IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS)
e-ISSN:2278-3008, p-ISSN:2319-7676. Volume 11, Issue 2 Ver. IV (Mar.- Apr.2016), PP 26-34
www.iosrjournals.org

The Inhibitory Activity Of Medicinal And Aromatic Plants Used In Folklore Medicine In Jazan Region Of Kingdom Saudi Arabia

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***Abstract*:** *Treatment of various human disorders with folkloric medicine has been in practice for centuries. This study was conducted on twenty medicinal and aromatic plants found in Jazan region of the Kingdom of Saudi Arabia. The aim was to investigate the antimicrobial activity of different extracts from these plants on nine common bacterial and four fungal pathogens. The extracts showed varying but high microbial growth inhibitory activity against most of the pathogens tested, which was in some cases comparable to commercially available antimicrobials. The study provides baseline information about the potential use of these plants in the discovery and development of effective antimicrobials.*

Keywords: *Antimicrobial activity, Plant extracts, Bacterial pathogens, Fungal pathogens.*

I. Introduction.

Herbal medicines have been used since centuries by humans. Practitioners of traditional medicine have described the therapeutic efficacy of many plants for several disorders (Ramasamy and Charles, 2009). Studies on antimicrobial properties of medicinal plants are being increasingly reported from different parts of the world. According to estimates of the World Health Organization (WHO), 80% of the world population use plant extracts or their active constituents as folk medicine in traditional therapies (WHO, 1993; Shaik et al., 1994). Because of its impact on both world health and international trade, the importance of herbal medicines has increased significantly over the past decades.

The health-related quality of human life has greatly benefited since the introduction of antibiotics, which are our most important weapons against bacterial infections. Even though a number of new antibiotics have been produced by pharmaceutical industries, but over the past few decades, these drugs have become less and less effective either because of their toxic reactions or due to the emergence of multiple drug-resistant microorganisms. The genetic ability of bacteria to transmit and acquire resistance to synthetic drugs used as therapeutic agents (Towers et al., 2001) has created alarming clinical situations in the treatment of infections. Therefore, it is essential to explore newer drugs derived from natural sources. Traditional medicine is still one of the primary health care systems in many developing countries (Farnsworth, 1993; Houghton, 1995) where herbs are widely exploited because of their curative potential (Dubey et al., 2004). Drugs based on natural products have been very successful in the treatment of infectious diseases and cancer over the past three decades (Cragg and Newman, 2005). The effect of plant extracts on microbial infections and other diseases is being widely studied by researchers in different parts of the world, however, such studies are very scarce in the Arabian peninsula particularly the Kingdom of Saudi Arabia.

According to recent estimates, the south-western mountainous region of Saudi Arabia extending from Taif to Yemen border contains about 70% of its floristic elements. A number of these plants are utilized by locals for producing medicines, oils, etc., some of which are essential to their daily existence (Carrubba and Scalenghe, 2012). Hundreds of plant species have been identified in the past decades, which have been widely used in Saudi folk medicine and for aromatic purposes. However, the literature search reveals very limited information on biological activity of these plants in Saudi Arabia. In this study, we collected twenty species of medicinal and aromatic plants from different areas of Jazan region and studied their antimicrobial activity against nine different clinical isolates of bacteria and four clinical isolates of fungi.

II. Materials And Methods.

Twenty medicinal and aromatic plants found in the Jazan region of Saudi Arabia were collected from different areas, namely Bish, Samta, Abu-Arish and Arda. The list of medicinal and aromatic plants that were collected for this study is shown in Table (1) & Fig (1). The use of these plants in herbal or traditional medicine has been reported by some investigators (Mitchell and Bastyr, 2003; Lai and Roy, 2004; Carrubba and Scalenghe, 2012). Utmost care was taken to preserve all parts of each plant during collection. Briefly, complete plant (including Roots, Stems, Branches, Leaves, Buds and Fruits) were collected and placed in a clean plastic bag to avoid microbial contamination. The plants were dried in the sun, crushed and grounded under sterile

conditions to obtain their powder form. The classification of plants was based on the inputs given by the spice dealers of Jazan region followed by scientific inputs from plant science specialists at the Jazan University.

1- Preparation of plant extracts.

Twenty grams powder of each plant, separately, was put on a solvent extraction (Soxhlet apparatus) for 24 hours with chloroform and methanol as solvents (Oloke and Kolawole, 1998). The resulting extracts were dried under pressure. Melting residues were extracted on the same extraction solution (20 ml). The extracts were then stored in refrigerator until use.

Aqueous extracts of the plants were prepared by taking 20 grams of dry plant powder in a 250 ml Erlenmeyer's flask and adding 100 ml of distilled sterile water to it. The flasks were covered and left for overnight in order to ensure the solubility. The extracts were filtered on second day using filter paper, aliquoted in the capped tubes (20 ml each) and stored in refrigerator until use.

2- Bacterial and fungal strains used.

Bacterial strains were obtained from pure culture that have been isolated from clinical morbidity (Ahmed, 2014) namely *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus agalactiae*, *Streptococcus pyogenes, Bacillus cereus, Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumonia* and *Klebsiella oxytoca*. All these strains were grown on Mueller-Hinton agar and incubated at 37°C for 24 hours.

We also tested four fungal strains namely *Candida albicans, Aspergillus flavus, Aspergillus fumigatus* and *Aspergillus niger*. Fungal strains were grown on Sabouraud dextrose agar and incubated at 25°C for 7 days.

3- Testing antibacterial activity of the plant extracts.

The antimicrobial activity of the 20 plant extracts (aqueous extract, methanol extract and chloroform extract), each separately, against nine bacterial strains was done using the method of Grove and Randall, 1955 with some modifications. Filter paper disks with a diameter of 6 mm were punched using a paper punch and soaked in dimethyl sulphoxide solution for sterilization. Disks were then dried and placed in plant extracts (0.1 ml for each disk) and placed on the surface of bacterial pre-inoculated Mueller-Hinton agar in petri dishes. The same concentration of each extract (0.1 ml) was used in testing antibacterial antagonism. The petri dishes were incubated at 37°C for 24 hours, after which the zone of inhibition around each disk was measured in millimeters (mm) using a ruler. Comparison of antibacterial antagonism of plant extracts with standard antibiotics like erythromycin and Remox (Amoxycillin) was also done. These antibiotics were used at a concentration of 40 µg/ml each disk.

4- Testing antifungal activity of the plant extracts.

Filter paper disks were prepared as above and placed on the surface of fungal pre-inoculated Sabourauds dextrose agar in petri dishes. Petri dishes were incubated or preserved at 25°C and observed after 7-10 days. Growth free area (zone of inhibition) around each disk was measured with the help of a ruler in mm. Antifungal activity of the plant extracts was also compared with the activity of standard antifungal like clotrimazole and nystatin (concentration of 40 µg/ml each disk).

III. Results

1- Antibacterial activity of the plant extracts.

The inhibitory activity of aqueous, chloroform and methanol extracts of the plants against different bacterial isolates is shown in Table 2, 3 and 4 respectively. The results indicated that the plant extracts showed antibacterial activities at variable degrees against both Gram positive and Gram negative bacterial isolates tested in this study. The zone of inhibition varied from 1 mm to 22 mm at a concentration of 0.1 ml of the extracts. Extracts of *Ocimum basilicum* (Basil) displayed the highest inhibitory activity (zone of inhibition ranging from 12 to 22 mm), while as extracts of *Ficus carica* (Figs) and *Pandanus tectorius* (Kadi) showed the lowest inhibitory activity (zone of inhibition ranging from 1 to 14 mm). *Ocimum basilicum* extracts showed the highest inhibitory against Gram negative bacilli, *E. coli* and *Pseudomonas aeruginosa*. All other plant extracts were almost equally effective against both Gram positive and Gram negative bacteria. Amoxycillin (Remox) and erythromycin used as the reference antibiotics, each at a concentration of 40 µg/ml, showed variable inhibitory activity on different bacterial isolates with a zone of inhibition for amoxicillin ranging from 12 to 19 mm and for

erythromycin from 15 to 23 mm (Table 6). The growth inhibitory activities of some of the plant extracts against the bacterial isolates were equivalent to those obtained with these reference antibiotics.

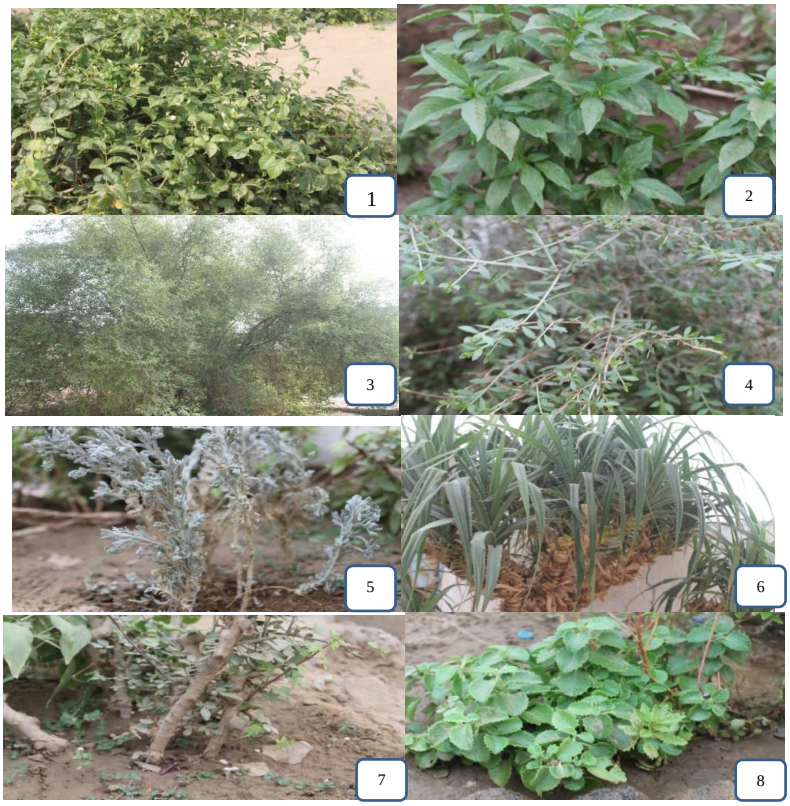

Fig. 1: Examples of some of the plants (Scientific names) in Jazan region.(1) *Jasminum sambac*; (2) *Ocimum basilicum;* (3) *Ziziphus nummularia*; (4) *Lawsonia inermis*; (5) *Artemisia absinthium*; (6) *Pandanus tectorius*;(7) *Salvador persica*; (8) *Coleus forskohlii*.

Table 1: Common and scientific names of medicinal and aromatic plants, their families and medicinal use.

Common Name	Scientific Name	Plant family	Medicinal use (Mitchell and Bastyr, 2003; Lai and Roy, 2004; Carrubba and Scalenghe, 2012)
Sidra	*Ziziphus nummularia*	Rhamnaeae	- Useful in cases of chest and respiratory diseases - Antiseptic for body - Cleaning and disinfection of the scalp - Dealing with fungal head - Boil the leaves in water and drink to kill the worms - Blood Purification - Anti-diarrheal - Expelling sputum
Coleus	*Plectranthus amboinicus*	Lamiaceae	- Treatment for ear pains - Treatment of digestion problems - Strong medicine for various ailments including heart failure, chronic inflammation and asthma
Ginger	*Zingiber officinale*	Zingiberaceae	- Treatment for sore throat and cold, stomach pain - Solvent for excess body fats - Repelling gas and winds - Expelling sputum - Tonic for the circulation
Anise	*Pimpinella anisum*	Apiaceae	- Treatment for intestinal colic in infants children and adults. - Tonic for digestion and diuretic - Handy for the birth process and milk production - Tranquilizer - Expelling sputum
Fenugreek	*Trigonella foenum-graecum*	leguminosae	- Analgesic and cough, heat and asthma suppressant - Treatment of fractures - Diuretic during menstruation - Expelling of viscous phlegm in the chest and stomach. - Used as an appetite suppressant

Table 1: Continued,

Cresson	*Lepidium sativum*	CtuciFerae	- Treatment of eye infections, chest infections - Aperitif - Diuretic - Reducing blood pressure and for strengthening nerves - Combat Cancer - Useful in skin diseases
Salvia	*Salvia officnalis*	Lamiaceae	- Treatment of sore throat - Treatment of menstrual disorders - Strengthening nerves
Chamomile	*Matricaria recutita*	Lamiaceae	- Analgesic - Used to treat colds, diarrhea, eczema - Benefit in the treatment of all types of pain in body convulsions - Powdered flowers used for treatment of skin infections and wounds and sores in the mouth
Caraway	*Carum carvi*	Umbelliferae	- Reduction of goiter, pain of colic - Repelling gas - Helps relaxation of the muscles of the stomach and intestines - Used as an adjunct in the treatment of gastric and duodenal ulcers and in treatment of inflammatory bowel ulcer - Frequent use of boiled caraway prevents transformation of normal cells into cancer cells
Black Cumin	*Nigeria Sativa*	Ranunculacea e	- Hair loss treatment - Treatment of cough, heart burn, skin problems, diarrhea - Increasing mother's milk production during lactation - Getting rid of gallstones in a natural way -Treatment of insomnia
Myrrah	*Commiphora Molmol*	Commiphora	- Used in colic pain, skin infections, sore throats and colds
Sweet Marjoram	*Origanum majorana*	Lamiaceae	- Helps to balance hormones - Antiseptic, Hypotensive and hypnotic - Relieves cough and cold and cramps, pain in liver, gallbladder -Works on the activity of the thyroid glands
Cinnamon	*Cinnamomum Zeylanicum*	Lauraceae	- Analgesic for colic pain - Effect on menstrual cycle in women
Figs	*Ficus carica*	Moraceae	- Soothing and removes blackheads - Eliminates the effects of colds and flu on the nose and throat -Used in dental abscesses and infections of the gums and mouth tumors -Handles circulation and diseases of the veins especially hemorrhoids - For breaking gravel and sand in urine -Treats skin diseases such as vitiligo
Basil	*Ocimum basilicum*	Lamiaceae	- Bowel cleansing - Acne Treatment
Henna	*Lawsonia inermis*	Lythraceae	- Used in headache
Harmal	*Rhazia stricta Dcne*	Apocynaceae	- Helps in the treatment of arthritic pain
Sewak Arak	*Salvadora persica*	Salvadoraceae	- Stops the growth of bacteria in mouth - Strengthen the capillaries feeding the gums - Increase the whiteness of teeth - The fruits strengthens the stomach and improves digestion - Useful for back pain -Kills various types of bacteria in the gut
Kadi	*Pandanus tectorius*	Pandanaceae	- Leaves are used for prevention of diseases and toxins and providing vitamins to men for sexual vigor - Useful for the treatment of dysuria. -Oil is anti-colic and also used to treat headaches, rheumatism - Oil is used in perfume.
Arabian Jasmine	*Jasminum sambac*	Oleaceae	- Oil is often described as a natural remedy to get rid of stress, concern, depression, fatigue, menstrual cramps, menopausal symptoms. - Used as tonic to increase sexual vigor.

Table 2: Antibacterial activity of Aqueous extracts of medicinal plants from Jazan region (*In vitro*).

Medicinal & Aromatic plants	Zone of inhibition (mm) Aqueous extracts								
	Staphylococcus aureus	Staphylococcus epidermidis	Streptococcus agalactiae	Streptococcus pyogenes	Bacillus cereus	Escherichia coli	Pseudomonas aeruginosa	Klebsiella pneumonia	Klebsiella oxytoca
Ziziphus nummularia	19.00	12.00	18.00	14.00	16.00	16.00	17.00	13.00	15.00
Plectranthus amboinicus	9.00	11.00	9.00	12.00	14.00	13.00	6.00	11.00	13.00
Zingiber officinale	16.00	15.00	13.00	11.00	17.00	18.00	14.00	16.00	14.00
Pimpinella anisum	12.00	14.00	14.00	15.00	14.00	16.00	13.00	13.00	10.00
Trigonella foenum graecum	8.00	8.00	11.00	14.00	8.00	9.00	7.00	9.00	10.00
Lepidium sativum	7.00	10.00	9.00	10.00	11.00	8.00	8.00	8.00	9.00
Salvia officnalis	13.00	13.00	10.00	11.00	10.00	12.00	11.00	9.00	13.00
Matricaria recutita	18.00	19.00	17.00	15.00	16.00	19.00	18.00	16.00	14.00
Carum carvi	12.00	12.00	10.00	13.00	11.00	11.00	10.00	11.00	13.00
Nigeria Sativa	17.00	14.00	18.00	14.00	17.00	19.00	16.00	12.00	16.00
Commiphora Molmol	12.00	13.00	18.00	11.00	9.00	12.00	13.00	11.00	12.00
Origanum majorana	14.00	16.00	19.00	12.00	18.00	19.00	18.00	12.00	13.00
Cinnamomum Zeylanicum	11.00	13.00	11.00	13.00	10.00	14.00	16.00	10.00	12.00
Ficus carica	12.00	8.00	9.00	11.00	9.00	5.00	2.00	2.00	6.00
Ocimum basilicum	16.00	16.00	14.00	14.00	17.00	21.00	22.00	18.00	16.00
Lawsonia inermis	15.00	18.00	13.00	14.00	15.00	15.00	14.00	14.00	12.00
Rhazia stricta Dcne	10.00	12.00	11.00	9.00	12.00	11.00	11.00	9.00	8.00
Salvadora persica	14.00	14.00	13.00	12.00	13.00	11.00	15.00	12.00	11.00
Pandanus tectorius	9.00	11.00	10.00	8.00	7.00	6.00	2.00	5.00	4.00
Jasminum sambac	11.00	13.00	14.00	10.00	11.00	11.00	10.00	4.00	6.00

The concentration used (0.1 ml), Each value is a mean of five replicates, mm - millimeter

Table 3: Antibacterial activity of Chloroform extracts of medicinal plants from Jazan region (*In vitro*).

Medicinal & Aromatic plants	Zone of inhibition (mm) Chloroform extracts								
	Staphylococcus aureus	Staphylococcus epidermidis	Streptococcus agalactiae	Streptococcus pyogenes	Bacillus cereus	Escherichia coli	Pseudomonas aeruginosa	Klebsiella pneumonia	Klebsiella oxytoca
Ziziphus nummularia	20.00	13.00	16.00	13.00	17.00	13.00	15.00	14.00	11.00
Plectranthus amboinicus	14.00	12.00	12.00	13.00	10.00	11.00	9.00	10.00	9.00
Zingiber officinale	14.00	13.00	14.00	12.00	16.00	17.00	12.00	15.00	10.00
Pimpinella anisum	12.00	16.00	13.00	13.00	15.00	14.00	16.00	14.00	12.00
Trigonella foenum graecum	12.00	14.00	12.00	11.00	10.00	12.00	14.00	13.00	12.00
Lepidium sativum	11.00	12.00	9.00	14.00	13.00	8.00	10.00	12.00	13.00
Salvia officnalis	15.00	16.00	12.00	11.00	11.00	13.00	14.00	12.00	10.00
Matricaria recutita	20.00	19.00	18.00	14.00	15.00	17.00	19.00	15.00	15.00
Carum carvi	15.00	14.00	13.00	13.00	14.00	15.00	13.00	12.00	15.00
Nigeria Sativa	17.00	15.00	16.00	15.00	18.00	15.00	14.00	14.00	12.00
Commiphora Molmol	11.00	10.00	19.00	14.00	12.00	11.00	12.00	14.00	14.00
Origanum majorana	17.00	18.00	17.00	14.00	16.00	16.00	17.00	15.00	11.00
Cinnamomum Zeylanicum	16.00	15.00	13.00	13.00	12.00	12.00	18.00	14.00	14.00
Ficus carica	12.00	13.00	12.00	14.00	13.00	9.00	5.00	5.00	5.00
Ocimum basilicum	16.00	18.00	15.00	14.00	16.00	19.00	22.00	17.00	12.00
Lawsonia inermis	16.00	19.00	15.00	15.00	13.00	16.00	15.00	16.00	14.00
Rhazia stricta Dcne	13.00	13.00	14.00	9.00	11.00	13.00	14.00	9.00	10.00
Salvadora persica	16.00	14.00	15.00	11.00	14.00	13.00	14.00	14.00	13.00
Pandanus tectorius	13.00	10.00	10.00	8.00	8.00	5.00	3.00	4.00	3.00
Jasminum sambac	16.00	12.00	18.00	10.00	14.00	13.00	12.00	8.00	8.00

Concentration used (0.1 ml), Each value is a mean of five replicates, mm - millimeters

2- Antifungal activity of the plant extracts

The antifungal activity of the plant extracts was studied against four pathogenic fungal strains namely *Candida albicans*, *Aspergillus flavus*, *Aspergillus fumigatus* and *Aspergillus niger*. Antifungal potential of the extracts was also assessed in terms of zone of inhibition of fungal growth and the results are presented in Table 5. *Pandanus tectorius* (Kadi) extracts showed highest antifungal activity with zones of inhibition ranging from 8 to 20 mm, while as Rhazia stricta Dcne (Harmal) depicted lowest activity with zones from 2 to 8 mm. Antifungal activity of the majority of the plant extracts was relatively comparable (inhibition zones ranging from 5 to 13 mm at the concentration of 0.1 ml. Although, when compared with standard antifungal drugs as clotrimazole and nystatin (inhibition zones ranging from 18 to 23 mm at the concentration of 40 µg/ml; Table 6), the sensitivity of the fungal isolates to the plant extracts showed a decreasing trend which may increase with increasing their concentration.

Table 4: Antibacterial activity of Methanol extracts of medicinal plants from Jazan region (*In vitro*).

Medicinal & Aromatic plants	Zone of inhibition (mm)								
	Methanol extracts								
	Staphylococcus aureus	Staphylococcus epidermidis	Streptococcus agalactiae	Streptococcus pyogenes	Bacillus cereus	Escherichia coli	Pseudomonas aeruginosa	Klebsiella pneumonia	Klebsiella oxytoca
Ziziphus nummularia	16.00	12.00	16.00	13.00	16.00	14.00	14.00	10.00	11.00
Plectranthus amboinicus	10.00	10.00	8.00	10.00	12.00	11.00	4.00	11.00	10.00
Zingiber officinale	13.00	13.00	11.00	10.00	13.00	14.00	14.00	14.00	12.00
Pimpinella anisum	14.00	12.00	11.00	12.00	12.00	15.00	11.00	11.00	8.00
Trigonella foenum graecum	9.00	8.00	10.00	11.00	9.00	8.00	9.00	10.00	9.00
Lepidium sativum	7.00	11.00	10.00	8.00	10.00	6.00	7.00	7.00	8.00
Salvia officnalis	11.00	10.00	8.00	10.00	8.00	10.00	9.00	10.00	10.00
Matricaria recutita	19.00	17.00	16.00	13.00	14.00	16.00	14.00	12.00	10.00
Carum carvi	10.00	11.00	9.00	14.00	12.00	12.00	10.00	10.00	10.00
Nigeria Sativa	14.00	12.00	16.00	15.00	18.00	16.00	15.00	13.00	14.00
Commiphora Molmol	11.00	11.00	16.00	12.00	10.00	10.00	11.00	10.00	10.00
Origanum majorana	12.00	17.00	17.00	10.00	13.00	20.00	16.00	10.00	9.00
Cinnamomum Zeylanicum	9.00	11.00	10.00	11.00	8.00	12.00	14.00	8.00	9.00
Ficus carica	13.00	9.00	8.00	11.00	9.00	3.00	2.00	1.00	4.00
Ocimum basilicum	17.00	14.00	12.00	12.00	15.00	22.00	20.00	16.00	13.00
Lawsonia inermis	14.00	15.00	11.00	12.00	16.00	13.00	11.00	10.00	10.00
Rhazia stricta Dcne	8.00	11.00	11.00	9.00	10.00	11.00	10.00	8.00	8.00
Salvadora persica	12.00	14.00	11.00	10.00	11.00	10.00	14.00	12.00	10.00
Pandanus tectorius	7.00	10.00	10.00	8.00	6.00	6.00	3.00	3.00	2.00
Jasminum sambac	10.00	11.00	12.00	8.00	8.00	10.00	8.00	3.00	5.00

Concentration used (0.1 ml), Each value is a mean of five replicates, mm – millimeters.

Table 5: Antifungal activity of medicinal plants from Jazan region (*In vitro*).

Medicinal & Aromatic plants	Zone of inhibition (mm)											
	Aqueous extracts				Chloroform extracts				Methanol extracts			
	Candida albicans	Aspergillus flavus	Aspergillus fumigatus	Aspergillus niger	Candida albicans	Aspergillus flavus	Aspergillus fumigatus	Aspergillus niger	Candida albicans	Aspergillus flavus	Aspergillus fumigatus	Aspergillus niger
Ziziphus nummularia	8.00	7.00	5.00	9.00	4.00	7.00	7.00	8.00	12.00	11.00	9.00	11.00
Plectranthus amboinicus	6.00	5.00	8.00	9.00	7.00	7.00	8.00	10.00	9.00	8.00	10.00	8.00
Zingiber officinale	12.00	9.00	10.00	10.00	6.00	7.00	11.00	9.00	11.00	10.00	10.00	9.00
Pimpinella anisum	7.00	8.00	8.00	11.00	12.00	9.00	10.00	13.00	11.00	8.00	8.00	7.00
Trigonella foenum graecum	11.00	9.00	7.00	13.00	9.00	10.00	12.00	11.00	13.00	12.00	12.00	9.00
Lepidium sativum	7.00	6.00	4.00	8.00	8.00	7.00	6.00	10.00	7.00	10.00	9.00	11.00
Salvia officnalis	10.00	8.00	6.00	9.00	11.00	8.00	8.00	7.00	9.00	9.00	10.00	9.00
Matricaria recutita	12.00	10.00	9.00	10.00	13.00	11.00	10.00	10.00	11.00	9.00	7.00	11.00
Carum carvi	8.00	9.00	6.00	6.00	6.00	6.00	7.00	9.00	10.00	9.00	8.00	9.00
Nigeria Sativa	10.00	11.00	11.00	10.00	10.00	10.00	8.00	9.00	6.00	7.00	7.00	6.00
Commiphora Molmol	8.00	8.00	9.00	11.00	11.00	9.00	10.00	13.00	8.00	7.00	7.00	9.00
Origanum majorana	10.00	6.00	8.00	8.00	12.00	13.00	9.00	8.00	14.00	14.00	10.00	11.00
Cinnamomum Zeylanicum	9.00	9.00	8.00	9.00	7.00	6.00	9.00	5.00	10.00	11.00	7.00	6.00
Ficus carica	8.00	6.00	10.00	7.00	9.00	8.00	9.00	8.00	9.00	7.00	9.00	9.00
Ocimum basilicum	11.00	9.00	13.00	9.00	11.00	10.00	14.00	11.00	9.00	7.00	10.00	6.00
Lawsonia inermis	12.00	8.00	9.00	6.00	12.00	8.00	8.00	8.00	13.00	9.00	9.00	7.00
Rhazia stricta Dcne	7.00	5.00	4.00	2.00	7.00	5.00	5.00	4.00	8.00	7.00	6.00	6.00
Salvadora persica	9.00	8.00	11.00	10.00	10.00	9.00	11.00	10.00	7.00	7.00	9.00	8.00
Pandanus tectorius	13.00	20.00	14.00	14.00	12.00	15.00	12.00	13.00	11.00	11.00	9.00	8.00
Jasminum sambac	9.00	7.00	7.00	5.00	8.00	11.00	7.00	7.00	8.00	10.00	9.00	6.00

Concentration used (0.1 ml), Each value is a mean of five replicates, mm – millimeters.

Table 6: Antagonistic effect of some of the standard antibiotics on bacterial and fungal growth (*In vitro*).

Antibiotics/ Antifungals	Zone of inhibition (mm)												
	Bacterial Strains									Fungal Strains			
	Staphylococcus aureus	Staphylococcus epidermidis	Streptococcus agalactiae	Streptococcus pyogenes	Bacillus cereus	Escherichia coli	Pseudomonas aeruginosa	Klebsiella pneumonia	Klebsiella oxytoca	Candida albicans	Aspergillus flavus	Aspergillus fumigatus	Aspergillus niger
Remox	14.00	15.00	17.00	16.00	19.00	14.00	18.00	13.00	12.00	-	-	-	-
Erythromycin	20.00	19.00	18.00	21.00	23.00	19.00	16.00	15.00	17.00	-	-	-	-
Clotrimaxole	-	-	-	-	-	-	-	-	-	19.00	23.00	20.00	18.00
Nystatin	-	-	-	-	-	-	-	-	-	20.00	21.00	18.00	21.00

(-) - Not tested, Concentration used 40 µg/ml, Each value is a mean of five replicates, mm – millimeters.

IV. Discussion

In this study, we studied the antimicrobial activity of aqueous, chloroform and methanol extracts of twenty medicinal and aromatic plants of Jazan region of Saudi Arabia against nine different bacterial isolates from clinical morbidity and also against four fungal pathogens. Most of the plant extracts tested in this study displayed high antibacterial activity comparable to the activity of standard antibiotics like amoxicillin and erythromycin. Although, the antifungal activity of the plant extracts was not comparable to the activity of standard antifungals like clotrimazole and nystatin but was still promising and may be increased by increasing their concentration or isolating and using their effective active compounds. We observed variability in antimicrobial activity between different plant extracts which could be because of the presence of different chemical compounds present in these plants. Among others, the antimicrobial properties of plants have also been attributed to their secondary metabolites (Cowan, 1999; Noumedem et al., 2013).

Researchers and practitioners from all over the world are increasingly reporting antimicrobial properties of medicinal plants. Plant extracts or their active constituents use in traditional therapies for treatment of various diseases by majority (~80%) of the world's population (WHO, 1993). Therefore, medicinal plants are being looked upon as an excellent alternative to combat the spread of emerging drug resistant pathogens in hospitals and homes. A few studies from Saudi Arabia have also reported the antimicrobial activity of some of the indigenous plants (Al-Taweel et al., 2004; El-Deeb et al., 2004; Saadabi et al., 2006; Abdel-Sattar et al., 2008; Al-Juraifani, 2011; Masoud and Gouda, 2012; Alamri and Moustafa, 2012) against various microbial pathogens. The current study is different in that we have studied the activity of a vast collection of medicinal and aromatic plants found and used in the Jazan region of Saudi Arabia against bacterial isolates from clinical morbidity and common fungal pathogens. Although our study lacks in the phytochemical analysis of the plant extracts, however, their significant antibacterial and antifungal activity indicates the presence of highly effective and biologically active constituents that can be of the valuable therapeutic index. Also, the spectrum of their antimicrobial activity may be large which needs to be studied further.

V. Conclusion

This study justifies the use of these medicinal and aromatic plants in folklore medicine for treatment of various infectious diseases. However, further studies aiming to investigate the potential effectiveness of biologically active components, isolated from the crude extracts of these plants, against a wide variety of clinical pathogens prevalent in Kingdom of Saudi Arabia is needed. The results of this study will help in selection of plant species for further investigations intended for potential discovery of new natural bioactive compounds against various microbes including their multi-drug resistant strains.

Note: Paper submitted at the 3rd International Conference on Food, Ecological and Life Sciences (FELS-2016) Kuala Lumpur, Malaysia.

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VI. References

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