International Journal of Academic Health and Medical Research (IJAHMR)
ISSN: 2643-9824
Vol. 3 Issue 10, October – 2019, Pages: 36-39

Comparison of the Antibacterial Activity of Selected Plants Oils and Extracts

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Abstract: *The antibacterial effects in vitro were evaluated from selected plants oils and aqueous extracts. Different concentrations are used on three bacterial strains: Staphylococcus aureus, Escherichia coli and Pseudomonas aeruginosa. Screening for the antibacterial activity among the oils, only cinnamon and cloves oils possess strong activity, and the inhibitory power seems to be proportional to the concentration. All the bacterial isolates were susceptible to both plant oil and extract of clove, and only for the oil of cinnamon. We noted that E. coli seems to be more sensitive among other strains to the effect of the cinnamon oil with the highest inhibition zone of 30 mm. Clove oil and extract seemed to have similar antibacterial effect against the three tested bacteria.*

Keywords: Antibacterial activity; Plant extract; Plant oil; Cinnamon; Clove; Rosemary

1. Introduction

Plants are the chief source of natural products that are used in medicine. Even Aspirin, the world best known and most universally used medication, has its natural origins from the glycoside salicin which is found in many species of the plant genera Salix and Populus(Surh Y,.1999). Since 1990s there has been a growing shift in interest towards plants as significant sources for new pharmaceuticals. Many pharmaceutical companies show interest in plant-derived drugs mainly due to the current widespread belief that 'Green Medicine' is safe and more dependable than the costly synthetic drugs, which have adverse side effects. As per the World Health Organization (WHO) report, 80% of the world population, presently use herbal medicine for some aspect of primary health care (Sujatha S, 2004). Yahya EB (2018) describes the antimicrobial activity of some plants essential oil that significantly inhabited the growth of most tested bacteria (Esam, 2018). Essential oils and their components are gaining increasing interest because of their relatively safe status, their wide acceptance by consumers, and their exploitation for potential multi-purpose functional use. However, these complementary components give the plant as a whole a safety and efficiency much superior to that of its isolated and pure active components (Shariff, Z.U, 2001). The screening of plant extracts and plant products for antimicrobial activity has shown that higher plants represent a potential source of novel antibiotic prototypes (Afolayan, A.J, 2003).

The lack of scientific data regarding the presence of antibacterial activity of many medicinal plants led us to investigate the antibacterial activity present in the water extracts and compare it with the activity of their oils, which may provide scientific justification to the traditional uses in treating various ailments.

2. Material and Methods

2.1 Microorganisms

The Screening for the antibacterial activity was done individually on *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa* which all was obtained from Tripoli Medical Center (TMC). Bacterial strains were maintained on nutrient agar at 4° C and sub-cultured in our laboratory.

2.2 Plants oils

Eight plants oils have been selected for the screening of antibacterial activity from Hemani CO Pakistan, including: Cinnamon, Thyme, Rosemary, Castor, Cingen, Ginseng, Lemon and Black seed oils. In addition, from Tanamira CO Malaysia three oils were selected for the screening and comparison of the antibacterial activity with their extract including Cinnamon, Clove and Rosemary. The dilution of the plants oils were done using ethyl acetate, while the plants extracts using distilled water.

2.3 Plants extracts

The plants used for the study were cinnamon (*Cinnamomum verum*), Clove (*Syzygium aromaticum*) and Rosemary (*Rosmarinus officinalis*). The plant parts were shadow dried, ground to a fine texture and 30 g of air-dried plant powder was soaked in 300 ml of distilled water separately for 24 h in a round bottomed flask at room temperature. Extracts were filtered through the Whatman filter paper No.1. The filtrate was allowed to dry at 60°C. Condensed e tracts were weighed and stored in air-tight containers at 4°C till further investigation (McCloud, T, 1988).

2.4 Antimicrobial activity:

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The antimicrobial potency of plants oils and extracts on the selected three pathogens was studied using disk inhibition method (Duraipandiyan V et al., 2006). In disk inhibition zone method, the Mueller-Hinton agar medium was inoculated with freshly prepared cells of each bacteria to yield a lawn of growth. After solidification of the agar, a number of sterilized disks were dipped into extract solutions of different concentrations, and placed on the plates. After incubation at 37˚C for 24 h, the antimicrobial activity was measured as diameter of the inhibition zone formed around the disc (Tagg J.R, 1971).

3. Results

3.1 Antibacterial Activity of Plants oils

Screening for the antibacterial activity of plants oils was performed in duplicate using disk diffusion method. The results are presented in table 1, which show only Cinnamon oil posses strong activity against all the selected pathogens. However, among the three bacteria, *P. aeruginosa* was the less sensitive to the plants oils, compared to *E. coli* and *S. aureus*, as presented in the figures 1,2 and 3.

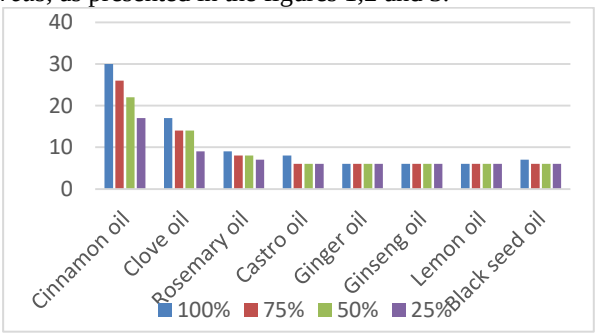

Figure 1: Inhibition of S. aureus with different concentrations of plants oils by disc diffusion method.

Table 1: Antibacterial activity of Commercial Hemani CO

Plant oil	MO	100%	75%	50%	25%
Cinnamon oil	*S. aureus*	18	16	13	11
	E. coli	30	26	22	17
	P. aeruginosa	15	13	10	9
Clove oil	*S. aureus*	20	16	13	8
	E. coli	17	14	14	9
	P. aeruginosa	15	11	10	8
Rosemary oil	*S. aureus*	11	7	6	6
	E. coli	9	8	8	7
	P. aeruginosa	8	7	6	6
Castor oil	*S. aureus*	6	6	6	6
	E. coli	8	6	6	6
	P. aeruginosa	9	8	6	6
Ginger oil	*S. aureus*	6	6	6	6
	E. coli	7	6	6	6
	P. aeruginosa	6	6	6	6
Ginseng oil	*S. aureus*	6	6	6	6
	E. coli	6	6	6	6
	P. aeruginosa	6	6	6	6
Lemon oil	*S. aureus*	6	6	6	6
	E. coli	6	6	6	6
	P. aeruginosa	6	6	6	6
Black seed oil	*S. aureus*	10	8	7	6
	E. coli	7	6	6	6
	P. aeruginosa	6	6	6	6

3.2 Antibacterial Activity of Plants Extracts

Three plants was selected for the comparison of the extracts with the plants oil. The results in table 2 present the activity of the plants extracts against the three bacteria. Clove extract express the highest activity on the three bacteria. However, cinnamon extract didn't give any effect in this study unlike the oil if the plant.

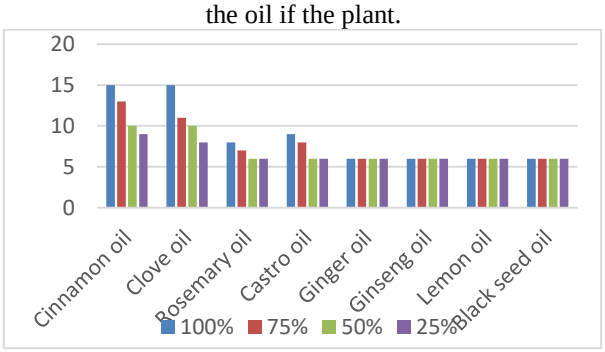

Figure 2: Inhibition of E. coli with different concentrations of plants oils by disc diffusion method.

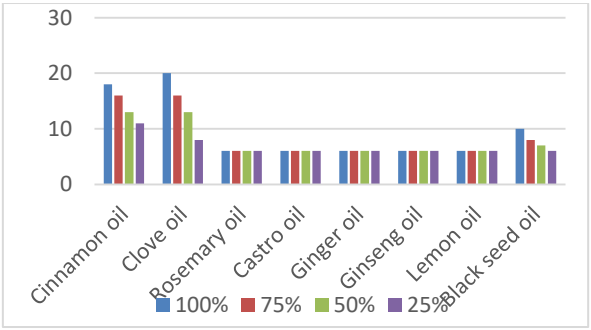

Figure 3: Inhibition of P. aeruginosa with different concentrations of plants oils by disc diffusion method.

The observed antibacterial activity (Table 2) is attributed to the presence of many bioactive compounds in the extracts of some tested plants such as clove. The presence of these compounds in crude extracts is known to confer antibacterial activity against disease-causing microorganisms (Farnsworth AC, 1982) and offer protection to plants themselves against pathogenic microbial infections(De N et al., 1982).

Table 2: Antibacterial activity of Selected Plants extracts

Plant	MO	100%	75%	50%	25%
Cinnamon Extract	*S. aureus*	-	-	-	-
	E. coli	9	-	-	-
	P. aeruginosa	-	-	-	-
	S. aureus	22	21	15	8

Clove Extract	*E. coli*	13	17	15	13
	P. aeruginosa	13	16	14	11
Rosemary Extract	*S. aureus*	10	12	-	-
	E. coli	-	-	-	-
	P. aeruginosa	-	-	-	-

3.3 Antibacterial activity of plants oils and plants extracts

The medicinal or antibacterial action of plants are unique to a particular plant species or group, consistent with the concept that the combination of secondary products in a particular plant is taxonomically distinct (Wink M, 1999). The plant's secondary products maybe water soluble which dissolve in aqueous solution or organic soluble dissolve in in organic solvent. Table 3 present a comparison of the antibacterial activity of the water extract of selected three plants and their oil of two commercial companies. Clove oil and extract give the best activity against all tested pathogens, followed by cinnamon with lower activity in the oil and weak activity of its extract. Rosemary reported to have weak activity in both oil and extract against the three bacteria.

Table 3: Antibacterial activity of Selected Plants extracts

Plant		*S. aureus*	*E. coli*	*P. aeruginosa*
Cinnamon	CO1	18	30	15
	CO2	14	8	12
	PE	6	9	6
Clove	CO1	20	17	15
	CO2	20	25	11
	PE	22	13	13
Rosemary	CO1	11	9	8
	CO2	7	8	6
	PE	10	6	6

4. Discussion

The active components of herbal remedies have the advantage of being combined with many other substances that appear to be inactive. However, these complementary components give the plant as a whole a safety and efficiency much superior to that of its isolated and pure active components (Shariff, Z.U, 2001). In this study, the antimicrobial effect of selected plants oils, was tested against three bacteria. The results in the present study indicate that plants oils have variable antibacterial effect against S. aureus, *E. coli* and *P. aeruginosa*. Only few commercial oils (cinnamon & clove) had a good antibacterial activity unlike most of the other plants oils, which denies so many studies including (Seenivasan P *et al.,* 2006; Jeongmok K *et al.,* 1995; Bektaş TepeDimitra *et al.,* 2004) that concluded that most of their selected essential oils expressed a strong antibacterial activity. Plants oils have a wide range of applications all over the world. They can be used as antiflogistics, stomachics, carminatives, diuretics, sedatives, antimycotics, antivirotics, disinfectants, etc. One of the main benefit is also their antibacterial effects, which is the main investigation of this study. They act against bacteria by various mechanism on different bacterial structures. The structure of gram-positive (G+) bacteria facilitates the penetration of hydrophobic molecules into the cell and act on the bacterial wall, cytoplasmic membrane or cytoplasm which explain the high effect of oils against S. aureus. At low concentrations, they can react with enzymes responsible for producing energy, while at higher concentration they can denaturate proteins. Because of the reduced proton gradient by influencing the transfer of H+, essential oils reduce the synthesis of energy compound ATP and thus the intracellular store of ATP. They can cause the degradation of each of bacterial cell walls, damage of cytoplasmic membranes and even coagulation of the cytoplasm. By damaging the membrane proteins, they increase the permeability of the membrane and cause leakage of the cell contents (Burt, S., 2004). In the other side, gram negative (G–) bacteria are more resistant against plants oils in comparison to gram-positive (G+) because of the different structure and different composition of the bacterial cell walls (Zaika, L.L., 1988). Gram negative bacteria have a thin layer of peptidoglycan and lipopolysaccharide layer (LPS) on their outer membrane that is lacking in gram positive bacteria. Small hydrophilic molecules can penetrate through the porin proteins of G– bacteria. The porins are relatively resistant to hydrophobic molecules, but not completely. Some plants oils, e. g. cinnamon and clove, act on both gram positive and negative bacteria, which has been proven in the results of this study, as they strongly inhabited the growth of E. coli and S. aureus. However, they are less effective against Pseudomonas spp. In general and P. aeruginosa in specific because it increases its resistency by producing exopolysaccharides and by creating biofilms (Nazzaro, F, 2013). This study also aimed to compare the effect of some commonly used essential oils in and aqueous extract of selected three plants including cinnamon, clove and rosemary. The results indicates only a good antibacterial activity in clove aqueous extract compared to the other two tested plants. Studies have shown that the phenolic compounds play an important role in the antimicrobial properties of plants. These compounds destroy microorganisms by the mechanisms explained earlier, which explain the better effect of oils compared to plant extract.

5. Conclusion

The results of this study are promising and show a possible therapeutic alternative by using cinnamon and clove to treat various infections caused by pathogenic bacteria. The findings also relatively support the traditional usage of Medicinal plants and suggests that some unknown plants may possess compounds with high antibacterial properties. Therefore, new researches have been proposed in order to elucidate the possible action mechanisms involved and to find new bioactive compounds in medicinal plants in the upcoming near future study.

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