobacter aerogenes*, *Staphylococcus aureus* and *Proteus vulgaris*. It was found that all the investigated leaf extracts were effective inhibitors of *H. alvei*, *S. aureus*, *E. coli*, *Bac. cereus*, *E. faecalis* and *E. aerogenes*, however the extracts isolated from the roots were less effective; all of them possessed high activity only against *B. cereus* and *E. faecalis*. *C. freundii* and *P. vulgaris* were resistant against celery extracts isolated both from roots and leaves [94-95].

Arachis hypogaea

Peanut peptides also exerted antimicrobial effects. They were active against *Escherichia coli* O157:H7 and *Listeria monocytogenes*[96-97].

Arctium lappa

Antibacterial activity against Gram negative (*E. coli*, *Shigella flexneri*, and *Shigella sonnei*), Gram positive (*Staphylococcus aureus*, *Bacillus subtilis*) and Mycobacterium, have been documented for *A. lappa*. The lyophilized extract of *A. lappa* was effective against *B. subtilis* and *C. albicans*. Ethyl acetate fraction was used as intracanal medication for 5 days in teeth infected with *C. albicans*, *E. coli*, *L. acidophilus*, *P. aeruginosa* and *S. mutans*. It inhibited microbial growth after 14 days. The antimicrobial activity of rough extracts from leaves of *Arctium lappa* and their phases was tested *in vitro* against microorganisms commonly found in the oral cavity, specifically in endodontic infections, *Enterococcus faecalis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Bacillus subtilis*. The *Arctium lappa* constituents exhibited a great microbial inhibition potential against the tested endodontic pathogens [98-100].

Artemisia campestris

The methanolic leaves extract of *A. campestris* exerted antibacterial activity only against Gram-positive with no antagonistic effects against Gram-negative bacterial species. The minimum inhibitory concentrations against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Salmonella typhi* were 12.5, 12.5, 250, 500 and 250 µg/ml respectively. The antibacterial activity of *Artemisia campestris* L. essential oil was tested against *Escherichia coli* ATCC 25922, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* ATCC, *Pseudomonas aeruginosa* 27853, *Salmonella typhimurium*, *Staphylococcus aureus* ATCC 43300, and *Staphylococcus aureus*. The best antibacterial activity was obtained against *Pseudomonas aeruginosa* ATCC 27853 and *Escherichia coli* with 23 mm and 20 mm inhibition zones, respectively [101-102].

Arundo donax

Aqueous extract of the stem nodes of *Arundo donax* exerted antibacterial activity against methicillin resistant *Staphylococcus aureus* (MRSA) in a concentration of 128 µg/ml. The aqueous extracts of the reed nodes (which contain the white hemicellulose membrane) demonstrated a marked dose-dependent response for anti-biofilm activity, both in preventing MRSA biofilm formation and disrupting established biofilms. These results may suggest that the traditional application of the reed membrane to fresh lacerations may be useful as a prophylactic for biofilm-related infection. The antimicrobial effects of methanolic extracts of 14 medicinal plants species were examined comparing to conventional therapeutic antibiotics against standard bacterial strains (*Staphylococcus aureus*, *Micrococcus luteus*, *Klebsiella pneumoniae*, *Escherichia coli* and *Pseudomonas aeruginosa*). *Arundo donax* extract showed the maximum effect against *Escherichia coli* and *Pseudomonas aeruginosa* among the examined fourteen medicinal plants species. The antimicrobial effects of 4% methanolic extracts of *Arundo donax* were comparable to Cephalotin (30mcg), Piperacilin (30mcg) and Amikacin (30mcg) against *Escherichia coli* and *Pseudomonas aeruginosa* [103-104].

Asclepias curassavica

The antibacterial activity of *Asclepias curassavica* was examined against *Bacillus subtilis*, *Staphylococcus aureus*, *Proteus vulgaris*, *Escherichia coli* and *Klebsiella pneumoniae*. Methanol extract was

found to exhibit growth inhibition on all tested microorganisms, except *P. vulgaris*. Petroleum spirit extract showed activity against three out of five tested organisms, but comparatively with less activity than methanolic extract. A poor response was obtained by ethyl acetate extract which showed activity against only two microorganisms, *S. aureus* and *B. subtilis*. There was no antibacterial activity for chloroform and hexane extracts. Among all the tested organisms, *P. vulgaris* was found to be resistant and remained unaffected by all extracts. *K. pneumoniae* showed moderate inhibitory zone with three extracts. The effect of petroleum spirit root extract against *E. coli* was so prominent. Among the various solvent extracts of leaf and root tested against different bacteria, the root extracts showed better inhibitory effects than leaf extracts. The crude extracts of petroleum ether, chloroform and methanol and two pure fractions obtained from methanol extract were tested for their antimicrobial property. The crude extract of chloroform was effective against *Pseudomonas solanacearum* and *Escherichia coli* than other extracts. The *in vitro* bioassay of the root extracts of *Asclepias curassavica* Linn. was done by cold percolation and Soxhlet method against four bacterial species, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Proteus vulgaris*. The MIC value for root extract of *Asclepias curassavica* was 3.06 mg/ml and the bactericidal concentration was found to be 100 mg/ml [105].

Asparagus officinalis

The antibacterial potential of the ethanolic extracts of *in vitro* grown *A. officinalis* as well as ethanolic extract of undifferentiated callus cells of *A. officinalis* were studied using the paper disc diffusion method against two gram-negative pathogenic bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*) and two gram-positive pathogenic bacteria (*Staphylococcus aureus* and *Bacillus cereus*). Antibacterial effect recorded only for callus extract (100 mg/ml) against *Bacillus cereus*. The rest of the extracts showed no antimicrobial activity in the same concentration against any of the tested pathogenic bacteria. However Naema *et al.*, found that aqueous extract of *Asparagus officinalis* showed a wide zone of inhibition when tested against *E. coli* growth in a concentration of 5% [106-107].

Avena sativa

The 70% ethanolic extract of the *Avena sativa* exerted antibacterial activity against gram positive bacteria (*Staphylococcus aureus*), and gram negative bacteria (*E. coli*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, and *Klebsiella*) [108-109].

Bacopa monniera

Methanol extracts of *Bacopa monniera* were found to be the most potent antimicrobial agent in comparison to other extracts. Aqueous extracts showed no activity against any of the microorganisms. Hexane and petroleum ether extracts showed similar antimicrobial activity but less significant in comparison to methanol extracts. The MIC of the methanol extracts was found to be the lowest against *E. coli*, *Salmonella typhimurium*, *Staphylococcus aureus* and *Saccharomyces cerevisiae* [110].

Methanolic extract (1mg/ml) of callus of *Bacopa monnieri* showed good activity against *Staphylococcus aureus*, *Salmonella typhi* and *E. coli* and maximum activity was observed against *Staphylococcus aureus*. No activity was observed against *K. pneumoniae*. Ether extract of *Bacopa monnieri* showed antimicrobial activity against four bacteria *Salmonella typhi*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Vibrio cholera* [111-112].

Ballota nigra

B. nigra subsp. *Anatolica* and *B. nigra* subsp. *Foetida* showed a good antibacterial activity against *Listeria monocytogenes*, *L. ivanovii*, *L. innocua* and *L. murrayi*. However, *B. nigra* subsp. *nigra* and *B. nigra* subsp. *Uncinata* showed nearly the same activity except against *L. innocua* [113-114].

Ethanol and chloroform fractions show maximum inhibition against *Escherichia coli* (17 mm). The antibacterial effects were correlated with the presence of heavy metals in *Ballota nigra*. The oil was active against both Gram-negative and Gram-positive bacteria. Phenylpropanoid glycosides isolated from generative aerial parts of *Ballota nigra* exhibited moderate antimicrobial activity against *Proteus mirabilis* and *Staphylococcus aureus* including one methicillin-resistant strain [115].

Bauhinia variegata

The antibacterial effects (against *Escherichia coli* MTCC 64, *Enterobacter aerogenes* MTCC 111, *Klebsiella pneumoniae* MTCC 39, *Pseudomonas aeruginosa* MTCC 424, *Salmonella typhi*, *Bacillus subtilis* MTCC 121), of the ethanolic extracts of *Bauhinia variegata* were investigated *in vitro*. It appeared that the extracts were more effective against gram positive compared to gram negative bacteria [116].

The extracts of *B. variegata* and fractions were evaluated for their antibacterial potential against selected bacterial strain (*Staphylococcus aureus*, *Bacillus subtilis* and *Klebsiella pneumonia*). The chloroform and methanolic fractions of *B. variegata* were found to be active against *Staphylococcus aureus*, *Klebsiella pneumonia*, *Bacillus subtilis* and showed high inhibitory zone of (14 nm) at the concentration of 22 mg/ml. The antimicrobial effect of *Bauhinia variegata* L. leaf and bark extract was evaluated on Gram positive species *Staphylococcus aureus* and *Bacillus subtilis* and Gram negative species *Escherichia coli* and *Pseudomonas aeruginosa*. The alcoholic extract of leaves of *Bauhinia variegata* shows maximum antimicrobial activity compared with petroleum ether and chloroform extracts. Ethanolic extract of the stem bark of *B. variegata* exerted antimicrobial activity against *B. subtilis*, *P. aeruginosa*, *S. typhi*, *S. dysenteriae*, *S. aureus* and *Vibrio cholerae*. It was more effective against gram positive than gram negative bacteria [117].

Bellis perenni

The antimicrobial effect of the aqueous and ethanolic extracts of the aerial parts of *Bellis perennis* was studied by *in vitro* method. Among the microorganisms tested, the most susceptible strains were *Staphylococcus epidermidis* MU 30 and *Staphylococcus aureus* MU 38. The antibiofilm effect of the extracts was measured by microplate biofilm method. Ethanolic extract of *Bellis perennis* did not inhibit biofilm formations of the tested microorganisms, however the aqueous extract showed limited anti-biofilm activity against *P. aeruginosa* ATCC 27853, *P. fluorescens* MU 181 and *S. epidermidis* MU 30 at 10 mg/ml concentration. Anti-Quorum Sensing (QS) activity of extracts was determined using biosensor bioassay with *Chromobacterium violaceum* CV026. The concentration of 100 mg/ml of aqueous extract of *Bellis perennis* showed promising anti-QS activity on *Chromobacterium violaceum* CV026 with zone of pigment inhibition of 10mm. Inhibition of QS-regulated violacein production in *Chromobacterium violaceum* ATCC 12472 and swarming motility in *Pseudomonas aeruginosa* PA01 were carried out using standard methods. Aqueous and ethanol extracts of *Bellis perennis* inhibited swarming by 9.5% and 38.1%, respectively. The results suggest that *Bellis perennis* could be an alternative source to explore for useful contents in the fight against bacterial infections [119]. Deca-4,6-diynoic acid and deca-4,6-diyne-1,10-dioic acid showed antimicrobial activity, the two compounds effective against Gram-positive and Gram-negative bacteria, respectively [121].

Benincasa hispida

The antibacterial activity of seed oil of *B. hispida* was tested against selected pathogens (gram positive, *M. luteus*, *S. aureus* and *B. subtilis*; and gram negative, *E. coli*, *P. multocida* and *P. aeruginosa*). Maximum mean zone of inhibition was observed against *B. subtilis* (16mm) and the minimum against *Micrococcus luteus* (11mm) [122].

However, the antibacterial activity of methanolic extract of *Benincasa hispida* was studied against three gram positive bacteria *Staphylococcus aureus*, *Staphylococcus epidermidis* and *Bacillus subtilis* and three gram negative bacteria *Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia*. The methanolic extract of *Benincasa hispida* showed no antibacterial activity [123-124].

Betula alba

Betulinic acid showed a considerable antibacterial effects, it was active against *Bacillus subtilis*, *Staphylococcus aureus* and *E. coli*, and it also showed a strong inhibition of the urease activity of *Helicobacter pylori* [125-126].

Bidens tripartita

The antibacterial properties of the essential oil were evaluated against eight Gram-positive and 11 Gram-negative bacterial species. Twelve extracts and two essential oils of *Bidens tripartita* were investigated for activity against different Gram-positive *Bacillus subtilis*, *Micrococcus luteus*, *Staphylococcus aureus*, Gram-negative bacteria *Escherichia coli*, *E. coli* (β -lactamase +), *Klebsiella pneumoniae* (ESBL+) and *Pseudomonas aeruginosa* using a broth microdilution and disc diffusion methods. The results obtained indicate antimicrobial activity of the tested extracts (except butanolic extracts) [127].

Brassica rapa

The susceptibility of six microorganisms (gram positive and gram negative bacteria) to the extracts and fractions of *Brassica rapa* was measured using cut plug method and the results compared with standard antibiotic gentamycin. All the tested fractions and crude extracts revealed positive inhibitory effects against *Pseudomonas aeruginosa* and *Bacillus subtilis*. MIC of the two aqueous extracts as well as the ethylacetate fraction of turnip roots of *Brassica rapa* were calculated as 25mg /ml, 25mg /ml and 12.5 mg /ml respectively [128-129].

Bryophyllum calycinum

The antimicrobial effects of petroleum ether, chloroform, methanol and aqueous extracts was evaluated *in vitro* against *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*. Methanolic extract of roots was found to be most effective antibacterial compared to others [130-131].

Agar cup plate test was used to determine the sensitivity of the tested *Bryophyllum calycinum* Salisb leaf extracts and the micro-dilution method was used to determine the minimum inhibitory concentration. The aqueous extract was active against all tested microbial strains (Gram-positive :*Staphylococcus aureus* ATCC 25925, *Bacillus subtilis* ATCC 6633, *Staphylococcus epidermis* ATCC 12228 and *Micrococcus luteus* ATCC 10240 ; and Gram-negative : *Enterobacter aerogens* ATCC 13048, *Escherichia coli* ATCC 25922, *Salmonella typhi* ATCC 51812 and *Shigella dysenteriae* ATCC 25931). The aqueous extract showed antimicrobial activity against all tested microorganism with minimum inhibitory concentration ranging between 0.26 to 2.08 mg/ml, while , the MICs of alcoholic extract ranged between 1.04 to 8.32 mg/m. Flavonoids , (5 methyl 4,5,7 trihydroxyl flavone and 4,3,5,7 tetrahydroxy 5-methyl 5-propenamine anthocyanidines) possessed significant antimicrobial activity against *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *E.coli* and *Staphylococcus aureus* [132-133].

Caesalpinia crista

The antibacterial effects of methanol extract of *Caesalpinia crista* leaves and its fractions were investigated by the disc diffusion method against four gram - positive and five gram- negative bacteria at concentration of 300, 500 and 800 mug/disc. The methanol extract and its three fractions exhibited better activities at higher concentrations. *Staph aureus* and *P. aeruginosa* showed better sensitivities to all extracts at all three concentrations excluding the petroleum ether fraction. *Bacillus megaterium* and *Klebsiella* spp were two bacteria amongst nine that showed lowest sensitivity to the extracts. The maximum zone of inhibition (25 mm) was obtained by the methanol extract at an 800 mug/disc concentration against *Staph aureus*. Furthermore, the crude extract of *Caesalpinia crista* and its fractions were studied for antibacterial activity. The strongest antibacterial effect was displayed by the n -butanol (72%) and ethyl acetate (80%) fractions, followed by the crude extract against *Escherichia coli* and *Bacillus subtilis*[134].

Calendula officinalis

The antimicrobial effect of ethanol crude extract of petals and reproductive parts of flowers in different concentrations was evaluated against eight types of bacteria (*Bacillus subtilis*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Proteus mirabilis* and *Enterococcus pneumoniae*). The extracts of petals part were clearly superior against all bacteria especially *Pseudomonas aeruginosa* (inhibition zone was 25mm in the concentration of 100 mg/ml), and *Staphylococcus aureus* (inhibition zone was 14mm in the concentration 50mg/ml); while the extracts of reproductive parts were less effective than petals part [135-136].

The antimicrobial activity of methanol and ethanol extracts of *Calendula officinalis* petals was tested against clinical bacterial pathogens. Methanol extract of *C. officinalis* exhibited better antibacterial activity against most of the tested bacteria, than ethanol extract. The methanol extract and 10% decoction of the plant's flowers showed antimicrobial activity against facultative aerobic periodontal bacteria (*Porphyromonas gingivalis*, *Prevotella* spp., *Furobacterium nucleatum*, *Caphocytophaga gingivalis*, *Veilonella parvula*, *Eikenella corrodens*, *Peptostreptococcus micros* and *Actinomyces odontolyticus*) with MIC 2048 mg/l [137]. Mouthwashes containing *Calendula officinalis* reduced the number of microorganisms adhered to the sutures after extraction of unerupted third molars compared to the control group [138].

The antibacterial activities of free oleanolic acid and its glucosides and glucuronides isolated from marigold (*Calendula officinalis*) were investigated. Oleanolic acid inhibited bacterial growth and survival, influenced cell morphology and enhanced the autolysis of Gram-positive bacteria suggesting that bacterial envelopes are the target of its activity [139].

Calotropis procera

The antimicrobial activity of aqueous and ethanolic extract of roots and leaves of *Calotropis procera* against *Staphylococcus aureus*, *Streptococcus pyogen*, *Escherichia coli* and *Pseudomonas aeruginosa* was studied on disc method. Both ethanolic and aqueous extracts of *Calotropis procera* had inhibitory effect on the growth of isolates. The effect exhibited by ethanolic extract of leaves and roots was significantly greater than that of the aqueous extract of leaves and roots. The petroleum ether extract of *Calotropis procera* exhibited the best antibacterial activity against *Pseudomonas aeruginosa* ATCC and *Klebsiella pneumonia* while the chloroform extract was more potent antibacterial against *Pseudomonas aeruginosa* ATCC with 19 mm, 16 mm and 17 mm inhibition zone diameters respectively [140-141].

The methanolic and aqueous extract of leaves of *Calotropis procera* were subjected to the potential antibacterial against both Gram-positive bacteria (*Staphylococcus aureus*, *Staphylococcus epidermidis*, *Staphylococcus saprophyticus* and *Streptococcus pyogenes*) and Gram-negative bacteria (*Pseudomonas shigelloides*, *Shigella dysenteriae*, *Vibrio cholerae*, *Salmonella typhi*, *Shigella flexneri*, *Shigella boydii*, *Shigella sonnei* and *Pseudomonas aeruginosa*) in agar diffusion method. It was evident that both extracts are active against the bacteria at low concentrations. Antimicrobial activity of solvent extracts of *Calotropis procera* growing wild in Saudi Arabia was evaluated against Gram-positive bacteria (*Staphylococcus aureus* and *Bacillus subtilis*) and Gram-negative (*Pseudomonas aeruginosa* and *Salmonella enteritidis*) using agar well-diffusion method. A bioassay-guided fractionation of the crude flavonoid fraction (Cf3) of methanol extract which showed the highest antimicrobial activity led to the isolation of four flavonoid glycosides as the bioactive constituents. Most of the isolated extracts showed antimicrobial activity against the test microorganisms, where the crude flavonoid fraction was the most active, diameter of inhibition zones ranged between 15.5 and 28.5 mm against the tested bacterial strains. The minimal inhibitory concentrations varied from 0.04 to 0.32 mg/ml against all of the tested microorganisms in case of the crude flavonoid fraction. Quercetin-3-O-rutinoside showed superior activity over the remainder flavonoids. The Gram-positive bacteria (*Staphylococcus aureus* and *Bacillus subtilis*) were more susceptible than the Gram-negative (*Pseudomonas aeruginosa* and *Salmonella enteritidis*). Calo-protein was purified from the most-active aqueous extracts of *C. procera* and showed broad-spectrum antibacterial activity. Calo-protein inhibited the growth of *S. aureus* and *E. aerogenes* effectively at 25 µg/ml concentration. Ethyl acetate, methanol, and aqueous extracts (20 µL of the extracts, containing 100 µg of residues), displayed high antimicrobial activity against *E. coli*, *E. aerogenes*, *P. vulgaris*, *P. mirabilis*, *P. aeruginosa* and *S. aureus*. Methanolic extract appeared as the most potent antimicrobial extract, with a diameter of inhibition zone (mm) of 14±0.31, 19±0.2, 23±0.4, 20±0.6, 8±0.12 and 27±0.06 against *E. coli*, *E. aerogenes*, *P. vulgaris*, *P. mirabilis*, *P. aeruginosa* and *S. aureus* respectively [142-143].

Canna indica

Methanolic extract of *Canna indica* leaves and flowers showed antibacterial activity against *B. subtilis*. Ethyl acetate extracts of flowers and stems/ barks also showed activity against *B. subtilis*, while, hexane and distilled water extracts of *Canna indica* leaves, flowers and stems/ barks showed no antibacterial activity. The oil showed good antibacterial activity against *Staphylococcus aureus* but mild activity against *Bacillus subtilis* [144-145].

Capparis spinosa

The antibacterial activity of petroleum ether, water, butanol, methanol and hexane crude extracts obtained from the aerial parts of *C. spinosa* was examined by agar well diffusion method. Different fractions exhibited good to moderate degrees of activity against most of the tested bacteria. Extracts were most active against *Staphylococcus epidermidis* and *Streptococcus faecalis*. Crude extract fractions and essential oils obtained from *Capparis spinosa* L. var. *arvensis* from Jordan were examined for antibacterial activity. Antibacterial activities of extract fractions were evaluated *in vitro* against a variety of Gram-positive and Gram-negative bacteria by agar well diffusion. The butanol fraction showed the broadest range of antibacterial efficacy, while the hexane fraction showed the narrowest. Antibacterial activity tests of essential oils showed that they were antibacterial, and the highest activities were recorded against *Micrococcus luteus* [146-147].

The petroleum ether, methanol, hexane, butanol and aqueous crude extracts of the whole aerial parts of *Capparis spinosa* exhibited variable degrees of antimicrobial activity. Extracts had low to moderate activity against four bacterial species (*E. coli*, *S. typhimurium*, *B. cereus*, and *Staph. aureus*) [148]. Ethanolic and petroleum ether extracts were used to study the antimicrobial activity of *Capparis spinosa* against Gram positive and Gram negative organisms by disc diffusion method. Both extracts shown significant antimicrobial activity against Gram positive organisms, *Bacillus cerus* and *Staphylococcus auerus*, and Gram negative organisms, *Pseudomonas aeruginosa* and *E.coli* compared with standard antibiotics [149].

Capsella bursa-pastoris

Soxhlet benzene extracts of *Capsella bursa-pastoris*, exerted an effective antibacterial effects. Alkaloids and flavonoids of *Capsella* gave the highest antibiotic potencies and had the broadest antimicrobial spectra. Antibacterial activity of ethanolic and aqueous extracts of *Capsella bursa-pastoris* were carried out against eight different species of bacteria, Gram-positive *Staphylococcus aureus* and *Enterococcus faecalis* and Gram-negative *Escherichia coli*, *Proteus vulgaris*, *Serratia marcescens*, *Acinitobacter bumani*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. It is active antibacterial only against gram-negative bacteria. The ethanolic and aqueous extract showed different activities; the aqueous extract (hot) showed the same or greater activity than the ethanolic extract by disc diffusion. Hot aqueous extract in a concentration of 2000 and 3000 µg/ml inhibited the growth of five gram negative pathogens in almost similar pattern. Ethanolic extract was

active only against *Ps. aeruginosa* and *K. pneumoniae*. All isolates were tested by different concentration of sub-MIC of aqueous and ethanolic extracts, these concentrations inhibited or omitted the ability of those isolates to produce virulence factors (DNase, haemolysin production and lipase production) [150-151].

C. bursa-pastoris ethanolic extract showed good antibacterial activity against six oral pathogens [*Streptococcus mutans* (PTCC 1683), *S. sanguis* (PTCC 1449), *Actinomyces viscosus* (PTCC 1202), *Enterococcus faecalis* (ATCC 29212) as oral pathogens and *Staphylococcus aureus* (ATCC 25923) and *Escherichia coli* (ATCC 29922)]. No strain showed resistance against this extract. The effect of *Capsella bursa pastoris* alcoholic extract was assayed on different stages of bacterial growth (*E. coli*, *Pseudomonas aerogenensis*, *Staphylococcus aureus*, *Bacillus cereus*). The results showed that extract caused significant changes in the bacterial growth in different concentrations. A sulfuraphane-containing solution (SCS) isolated from shepherd's purse (*Capsella bursa-pastoris*) inhibited vancomycin-resistant enterococci (VRE) and *Bacillus anthracis*. The minimal inhibitory concentration was 250 µg/ml for VRE and 1,000 µg/ml for B. anthracis [152].

Two novel antimicrobial peptides were isolated and characterized from the roots of shepherd's purse, *Capsella bursa-pastoris*. These antimicrobial peptides, named shepherdin I and shepherdin II, consist of 28 and 38 amino acids, respectively, and are glycine- and histidine-rich peptides. Shepherdin I and shepherdin II have 67.9% and 65.8% (mol/mol) glycine, respectively, and 28.6% and 21.1% (mol/mol) histidine, respectively. Both shepherdins have a Gly-Gly-His motif. These antimicrobial peptides exhibit antimicrobial activity against Gram-negative bacteria[153].

The antibacterial potential of *Capsella bursa-pastoris* MeOH, MeOH/H₂O and dichloromethane extracts were screened for activity against five Gram-positive (*Staphylococcus aureus*, *Staphylococcus epidermidis*, *Micrococcus luteus*, *Enterococcus faecalis* and *Bacillus cereus*) and four Gram-negative (*Proteus mirabilis*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Salmonella typhimurium*) bacteria. The MICs obtained for MeOH and MeOH/H₂O extracts were lower than those of dichloromethane. In addition, Gram-positive bacteria were more susceptible than Gram-negative ones[154].

Capsicum annuum

The butanol extract of *Capsicum annuum* fruit showed high antimicrobial activity against all the tested pathogens while other extracts showed comparatively moderate activity. The ethanol extract (100 mg/ml) of *Capsicum annuum* showed high antimicrobial activity against *Micrococcus sp* (20 mm), *Bacillus* (10 mm), *E. Coli* (17 mm), *Pseudomonas sp* (16mm) and *Citrobacter sp*(15 mm). The chloroform extract of *Capsicum annuum* showed less antimicrobial activity against all the tested pathogens [155-156].

The inhibitory effect of the extract of *Capsicum annuum* bell pepper type was evaluated against *Salmonella typhimurium* and *Pseudomonas aeruginosa*, inoculated in minced beef meat mixed with different concentrations of the extract, and stored at 7 degrees °C for 7 days. The minimum inhibitory concentration of the extract to prevent the growth of *S. typhimurium* in minced beef was 1.5 ml/100 g of meat. In the case of *P. aeruginosa*, a concentration of 0.3 ml of the extract/100 g of meat showed a bacteriostatic effect, while a concentration of 3 ml/100 g of meat showed a bactericidal effect [157].

Antibacterial activity of *Capsicum annuum* was evaluated against pathogenic strains isolated from the urinary tract (2 *Klebsiella pneumoniae*, 2 *Pseudomonas aeruginosa* and 2 *E.coli*). The different concentrations of the plant extracts showed antibacterial activity at 5 and 10mg/ml against the tested microorganisms [158].

Capsicum frutescens

The ethanol extract (100 mg/ml) of *Capsicum frutescens* showed high antimicrobial activity against *Micrococcus sp* (17 mm), *Bacillus* (10 mm), *E. Coli* (14 mm), *Pseudomonas sp* (12 mm) and *Citrobacter sp* (13 mm). The chloroform extract of *Capsicum frutescens* showed less antimicrobial activity against all the tested pathogens. The minimal inhibitory concentration of *C. frutescens* was determined against six strains of Gram positive (*Staphylococcus aureus* UFPEDA02, *Enterococcus faecalis* ATCC6057, *Bacillus subtilis* UFPEDA 86), and Gram negative (*Escherichia coli* ATCC25922, *Klebsiella pneumonia* ATCC29665, *Pseudomonas aeruginosa* UFPEDA416) bacteria, but for all of these microorganisms, the necessary concentrations were higher than 1000 µg/ml [159].

Carthamus tinctorius

The antibacterial activity of methanol extract of *Carthamus tinctorius* was evaluated against *H. pylori*. The inhibition zone of methanol extract of *Carthamus tinctorius* at concentration 2 mg/disc against *H. pylori* clinical isolates was 18.77±0.56mm, while, MIC and MBC for the same extract were 691.25 691.25 µg/ml respectively. An ethanol extract of the flowers inhibited the growth of *Staphylococcus aureus in vitro* at a concentration of 0.5 mg/plate, but was not effective against *Escherichia coli*. A 95% ethanol extract of the flowers inhibited the growth of *Bacillus subtilis*, *Salmonella typhosa* and *Staphylococcus aureus in vitro* at a concentration of 100 µg/plate, but was not effective against *E. coli* and *Shigella dysenteriae* [160-161].

Carum carvi

Carum carvi volatile oil showed weak antimicrobial activity against *Pseudomonas aeruginosa* at 2% concentration. 1% concentration of the volatile oil was the minimum inhibitory concentration against *Escherichia coli* and 0.5% concentration against *Pseudomonas aeruginosa* [162-163].

The essential oil of *Carum carvi* L. seeds was screened for its antimicrobial activity against ten pathogenic bacteria. The essential oil showed promising inhibitory activity against all the test bacteria. The minimum inhibitory concentration was 100-300 ppm and minimum bactericidal concentration was 200-400 ppm. Diameter of zone of inhibition (mm) of 2, 3, 10 and 15 (μl/disc) of essential oil of *Carum carvi* seeds against Gram-positive organism were: *Bacillus cereus* 30, 35, 38 and 43; *Bacillus megaterium* 38 42 47 52; *Bacillus subtilis* 38, 40, 43 and 46 ; *Staphylococcus aureus* 29, 34, 38 and 45 respectively, while , the diameter of zone of inhibition (mm) of the same concentrations against Gram-negative organism were: *Escheriachia coli* 31, 33, 36 and 40; *Pseudomonas species* 29, 32, 36 and 41 ; *Salmonella typhi* 27, 32, 35 and 39; *Shigella dysenteriae* 35, 39, 42 and 46 ; *Shigella sonnei* 45, 48, 52 and 59 and *Vibrio cholerae* 35, 38, 42 and 47. Caraway essential oil also inhibited growth of *Salmonella typhi*, *Vibrio cholera* and *Mycobacterium tuberculosis*. The microbiological activity of caraway oil obtained from different genotypes was studied in addition to the correlation between the activity and essential oil content. Caraway essential oil exhibited medium antimicrobial activity, the minimal inhibitory concentration of oil, which inhibited standard bacterial strain (*Staphylococcus aureus* ATCC 6538 P) was investigated. MIC value was recalculated to antibiotic units (AU). The microbiological activity of caraway oil of the tested objects was significantly different. The strongest activity was recorded for the oil of genotype Cluj (MIC=0.16 mg/ml; AU=8650), while the weakest activity was determined for oil of population from genotype Krakow (MIC=1.75 mg/ml; AU=582). A significant negative correlation was observed between MIC and carvone content, however positive correlation was observed between MIC and limonene content [164].

Antibacterial activity of the essential oil was recorded against Gram-positive and Gram-negative bacterial species in this study. The activity was particularly high against the genera *Clavibacter*, *Curtobacterium*, *Rhodococcus*, *Erwinia*, *Xanthomonas*, *Ralstonia*, and *Agrobacterium*, a lower activity was observed against bacteria belonging to the genus *Pseudomonas* [165].

The antimicrobial efficacy of pullulan films containing caraway essential oil (CEO) was evaluated. The films were prepared from a 10% of pullulan, containing 0.12% to 10.0% CEO. The composition of the CEO was analyzed with the use of gas chromatography. The antimicrobial activity of the CEO was evaluated with the method of serial microdilutions, and the films containing CEO-with the agar diffusion method against selected Gram-negative and Gram-positive bacteria. The structure of the film surface and its cross-section were analyzed using a scanning electron microscope (SEM). Analyses were also carried out to determine the efficacy of a pullulan coating with 10% CEO on baby carrots experimentally inoculated with *Salmonella enteritidis*, *Staphylococcus aureus* and *Saccharomyces cerevisiae*, and stored at a room temperature for 7 d. At a concentration of 0.12%, CEO inhibited the growth of all the tested microorganisms. Pullulan films containing 8% to 10% CEO were also active against all tested microorganisms. Populations of *S. aureus* on carrot samples were reduced by approximately 3 log CFU/g, while those of *A. niger* and *S. cerevisiae* by 5 and 4 log CFU/g respectively, after 7 days of storage. *S. enteritidis* was the most resistant among the tested species, since it was not significantly reduced after 7 days of storage. At the end of storage, samples treated with pullulan-caraway oil coating maintained better visual acceptability than control samples [166].

The in vitro susceptibility of 15 *H. Pylori* strains to *Carum carvi* seed methanolic extract was studied. Methanol extracts of *Carum carvi* showed anti *H. pylori* effect with MIC of 100 microg/ml [167].

Cassia occidentalis

Cassia occidentalis showed strong antimicrobial activity against *Staphylococcus aureus*, *Bacillus subtilis*, *B. protens* and *Vibrio cholerae*. Leaves of *Cassia occidentalis* were extracted with ethanol and water. The extracts were used to carry out antimicrobial screening *in vitro* on *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Salmonella typhi*, *Shigella spp.* The result showed that these extracts were effective against all tested organisms. The highest activity (diameter of the zone of inhibition was about 18mm) was demonstrated by the ethanol extract of *Cassia occidentalis* leaves against *Salmonella typhi* while the lowest activity (7mm) exerted by the water extract against *Shigella spp.* On the other hand the ethanol extract were not active against *E. coli* at all concentration. The water extract showed inhibition at lower concentration (30 and 60mg/ml) against *E. coli* and *Salmonella typhi* [168-169].

The antibacterial activity of the hexane, methanol, chloroform and water extracts of *Cassia occidentalis* was tested against *E. coli*, *P. multocida*, *S. typhi*, *S. typhimurium*, *S. pyogenes*, *S. pneumoniae* and *K. pneumoniae*. The results showed that *E. coli* was the most susceptible microorganism. The antibacterial activity of *Cassia occidentalis* flower extract was evaluated against *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Streptococcus pneumoniae* and *Pseudomonas aeruginosa*. The results showed that all the extracts had activity

against *Klebsiella pneumoniae* at a concentration between 30-90 mg/ml. The minimum inhibitory concentration ranged between 35-55 mg/ml for water extract and 25-55 mg/ml for chloroform extract. The minimum bactericidal concentration was 55 mg/ml by both water and chloroform extract. Antibacterial activity (against *Staphylococcus aureus*, *Bacillus subtilis*, *Proteus vulgaris* and *Pseudomonas aeruginosa*) and antitubercular activities was evaluated for petroleum ether, benzene, chloroform and methanol extracts of *Cassia occidentalis* leaves. Several fractions of *C. occidentalis* extracts showed good antibacterial activity (MIC: 2–8 µg/ml) and moderate antitubercular activity (MIC 25-50 µg/ml). Antibacterial activity of various extracts of *Cassia occidentalis* L. seeds was evaluated against three respiratory tract pathogens (*Staphylococcus aureus* MTCC 1144, *Streptococcus pneumoniae* MTCC 655 and *Streptococcus pyogenes* MTCC 442). The results showed that methanol extract was more active antibacterial than other extracts. The zone of inhibition exhibited by methanol extract against tested microorganisms ranged between 20.9±0.21 to 23.1±0.15 mm. The rate of release of sodium and potassium ions by aqueous and ethanolic extract of leaves of *Cassia occidentalis* was investigated for some selected pathogenic bacteria in the genera *Bacillus*, *Staphylococcus*, *Escherichia*, *Streptococcus*, *Klebsiella*, *Pseudomonas* and *Salmonella* using flame photometer. The aqueous extract was found to be more effective in the leakage of Na⁺ and K⁺ ions than the ethanolic extract for all organisms investigated except *Salmonella*. The aqueous extract released 2.66 ppm sodium ions on *Pseudomonas aeruginosa*, whereas ethanolic extract released 13.3 ppm, while the K⁺ ions released were 9.282 and 49.980 ppm for ethanolic and aqueous extract, respectively. Comparison of the amount of Na⁺ and K⁺ ions release by the plant extract with two commercial antibiotic (chloramphenicol and tetracycline) showed that the latter gives a higher value than the former. For sodium ion, *Bacillus subtilis* gives 167 ppm and 164 ppm for chloramphenicol and tetracycline respectively where as 2.28 and 3.42 ppm were released by ethanolic and aqueous extract of the *Cassia occidentalis* respectively. There was no significant difference in the amount of leaked Na⁺ ions and potassium ions between the two antibiotics. For Na⁺ [170].

Casuarina equisetifolia

The crude methanolic extracts of bark, wood, leaf and fruits of *Casuarina equisetifolia* and chromatographically isolated compounds were studied for antibacterial. The screenings of antibacterial activities of isolated compounds were compared with ampicillin (10 units/disc) and ketokonazole (10 units/disc) respectively. The isolated compounds have shown activity against Gram negative bacteria and less activity against Gram positive bacteria. Among these, (gallic acid) and (lupeol) have shown good activity against Gram-negative (*E. coli* and *Pseudomonas aeruginosa*) bacteria. Methanolic extracts of wood, bark and fruit has shown good activity (10.0, 12.0 and 10.0 mm respectively) against Gram positive microorganisms (*Staph. aureus*) while the extracts were without any effect against Gram negative microorganism. Antibacterial activity of *Casuarina equisetifolia* was tested by the disc diffusion method. Methanolic extracts of the leaves of *Casuarina equisetifolia* showed mild antibacterial activity against Gram positive (*Bacillus subtilis* and *Bacillus cereus*) and Gram negative (*Pseudomonas aeruginosa* and *E. coli*). The diameter of zone of inhibition (mm) for 250µg/disc of the methanolic extract was 8.02 ±0.23, 6.11 ±0.12, 7.23 ±0.27 and 7.14 ±0.33 against *Bacillus subtilis*, *Bacillus cereus*, *Pseudomonas aeruginosa* and *E. coli*. Aqueous extract of *Casuarina equisetifolia* was active against *S. epidermidis*, *B. subtilis*, *P. pseudoalcaligenes* and *S. typhimurium* (Zone of Inhibition 8-11mm), while, methanolic extract was active against *S. epidermidis*, *B. subtilis*, *P. pseudoalcaligenes*, *P. vulgaris* and *S. typhimurium* (Zone of Inhibition 12-18mm) [171-172].

The antibacterial effect of *Casuarina equisetifolia* was evaluated against *Bacillus cereus* ATCC11778, *Staphylococcus aureus* ATCC25923, *Enterobacter aerogenes* ATCC13048, *Escherichia coli* ATCC25922 and *Klebsiella pneumoniae* NCIM2719. The solvents used for the extraction of plant were water and methanol. The in vitro antibacterial activity was performed by agar disc diffusion and agar well diffusion method. Water extract of *Casuarina equisetifolia* showed antibacterial effect against *B. cereus* (13mm), *S. aureus* (11mm) and *K. pneumonia* (10mm), while methanolic extract was active against *B. cereus* (19mm), *S. aureus* (17mm), *E. aerogenes* (12mm), *E. coli* (12mm) and *K. pneumonia* (17mm). The antimicrobial activities of leaves extract was investigated against 7 medically important bacterial strains, *Bacillus subtilis*, methicillin-resistant *Staphylococcus aureus* (MRSA), *Micrococcus*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. The antibacterial activity of aqueous and organic solvents was determined by agar well diffusion method. The most pronounced effect was shown by the methanol extract. The most susceptible bacteria were *S. aureus*, followed by *K. pneumoniae*, while the most resistant bacteria was *B. subtilis* followed by *Micrococcus* [173].

The anti-*Helicobacter pylori* and urease inhibition activities of extracts of *Casuarina equisetifolia* were investigated. The extracts exhibited lower activity than the standard antibiotics [174].

Celosia cristata

Celosia cristata flowers showed antimicrobial effect. The antimicrobial properties of ethanolic, methanolic and other solvent extracts of *Celosia cristata* L. was evaluated against micro organisms, *Staphylococcus aureus*, *Bacillus subtilis*, *Salmonella typhimurium*, *Escherichia coli* and *Pseudomonas aeruginosa*. The minimal inhibitory concentration (MIC) values of the extracts against animal pathogenic bacteria were assessed using the broth microdilution methods. Results showed that the different extracts differed clearly in their antimicrobial activities. MIC values in the range of 0.125 to 1mg/ml hexane fraction of methanolic and ethanolic extracts exhibited good activity against *Staphylococcus aureus* (0.125mg/ml), *Bacillus subtilis* (0.5mg/ml) and dichloromethane fraction showed similar results [175-176].

Centaurea cyanus

The drug has an antibacterial effect in vitro (centaurocyanin), but only for the aerial parts of the plant without the flowers. The water, ethanol and ethyl acetate extract of *Centaurea cyanus* were tested against *Agrobacterium radiobacter* var. *tumefaciens*, *Bacillus subtilis*, *Erwinia carotovora*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Ps. fluorescens*, *Sarcina lutea* and *Staphylococcus aureus*, in a concentration of 5, 10, and 15mg/disc. The water and ethanol extracts showed moderate activity against *Staphylococcus aureus* only [177-179].

Chenopodium album

The extracts of the plant caused varied inhibition of some bacterial strains [180]. The antibacterial effects of *Chenopodium album* ethanolic leaf extract (CAE) was studied against gram positive and gram negative microorganisms. Antibacterial activity was recorded against *Bacillus subtilis* with 13 mm of inhibition zone [181].

The *in vitro* antimicrobial activities of the flowers and leaves methanolic and ethanolic extracts of *Chenopodium album* was studied against 4 bacterial strains [*Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 27853), *Bacillus cereus* (ATCC 1274) and *Staphylococcus aureus* (ATCC25923)]. However, in other studies, the antibacterial activities of *Chenopodium album* was investigated against five human pathogenic bacteria (*Escherichia coli*, *Salmonella typhimurium*, *Staphylococcus aureus*, *Proteus vulgaris* and *Pseudomonas aeruginosa*). The leaf extracts of *Chenopodium album* (aqueous and methanol) exhibited significant antibacterial activity against all the tested bacteria. The aqueous extract performed strongest antibacterial activity against *Staphylococcus aureus* with (25 mm) zone of inhibition and the least antibacterial activity was observed against *Salmonella typhimurium* with (17.75 mm) zone of inhibition. On the other hand, methanol leaf extract of *C album* also displayed potential antibacterial activity against all the tested bacteria. The strongest activity was recorded against *Pseudomonas aeruginosa* with (28.30 mm) zone of inhibition, while, the lowest antibacterial activity was observed against *Salmonella typhimurium* with (14.00 mm) zone of inhibition [182].

The zones of growth inhibition of methanol and ethyl acetate extracts of the plant were: 17.3mm against *Staphylococcus aureus* ATCC 25923, 19.7mm against *Bacillus subtilis* UC 564 (19.7 mm), 18.3mm against *Bacillus polymyxa* 474, 16.7mm against *Streptococcus faecalis* ATCC 29212, 17.7mm against *Pseudomonas aeruginosa* 25619, 16.7mm against *Salmonella typhi* 57, 17.3mm against *Vibrio cholerae* 824, 17.3mm against *Shigella dysenteriae* ATCC C3 and 18.0mm against *Escherichia coli* [183-184].

However, Amjad and Alizad mentioned that the flowers and leaves methanolic and ethanolic extracts of *Chenopodium album* don't have any activity against the tested bacterial strains [185].

Chrozophora tinctoria

Antibacterial activity of crude plant extract was carried out against six bacterial strains [three gram-positive bacterial strains, *Bacillus subtilis* (ATCC 6633), *Micrococcus leuteus* (ATCC 10240), *Staphylococcus aureus* (ATCC 6538)] and three gram negative ones, *Escherichia coli* (ATCC 1522), *Salmonella setubal* (ATCC 19196) and *Bordetella bronchiseptica* (ATCC). The result showed that the plant extract showed antibacterial activity against three bacterial strains (*M. leuteus*, *B. bronchiseptica*, *S. Setubal*) at the concentrations 5-25mg/ml [186-187].

The antibacterial effect of ethanolic and water extracts of *Chrozophora tinctoria* stems and leaves at different concentrations was evaluated against four endemic bacteria *E coli*, *Staph aureus*, *Ps aeroginesa* and *P mirabilis*. The alcoholic extract of the plant was more potent antibacterial (Diameter of inhibition 10.97mm) than water extract (Diameter of inhibition 5.38mm). The leaves extract was more potent than stems extracts (Diameter of inhibition 8.43 and 7.90 respectively) The concentration of 0mg/l was the more potent (Diameter of inhibition 13.96) followed by the concentration 25mg/l (Diameter of inhibition 11.12mm), then the concentration 10mg/l (Diameter of inhibition 1.03mm)[188].

Chrysanthemum cinerariaefolium

Chrysanthemum cinerariaefolium extracts showed antibacterial activity against *Staphylococcus aureus*. Growth Inhibition diameter of the ethanolic extract against *Staphylococcus aureus* SPMIC-29, *Staphylococcus aureus* SPMIC-130 and *Staphylococcus aureus* SPMIC-132 strains were 9 ± 1.54 , 11 ± 2.94 and 6 ± 0.84 , and that of methanolic extract were 10 ± 0.45 , 9 ± 1.95 and 11 ± 1.76 mm respectively. The diameter of the growth inhibition of *Chrysanthemum cinerariaefolium* leaf extract against three different strains of *Pseudomonas aeruginosa* (*Pseudomonas aeruginosa* PA-37, *Pseudomonas aeruginosa* PA-38 and *Pseudomonas aeruginosa* PA-39) were 4-8 mm for methanolic extract and 9-11mm for ethanolic extract [189].

Cicer arietinum

The antibacterial activities of the extracts obtained from *Cicer arietinum* L. varieties (seed extract, fruit skin extract and aerial part extract) were studied *in vitro*. Chickpea seed extracts (Cse) showed varying antibacterial activity against Gram negative strains (*E. coli*, *P. aeruginosa*, *K. pneumoniae*) in MIC range 16–64 µg/ml, but were less active against gram-positive (*S. aureus*, *B. subtilis*, *E. faecalis*) strains with MIC of 64 µg/ml. Statistically different MICs were observed between the extracts of the fruit skin (Cfs) and the aerial part (Cap) ($p < 0.05$). The antibacterial activity of Chickpea fruit skin (Cfs) and Chickpea aerial parts (Cap) extracts were not statistically different ($p > 0.05$) as they showed the same degree of inhibition against Gram-negative (*E. coli* and *K. pneumoniae*) bacteria and gram positive bacterium, (*E. faecalis* at the concentration of 32 µg/ml). Additionally, they were both less effective against *P. aeruginosa*, *S. aureus*, and *B. subtilis* at a concentration of 64 µg/ml [190-191].

The hydroalcoholic extract and its acetone and methanol fractions of the root of *C. arietinum* were studied for their antibacterial activity by disc diffusion method against different gram positive (*Staphylococcus aureus* and *Bacillus subtilis*) and gram negative (*Escherichia coli*) bacteria. It was observed that the hydroalcoholic extract and its acetone and methanol fraction showed significant activity against all the tested microorganisms [*E. coli* (NCIM - 2831), *S. aureus*, (NCIM - 2079) *B. subtilis* (NCIM - 2439)] and the hydroalcoholic extract showed the highest activity (13 mm) against *S. aureus* [192].

Cicer arietinum L ferritin was successfully isolated with two subunits with molecular weights of 20.1-kDa and 29- kDa respectively. The antibacterial effect of ferritin extracted from Chick pea (*Cicer arietinum* L.) was evaluated against Gram negative microorganisms (*Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Proteus vulgaris*), as well as Gram-positive microorganism (*Staphylococcus aureus*, *Staphylococcus epidermidis*). Among all the test pathogens *E. coli* was found susceptible (with zone of inhibition 8 mm) to the purified ferritin extract [193].

Cichorium intybus

The antibacterial effect of *Cichorium intybus* extracts was examined against Gram Positive (*Bacillus subtilis*, *Staphylococcus aureus* and *Rhizobium leguminosarum*) and Gram negative (*Vibrio cholerae*, *Escherichia coli* and *Pseudomonas fluorescens*) bacterial species. The ethyl acetate extract of chicory root showed antibacterial effects against Gram positive and Gram negative bacteria. Hexane extract of chicory on the other hand showed no such antibacterial effect [194-195].

The low molecular mass (LMM) extract of *Cichorium intybus* var. Silvestre (red chicory) has been shown to inhibit virulence-linked properties of oral pathogens including *Streptococcus mutans*, *Actinomyces naeslundii* and *Prevotella intermedia*. HPLC-DAD-ESI/MS(2) was used to investigate the compounds contained in this extract for their anti-virulence activity. The extract contained a number of components, including oxalic, succinic, shikimic and quinic acids, which interfere with the growth and virulence traits (i.e., biofilm formation, adherence to epithelial cells and hydroxyapatite) of oral pathogens involved in gingivitis and tooth decay. Succinic and quinic acid seem to be the most potent, mainly by interfering with the ability of oral pathogens to form biofilms (either through inhibition of their development or promotion of their disruption). The authors postulated that one or more of these compounds may modulate plaque formation *in vivo*, which is a prerequisite for the development of both caries and gingivitis [196].

The antibacterial activity of the root extracts of chicory was examined against pathogenic bacteria, Gram positive (*Bacillus subtilis*, *Staphylococcus aureus* and *Micrococcus luteus*) and Gram negative (*Escherichia coli* and *Salmonella typhi*) bacteria by *in vitro* agar well diffusion method. The hexane and ethyl acetate root extracts of chicory showed pronounced inhibition than chloroform, petroleum ether and water extracts. Root extracts showed more inhibitory action on *Bacillus subtilis*, *Staphylococcus aureus* and *Salmonella typhi* than *Micrococcus luteus* and *Escherichia coli* [197].

The root and leaf extracts (methanol, distilled water, chloroform, petroleum ether and acetone) of *Cichorium intybus* were investigated for antibacterial activity against Gram negative pathogenic bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*). The extracts showed a wide spectrum of inhibition against the

test pathogens. Methanolic extract of root and leaf proved to have the strongest antibacterial activity. Antibacterial activity of the test extracts at different inhibitory concentration varied significantly at 0.05 level of significance. The maximum activity was recorded at 200mg/ml concentration, the activity decreased with the decreasing of the concentration of the extract [198].

Several extracts displayed antibacterial activities against *Escherichia coli*, *Staphylococcus aureus*, *Bacillus thuringiensis*, *Bacillus subtilis*, and *Salmonella typhi* [199].

Synergistic activity of *Cichorium intybus* extracts and commonly used antibiotics, amoxicillin and chloramphenicol, were evaluated. Interactions between plant extract and antibiotics were tested against *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853 and clinical isolates *Staphylococcus aureus*, *Bacillus subtilis*, *Enterobacter cloacae*, *Klebsiella pneumoniae*, *Escherichia coli* and *Proteus mirabilis*. The combinations of acetone and ethyl acetate extract from *Cichorium intybus* and antibiotics resulted in additive effects against the tested bacteria [200].

The antimicrobial effectiveness of methanolic extract and different fractions (*n*-butanol, ethyl acetate, chloroform and *n*-hexane) of *Cichorium intybus* seeds was studied *in vitro*. The antimicrobial activity was determined by the disc diffusion method and minimum inhibitory concentration (MIC) against four bacterial strains (*P. multocida*, *E. coli*, *B. subtilis* and *S. aureus*). The results indicated that seeds methanolic extract and its fractions showed moderate activity as antibacterial agent [201].

Cistanche tubulosa

The extracts of the aerial parts of *Cistanche tubulosa* showed mild antibacterial effects against *Bacillus subtilis*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Salmonella enterica*, subsp. *enterica*, *S. typhi*, *Escherichia coli* and methicillin resistant *Staphylococcus aureus* [93]. Phenylethanoid glycosides, Campneosid I and Campneosid II, isolated from *Cistanche tubulosa*, have high antibacterial activity. Campneosid I showed significant antibacterial activity against several pathogenic strains of *Streptococcus* and *Staphylococcus* [202].

Citrullus colocynthis

Inhibitory and bactericidal activities of crude extracts, fractions and compounds of *Citrullus colocynthis* plant aerial parts and ripe deseeded fruits were performed against the drug sensitive standard strain of *Mycobacterium tuberculosis* H37Rv (ATCC 27294), 16 drug resistant strains of *Mycobacterium tuberculosis* and two *Mycobacterium* other than *tuberculosis* (MOTT) strains, using radiometric BACTEC system. Methanolic extract of ripe deseeded fruit of *Citrullus colocynthis* has shown good activity (MIC \leq 62.5 μ g/ml), one of the bioactive fractions demonstrated the best activity (MIC 31.2 μ g/ml) against *Mycobacterium tuberculosis* H37Rv. However 3 bioactive fractions also inhibited 16 clinical isolates of *Mycobacterium tuberculosis* consisting of seven non-multidrug resistant, eight multidrug resistant, one extensively drug resistant and two of *Mycobacterium* other than *tuberculosis* (MOTT) bacilli with MICs in the range of 50-125, 31.2-125 and 62.5-125 μ g/ml, respectively. Ursolic acid and cucurbitacin E 2-O- β -D-glucopyranoside were identified as the main biomarkers active against *Mycobacterium tuberculosis* H37Rv (MICs 50 and 25 μ g/ml respectively), as well as against the 18 clinical isolates [203-204].

The maximum antimicrobial activity was exhibited by acetone, ethanol, methanol and distilled water extract of the fruits against *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, and *Shigella shigella*. Whereas petroleum ether extract is less effective against the test strains [205].

The ethanolic extract showed dose dependent inhibitory activity against *Staphylococcus aureus* more than water extract. 5 mg/ml fruits ethanolic extract possessed a similar inhibitory effect to novobiocin against standard *Staphylococcus aureus* strain [206].

MIC and MBC/MFC were determined for plant organs at different maturation stages. Aqueous and diluted acetone extracts (from the plant's roots, stems, leaves and three maturation stages of its fruit and seeds) were screened for activity against Gram-negative and Gram-positive bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Enterococcus faecalis*). All extracts showed activity against all strains. The highest MICs and MBCs/MFCs were obtained from the fruit aqueous extracts (MIC 0.20 mg/ml against *E. coli* and *P. aeruginosa*), the lowest antibacterial was recorded for the root extracts of *Citrullus colocynthis* [207].

The antimicrobial activity of alkaloid extracted from *Citrullus colocynthis* were examined against five local bacterial isolates (*Escherichia coli*, *Staphylococcus aureus*, *Streptococcus* sp., *Bacillus subtilis*, and *Klebsiella* sp.) using agar disc diffusion method. The most active antimicrobial activity of extracted alkaloid were shown against *Streptococcus* sp. Broth dilution methods were used to determine the minimum inhibitory concentration (MIC) for the extracted alkaloid. The study showed that MIC values of 600 μ g/ml, 3000 μ g/ml, were recorded against *Staph. aureus*, and *E.coli* isolates respectively [208].

Citrus species

The antibacterial potential of the leaf essential oil and petroleum ether, chloroform, ethyl acetate and methanol extracts of the leaves of *Citrus aurantifolia* were studied against human pathogenic bacteria (*Bacillus cereus*, *Enterobacter faecalis*, *Salmonella paratyphi*, *Staphylococcus aureus*, *Escherichia coli*, *Proteus vulgaris*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Serratia marcescens*) by agar well diffusion method. Leaf essential oil as well as ethyl acetate, chloroform and methanol extracts of *Citrus aurantifolia* leaves exhibited pronounced activity against Gram-positive and Gram-negative bacteria and their activity was quite comparable with the standard antibiotics such as tobramycin, gentamicin sulphate, ofloxacin and ciprofloxacin screened under similar conditions [209].

Studying of the antibacterial effect of varieties of citrus available in Malaysian (*Citrus aurantifolia*, *Citrus reticulata*, *Citrus microcarpa*, *Citrus limon* and *Citrus sinensis*) against *Streptococcus pyogenes*, *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa* showed that the methanol extract of the five varieties of citrus exerted no inhibition at 5 and 10 mg/ml. The methanol extract of *Citrus microcarpa*, *Citrus reticulata* and *Citrus sinensis* at 20 mg/ml showed better inhibition compare to *Citrus aurantifolia* and *Citrus limon* against *Staphylococcus aureus* and *Escherichia coli* [210].

Citrus sinensis, *Citrus limon*, and *Citrus aurantifolia* fruit peel extracts were investigated against gastrointestinal pathogens. *Citrus aurantifolia* and *Citrus limon* showed high zone of inhibition against *Shigella* Spp., and *E. coli* strains. Whereas *Citrus aurantifolia* was effective against *Salmonella* Spp [211].

The antimicrobial potency of *Citrus aurantifolia* was studied against many bacterial pathogenes, in the different forms [juice of the fruit, burnt rind of the fruit commonly known as (epa-ijebu) in the Yoruba dialect, and the oil obtained from steam distillation of the fruit]. Antimicrobial activity was carried out by the agar well diffusion. The clinical isolates used included *Staphylococcus aureus* ATCC 25213, *Staphylococcus aureus*, *Salmonella paratyphi*, *Shigella flexnerii*, *Streptococcus faecalis*, *Citrobacter* spp, *Serratia* spp, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Escherichia coli* ATCC 25922, and *Escherichia coli*; and anaerobes which includes *Bacteroides* spp, *Porphyromonas* spp, and *Clostridium* spp. Crude extracts of all solvents used varied in zones of inhibition. The anaerobes and the Gram-positive bacteria were susceptible to all the extracts with minimum inhibitory concentration (MIC) ranging from 32mg/ml-128g/ml. The Gram-negatives showed MIC ranging from 64mg/ml-512mg/ml. Minimum bactericidal concentration (MBC) ranged between 32mg/ml to 512mg/ml depending on isolates and extracting solvent. The oil and palm-wine extract showed greater activity than the other extracts [212-213].

The antibacterial efficacy of leaf extract of *Citrus aurantifolia* Linn (CA) was evaluated against *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumonia* and *Pseudomonas* spp. 100 µl of 10 mg CA were assessed against eight test microorganisms by agar well diffusion method. A different solvent was used to obtain CA leaf extract using maceration technique. Due to its high yield value, hydroalcoholic extract of CA was used for estimating the antimicrobial activity. The study demonstrates that the hydroalcoholic extract of CA leaf exhibited antibacterial activity on *Klebsiella pneumonia*, *Pseudomonas* sp and *Staphylococcus aureus*. [214].

Citric acid extracted from *Citrus aurantifolia* was tested as antimicrobial agent. The largest inhibition area of citric acid was obtained against *Escherichia coli*, 3.92 cm, and the smallest inhibition area is obtained against *Lactobacillus acidophilus*, 2.16 cm [215].

Citrus aurantifolia oils were tested against *Mycobacterium tuberculosis*. The saturated fatty acid palmitic acid exhibited higher activity against multidrug-resistant *M. tuberculosis* strains (MICs = 50 µg/ml) than the unsaturated fatty acids oleic acid and linoleic acid, which showed less activity (MICs = 100 µg/ml) [216].

The antibacterial activity of Lemon, lime and sudachi juices was studied against seven strains of *Vibrio* species. All juices were effective in inhibiting the growth of the *Vibrio* strains. Citric acid, the major organic acid in these juices, were found to be responsible for inhibiting the growth of *Vibrio parahaemolyticus*, whereas the sauce adjusted to higher pH values had no bacterial activity. Diluted sudachi juice or citric acid solution also had antibacterial activity independently. The results suggest that citrus fruit juices were effective in preventing infection with *Vibrio* species [217].

The effect of essential oils, natural and concentrated lemon juice and fresh and dehydrated lemon peel was studied against *V. cholerae* O1 biotype Eltor serotype Inaba tox+. Products were used at different dilutions, when *V. cholerae* present at concentrations of 10^2 , 10^4 , 10^6 and 10^8 colony forming units (CFU) /ml, and after different exposure times. Concentrated lemon juice and essential oils inhibited *V. cholerae* completely at all studied dilutions and exposure times. Fresh lemon peel and dehydrated lemon peel partially inhibited growth of *V. cholerae*. Freshly squeezed lemon juice, diluted to 10^{-2} , showed complete inhibition of *V. cholerae* at a concentration of 10^8 CFU/ ml after 5 min of exposure time; a dilution of 2×10^{-3} produced inhibition after 15 min and a dilution of 10^{-3} after 30 min [218].

The antibacterial activity of crude extracts (aqueous and ethanolic) of *Citrus limonum* fruits against four wound isolates *Staphylococcus* sp, *Pseudomonas* sp, *Escherichia coli* and *Klebsiella* sp. showed that they exerted antibacterial activity with diameter of inhibition zone of 20, 18, 20 and 15 mm for ethanolic extract, and 15, 20, 11, and 10 mm for aqueous extract respectively [219-220].

The antimicrobial activity of *Citrus lemon* was studied *in vitro*. The citrus peel oils show strong antimicrobial activity. The antimicrobial activity has been checked in terms of MIC by using different solvents against microorganisms like *Pseudomonas aeruginosa* NCIM 2036 for which MIC was 1:20 by methanol extract, for *Salmonella typhimurium* NCIM 5021 the observed MIC was 1:20 by acetone extract. While, for *Micrococcus aureus* NCIM 5021 the observed MIC was 1:20 by ethanol extract [221].

The antimicrobial activity of different types and parts of lemon was evaluated against different microbial isolates. The antimicrobial effects of aqueous extracts of peel and juice from fresh and dried citrus and sweet lemon were evaluated against 6 Gram-positive and 8 Gram-negative bacterial isolates, including *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus pyogenes*, *Enterococcus faecalis*, *Streptococcus pneumoniae*, *Streptococcus agalactiae*, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Klebsiella pneumoniae*, *Escherichia coli*, *Salmonella typhi*, *Proteus spp.*, *Moraxella catarrhalis* and *Acinetobacter spp.* The water extracts of all the materials showed various inhibitory effects. The juice of *Citrus limon* has antimicrobial activities more than other types of extracts. *Escherichia coli*, *Staphylococcus epidermidis* and *Streptococcus agalactiae* showed the highest resistance to these extracts. Lemon species might have antimicrobial activity against different Gram-positive and Gram-negative and could be used for prevention of various diseases caused by these organisms [222].

The effects of *Citrus limonum* essential oils (EO) compared to 0.2% chlorhexidine (CHX) and 1% sodium hypochlorite (NaOCl) was studied in multispecies biofilms formed by *Enterococcus faecalis* and *Escherichia coli*. The biofilms were grown in acrylic disks immersed in broth, inoculated with microbial suspension (10⁶ cells/ml) and incubated at 37°C /48 h. After the biofilms were formed, they were exposed for 5 minutes to the solutions: *Citrus limonum* EO, 0.2% CHX, 1% NaOCl or sterile saline solution. The discs were placed in sterile 0.9% NaCl and sonicated to disperse the biofilms. Tenfold serial dilutions were performed and the aliquots were seeded onto selective agar and incubated at 37°C / 48 h. Next, the number of colony-forming units per milliliter was counted and analyzed statistically (Tukey test, p <0.05). *Citrus limonum* EO promoted a 100% reduction of *C. albicans* and *E. coli*, and 49.3% of *E. faecalis*. CHX was less effective against *C. albicans* and *E. coli*, yielding a reduction of 68.8% and 86.7%, respectively. However, the reduction of *E. faecalis* using CHX (81.7%) was greater than that obtained using *Citrus limonum* EO. *Citrus limonum* EO was effective in controlling multi-species biofilms; the microbial reductions achieved by EO were not only similar to those of NaOCl, but even higher than those achieved by CHX, in some cases [223].

The antibacterial activity of *Citrus limon* was studied against *Acne vulgaris*. *Citrus limon* juice was used at different concentrations of (20%, 40%, 60%, 80% and 100%) on *Propioni bacterium acne*. The *Citrus limon* juice was found to be effective at all concentrations used [224].

Essential oil from the fresh leaf of *Citrus medica* L. var. *sarcodactylis* possessed strong antimicrobial activity against *Staphylococcus aureus* and *Bacillus subtilis* (MIC 2,500 ppm). However, the antimicrobial efficiency of essential oil from this plant was much lower (about 40%) than that of tetracycline solution at the same concentration [225].

The antibacterial effect of the peels of *Citrus medica* was evaluated on *Staphylococcus aureus* MTCC96, *Escherichia coli* MTCC739, *Proteus vulgaris* MTCC426, *Bacillus subtilis* MTCC441, *Klebsiella pneumonia* MTCC109 and *Pseudomonas aeruginosa* MTCC424. The solvent used for the extraction of plants was water ethanol. The *in vitro* antibacterial activity was performed by agar cup method. The most susceptible Gram-positive bacteria were *Staphylococcus aureus* while the most susceptible Gram-negative bacteria was *Klebsiella pneumonia* and *Pseudomonas aeruginosa*. The antibacterial activity of active extract was compared with the standard antibiotic, streptomycin (100 ppm) [226].

Antibacterial activity of fruit juice and ethanolic extracts of root, leaf, bark, peel and pulp of *Citrus medica* were examined against seven bacteria (*Bacillus subtilis*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Proteus vulgaris*). The antimicrobial effects were studied using an *in vitro* disc diffusion method; minimum inhibitory concentrations (MIC) and minimum bactericidal concentrations (MBC) were determined by standard agar dilution method. All extracts and fruit juice showed varied level of antibacterial activity against one or more test bacteria. Root, leaf and bark extracts inhibited *S. aureus*, *E. faecalis* and *P. vulgaris* with maximum inhibition by root extract comparable to standard antibiotic. Fruit peels have shown least activity among all extracts and slightly inhibited growth of *S. aureus*, *K. pneumoniae* and *P. vulgaris*. Among bacteria *S. aureus* and *P. vulgaris* were highly susceptible to all extracts while *B. subtilis* was highly resistant and inhibited by only fruit juice. Root extract had the lowest MIC 0.5mg/ml and MBC 1mg/ml against *S. aureus*. The maximum MIC of extracts was 50 mg/ml and MBC 75

mg/ml. The minimum MIC of juice was < 1% and MBC 1% against *P. vulgaris* while maximum MIC was 3.5% and MBC 7% [227].

The antibacterial activity against selected bacteria was observed for the alcoholic extract of *Citrus medica*, it was active against all the tested bacteria (*Enterobacter aerogenes*, *Staphylococcus aureus*, *Bacillus subtilis*, *Proteus vulgaris*, *Klebsiella pneumoniae*, *Shigella flexneri* and *Chryseobacterium gleum*). The maximum antibacterial activity was shown against *Staphylococcus aureus* (6.3 mm) by methanolic extract [228].

The antibacterial investigation of crude extracts (aqueous and ethanolic) of fruits of *Citrus medica* var. *limetta* against four wound isolates *Staphylococcus* sp., *Pseudomonas* sp., *Escherichia coli* and *Klebsiella* sp., showed that they exert antibacterial activity with diameter of inhibition zone of 10, 12, 10 and 10 mm for ethanolic extract, and 8, 9, 8 and 9 mm for aqueous extract respectively [229].

The aqueous extract of the peels of *C. limetta* produced a good antimicrobial activity against 15 isolates, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus pyogenes*, *Enterococcus faecalis*, *Streptococcus pneumoniae*, *Streptococcus agalactiae*, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Klebsiella pneumoniae*, *Escherichia coli*, *Salmonella typhi*, *Proteus* spp., *Moraxella catarrhalis* and *Acinetobacter* spp., with inhibition zones ranged (from 10 to 35mm) against Gram-positive or Gram-negative bacteria [230].

The results of antimicrobial activity of peel essential oil of *Citrus limetta* var. *Mitha* tested by disc diffusion method, against different bacteria showed that it exhibited maximum zone of inhibition against *Bacillus cereus* ATCC 14579 (28 mm) and *Bacillus subtilis* ATCC 6633 (26 mm) followed by *Staphylococcus aureus* ATCC 25923 (21 mm), whereas the minimum zone of inhibition was shown by *Fusarium oxysporum* ATCC 48122 (11 mm) after 48 h of incubation [231].

The anti typhoid activity of aqueous extract of fruit peel *Citrus sinensis* was studied *in vitro*. The aqueous extracts of fruit peel *Citrus sinensis* exhibited antityphoid activity against *Salmonella typhi*, *Salmonella paratyphi* A and *Salmonella paratyphi* B [232].

The antibacterial activity of aqueous and ethanol extracts of *Citrus sinensis* leaves was evaluated against *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Staphylococcus aureus*. The *in vitro* antibacterial activity was performed by agar disc diffusion method. The aqueous extract showed a zone of inhibition against *Escherichia coli* (7mm), while on the other organisms it showed little or no zones of inhibition ranging from 0-3mm in diameter. The ethanol extract also showed little zones of inhibition against the tested organisms ranging from 1-3mm in diameter [233].

The peels were air-dried and ground to powder, extracted with 95% ethanol. The extract was subjected to antibacterial study against six *Salmonella paratyphi* B, one *Salmonella typhi* and three *Aeromonas hydrophila*. Agar diffusion method was employed to test the antibacterial activity of the extract and the MIC and MBC of the extract were determined by broth dilution technique. The results showed that the isolates were sensitive to the extract, with MIC of 0.25-2.5mg/ml and MBC of 0.5-5.0mg/ml [234].

Peels of *Citrus lemon*, *Citrus sinensis* and *Citrus limetta* were dried and extracted by cold water, hot water, methanol, ethanol, ethyl acetate and acetone. Extracts were subjected to antibacterial susceptibility assay against (*Pseudomonas aeruginosa* and *Salmonella typhimurium*) by agar well diffusion method. All the extracts of *Citrus lemon* were found to be effective against the tested bacterial pathogens except hexane extracts. Methanol and acetone extract showed maximum zone of inhibition of 18 mm. Hexane extract of *Citrus sinensis* was found to be most effective against bacterial pathogens giving a zone of 13 mm [235].

The antibacterial activity of methanolic extract of *C. sinensis* fruit peel was tested against three bacterial using turbidimetric or tube dilution method and paper disc diffusion method. *C. sinensis* fruit peel methanolic extract exhibited antibacterial activity against *Escherichia coli* with minimum inhibitory concentration of 0.78 µg/ml and minimum bactericidal concentration of 6.25 µg/ml [236].

The dried peels of *Citrus sinensis* were defatted and then were subjected to the methanolic extraction. The methanolic extract obtained was dissolved in various solvents such as water, methanol, ethanol, chloroform, diethyl ether and were subjected to evaluation of antitubercular activity against *Mycobacterium tuberculosis* by Microplate Alamar Blue Assay (MABA) method. The results concluded that the extract dissolved in water as solvent showed significant activity at 50µg/ml [237].

The antimicrobial activity of petroleum ether extract of the peels of *Citrus sinensis* was studied against various Gram positive organisms (*Staphylococcus epidermidis*, *Micrococcus luteus*, *Bacillus subtilis*) and Gram negative organisms (*Escherichia coli*, *Pseudomonas vulgaris*, *Salmonella typhi*). Antimicrobial activity was conducted by the agar well diffusion method. The extract showed various levels of antimicrobial activity on the tested microorganisms. It was more effective against *Staphylococcus epidermidis*, *Micrococcus luteus* and *Pseudomonas vulgaris* followed by *Salmonella typhi* and *Escherichia coli* [238].

The antimicrobial effects of aqueous extracts of peel, juice and leaves from fresh *Citrus sinensis* was evaluated against 3 Gram-positive and 6 Gram-negative bacterial, including *S. aureus*, *S. pyogenes*, *E. faecalis*,

P. aeruginosa, *K. pneumoniae*, *E. coli*, *S. typhi*, *Proteus* spp., *M. catarrhalis*. Citrus juices showed the highest antibacterial activity against most of the studied bacterial isolates. Moderate activity produced by the citrus peels and the lowest effect was produced by the extract of the citrus leaves [239].

The antimicrobial activity of *Citrus sinensis* oil was studied by paper disc diffusion method against *Bacillus subtilis* and *Escherichia coli*. Zones of inhibition of *E. coli* and *B. subtilis* were 13 and 17mm respectively [240].

The antimicrobial potential and the minimum inhibitory concentration (MIC) of aqueous and ethanol (cold and hot) extracts of *Citrus sinensis* peel extracts was investigated against *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis* and *Prevotella intermedia*, using agar well diffusion method. The results showed that *Prevotella intermedia* and *Porphyromonas gingivalis* were resistant to aqueous extracts while *Aggregatibacter actinomycetemcomitans* was inhibited at very high concentrations. Hot ethanolic extracts showed significantly higher zone of inhibition than cold ethanolic extract. Minimum inhibitory concentration of hot and cold ethanolic extracts of *Citrus sinensis* peel ranged between 12-15 mg/ml against all three periodontal pathogens [241].

Clerodendrum inerme

When *Clerodendrum inerme* tested against *S. typhi*, *K. pneumonia*, *S. aureus*, *Proteus* sp. and *B. subtilis*, Iso amyl alcohol extract showed antibacterial activity against all the bacterial species, propanol extracts also active against all species except *Proteus* sp., while ethanol, methanol and chloroform extracts exerted activity against *Proteus* sp. and *S. aureus* only [134].

The antibacterial studies of *Clerodendrum inerme* were carried out by disc diffusion technique against *Shigella sonnei*, *Klebsiella pneumoniae*, *Bacillus subtilis*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Pseudomonas solanaceum* and *Xanthomonas citri*. The maximum antibacterial activities were observed in ethanol extract (0.30 ± 0.10). Among the seven bacterial organisms, growth suppression was observed in *Pseudomonas solanaceum*, *Xanthomonas citri* and *Klebsiella pneumonia* only [242].

The antimicrobial activity of *Clerodendrum inerme* was investigated against *E. coli*, *Shigella flexneri*, *Shigella dysenteriae*, *Vibrio cholerae*, *Salmonella paratyphi*, *Proteus* spp., *Staphylococcus aureus* and *Staphylococcus epidermis* using disc diffusion assay. The chloroform bark extract of *C. inerme* showed excellent performance against all tested bacteria except *Staphylococcus epidermis* [243].

The effectiveness of the crude extracts of *Clerodendrum inerme* (L.) Gaertn. was studied against some of the human pathogenic bacteria, Gram positive (*Staphylococcus aureus*, *Staphylococcus aureus* ATCC 25953, *Staphylococcus albus*, *Streptococcus haemolyticus* Group-A, *Streptococcus haemolyticus* Group-B, *Streptococcus faecalis* and *Bacillus subtilis*) and Gram negative (*Escherichia coli*, *Edwardsiella tarda*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Shigella boydii*, *Shigella dysenteriae*, *Shigella flexneri* and *Plesiomonas shigelloides*). Five plant extracts (Petrol, Benzene, Methanol, Ethyl acetate and Aqueous) under six different concentrations (500 mcg, 1mg, 2mg, 5mg, 10mg and 15mg/ml) were tested by disk diffusion method. Methanol, Ethyl acetate and Aqueous extracts of the plant showed significant inhibition against fifteen of the eighteen tested bacteria [244].

The antimicrobial activities of different extracts (ethanol, benzene and aqueous) of *Clerodendrum inerme* plant parts were evaluated *in vitro* by disc diffusion method against Gram positive - *Bacillus subtilis* (ATCC 6633), *Staphylococcus aureus* (ATCC 25923) and Gram negative- *Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 27853). The methanol leaves extract exhibited highest zone of inhibition against *S. aureus* (16.67 ± 0.47 mm) with low MIC values (0.78 mg/ml for). However, no activity was shown by aqueous extract against the tested pathogenic strains [245-246].

Clitoria ternatea

Different extracts of *Clitoria ternatea* showed inhibitory effects against *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumonia*, *Bacillus subtilis*, *Aeromonas formicans*, *Aeromonas hydrophila* and *Streptococcus agalactiae*. Ethyl acetate extracts of *Clitoria ternatea* showed maximum zone of inhibition against *A. formicans* (18 mm), *A. hydrophila* (19 mm), *B. subtilis* (19 mm) and *P. aeruginosa* (21 mm) next to that ethanol extract of *Clitoria ternatea* showed maximum zone of inhibition against *A. formicans* (18 mm) and *E. coli* (14 mm) followed by the acetone extract which showed maximum zone of inhibition against *S. agalactiae* (19 mm) and *K. pneumonia* (17 mm) [247].

Aqueous extracts of both seed and callus were prepared for evaluating the antimicrobial activity against selected pathogenic bacteria (*Bacillus subtilis* (NCIM 2010), *Escherichia coli* (NCIM 2645), *Micrococcus flavus* (NCIM 2376), *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Salmonella typhi*) using the agar well diffusion technique. Seeds and leaf delivered calli of *Clitoria ternatea* were extracted using standardized laboratory protocol. The seed extract of *Clitoria ternatea* showed maximum zone of inhibition (22 ± 0.5 mm) against *Escherichia coli* (NCIM 2645) at 0.75 mg concentration and minimum (14 ± 1.0 mm) with *Micrococcus flavus* (NCIM 2376). The callus extract showed maximum zone of inhibition (16 ± 2.0 mm) against *Salmonella*

typhi, the minimum zone of inhibition was recorded against *Escherichia coli* (NCIM 2645) and *Staphylococcus aureus* (12 ± 1.0 mm and 12 ± 0.9 mm, respectively) [248].

The antimicrobial activities of the methanol extracts of the leaf, stems, flower, seed and roots of *Clitoria ternatea* were tested in vitro against 12 bacterial species by the agar diffusion and broth dilution methods. The leaf and root extracts were found to be most effective against all of the tested organisms ($p < 0.05$). The MIC (minimum inhibitory concentration) and MBC (minimum bactericidal concentration) values of *C. ternatea* extracts ranged from 0.3 mg/ml to 100.00 mg/ml [249].

The antibacterial properties of *Clitoria ternatea* was investigated by agar disc and well diffusion methods. The organic solvent (petroleum ether, ethyl acetate and methanol) extracts from the leaves of *Clitoria ternatea* were tested against *Bacillus cereus*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Proteus vulgaris* and *Salmonella typhi*. The results showed promising antibacterial activity against the tested microbial pathogens. Among extracts, methanol extract was found to possess a more potent inhibitory activity when compared to the other extracts (petroleum ether and ethyl acetate) [250-25].

Colchicum balansae

The antibacterial properties of *Colchicum balansae* Planchon (CB) were studied. The results showed that *Colchicum* ethanol extract had a weak inhibitory effect against tested bacteria (*Staphylococcus aureus* ATCC 25923, *Staphylococcus epidermidis* ATCC 12228, *Enterococcus faecalis* ATCC 29212, *Klebsiella pneumoniae* ATCC 13883, *Escherichia coli* ATCC 25922, *Enterobacter cloacae* ATCC 23355, *Serratia marcescens* ATCC 8100, *Proteus vulgaris* ATCC 13315, *Pseudomonas aeruginosa* ATCC 27853, *Salmonella typhimurium* ATCC 14028). *S. aureus* ATCC 25923 was more sensitive to ethanol extract (10 mm inhibition zone). When comparing the antimicrobial activity of the control antibiotics, the ethanol extract exhibited lower antimicrobial activity [252-253].

Convolvulus arvensis

The aqueous and acetonc extracts of *Convolvulus arvensis* were tested against *Staphylococcus aureus*, *Streptococcus pyogenes*, *Escherichia coli* and *Klebsiella pneumonia* using five concentrations (500, 250, 125, 0.06 and 0.03 mg/ ml). The aqueous extract of *Convolvulus arvensis* showed no antibacterial activity against all the tested microorganisms in all concentrations. However, ethanolic extract of *Convolvulus arvensis* L. showed antibacterial activity against all the tested microorganisms (except *Klebsiella pneumonia*) when used in a concentration of 0.06 mg/ml and more [254-255].

Corchorus aestuans

Fusidic acid which was obtained earlier from a fungi (*Fusidium coccineum*), then isolated from the plant *Corchorus aestuans*, has a wide range of antibacterial effects. The antimicrobial activity of various solvent extracts of *Corchorus aestuans* was evaluated against the clinical isolates of Gram-positive and Gram-negative bacterial strains. The Gram-positive bacteria used were included *Staphylococcus aureus*, *Bacillus cereus* and *Micrococcus luteus*, and the Gram-negative bacteria were *Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia*. It was appeared that ethanol, methanol, ethyl acetate, acetone, chloroform, petroleum ether, hexane and aqueous extracts showed antibacterial activity. The Ethyl acetate extract of *Corchorus aestuans* showed more activity against *Micrococcus luteus*, zone of diameter 13 ± 0.15 mm and *Escherichia coli*, zone of diameter 13.07 ± 0.12 mm. Ethyl acetate extract showed more inhibition to the growth of tested organism, than ethanol, methanol and acetone extracts [256-257].

The antibacterial potential of the methanol extracts of leaves and aerial parts of *Corchorus aestuans* was studied against four Gram positive and Gram negative bacteria [*Bacillus subtilis* MTCC (121), *Staphylococcus aureus* MTCC (96), *Pseudomonas aeruginosa* MTCC (429) and *Escherichia coli* MTCC (443)], using cup-plate method. The methanol extracts of leaves and aerial parts of the plant significantly inhibited the growth of bacteria as compared to standard antibacterial drug (streptomycin) [258].

The leaf, capsule and root extracts of *Corchorus aestuans* were tested for antibacterial against Gram positive (*Bacillus subtilis*, *Bacillus pumilis*, *Bacillus cereus*, *Staphylococcus aureus*) and Gram negative bacteria (*Escherichia coli*, *Psuedomonas aeruginosa*, *Psuedomonas vulgaris*, *Serratia marcescens*), they showed potent antibacterial activity. The leaf and root extracts of *Corchorus aestuans* showed more antibacterial activity compared to *Corchorus aestuans* capsule extract. The chloroform and methanolic *Corchorus aestuans* leaf, capsule and root extracts showed potent antibacterial activity [259].

Corchorus capsularis

Disc diffusion method was used to determine the antibacterial activity of the crude methanolic extract of *Corchorus capsularis* (leaves) against Gram positive bacteria (*Bacillus subtilis*, *Staphylococcus aureus*, *Beta hemolytic streptococcus*, *Bacillus cereus* and *Streptococcus pyrggen*) and Gram negative bacteria (*Shigella*

boydii, *Salmonella typhi*, *E. coli*, *Klebsiella* and *Vibrio mimicus*). *Corchorus capsularis* extracts possessed antimicrobial activity. N-hexane fraction of methanolic extract of leaves of *Corchorus capsularis* showed the highest activities against gram positive and gram negative bacteria with a zone of inhibition 0.9-1.5mm, followed by hexane extract [260-261].

Cordia myxa

The antimicrobial activity of *Cordia myxa* leaf extracts was studied against three bacterial strains (*E. coli*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*). Antimicrobial activity tests were performed by Agar well diffusion method. *Cordia myxa* showed highest inhibition against *Staphylococcus aureus* and then *E. coli* [262-263].

Coriandrum sativum

The antibacterial effect of aqueous and ethanolic extracts of different coriander parts was studied against nine different pathogenic bacteria isolated from urine, blood, stool and cerebrospinal fluid of different patients (*Burkholderia capacia*, *Escherichia coli*, *Enterobacter cloacae*, *Gamella morbillorum*, α -*Haemolytic streptococci*, *Klebsiella pneumonia*, *Proteus mirabilis*, *Streptococcus pneumonia*, and *Salmonella typhi*). Cold aqueous extract of coriander seeds had inhibitory effect against some tested bacteria. On the other hand, ethanolic extracts of seeds, leaves and stems showed wide range of antibacterial activity and the highest values for inhibition zone was recorded against *Klebsiella pneumoniae* and *Proteus mirabilis* [264].

Essential oils from commercial samples of coriander were assayed for their antibacterial activities. Twenty-five genera of bacteria were used as test organisms. The essential oils showed a high degree of inhibition against all the tested microorganisms [265].

The antimicrobial activity of ethanol, methanol, acetone, chloroform, hexane and petroleum ether extracts of *Coriandrum sativum* was investigated against *E. coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Klebsiella Pneumonia* using agar well diffusion method. The methanol extract of *Coriandrum sativum* showed more antibacterial activity against *Staphylococcus aureus* (zone of diameter 12.17 ± 0.29 mm) and *Klebsiella pneumonia* zone (12.17 ± 0.15 mm). It appeared that methanol extract showed a varying degree of antibacterial effects more than ethanol, acetone, chloroform, hexane and petroleum ether extracts [266].

The antibacterial potential of the leaf essential oil, petroleum ether, chloroform, ethyl acetate and methanol extracts of the leaves of *Coriandrum sativum* were studied against human pathogenic bacteria (*Bacillus cereus*, *Enterobacter faecalis*, *Salmonella paratyphi*, *Staphylococcus aureus*, *Escherichia coli*, *Proteus vulgaris*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Serratia marcescens*) by agar well diffusion method. Leaf essential oil as well as leaf ethyl acetate, chloroform and methanol extracts of *Coriandrum sativum* exhibited pronounced activity against Gram-positive and Gram-negative bacteria and their activity was quite comparable with the standard antibiotics such as tobramycin, gentamicin sulphate, ofloxacin and ciprofloxacin screened under similar conditions [267].

The antibacterial effect of *Coriandrum sativum* essential oil against Gram-positive and Gram-negative bacteria was evaluated using classical microbiological techniques concomitantly with the use of flow cytometry for the evaluation of cellular physiology. The results showed that coriander oil has an effective antimicrobial activity against all tested bacteria. Propidium iodide incorporation and concomitant loss of all other cellular functions such as efflux activity, respiratory activity and membrane potential seem to suggest that the primary mechanism of action of coriander oil was membrane damage, resulted in cell death [268].

Aliphatic (2E)-alkenals and alkanals isolated from the fresh leaves of the *Coriandrum sativum* were found to possess bactericidal activity against *Salmonella choleraesuis* ssp. *choleraesuis* ATCC 35640. (2E)-Dodecenal (C12) was the most effective against this food-borne bacterium with the minimum bactericidal concentration (MBC) of 6.25 microg/ml (34 microM), followed by (2E)-undecenal (C11) with an MBC of 12.5 microg/ml (74 microM). The time-kill curve study showed that these alpha, beta-unsaturated aldehydes were bactericidal against *S. choleraesuis* at any growth stage and that their bactericidal action came in part from the ability to act as nonionic surfactants [269-270].

Twelve essential oils were tested *in vitro* for antimicrobial activities against several strains of *Campylobacter jejuni*, a pathogen causing food-borne diseases worldwide. Coriander oil exhibited the strong antimicrobial activity against all tested strains. In evaluating the antimicrobial potency of coriander oil against *C. jejuni* on beef and chicken meat at 4 degrees C and 32 degrees C, it reduced the bacterial cell load in a dose-dependent manner. The type of meat and temperature did not influence the antimicrobial activity of the oil [271].

Antimicrobial effect of essential oils from the seeds of *Coriandrum sativum* was studied against gram-positive bacteria and gram-negative bacteria. Essential oil appeared effective against *Listeria monocytogenes* [272].

The antibacterial potential of two commercial essential oils (EOs) from *Coriandrum sativum* was studied against vaginal clinical strains of bacteria. Antimicrobial activities were determined using macro-diffusion (disc, well) and micro-dilution method against twelve clinical strains of bacteria: *Escherichia coli*, *Proteus mirabilis*, *S. aureus* and *Enterococcus* sp., *S. aureus* ATCC 25923, ATCC 6538 and *Escherichia coli* 25922. An antimicrobial effect of EOs was strain specific. Bactericidal activity was higher for coriander EO (MICs 0.4 – 45.4 µl/ml) against almost all tested bacteria, except multiple resistant strains of *Enterococcus* sp. and *Proteus* sp [273].

Antimicrobial activities of essential oils were evaluated against *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa* by microdilution method. The essential oils of *Coriandrum sativum* fruits obtained by hydrodistillation (HD EO) showed greater activity against *Staphylococcus aureus* than that obtained by microwave-assisted hydrodistillation (MAHD EO). Moreover, their activities against *E. coli* and *P. aeruginosa* were the same with minimum inhibitory concentration, MIC 0.781 and 6.25 µl/ml, for HD EO and MAHD EO respectively [274].

The antibacterial activity of essential coriander oil (ECO) on bacteria with dermatological relevance and skin tolerance of antimicrobial effective ECO concentrations were investigated. Essential coriander oil showed good antibacterial activity towards the majority of the bacterial strains tested, including *Streptococcus pyogenes* (Lancefield group A) and methicillin resistant *Staphylococcus aureus* (MRSA), with mean minimal inhibitory concentrations of 0.04% v/v and 0.25% v/v, respectively. The skin tolerance of a cream and a lotion containing 0.5% and 1.0% ECO was assessed in 40 healthy volunteers using the occlusive patch test. No skin irritation could be observed by sensitive photometric assessment in any of the volunteers. The authors suggested that, because of its activity against *Streptococcus pyogenes*, *Staphylococcus aureus* and MRSA, with excellent skin tolerance, ECO might be useful as an antiseptic for the prevention and treatment of skin infections with Gram-positive bacteria [275].

A series of experiments were conducted to evaluate the ability of cilantro oil (the essential oil of *Coriandrum sativum*) to control the growth of *Listeria monocytogenes* on vacuum-packed ham. The *in vitro* minimal inhibitory concentration for five strains of *L. monocytogenes* was found to vary from 0.074% to 0.018% depending on strain. Cilantro oil treatments were then tested on ham disks inoculated with a cocktail of the five *L. monocytogenes* strains. The concentrations studied were 0.1%, 0.5%, and 6% cilantro oil diluted in sterile canola oil or incorporated into a gelatin gel in which lecithin was used to enhance incorporation of the cilantro oil. Gelatin gel treatments were also conducted with 1.4% monolaurin with or without 6% cilantro oil to determine if an interaction between the antimicrobials could increase inhibition of *L. monocytogenes*. Treated ham was then vacuum-packed and stored at 10 degrees C for up to 4 weeks. The only cilantro oil treatment which inhibited growth of *L. monocytogenes* on the ham samples was 6% cilantro oil gel. Samples receiving this treatment had populations of *L. monocytogenes* 1.3 log CFU/ml lower than controls at week 1 of storage, there was no difference between treatments from week 2 onward. It appears that immobilization of the antimicrobial in a gel enhanced the effect of treatments [276].

The hydroalcoholic extract of the crude *Coriandrum sativum* was screened for antibacterial activity against various bacterial species by disk diffusion method. Assay was performed using clinical isolates of *B. cereus*, *S. aureus*, *P. aeruginosa* and *E. coli*. Crude extract of *Coriandrum sativum* was effective only against *Bacillus cereus* [277].

The synergistic antibacterial effect between *Coriandrum sativum* essential oil and six different antibacterial drugs (cefoperazone, chloramphenicol, ciprofloxacin, gentamicin, tetracycline and piperacillin) was investigated. The antibacterial activity of coriander oil was assessed using microdilution susceptibility testing and synergistic interaction by checkerboard assays. The association of coriander essential oil with chloramphenicol, ciprofloxacin, gentamicin and tetracycline against *Acinetobacter baumannii* showed *in vitro* effectiveness, which was an indicator of a possible synergistic interaction against two reference strains of *A. baumannii* (LMG 1025 and LMG 1041, FIC index from 0.047 to 0.375). However, when tested the involvement between coriander essential oil and piperacillin or cefoperazone, the isobolograms and FIC index showed an additive interaction. The *in vitro* interaction could improve the antimicrobial effectiveness of ciprofloxacin, gentamicin and tetracycline and may contribute to resensitize *A. baumannii* to the action of chloramphenicol [278].

Coronilla varia

Coronilla varia aerial parts extracts were tested for their antibacterial activity against *Streptococcus pyogenes* (ATCC 19615), *Staphylococcus aureus* (ATCC 25923), *Staphylococcus epidermidis* (ATCC 12228), *Pseudomonas aeruginosa* (ATCC 27853), *Klebsiella pneumoniae* (ATCC 13883) and *Escherichia coli*. Two agar diffusion methods, well diffusion assay and disc diffusion assay were used to compare the susceptibility of the bacterial strains to the plant extracts. *Coronilla varia* extracts showed antibacterial activity against

Streptococcus pyogenes (ATCC 19615), *Staphylococcus aureus* (ATCC 25923), *Pseudomonas aeruginosa* (ATCC 27853), *Klebsiella pneumoniae* (ATCC 13883) and *Escherichia coli* [279].

Antibacterial activity of plant extract was determined by disc diffusion method against three Gram negative bacteria (*Proteus mirabilis* PTCC (1076); *Enterobacter cloacae* PTCC (1003), and *Klebsiella pneumonia* PTCC (1290)) and two Gram positive (*Staphylococcus aureus* PTCC (1112) and *Bacillus subtilis* PTCC (1023)). The extracts from *Coronilla varia* had interesting activity against *Proteus mirabilis* in the concentration of 700 µg/disc and did not show any activity against *Staphylococcus aureus*, *Bacillus subtilis*, *Klebsiella pneumonia* and *Enterobacter cloacae* [280-282].

Cotoneaster racemiflora

The antibacterial and anti-methicillin resistant *S. aureus* (MRSA) activities of water, methanol and ethyl acetate extracts of the plant were investigated by broth microdilution method. Water extract possessed remarkable antibacterial against gram positive microorganisms. The MIC values were determined as 0.625 mg/ml for *S. aureus* (MSSA), *S. aureus* (MRSA), and *S. lutea*. It has been seen that water extract revealed a significant effect against MRSA. While *E. faecalis* was the most sensitive bacterium. *B. cereus* and *S. pneumonia* were resistant Gram-positive bacteria against water extract. The MIC value of water extract was determined as 0.039 mg/ml against *E. faecalis*. Although *E. coli* was affected by water extract at a 0.625 mg/ml dose, *K. pneumoniae*, *S. enteritidis*, and *P. aeruginosa* were found to be resistant to this extract. Gram-negative microorganisms were more resistant than Gram-positive bacteria against water extract of cotoneaster. Methanol extract exhibited significant antibacterial activity against *E. faecalis* at a concentration of 0.312 mg/ml. The MIC values of methanol extracts were determined as 2.5 mg/ml against *E. coli*, *P. aeruginosa* MSSA, and MRSA. *B. cereus*, *K. pneumoniae*, *S. lutea*, and *S. enteritidis* were not affected by this extract at all tested doses. The MIC value was determined as 0.625 mg/ml for *S. pneumoniae*. While, *P. aeruginosa* and *S. pneumoniae* which resisted water extract, they were affected by methanol extract. However, MIC values of the water extract were lower than those of methanol extract. Except for MRSA strain, the ethyl acetate extract of cotoneaster exhibited antimicrobial activity at a concentration of 2.5 mg/ml against both standard and isolated bacteria. The MIC value was determined as 1.25 mg/ml for MRSA strain. The authors concluded that *E. faecalis* was the most sensitive bacteria and *B. cereus*, *K. pneumoniae*, and *S. enteritidis* were the most resistant bacteria to the tested cotoneaster extracts except to ethyl acetate extract. The extracts of cotoneaster displayed antimicrobial activity against both *S. aureus* ATCC 43300 and all of the 14 tested MRSA *S. aureus* strains. Water extract of Cotoneaster exhibited significant anti MRSA activity at doses of 0.625 mg/ml against 10 MRSA strains. The methanol extracts of Cotoneaster showed anti MRSA activity at a dose of 2.5 mg/ml against 7 MRSA strain [283-284].

Cressa cretica

Antibacterial activity of various extracts of *Cressa cretica* and the crude alkaloid solution was tested against four micro organisms (*E. coli*, *Staphylococcus aureus*, *Proteus* Spp and *Pseudomonas* spp.). Antibacterial analysis revealed considerable antibacterial activity exerted by all the extracts except hexane extract and in the case of *Proteus* spp the extracts showed greater activity compared to the control. All extracts showed maximum activity against *E. coli* [285-286].

The antibacterial effect of the different fractions (hexane, ethylacetate and methanol) of the whole methanolic extract of *Cressa cretica* were studied against wide ranges of bacteria (both positive and negative strain) by agar disc diffusion method. Among the three fractions, the ethylacetate fraction of *Cressa cretica* showed the highest activity, but among the pathogens highest activity was revealed against *Escherichia coli*, *Klebsiella pneumoniae* (zone of inhibition diameter was found to be 26 and 31mm, respectively). The ethylacetate fraction was active against both gram positive and gram negative bacterias. [287].

The antibacterial activity of methanolic extract of *Cressa cretica* was studied by cup plate method against various organisms like *E. coli*, *S. aureus*, *S. typhi* and *B. subtilis*. 200-800µg/ml of the ethanolic extract showed dose dependent antimicrobial activity, the diameter of zone of growth inhibition (mm) was 25-30 against *E. coli*, 15-25 against *S. aureus*, 20-30 against *S. typhi*, and 20-25 against *B. subtilis* [288].

Crotalaria juncea

The ethanol extract of flowers part (CJFEE) and seeds part (CJSEE) were evaluated for the antibacterial activity by the agar disc diffusion method against *C. freundii*, *E. coli*, *E. faecalis*, *K. pneumonia*, *P. aeruginosa*, *S. flexneri*, *S. aureus*, *S. dysenteriae* and *V. cholerae*. Results revealed that CJSEE possess significant antibacterial activity against the *E. coli*, *K. pneumonia*, *P. aeruginosa*, *S. aureus* and *V. cholerae*. However, the ethanol extract of seeds part had higher antibacterial than ethanol extract of flower parts of *Crotalaria juncea* [289].

The antibacterial activity of *Crotalaria juncea* seed oil (CJSPE) was evaluated by the disc diffusion method against *E. faecalis*, *S. aureus*, *E. coli*, *K. pneumonia*, *P. aeruginosa*, *S. flexneri*, *S. dysenteriae* and *V. cholerae*. Results showed that CJSPE have good antibacterial activity against the *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumonia* and *Shigella flexneri*. However, the zone of inhibition showed by CJSPE was found less than that of ciprofloxacin (5 µg/disc) used as standard [290].

Antibacterial activity of crude extracts prepared in sodium phosphate buffer against *Xanthomonas* strain was studied. There has been found a highly strong activity of *Crotalaria juncea* extracted in sodium phosphate buffer against plant bacterial pathogen, *Xanthomonas oxanopodis* pv. *Punicae* [291-292].

Cuminum cyminum

Ethanol extracts of seed of *Cuminum cyminum* were tested for antimicrobial activity *in vitro* by the microdilution method. Ethanol extract of seed exhibited antimicrobial activity against biofilm *Escherichia coli* [293].

All essential oils, and cuminic aldehyde, were tested, using agar diffusion and serial dilution methods, against different Gram-positive and Gram-negative bacteria isolated from different sources of food (pork fillet, minced meat and sausages) and clinical isolates. All cumin oils and cuminic aldehyde exhibited a considerable inhibitory effect against all the tested organisms, except *Pseudomonas* spp [294].

The volatile oil of *Cuminum cyminum* was active against *Staphylococcus epidermidis*, *S. aureus*, *S. haemolyticus*, *Propionibacterium acnes*, *Corynebacterium diphtheriae*, *Erysipelothrix rhusiopathiae*, *Bacillus cereus*, *Clostridium tetani*, *C. difficile*, *Escherichia coli*, *Salmonella typhi*, *Klebsiella pneumoniae*, *Vibrio cholerae*, *Aeromonas hydrophila*, *Mycobacterium tuberculosis* and *Neisseria gonorrhoeae*. The antimicrobial activity induced by methanolic, hydroalcoholic and aqueous extracts was less than that produced by volatile oils [197].

The essential oil of Bulgarian *Cuminum cyminum* was active against *Bacillus subtilis* and *Staphylococcus epidermidis* [295].

The inhibitory effect of steam distilled essential oil of cumin fruits was tested against 3 Gram-negative bacteria (*Pseudomonas fluorescens*, *Escherichia coli*, and *Serratia marcescens*), 4 Gram-positive bacteria (*Staphylococcus aureus*, *Micrococcus* spp., *Sarcina* spp., and *Bacillus subtilis*), and acid fast bacterium (*Mycobacterium phlei*). The results showed that cumin oils possessed strong antimicrobial activity [296].

The cumin essential oil showed activity against *E. coli*, *Pseudomonas aeruginosa* and *Salmonella* sp. and their inhibitory zones were 18, 10 and 23 mm, respectively [297].

Antimicrobial testing showed high activity of the essential *Cuminum cyminum* oil against *Bacillus subtilis* and *Staphylococcus epidermidis* [298].

Cuminum cyminum essential oil exhibited strong antimicrobial activity against *E. coli*, *S. aureus* and *L. monocytogenes*. Complete death time on exposure to *Cuminum cyminum* oil was 20, 180 and 90 min for *E. coli*, *S. aureus* and *L. monocytogenes*, respectively [299].

The effectiveness of the essentials oils from cumin (*Cuminum cyminum*) was studied on the growth of some bacteria commonly used in the food industry, *Lactobacillus curvatus*, *Lactobacillus sakei*, *Staphylococcus carnosus* and *Staphylococcus xylosus* or related to food spoilage *Enterobacter gergoviae*, *Enterobacter amnigenus*. The agar disc diffusion method was used to determine the antibacterial activities of the oils. *Cuminum cyminum* essential oils showed an inhibitory effect against all the tested bacteria [300].

Cuminum cyminum oil exhibited higher antibacterial with a high effectiveness against *Vibrio* spp. strains with a diameter of inhibition zones ranging from 11 to 23 mm, and MIC and MBC values ranging from (0.078-0.31 mg/ml) to (0.31-1.25 mg/ml) respectively [301].

A great inhibition of *Cuminum cyminum* essential oil was recorded on *Pseudomonas syringae* pv. *Syringae* [302].

The ranges of minimum inhibitory concentration of *Cuminum cyminum* oils against several food-borne pathogens (*Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli* O157:H7, *Salmonella enteritidis* and *Listeria monocytogenes*) were 0.37-3.0 mg/ml. Moreover, the combination of *B. persicum* and *Cuminum cyminum* essential oils confirmed synergistic and additive activities against the pathogens [303].

The chemical composition of essential oils from cumin (*Cuminum cyminum*), laurel (*Laurus nobilis*), oregano (*Oreganum onites*), rosemary (*Rosmarinus officinalis*), anise (*Pimpinella anisum*) and clove (*Syzygium aromaticum*) was determined and their antibacterial activities were tested against *Salmonella typhimurium* CCM 5445, *Staphylococcus aureus* (MRSA) RSKK 95047, *Staphylococcus aureus* ATCC 6538P, *Escherichia coli* ATCC 29998 and *Escherichia coli* O157:H7 RSKK 232 by two different methods (disc diffusion and agar dilution). The results showed that oregano essential oil showed the highest inhibition (0.0625-0.125 mg/ml) effect followed by cumin (0.0625-2.0 mg/ml) and clove (0.25-1.0 mg/ml) [304].

Antibacterial activity of seed extracts of cumin (*Cuminum cyminum*) was investigated against 10 Gram positive and Gram negative bacteria. Disc diffusion method was used to test the antibacterial activity. Minimum

inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were determined by using standard procedures. The highest inhibition zone of 16.67 ± 0.47 mm was found at 250 mg/ml against *Escherichia coli*. On the other hand, the inhibition zones 15.00 ± 0.82 mm for ethanol, 15.33 ± 0.47 for methanol, and 15.67 ± 0.82 for acetone were recorded against *Bacillus subtilis*, *Sarcina lutea* and *Klebsiella pneumonia*, respectively. MIC value (20 to 50 mg/ml) and MBC value (40 to 60 mg/ml) were recorded against the studied bacteria [305].

Antibacterial activity of *Cuminum cyminum* essential oil was observed against Gram-positive and Gram-negative bacterial species. The activity was particularly high against the genera *Clavibacter*, *Curtobacterium*, *Rhodococcus*, *Erwinia*, *Xanthomonas*, *Ralstonia*, and *Agrobacterium*, which were responsible for plant or cultivated mushroom diseases worldwide. In general, a lower activity was observed against bacteria belonging to the genus *Pseudomonas* [306].

Antimicrobial activities and biofilm-formation preventive properties of *Cuminum cyminum* essential oils and chlorhexidine were assessed against *Streptococcus mutans* and *Streptococcus pyogenes*. The minimal bactericidal concentrations (MBC) of the oils and chlorhexidine and microbial decimal reduction time (D value) were determined. *Cuminum cyminum* induced mild antibacterial and *in vivo* biofilm preventive effects (less than chlorhexidine). *In vivo* experiments conducted on male and female volunteers who brushed with essential oil blended toothpastes indicated that lower concentrations of the oils were significantly higher ($p < 0.001$) and effective during the course of the study as compared to chlorhexidine [307].

The effect of different concentrations of *Cuminum cyminum* essential oil (0, 15, 30 and 45 μ l/100 ml) and nisin (0, 0.5 and 1.5 μ g/ml) combination at different temperatures (10, 25 and 35°C) was studied on growth of *Salmonella typhimurium* and *Staphylococcus aureus* in the brain-heart infusion (BHI) broth model. The concentrations of 0 μ l/100 ml for essential oil and 0 μ g/ml for nisin imply the negative control. The growth of *S. typhimurium* was significantly decreased by the concentration of essential oil ≥ 30 μ l/100 ml in combination with nisin ≥ 0.5 μ g/ml at temperature = 10°C ($p < 0.05$). Also, in combination of the essential oil ≥ 15 μ l/100 ml and nisin ≥ 0.5 μ g/ml at temperature $\leq 25^\circ\text{C}$, the growth of *S. aureus* was significantly reduced ($p < 0.05$). The results indicated that the combination of essential oil and nisin inhibited the growth of *S. typhimurium* and *S. aureus* bacteria and there was the possibility of using them as substitutes for chemical food preservatives [308].

The antimicrobial activity of cumin oil against many pathogenic bacteria, showed that *E. coli*, *S. aureus*, and *S. faecalis* were sensitive to various oil dilutions [309].

The antimicrobial activity of *Cuminum cyminum* essential oil was evaluated against: *Micrococcus luteus* LA 2971, *Bacillus megaterium* NRS, *Bacillus brevis* FMC 3, *Enterococcus faecalis* ATCC 15753, *Pseudomonas pyocyaneus* DC 127, *Mycobacterium smegmatis* CCM 2067, *Escherichia coli* DM, *Aeromonas hydrophila* ATCC 7966, *Yersinia enterocolitica* AU 19, *Staphylococcus aureus* Cowan 1, *Streptococcus faecalis* DC 74 bacteria. *Cuminum cyminum* essential oil (2 μ l) exerted antibacterial effect against all the tested microorganisms with MIC ranged from 10- 60mm. While the inhibition zone was higher in the bacteria *E. faecalis*, it was lowest in *E. coli* and *P. pyocyaneus*. In combined application of *Cuminum cyminum* essential oil (2 μ l) and gentamicin antibiotics discs, a synergistic effect in *P. pyocyaneus* and *A. hydrophila*, an antagonistic effect in other bacteria were noted [310].

The antimicrobial effects of garlic, bay, black pepper, origanum, orange, thyme, tea tree, mint, clove, and cumin essential oils were studied against *Listeria monocytogenes* AUFE 39237, *Escherichia coli* ATCC 25922, *Salmonella enteritidis* ATCC 13076, *Proteus mirabilis* AUFE 43566 and *Bacillus cereus* AUFE 81154. Thyme, origanum, clove, and orange essential oils were the most inhibitory against bacteria [311].

The activity of cumin seed essential oil and alcoholic extract against *Klebsiella pneumoniae* ATCC 13883 and clinical *K. pneumoniae* isolates was studied by evaluating the effect of subminimum inhibitory concentrations (sub-MICs) on cell morphology, capsule expression and urease activity. Growth of *K. pneumoniae* strains exposed to sub-MICs of *Cuminum cyminum* extracts resulted in cell elongation and repression of capsule expression. Urease activity was decreased [312].

Chloroformic and isoamyl alcohol extracts of *Cuminum cyminum* were investigated for their *in vitro* antibacterial activity against six human bacterial pathogens. The antibacterial activity was evaluated and based on the zone of inhibition using agar disc diffusion method. The tested bacterial strains were included *Streptococcus pyogenes*, *Staphylococcus epidermidis*, *Klebsiella pneumonia*, *Staphylococcus aureus*, *Serratia marcescens*, and *Pseudomonas aeruginosa*. Chloroform and isoamyl alcohol extracts of *Cuminum cyminum* had significant effect against *P. aeruginosa*, *S. marcescens* and *S. pyogenes* [313].

Cupressus sempervirens

The antibacterial activity of the methanol, ethanol and ethyl acetate extracts of the aerial parts of *Cupressus sempervirens* were studied against *S. aureus* (ATCC6538), *B. subtilis* (ATCC6633), *P. aeruginosa* (ATCC6643), *E. coli* (ATCC15224), *K. pneumonia* (MTCC618) and *S. typhimurium* (ATCC13048). The

extracts were used in 8 concentrations (1, 2, 3, 5, 7.5, 10, 12.5 and 15 mg/ml). All *Cupressus sempervirens* extracts induced dose dependent bacterial growth inhibition against all the tested bacteria [314].

The antibacterial activities of water and chloroform extracts of *Cupressus sempervirens* were carried out against six bacterial strains *Bacillus subtilis*, *Proteus vulgaris*, *Staphylococcus aureus* (Gram-positive) and *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi* (Gram-negative) *Cupressus sempervirens* showed high activity against Gram positive bacteria (zone of inhibition 9-14 mm for water extract and 9-12 mm for chloroform extract) and low activity against Gram negative bacteria (zone of inhibition 1-6 mm for water extract and 1-5 mm for chloroform extract) [315-316].

The antibacterial activity of methanolic, ethanolic and ethyl acetate extracts of leaf of *Cupressus sempervirens* was determined against six bacteria (*Staphylococcus aureus*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae* and *Salmonella typhimurium*) using agar well diffusion method. Among the plant extracts, a significant antimicrobial activity was obtained by methanolic extracts followed by the ethyl acetate and ethanol extracts. The methanolic extract exhibited maximum inhibitory activity against *K. pneumonia*, *B. subtilis* and *S. aureus*. The ethanolic extract showed higher activity against *P. aeruginosa*. Greater inhibitory activity against *S. typhimurium* and *E. coli* was possessed by ethyl acetate extract of *Cupressus sempervirens* [317].

Essential oil exerted moderate *in vitro* antimicrobial activity against bacteria including Gram positive (*Bacillus cereus*, *Enterococcus faecalis*, *Serratia marcescens*, *Staphylococcus aureus*), and Gram negative (*Aeromonas hydrophila*, *Escherichia coli*, *Klebsiella pneumonia*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Salmonella indica*) with diameter zones of inhibition 4 to 12 mm, with MIC and MBC values ranging from 62.5 to 250 µg/ml. However, the methanol extract of *Cupressus sempervirens* was strongly inhibited the growth of all tested bacteria [318].

The antimicrobial activity of *Cupressus sempervirens* essential oil was studied against *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis*, *Halomonas elongate*, *Salmonella typhimurium* and *Enterococcus hirae*. The results revealed that the oil of *Cupressus sempervirens* inhibited the growth of susceptible bacteria. The MIC and MCC values indicated that *Cupressus sempervirens* essential oil was highly effective. In addition, MIC/MCC ratio confirmed a bactericidal activity of the essential oil. However, the antimicrobial activity of the *Cupressus sempervirens* essential oils was more pronounced against Gram-positive than Gram-negative bacteria [319].

The zone of inhibition of 2 and 4 µl/disc of essential oil of *Cupressus sempervirens* against the tested microorganisms were (respectively): *Micrococcus luteus* 10 and 13; *Staphylococcus aureus* 7 and 8; *Mycobacterium smegmatis* 10 and 11; *Pseudomonas pyocyaneus* 9 and 11; *Yersinia enterocolitica* 8 and 9; *Aeromonas hydrophila* 7 and 10; *Enterococcus faecalis* 7 and 9; *Bacillus megaterium* 7 and 9; *Streptococcus faecalis* 7 and 9 and *Bacillus brevis* 7 and 8 mm [320].

The essential oil of *Cupressus sempervirens* was tested against three bacteria (*Escherichia coli*, *Micrococcus luteus*, and *Bifidobacterium lactis*). The zone of inhibition of essential oils after 96 hr incubation against *Escherichia coli* was 16.11 mm, *Micrococcus luteus* 11.90 mm and *Bifidobacterium lactis* 24.05 mm [321].

Diterpenes, 6-deoxytaxodione (11-hydroxy-7, 9(11), 13-abietatrien-12-one), and taxodione isolated from *Cupressus sempervirens* cones (fruits) showed potent antibacterial activities (IC₅₀ 0.80 and 0.85 µg/ml) against methicillin-resistant *Staphylococcus aureus* [322].

Cuscuta planiflora

The antibacterial study of the methanol extract of *Cuscuta planiflora* showed moderate antibacterial activities against *Bacillus megaterium*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Salmonella typhi* with MIC values of 4.96±0.20, 3.03±0.16, 3.47±0.20 and 4.07±0.08 mg/ml, respectively [323-324].

Cydonia oblonga

The antimicrobial activity of *Cydonia oblonga* leaves extracts against different microorganism strains was also investigated. Quince peel extract was the most active for inhibiting bacteria growth with minimum inhibitory and bactericide concentrations in the range of 102-5 x 10³ microg polyphenol/ml. It appeared that chlorogenic acid acts in synergism with other components of the extracts to exhibit their total antimicrobial activities [325].

The ethanolic extract of *Cydonia oblonga* seeds was dissolved in dimethylsulfoxide (DMSO) to obtain the final concentrations: 500, 250, and 125 mg/ml and the agar well diffusion method was used to determine antibacterial activity of extract. Six millimeter diameter wells were punched in to the agar and filled with 0.1ml of each extract. Solvents were used as negative control. Tract exhibited antibacterial activity against *s. aureus* at all concentrations and the sensitivity increases directly with increasing the concentration, *s. epidermidis* was

sensitive at 500 mg/ml and *k. pneumonia* was sensitive at 250mg/ml. *E. coli* and *Moraxella* were resistant to ethanolic extract [326].

The antibacterial effects of *Cydonia oblonga* fruit and seed (ethanolic, acetonic and aquatic extracts) were studied on some dermatic bacteria such as *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Staphylococcus epidermidis*. Ethanolic extract of quince seed was the most effective extract. Quince seeds extracts showed more antibacterial effect compared with Quince fruit. The aquatic extracts didn't show antibacterial effect [327].

The antibacterial effects of extracts of the fruit and seed of *Cydonia oblonga* Miller was studied against *Klebsiella pneumoniae*, *Escherichia coli* and *Enterobacter aerogenes*. The results showed that the ethanolic extract of seeds was the most effective. *E. coli* was the most sensitive bacterium to the extracts, and aqueous extract only showed antimicrobial effect against *E. aerogenes* [328].

The antimicrobial activity of *Cydonia oblonga* was studied. *Cydonia oblonga* was performed by the diffusion method in dishes with disks embedded at the concentrations of 100, 200 and 400 mg/ml fruit decoction and crude extract from *Cydonia oblonga* leaves, were tested against six bacteria. The crude extract from leaves showed antibacterial activity, it partially inhibited the growth of *Streptococcus agalactiae* [329].

The antimicrobial effect of extracts from quince fruits was investigated against foodborne pathogenic (*Staphylococcus aureus*) strains. The antimicrobial effect was investigated by rapid impedance method. The antimicrobial effect of extracts was confirmed by decreasing of the integrated area of the impedimetric growth curve [330].

The *in vitro* anti-*Helicobacter pylori* activity of 33 substances, juices and plant extracts and 35 of their combinations were tested using an agar diffusion method on Columbia blood agar. Quince (*Cydonia oblonga*) juice demonstrated the strongest anti-*H. pylori* activity followed by cranberry juice [331-332].

Cymbopogon schoenanthus

Aqueous extract, proanthocyanidin rich extract, and organic extracts of *Cymbopogon schoenanthus* shoots from three different locations in south Tunisia were screened for antimicrobial activity. The proanthocyanidin extracts showed a good antimicrobial activity against *Streptococcus sobrinus* at low concentration (MIC=4mg/ml) [333].

Ethanol and chloroform extract of the plant were active against *Escherichia coli* and *Staphylococcus aureus*. However, ethanol extract was more active against *Escherichia coli*, while chloroform extract was more active against *Staphylococcus aureus* [334].

However, the aerial parts extract of *Cymbopogon schoenanthus* showed activity against *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli* and *Pseudomonas aeruginosa* [335].

The antibacterial activity of *Cymbopogon schoenanthus* was evaluated against three pathogenic bacteria (*Staphylococcus aureus* MARSA, *Escherichia coli* and *Salmonella typhi*). Organic extraction of *Cymbopogon schoenanthus* showed high antibacterial activity against all the tested pathogenic bacteria (*Staphylococcus aureus* MARSA, *Salmonella typhi* and *Escherichia coli*) [336].

Cynodon dactylon

The *in vitro* antibacterial evaluation of the leaves extract of *Cynodon dactylon* was carried out against *Escherichia coli*, *Staphylococcus aureus* and *Streptococcus pyogenes*. 10% concentration of extract was found to be most effective as antibacterial concentration [337].

The aqueous extract of *Cynodon dactylon* (50-400 mg/ml) was used to determine the antimicrobial activity against *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumonia* and *Proteus mirabilis*. The aqueous extract of *Cynodon dactylon* exerted concentration dependent antimicrobial activity against all the tested microorganisms [338].

The hydroalcoholic extract of *Cynodon dactylon* was investigated for its antibacterial activity against two Gram positive bacteria (*Staphylococcus aureus* and *Staphylococcus albus*) and two gram-negative bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*) using agar well diffusion method (zone of inhibition) and micro-dilution method (minimum inhibitory concentration). Hydroalcoholic extract of *Cynodon dactylon* possessed an effective antibacterial activity, from results of minimum inhibitory concentration, it appeared that all tested bacterial strains were sensitive to *Cynodon dactylon* extract [339].

The antimicrobial activity of *Cynodon dactylon* crude extracts from seven different solvents (acetone, chloroform, diethyl ether, ethanol, ethyl acetate, methanol, and n-pentane) was investigated against some pathogens (*Bacillus cereus*, *Bacillus subtilis*, *Escherichia coli*, *Klebsiella spp.*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcus pyogenes*, and *Streptococcus pneumonia*) using disc diffusion method. The antimicrobial study revealed broad spectrum antimicrobial activity for ethanol (7.0–10.0 ± 0.0–1.0 mm) and ethyl acetate (7.0–12.0 ± 0.0–1.0 mm) extracts against all of the bacterial pathogens. Both methanol and acetone extracts showed activity against *B. cereus* (8.0 ± 0.0 mm) and *B. subtilis* (7.0 ± 0.0 mm), while chloroform

extract showed activity against *B. subtilis* (7.0 ± 0.0 mm) and *S. pyogenes* (8.3 ± 0.6 mm). activity was observed from n-pentane extraction. Great antimicrobial activity were observed for both ethyl acetate and ethanol extracts with size of inhibition ranging from 8.0 ± 0.0 mm to 15.7 ± 0.6 mm for ethyl acetate and 8.0 ± 0.0 mm to 13.0 ± 0.0 mm for ethanol extract [340].

Six different organic solvents were used to extract the bioactive compounds from the leaves of *Cynodon dactylon* to screen the antibacterial activity against bacterial pathogens (*Bacillus subtilis*, *Streptococcus pyogens*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Escherichia coli*, *Proteus mirabillis* and *Pseudomonas aeruginosa*) by paper disc method. The butanolic extract of *Cynodon dactylon* was the most active against most of the tested organism, followed by ethyl acetate, methanol, petroleum ether and chloroform extract [341].

The antimicrobial activity of ethanol, methanol, acetone, chloroform, hexane and petroleum ether extract of *Cynodon dactylon* was tested against infectious disease causing bacterial pathogens (*E.coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Klebsiella pneumonia*) using the agar well diffusion method. It was observed that ethanol, methanol, acetone, chloroform, hexane and petroleum ether showed activity against bacteria. The ethanol extract of *Cynodon dactylon* showed more activity against *Pseudomonas aeruginosa* (zone of diameter 13.83 ± 0.29 mm), *Staphylococcus aureus* (zone of diameter 12.0 ± 0.10 mm), when compared to other solvent extracts [342-343].

The antimicrobial activity of *Cynodon dactylon* crude extract from three different extraction (hot and cold aqueous extraction and methanol extraction) was investigated against some of the Gram positive bacteria (*Staphylococcus epidermidis* and *Bacillus cereus*) and Gram negative bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi* and *Shigella dysenteriae*) using disc diffusion method. Amoxicillin and Gentamicin were taken as positive control. The aqueous extract of *Cynodon dactylon* had antimicrobial activity against all the test organisms which indicated broad spectrum activity of the extract against both Gram positive and Gram negative bacteria, while, no clear zone formed with methanol extract [344].

The antibacterial activity of the leaf extracts of *Cynodon dactylon* was investigated against pathogenic bacteria (*Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumonia* and *Pseudomonas aeruginosa*), by *in vitro* agar well diffusion method. The results showed that chloroform *Cynodon dactylon* leaf extracts possessed antibacterial activity against all the tested bacteria. Chloroform extracts of *Cynodon dactylon* at a concentration of $75 \mu\text{l/ml}$ exhibited relatively higher zone of inhibition compare to 25 and $50 \mu\text{l/ml}$. However, the *Bacillus subtilis*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* were resistant to aqueous leaf extracts of *Cynodon dactylon* [345].

Cyperus rotundus

The antimicrobial activity of oils of *Cyperus rotundus* was studied by disc agar diffusion method. The diameters of zones of inhibition were measured comparing with negative control, as well as ofloxacin, rifampicin and amphotericin B ($5 \mu\text{g/disc}$) as positive control for each micro-organism. *Cyperus rotundus* essential oil was significantly active against Gram-positive microorganisms (*Staphylococcus aureus* and *Streptococcus species*), moderately active against *Sarcina lutea*, *Bacillus subtilis* and the acid fast *Mycobacterium phlei*. The oil is completely inactive against Gram-negative microorganisms. [346].

Cyperus rotundus rhizomes petroleum ether, chloroform, ethanol and water extracts were evaluated against six important pathogenic microbes (*Staphylococcus epidermidis*, *Bacillus cereus*, *Pseudomonas aeruginosa* and *Escherichia coli*). The antibacterial activities were performed by both agar well diffusion and serial dilution methods. The ethanolic extract exhibited highest activity against the tested bacteria. The inhibitory effect is very similar and comparable with that of standard drug [347].

The growth and acid production of *Streptococcus mutans* were reduced by the tuber extract of *Cyperus rotundus*. *S. mutans* is known as the causative bacteria in the formation of dental plaque and dental caries. Moreover, the same tuber extract inhibited the adherence of *S. mutans* to saliva coated hydroxyapatite beads. Glucosyl transferase enzyme, which synthesized water-insoluble glucan from sucrose, was also inhibited by the tuber extract. Accordingly *Cyperus rotundus* inhibited cariogenic properties of *S. mutans* [348-349].

The antibacterial properties of *Cyperus rotundus* root extracts (petroleum ether, acetone, methanol and water) was investigated against three Gram-positive and two Gram-negative bacteria causing respiratory tract infections. Results showed that methanol extract was the most active as comparison to other extract. The maximum inhibition was noted against *H. influenzae* (18.4 ± 0.07 mm) followed by *S. pyogenes* (17.3 ± 0.13 mm), *P. aeruginosa* (16.2 ± 0.07 mm) and *S. pneumoniae* (15.5 ± 0.15 mm) and the minimum activity was recorded against *S. aureus* (15.3 ± 0.05 mm) respectively [350].

Methanolic extract of the fresh aerial part of the *Cyperus rotundus* was fractionated by column chromatography method using petroleum ether, chloroform, ethyl acetate and methanol. The *in vitro* antibacterial activity was carried out against (*Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and

Pseudomonas aeruginosa) for all fractions. The ethyl acetate fraction showed potent antibacterial activity compared to control and standard commercial antibiotic tetracycline [351].

The Antibacterial activity of *Cyperus* oil was studied against (*Staphylococcus aureus*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Streptococcus pyogenes*, *Escherichia coli* and *Pseudomonas aeruginosa*). The MIC and MBC for each microbe were estimated. The oil of *Cyperus rotundus* exerted remarkable activity against Gram-positive bacteria, less antibacterial activity was recorded against Gram-negative bacteria and no activity against *Pseudomonas aeruginosa* and *Proteus vulgaris* [352].

Antimicrobial activity of *Cyperus rotundus* ethanolic extract was carried out on human pathogenic bacteria such as *Morexilla catarhalis*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*. Excellent, moderate low and no activity were found on these organism. Ethanolic extract caused 133.3% inhibition of *K. pneumoniae* and 70% inhibition of *Staphylococcus aureus* as compared to standard drug amoxicillin 20µg/ml, while the ethanolic extract showed low inhibition (46.66, 37.5 and 33.3% in *E. coli*, *P. aeruginosa* and *M. catarhalis* respectively). No zone of inhibition was observed in *Acinetobacter*[353].

Dactyloctenium aegyptium

The methanolic extract of *Dactyloctenium aegyptium* possessed antibacterial activity against standard *Staphylococcus aureus* (ATCC 25953) and hospital isolated *Staphylococcus aureus* strains with MIC of 7.6-7.7 mg/ml. *Dactyloctenium aegyptium* methanolic extract possessed antibacterial activity against *Staphylococcus aureus* and *Escherichia coli* with MIC of 6.5-7 mg/ml [353].

Antimicrobial activities of *n*-hexane, ethyl acetate and *n*-butanol fractions of *Dactyloctenium aegyptium* aerial parts were investigated against Gram positive bacteria [*Staphylococcus aureus* (RCMB 010028) and *Bacillus subtilis* (RCMB 010067)], AND Gram negative bacteria [*Escherichia coli* (RCMB 010052) and *Pseudomonas aeruginosa* (RCMB 010043)]. The ethyl acetate extract was the most active against *E. coli* compared to that of *n*-butanol. The *n*-hexane showed no antimicrobial activity against all microorganisms tested [354].

The antibacterial activity of *Dactyloctenium aegyptium* was studied against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *E.coli*, *Klebsiella pneumoniae*, *Proteus vulgaris* by disc diffusion method. The maximum zone of inhibition was observed against *pseudomonas aeruginosa* and the minimum zone of inhibition was observed against *Proteus vulgaris*, *E.coli*, *Klebsiella pneumoniae* for ethanol extract [355].

Ethanolic extract of *Dactyloctenium aegyptium* were examined for antimicrobial potential against three standard bacteria (*Escherichia coli*, *Klebsiella Pneumonia*, *Staphylococci*). The ethanolic extract of *Dactyloctenium aegyptium* showed antibacterial activity against all the tested bacteria with a dose dependent increase in zone of inhibition [356].

The antimicrobial potential of the methanolic extracts of nine medicinal plants from Saudi folk medicine was studied against seven pathogens (*E. coli*, *B. cereus*, *S. typhi*, *K. pneumonia*, *P. aeruginosa* and *S. aureus*). *Dactyloctenium aegyptium*, showed good antibacterial activity [357-358].

Dalbergia sissoo

The methanol, hexane extracts and isolated okanin from methanol extracts were exhibited good antibacterial activity towards various pathogens, Gram positive (*Micrococcus luteus* and *Staphylococcus aureus*) and Gram negative bacteria (*Escherichia coli*, *R. planticola* and *Acinetobacter*) [359].

1,2-benzenedicarboxylic acid dibutyl ester (13.68%) and 5-nirto-2,4 (1H,3H)-pyrimidine dione isolated from the plant, showed antibacterial activity against *Staph aureus*, *Bacillus cereus*, *Serratia marcescens* and *Proteus mirabilis* [360].

A herbal preparation containing *Dalbergia sissoo* and *Datura stramonium* was evaluated for its antibacterial potential against pathogenic strains of Gram positive (*Staphylococcus aureus* and *Streptococcus pneumoniae*) and Gram negative (*Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*) bacteria. The extracted fractions of the herbal preparation were found active against both Gram positive as well as Gram negative bacteria. Gram positive bacteria showed higher sensitivity [361].

Dalbergia sissoo was evaluated for its antibacterial potential against eight human pathogenic bacterial strains. Triple maceration method was adopted for the methanolic extraction of whole plant and leaves. *In vitro*, antimicrobial test was performed by disc diffusion method. Whole plant's extract showed good antibacterial activity against *S. aureus* (18.00mm), *S. pneumoniae* (17.50mm), *B. cereus* (17.90mm), *B. pumilus* (16.45mm), *E. coli* (19.00mm), *K. pneumoniae* (17.45mm), *P. aeruginosa* (16.20mm) and *C. freundii* (15.00mm), with relative percentages of inhibition of 81.00, 80.54, 76.65, 64.65, 78.45, 72.45, 70.37 and 62.30 respectively, as compared with leaves with relative percentages of inhibition of 70.56, 67.32, 54.20, 43.24, 62.80, 57.03, 51.05 and 36.65 against same microbes. Modified agar well diffusion method was used to measure the minimum

inhibitory concentration. MIC values of the whole plant extract lies within the range of 75 to 300 µg /ml for the Gram positive strains while 75 to 600 µg /ml for Gram negative strains [362-363].

Daphne mucronata

Antibacterial activity of the ethanolic extract of leave and stem of *Daphne mucronata* were evaluated against four species of Gram positive and Gram negative bacteria. The results showed that extracts were active against *Escherichia coli* and *Staphylococcus aureus*, however, ethanolic extract of the roots of plant were the most effective against Gram positive bacteria (*Staphylococcus aureus* and *Bacillus subtilis*). The leaves and stems extract of the plant had no effect on *Pseudomonas aeruginosa* even at high concentration [364].

Biofilms protect the pathogens from inhibitory effect of antibiotics and immune cells. *Pseudomonas aeruginosa* was an important pathogen, and one of the hallmarks of *Pseudomonas aeruginosa* infection was its capability to adhere to, and propagate on medical devices, such as catheters, contact lenses, and wound dressings by forming strong biofilms. Antipseudomonal activity of *Daphne mucronata* 5% aqueous extracts was determined using Disk-Diffusion assay. *Daphne mucronata*, produced zone of inhibition of 12mm, biofilm reduction 40.08% and biofilm removal 46.02% [365-366].

Datisca cannabina

The antimicrobial activity of crude extracts of plants and pigments of *Datisca cannabina* were investigated against *Staphylococcus aureus* (ATCC 6533), *Enterococcus hirae* (ATCC 10541), (Gram-positive bacteria), *Escherichia coli* (ATCC 10536), *Pseudomonas aeruginosa* (ATCC 15442), *Salmonella typhimurium* (ATCC 13311) (Gram-negative bacteria). Results revealed that the dyes exerted showed inhibitory effects against 6 of the 7 (85.7%) studied organisms. MIC varied between 2.4 and 625 µg g/ml [367].

Datura metel

The antibacterial effect of hydro-alcoholic and methanolic seed extracts of *Datura fastuosa* was evaluated against three clinical bacterial strains (*Escherichia coli*, *Staphylococcus aureus* and *Bacillus subtilis*) by tube dilution method. Both plant extracts were active against the tested microorganisms. The methanolic extract of *Datura fastuosa* inhibited *E. coli* effectively with minimum bactericidal concentration (MBC) of 25µg/ml. The hydroalcoholic extract of *Datura fastuosa* seeds was found to be more potent in terms of its bactericidal concentration against *B. subtilis* with both minimum inhibitory concentration (MIC) and MBC values of 25 µg/ml. Methanolic extract was found to be more efficient in inhibiting *S. aureus* with MIC of 12.5 µg/ml [368].

A new antibacterial agent 5^l, 7^l dimethyl 6^l- hydroxy 3^l, phenyl 3 a - amine b - yne sitosterol was isolated from the plant leaves. It displayed antibacterial activity against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Salmonella typhi*, *Bacillus subtilis* and *Klebsiella pneumonia* but could not inhibit *Escherichia coli* [369].

The antipathogenic effect of carbon tetrachloride, benzene and chloroform extract crude extracts of *Datura* leaf extract was studied against Enterobacter species. Carbon tetra chloride and benzene extracts (1000µg/ml) of the leaves of *Datura metel* showed excellent activity on comparing with that of standard drug, ciprofloxacin (100µg/ml) [370-371].

Datura stramonium

The antimicrobial activity of the aqueous and ethanolic extract of the stem-bark of *Datura stramonium* was investigation against *Staphylococcus aureus*, *Salmonella typhi*, *Shigella* spp, *Escherichia coli*, *Klebsiella pneumonia* and *Neisseria gonorrhea*. Ethanolic extract showed more antibacterial activity than the aqueous extract. It showed antibacterial activity against all the tested bacteria except *Neisseria gonorrhea*. The aqueous extract showed activity only against *Staphylococcus aureus* [372].

The antimicrobial properties of whole plants (extracted sequentially with different organic solvents) of *Datura stramonium* were studied against *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*. All the solvent extracts showed significant activity against all the tested microorganisms. Methanolic extract was the most active against all microorganisms, whereas all the extracts showed significant activity against *P. aeruginosa*. All the solvent extracts showed low MIC against *A.niger* [373].

The antibacterial effects of benzene, chloroform and ethanol extracts of branches and leaves of *Datura stramonium* branches and leaves were studied against Enterobacter (clinical strain/PIMS), *Micrococcus luteus* (clinical strain/PIMS), *Pseudomonas aeruginosa* (clinical strain/PIMS), *E.coli* ATCC 25922, *Staphylococcus aureus* (clinical strain/PIMS) and *Klebsiella pneumonia* ATCC 700603. *Datura stramonium* chloroform extract produced maximum zone of inhibition 16±0.7mm against Enterobacter, while it produced minimum zone of inhibition (7±0.7mm) against *K. pneumonia*. Benzene extract of the plant exhibited maximum zone of inhibition (15±0.7mm) against Enterobacter and *M. luteus*, while it produced minimum zone of

inhibition (9 ± 0.3 mm) against *S. aureus* and *K. pneumonia*, ethanol extract of *Datura stramonium* gave maximum zone of inhibition against *K. pneumonia* and minimum against *E. coli*. The MBC values revealed that benzene extract (3.12 mg/ml) was effective against *P. aeruginosa* while the same concentration of chloroform extract was very active against *S. aureus*, *P. aeruginosa* and *M. luteus* [374].

Datura stramonium extracts were investigated for their in vitro activity against *Staphylococcus aureus* ATCC25923, Methicillin-resistant *S. aureus*, *Enterococcus* sp., *Escherichia coli* ATCC25922, Enteroinvasive *Escherichia coli* and *Pseudomonas aeruginosa*. *Datura stramonium* leaf extracts exhibited a considerable antibacterial activity even at low concentrations. Methanolic leaf extracts showed the maximum inhibitory effect. The growth inhibition zone against *Escherichia coli* was 9.8 mm and against *Staphylococcus aureus* was 6.8 mm [375].

The antimicrobial effect of methanol extract from flower, seed and leaf of explant callus was studied against (*Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus epidermidis* and *Bacillus subtilis*). The result showed that the methanol extract from green leaf explant callus possessed inhibitory effects on the growth of *B. subtilis* (22 mm) and *S. epidermidis* (23 mm) [376].

Aqueous and organic solvent extracts of different parts of the plant were investigated for its anti-*Vibrio cholera* non-O1, and *Vibrio parahaemolyticus* using the disk diffusion method. The results revealed that *Datura stramonium* possessed a broad-spectrum vibriocidal effect [377].

Aqueous and ethanolic extracts of various parts of *Datura stramonium* were examined for their potential antimicrobial activity against pathogenic bacteria [*Bacillus subtilis*-2699, *Escherichia coli*-2803, *Staphylococcus aureus*-2602, *Proteus vulgaris*-2027 and *Salmonella typhi*-2501]. The results showed that the ethanolic extracts were more potent than the aqueous extracts and leaf extract possessed better antimicrobial activity than stem, and root. Aqueous extract of the leaves showed antibacterial activity against *Bacillus subtilis* and *Escherichia coli* with zone of inhibition of 16 and 10 mm respectively, while ethanolic extracts of the leaves exerted antibacterial activity against *Bacillus subtilis* (31 mm), *Escherichia coli* (18 mm), *Staphylococcus aureus* (24 mm) and *Salmonella typhi* (10 mm) [378].

Daucus carota

Four sesquiterpenes daucane esters, one polyacetylene, one sesquiterpene coumarin, and sitosterol glucoside isolated from the roots of the wild *Daucus carota* ssp *carota*, showed a range of low antibacterial activities against four Gram positive (*Staphylococcus aureus*, *Streptomyces scabies*, *Bacillus subtilis* and *Bacillus cereus*) and two Gram negative species (*Pseudomonas aeruginosa* and *Escherichia coli*) [379-380].

The flavones isolated from the methanol extract of *Daucus carota* seeds (luteolin, luteolin 3'-O-beta-D-glucopyranoside and luteolin 4'-O-beta-D-glucopyranoside) were evaluated for antibacterial effects. Both luteolin and its 4'-O-glucoside demonstrated bactericidal activity against *Staphylococcus aureus* and *Escherichia coli*, MIC = 5.0×10^{-2} - 1.0×10^{-1} mg/ml). Luteolin also demonstrated antibactericidal activity against *Bacillus cereus* and *Citrobacter freundii* (MIC = 5.0×10^{-2} mg/ml). Luteolin 3'-O-glucoside showed bactericidal activity against *Bacillus cereus* and *Lactobacillus plantarum* (MIC = 2.5×10^{-1} mg/ml and 5×10^{-1} mg/ml, respectively) [381].

The antimicrobial activity of the essential oils of the flowering and mature umbels with seeds of wild *Daucus carota* L. subsp. *carota* from two different sites in Tunisia, were assayed by using the broth dilution method on *Escherichia coli* ATCC 35218 and *Staphylococcus aureus* ATCC 43300. The MIC values obtained were $> 2.5\%$ (v/v) [382].

The in vitro antimicrobial activity of essential oils of *Daucus carota* seeds was evaluated, using the disk-diffusion method, against one Gram-positive (*Staphylococcus aureus*) and two Gram-negative bacteria (*Escherichia coli* and *Salmonella typhimurium*). All tested essential oils exhibited antibacterial activities against the assayed microorganisms [383].

The antibacterial activity of the essential oil of *Daucus carota* subsp *carota* from Portugal was evaluated against several Gram positive and Gram negative bacteria. The results showed a significant activity towards Gram positive bacteria (MIC = 0.32–0.64 µl/ml). [384].

The antimicrobial effect of wild *Daucus carota* extracts seed (70% and 40% ethanol) were examined against Gram positive (*Staphylococcus aureus* ATCC 6538-P, *Staphylococcus hyicus* – isolated from the soil, *Micrococcus luteus* – isolated from soil, cryptogamic culture of *Bacillus subtilis* ATCC 6633) and Gram negative (*Pseudomonas aeruginosa* ATCC 9027, *Escherichia coli* ATCC 8739 and *Salmonella Abony* CIP- 8039, and *Acinetobacter johnsonii* – isolated from the environment, *Moellerella wisconsensis* – isolated from the environment). The extracts were active against bacteria, the MIC against 2 Gram positive bacteria was 1.56-3.125 mg/ml and against 3 strains of Gram negative bacteria was 3.125-12.50 mg/ml [385].

The essential oil of wild *Daucus carota* aerial parts at the end of the flowering stage (DCEO) inhibited the growth of *Campylobacter jejuni*, *Campylobacter coli*, and *Campylobacter lari* strains, including one

multidrug resistant *Campylobacter jejuni*. The molecules responsible for the antibacterial activity were identified as (E)-methyloisoeugenol and elemicin [386].

Delphinium brunonianum

Antimicrobial assay of extracts, fractions, subfractions and compounds was performed on different microbes (*Escherichia coli*, *staphylococcus aureus*, *Pseudomonas aureginous*, *Salmonella flexinariae* and *Bacillus subtilis*). Extract and the compound isolated from *Delphinium brunonianum* (β -amyrin, β -sitosterol, β -sitosterol glucoside and anthriscifoldine) displayed moderate to good antibacterial properties on the tested bacteria in which the last compound (anthriscifoldine) showed comparatively higher activity regarding its minimum inhibitory concentrations and zone of inhibition, than other compounds [387].

Desmostachya bipinnata

In studying the antimicrobial effect of *Desmostachya bipinnata*, it appeared that β -Sitosterol-D-glucopyranoside was the bioactive compound identified to have the best antimicrobial activity (MIC 6-50 μ g/ml) and it works synergistically with most antibiotics, especially with ciprofloxacin. Time kill curves showed that β -Sitosterol-D-glucopyranoside kills most of the pathogens within 5-10 h [388].

The antimicrobial effect of the ethanolic extract of *Desmostachya bipinnata* rootstock was investigated against *Aeromonas hydrophila*, *Bacillus cereus*, *Bacillus subtilis*, *Enterobacter aerogens*, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, *Salmonella typhimurium*, *Staphylococcus aureus*, *Streptococcus pyrogens* and *Vibrio fischeri*. The ethanolic extract (15.652, 31.25, 62.5, 125.250 and 500 mg/ml) was found to inhibit *K. pneumonia* (16-25 mm), *E. coli* (12-22), *B. cereus* (9-18mm), *S. typhimurium* (13-17mm), and *P. vulgaris* (10-13mm) [389].

Ethanolic extract of *Desmostachya bipinnata* possessed antibacterial activity against *Micrococcus luteus*, *Bacillus subtilis*, *Proteus merabiles*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Sarcina ventricull*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Escherichia coli* and *Serratia marcesens* [390-391].

The antibacterial study of the oil of the aerial parts of *Desmostachya bipinnata* was evaluated using agar diffusion and broth dilution methods. The antibacterial studies revealed that the oil possessed significant inhibitory effect against four bacteria strains [392].

The crude extract of *Desmostachya bipinnata* (64 μ g) showed antibacterial activity against *Escherichia coli* (17mm), *Klebsiella sp* (15mm) and *Staphylococcus aureus* (16mm) [393].

Dianthus caryophyllus

Eugenol was isolated from the essential oils of the plant and investigated for its antibacterial activities against seven selected pathogenic bacteria (*Staphylococcus aureus*, *Bacillus cereus*, *Listeria monocytogenes*, *Proteus mirabilis*, *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*). Eugenol achieved strong MIC values against most tested pathogens and the best MIC value (15.6 microg/ml) was observed against *B. cereus*, *L. monocytogenes* and *K. pneumoniae* whereas, *S. aureus*, *P. mirabilis* and *E. coli* were inhibited with a MIC value of 31.2 microg/ml [394].

Whole *Dianthus caryophyllus* extracts showed antibacterial activity against *Staphylococcus epidermidis*, *Klebsiella pneumonia* and *Bordetella bronchiseptica* [395].

Standard bacterial strains included [*Pseudomonas aeruginosa* (PTCC No. 1074), *P. fluorescens* (PTCC No. 1181), *Bacillus subtilis* (PTCC No. 1023), *B. cereus* (PTCC No. 1015) and *B. pumilis* (PTCC No. 1319)] were used to evaluate the antibacterial activity of *Dianthus caryophyllus*. *Dianthus caryophyllus* (the whole plant, methanolic extract) was the most active plant, among 180 tested plants, against all tested bacterial species, with MIC of 1.87, 7.5, 3.72, 3.75 and 0.46 mg/ml against *B. subtilis*, *B. cereus*, *B. pumilis*, *P. aeruginosa* and *P. fluorescens* respectively [396].

Aqueous and methanolic extracts of aerial parts of *Dianthus caryophyllus* showed anti-*Helicobacter pylori* activity with MIC >1000 and >500 μ g/ml respectively [397-398].

Dodonaea viscosa

The growth inhibitory activity of *Dodonaea viscosa* var. *angustifolia* (DVA) leaves extract was investigated against *Streptococcus mutans* and its biofilm. The results revealed that the reduction of the growth of *Streptococcus mutans* was concentration and exposure time dependent. The crude extract killed 48% of *S. mutans* at a lowest concentration of 0.1 mg/ml and 100% at 25 mg/ml after 6 h. Biofilm formation was reduced by 95, 97 and 99% after 6, 24 and 30 h of exposure to the sub-inhibitory concentration of crude extract respectively. At high concentration the crude extract was bactericidal to *Streptococcus mutans* but sub-inhibitory concentration significantly reduced the planktonic cells and biofilm formation [399-400].

The n-hexane, dichloromethane, ethyl acetate, n-butanol and aqueous fractions of *Dodonaea viscosa* were analyzed for antimicrobial potential against four Gram positive bacteria [*Bacillus subtilis* (MRL M 1),

Bacillus cereus (MRL M 52), *Micrococcus luteus* (ATCC 10240), *Staphylococcus aureus* (ATCC 6538)], three Gram negative [bacteria: *Escherichia coli* (ATCC 25922), *Salmonella typhi* (Cl. I. 140) and *Pseudomonas aeruginosa* (ATCC 9721)]. Extracts possessed antibacterial activity against *S. aureus*, *M. luteus*, *B. subtilis*, *E. coli* and *P. aeruginosa*. However, 15, 16-epoxy-cis-cleroda-3, 13(16),14-trien-18-oic acid-18,6-olide, a clerodanefuranolactone isolated from n-hexane fraction of *Dodonaea viscosa*'s crude ethanolic extract showed antibacterial effects against Gram positive and Gram negative bacteria, its MIC's against *S. aureus* (NCIMB 6571) and *E. coli* (NCIMB 8797) were 64 µg/ml and 128 µg/ml respectively. The MBC's against these organisms were 128 µg/ml and 256 µg/ml, respectively [401].

The antibacterial activity of crude and step gradient solvent of methanol and chloroform of whole *Dodonaea viscosa* was studied using agar well diffusion technique against six bacterial human pathogens (*S. typhi*, *S. flexneri*, *E. coli*, *V. cholerae*, *M. tuberculosis*, *P. fluorescens*). The growths of *S. flexneri* and *V. cholerae* were inhibited by the crude and step gradient extracts of *Dodonaea viscosa*. The maximum inhibition zone was obtained with the using of methanol 80% and chloroform 20% against the tested pathogens [402].

Methanol and n-hexane extracts of the leaves of *Dodonaea viscosa* were screened for antibacterial activities, against different Gram positive and Gram negative bacterial strains. The results showed that n-hexane extract of plant was inactive against *Pseudomonas aeruginosa* while methanolic extract of the plant was active against all the tested organisms [403].

The anti-biofilm activities of leaves of *Dodonaea viscosa* in successive different concentration were tested against *E. coli*. The leaves extracts of *Dodonaea viscosa* showed broad spectrum antibiofilm activity [404].

The antibacterial effect of methanolic and hot aqueous extracts of *Dodonaea viscosa* was studied against *Staphylococcus aureus* ATCC 6538, *Bacillus subtilis* ATCC 6059, *Micrococcus flavus* SBUG 16, *Escherichia coli* ATCC 11229, *Pseudomonas aeruginosa* ATCC 27853, multiresistant *Staphylococcus epidermidis*, multiresistant *Staphylococcus haemolyticus* and North German multiresistant *Staphylococcus aureus*. *Dodonaea viscosa* methanolic extract showed antibacterial activity against all tested bacteria with MIC 10-15 mm, except *Escherichia coli* and *Pseudomonas aeruginosa*, while hot aqueous possessed activity against *Staphylococcus aureus*, *Bacillus subtilis*, *Micrococcus flavus* and multiresistant *Staphylococcus epidermidis* only, with MIC 7.3-16mm [405].

The antimicrobial activity of *Dodonaea viscosa* leaf, stem and root using aqueous, methanol and chloroform solvents was studied using disc diffusion method. *Vibrio cholerae* was controlled by all parts of *Dodonaea viscosa* extracted by all the three types of solvent. Maximum zone of inhibition was recorded by the methanol extract of stem against *Vibrio cholerae*. Similarly, *Bacillus subtilis* was controlled by all the extracts except that of methanol extract of root. The root extract of the weed showed no efficacy against the *Escherichia coli* and *Proteus mirabilis*[406].

The inhibitory effects of the aerial plant part (leaves and bark) extracts of *Dodonaea viscosa* before and during flowering were evaluated against some pathogenic bacteria isolated from human and plants (*Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcus agalactiae*, *E. carotovora* and *A. tumefaciens*) using ethanol and diethyl ether solvents (0, 2.5, 5, 10, 20, 30, 40 or 50 mg/ml). The results showed that ethanolic extracts of the bark and leaves, and diethyl ether extracts of the leaves demonstrated potent inhibitory effect against the tested microorganisms [407].

Anti- salmonella activity of aqueous and ethanol extracts of *Dodonaea viscosa* was studied using well and disc diffusion assay. The highest inhibition zone was (22 mm) for well diffusion and (15mm) for disc diffusion assay were recorded. The results revealed that ethanol extract possessed more antibacterial effect than aqueous extract, the percentage of bacterial isolates affected by ethanol extract was (71.19%) comparing with aqueous extract (28.81%) by using disc diffusion assay, while the percentage of bacterial isolates affected by ethanol extract was (88.13%) comparing with aqueous extract (52.54%) by using well diffusion assay [408].

The crude ethanolic extract and n-hexane, dichloromethane, ethyl acetate, n-butanol and aqueous fractions of *Dodonaea viscosa* were analyzed for antibacterial potential against four Gram positive bacteria (*Bacillus subtilis*, *Bacillus cereus*, *Micrococcus luteus* and *Staphylococcus aureus*), and three Gram negative bacteria (*Escherichia coli*, *Salmonella typhi* and *Pseudomonas aeruginosa*). The results revealed that the crude extract possessed antibacterial activity against *Staphylococcus aureus*, *Micrococcus luteus*, *Bacillus subtilis*, *Escherichia coli* and *Pseudomonas aeruginosa* with zones of inhibition of 11-13.3mm. The results also showed that ethyl acetate fraction was active against five out of seven tested organisms, followed by the n-butanol fraction which inhibited four organisms and the n-hexane fraction which inhibited two organisms [409].

Chloroform, ethanol and methanol crude extracts of stem bark and leaves of *Dodonaea viscosa* were investigated for their antibacterial potential against two Gram positive bacteria (*Bacillus subtilis*, *Staphylococcus aureus*) and one Gram negative bacterium (*Escherichia coli*). Ethanol and methanol extracts

were found to be active against the tested Gram positive and Gram negative bacteria. However, Gram positive bacteria were more sensitive to the extracts of *Dodonaea viscosa* than Gram negative bacterium [410].

***Dolichos lablab* (Syn: *Lablab purpureus*)**

The antibacterial activity of leaf and flower extracts of *Lablab purpureus* was studied against clinical *Staphylococcus aureus* isolates. Both extracts showed antibacterial activity, but the flower extract showed marked inhibition of *Staphylococcus aureus* isolates [411].

The antimicrobial activity of crude extracts (chloroform, n-hexane, ethyl acetate) of leaves of *Lablab purpureus* L. were studied using disc diffusion technique. Extracts were tested against eleven important pathogenic bacteria including both Gram positive and Gram negative bacteria. The tested bacteria were *B. megaterium*, *B. subtilis*, *Staphylococcus aureus*, *Sarcina lutea*, *Escherichia coli*, *Salmonella paratyphi*, *S. typhi*, *Shigella boydii*, *S. dysenteriae*, *Vibrio mimicus* and *V. parahemolyticus*. The extracts showed antimicrobial activity against most of the bacterial strains with an average zone of inhibition of 8-20mm. Among the three solvent extracts used, the most effective extract was n-hexane extract and maximum activity (20 mm, zone of inhibition) was recorded against *Staphylococcus aureus* with minimum inhibitory concentration (MIC) values of 64µg/ml. The maximum zone of inhibition for chloroform extract was 17mm against *Bacillus subtilis* and *E.coli* with MIC of 128µg/ml and 32µg/ml respectively. The maximum zone of inhibition for ethyl acetate extract was 17mm against *Vibrio mimicus* with MIC values of 64µg/ml [412-413].

Echinochloa crus-galli

The 1% acidified methanol and ethyl acetate extracts of *Echinochloa crus-galli* seeds showed zone of inhibition ranged from 9 mm to 16 mm against *B. megaterium*, *S. aureus*, *E. coli* and *P. aeruginos* [414].

Echinochloa crus-galli extracts (50,100 and 200 mg/ml) were prepared in six different solvents (water, ethyle Acetate, acetone, 95% ethanol, chloroform and 1% acidified methanol). The antibacterial effects of these extracts were investigated against Gram positive [*Staphylococcus aureus* (MTCC 96) and *Bacillus megaterium* (MTCC-428)] and Gram negative [*Escherichia coli* (MTCC 443) and *Pseudomonas aeruginos* (MTCC1688)] bacteria. All extracts at concentration of 200 mg/ml possessed antibacterial activity against all the tested microorganism [415-416].

Echium italicum

Echium italicum extracts caused a zone of growth inhibition of at least 4 mm against *Pseudomonas solanaciurum* and 1 cm² against *Cladosporium cucumerinum*[417].

The antimicrobial activity of *Echium italicum* oil was studied using the disk diffusion method and determination of minimal inhibitory concentration values against *Bacillus subtilis* PTCC 1023, *Staphylococcus aureus* PTCC 1112, *Escherichia coli* PTCC 1330, *Salmonella typhi* PTCC 1639 and *Pseudomonas aeruginosa* PTCC 1074. *Echium italicum* oil exhibited concentration-dependent antimicrobial activity against all the tested microorganisms [418-419].

Ephedra alata* and *Ephedra foliate

The antimicrobial activity of different extracts of *Ephedra alata* stem was investigated against Four bacteria, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, and *Escherichia coli*. Acetonitrile extracts exhibited the most potent antimicrobial effect with a broad spectral range. Thin layer chromatographic separation of active constituents in acetonitrile extracts revealed the presence of seven fractions. All fractions showed antimicrobial activities with four fractions having a potent inhibitory effect [420-421].

The antibacterial activity of flavonoid extracts of *Ephedra alata* was evaluated against Gram positive and Gram negative pathogenic bacteria (*Serratia marcescens* ATCC 13880, *Pseudomonas aeruginosa* ATCC 10145, *Bacillus subtilis* ATCC 6051, *Escherichia coli* ATCC 25922, *Enterococcus faecalis* ATCC 29212, *Staphylococcus aureus* ATCC 25923, *Bacillus cereus* ATCC 11778, *Methicillin -resistant Staphylococcus aureus* (MRSA) ATCC 013300 and *Staphylococcus aureus* ATCC 29213). The results exhibited variable susceptibilities of microorganisms. The activity was associated with high concentration. The extracts of *Ephedra alata* displayed relatively important effects with a variable diameter of growth inhibition zones in most types of bacteria. However no effect was recorded against *Serratia marcescens* ATCC 13880 with butanol extracts of flowers and leaves and ethyl acetate and dichloromethane extracts of leaves. Butanol, ethyl acetate, and dichloromethane extracts of leaves showed no activity against *Enterococcus faecalis* ATCC 29212 [422-423].

Equisetum arvense

The methanolic extract of the aerial parts of *Equisetum arvense* displayed antibacterial activity against *Escherichia coli* at high concentration (1g/ml) [424].

Equisetum arvense extracts showed antimicrobial activity against *Staphylococcus epidermidis* and *Escherichia coli*. A disk diffusion method was used for the evaluation of the antimicrobial activity of volatile constituents of *Equisetum arvense* against *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Salmonella enteritidis*. The 1:10 dilution of the essential oil of *Equisetum arvense* possessed a good activity against all the tested bacteria [425-426].

The antibacterial activity of ethanolic and aqueous extract of *Equisetum arvense* was screened against selected urinary tract pathogens (*E.coli*, *Klebsiella pneumonia*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Staphylococcus saprophyticus* and *Enterococcus faecalis*) using disc diffusion technique. Both the extracts at different concentration exhibited antibacterial activity against all the tested bacterial strains. Ethanolic extract exhibited comparably a high degree of activity than the aqueous extract. The ethanolic extract was more effective against *E.coli*, *Proteus mirabilis* and *Staphylococcus saprophyticus* with a zone of inhibition of 24mm, 23mm and 24 mm diameter (at concentration of 1000µg) respectively and was least effective against *Pseudomonas aeruginosa* with zone of inhibition of 11mm (at concentration of 1000µg). Among the other studied bacterial species, *Klebsiella pneumoniae* and *Enterococcus faecalis* showed a zone of inhibition of 18mm diameter (at concentration of 1000µg) and *Staphylococcus aureus* showed inhibition zone of 14mm diameter (at concentration of 1000µg) [427].

The *in vitro* antibacterial activity of ethanol stem extract (50-400µg/ml) of *Equisetum arvense* was studied against two Gram positive (*Bacillus subtilis* and *Micrococcus luteus*) and four Gram negative (*Vibrio cholerae*, *Escherichia coli*, *Shigella flexneri* and *Shigella dysenteriae*) bacteria. Out of six bacterial species (except *Shigella dysenteriae* and *Vibrio cholera*), four were found to be very sensitive to plant extract at all concentrations. The mean zone of inhibition for the extract against Gram positive and Gram negative bacteria increased with the increasing concentration of the extract. The highest mean zone of inhibition (32 mm) was recorded against *Escherichia coli* [428].

Erigeron canadensis

The antibacterial activity of *Erigeron canadensis* was carried out against eight pathogenic bacteria (*Pseudomonas aeruginosa*, *Vibrio cholerae*, *Escherichia coli*, *Shigella dysenteriae*, *Shigella flexneri*, *Bacillus subtilis*, *Micrococcus luteus*, and *Staphylococcus aureus*). The ethanolic floral extract showed highest inhibition zone (17 mm) against *P. aeruginosa* and minimal inhibition zone against *B. subtilis* (5 mm). The methanolic extract of flower showed highest inhibition zone against *E. coli*, with lowest zone against *M. luteus*. No inhibition zone was noted by the ethanolic and methanolic stem extract of the plant [429].

The whole plant was extracted with 80% ethanol and the extract was suspended in water and fractionated with n-hexane, chloroform and ethyl acetate. Two isolated compounds (conyzolide and conyzoflavone) were studied for antibacterial effects, against *E. coli* ATCC 25922, *B. subtilis* ATCC 6633, *S. flexneri* (clinical isolate), *S. aureus* ATCC 25923, *P. aeruginosa* ATCC 27853 and *S. typhi* ATCC 19430. Conyzolide showed comparatively better and significant antibacterial activities against *E. coli* (MIC: 25 µg/ml). It also revealed considerable activities against *S. aureus* (MIC: 50 µg/ml) *P. aeruginosa* (MIC: 100 µg/ml) and *S. typhi* (MIC: 100 µg/ml). However, Conyzoflavone showed significant activity against *S. typhi* (MIC: 50µg/ml) in addition to its weak to moderate activity against all the tested pathogens [430-431].

The crude methanolic extract of the plant and its various solvent fractions were evaluated for antibacterial effects against *E. coli*, *P. aureginosa*, *Klebsella*, *S. aureus* and *Bacillus*. The result showed that the tested samples were only effective against *E.coli*, *P. aureginosa*, *S. aureus*, while the remaining bacteria showed 100 % resistance. The methanolic extract, chloroform and ethyl acetate fraction demonstrated maximum activity with zone of inhibition 14, 12 and 13 mm respectively while, the n-hexane fraction was devoid of antibacterial effect at low dose and exhibited low activity at high dose against *E. coli*, *P. aureginos* and *S. aureus* with zone of inhibition 10, 11 and 9 mm respectively [432].

The bacteriostatic activities of the oil of *Erigeron canadensis* were investigated by agar-diffusion method, against *Enterococcus faecalis* (ATCC29212), *Staphylococcus aureus* (ATCC25923) and *Streptococcus pyogenes* (HNCMB80002) as Gram-positive bacteria and *Escherichia coli* (ATCC25922), *Pseudomonas aeruginosa* (ATCC27853) as Gram-negative bacteria. None of the oils showed any activity against the tested bacterial strains[433].

Erodium cicutarium

The essential oils of *Erodium cicutarium* were tested against Gram positive *Staphylococcus aureus* (ATCC 27853), *Staphylococcus aureus* (clinical isolate), *Clostridium perfringens* (ATCC 19404), *Bacillus subtilis* (ATCC 6633), Gram negative *Escherichia coli* (ATCC 25922), *Escherichia coli* (clinical isolate), *Klebsiella pneumoniae* (clinical isolate) and *Pseudomonas aeruginosa* (ATCC 25923). MIC of *Erodium cicutarium* against *P. aeruginosa* was 0.312 mg/ml, *Escherichia coli* (ATCC 25922) 0.625 mg/ml, *Escherichia coli* (clinical isolate) 2.5 mg/ml, *K. pneumoniae* 1.25 mg/ml, *Staphylococcus aureus* (ATCC

27853) 0.312 mg/ml, *Staphylococcus aureus* (clinical isolate) 2.5 mg/ml, *C. perfringens* 0.312 mg/ml, *B. subtilis* 0.625 mg/ml and *P. chrysogenum* 0.156 mg/ml [434-436].

Eryngium creticum

The antibacterial activity of the Aqueous and ethanolic extracts of *Eryngium creticum* leaves and stems was studied against three Gram positive bacteria (*Staphylococcus epidermidis* CIP 444, *Staphylococcus aureus* ATCC 25923, and *Enterococcus faecalis* ATCC 29212) and two Gram negative strains (*Escherichia coli* ATCC 35218 and *Pseudomonas aeruginosa* ATCC 27853). Aqueous extracts from *Eryngium creticum* showed stronger antibacterial activity than the ethanolic extracts against both Gram positive and Gram negative strains. Among these strains, Gram positive ones were more sensitive, with *Staphylococcus epidermidis* being the most inhibited with MIC=MBC=5 mg/ml for the leaves aqueous extract, in particular in the first harvest period. During the second period, however, the activity decreases, to show equal concentrations (MIC = MBC = 27.9 mg/ml). Whereas the stem aqueous extract, during the first harvest period, exhibited a considerable activity with MIC=26 mg/ml and MBC=53 mg/ml [437].

The antibacterial activity of *Eryngium creticum* was tested against *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus vulgaris* and *Pseudomonas aeruginosa* using disc diffusion method. The aqueous was more effective against *K. pneumoniae* than the ethanolic extract, while the ethanolic extract was more effective against *P. vulgaris*. However, against *S. aureus*, *E. coli* and *P. aeruginosa*, there were no differences between the effect of the aqueous and ethanolic extracts [438].

The essential oils of *Eryngium creticum* were tested for their inhibitory activity against nine different methicillin-resistant *Staphylococcus aureus* (MRSA) strains by agar disc diffusion method. Three strains showed zone of inhibition 9-11 mm, four strains 5-7 mm and 2 strains resisted *Eryngium creticum* essential oils [439-440].

***Eucalyptus* species**

The antibacterial effect of Eucalyptus oil was investigated against *Klebsiella* spp., *Proteus* spp., *Pseudomonas* spp., *Escherichia coli*, and *Staphylococcus aureus*. The results showed that, *Escherichia coli* and *Klebsiella* spp. were sensitive to 5 µl, *Staphylococcus aureus* to 25 µl, while *Pseudomonas* and *Proteus* spp. required 50 µl of Eucalyptus oil. With an increasing dose of oil of Eucalyptus, the resulting diameter of the zone of inhibition increased for all the organisms [441].

The *in vitro* antimicrobial activity of the essential oil and methanol extracts of *Eucalyptus largiflorens* (*Eucalyptus bicolor*) was studied against *Pseudomonas aeruginosa* ATCC 27853, *Bacillus subtilis* ATCC 6633, *Staphylococcus aureus* ATCC 29737, *Escherichia coli* ATCC 10536, *Klebsiella pneumoniae* ATCC 10031, *Staphylococcus epidermidis* ATCC 12228, *Shigella dysenteriae* PTCC 1188, *Proteus vulgaris* PTCC 1182 and *Salmonella paratyphi-A* serotype ATCC 5702. The essential oil of *Eucalyptus largiflorens* exhibited moderate to high antimicrobial activity against all the bacteria tested, except three microorganisms, *Pseudomonas aeruginosa*, *Escherichia coli* and *Shigella dysenteriae*. The evaluation of methanol fraction indicated that polar fraction showed strong activity against the majority of the tested microorganisms, while non-polar fractions did not possess any inhibitory action against the strains evaluated except *Escherichia coli* [442-443].

The antimicrobial properties of essential oil, its major component, 1,8-cineole, and extracts of *Eucalyptus largiflorens* (*Eucalyptus bicolor*) were evaluated *in vitro*. Minimum inhibitory concentration of the extracts was calculated by broth dilution method and the zone of inhibition was studied by agar disk diffusion method. Gentamicin (10 µg/disk) and rifampin (5 µg/disk) were used as reference controls for antibacterial tests. The results of MIC study revealed that the essential oil has a stronger activity and broader spectrum than those of methanol extracts. The oil also had greater antimicrobial potential than 1,8-cineole [444].

Disk diffusion method was used to determine the antimicrobial activity of aqueous extract and essential oils of *Eucalyptus incrassata* leaves against eight isolates of multidrug-resistant *Staphylococcus aureus*. It was found that aqueous extract and essential oils possessed variable antimicrobial activity (the inhibition zone diameter ranged from 7 to 14 mm respectively). Essential oils showed more antibacterial effect than aqueous extract [445].

The *in vitro* antimicrobial activity of acetone, methanol and water extracts of leaf, stem and bark of *Eucalyptus camaldulensis* was studied against six bacterial species *Bacillus megaterium*, *Bacillus subtilis*, *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Micrococcus luteus* and *E. coli* using the agar well diffusion method. The results showed that the extracts exhibited a dose-dependent inhibition of microorganisms. The acetone and methanol extracts of leaf and stem bark of *Eucalyptus camaldulensis* displayed maximum antibacterial activity against all the bacterial species. There was no significant difference in the antimicrobial activity of the extracts on Gram negative and Gram positive bacteria [446].

The antibacterial activity of the crude leaf extracts of *Eucalyptus camaldulensis* were studied against clinical isolates of *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, *Proteus mirabilis* and *Klebsiella pneumoniae*. The growth of all the pathogenic bacteria was arrested at 50 mg/ml concentration of extracts. The least activity was possessed by aqueous extract against *E. coli* (7 mm), *K. pneumoniae* (9 mm), *P. mirabilis* (13 mm), *S. typhi* (12 mm) and *S. aureus* (12 mm), while the highest was recorded for the acetone extract, with a diameter of inhibition for *E. coli* (12 mm), *K. pneumoniae* (13 mm), *S. typhi* (14 mm), *P. mirabilis* (15 mm) and *S. aureus* (14 mm) [447].

The antibacterial activities of *Eucalyptus camaldulensis*, *Eucalyptus camaldulensis* var. obtusa and *Eucalyptus gomphocephala* essential oils were studied using agar disc diffusion and minimum inhibitory concentration methods. The essential oils from the leaves of *Eucalyptus* spp. exhibited considerable antibacterial activity against Gram positive and Gram negative bacteria [448].

The antimicrobial and biofilm preventing activities of the oils of *Eucalyptus camaldulensis* were studied *in vitro* and *in vivo*. Minimal bactericidal concentrations (MBC) of the *Eucalyptus camaldulensis* oils were found to be 4 and 2 mg/ml, and those of chlorhexidine (2%) were 8 and 1 mg/ml for both *S. mutans* and *S. pyogenes* respectively. Decimal reduction time of *S. mutans* by *Eucalyptus camaldulensis* oils at their MBC levels was 2.8 min, while that of chlorhexidine was 12.8 min. D-value of *S. pyogenes* exposed to the MBC levels of *Eucalyptus camaldulensis* oils and of chlorhexidine were 3.6 and 2.8 min respectively. Antibacterial and *in vivo* biofilm preventive efficacies of all the concentrations of *Eucalyptus* oil were significantly ($P < 0.001$) higher than that of chlorhexidine [449].

The antimicrobial potential of two *Eucalyptus camaldulensis* essential oils was investigated against multi-drug resistant (MDR) *Acinetobacter baumannii* wound isolates, the possible interactions of essential oils with conventional antimicrobial agents was also studied. MIC values of essential oils against *Acinetobacter baumannii* strains were estimated by modified broth microdilution method. The components responsible for antimicrobial activity were detected by bioautographic analysis. The potential synergy between the essential oils and antibiotics (ciprofloxacin, gentamicin and polymyxin B) was examined by checkerboard method and time kill curve. The bioautographic assay confirmed antibacterial activity of polar terpene compounds. In combination with conventional antibiotics (ciprofloxacin, gentamicin and polymyxin B), the examined essential oils showed synergistic antibacterial effect. The synergistic interaction was confirmed by time-kill curves for *Eucalyptus camaldulensis* essential oil and polymyxin B combination which reduced bacterial count under detection limit very fast, after 6h of incubation [450].

The *in vitro* antimicrobial activities of the crude oil of *Eucalyptus camaldulensis* leave was investigated against *Escherichia coli* and *Staphylococcus aureus*. The diameter of zones of inhibition by the crude oil of leaf extracts of *Eucalyptus camaldulensis* was 10- 31mm and 10-26mm for *Escherichia coli* and *Staphylococcus aureus*. Gram positive, *Staphylococcus aureus* was more resistant than Gram negative, *Escherichia coli* [451].

The *in vitro* anti- *Helicobacter pylori* of *Eucalyptus camaldulensis* was investigated in six strains of *H. pylori* (ATCC 4504, ATCC 47619, A2, TI8984, 019A, and A6). The minimum inhibitory concentrations of the crude extracts against all the tested strains ranged from 12.5 to 400 µg/ml [452].

Hexane, chloroform, methanol extracts, and isolated compounds of *Eucalyptus camaldulensis* were screened for activity against *Mycobacterium tuberculosis* H37Rv (MtbH37Rv). The extracts inhibited the growth of *Mycobacterium tuberculosis* with MIC of 4-64 µg/ml. Spectroscopic characterization led to the identification of two compounds, hydroxymyristic acid methylester and a substituted pyrenyl ester, a sterol. These two compounds had MIC of 49.45 and 46.99 µg/ml; $IC_{50} > 100$ and 38.21 µg/ml; selectivity index (SI) > 2.02 and 0.81, respectively, and a minimum bactericidal concentration of 62.50 µg/ml [453].

Essential oil of the leaves of *Eucalyptus camaldulensis* possessed high antibacterial effects against Gram positive and negative bacteria with inhibition zones ranged from 9.3 to 12.5 Mm [454].

The antibacterial effect of essential oil of *Eucalyptus camaldulensis* was evaluated against *L. monocytogenes*, *S. aureus*, *E. coli*, *K. pneumoniae*, *S. cerevisiae*, *C. albicans*, *M. ramannianus* and *A. ochraceus*. Essential oil of *Eucalyptus camaldulensis* showed activity against *S. aureus* (21mm), *B. subtilis* (24mm) and *E. coli* (10mm) [455].

The aqueous, ethanolic, chloroform and acetone extracts of *Eucalyptus microtheca* showed inhibitory effects against *Staphylococcus aureus* while benzene extract was not effective. The aqueous, ethanolic and acetone extracts also possessed inhibitory effects against *S. typhimurium*. The extracts also showed synergistic inhibitory activity when combined with antibiotics against both *Staph. aureus* but not against *S. typhimurium* [456].

The antibacterial activity of *Eucalyptus microtheca* leaves crude (ethanolic, methanolic and aqueous) extracts were tested against *Pseudomonas aeruginosa* isolates. All crude extracts exhibited an *in vitro* antibacterial activity against all *Pseudomonas aeruginosa* isolates with a zone of inhibition ranged between 17-

25mm for methanolic extract, 20-29mm for ethanolic extract at a concentration of 1 mg/ml, while the zone of inhibition for aqueous extract was 12-16mm [457].

The antibacterial activity, MIC, and MBC of alcoholic extracts of *Eucalyptus microtheca* were studied against *Bacillus cereus*, *Staphylococcus aureus*, *Salmonella typhi*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, and *Proteus mirabilis* using standard disk diffusion method. The structural changes following the exposure to these extracts were also investigated in the tested bacteria. Significant antibacterial activity was found against Gram positive and Gram negative bacteria, among them, *Escherichia coli* and *Pseudomonas aeruginosa* showed the most sensitivity and *Staphylococcus aureus* the least. The value of MIC and MBC for both extracts were 8 mg/ml for *E. coli*, 8 and 16 mg/ml for *Bacillus cereus*, respectively. MIC and MBC values of methanolic and ethanolic extracts against *P. aeruginosa* were 8 and 16 mg/ml respectively. Scanning electron microscopy revealed structural changes in the affected bacteria, which suggested that the cell wall was the main target site of active constituents [458].

The antibacterial effect of essential oil of *Eucalyptus microtheca* was evaluated against *L. monocytogenes*, *S. aureus*, *E. coli*, *K. pneumoniae*, *S. cerevisiae*, *C. albicans*, *M. ramannianus* and *A. ochraceus*. Essential oil of *Eucalyptus microtheca* showed activity against *S. aureus* (16mm), *B. subtilis* (20mm) and *E. coli* (11mm)[459].

The antimicrobial properties of aqueous and alcoholic extracts of *Eucalyptus* leaves was investigated against the most cariogenic bacteria in mouth (Mutans streptococci and Lactobacilli). There was statistically highly significant difference ($P < 0.001$) between different concentrations of the aqueous and alcoholic extracts on the sensitivity of the isolates, whilst the alcoholic extract was more effective than aqueous extract just at low concentrations. At 100 and 150 mg/ml the alcoholic and the aqueous extracts showed more potent effect than 2mg/ml chlorhexidine against Mutans streptococci. Minimum bactericidal concentration for the aqueous extract was 5-8mg/ml, 6-10mg/ml and against Mutans streptococci and Lactobacilli respectively while that of alcoholic extract was 4-8mg/ml and 6-10mg/ml against the same microorganisms respectively [460].

The effect of chewing gum containing *Eucalyptus* extract on periodontal health was investigated in a double-masked, randomized, controlled trial. Healthy humans with gingivitis but not deep periodontal pockets were randomly assigned to the following groups: high-concentration group (n=32): use of 0.6% *Eucalyptus* extract chewing gum for 12 weeks (90 mg/day); low-concentration group (n=32): use of 0.4% *Eucalyptus* extract chewing gum for 12 weeks (60 mg/day); and placebo group (n=33): use of chewing gum without *Eucalyptus* extract for the same period. Plaque accumulation (PLA), gingival index (GI), bleeding on probing (BOP), periodontal probing depth (PD), and clinical attachment level (CAL) were measured at weeks 0, 4, 8, 12, and 14. The interaction between the effects of *Eucalyptus* extract chewing gum and the intake period was statistically significant for PLA, GI, BOP, and PD, but not for CAL. The low- and high-concentration groups exhibited statistically significant ($P < 0.05$) improvements compared to the placebo group for PLA, GI, BOP, and PD [461].

Eupatorium cannabinum

The antibacterial effect of the essential oil of the aerial parts of *Eupatorium cannabinum* was studied against Gram positive (*Staphylococcus aureus*, *Streptococcus faecalis*, *Bacillus subtilis* and *Bacillus cereus*) and Gram negative (*Pseudomonas aeruginosa*, *Proteus mirabilis*, *Escherichia coli* and *Salmonella typhi* Ty2) bacteria. The results showed a significant antimicrobial activity against all the tested microorganisms, mostly against Gram positive bacteria, particularly *Streptococcus faecalis*, while, *Pseudomonas aeruginosa* showed the highest resistance to the oil [462].

Different extracts of *Eupatorium cannabinum* (chloroformic, water and hydroalcoholic extract) were tested for their antimicrobial activity against Gram positive bacteria (*Bacillus cereus*, *Staphylococcus aureus* and *Enterococcus faecalis*) and Gram negative test bacteria (*Escherichia coli*). The chloroformic and hydroalcoholic extracts of the *Eupatorium cannabinum* showed inhibitory activity against *Escherichia coli* and *Bacillus cereus* only. No clear inhibition have been noticed against *Staphylococcus aureus* and *Enterococcus faecalis*[463-464].

Euphorbia hirta

The antibacterial study showed that the leaf extract of *Euphorbia hirta* inhibited the growth of *P. aeruginosa*, *S. aureus* activity index of 0.2, 0.3 respectively [465-466].

The antibacterial effect of methanol, ethyl acetate, acetone and hot water extracts (0.02-1.66 mg/ml) of *Euphorbia hirta* was evaluated against multidrug- resistant (MDR) pathogens. All leaves extracts were active against the tested microorganisms, but, the best antibacterial effects were exerted by methanolic extract of the leaves against *P.aeruginosa*, *S.aureus* and *E.coli* (diameter of inhibition 22, 23 and 25 mm) respectively [467].

The ethanol extract of the leaves of *Euphorbia hirta* was studied for its antimicrobial activity by agar well diffusion method against: *Staphylococcus aureus* (MTCC 2940), *Bacillus cereus*, *Salmonella typhi* (MTCC 733), *Klebsiella pneumoniae* (MTCC139) and *Pseudomonas aeruginosa* (MTCC 741). The ethanol extract of the leaves of *Euphorbia hirta* showed significant antimicrobial effects [468].

The agar well diffusion method was used to determine the antimicrobial activity of *Euphorbia hirta* against *Escherichia coli*, *Klebsiella pneumoniae*, *Shigella dysenteriae*, *Salmonella typhi* and *Proteus mirabilis*, a group of Gram negative bacteria that frequently cause enteric infections in humans. The minimum inhibitory concentration and minimum bactericidal concentration values ranged from 25 to 100 mg/ml. The growth of all the bacteria were inhibited to varying degrees [469].

The antibacterial activity of aqueous and organic solvent (acetone, chloroform, benzene, butanol, ethanol, dimethylformamide and diethyl ether) leaf extracts of *Euphorbia hirta* were studied against *Pseudomonas putida*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Aeromonas liquefaciens* and *Caligenes* spp. All extracts showed antibacterial activity against the tested bacteria except water and butanol extracts which showed no activity against *Klebsiella pneumoniae* and *Aeromonas liquefaciens*. However ethanol extracts showed the highest activity (14,12,12, 14mm) against *Pseudomonas putida*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Aeromonas liquefaciens* respectively [470].

The antimicrobial activities of the methanolic extracts of *Euphorbia hirta* leaves, flowers, stems and roots were evaluated against four Gram positive (*Staphylococcus aureus*, *Micrococcus* sp., *Bacillus subtilis* and *Bacillus thuringensis*), four Gram negative (*Escherichia coli*, *Klebsiella pneumoniae*, *Salmonella typhi* and *P. mirabilis*). Leaves extract inhibited the growth of all tested microorganisms with larger zones of inhibition (18-28mm), followed by that of flowers (9-28 mm), which also inhibited all the bacteria. The most susceptible microbes to all extracts were *S. aureus* and *Micrococcus* sp. Root extract displayed larger inhibition zones against Gram positive bacteria than Gram negative bacteria and had larger inhibition zones compared to stem extract. The lowest MIC values were obtained against *E. coli* (3.12 mg/ml), followed by *S. aureus* (12.50 mg/ml) and *P. mirabilis* (50.00 mg/ml). All the other bacteria had MIC values of 100.00 mg/ml. Scanning electron microscopic studies revealed that the cells exposed to leaf extract displayed a rough surface with multiple blends and invaginations which increased with increasing time of treatment. Cells exposed to leaf extract for 36 h showed sever damage, with abundant surface cracks which may be related to final cell collapse and loss of function [471].

The *Euphorbia hirta* methanol extract showed a potent antimicrobial (MIC 0.250 mg/ml against *Escherichia coli* and *Klebsiella pneumoniae* [472].

The antibacterial activity of the ethanol and petroleum ether extracts of *Euphorbia hirta* was investigated against *Staphylococcus aureus*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Vibrio cholera* and *Escherichia coli*. Different concentrations of crude drugs (25µg/ml, 50µg/ml, 75µg/ml, and 100µg/ml) were tested. The result showed that ethanol and petroleum ether extracts of leaf, stem, root and bud were active against the tested bacteria. However, ethanol extracts of *Euphorbia hirta* have potentially deleterious effects on microorganisms [473].

The antibacterial effects of *Euphorbia hirta* leaves extracts (methanol, n-hexane and ethyl acetate) were studied against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Vibrio cholerae*, and *Enterococcus faecalis* at 100µg/ml concentration. Among the three solvent extracts, methanol extract of *Euphorbia hirta* showed 10-15 mm inhibition against *B. subtilis*, *E. coli*, and *V. cholerae* whereas no activity was observed against *S. aureus* and *E. faecalis* at 100µg/ml. The ethyl acetate extract showed activity only against *B. subtilis* (12mm) and *E. faecalis* (10mm), while n- hexane extract showed no activity. Antimycobacterial activity of different solvent extracts of *Euphorbia hirta* was also tested against *M. tuberculosis* H37Rv at 250 and 500 µg/ml concentrations by adopting relative light unit (LRP) assay. The ethyl acetate extracts at concentration of 500 µg/ml showed maximum reduction in RLU (about 64.73%) compared to methanol and n-hexane extracts [474].

The antimicrobial activity of supercritical fluid crude extracts of the leaves of *Euphorbia hirta* was studied against *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli* and *Pseudomonas aeruginosa*. *Euphorbia hirta* extract showed antibacterial activities, the diameters of zone of growth inhibition were *B. subtilis* 9.58, *S. aureus* 9.67, *E. coli* 9.17 and *P. aeruginosa* 9.00 mm [475].

Euphorbia hirta extracts (hexane, dichloromethane, ethyl acetate and methanol), were investigated for its potential antibacterial activity towards Gram negative bacteria, *Ralstonia solanacearum* and *Xanthomonas axonopodis* pv *vesicatoria*. *R. solanacearum* and *X. axonopodis* were known to cause bacterial wilt and bacterial spot disease in tomato crop (*Solanum lycopersicum*). Among the four extracts, *Euphorbia hirta* methanol extract at 1280 mg/l concentration showed 90% inhibition (IC₉₀) of *R. solanacearum* and *X. axonopodis* growth. *Euphorbia hirta* methanol extract at 40 mg/l and 640 mg/l showed 50% inhibition (IC₅₀) of *R. solanacearum* and *X. axonopodis* growth respectively [476].

The effect of herbal water of *Euphorbia hirta* on flu like symptoms and blood biochemical parameters especially thrombocytopenia was studied in patients with Dengue fever. Blood samples were collected on the day of enrollment and subsequently after *Euphorbia hirta* therapy. Before the treatment, platelet count in male patients was < 25000, and in females >50000. Hematocrit values were >40% in males and less than 30-40% in females. Total leukocyte count (TLC) was observed in a range of 4000-11000/mm³ in both male and female subjects. IgM haemagglutination antibody titer values greater than 1:160 were observed in 71% females and 50% males. AST level was found to be >40 IU/L in 38% female and 36% males while ALT level was >40 IU/L in 9% females and 12% males. Platelet count and TLC were increased non significantly after treatment, while HCT value was non significantly decreased after herbal use. Over 70% patients had slight recovery of platelet count and increased retrieval of leukopenia after herbal therapy along with recovery from fever and flu like symptoms [477].

***Euphorbia tinctoria* (syn: *Euphorbia macroclada*)**

The antibacterial effects of *Euphorbia macroclada* methanol extracts of the flowering branches was studied against 6 bacteria (*Staphylococcus aureus* COWAN 1, *Bacillus megaterium* DSM 32, *Proteus vulgaris* FMC 1, *Klebsiella pneumoniae* FMC 66032, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* DMS 50071 SCOTTA Inhibition zone diameter (mm) of *Euphorbia macroclada* methanolic extracts of the flowering branches were: *Staphylococcus aureus*: 11±0.88, *Bacillus megaterium*: 13±0.57, *Proteus vulgaris*: 11±0.57, *Klebsiella pneumoniae*: 9±0.33, *Escherichia coli*: 8.33±0.33 and *Pseudomonas aeruginosa*: 13±0.57. The inhibition zone diameter (mm) for *Euphorbia macroclada* latex (500µg/disc) were *S. aureus*: 10±1.15, *B. megaterium*: 8.33±0.33, *P. vulgaris*: 9±0.57, *K. pneumoniae*: 23±1.15, *E. coli*: 8.33±0.33 and *P. aeruginosa*: 9±0.57. The MIC values of *Euphorbia macroclada* methanolic extract of the flowering branches were: *S. aureus*: 50, *B. megaterium*: 25, *P. vulgaris*: 50, *K. pneumoniae*: 100, *E. coli*: 25 and *P. aeruginosa*: 100 µg[478].

The percent of growth of resistant *Escherichia coli* when *Euphorbia macroclada* latex combined with antibiotics was, 80.8±6.4 when combined with chloramphenicol, 90.1 ±8.4%, with neomycin, 45.7±5.9% with doxycycline, 80.5±8.1% with clarithromycin, 72.5±7.6% with cephalexin and 99.7± 8.1% with nalidixic acid compared with blank (100%) [479].

Fagopyrum esculentum

The antibacterial activity of buckwheat hulls extract (four concentrations, ranging from 6.25 to 100 mg/ml) was studied against three species of Gram-positive (*Bacillus cereus*, *Staphylococcus aureus*, *Enterococcus faecalis*) and three species of Gram-negative bacteria (*Salmonella choleraesuis*, *Escherichia coli* and *Proteus mirabilis*). Buckwheat hulls extract exhibited higher antimicrobial activity against Gram-positive than Gram-negative bacteria. Buckwheat hulls extract in concentration of 50 mg/ml produced zone of inhibition of 13.3 ± 0.88 mm against *Bacillus cereus*, 13.3 ± 0.57 mm against *Enterococcus faecalis* and 11.6 ± 0.88 mm against *Staphylococcus aureus*. The same concentration of buckwheat hulls extract exerted lower inhibition zones against Gram-negative bacteria [480-481].

Ficus carica

The antimicrobial activity of methanol extract of figs was studied against oral bacteria [*Streptococcus mutans* (ATCC 25175), *Streptococcus sanguinis* (ATCC 10556), *Streptococcus sobrinus* (ATCC 27607), *Streptococcus rattus* (KCTC 3294), *Streptococcus criceti* (KCTC 3292), *Streptococcus anginosus* (ATCC 31412) and *Streptococcus gordonii* (ATCC 10558), *Aggregatibacter actinomycetem comitans* (ATCC 43717), *Fusobacterium nucleatum* (ATCC 51190), *Prevotella intermedia* (ATCC 49046) and *Porphyromonas gingivalis* (ATCC 33277)]. The methanolic extract showed (MICs: 0.156 to 5 mg/ml and MBCs: 0.313 to 5 mg/ml) against the tested oral bacteria. The combination of methanolic extract and ampicillin or gentamicin showed synergistic effect against oral bacteria [482].

The antibacterial effects of different polarities crude extract from the leaves of *Ficus carica* (250-2000 µg/ml) were studied against *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas* sp by agar disc diffusion method. The dried leaves were macerated in absolute ethanol and the crude extract was defatted with ethanol-water, then the defatted hydro alcoholic crude extract was extracted with hexane, chloroform and ethyl acetate. Hydroalcoholic crude extract and its derived fractions display moderate antimicrobial potential against *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas* sp, in the range of 0%–13% [483].

Ethanol leaf extract and latex of fig (*Ficus carica*) were investigated for their antimicrobial activity against six bacterial strains, two Gram positive (*Staphylococcus aureus* and *Streptococcus pyogenes*) and four Gram negative (*Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Salmonella typhi* and *Escherichia coli*). The ethanol extract of leaves exhibited strong activity against *Staphylococcus aureus* (13 mm) and *Salmonella typhi* (14 mm), whereas The latex showed higher activity against *Staphylococcus aureus*, *Salmonella typhi* and *Streptococcus pyogenes* (15, 15 and 14mm respectively). *Klebsiella pneumoniae* and *E. coli* seemed to be

resistant to both extract which showed (8 and 9 mm) for leaf extracts and (11 and 10 mm) for ethanolic leaf extract and latex respectively [484].

Methanolic, hexanoic, chloroformic and ethyl acetate extracts of *Ficus carica* latex were investigated for their *in vitro* antimicrobial properties against five bacteria species. The methanolic extract had no effect against bacteria except against *Proteus mirabilis*, while the ethyl acetate extract showed inhibitory effect on the multiplication of five bacteria species (*Enterococcus faecalis*, *Citobacter freundii*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Proteus mirabilis*) [485-486].

The antimicrobial effects of the methanol extract (40-60 µg/ml) of *Ficus carica* leaves were tested against *S. epidermidis*, *K. Pneumoniae*, *B. Subtilis*, *E. aerogens*, and *B. cereus*. The extract possessed antibacterial activity with MIC of 7, 3, 4, 6 and 3.5 µg/ml and MBC of 11, 6, 7, 11 and 8 µg/ml against *S. epidermidis*, *K. Pneumoniae*, *B. Subtilis*, *E. aerogens*, and *B. cereus* respectively [487].

The antimicrobial activity of methanol extract of fig leaves was investigated against methicillin-resistant *Staphylococcus aureus* (MRSA). MICs: 2.5 to 20 mg/ml and MBCs: 5 to 20 mg/ml were recorded for the methanol extract against MRSA isolates. The combination of the methanol extract and oxacillin or ampicillin showed reduction of growth ≥ 4 -8-fold in all tested bacteria, which was considered to be synergistic. Furthermore, time-kill study revealed that a combination of methanol extract with oxacillin or ampicillin produced a more rapid decrease in the concentration of bacteria CFU/ml than methanol extract alone [488].

Two different extracts of *Ficus carica* fruits were evaluated against drug resistant human pathogens (*E.coli*, *Pseudomonas aeruginosa*, *Streptococcus sp.*, *Enterobacter sp.*, *Klebsiella pneumonia*, *S. typhi* and *S. paratyphi*). The ethanol extracts were found to be more effective than methanol extract. The MIC values fell in the range of 0.94 to 30 µg/ml [489].

Hexane extract of *Ficus carica* latex was assayed for antibacterial activity against several Gram-positive and Gram-negative bacteria. A strong bactericidal effect was demonstrated. The most sensitive bacteria were *Staphylococcus saprophyticus* clinical isolate, and *Staphylococcus aureus* ATCC 25923, with MIC of 19 µg/ml [490].

Antibacterial activity of fig fruit extract was investigated against *Proteus mirabilis* and three Gram positive (*Staphylococcus aureus*, *Staphylococcus epidermidis* and *Bacillus subtilis*). The dried fig extract inhibited only two isolates, *Bacillus subtilis* (16 mm, 100mg/ml) and *Proteus mirabilis* (18.5mm, 100mg/ml) [491].

The crude extracts of *Ficus carica* were examined for their anti-quorum sensing properties. Anti-quorum sensing activity was measured by quantifying violacein production and swarming motility. Results revealed that all extracts possessed anti-quorum sensing ability. The dichloromethane extract exhibited the most pronounced inhibition of quorum sensing activity [492].

Ficus religiosa

Ethanol extracts of the *Ficus religiosa* were screened for antibacterial activity against *Enterococcus faecalis*, *Proteus vulgaris*, *Staphylococcus saprophyticus*, *Shigella flexneri*, *Shigella sonnei* and *Shigella dysenteriae*. The minimum inhibitory concentrations against these bacteria were within the range of 250-500 µg/ml [493].

The MIC of *Ficus religiosa* leaves ethanolic extract against ampicillin and vancomycin resistant native strain of *Staphylococcus aureus* was 3.91±0.43 mg/ml [494].

The various solvents extract like aqueous, methanol, chloroform, petroleum ether and hexane of the bark of *Ficus religiosa* were screened for antibacterial activity against Enterotoxigenic *E. coli* isolated from diarrhoeal patients, at 200mg/ml concentration by disc diffusion method. The methanol extracts exhibited good activity compared to chloroform and aqueous extracts. Petroleum ether and hexane extracts did not show any activity [495].

A combination of hot alcoholic extracts of *Ficus infectoria*, *Ficus religiosa* and *Piper betel* were found to be effective against resistant and sensitive strains (Gram negative resistant *Klebsiella* strains, sensitive *Klebsiella* strains, resistant *Enterobacter* strains, sensitive *Enterobacter* strains, resistant *Escherichia coli* strains, resistant *Pseudomonas* strains, sensitive *Pseudomonas aeruginosa* strains and standard *Pseudomonas aeruginosa* ATCC 2862) and (Gram positive resistant *Staphylococcus* strains, sensitive *Staphylococcus* strains, resistant *Micrococcus* strain and standard *Staphylococcus aureus* ATCC 2901), isolated from skin and soft tissue infections. The combined extract was formulated in different ointment bases. The ointment showed bactericidal activity within 2 h against the resistant strain of *Pseudomonas spp* [496].

Effect of ethanolic extract of *Ficus religiosa* fruits extract was studied against two Gram positive bacteria (*Staphylococcus epidermidis* and *Staphylococcus aureus*) and two Gram negative bacteria (*P. vulgaris* and *Klebsiella pneumonia*). The minimum inhibitory concentration of extract against *Staphylococcus epidermidis* and *Klebsiella pneumonia* was 15 mg/ml, while the minimum inhibitory concentration against *Staphylococcus aureus* and *P. vulgaris* was 30 mg/ml. At 15 mg/ml concentration of extract *K. pneumonia*

showed more sensitivity (21 mm) than *S. epidermidis* (19 mm). At 30 mg/ml concentration *P. vulgaris* showed more sensitivity (12 mm) than *S. aureus* (9 mm) [497].

Bark of *Ficus religiosa* was dissolved in 67% ethanol. Extract was then subjected to antimicrobial efficacy tests against primary plaque colonizers and periodontal pathogens. *Ficus religiosa* showed antibacterial activity against primary plaque colonizers at 48 h with mean zone of inhibition of 2.6 ± 0.54 mm [498].

The antimicrobial activity of methanol and diethyl ether extracts of bark and leaves of *Ficus religiosa* (100, 200, 300 and 400 mg/ml) was investigated against two Gram negative bacteria (*E. coli* and *Pseudomonas aeruginosa*), and one Gram positive bacteria (*Staphylococcus aureus*). The methanol extracts of leaves and bark showed antimicrobial activity, a higher activity was recorded at 400 mg/ml concentration against the three tested bacteria. Both leaf and bark methanol extracts gave zone of inhibition of 2.8 and 2.2 mm against *S. aureus*, 2.4 and 1.8 mm against *E. coli* and 2.2 and 1.1 mm against *P. aeruginosa* respectively [499].

The antimicrobial activity of the aqueous extract of bark leaf, stem, fruit of *Ficus religiosa* was determined by disc diffusion method against *Escherichia coli*, *Enterobacter aerogenes*, *Pseudomonas aeruginosa*, *Aeromonas hydrophila*, *Staphylococcus aureus*, and *Streptococcus pyogenes*. The highest zone of inhibition (10-15 mm in diameter) was observed in 100 mg/ml concentration in all tested microbes [500-501].

The acetone, methanol, ethylacetate extracts (25-100 µg/ml) of *Ficus religiosa* bark were evaluated for antibacterial activity against *Pseudomonas aeruginosa*, *Escherichia coli*, *Proteus vulgaris*, *Bacillus subtilis* and *Staphylococcus aureus*. The growth of *Bacillus subtilis* was significantly inhibited by acetone extract of *Ficus religiosa*. Higher concentrations of the same extract were required to inhibit *E. coli*. Methanol extract of the plant was very active against all the tested bacterial pathogens except *P. aeruginosa*. Ethyl acetate extract was not active against all the bacterial species [502].

High antibacterial activity was possessed by aqueous extract of *Ficus religiosa* against *B. subtilis* with about 24 mm inhibition zone. It also exerted antibacterial activity against multi drug resistant *P. aeruginosa* [503].

Foeniculum vulgare

The antibacterial effects of methanolic extracts of 23 fennel samples were evaluated. The seed extracts of two samples showed moderate to good inhibitory activities (MICs=62.5-125 µg/ml) against three bacteria [504].

Crude extracts of *Foeniculum vulgare* seeds was investigated for antimicrobial activity against *Staphylococcus aureus*, *Micrococcus* spp and *Enterococcus* spp. The results showed that the ethanolic extract had greater activity against *Micrococcus* spp. (MIC=250 µg/ml) [505].

Antibacterial activity of aqueous and organic *Foeniculum vulgare* seed extracts was assessed against *Enterococcus faecalis*; *Staphylococcus aureus*; *Escherichia coli*; *Klebsiella pneumoniae*; *Pseudomonas aeruginosa*, *Salmonella typhi*; *Salmonella typhimurium*; *Shigella flexneri*, using agar diffusion assay, minimum inhibitory concentration and viable cell count studies; and their antibacterial effect was compared with some standard antibiotics. Out of the aqueous extracts prepared in three different ways, hot water extract of seeds (prepared at 40°C) gave better inhibition zones as compared to extracts prepared at ambient temperature of water and boiling water. Organic extracts showed similar results as observed in case of aqueous extracts with some variations. The extracts prepared in hexane and acetone gave relatively better inhibitory zones ranging from 9-30 mm [506].

The antimicrobial effect of the methanol, ethanol, diethyl ether, and hexane extracts of seed of *F. vulgare* was investigated against *Escherichia coli*, *Salmonella typhi*, *Bacillus cereus* and *Staphylococcus aureus*. Methanolic extract showed more antimicrobial activity than the other extracts. The results indicated that *Bacillus cereus* was the most sensitive microorganisms tested, showing the largest inhibition zones and the lowest MIC values. The least antimicrobial activity was recorded against *Escherichia coli* [507].

The antibacterial activity of aqueous extract of *Foeniculum vulgare* was studied against *E. coli*, *Klebsiella* spp. and *Pseudomonas* spp. The aqueous extracts of *Foeniculum vulgare* showed antibacterial activity, it inhibited the coliform and *Klebsiella* spp [508].

The essential oils of the fruits of and *Foeniculum vulgare* Miller var. *vulgare* (Miller) were assayed in vitro for antibacterial activity against *Escherichia coli* and *Bacillus megaterium*, bacteria routinely used for comparison in the antimicrobial assays, and 27 phytopathogenic bacterial species and two mycopathogenic ones responsible for cultivated mushroom diseases. A significant antibacterial activity, as determined with the agar diffusion method, was shown by *F. vulgare* var. *vulgare* oil [509].

Essential oil was investigated for its antibacterial activity against seven infectious microbial pathogens, *Escherichia coli* (ATCC 25922), *Bacillus cereus* (ATCC 11778), *Lactobacillus acidophilus* (ATCC 53103), *Micrococcus luteus* (ATCC 9341), *Staphylococcus aureus* (ATCC 25923), *Klebsiella pneumoniae* (ATCC 15380) and *Streptococcus pneumoniae* (ATCC 12755). The *Foeniculum vulgare* essential oil showed the diameter of inhibition zone ranging from 19.4 ± 0.07 - 26.4 ± 0.09 mm at a concentration level of 28 µg/disc

against strains tested. The minimum inhibitory concentration (MIC) of essential oil against bacterial was obtained in the range of 7.0 - 56 µg/ml[510].

The antibacterial effects of the ethanolic fruit extract were studied against *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Proteus vulgaris*. The plant extract prevented the growth of *Staphylococcus aureus* and *Bacillus subtilis*. The minimum inhibitory concentration was found to be similar for both microorganisms (1 mg/ml). Other tested organisms were not affected at any of the concentrations used[511].

The antimicrobial effect of organic and aqueous leaves extracts of *Foeniculum vulgare* was studied against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterococcus hirea* and *Escherichia coli*. All extracts of *Foeniculum vulgare* showed antibacterial activity against all the tested microorganisms. The most significant and active extract were methanol and ethyl acetate against all the tested bacteria in comparison to the hexane and aqueous extracts [512-513].

Fraxinus ornus

Esculetin, fraxin and fraxetin are mainly responsible for the antimicrobial properties of *F. ornus* bark extracts [514].

The antibacterial investigation of the ethanolic extract and decoction from the bark of *Fraxinus ornus* revealed antibacterial effect against *Staphylococcus aureus* and *Bacillus subtilis*, as well as a marked activity against *Leptospira ponomi*[515].

The antimicrobial activity of the *n*-hexane fraction from the seeds of *Fraxinus ornus* L. was studied against *Streptococcus pneumonia*, *Bacillus subtilis*, *Streptococcus pyogenes*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae* and *Neisseria gonorrhoeae*. The *n*-hexane fraction from the seeds of *Fraxinus ornus* possessed antibacterial activities. Its antibacterial activity against Gram positive bacteria was higher than that against both Gram negative bacteria. The antibacterial activity against *N. gonorrhoeae* was the highest followed by *B. subtilis*, *K. pneumoniae* and *E. faecalis*. Mild antibacterial activity was recorded against *S. pneumoniae*, *S. pyogenes* and *E. coli* [516-517].

In studying of antimicrobial activity of different bark constituents (coumarins, secoiridoids and phenylethanoids), It appeared that there was a clear correlation between structure and antibacterial activity against *S. aureus* and *E. coli*. Compared to the aglucones (MIC=500 and 125 µg/ml, the glucosides showed a negligible activity (MIC= 1000 µg/ml). It was appeared that methylation of phenolic OH decreases the activity, while acetylation does not alter the activity. Fraxetin and its diacetate appeared the most potent inhibitors of *S. aureus*. The secoiridoid glucosides, and the phenylethanoid ornosol inhibited the growth of *S. aureus* and *Cladosporium cucumerinum*. The caffeoyl esters of phenylethanoid glycosides showed no activity against *Pseudomonas stutzeri*[518-519].

Fumaria officinalis

Bactericidal activity against the Gram-positive organisms *Bacillus anthracis* and *Staphylococcus* have been recorded [520].

The antimicrobial activity of aqueous and methanolic extract of aerial parts of *Fumaria officinalis* was carried out by disc diffusion test against *Acinetobacter lwoffii*, *Alcaligenes faecalis*, *Bacillus cereus*, *Bacillus subtilis* ATCC 6633, *Enterobacter cloacae*, *Escherichia coli* 1328, *Escherichia coli* 1402, *Klebsiella pneumonia* subsp. *ozanae* 5713, *Klebsiella pneumonia* subsp. *pneumonia* 2124, *Listeria monocytogenes* 8353, *Proteus mirabilis* 3242, *Proteus vulgaris* KÜKEM, *Providencia alcaliicens*, *Pseudomonas aeruginosa* ATCC 9027, *Pseudomonas aeruginosa* 3428, *Pseudomonas fluorescens* 7324, *Pseudomonas pseudoalcaligenes* 3445, *Pseudomonas putida* 1617, *Salmonella typhimurium* RSSK 95091, *Staphylococcus aureus* 7231, *Staphylococcus hominis* 3221 and *Streptococcus pyogenes* ATCC 176. The methanolic extract showed activity against *Staphylococcus aureus* 7231(15mm), *Cladosporium herbarum* (14mm), and *Pseudomonas aeruginosa* 3428 (10mm) [521].

Fumaria parviflora

Disc diffusion and broth micro dilution methods were used to study the antibacterial [Gram positive, *Staphylococcus epidermidis* and *Bacillus subtilis*; Gram negative, *Escherichia coli* and *Salmonella typhimurium*] activity of N-octacosan 7β ol isolated from the methanolic extract of whole plant of *Fumaria parviflora*. N-octacosan-7β-ol, possessed significant antibacterial activity against *Staphylococcus epidermidis* and *Escherichia coli* *in vitro* with MIC of 250 µg/ml[522-523].

Galium aparine

The ethanolic extracts of *Gallium* species were tested for the antimicrobial activity against two Gram-positive bacterial strains: *Staphylococcus aureus* (ATCC 49444), *Listeria monocytogenes* (ATCC 13076),

against two Gram-negative bacterial strains: *Escherichia coli* (ATCC 25922) and *Salmonella typhimurium* (ATCC 14028). Ethanolic extracts of *Gallium aparine* showed no antibacterial activity against the tested microorganisms [524-525].

The antibacterial activities of *Galium aparine* herb lipophilic complex were investigated against *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Proteus vulgaris* ATCC 4636 and *Bacillus subtilis* ATCC 6633. The results revealed that *S. aureus* (Zone of growth inhibition: 35.4 ± 0.1 mm, Minimum inhibitory concentration $31.25 \mu\text{g/ml}$ and Minimum bactericidal concentration $62.50 \mu\text{g/ml}$), *P. aeruginosa* (Zone of growth inhibition: 26.0 ± 0.4 mm, Minimum inhibitory concentration $62.50 \mu\text{g/ml}$ and Minimum bactericidal concentration $125.00 \mu\text{g/ml}$), *B. subtilis* (Zone of growth inhibition: 23.1 ± 0.3 mm, Minimum inhibitory concentration $125.00 \mu\text{g/ml}$ and Minimum bactericidal concentration $250.00 \mu\text{g/ml}$) showed moderate sensitivity; *E. coli* (Zone of growth inhibition: 10.0 ± 0.1 mm, Minimum inhibitory concentration $250.00 \mu\text{g/ml}$ and Minimum bactericidal concentration $500.00 \mu\text{g/ml}$) and *P. vulgaris* (Zone of growth inhibition: 14.2 ± 0.1 mm, Minimum inhibitory concentration $250.00 \mu\text{g/ml}$ and Minimum bactericidal concentration $500.00 \mu\text{g/ml}$) were nonsensitive to *Galium aparine* herb lipophilic complex [526-527].

Galium verum

The antimicrobial activity of water, alcohol (70%) and chloroform extracts was investigated against *Staphylococcus aureus* 15923, *Escherichia coli* 25922, *Pseudomonas aeruginosa* 2789, *Bacillus subtilis* 6633 and *Proteus vulgaris* 4636. Chloroform extract 20 and 50 g/l showed strong antibacterial activity against all the tested bacteria, diameter of growth inhibition zones at concentration of 20 and 50 g/l were 30.3 ± 0.4 and 32.4 ± 0.3 mm against *Staphylococcus aureus*, 12.0 ± 0.1 and 13.2 ± 0.2 mm against *Escherichia coli*, 21.2 ± 0.2 and 20.2 ± 0.3 mm against *Pseudomonas aeruginosa*, 20.2 ± 0.3 and 30.3 ± 0.4 against *Bacillus subtilis* and 16.1 ± 0.3 and 15.1 ± 0.2 against *Proteus vulgaris* respectively. Lipophilic complexes of *Galium verum* showed antibacterial activity against *Staphylococcus aureus* 15923, *Escherichia coli* 25922, *Pseudomonas aeruginosa* 2789, *Bacillus subtilis* 6633 and *Proteus vulgaris* 4636 with adiameter zone of growth inhibition of 32.4 ± 0.3 , 13.2 ± 0.2 , 20.2 ± 0.3 , 30.3 ± 0.4 and 15.1 ± 0.2 mm respectively [528-529].

Extracts of *Galium verum* also showed antibacterial activity against pathogenic plants bacteria [530].

Geum urbanum

The effects of extracts on bacterial growth were measured *in vitro* by agar disc diffusion method against many types of plant and human pathogenic bacteria. The results revealed that *Geum urbanum* leaves methanolic extracts showed the maximum activity against all bacteria, including *Pseudomonas aeruginosa*, followed by *Pseudomonas viridiflava*, *Bacillus subtilis*, *Rathayibacter toxicus*, *Xanthomonas campestris*, *Acidovorax avenae*, *Staphylococcus aureus*, *Pseudomonas syringae*, *Erwinia amylovora* and *Escherichia coli*, respectively. The maximum antibacterial activity of *Geum urbanum* root extract was observed against: *Pseudomonas aeruginosa*, followed by *Escherichia coli*, *Pseudomonas viridiflava*, *Rathayibacter toxicus*, *Pseudomonas syringae*, *Bacillus subtilis*, *Acidovorax avenae*, *Xanthomonas campestris*, *Staphylococcus aureus* and *Erwinia amylovora* [531].

Glaucium corniculatum

The antimicrobial activity of the water, ethanolic and methanolic extracts (1.25-10 mg) of powdered whole *Glaucium corniculatum* was evaluated against mouth microflora (streptococci, bacillus, actinomycetes, diptheroids and lactobacillus). The results showed that *Glaucium corniculatum* extracts possessed antimicrobial effect and the least effective concentration was 2.5%. The ethanol extract was the most effective followed by methanol then aqueous extract. The antimicrobial effect was differ among different microflora, Streptococci were the most sensitive microorganisms while bacillus was the least sensitive to the extract [532].

Glossostemon bruguieri

The aqueous extracts of *Glossostemon bruguieri* root possessed no antibacterial effects when it tested *in vitro* against *A. baumannii*, *E. faecium*, *P. aeruginosa*, *G. morbillorum*, *E. cloacae* and against Standard strains (Gram-positive *S. aureus* ATCC 29213 and Gram-negative *E. coli* ATCC 25922) [533].

The ethanolic extract of *Glossostemon bruguieri* showed antibacterial activity. The zone of inhibition of the extract (5mg/ml in well of 6 mm in diameter) against Gram negative microorganisms: *Enterococcus faecalis* was 8 mm, *E. coli* 9 mm, *Moraxella lacunata* 10 mm, *Proteus merabiles* 11 mm, *Serratia marcesens* 10 mm, *Pseudomonas aerugenosa* 7 mm; *Bacillus subtilis* 12 mm, *Micrococcus luteus* 8 mm, *Sarcina ventricull* 8 mm and *Staphylococcus aureus* 15 mm [534].

Glycyrrhiza glabra

The antibacterial effect of alcoholic extract obtained by percolation from roots of *G. glabra* was tested against *Escherichia coli*, *Pseudomonas fluorescens*, *Enterococcus faecalis*, *Bacillus cereus*, and *Staphylococcus aureus*, the extract showed the strong antibacterial activity against all bacterial strains tested. The maximum inhibition diameter was 15 mm against *E. coli*, *E. faecalis*, *B. cereus*, whereas *P. fluorescens* showed the lowest sensitivity, with an inhibition of 9 mm[535].

The antimicrobial effect of the methanolic extract of *Glycyrrhiza glabra* was investigated against *B. megaterium*, *B. subtilis*, *Staphylococcus aureus*, *Sarcina lutea*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella paratyphi*, *S. typhi*, *Shigella boydii*, *S. dysenteriae*, *Vibrio mimicus* & *V. parahemolyticus*. *G. glabra* showed potent antimicrobial activity against almost all the test organisms except *Pseudomonas aeruginosa*. It exhibited highest activity against *Staphylococcus aureus* with a zone of inhibition of 22 mm[536].

The antimicrobial activity of methanolic extract and different fractions (*n*-butanol, ethyl acetate, chloroform and *n*-hexane) of *Glycyrrhiza glabra* root was studied against four bacterial strains *Escherichia coli*, *Bacillus subtilis*, *Staphylococcus aureus* and *Pasturella multocida* using disc diffusion method and minimum inhibitory concentration. As general, plant extract and fractions were mildly potent antimicrobial agent. The results indicated that 100% methanolic extract showed good activity against *E. coli* and *B. subtilis*, showing the highest inhibition zones (33 and 27.5 mm) and the lowest MIC values (9.28 and 30.2 mg/ml), respectively. 80% methanolic extract showed strong activity against *B. subtilis* and *E. coli* with inhibition zones (30 and 28.5 mm) and the lowest MIC values (12.2 and 20.1 mg/ml), respectively. Least activity was exhibited against *S. aureus* with inhibition zone (19 mm) and the highest MIC value (110 mg/ml), respectively[537].

The antibacterial effect of flavonoid extract of *Glycyrrhiza glabra* was tested against four pathogenic bacterial strains. *Escherichia coli*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Staphylococcus aureus*. The antibacterial effect was concentration dependent. Flavonoids possessed an inhibitory effect on both *Staphylococcus aureus* and *Enterococcus faecalis* but they showed less inhibitory effect against *Escherichia coli* and *Pseudomonas aeruginosa*[538].

The antimicrobial activities of licorice tea and infusion (0.05, 0.1, 0.2, 0.4, 0.6 and 0.8%) were studied against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Salmonella* and *Saccharomyces cerevisiae*. The results revealed that these concentrations didn't possess antibacterial activity[539].

The anti-bacterial activities of the methanol, ethyl acetate, acetone and chloroform extracts of *G. glabra* plant roots were tested against six bacterial species (*Bacillus coagulans*, *Enterococcus faecalis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Salmonella typhimurium*) by the agar disc diffusion method. The results indicated that the extract of *G. glabra* showed various antibacterial activities (9-14mm/20µl inhibition zone) against the tested bacteria. The methanol, ethyl acetate, acetone and chloroform extracts did not inhibit *Enterococcus faecalis*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* but showed an inhibitory effect against *B. coagulans*, *E. coli* and *S. typhimurium*[540].

The antibacterial potency of 100%, 75%, 50% and 25% of methanolic and acetic extract of root of *Glycyrrhiza glabra* was investigated against *Salmonella typhi*, *Escherichia coli*, *Vibrio cholerae*, *Staphylococcus aureus*, *Bacillus cereus* and *Bacillus subtilis* strains. The 100% (w/v) concentration of both extracts showed maximum inhibition against *B. subtilis* followed by *E. coli*, *S. aureus*, *B. cereus*, *S. typhi* and *V. Cholerae*. Maximum activity in acetic extract was obtained against *B. cereus* followed by *S. typhi*, *E. coli*, *V. cholerae* and *S. aureus* and minimum in *B. subtilis*. A reverse pattern of inhibition activity was found in both extracts (methanolic and acetic) against *B. subtilis*. Maximum activity was found in methanolic extract against *B. subtilis* (18.6 mm) and in acetic extract against *B. cereus* (16.3mm)[541].

The antibacterial activity of *Glycyrrhiza glabra* was investigated against oral pathogens [*Streptococcus mutans* (PTCC 1683), *Streptococcus sanguis* (PTCC 1449), *Actinomyces viscosus* (PTCC 1202), *Enterococcus faecalis* (ATCC 29212) as oral pathogens] and *Staphylococcus aureus* (ATCC 25923) and *Escherichia coli* (ATCC 29922) as controls. *G. glabra* extract possessed inhibitory activity against the tested oral bacteria. No strain showed resistance to the extract. The inhibitory zone significantly increased in a dose dependent manner[542].

The diameter of the inhibitory zone of the aqueous extract and methanolic extracts of the root of *Glycyrrhiza glabra*, ranged between 10 - 22 mm against *Staphylococcus aureus*, *Streptococcus agalactiae* and *E. coli*. The methanolic extract was more effective than aqueous extract against *Staphylococcus aureus* (20 mm), *Streptococcus agalactiae* (22 mm) and *E. coli* (17 mm) at the concentration of 8 mg/disc. The MIC values of methanolic extract was 3.125 mg/ml for *S. aureus*, 1.56 mg/ml for *St. agalactiae* and 12.5 mg/ml for *E. coli*. Whereas the aqueous extract having higher MIC values, 6.25 mg/ml for *S. aureus*, 3.125 mg/ml for *St. agalactiae* and the result was negative for *E. coli*[543].

Glycyrrhiza glabra root extracts (ether, chloroform, acetone) showed significant antibacterial activities against two gram-positive (*Bacillus subtilis* and *Staphylococcus aureus*) and two gram-negative (*Escherichia coli* and *Pseudomonas aeruginosa*) bacteria. Acetone extract showed the highest antibacterial activity with

diameter of inhibition of 32, 22, 22, 15 against *Staphylococcus aureus*, *Bacillus subtilis*, *Pseudomonas aeruginosa* and *Escherichia coli*[544].

The antibacterial effect of the glycoside extracted from *Glycyrrhiza glabra* was investigated against three bacterial strains, *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*. It showed inhibitory effect on the Gram positive strain (*Staphylococcus aureus* ATCC23) and the Gram negative strain (*Pseudomonas aeruginosa* ATCC53), but it possessed no effect on *Escherichia coli* ATCC22 strain[545].

The antimicrobial effects of roots extracts of *Glycyrrhiza glabra* was investigated against *Staphylococcus aureus*, *Salmonella typhi*, *Staphylococcus sciuri* and *Escherichia coli*. The methanolic extract of *G. glabra* showed maximum antibacterial activity against *Staphylococcus aureus* at 500µg/ml (inhibition zone 13 mm)[546].

The antimicrobial activities of ethanolic and aqueous extracts from licorice leaves were studied compared to root extracts activities against *Bacillus subtilis*, *Enterococcus faecalis*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Escherichia coli*. The root and leave extracts showed activity against the tested gram-positive bacteria in a dose dependent manner. The ethanolic extract of the leaves was the most active extract against gram-positive bacteria[547].

Glabridin exhibited antimicrobial activity against both Gram-positive and Gram-negative bacteria, the highest activity was recorded against Gram positive bacteria. Glabridin isolated from *Glycyrrhiza glabra* roots was potentially active against both *Mycobacterium tuberculosis* H37Ra and H37Rv strains at 29.16 µg/ml concentration[548].

The antimicrobial effect of root methanolic extracts of *Glycyrrhiza glabra* var. *glandulifera* was investigated against nine bacterial strains [six Gram-positive bacteria [*Staphylococcus aureus* ATCC 6538, *Enterococcus faecalis* ATCC 51299, *Micrococcus luteus*, *Bacillus cereus* 7064, vancomycin-resistant *Enterococcus* (VRE) and methicillin resistant *Staphylococcus aureus* (MRSA)] and three Gram negative bacteria (*Escherichia coli* ATCC 11293, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*) using disc diffusion and minimum inhibitory concentration methods. The results indicated that the plant root extracts were more effective against Gram-positive bacteria than against Gram-negative ones. The plant methanolic extracts inhibited the growth of *B. cereus*, *E. faecalis*, *K. pneumoniae*, MRSA, *S. aureus*, VRE, *C. krusei* and *C. parapsilosis*. However, there was no activity against *E. coli*, *K. pneumoniae* and *M. luteus*[549].

The in vitro activity of glycyrrhizic acid, glycyrrhetic acid and a novel lipophilic derivative of glycyrrhetic acid monoglucuronide acetylated GAMG was investigated against 29 *Helicobacter pylori* strains. Glycyrrhetic acid was the most potent compound (MIC_{50/90}, 50/100 mg/l), inhibiting 79.3% of the strains at MIC <50 mg/l[550-551].

Gossypium species

G. herbaceum and *G. hirsutum* showed activity against *B. cereus* and *Salmonella typhimurium*. Free flavonoid fraction of seeds of *G. herbaceum* and *G. hirsutum* showed activity against *B. cereus*, *S. epidermidis*, *Trichoderma viride*, *Salmonella typhimurium*, *E. coli* and *Trichoderma viride*[552]. *Gossypol* displays pronounced antibiotic activity towards aerobic sporeformers[553].

The antimicrobial effect of *gossypol* was tested against *Edwardsiella ictaluri*. Concentrations of racemic *gossypol*, (+)-*gossypol* and (-)-*gossypol* of 1.5 µg/ml or higher significantly reduced the number of bacterial colonies compared with that of the control. The growth of *Edwardsiella ictaluri* was completely inhibited on agar plates supplemented with 3 µg/ml, regardless of the forms of *gossypol*. The inhibitory effect of (+)-*gossypol* was higher than that of (-)-*gossypol* or *gossypol*-acetic acid. Recovery of *Edwardsiella ictaluri* was <50% for all three forms of *gossypol* at concentrations of 5 µg/ml[554].

Leaves extracts of *Gossypium hirsutum* plant showed antibacterial activity against clinically important bacteria like *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Shigella dysenteriae*, ethanolic extract possessed more antibacterial activity than aqueous extract, *Shigella dysenteriae* was the more sensitive microorganism (13mm) and *Pseudomonas aeruginosa*, was the least sensitive (6mm). The minimum inhibitory concentration was 0.25 (% w/v) against all the tested bacteria[555].

The antimicrobial activity of *Gossypium hirsutum* oils was investigated against *Escherichia coli* by agar well diffusion method. *Gossypium hirsutum* oils possessed antibacterial activity against *Escherichia coli* with diameter of inhibition of 12.33mm at a concentration of 1 mg/ml[556].

Low antibiotic activity was found in hexane extract, high activity in methanolic extract and residue, and no activity in acetone and water extracts of *Gossypium hirsutum* buds. A condensed tannin isolated from methanolic extract was the major antibiotic component[557-558].

Haplophyllum species

Ethanolic extract of the aerial parts of *Haplophyllum tuberculatum* exhibited a significant effect against all tested Gram -ve and Gram +ve microorganisms (at concentration of 1 mg/ml) [*Staphylococcus aureus*

(RCMB 010028), *Enterococcus faecalis* (RCMB 010084), *Streptococcus mitis* (RCMB 010039), *Lactobacillus acidophilus* (RCMB 010094), Methicillin-resistant *Staphylococcus aureus* [MRSA] (RCMB 010028) and *Escherichia coli* (RCMB010052)], but inactive against *Pseudomonas aeruginosa*. Ethanol extract showed remarkable antibacterial potency against *Staphylococcus aureus* and *Escherichia coli* (MIC 1.95 and 15.63 µg/ml). Volatile oil of the aerial parts of *Haplophyllum tuberculatum* possessed significant antibacterial effect against *Enterococcus faecalis* and *Lactobacillus acidophilus* (MIC 1.95 and 0.98 µg/ml)[559].

25 mg of pure essential oil of *Haplophyllum tuberculatum* partially inhibited the growth of *Escherichia coli*, *Salmonella choleraesuis*, and *Bacillus subtilis* to the same extent as 0.10 microg of gentamycin sulfate. The oil also affected the mycelial growth of *Curvularia lunata* and *Fusarium oxysporium* in a dose-dependent manner but had no effect on the germination of their spores[560].

Antimicrobial tests based on polyphenolic and alkaloid extracts of the plant showed average activity on a few bacterial strains (*Bacillus subtilis* ATCC 6633, *Staphylococcus aureus* ATCC 25923, and *Pseudomonas aeruginosa* ATCC 27953); With MICs varying from 0.625 mg/ml to 10 mg/ml for alkaloids and from 5 mg/ml to 20 mg/ml for polyphenols[561-562].

Hedera helix

The mixture of saponins of the leaves of *H. helix*, with a large amount of hederacoside C, possessed significant antibacterial activity against Gram-positive bacteria (*Bacillus* spp, *Staphylococcus* spp, *Enterococcus* spp and *Streptococcus* spp) with MIC values: 0.3–1.25 mg/ml and against Gram-negative bacteria (*Salmonella* spp, *Shigella* spp, *Pseudomonas* spp, *Escherichia coli* and *Proteus vulgaris*) with MIC values: 1.25–5 mg/ml[563].

The antimicrobial activity of different extracts of *Hedera helix* (whole plant) was investigated against three strains of Gram-positive bacteria (*Staphylococcus aureus*, *Staphylococcus epidermidis* and *Bacillus subtilis*) and two of Gram-negative bacteria (*Escherichia coli* and *Klebsiella pneumonia*) . The ethyl acetate and methanol extracts of *Hedera helix* were the most active, showing activity against three selected Gram positive and two Gram negative bacterial stains and displayed highest inhibitory zone at the tested concentration (22 mg/ml)[564].

Antibacterial activity of the leaves extracts was investigated by using disc diffusion assay. The diameters of growth inhibition were 9.3, 7.3 and 12.6mm against *S. aureus* , *P. aeruginosa* and *E. coli* respectively[565-566].

Helianthus annuus

The anti-microbial properties of sunflower seed oil were investigated against different pathogenic microorganisms (*Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Bacillus subtilis*). The results revealed that the oil possessed antimicrobial activity against *Staphylococcus aureus*, *Escherichia coli* and *Bacillus subtilis* [567].

The antimicrobial properties of the ethanol stem extract of *Helianthus annuus* was evaluated against *Staphylococcus aureus* and *Escherichia coli*. Ethanol extract of *Helianthus annuus* stem possessed antimicrobial activities against *Staphylococcus aureus*, while *Escherichia coli* resisted to the extract. MIC and MBC/MFC of the ethanol stem extract of *Helianthus annuus* against *Staphylococcus aureus* were 70 and 90 mg/ml [568].

The antibacterial effect of the aqueous and ethanolic leaf extracts of *Helianthus annuus* was evaluated using disc diffusion method and agar well diffusion method. In the disc diffusion method, the aqueous extract had an inhibition zone (mm) of 1.1±0.5 on *Staphylococcus aureus*, 1.2±0.1 on *Klebsiella pneumonia*, 1.6±0.3 on *Pseudomonas aeruginosa*, 1.7±0.5 on *Bacillus subtilis*, 1.3±0.5 on *Escherichia coli*, 1.1±0.2 on *Salmonella typharium*, and 1.1±0.3 on *Micrococcus luteus* while the ethanol extract had 6.1± 0.2 on *Staphylococcus aureus*, 5.88±0.7 on *Klebsiella pneumonia*, 6.12±0.3 on *Pseudomonas aeruginosa*, 7.1 ±0.5 on *Bacillus subtilis*, 5.5 ± 0.1 on *Escherichia coli*, 5.6 ±0.2 on *Salmonella typharium* and 5.3 ±0.2 on *Micrococcus luteus*. For the agar well diffusion method, the aqueous extract had inhibition zone of 1.9± 0.5 on *Staphylococcus aureus*, 1.3 ±0.2 on *Klebsiella pneumonia*, 1.67 ±0.2 on *Pseudomonas aeruginosa*, 2.1 ± 0.1 on *Bacillus subtilis*, 1.3±0.1 on *Escherichia coli*, 1.1±0.5 on *Salmonella typharium* and 1.7±0.1 on *Micrococcus luteus*. The ethanol extract had 5.8 ± 0.1 on *Staphylococcus aureus*, 5.71 ±0.5 on *Pseudomonas aeruginosa*, and 5.7 ± 0.1 on *Bacillus subtilis*, 5.8±0.2 on *Escherichia coli*, 5.2 ±0.1 on *Salmonella typharium* and 5.5±0.3 on *Micrococcus luteus*[569].

The antimicrobial activity of methanolic extract of seeds from *Helianthus annuus* was studied against *Bacillus subtilis*, *Staphylococcus aureus*, *Salmonella typhi* and *Vibrio cholera*. The seed extract of *Helianthus annuus* showed high activity against *Salmonella typhi*, moderate activity against *Staphylococcus aureus* and *Vibrio cholera* and less activity against *Bacillus subtilis* [570].

The effect of topical application of sunflower seed oil 3 times daily to preterm infants <34 weeks gestational, on skin condition, rates of nosocomial infections and mortality was studied in Kasr El-Aini neonatal intensive care unit at Cairo University. Treatment with sunflower seed oil resulted in a significant improvement in skin condition ($P = 0.037$) and a highly significant reduction in the incidence of nosocomial infections (adjusted incidence ratio, 0.46; 95% confidence interval, 0.26-0.81; $P = 0.007$) compared with infants not receiving topical prophylaxis. No adverse events were recorded as a result of topical therapy[571].

The effect of polar oil extract from the seeds of sunflower (*Helianthus annuus*) in Napkin dermatitis and its antimicrobial activity against *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Proteus vulgaris* were studied. The extract was efficient as topical treatment in Napkin dermatitis. The results also showed that the extract inhibited the growth of all the tested microorganisms at different concentrations[572].

Sunflower oil is easily absorbed by the skin and provides deep nourishment and moisturizing. For these reasons, it is a popular ingredient in over-the-counter and homemade beauty products including lotions, creams and massage oils. It can retain moisture in the skin. It may also provide a protective barrier that resists infection in premature infants. Infants receiving a daily skin treatment of sunflower oil were 41% less likely to develop infections in the hospital[573-574].

***Helicophyllum rauwolfii* (Eminium rauwolfii):**

The antimicrobial activity of the crude extract of *Eminium spiculatum* and the isolated compounds was tested using well-in-agar method and in vitro. No pronounced antibacterial activity was observed with either the crude extract or with the isolated compounds. Luteolin exhibited moderate antibacterial activity against *Staphylococcus aureus* in concentrations of 0.625 mg/ml, while negligible weak antibacterial activity (41mg/ml) was observed for vitexin and isoorientin[575].

The antimicrobial activity of the aqueous and ethanolic extracts of *Eminium spiculatum* was evaluated in vitro against *E. coli*, *P. aeruginosa* and *S. aureus* (MRSA) Leaves and stem water extracts exert antibacterial activity against *E. coli* with diameter of inhibition of $23.3 \pm 1.5\text{mm}$ and $20.3 \pm 0.6\text{mm}$ respectively. Stem water and ethanolic extracts possessed antibacterial activity against *P. aeruginosa* with diameter of inhibition of $17.3 \pm 1.5\text{ mm}$ and $29.3 \pm 1.5\text{ mm}$ respectively. Stem water extract showed anti-*Staphylococcus aureus* (MRSA) with a diameter of inhibition of $21.7 \pm 0.6\text{mm}$ [576].

The methanolic crude leave extract of *Eminium spiculatum* showed antibacterial activity against *Salmonella typhimurium* and *Pseudomonas aeruginosa* with diameter of inhibition of 19.3 and 22mm respectively, while water extract of the leaves showed antibacterial activity against *Staphylococcus aureus* with diameter of inhibition of 23.3mm[577].

The growth inhibition zone (mm) of ethanolic *Eminium spiculatum* leave extracts (concentration 10^{-1} ml) against *E. coli* was 15mm, *P. aeruginosa*, 14mm, *K. pneumonia* 13mm, *S. aureus* 16mm and *S. pyogenes* 13mm. while the diameters of growth inhibition around the discs in the concentrations of 10^{-3}ml , were 13, 9, 9, 11 and 10mm against the same microorganisms respectively[578].

***Heliotropium* Species:**

The antimicrobial activity of *Heliotropium europaeum* oil (250, 500, 1000, 2000, 4000 and 8000 μg / disk) was investigated against *Bacillus subtilis* PTCC 1023, *Staphylococcus aureus* PTCC 1112, *Escherichia coli* PTCC 1330 and *Salmonella typhi* PTCC 1639. The diameter of zone of growth inhibition was 12, 12.5 and 15.75mm against *Bacillus subtilis* and 11.75, 12.5 and 12mm against *Salmonella typhi* at concentration of 2000, 4000 and 8000 μg / disk respectively. However it showed weak activity against *Escherichia coli*, and no activity against *Staphylococcus aureus* [579].

The antimicrobial effects of leaves, flowers, and stem extracts of *Heliotropium bacciferum* were against seven bacterial species [*Escherichia coli* (ATCC 25922), *Staphylococcus aureus* (ATCC 6538), *Bacillus cereus* (ATCC 7722), *Pseudomonas aeruginosa* (ATCC 9721), *Klebsiella pneumoniae* (ATCC 6824), *Proteus mirabilis* (ATCC 7103), and *Erwinia carotovora* (ATCC 8452)] All plant extracts exhibit a range antibacterial effects. Methanol, *n*-hexane, and ethyl acetate extracts of plant leaves (15 μg) revealed significant activities ($18 \pm 0.46\text{ mm}$, $20 \pm 0.71\text{ mm}$, and $21 \pm 0.69\text{ mm}$) against *Klebsiella pneumoniae*, *Staphylococcus aureus* ($16 \pm 0.51\text{ mm}$, $17 \pm 0.34\text{ mm}$, and $19 \pm 0.53\text{ mm}$), *Pseudomonas aeruginosa* ($16 \pm 0.44\text{ mm}$, $17 \pm 0.58\text{ mm}$, and $15 \pm 0.53\text{ mm}$), and *Escherichia coli* ($13 \pm 0.32\text{ mm}$, $19 \pm 0.46\text{ mm}$, and $18 \pm 0.65\text{ mm}$), respectively. Plant leaves chloroform and *n*-butanol extracts (15 μg) were active against *Pseudomonas aeruginosa* ($16 \pm 0.37\text{ mm}$ and $14 \pm 0.75\text{ mm}$) and *Klebsiella pneumoniae* ($17 \pm 0.73\text{ mm}$ and $10 \pm 0.28\text{ mm}$). Plant flowers *n*-hexane, ethyl acetate, and *n*-butanol extracts (15 μg) showed prominent activities against *Escherichia coli* ($17 \pm 0.46\text{ mm}$, $16 \pm 0.64\text{ mm}$, and $14 \pm 0.34\text{ mm}$), *Staphylococcus aureus* ($19 \pm 0.76\text{ mm}$, $20 \pm 0.74\text{ mm}$, and $11 \pm 0.54\text{ mm}$), and *Klebsiella pneumoniae* ($19 \pm 0.75\text{ mm}$, $19 \pm 0.48\text{ mm}$, and $13 \pm 0.46\text{ mm}$), respectively. Chloroform and *n*-butanol extracts (15 μg) of plant stem showed noteworthy activities ($15 \pm 0.53\text{ mm}$ and $11 \pm 0.43\text{ mm}$) against

Escherichia coli and *Klebsiella pneumonia* (17 ± 0.56 mm and 15 ± 0.64 mm), respectively. Aqueous extracts ($15 \mu\text{g}$) of plant stem were active against *Klebsiella pneumoniae* (13 ± 0.42 mm), *Proteus mirabilis* (10 ± 0.29 mm), and *Erwinia carotovora* (11 ± 0.26 mm). Ethyl acetate and *n*-hexane extracts ($15 \mu\text{g}$) of plant stem were active against all bacterial microorganisms [580-581].

The crude (methanol fraction) and *n*-hexane, ethyl acetate, butanol and aqueous fractions of *Heliotropium bacciferum* were subjected to antibacterial activities against *Salmonella typhi*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Erwinia carotovora*, *Klebsiella Pneumoniae*, *Bacillus subtilis* and *Bacillus*. All the fractions were active against different bacterial strains but *n*-hexane and ethyl acetate showed (Zone of inhibition ranged from 18-30 mm) highest activity[582].

The antibacterial effects of extracts and fractions of chloroform, ethyl acetate and aqueous, aerial parts of *Heliotropium bacciferum* Forssk was evaluated against five bacterial strains. *H. bacciferum* extracts exhibited a significant activity against *Staphylococcus aureus*, *Bacillus cereus*, *Pseudomonas aeruginosa*, *E.coli* and *Salmonella enteritidis*. MIC between 7.6-125 $\mu\text{g/ml}$. Among the extracts, aqueous showed the most antibacterial[583-584].

***Herniaria glabra*:**

Phytoligands were investigated on multiple drug resistance (MDR), *Salmonella typhi*, *Staphylococcus aureus*, and *Vibrio cholera*. The inhibitory properties of these ligands against drug targets were studied by molecular docking. Herniarin from *Herniaria glabra* was identified as the best leads against *dfrA1* of *V. cholera* [585].

The effects of many medicinal plants extracts included *Herniaria glabra* extract were studied against bacterial survival and virulence factors involved in tissue colonization and biofilm formation of the uropathogenic *Escherichia coli*. The results indicated significant differences between investigated extracts in their antimicrobial activities. The extracts of *H. glabra* showed the highest growth-inhibitory effects ($p < 0.05$). Surface hydrophobicity of autoaggregating *E. coli* strain changed after exposure to all plant extracts and all extracts exhibited the anti-biofilm activity[586-587].

Herniaria hirsuta

Herniaria hirsuta extracts were examined for antibacterial activity against *E. coli* MAR strain. The minimal inhibitory concentrations (MICs) for ethanol and aqueous extracts of *Herniaria hirsuta* against hospital *E. coli* strain were 250 and 500 $\mu\text{g/ml}$, and against *E. coli* ATCC 25922 strain were: 100 and 250 $\mu\text{g/ml}$ respectively [588].

The use of tincture of umbelliferone 300mg, extracted from *Herniaria hirsuta*, arbutin 60mg, and Nacetylcysteine 150mg is able to reduce *E. faecalis* colonization and biofilm development on the surface of urinary catheter[589].

Hibiscus cannabinus

The antibacterial effects of aqueous and ethanol extracts of *Hibiscus cannabinus* leaves (120000 $\mu\text{g/10ml}$ to 12 $\mu\text{g/10ml}$) were studied against *Salmonella typhimurium*. The extracts showed different activity, the growth inhibition zones ranged between 12.67 ± 1.52 to 6.67 ± 1.15 mm for the aqueous extract and 12.33 ± 2.08 to 6.33 ± 0.58 mm for the ethanol extract[590].

In studying the antibacterial activity of *Hibiscus cannabinus* leaves extracts, acetone extract exerted antibacterial activity against *Klebsiella* Sp. (9 mm at concentration of 10 μl). Chloroform extract showed antibacterial activity against *E. coli* (10, 8 and 10 mm at concentration of 10, 20 and 3010 μl), against *Klebsiella* Sp. (12 mm at concentration of 10 and 30 μl), against *Pseudomonas* Sp. (14 and 12 mm at concentration of 20 and 30 μl) and against *Staphylococcus* Sp (11 mm at concentration of 30 μl)[591-592].

Hibiscus rosa-sinensis

The antibacterial activity of *Hibiscus rosa-sinensis* flower extract was studied against human pathogens. The results showed that the cold extract possessed a maximum zone of inhibition against *Bacillus subtilis* and *Escherichia coli* (17.00 ± 2.91) and (14.50 ± 1.71) mm respectively, followed by hot extraction against, *E. coli* and *Salmonella* sp. (11.66 ± 3.14) and (10.60 ± 3.09) mm respectively. Methanol extract showed a highest zone of inhibition against *B. subtilis* and *E. coli* (18.86 ± 0.18) and (18.00 ± 1.63) mm respectively, while ethanol extract showed utmost zone of inhibition against *Salmonella* sp. at (20.40 ± 1.54) mm. The crude protein from flower showed a maximum inhibitory zone against *Salmonella* sp. and *E. coli* (16.55 ± 1.16) and (14.30 ± 2.86) mm respectively [593].

The methanol, chloroform, *n*-hexane and aqueous extracts of *Hibiscus rosa-sinensis* (25, 50 and 100 mg/ml) showed antibacterial activity against *Staphylococcus epidermidis* (11-23mm), *Bacillus subtilis* (13-26mm) and *Escherichia coli* (12-24mm). It appeared that the methanolic extract was the most potent

antibacterial and extract, its diameters of inhibition for the concentration 100, 50 and 25 mg/ml were 20-26mm against *Bacillus subtilis*, 17-24mm against *Escherichia coli*, 19-23mm and against *Staphylococcus epidermidis*, 15-19mm [594].

The crude petroleum ether extract, ethyl acetate extract and methanol extract from the leaves, stems and flowers of the plant were tested at concentrations ranging from 4 mg/disc to 0.017 mg/disc against methicillin-resistant *Staphylococcus aureus* (MRSA), *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia*. The petroleum ether extract from the leaves, stems and flowers and methanol extract from the leaves showed inhibition zones with diameters > 12 mm against MRSA. The petroleum ether extract from flowers at concentrations of 4 mg/disc and 2 mg/disc displayed the strongest inhibition zones of 18.6 ± 2.85 mm and 18.5 ± 0.29 mm, respectively compared with vancomycin 30 µg/ml (18.0 ± 0.10 mm)[595].

The antimicrobial activity of 70% methanolic extract of *Hibiscus rosa sinensis* petals was studied against *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis*, *Pseudomonas aeruginosa* and *Proteus vulgaris*. *H. rosasinensis* showed antimicrobial activity against *E. coli* and *P. vulgaris* with a zone of inhibition was 17.06 and 18.96mm respectively at the concentration of 20µl/ml[596].

Hibiscus rosa-sinensis leaves and flowers 95% ethyl alcohol extracts (20 µl extract/disc) possessed anti- *Shigella dysenteriae* effect (diameter of zone of inhibition of 11 and 12 mm respectively[597].

The antibacterial activity of the extracts of *H. rosa-sinensis* leaves and flowers was studied against some clinical bacterial isolates. The extracts of *H. rosa-sinensis* flowers showed stronger antibacterial activity than that of leaves. The maximum zone of inhibition (29 mm) was observed against *S. aureus*, followed by *P. vulgaris* (25 mm), *P. aeruginosa* (24 mm) and *Citrobacter sp.* (24mm) and the lowest against *S. typhimurium* (13 mm) at the highest amount of flower extracts (100 mg/well). All the test bacteria responded to the extracts in a dose-dependent manner. However, *K. pneumoniae* was found to be resistant to the flower extracts at any of the applied doses (50 and 100 mg/well)[598].

Antibacterial activity of crude extract of *Hibiscus rosa-sinensis* was evaluated against *Staphylococcus sp.*, *Bacillus sp.* and *Escherichia coli*, using agar disc diffusion method. The growth inhibitory diameters against *Staphylococcus sp.*, *Bacillus sp.* and *Escherichia coli* were in the range of 12.75 ± 1.17 to 16.75 ± 2.10 mm[599].

The antibacterial activity of aqueous *Hibiscus rosa-sinensis* flower extract was studied against *Escherichia coli* and *Bacillus subtilis*. The result showed that aqueous extract exerted high zone of inhibition against *Bacillus subtilis* 15.00 ± 2.81 mm and *Escherichia coli* 12.50 ± 1.81 mm. However, hexane extract showed the highest zone of inhibition against *B. subtilis* 19.86 ± 0.15 mm and *E. coli* 18.00 ± 1.53 mm[600].

The antibacterial activity of the methanolic and ethanolic extract of *Hibiscus rosa-sinensis* petals was evaluated against dental pathogen, *Streptococcus mutans* in different concentration. The high concentration of 300 µl methanol extract of *Hibiscus rosa-sinensis* showed strong activity (27.33 ± 1.632) against this pathogen[601].

The antimicrobial activity of *Hibiscus rosa sinensis* extracts was examined against Gram positive and Gram-negative bacteria strains by measuring zone of inhibition. The leaf extract showed high activity against *Staphylococcus aureus* at very low concentration (2.5µg/ml) compared to *E.coli*, *Bacillus subtilis*. The *Hibiscus Rosa-sinensis* root extract showed high activity against all the bacteria at very low concentration (2.5µg/ml). The flowers extract showed activity against *E.coli* and *Staphylococcus aureus* (12 mm) at very low concentration (2.5µg/ml)[602].

The methanolic leaf and flower extracts (31.25 to 500 mg/disc) were tested for antibacterial activity against *E.coli* and *S. aureus*. Both extracts showed increasing antibacterial property with increase in the extract concentration. Maximum zone of inhibition observed for both methanolic leaf and flower extracts of *H. rosa sinensis* at concentration of 500 mg against *E. coli* was 23 ± 1.01 mm and 13.75 ± 0.99 mm, respectively. However, against *S.aureus*, methanolic leaf and flower extracts of *H. rosa sinensis* at concentration of 500 mg showed maximum zone of inhibition 19.33 ± 0.29 mm and 9.75 ± 0.76 mm[603].

The antibacterial properties of *Hibiscus rosa-sinensis* flower extract was investigated against four Gram-positive (*Bacillus cereus*, *Bacillus subtilis*, *Staphylococcus aureus*, *Listeria monocytogenes*) and four Gram-negative bacteria (*Escherichia coli*, *Salmonella typhimurium*, *Salmonella enteritidis*, *Klebsiella pneumoniae*). Aqueous extract of hibiscus inhibited the growth of *Salmonella typhimurium* (diameter of zone of growth inhibition: 11.5 and 9.0 mm at concentration of 100 and 50 mg/ml respectively), while ethanolic extracts inhibited the growth of *Staphylococcus aureus* (diameter of zone of growth inhibition: 14.0 12.0 mm at concentration of 100 and 50 mg/ml respectively)[604-605].

Hibiscus sabdariffa

Extracts and fractions of *Hibiscus sabdariffa* were tested against some pathogenic bacteria of human, Gram positive (*Corynebacterium diphtheria*, *staphylococcus aureus*, *staphylococcus capitis*), and Gram negative

(*Pseudomonas aurogenosa* and *Proteus merabeles*), from the all extracts, the fraction of (Chloroform-Ethanol) gave the highest effect, it gave inhibition range: (26-34 mm)[606].

The antimicrobial activity of the Roselle water and ethanol extracts was tested against *Bacillus subtilis* (ATCC6633), *Staphylococcus aureus* (ATCC6538) and *Escherichia coli* (ATCC 8739). The inhibition of the Roselle ethanol extract against *B. subtilis* and *S. aureus* was slightly higher than that of water extract but this difference was not significant. However, *E. coli* was strongly inhibited by the Roselle water extract at concentrations of 25 and 50 mg/ml[607].

The antibacterial effects of *Hibiscus sabdariffa* calyces extracts were evaluated against *Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 27853), *Klebsiella pneumoniae* (ATCC 15380), *Haemophilus influenzae* (ATCC 10211), *Staphylococcus aureus* (ATCC 25923), *Streptococcus pyogenes* (ATCC 12344) and *Streptococcus pneumoniae* (ATCC 6305). The zone of growth inhibition exerted by the ethanolic extract of calyces: *Pseudomonas aeruginosa* (ATCC 27853): 15mm, *Klebsiella pneumoniae* (ATCC 15380): 27mm, *Haemophilus influenzae* (ATCC 10211): 20mm, *Staphylococcus aureus* (ATCC 25923): 29mm, *Streptococcus pyogenes* (ATCC 12344): 11mm, *Streptococcus pneumoniae* (ATCC 6305): 29mm. The zone of growth inhibition exerted by the ethyl acetate of calyces: *Escherichia coli* (ATCC 25922): 11mm, *Streptococcus pyogenes* (ATCC 12344): 11mm. The zone of growth inhibition exerted by the methanolic extract of calyces: *Escherichia coli* (ATCC 25922): 16mm, *Pseudomonas aeruginosa* (ATCC 27853): 29, *Klebsiella pneumoniae* (ATCC 15380): 28, *Haemophilus influenzae* (ATCC 10211): 27, *Staphylococcus aureus* (ATCC 25923): 25, *Streptococcus pyogenes* (ATCC 12344): 34mm. The zone of growth inhibition exerted by the aqueous extract of calyces: *Escherichia coli* (ATCC 25922): 30mm, *Pseudomonas aeruginosa* (ATCC 27853): 31mm, *Klebsiella pneumoniae* (ATCC 15380): 22mm, *Haemophilus influenzae* (ATCC 10211): 25mm, *Staphylococcus aureus* (ATCC 25923): 23mm, *Streptococcus pyogenes* (ATCC 12344): 20mm, *Streptococcus pneumoniae* (ATCC 6305): 19mm[608].

The antimicrobial potential of leaves and seeds methanolic extracts of *Hibiscus sabdariffa* was studied against Gram-positive and Gram-negative bacteria strains. Leaves methanolic extracts of *H. sabdariffa* possessed antibacterial effects against Gram-positive bacteria (*Bacillus subtilis* NCTC: 8236 and *Staphylococcus aureus* ATCC: 25923), as well as Gram-negative bacteria (*Escherichia coli* ATCC: 25922, *Pseudomonas aeruginosa* ATCC: 27853, *Klebsiella pneumoniae* ATCC: 53657 and *Proteus vulgaris* ATCC: 6380)[609].

The antibacterial activity of methanol extract of *Hibiscus sabdariffa* (*H. sabdariffa*) calyces was studied against five hospital isolates of multidrug resistant *Acinetobacter baumannii* (MDR *A. baumannii*). The methanol extract exhibited significant antibacterial properties against the non-MDR *A. baumannii* as well as the MDR *A. baumannii* strains with a zone of inhibition ranging from (11.3 ± 0.3) to (13.6 ± 0.3) mm. Values of minimum inhibitory concentration and minimum bactericidal concentration ranged from 25 to 50 and 50 to 100 mg/ml, respectively. The percentage inhibition of *H. sabdariffa* extract (10 mg/disc) with respect to gentamicin (10 mg/disc) revealed that *H. sabdariffa* was much more effective than gentamicin[610].

The antimicrobial potency of roselle (*Hibiscus sabdariffa* L.) leaf extracts were evaluated against *Klebsiella pneumoniae*, *Salmonella typhi* and *Shigella dysenteriae*. Mean zones of inhibition of the aqueous leaf extracts for the 20 and 40 mg/ml for *K. pneumoniae* (15.33±0.58 and 18.67±0.76), *S. typhi* (15.50±0.50 and 16.33±0.58) and *S. dysenteriae* (17.83±0.76 and 19.17±1.04). Hexane extracts showed no activity against the test organisms. The minimum inhibitory concentration and the minimum bactericidal concentration for the aqueous leaf extract were: *K. pneumoniae* (10.0 and 15.5 mg/ml), *S. typhi* (10.0 and 12.5 mg/ml) and *S. dysenteriae* (7.5 and 12.5 mg/ml) respectively[611].

The antimicrobial activity of concentrations of 10%, 5%, and 2.5% methanol extract of *Hibiscus sabdariffa* was studied against *Escherichia coli* O157:H7 isolates from food, veterinary, and clinical samples. The results revealed that the most potent concentration was 10%, then 5%, and finally 2.5%. The overall mean zone of inhibition for the *Hibiscus sabdariffa* extract was 12.66 mm for 10%, 10.75 mm for 5%, and 8.9 mm for 2.5%. The highest inhibition zones (11.16 mm) were observed in veterinary samples, and the lowest (10.57 mm) in the food samples[612].

Aqueous extracts from the dried calyces of *Hibiscus sabdariffa* was tested for antimicrobial activity against the foodborne pathogens *Escherichia coli* O157:H7 strains ATCC 43894 and *Staphylococcus aureus* strains SA113 and ATCC 27708. Against *E. coli*, the results of 20 mg/ml filtered extract were not different from those of the control, whereas autoclaved extracts reduced viable cells ca. 3 to 4 log CFU/ml. At 60 mg/ml, both extracts inactivated cells after 24 h. There were reduced populations of both strains of *S. aureus* (ca. 2.7 and 3 log CFU/ml, respectively) after 24 h of incubation in 40 mg/ml filtered extracts[613].

The methanol extract of the dried calyces of *H. sabdariffa* were investigated for antibacterial activity against Gram positive and Gram negative bacteria. The highest antibacterial activity of *H. sabdariffa* calyces was recorded by *S. aureus* (18.5 ± 0.5 mm), followed by *S. epidermidis* (17.5 ± 1.5 mm), *S. enteric* (17.5 ± 1.5

mm), *K. pneumonia* (17.5 ± 0.5 mm), *P. aeruginosa* (15.5 ± 0.5 mm), *E. coli* (14.5±0.5 mm), *P. vulgaris* (14.5±0.5 mm), and *B. cereus* (13.5 ± 1.5 mm)[614].

The antimicrobial combinatory effect of the aqueous extract of *Hibiscus sabdariffa* with antibiotics (clarithromycin, amoxicillin, metronidazole) were evaluated against *Helicobacter pylori* strains. AEHS exerted remarkable bacteriostatic effect against all *Helicobacter pylori* tested strains with MICs values ranging from 9.18 to 16.68 µg/ml. Synergy effect of aqueous extract of *Hibiscus sabdariffa* with clarithromycin or metronidazole was obtained against four of seven *Helicobacter pylori* strains tested with Σ FIC ranging from 0.21 to 0.39. The additive effect of aqueous extract of *Hibiscus sabdariffa* with amoxicillin was obtained against five of seven *Helicobacter pylori* strains tested with Σ FIC ranging from 0.61 to 0.91[615-616].

Hyoscyamus Species

The antimicrobial effects of *Hyoscyamus albus* leaves extracts was studied against three reference strains (*S. aureus* ATCC 25923, *E.coli* ATCC 25922, *P. aeruginosa* ATCC 27853), four clinical strains (*S.aureus*, *E coli* *P. aeruginosa*, *P. mirabilis*). The results showed that the butanolic extract of *H. albus* possessed antibacterial effects against *S. aureus* ATCC 25923, *S. aureus*, *E coli* ATCC 25922, *E coli*, *P. aeruginosa* ATCC 27853, *P. mirabilis* with MIC values of: 8.30, 6.00, 6.93, 8.32, 7.63, 7.53 mg/ml respectively. Methanolic extract also showed an antimicrobial activity against all the microbial strains [617].

The diameters of inhibition zone of water, hot water and methanol extracts of the leaves of *Hyoscyamus albus* against *Staphylococcus aureus* were 17, 17, 32 mm, against *Escherichia coli* 19, 17, 26 mm; against *Bacillus subtilis* 15, 20, 18 mm and against *Salmonella typhi* 10, 18, 24 mm respectively. The diameter of inhibition zone of the *Hyoscyamus albus* leaves alkaloids against *Staphylococcus aureus*, *Escherichia coli*; *Bacillus subtilis*, *Salmonella typhi*, methicillin-resistant and *Pseudomonas aeruginosa* were 41, 43, 34, 35, 32 and 30 mm respectively[618].

Alkaloid extracts of *H. albus* showed antibacterial activity against *Pseudomonas stutzeri*, *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumonia* [619].

The methanol extracts of the seeds of *Hyoscyamus niger* were investigated for antimicrobial effect against urinary tract pathogens (*Enterococcus faecalis*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Proteus mirabilis*). The extracts showed strong antimicrobial activity against *Enterococcus faecalis* and *Klebsiella pneumoniae* with inhibition zones of 26.0 and 19.0 mm respectively, and moderate activity against the other test microorganisms[620].

The aqueous extract of *Hyoscyamus niger* seeds possessed dose dependent anticlostridial (*Clostridium petfringens*) activity (diameter of zone of growth inhibition 16-18mm)[621].

Hyoscyamus niger crude protein extract was tested against *E.coli*, *S. aureus*, *P. aeruginosa* and *P. vulgaris*. It showed diameters of growth inhibition zone of 14, 15, 14 and 20 mm against these pathogens respectively[622].

The antimicrobial effects of hexane and water extracts of *Hyoscyamus reticulatus* were evaluated against (*Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Klebsiella pneumonia* ATCC 70603, methicillin resistant *Staphylococcus aureus* ATCC 43300 MRSA), *Salmonella enteritidis* ATCC 13076, *Streptococcus pneumoniae* ATCC 10015 and *Sarcina lutea* ATCC 9341, with broth micro dilution method. Hexane extract has exhibited significant an antimicrobial effect as compared to water extract[623-624].

Hypericum triquetrifolium

Methanolic extract was active against *Bacillus subtilis*, *Salmonella typhimurium*, *Staphylococcus aureus* and *Escherichia coli*; acetone extract was active against *Bacillus subtilis*, *Salmonella typhimurium* and *Staphylococcus aureus*; CHCL₃ extract was active against *Bacillus subtilis*, *Salmonella typhimurium*, *Staphylococcus aureus* and *Micrococcus luteus*[625-627].

The essential oils of *Hypericum triquetrifolium* from five different Tunisian localities (Fondouk DJedid, Bou Arada, Bahra, Fernana and Dhrea Ben Jouder) were evaluated for their antimicrobial activities against bacterial strains (*Bacillus cereus*, *Escherichia coli*, *Vibrio alginolyticus*, *Vibrio cholerae*, *Pseudomonas aeruginosa*, *Salmonella typhimurium*, *Aeromonas hydrophila*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Staphylococcus epidermidis*). The results showed a good antibacterial activities against a wide range of bacterial strains, MIC values ranging between 0.39-12.50 mg/ml and MBC values between 1.56-25.0 mg/ml[628].

Five extracts and pure compounds from the aerial parts of *Hypericum triquetrifolium* were tested for antibacterial activity against 31 gram-positive and gram-negative strains using the agar dilution method. The ethyl acetate extract exhibited a weak antibacterial activity against *Staphylococcus* strains, quercetin and I3,II8-biapigenin were the active components of the extract[629].

H. triquetrifolium showed antibacterial effect with diameter of growth inhibition: *Escherichia coli* K12 (12 mm, 60µg/disc), *Escherichia coli* PBR322 (10 mm, 40µg/disc), *Escherichia coli* PUC9 (10 mm,

40µg/disc), *Bacillus brevis* ATCC (10 mm, 40µg/disc), *Bacillus cereus* DM65(12 mm,40µg/disc), *Streptococcus pyogenes* DM41(12 mm, 40µg/disc), *Pseudomonas aeruginosa* DMC66 (12 mm,40µg/disc) and *Staphylococcus aureus* DMC70 (16 mm,40µg/disc)[630-631].

Inula graveolens

The antibacterial activity of *Inula graveolens* essential oils was evaluated against *Staphylococcus aureus* with studying the effect at the cellular level. A bactericidal mode of inhibition was established for the essential oils, it rapidly reduced the cell viability of *S. aureus* MIC (5 mg/ml). No lysis occurred after treatments with the MIC and eight times the MIC of the essential oil. Thickenings of the cell wall as well as an aggregation of the cytoplasmic contents were observed in *S. aureus* cells treated with the MIC of the essential oils. The results suggest that the cytoplasmic membrane and the cell wall were involved in the toxic action of *Inula graveolens* essential oils[662].

The antimicrobial activity of the essential oil was studied against five bacterial and strain using a disk-diffusion assay. The essential oil was active only against Gram-positive bacteria[663].

The antimicrobial effects of *Inula graveolens* petroleum ether, chloroform and ethanol extracts were investigated (at concentration of 20, 40 and 80 µl of 5% concentration in dimethyl sulphoxide) against *Bacillus subtilis*, *Micrococcus luteus*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumonia* and *Pseudomonas aeruginosa*. The extracts showed concentration dependent antimicrobial effects against *Bacillus subtilis*, *Micrococcus luteus* and *Staphylococcus aureus*. The most potent effect was recorded for petroleum ether extract. However, all extract in the higher concentrations (40 µl of 5% concentration in dimethyl sulphoxide) also showed antimicrobial effects against *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* [664].

The antibacterial effects of *Dittrichia graveolens* essential oil were investigated against nine different ATCC type strains of microbial species, including Gram-positive bacteria (*S. aureus*, *E. faecalis*, *B. subtilis*) and Gram-negative bacteria (*E. coli*, *P. aeruginosa*) The MICs and MLCs of oil against all tested microorganisms were in the range of 0.25–4 and 1–8 µl/ml, respectively. *E. faecalis* and *C. glabrata* were the most sensitive microorganisms with the lowest MIC and MLC values (0.5 and 1 µl/ml), whereas the least susceptible microorganisms were *S. aureus* and *E. coli* (4 and 8 µl/ml)[665].

The antibacterial activity of methanolic and acetone extract of aerial parts of *D. graveolens* was tested against *Shigella dysenteriae* (PTCC1188), *Pseudomonas aeruginosa* (PTCC1430), *Escherichia coli* (PTCC1399), *Staphylococcus aureus* (PTCC1431), *Bacillus cereus* (PTCC1015), *Salmonella typhimurium* (ATCC1596), Methanolic extract showed more potent antibacterial activity. *Staphylococcus epidermidis* (PTCC1114), *Enterococcus faecalis* (PTCC1393) and *Klebsiella pneumoniae* (PTCC1291). *Staphylococcus aureus*, *Staphylococcus epidermis*, *E. faecalis* and *B. cereus* with inhibition zone 35, 30, 26, 21 mm were the most sensitive bacteria, with minimum inhibitory concentrations (MIC) ranging from 12.6 to 112 µg/ml, respectively. *E. coli* and *Salmonella typhimurium* have moderate sensitivity and other bacteria were resistant to the plant extract[666].

The antibacterial activity of *Dittrichia graveolens* essential oil was investigated by the broth microdilution method against thirteen bacterial strains. The interactions of the essential oil and three standard antibiotics: chloramphenicol, tetracycline and streptomycin toward five selected strains were evaluated using the microdilution checkerboard assay in combination with chemometric methods: principal components analysis and hierarchical cluster analysis. The essential oil exhibited slight antibacterial activity against the tested bacterial strains in vitro, but the combinations *D. graveolens* essential oil-chloramphenicol and *D. graveolens*-tetracycline exhibited mostly synergistic or additive interactions. These combinations reduced the minimum effective dose of the antibiotics and, consequently, minimized their adverse side effects. In contrast, the association of *D. graveolens* essential oil and streptomycin was characterized by strong antagonistic interactions against *E. coli* ATCC 25922, *S. aureus* ATCC 29213 and *P. aeruginosa* ATCC 27853[667].

However, it was reported that *I. graveolens* extracts, obtained by extraction with hot and cold water and then lyophilization, were inactive against *S. aureus* and *S. faecium* cells[668-669].

Jasminum officinale

The in vitro anti-bacterial activity of ethanolic extracts of different parts (flowers, stems plus leaves and roots) of *J. officinale* was evaluated against four reference bacteria (*staphylococcus aureus* ATCC 29213, *Enterococcus faecalis* ATCC 29212, *Escherichia coli* ATCC 25922 and *Pseudomonas aeruginosa* ATCC 27853). The ethanolic extracts of all parts of the plant showed considerable activity against all the tested bacteria. The MIC of the ethanolic extracts of flowers and stems plus leaves against all the tested bacteria was 2 mg/ml and the MIC of roots against *S. aureus*, *E. faecalis* and *E. coli* was 4 mg/ml, while the MIC of root extract against *P. aeruginosa* was 2 mg/ml[670].

The *Jasminum officinale* flowers extracts were evaluated for antibacterial activity against *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Bacillus pumilis*, *P. vulgaris* and *E.coli*. Butanol fraction displayed antibacterial activity more than the standard drug Ampicillin against *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Bacillus pumilis*, *P.vulgaris* and *E.coli* with zone of inhibition of 19.2 ± 0.8 , 20.1 ± 1.2 , 20.1 ± 1.5 , 22.0 ± 1.2 , 19.4 ± 1.0 and 24.0 ± 0.8 mm respectively, on the other hand, chloroform fraction displayed significant activity with zone of inhibition of 14.8 ± 1.3 , 16.2 ± 1.4 , 16.2 ± 1.9 , 17.4 ± 1.3 , 14.2 ± 1.2 and 18.2 ± 1.6 respectively, while n-hexane fraction displayed very low activity[671].

The antimicrobial activity of different solvent extracts (methanol, DCM) of the flowers and whole plant (leaves, barks and roots) was studied against both Gram positive strains (*Staphylococcus aureus*, *Bacillus pumilis*, *Streptococcus pneumoniae*) and Gram negative strains (*Escherichia coli*, *Citrobacter freundii* and *Klebsiella pneumoniae*). Whole plant extract (methanol) showed significant antimicrobial activity with relative percentage of inhibition of 83.60 (G +ve) and 70.25 (G-ve), while flowers extract (methanol) showed 64.30 and 51.88 relative percentage of inhibition against G +ve and G-ve respectively. The diameters of growth inhibition were 11.00-15.15 and 9.90-11.95 mm against G+ve and G-ve for DCM flowers extract, and 13.35-16.35 and 10.45-12.50 mm against G+ve and G-ve for methanol flowers extract respectively, whereas, the diameters of growth inhibition were 18.00-20.00 and 14.10-16.80 mm against G+ve and G-ve for DCM whole plant extract, and 18.55-20.35 and 14.50-17.00 mm against G+ve and G-ve for methanol whole plant extract respectively[672].

The antibacterial effect of different extracts of leaves of *Jasminum officinale* were studied against *E. coli*, *Bacillus sp.*, *Streptococcus sp.*, *Salmonella sp.*, *Pseudomonas sp.*, *Serratia marcescens*, *Klebsiella pneumonia* and *Staphylococcus aureus*. Methanol extract exhibited the maximum activity against *Klebsiella pneumonia*, chloroform extract against *Bacillus subtilis* and *Staphylococcus aureus*, and hexane extract against *Serratia marcescens* and *E. coli*, while minimal activity was recorded for the ethanol extract against *Staphylococcus aureus*, for chloroform extract against *Salmonella* and *pseudomonas aeruginosa*, and for diethyl ether extract against *Streptococcus sp*[673].

Jasminum officinale (extract of flowers powder macerated in ethanol) were tested against *Propionibacterium acnes* and *Staphylococcus epidermidis*, as pus-forming bacteria triggering an inflammation in acne, using disc diffusion and broth dilution methods. MIC and MBC against *Propionibacterium acnes* was 5 and >5 mg/ml respectively, and MIC and MBC against *Staphylococcus epidermidis* was >5 mg/ ml[674-675].

Jasminum sambac

Antimicrobial efficiency of petroleum ether, chloroform, ethyl acetate and ethanol *Jasminum sambac* leaf extracts were examined against *Bacillus subtilis*, *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa* using agar disc diffusion method. The mean zone of inhibition produced by the extracts in disc diffusion assays were ranged from 5 mm to 27 mm. The ethanol extracts of *Jasminum sambac* showed highest antimicrobial activity, while, the ethyl acetate, petroleum ether and chloroform showed moderate antimicrobial activity against the tested microbial strains[676-677].

The antimicrobial activity of butanol extract of *Jasminum sambac* flowers was evaluated against human pathogenic bacteria, *Salmonella*, *Staphylococcus*, *Pseudomonas*, *Vibrio cholera*, *Streptococcus*, *Corynebacterium*, *Enterobacter aerogenes*, *Proteus mirabilis*, *Proteus vulgaris* and *Escherichia coli*. It showed antibacterial activity against *Salmonella* (14mm), *Vibrio cholera* (15mm), *Streptococcus* (14mm), *Corynebacterium* (12mm), *Proteus vulgaris* (14mm) and *coli* (13mm)[678].

The antimicrobial efficacy of *Jasminum sambac* leaf extracts was evaluated against six bacteria (*Staphylococcus aureus*, *Streptococcus mutans*, *S. pyogenes*, *S. sobrinus*, *S. sanguinis* and *Lactobacillus acidophilus*) causing dental infections. The methanol extract was more efficient in comparison to other extracts. The zone of inhibition ranged between 12.3 ± 0.57 - 17.3 ± 0.57 mm at 200 mg/ml, respectively. Minimum inhibitory concentration for methanol extract was 3.12-25 mg/ ml[679].

The antibacterial potentials of the methanolic extracts of leaves of *Jasminum sambac* (25, 50, 100, 250, 500 µg/ml) was evaluated against four Gram-positive bacteria (*Staphylococcus aureus*, *Bacillus subtilis*, *Bacillus cereus*, *Sarcina luteae*) and four Gram-negative bacteria (*Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella paratyphi*, *Shigella dysenteriae*). Significant antibacterial activity was recorded at a concentration of 500 µg/ml of methanolic extract. It possessed zone of inhibition of 17 mm, 14 mm, 15 mm and 13 mm against *Staphylococcus aureus*, *Bacillus subtilis*, *Bacillus cereus*, *Sarcina luteae* respectively and 14 mm, 15 mm, 15 mm and 16mm zone of inhibition against *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella paratyphi*, *Shigella dysenteriae* respectively[680].

The ethanolic callus extracts of *J. sambac* were screened for antimicrobial activity against *Staphylococcus albus*, *Proteus mirabilis* and *Salmonella typhi* at concentrations of 500 and 250mg/ml. The

results revealed that the extracts possessed antibacterial activity with zone of inhibition of 10, 11.5, 14.5mm respectively[681].

The antibacterial potential of the hexane, chloroform, ethanol and distilled water extracts of *Jasminum sambac* leaf was studied against Gram positive bacteria (*Staphylococcus aureus* and *Bacillus subtilis*) and Gram negative bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*) by agar well diffusion method. The n-hexane extracts of *Jasminum sambac* showed the highest activity against *E. coli*. Aqueous and ethanol extracts exhibited comparatively higher antibacterial potential against Gram negative bacteria than the Gram positive bacteria[682].

Ethyl acetate extracts of *Jasminum sambac* (Leaf and stem) showed antibacterial activity against eight bacterial isolates. The zone of growth inhibition was: *Staphylococcus aureus* ATCC12-13mm and 9-10mm, *Escherichia coli* ATCC 13-14mm and 14-15mm, *Pseudomonas aeruginosa* ATCC 16-17mm and 13-14mm, *Acinetobacter* 11mm and 10-11mm, *Klebsiella* 8-10mm and 8-18mm, *Citrobacter* 9-10mm and 10mm, *Enterobacter* 10-11mm and 9-10mm, *Proteus* 10-11mm and 9-10mm respectively[683].

The essential oil and methanol extract were evaluated for its antimicrobial activity against *Bacillus cereus* LMG 13569, *Enterococcus faecalis* CIP 103907, *Escherichia coli* CIP 11609, *Listeria innocua* LMG 1135668, *Salmonella enterica* CIP 105150, *Shigella dysenteriae* CIP 5451, *Staphylococcus aureus* ATCC 9244 and *Staphylococcus camorum* LMG 13567 BHI. The methanol extracts and essential oils were active against gram +ve and -ve bacteria. The antimicrobial activity of essential oil was stronger than that of the methanol extracts. The bacteria most sensitive to the essential oil of *J. sambac* were *S. pyogenes* (41 mm), *S. enterica* CIP 105150, *E. coli* CIP 105182 (31 mm), *S. dysenteriae* CIP 5451 (29 mm), *L. innocua* LMG 1135668 (28 mm). The other bacterial strains were sensitive with diameters of inhibition of 17-25 mm. The bacterial strain *S. camorum* LMG 13567 was resistant to the essential oil of *J. sambac*. The methanol extract of *J. sambac* was more active on *E. faecalis* CIP 103907 (17 mm), *Salmonella enterica* CIP 105150, *S. pyogenes* (16 mm). The other bacterial strains were sensitive with diameters of inhibition of 11- 15 mm. *S. camorum* LMG 13567, *E. faecalis*, *P. aeruginosa*, *S. aureus* were resistant to the methanol extract of *J. sambac*[684].

The antibacterial activity of *Jasminum sambac* flower hydro steam distilled essential oil, and six major individual components was assessed against *Escherichia coli* (MTCC-443) strain. The activity was bactericidal, and the Minimum inhibitory concentration ranged between 1.9-31.25 µl/ml[685-686].

Juglans regia

The antibacterial effect of *Juglans regia* leaf extract was studied against the pathogens caused acne lesions, *Propionibacterium acnes*, and other organisms that were isolated from acne lesions. The zones of inhibition due to *Juglans regia* leaf extract (15%) were *Providencia steari* 20mm, *Providencia rettgeri* 15mm, *Streptococcus* group C 15mm, *Streptococcus faecalis* 17mm and *Staphylococcus aureus* 10mm[687].

The influence of a walnut (*Juglans regia*) extract was evaluated on the growth of *Escherichia coli* AB1157, on the plasmid DNA topology and on the labeling of blood constituents. The extract possessed an inhibitory action of the growth of the *E. coli* AB1157 culture, no protective action of the walnut extract in plasmid DNA treated with SnCl₂. Moreover, walnut was also not capable to induce modifications in the DNA mobility in agarose gel but walnut was capable to decrease the distribution of 99mTc on the blood cell compartment[688].

The effects of hydroalcoholic extract of *Juglans regia* stem bark were studied on 6 pathogens (*Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, *Streptococcus* spp., *Pasteurella multocida* and *Mannheimia haemolytica*). Hydroalcoholic extract did not possess antibacterial effects on *E. coli* and *K. pneumoniae*. Minimum inhibitory concentration against *S. aureus*, *P. multocida*, *M. haemolytica* and *Streptococcus* spp. was 62.5mg/ml. There was not any significant response with concentrations below 100mg/disc on *S. aureus*, *Streptococcus species*, *P. multocida* and *M. haemolytica*. The minimum bactericidal concentration of this extract was 100mg/ml in all isolates[689].

The antibacterial activity of *Juglans regia* aqueous bark extract was studied against methicillin-resistant strains of *Staphylococcus epidermidis* and *Staphylococcus hemolyticus*. *Juglans regia* extract was more effective against *S. epidermidis* at an average MIC of 312.5 µg/ml than against *S. hemolyticus* with an average MIC of 2500 µg/ml[690].

Acetone, methanol and ethanol extracts of the leaves of *Juglans regia* were tested for antimicrobial activity against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Klebsella pneumoniae*. Antimicrobial activity was done by disc diffusion method at concentrations of 50 and 100µg/ml/disc of the extracts. All extracts showed varying degrees of inhibitory activity against all bacterial species. Ethanol and acetone extract showed significant activity against *E.coli* and *Klebsella* respectively[691].

The effect of hydroalcoholic extract of the stem bark of *Juglans regia* was studied against 50 methicillin-resistant *Staphylococcus aureus*. All of 50 MRSA strains were multi-drug resistant, resisted penicillin, ampicillin and methicillin. A low resistance was observed toward erythromycin (48%) and then

ciprofloxacin, gentamycin and clindamycin (34%). All strains except one were sensitive to vancomycin. All strains except one were *mecA* carrier in PCR. The hydroalcoholic extract of the stem bark of *Juglans regia* showed low MICs (15.62 mg/ ml) against the standard *S. aureus* strain (PTCC: 33591) and 7.81 mg/ml against MRSA isolates. Minimum bactericidal concentrations of this extract were 15.62 mg/ml and 31.25 mg/ml against *S. aureus* isolates and the standard strain, respectively[692].

The ethanol extract of walnut leaves was examined for antibacterial activities on *Streptococcus mutans*, *Streptococcus salivarius*, *Streptococcus sanguinis*, and *Actinomyces viscosus* using the microdilution method. The minimum inhibitory concentrations for ethanolic extract ranged between 15.6 and 187.5 mg/ml and minimum bactericidal concentrations ranged between 31.25 and 250 mg/ml[693].

The antibacterial activities of methanol extracts of stem bark of *Juglans regia* were investigated against two Gram positive bacteria (*Staphylococcus aureus*, *Streptococcus mutans*). Methanolic bark extract of *Juglans regia* possessed antibacterial activity, it showed zone of inhibition of 7.2 and 8.7mm against *S. mutans*, *S. aureus* respectively, while the inhibition zones of ciprofloxacin were 15.52mm, 15.1mm against *S. mutans*, *S. aureus* respectively[694].

Juglone potentially inhibited the three key enzymes from *Helicobacter pylori*, cystathionine γ -synthase (HpCGS), malonyl-CoA:acyl carrier protein transacylase (HpFabD), and β -hydroxyacyl-ACP dehydratase (HpFabZ) with IC₅₀ values of 7.0 \pm 0.7, 20 \pm 1, and 30 \pm 4 μ mol/L, respectively[695].

Over 45% of clinical isolates of *Helicobacter pylori* strain were inhibited by *J. regia* aqueous and equal mixture of methanol, diethyl ether and petroleum benzene extract[696-697].

Juncus maritimus

The antibacterial effect of some selected Algerian plants included *Juncus maritimus* (ethanol/ water 70/30 extract) were evaluated on several bacterial strains [*Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Staphylococcus coagulans* (ATCC 5118), *Staphylococcus aureus* ATCC 25923, *Klebsiella pneumoniae* and *Enterococcus faecalis*]. *Juncus maritimus* showed antibacterial effects against these microorganisms with diameter of growth inhibition of 11, 12, 13, 10, 10 and 7mm respectively. The combination of *Juncus maritimus* with each of the standard antimicrobs (Erythromycine, Chloramphenicol, Cefotaxime, Amoxicillin, Cefazoline and Cefalexine) were most active and showed significant synergic effects[698].

The extract of *J. maritimus* rhizomes possessed antibacterial activity against *Streptococcus dysgalactiae* and *S. pyogenes* (MIC = 39 μ g/mL). Bioactivity-directed fractionation of the *J. maritimus* rhizomes extract showed that the methylene chloride partition was most likely responsible for antibacterial. The two major compounds of the methylene chloride partition were identified as phenanthrene derivatives[699].

The antibacterial activity of 19 species (*Juncus acutus*, *J. alpinoarticulatus*, *J. articulatus*, *J. compressus*, *J. conglomeratus*, *J. effusus*, *J. filiformis*, *J. gerardii*, *J. inflexus*, *J. maritimus*, *J. monanthos*, *J. squarrosus*, *J. tenuis*, *J. trifidus*, *Luzula campestris*, *L. forsteri*, *L. luzuloides*, *L. sudetica* and *L. sylvatica*) was studied against methicillin-resistant *S. aureus* (MRSA), extended-spectrum β -lactamase (ESBL)-producing *C. freundii*, *E. coli*, *E. cloacae*, *K. pneumoniae*, and multiresistant *A. baumannii* and *P. aeruginosa*. Antibacterial susceptibilities were screened for inhibitory zones and MIC values determined by microdilution method. Among the tested extracts (n=96) 16 extracts prepared from *Juncus* species and 3 extracts from *Luzula* species showed mild to strong inhibitory activities against MRSA strains (inhibition zones=6.7mm-14.6mm; MIC values 9.75-156 μ g/ml). The main bioactive constituents of Juncaceae species are phenanthrenes. Four phenanthrenes [juncunen D, juncusol, dehydrojuncunen B, and jinflexin B isolated previously from *J. inflexus* with anti-MRSA activity were investigated by LC-MS in extracts proved to be active in antimicrobial test[700].

Juniperus communis

Antimicrobial screening of the essential oils of *Juniperus communis* was studied against 16 bacterial isolates of Gram positive and Gram negative bacteria and one strain of *Candida albicans*. The highest MIC (125 μ l/ml) of the essential oils were towards *Staphylococcus aureus* and *Streptococcus pyogenes*, and moderate antimicrobial activity against *Streptococcus agalactiae*, *Haemophilus influenzae*, *Corynebacterium* spp. and *Campylobacter jejuni* (MIC > 500 μ l/ml). *Candida albicans*, *Staphylococcus epidermidis*, *Acinetobacter* spp., *Salmonella enteritidis*, *Shigella flexneri*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Proteus mirabilis* were completely resistant to the antimicrobial activity of juniper oil[701].

At concentrations of 20 and 50%, *Juniperus communis* essential oils possessed antibacterial activity against *Staphylococcus aureus* NCIB 6751 (diameter of zone of growth inhibition 4.8 and 5mm respectively) and *Escherichia coli* NCIB 8879 (diameter of zone of growth inhibition 7.2 and 8.3 mm respectively)[702].

Many fractions as well as essential oil obtained from *Juniperus communis* were investigated for antimicrobial activity (*Escherichia coli* ATCC 8739, *Listeria monocytogenes* IM200, *Corynebacterium* sp. 754, *Pseudomonas aeruginosa* DV5999 and *Staphylococcus aureus* ATCC 6538. Some fractions showed

distinct antimicrobial activity with a wide spectrum and wide inhibition zones. Juniper essential oil showed low antimicrobial activity with respect to almost all the investigated species. *B. cereus* was susceptible to all the tested samples, while *E. coli* and *S. aureus* were resistant only to one fraction. *Corynebacterium* sp. and *P. aeruginosa* DV5999 were the least susceptible to all the oil samples[703].

The antibacterial activity of n-hexane extract of *Juniperus communis* roots against *Mycobacterium tuberculosis* H(37)Rv and *Juniperus communis* aerial parts against *Mycobacterium aurum* were studied in vitro with isolation and identification of the constituents responsible for this activity. *Juniperus communis* showed antimycobacterium activity, the antimycobacterial activity of *Juniperus communis* was attributed to a sesquiterpene identified as longifolene and two diterpenes, characterised as totarol and trans-communic acid[704].

Antimicrobial activity of the essential oil of *Juniperus communis* was investigated against *Staphylococcus aureus*, *Escherichia coli*, *Hafnia alvei* and *Pseudomonas aeruginosa*. The essential oil showed moderate to high activities against *Staphylococcus aureus*, *Escherichia coli*, *Hafnia alvei* (zone of inhibition 10-35mm for concentration of 5 mg/ml). *Pseudomonas aeruginosa* was resistant to the essential oil of *J. communis*[705].

The antibacterial effect of crude leaf organic extracts (methanol, ethanol, chloroform and hexane) and aqueous extracts of *Juniperus communis* was studied against five pathogenic multi drug resistant bacteria (*Bacillus subtilis*, *Erwinia chrysanthemi*, *Escherichia coli*, *Agrobacterium tumefaciens* and *Xanthomonas phaseoli*). All the extracts of *Juniperus communis* showed antibacterial activity except aqueous extract. The hexane extract showed maximum inhibition against the test microorganisms (zone of inhibition, 16 – 21 mm) followed by ethanol, methanol and chloroform extract (zone of inhibition, 6 – 17mm). The inhibitory activity of these extracts was found very effective as compared to Ampicillin (10 mcg) and Erythromycin (15 mcg) standard antibiotics which were used as positive controls[706].

Diterpenes isocupressic acid, communic acid and the aryltetralin lignan deoxypodophyllotoxin isolated from the *J. communis* extract were tested as antimycobacterium compounds. Isocupressic acid and communic acid displayed MICs of 78 μ M and 31 μ M and IC₅₀ of 46 μ M and 15 μ M against *M. tuberculosis* H37Ra respectively. Deoxypodophyllotoxin was less active, with a MIC of 1004 μ M and an IC₅₀ of 287 μ M[707].

The essential oils and their major compounds of *Juniperus communis* ssp. *communis* were tested against *Candida albicans*, *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*, and the minimum inhibitory concentration and minimum bactericidal concentration were determined. They possessed nonsignificant inhibitory effect[708-709].

Juniperus oxycedrus

The antimicrobial effect of the *J. oxycedrus* essential oils was studied against 16 bacterial isolates [five standard strains (*Staphylococcus aureus* ATCC 29213, *Escherichia coli* 25927, *Klebsiella pneumoniae* ATCC 700603, *Pseudomonas aeruginosa* ATCC 27853 and *Candida albicans* ATCC 10231) and 12 clinical strains (*Staphylococcus epidermidis*, *Enterococcus*, *Streptococcus pyogenes*, *Streptococcus agalactiae*, *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Proteus mirabilis*, *Salmonella enteritidis*, *Salmonella enteritidis*, *Shigella flexneri*, *Campylobacter jejuni*, and *Acinetobacter* spp.)]. The most sensitive bacteria was *Haemophilus influenzae* (MIC = 125 ml/ml). The essential oils possessed moderate antimicrobial activity against *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Streptococcus agalactiae*, *Streptococcus pyogenes*, *Corynebacterium* spp., *Escherichia coli* and *Campylobacter jejuni* (MIC > 500 ml/ml) and, it showed no activity against *Candida albicans*, *Staphylococcus epidermidis*, *Acinetobacter* spp., *Salmonella enteritidis*, *Shigella flexneri*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Enterococcus* and *Proteus mirabilis*[710].

Aqueous and methanol extracts of the leaves of *Juniperus oxycedrus* were investigated for antimicrobial effects against 143 laboratory strains belonging to 56 bacterial species. The aqueous extract of *J. oxycedrus* had no antimicrobial effect against the test microorganisms whereas the methanol extract had inhibitory effects on the growth of 57 strains of 24 bacterial species in the genera of *Acinetobacter*, *Bacillus*, *Brevundimonas*, *Brucella*, *Enterobacter*, *Escherichia*, *Micrococcus*, *Pseudomonas*, *Staphylococcus*, and *Xanthomonas*[711].

The antimicrobial of ether fruit extract of *Juniperus oxycedrus* was studied against *Bacillus subtilis*, *Staphylococcus aureus*, *Staphylococcus aureus* (MRSA), *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Candida albicans*. Extract showed zone of growth inhibition of 8,8,8,7 and 8mm against *Staphylococcus aureus*, *Staphylococcus aureus* (MRSA), *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* respectively[712].

The antibacterial activity of ethanolic extract of the fruits of *Juniperus oxycedrus* was studied against *Escherichia coli*, *Bacillus subtilis*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, *Aspergillus niger* and *Candida albicans*. It showed (MIC: 5 mg/ml) against all the tested pathogens[713].

The *in vitro* antibacterial activity of mixed essential oils of each of *J. oxycedrus* populations (Kbouche, Sidi Ameur, Dkhila Tabarka, and Oued El Bir- Tunisia) was studied against *Staphylococcus aureus* ATCC 25923, *Salmonella enteridis* ATCC 13076, *Escherichia coli* ATCC 35214 and *Salmonella typhimurium* NRRLB 4420. The essential oils of the *J. oxycedrus* ssp. *oxycedrus* showed antibacterial activities against two strains among four, while *J. oxycedrus* ssp. *macrocarpa* possessed antibacterial effect against three strains among four. *E. coli* was found to be the most resistant organism, whereas *Staphylococcus aureus* was the most sensitive organism. The zone of inhibition was ranging from 6.5mm (against *Salmonella enteridis*) to 13.5mm (against *Staphylococcus aureus*). *Salmonella typhimurium* was sensitive only to *J. oxycedrus* ssp. *macrocarpa* (8 mm)[714].

The methanolic extract of the leaves of five plants included *Juniperus oxycedrus* was tested for their antibacterial activities against *Bacillus cereus*, *Escherichia coli*, *Micrococcus varians* and *Staphylococcus aureus*. The methanol extract of *J. oxycedrus* leaves was the most active plant extract, which cause the maximum inhibition in the growth of all microbial species. *J. oxycedrus* leaf extract was more effective in decreasing the protein contents for all tested bacterial species reaching to the minimum value (0.33 µg/ml) in *E. coli*. Although, all tested plant extracts induced the tested bacterial species to produce more sugars in the culture filtrates, but, the maximum accumulation of sugars (2.00 µg/ml) was showed by the treatment of *M. varians* with the extract of *J. oxycedrus*[715-716].

Jussiaea repens

The methanolic extract of *L. adscendens* showed a broad spectrum antibacterial activity against all the tested bacteria except *S. aureus*. The zone of growth inhibition against the tested bacteria was: *Staphylococcus epidermis* 15, *Streptococcus pyogenes* 13, *Escherichia coli* 17, *Salmonella typhi* 20, *Shigella boydii* 18, *Shigella dysenteriae* 20, *Shigella flexneri* 15, *Shigella sonii* 17 and *Vibrio cholerae* 20mm[717-718].

***Kochia scoparia* (*Bassia scoparia*)**

The antibacterial activities of EtOH extract of *Kochia scoparia* and its *n*-hexane, EtOAc, *n*-BuOH and water fractions were evaluated against 15 strains of methicillin-resistant *S. aureus* (MRSA) and 1 standard methicillin-susceptible *S. aureus* (MSSA) strain. Antimicrobial activity of *n*-hexane fraction of *K. scoparia* was remarkable. Against the 16 strains, the zone of growth inhibition was in the range of 15-18 mm, the minimum inhibitory concentrations (MICs) were in the range of 7.8 to 31.25 µg/ml and FICI values ((MIC of drug A in combination/MIC of drug A alone) + (MIC of drug B in combination/MIC of drug B alone) for *n*-hexane fraction of *Kochia scoparia*+ Ampicillin and *n*-hexane fraction of *K. scoparia*+Oxacillin were 0.31 to 0.75 µg/ml and 0.12 to 0.37 µg/ml showing the increase of synergistic effect[719-720].

III. CONCLUSION

The resistance of pathogenic bacterial strains to antibiotics is one of the major public health problem. Plant extracts have shown inhibitory effect on the growth of wide range of bacteria. They are represented a good alternative for prevention and treatment of bacterial diseases. The current review highlighted the antibacterial effects of medicinal plants.

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