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THE ANTIBACTERIAL ACTIVITIES OF CERTAIN PLANT EXTRACTS AND ESSENTIAL OILS ON SOME PATHOGENIC BACTERIA

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Abstract

Antibiotics provide the main basis for the thereby of bacterial infections. Drug resistance to human pathogenic bacteria has been noted across the world in recent years. The plant-produced antimicrobial compounds are active toward human pathogenic bacteria as well as plants. Plant extracts are expected to produce target sites better than antibiotics ones. This study is a broad screening of eleven medicinal plant species and four essential oils against six pathogenic bacteria which include *Staphylococcus aureus*, *Staphylococcus epidermis*, *Staphylococcus aureus* MRSA, *Klebsiella pneumonia*, *Acinetobacter baumannii* and *Escherichia coli*. The maximum inhibition in the growth of *S. aureus* was by the essential oil of white musk with 48 mm. Then MRSA and *S. epidermis* had been inhibited by *C. verum* with 45 and 25mm) respectively. Furthermore, gram-negative bacteria *K. pneumonia* was inhibited by *C. verum* with 40mm. Also, *A. baumannii* had been inhibited by *A. sativum* with 38mm and *E. coli* by *C. verum* with inhibition zone 37mm in diameter.

Keywords : Antibacterial activities, Plant extracts, Essential oils.

Introduction

The growth of bacterial resistance to the available antibiotics has boosted the needs for the search for new antimicrobials (Anand *et al.*, 2008). (Jouda *et al.*, 2013) informed that resistant spread with remarkable speed. The world health leaders have described antibiotic-resistant microorganisms as "nightmare bacteria" considered as a catastrophic threat to humankind all over the world. The development of antibiotic resistance is multifactorial, including the specific nature of the relationship of bacteria to antibiotics, the usage of antibacterial against, host characteristics and environmental factors (World Health Organization, 2010)

Acinetobacter baumannii is gram-negative bacteria live in soil and water. Also, they can live in the skin of healthy people, especially in healthcare settings. It can also colonise or live in a patient without causing infection symptoms, especially in tracheostomy sites or open wounds (World Health Organization, 2010)

Staphylococcus aureus MRSA is a gram-positive bacterium this strain is resistant to methicillin and other beta-lactam antibiotics (PubMed health), and contain a capsule around its cell (Sutter *et al.*, 2011). Moreover, CDC noticed that methicillin-resistant MRSA is a type of staph bacteria that is resistant to several antibiotics. Skin infections are often caused by MRSA. For instance, it leads to pneumonia (lung infection) and other issues. If left untreated, MRSA becomes severe and cause sepsis – life-threatening reactions to severe infection in the body (Centers for Disease Control and Prevention (CDC), 2016).

Klebsiella pneumonia is a gram-negative bacteria and contains a capsule around its cell that can cause a different type of healthcare-associated infection, including pneumonia, bloodstream infections, wound or surgical site infections, and meningitis. *Klebsiella* bacteria commonly exists in the human intestine, (where they do not cause diseases). They are also found in human stool. In healthcare settings, the bacteria commonly occurs among sick patients who are receiving treatment for other condition.

Staphylococcus epidermis is a gram-positive bacteria commonly colonisers in the skin and mucous membranes of humans and other mammals. S. *epidirmidis* is the most frequently isolated species from human epithelia. It colonises the axillae, head, and nares predominantly.

Staphylococcus aureus is a gram-positive grows well, either aerobically or under anaerobic conditions and produces good grow which allow the production many different types of disease. The production of capsules around the bacterium helps prevent the phagocytosis by macrophages and leukocytes. The produces hemolysins that can cause the lysis of certain cells. Different strains produce different toxins that can cause a myriad of disease from mild to life-threatening.

Escherichia coli is gram-negative, non-sporing bacilli with most strains being motile and generally possessing both sex pili and adhesive fimbriae. *E. coli* was initially considered a non-harmful member of the colon flora but is now associated with a wide range of diseases and infections including meningeal, gastrointestinal, urinary tract, wound and bacteremia infections in all age groups. *E. coli* may cause intestinal or extraintestinal infections. Generally, extraintestinal *E. coli* are encapsulated. The capsules are important virulence determinants, which enable the pathogenic bacteria to evade or counteract the unspecific host defence during the early (preimmune) phase of infection. They interfere with the action of complement and phagocytes.

The spread of resistant bacteria has forced scientists to search for new antimicrobial substances from various sources as novel antimicrobial chemotherapeutic agents, but the cost production of synthetic drugs is high and they produce diverse effects compared to plant-derived drugs (Jouda *et al.*, 2013)

Plant as a source of medicinal compounds has continued to play a dominant role in the maintenance of human health since ancient times. According to the world health organisation, plant extracts or their active constituents which are used as folk medicine in traditional therapies of 80% of the world drugs, are of natural product origin.

Ginger scientifically known as *Zingiber officinale* Roscoe, belonging to family Zingiberaceae is one of the most important plants with several medicinal, nutritional and ethnomedical values, therefore, used extensively worldwide as a spice, flavouring agent and herbal remedy.

Frankincense resin is obtained from trees of the genus Boswellia (family Burseraceae). Incisions are made in the trunks of the trees to produce exuded gum, The aroma from these resins is valued for its presumed healing properties and superior qualities for religious rituals since the time of the ancient Egyptians and has been used in incense, fumigants, and as a fixative in perfumes been used for the treatment of rheumatoid arthritis and other inflammatory diseases such as Crohn's disease in traditional medicine of many countries(Frank *et al.*, 2009)

Myrrh is a resinous exudate obtained from the tree *Commiphora myrrha* (family Burseraceae) and various other Commiphora species. The genus Commiphora includes over 150 species and is mainly distributed in Eastern Africa, Arabia, and India. It is very well reported to possess medicinal properties and has been used in traditional medicines against a variety of diseases including ulcerative colitis, fever, ailments of the gallbladder, skin infections, dysmenorrhea, amenorrhea, tumours, chest ailments and in burn treatment (Narasimhan & Dhake, 2006).

Cinnamon (*Cinnamomum zeylanicum*), belonging to family Lauraceae, has been utilised as a potential therapeutic agent in various cultures for centuries. Historically, cinnamon bark is among the oldest known spices used against gastrointestinal complaints, chronic bronchitis, and inflammation of eyes in Ayurvedic medicine for over 6000 years. It protects metabolic syndromes, such as cardiovascular complications and diabetes. The determination of the potential antimicrobial activity of *Cinnamomum zeylanicum* extracts could be more information for future use in controlling the pathogenic microbes.

Allium sativum is commonly known as garlic is a member of the Alliaceae family, has been widely recognised as a valuable spice and a popular remedy for various ailments and physiological disorders

Coconut, *Cocos nucifera*, is a tree that is cultivated for its multiple utilities, mainly for its nutritional and medicinal values. The various products of coconut include tender coconut water, copra, coconut oil, raw kernel, coconut cake, coconut toddy, coconut shell and wood-based products, coconut leaves, coir pith etc. It is all parts used in some way or another in the daily life of the people in the traditional coconut growing areas. It is the unique source of various natural products for the development of medicines against various diseases and for the development of industrial products (DebMandal & Mandal, 2011)

The powerful herb Rosemary belongs to the family Lamiaceae that originates from the Mediterranean region. It has been named the Herb of the Year in 2001 by the International Herb Association. Today market demand of the plant is growing, as it is used in several commercially available products. Rosemary is composed of pine-like leaves, which is the heart of all medicinal and other benefits that are derived from the use of its oil (Begum *et al.*, 2013).

The genus *Prunus mahaleb* belongs to the family *Rosaceae* and comprises more than 400 species. *Prunus mahaleb* knew in Arabia as *mahaleb* has been used in folk medicine as atonic for sensory organs and the heart, in the treatment of asthma and relief of pains arising from the liver, kidney, and gastrointestinal troubles (Seyyednejad *et al.*, 2008).

White pepper is one of the value-added forms of black pepper that fetches a high value owing to superior quality and suitability to use in a wide range of food materials and low microbial contaminants. Indonesia is the largest white pepper producing country (Vinod *et al.*, 2014).

Curcuma longa (family Zingiberaceae) is a perennial, erect and leafy pant with huge, lily-like leaves up to 1.2m long. It is harvested from February to April. It is therapeutically used in various diseases such as asthma, amenorrhea, anaemia, ascetic, boils, bruises and catarrh (Ahmed *et al.*, 2010)

Nigella sativa (family Ranunculaceae) commonly known as the black seed, have been used as a food additive or spice for thousands of years, as well as a protective and curative remedy for several disorders. Traditionally, there is a common Islamic belief that black seed is a universal remedy for all ailments, but cannot prevent ageing or death. During the last twenty years, a massive number of studies have been performed on the effect of *N. sativa* seed extracts on various body system in vitro or in vivo. Seed extracts reveal a board spectrum of pharmacological activities, including immunopotentiation and antihistaminic, antidiabetic, antihypertensive, anti-inflammatory and antimicrobial activities (Sultana & Kourakis, 2015).

Musk, a dried prenuptial gland of the male musk deer, is one of the most popular and expensive Chinese drugs that has been utilised for cardiovascular stimulation, anti-inflammation and potentiation of b-adrenergic activity.

Aims

The study aims to evaluate the effect of different plant extracts with their common antibiotics; in order to test them against specific clinical bacteria, which are *Staphylococcus aureus*, *Acinetobacter banmannii*, *Staphylococcus aureus* MASA, *Escherichia coli*, *Staphylococcus epidermis* and *Klebsiella pneumonia*. Additionally, to evaluate the antibacterial activity of white musk, black musk, coconut oil and *Nigella sativa* against the same clinical pathogenic bacteria.

Material and Methods

The tested pathogenic bacterial isolates:

The tested pathogenic bacteria which used in this study were obtained from the laboratory of King Fahad Armed Forces Hospital (KFAFH) and included three gram-positive bacteria which are *Staphylococcus aureus*, *Staphylococcus aureus* MRSA and *Staphylococcus epidirmidis* and three gram-negative bacteria which are *Klebsiella pneumoniae*, *Acinetobacter baumannii* and *Escherichia coli*.

Disk diffusion method:

The susceptibility of all antibiotics was carried out using the disc diffusion method on nutrient agar (CLSI, 2008). The pathogenic bacterial isolates were spread on nutrient agar Petri dishes. Seventeen antibiotics discs were transferred aseptically on the Petri dishes. They were Ceftazidime (CAZ), Aztreonam (ATM), Piperacillin (PRL),

Imipenem (IMI), Ciprofloxacin (CIP), Amikacin (AK), Ampicillin (AP), Augmentin (AUG), Gentamicin (GM), Cefoxitin (FOX), Cephalothin (KF), Cottimoxazole (ST), Fusidic acid (FC), Vancomycin (VA), Cefepime (CPM), Oxacillin (OX), Chloramphenicol (C). All Petri dishes were incubated at 37° C for 24 hours. Then inhibition zones were measured by mm in diameter.

Plant Samples:

The tested plants against the selected pathogenic bacteria were gum of *Commiphora myrrha* and *Boswellia Carterii*, seeds of *Allium sativum*, *Prunus mahaleb* and *Piper nigrum*, roots of *Curcuma longa*, *Cinnamomum verum* and *Zingiber officinale* and leaves of *Piper nigrum*, *Rosmarinus officinalis* and *Frangula alnus*.

Essential oil samples:

Four essential oils, which were tested, were *Nigella sativa*, *Cocos nucifera*, white musk and black musk.

Plant Extractions:

Ten grams of each Plant powder was added to 100 ml of distilled water to prepare aqueous extraction. Ethanol, methanol, petroleum ether and acetone were used as solvent extractions as well for each tested plant. All extractions were left for one day to dissolve completely. Then, all materials were filtered (Whatman no. 1 filter paper) and evaporated at 40C in airtight flasks.

Well diffusion method:

Antibacterial activities of all tested plant extracts and essential oils were tested using well diffusion method as described by Bauer, 1996. Nutrient agar culture Petri dishes were inoculated with the tested pathogenic bacteria. 5 mm holes were made on the agar surface by cork borer. The extracts were poured into these wells using a sterile syringe. All Petri dishes were incubated at 37 °C for 24 h. Then inhibition zones were observed for each extract against each pathogenic bacterium.

Results

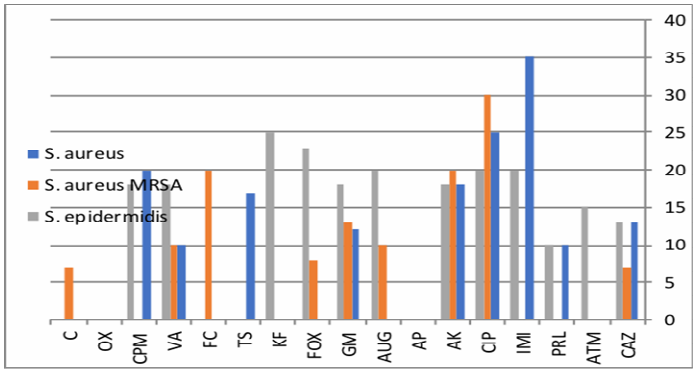

Fig. 1a : Antibacterial activities of some antibiotics against some pathogenic gram-positive bacteria

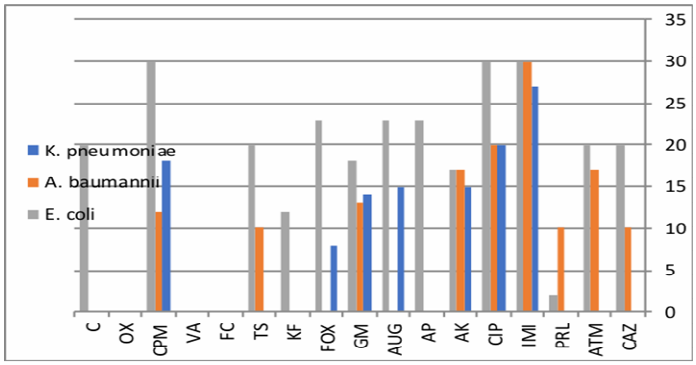

Fig. 1b: Antibacterial activities of some antibiotics against some pathogenic gram-negative bacteria.

Table 2a : Antibacterial activities of some plant extracts against *Staphylococcus aureus*

Plant (Scientific Name)	Extracted Part	Solvent Control	Inhibition Zone (mm) of each solvent extract.				
			Aq	E	M	A	PE
Commiphora myrrha	Gum	0	10	7	8	0	0
Boswellia carterii	Gum	0	10	9	12	9	10
Allium sativum	Seeds	0	27	15	10	11	20
Prunus mahaleb	Seeds	0	0	0	9	9	0
Piper nigrum	Seeds	0	0	12	20	12	13
Curcuma longa	Root	0	0	15	13	14	0
Rosmarinus officinalis	Leaves	0	0	14	17	10	0
Frangula alnus	Leaves	0	5	11	8	11	0
Cinnamomum verum	Roots	0	0	19	0	0	20
Zingiber officinale	Roots	0	0	10	12	13	0
Cinnamomum camphora	Leaves	0	12	15	14	33	30

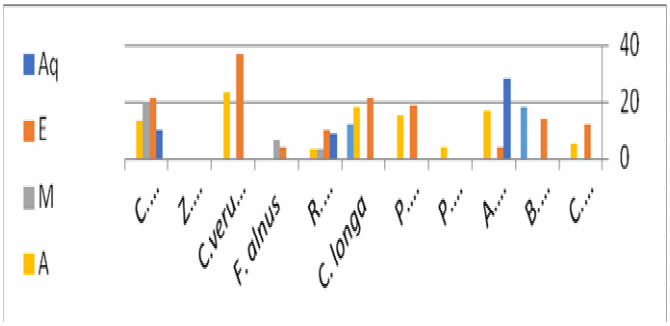

Fig. 2a : Antibacterial activities of some plant extracts against *Staphylococcus aureus*.

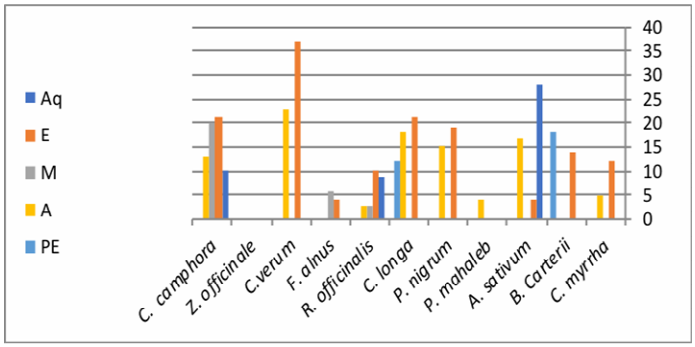

Fig. 2b : Antibacterial activities of some plant extracts against *Staphylococcus epidirmidis*

Table 2b : Antibacterial activities of some plant extracts against S*taphylococcus epidirmidis*

Plant (Scientific Name)	Extracted Part	Solvent Control	Inhibition Zone (mm) of each solvent extract.				
			Aq	E	M	A	PE
Commiphora myrrha	Gum	-	0	12	0	5	0
Boswellia carterii	Gum	-	9	13	21	15	17
Allium sativum	Seeds	-	18	3	0	15	0
Prunus mahaleb	Seeds	-	0	17	12	25	20
Piper nigrum	Seeds	-	3	0	0	19	0
Curcuma longa	Root	-	0	11	10	13	0
Rosmarinus officinalis	Leaves	-	0	18	17	10	12
Frangula alnus	Leaves	-	0	19	23	15	13
Cinnamomum verum	Stem	-	3	3	0	13	14
Zingiber officinale	Roots	-	14	0	0	14	0
Cinnamomum camphora	Leaves	-	19	13	12	11	12

Table 2c : Antibacterial activities of some plant extracts against *Staphylococcus aureus MRSA*

Plant (Scientific Name)	Extracted Part	Solvent Control	Inhibition Zone (mm) of each solvent extract.				
			Aq	E	M	A	PE
Commiphora myrrha	Gum	-	0	11	0	0	22
Boswellia Carterii	Gum	-	9	12	11	16	19
Allium sativum	Seeds	-	21	24	12	3	13
Prunus mahaleb	Seeds	-	0	0	0	3	0
Piper nigrum	Seeds	-	0	0	5	42	26
Curcuma longa	Root	-	0	19	24	22	43
Rosmarinus officinalis	Leaves	-	10	17	19	27	17
Frangula alnus	Leaves	-	10	14	11	3	17
Cinnamomum verum	Roots	-	15	45	19	0	23
Zingiber officinale	Roots	-	16	12	15	14	20
Cinnamomum camphora	Leaves	-	13	13	13	11	13

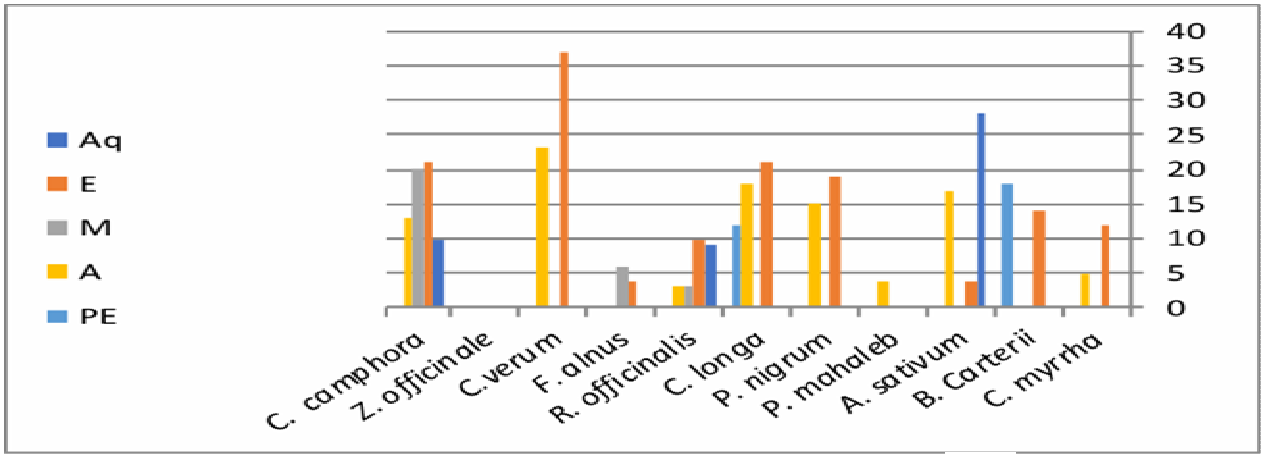

Fig. 2c : Antibacterial activities of some plant extracts against *MRSA*

Table 3a : Antibacterial activities of some plant extracts against *Acinetobacter baumannii*

Plant (Scientific Name)	Extracted Part	Solvent control	Inhibition Zone (mm) of each solvent extract.				
			Aq	E	M	A	PE
Commiphora myrrha	Gum	-	9	0	9	9	5
Boswellia carterii	Gum	-	9	11	10	10	13
Allium sativum	Seeds	-	38	10	13	15	0
Prunus mahaleb	Seeds	-	0	5	0	0	3
Piper nigrum	Seeds	-	5	0	0	0	0
Curcuma longa	Root	-	3	10	9	4	0
Rosmarinus officinalis	Leaves	-	0	15	0	10	0
Frangula alnus	Leaves	-	0	12	4	0	0
Cinnamomum verum	Stem	-	0	27	4	0	0
Zingiber officinale	Roots	-	0	0	0	0	0
Cinnamomum camphora	Leaves	-	13	19	19	26	18

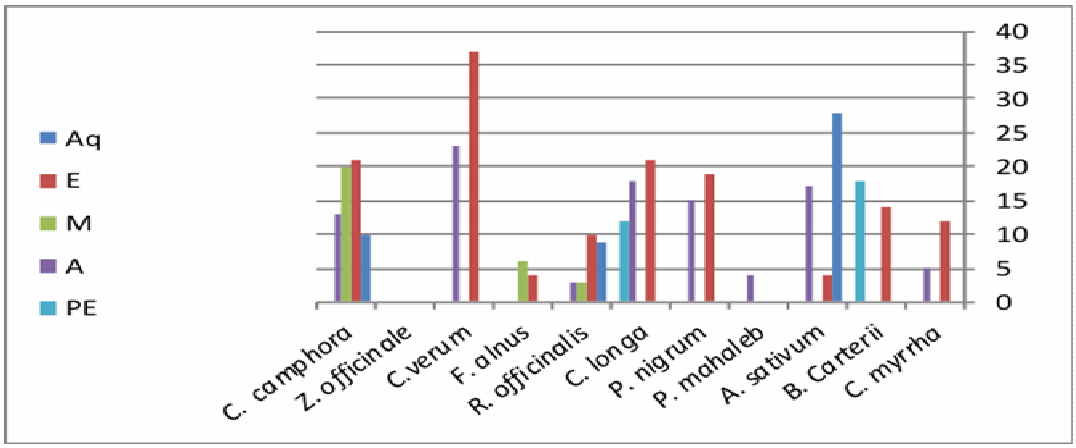

Fig. 3a : Antibacterial activities of some plant extracts against *Acinetobacter baumannii*

Table 3b : Antibacterial activities of some plant extracts against *Klebsiella pneumonia*

Plant (Scientific Name)	Extracted Part	Solvent control	Inhibition Zone (mm) of each solvent extract.				
			Aq	E	M	A	PE
Commiphora myrrha	Gum	-	0	9	0	0	0
Boswellia Carterii	Gum	-	9	0	0	0	13
Allium sativum	Seeds	-	16	0	12	16	0
Prunus mahaleb	Seeds	-	0	0	0	0	0
Piper nigrum	Seeds	-	0	17	0	0	0
Curcuma longa	Root	-	0	0	0	0	0
Rosmarinus officinalis	Leaves	-	0	0	0	9	0
Frangula alnus	Leaves	-	7	0	0	11	0
Cinnamomum verum	Roots	-	0	40	0	0	14
Zingiber officinale	Roots	-	0	10	0	0	0
Cinnamomum camphora	Leaves	-	0	10	11	10	0

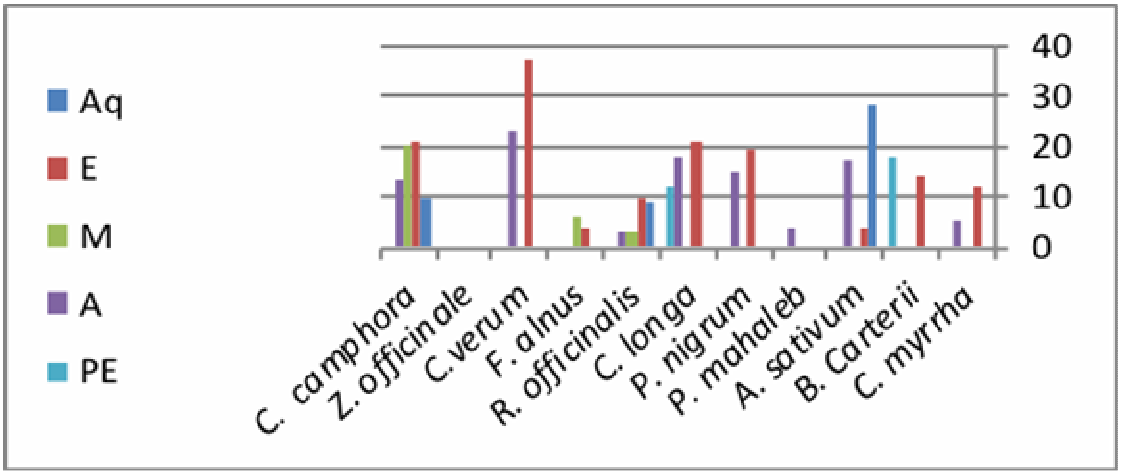

Fig. 3b : Antibacterial activities of some plant extracts against *Klebsiella pneumonia*

Table 3c : Antibacterial activities of some plant extracts against *Escherichia coli*

Plant (Scientific Name)	Extracted Part	Solvent control	Inhibition Zone (mm) of each solvent extract.				
			Aq	E	M	A	PE
Commiphora myrrha	Gum	-	0	12	0	5	0
Boswellia Carterii	Gum	-	0	14	0	0	18
Allium sativum	Seeds	-	28	4	0	17	0
Prunus mahaleb	Seeds	-	0	0	0	4	0
Piper nigrum	Seeds	-	0	19	0	15	0
Curcuma longa	Root	-	0	21	0	18	12
Rosmarinus officinalis	Leaves	-	9	10	3	3	0
Frangula alnus	Leaves	-	0	4	6	0	0
Cinnamomum verum	Stem	-	0	37	0	23	0
Zingiber officinale	Roots	-	0	0	0	0	0
Cinnamomum camphora	Leaves	-	10	21	20	13	0

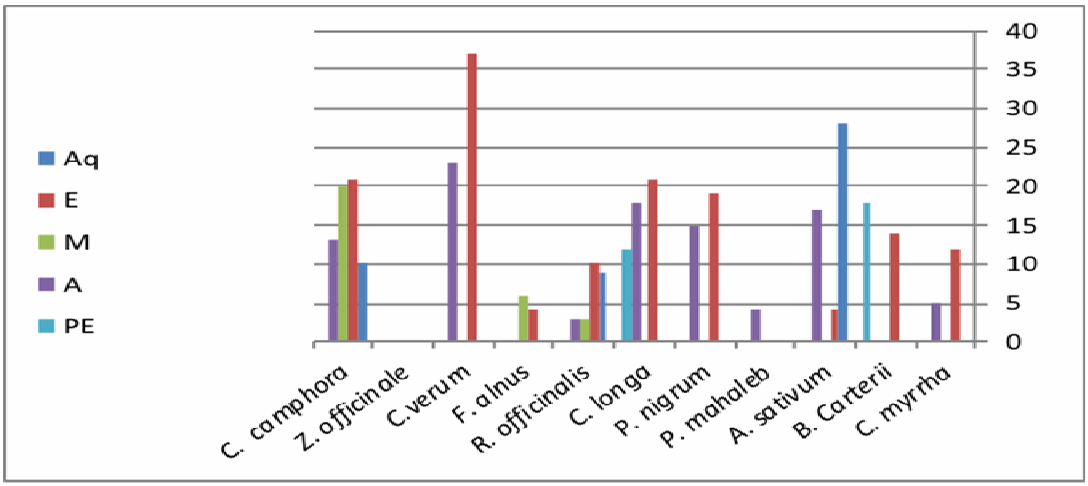

Fig. 3c : Antibacterial activities of some plant extracts against *Escherichia coli*

Table 4 : Antibacterial activities of some Essential oils against some clinical pathogenic bacteria

Inhibition Zone (mm)				Bacterial Isolate
Black musk	**White Musk**	***Cocos nucifera***	***Nigella sativa***	
0	23	0	0	***E. Coli***
3	18	0	18	***MRSA***
17	48	0	10	***S. aureus***
13	22	0	0	***A. baumannii***
0	23	0	0	***K. pneumonia***
11	14	0	22	***S. epidirmidis***

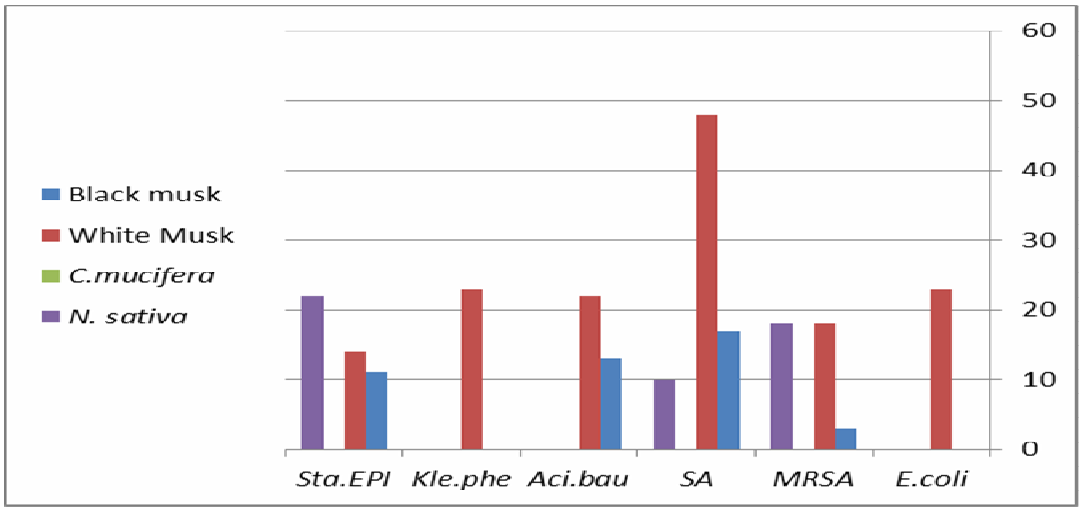

Fig. 4 : Antibacterial activities of some Essential oils against some clinical pathogenic bacteria

Fig. (1a) shows the antibacterial activities of seventeen antibiotic drugs against three pathogenic gram-positive bacteria; which are *Staphylococcus aureus, Staphylococcus epidirmidis*, and *Staphylococcus aureus* MRSA. The pick sensitive of *Staphylococcus aureus* by IMI with of inhibition zone 35 mm. Then *Staphylococcus aureus* MRSA by CIP with 30 mm of inhibition zone while the highest inhibition zone for *Staphylococcus epidirmidis* had majored by KF with 25 mm.

The results indicated in figure (1b) shows the efficiency of seventeen antibiotic drugs against some gram-negative bacteria. IMI had the highest inhibition effect on the growth of *K. pneumoniae* and *A. baumannii*, whereas the best inhibition zone by 30 mm for *E. coli* was caused by three antibiotics which are IMI, CIP and CPM. Nevertheless, the antibiotic drugs FC, VA and OX did not affect the tested pathogenic bacteria.

The analysis of aqueous, Methanol, Ethanol, Acetone, Petroleum Ether plant extracts had various effects against gram-positive bacteria, were screened for their antibacterial activity using the disc diffusion test. Then, the results which presented in Table (2a) and Fig. (2a) showed a significant level of inhibition against *S. aureus* by petroleum ether extract of *C. camphora* and aqueous extract of *A. sativum* with inhibition zones 30 and 27 mm respectively.

However, the aqueous extracts of all tested extracts of plants had no or weak inhibition impact on the growth of *Staphylococcus epidirmidis* except *Allium sativum*, *Cinnamomum camphora* and *Zingiber officinale* with inhibition zones 18, 14 and 19 respectively which illustrated in table (2b) and Fig. (2b). The elevated inhibition zone was caused by acetone extract of *Prunus mahale* with 25 mm. Methanol Extract of *Frangula alnus* had a close effect with 23 mm.

Table (2c) and Fig. (2c) indicates the antibacterial activities of the plant extracts against methicillin-resistant *Staphylococcus aureus* MRSA. Ethanol extract of *Cinnamomum verum*, petroleum ether extract of *Curcuma longa* and Acetone extract of *Piper nigrum* had summit impact against MRSA with inhibition zones 45, 43 and 42 mm respectively. On the other hand, all the extracts of *Cinnamomum camphora*, *Frangula Alnus* and *Prunus mahaleb* had weak activities against MRSA with inhibition zones between 0 and 17 mm.

Acinetobacter baumannii is known as a multidrug-resistant (MDR) strain. That fact indicates in table (3a) and fig. (3a) due to the remarkable resistance of *A. baumannii* against numerous plant extracts. *Zingiber officinale* had no activity by all its extracts against *A. baumannii.* Moreover, *Piper nigrum, Prunus mahaleb, Commiphora myrrha, Curcuma longa, Frangula Alnus* and *Boswellia carterii* had relatively low antibacterial activities against *A. baumannii* with inhibition zones between 0 and 12 mm. Nevertheless, the maximum inhibition was observed by aqueous extract of *Allium sativum* with inhibition zone 38 mm. Ten gradually the inhibition zone decreased to 27 and 26 mm with ethanol extract of *Cinnamomum verum* and acetone extract of *Cinnamomum camphora* respectively.

Furthermore, the demonstrated results in table (3b) and fig. (3b) show that *Klebsiella pneumonia* is high resistant bacteria towards some tested plant extracts. The peak inhibition zone was 40 mm caused by ethanol extract of *Cinnamomum verum*. Unfortunately, the inhibition zone rapidly decreased to 17 mm by ethanol extract of *Piper nigrum.* Then followed by 16 mm by aqueous extract and acetone extract of *Allium sativum*. Also, *Commiphora myrrha, Prunus mahaleb, Curcuma longa, Rosmarinus officinalis* and *Zingiber officinale* had no or weak antibacterial activities against *K. pneumonia*.

Results of the inhibition zone values against *Escherichia coli* exhibited in table (3c) and fig. (3c). Even though the ethanol extract of *Cinnamomum verum* had the highest antibacterial activity by 37 mm and the inhibition zone declined to 28 mm by using aqueous extract of *Allium sativum*, but some other tested plant extracts had shown no activity against *E. coli* such as *Zingiber officinale* or low antibacterial activities, which had been posted by *Frangula Alnus, Rosmarinus officinalis, Prunus mahaleb* and *Commiphora myrrha* with inhibition zones between 0 and 12 mm.

Finally, Table (4) and Fig. 4 reveal the wide range of antibacterial activity of the essential oil of white musk comparing to other tested essential oils that were used in that experiment. The essential oil of *Cocos nucifera* had entirely no antibacterial activities against all the tested pathogenic bacteria, While the essential oil of black musk had low inhibition activities with inhibition zones between o and 17 mm. Even though the essential oil of *Nigella sativa* had no antibacterial activities against *E. coli*, *A. baumannii* and *K. pneumonia*, but it had suitable inhibition activities against both of MRSA and *S. epidirmidis* by 18 and 25 mm, respectively.

Discussion

The bacterial activity of the plant solvent extracts showed a variety of antibacterial activities of controlling the inhibition. Medicinal plants could be a novel approach; since most of them are safe with a slight side effect, cost less and affect a wide range of antibiotic-resistant microorganisms. Another study has reported that gram-positive bacteria was found to be more susceptible than gram-negative bacteria. In this study, the results of gram-positive bacteria, White Musk pick inhibition effect against *S. aureus* (48mm). These results were occurred based on the chemical components of the white musk; since musk consists of musk xylene, musk ambrette and musk ketone.

On the other hand, the *C. verum* showed the most potent antibacterial activity in vitro against MRSA (45mm) in diameter, and the inhibition effect of *S. epidirmidis* appeared clearly with *N. sativa*, similar to (Abu-Al-Basal & Yasseen, 2009)with (25mm) inhibition zone.

However, in gram-negative bacteria *K. pneumonia* the widest range of inhibition zone was with (40 mm) of *C. verum* extract that was similar to the study in (Al-Mariri & Safi, 2014) and in E. coli the biggest inhibition zone (37 mm) with ethanol extract of *C. verum* that was similar to the study in (Park & Kwak, 2017). *A. sativum* can be used as an anti – Acinetobacter; because it had shown the maximum inhibition by 38 mm in diameter (Choobineh *et al.*, 2007).

Recommendation

This study showed a high level of inhibition activities of some plant extracts', which are *Allium sativum, Piper nigrum, Curcuma longa, Cinnamomum verum, Zingiber officinale* and *Cinnamomum camphora.* Likewise, the essential oil of white musk had shown high antibacterial activities against the tested pathogenic bacteria.

Therefore, further studies should be performed on the tested plants against other pathogenic bacteria; since it could have other antibacterial activities against other pathogenic bacteria.

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