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Screening of some plant materials used in South-West Algerian traditional medicine for their antibacterial activity

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Abstract

The initial introduction of new medicinal agents into the health care system sometimes, requires information beyond that is recorded in libraries relying instead, on reports available through traditions and healers within a society. This paper explored the antibacterial activity of aqueous and hydromethanolic extracts of nine folkloric medicinal plant from Bechar region (southwest Algeria) namely: *A. nardus, A. schoenanthus, G. vulgaris,* two species of *H. scoparia green & red, P. laevigata, R. tripartita, T. gallica* and *T. nudatum*, frequently used in the local traditional medicine. The antibacterial activity of different extracts were evaluated by using disc diffusion method agar and antibiotics susceptibility of ten selected microorganisms: seven reference strains, *Bacillus cereus, Enterococcus faecalis, Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae, Pseudomonas aeruginosa*, *Salmonella typhi*, and three clinically isolated strains, *Escherichia coli* (Urinary Tract Infection), *Escherichia coli* (Vaginal Infection) and *Staphylococcus aureus* (Skin Infection).

The maximum antibacterial activity was recorded against the gram negative reference strains *Pseudomonas aeruginosa*and *Escherichia coli* with a maximum inhibition diameter of 15.6 ± 0.5 and 15.0 ± 1.4 mm respectively displayed by the aqueous extract of *T. gallica,* followed by the activity detected by the hydromethanolic extract of *R. tripartita* against the gram negative reference strain *Pseudomonas aeruginosa* (14.6±1.2 mm) and the aqueous and hydromethanolic extracts of *R. tripartita* against the gram negative reference strains *Pseudomonas aeruginosa* and *Escherichia coli* with a maximum inhibition diameter of 14.3 ± 2.0 and 14.3±0.5 mm, respectively.

According to the present study, *H. scoparia red, P. laevigata, R. tripartita, and T. gallica*can be served as broad spectrum antibiotic and used as a potent source of natural antibacterial agents by replacing commercially available synthetic drug that may have a large number of side effects.

Keywords: Medicinal Plants, antibacterial activity, antibiotics susceptibility.

Introduction

Today there is an imperative necessity to find out new antibacterial compounds with various chemical structures and new mechanisms of action for new and re-emerging contagious syndromes [1][2][3]. Consequently, researchers are increasingly turning their attention to folk medicine; looking for new leads to develop better drugs that are effective against bacterial infections extracts of screened medicinal plants possess a broad spectrum of activity against a panel of bacteria responsible for the most common bacterial diseases [4]. These promissory extracts open the possibility of finding new clinically effective antibacterial compounds [5].

Therefore, this paper focused on the antibacterial screening of aqueous and hydromethanolic extracts of nine folkloric medicinal plant, frequently used in the local traditional medicine in Bechar region (southwest Algeria), namely: *A. nardus, A. schoenanthus, G. vulgaris,* two species of *H. scoparia* green & red, *P. laevigata, R. tripartita, T. gallica* and *T. nudatum*, using disc diffusion method agar and antibiotics susceptibility of ten selected microorganisms: seven reference strains, *Bacillus cereus, Enterococcus faecalis, Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae, Pseudomonas aeruginosa*, *Salmonella typhi*, and three clinically isolated strains, *Escherichia coli* (Urinary Tract Infection),

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Escherichia coli (Vaginal Infection) and *Staphylococcus aureus* (Skin Infection).

Materials and methods

Plants extraction preparation

Plant materials of nine plant species included in this study (Table 1) were collected from March 2014 to March 2015, from different regions of Bechar province (Southwest Algeria). After collection, the fresh plant samples were cut into pieces, ambient dried in shade, then grinded.

A total of 50 g of each powdered plant material was exhaustively refluxed with distilled water and 80% water-methanol mixture separately for 3h. The extracts were filtered out, evaporated and dried under reduced pressure using rotavapor.

Table 1. List of selected traditional medicinal plants

Scientific name	Family	Local name	Region of collect	Date of collect
Andropogon nardus L.	Poaceae	ليدخير	Bechar	February 2015
Andropogon schoenanthus L.	Poaceae	اللماد	Bechar	March 2015
Globularia vulgaris L.	Globulariaceae	تسلغا	Bechar	March 2015
Hammada scoparia Pomel.	Chenopodiaceae	الرمث الأحمر	Bechar	March 2014
Hammada scoparia Pomel.	Chenopodiaceae	الرمث الاخضر	Lahmer	March 2014
Periploca laevigata Ait.	Asclepiadaceae	الحلاب	Bechar	March 2015
Rhus tripartita R. Sch.	Anacardiaceae	الجداري	Bechar	February 2015
Tamarix gallica L.	Tamaricaceae	فرسيق	Bechar	March 2015
Traganum nudatum Del.	Chenopodiaceae	الضمران	Kenadsa	February 2015

Bacterial strains

The antibacterial potency of each plant extract was evaluated using ten bacterial strains, seven reference strains, Bacillus cereus (ATCC 11778), Enterococcus faecalis (ATCC 29212), Staphylococcus aureus(ATCC 25922), Escherichia coli (ATTC 25923), Klebsiella pneumoniae, Pseudomonas aeruginosa (ATCC27853), Salmonella typhi(ATCC25922), provided from Pasteur institute, Algiers, Algeria, and three clinically isolated strains, Escherichia coli(Urinary Tract Infection (UTI)), Escherichia coli (Vaginal Infection (VI))and Staphylococcus aureus (Skin Infection (SI)), provided from Microbiology Laboratory, Tourabi Boudjamaa Hospital, Bechar, Algeria.

Isolation and identification of the infectious strains

For the isolation of the three clinical isolates used in this study, samples were collected randomly from the infectious patients from Tourabi Boudjamaa Hospital, Bechar (South West Algeria). The samples collected were then plated on to Mac Conkey's agar, Mannitol salt agar and Nutrient Agar plates for bacterial isolation using sterilized loop. The plates were then incubated at 37°C for 24 hrs. The plates were observed for bacterial growth after 24 hours. In some plates, there were mixed cultures of organisms. These plates were subsequently sub cultured to isolate the pure strain. Morphological identification done by using Gram staining technique. Further, characterization of organisms was carried out by various biochemical test and the results were tabulated [6, 7].

Inoculums preparation

Each bacterial strain was sub cultured overnight at 35 C in Mueller-Hilton agar slants. The bacterial growth was harvested using 5 mL of sterile saline water. The concentration of the suspensions was adjusted to 0.5 McFarland standard to reach an optical density of 0.08-0.10 at 625 nm by adding sterile distilled water [8]. This gives a bacterial suspension containing 1.5 x 108 CFU/mL [9].

Evaluation of antibacterial activity of plant extracts

The disk diffusion method is used to evaluate antibacterial activity of each plant material. The plant extract residues (100 mg) were re-dissolved in 1 mL of sterilized Dimethyl sulfoxide (DMSO 5%), then loaded over sterile filter paper discs (6 mm in diameter). 10 mL of Mueller-Hilton agar medium was poured into sterile Petri followed with the seeded medium previously inoculated with bacterial suspension. Sterile filter paper discs loaded with 40 l of each plant extract separately were placed on the top of Mueller-Hilton agar plates. Sterile paper discs containing Dimethyl sulfoxide (DMSO 5%) alone was served as control. The plates were incubated at 37°C for 24 h.

The presence of inhibition zones was measured by Vernier caliper, recorded and considered as indication for antibacterial activity. For each test solution, three replicates were maintained [10-13].

Then, the proportion index (PI) was calculated as $PI = \frac{NP_E}{T_N}$

where NPE is Number of positive results obtained for extract and TN is Total number of tests carried out for each extract [14,15].

Antibiotic Sensitivity Assay

The antibiotic sensitivity against the ten bacterial strains was determined using the disc diffusion method. Seven antibiotics were used in this study including: Ampicillin (10 µg), Ofloxacin(5 µg), Fosfomycine (200 µg), Cefoxitin (30 µg), Gentamycin(10 µg), Oxacillin (1 µg)and Tetracycline (30 µg).

Statistical Analyses

All data were expressed as the mean ± standard deviation (SD) by measuring three independent replicates. One-way analysis of variance (SAS, 1990; ANOVA procedure) was performed to compare means and to test the significance of differences between means obtained among the treatments at $p < 0.05$ level of significance.

Results

Identification and characterization of clinical isolates

The *Escherichia coli* and *Staphylococcus aureus* species isolated from clinical samples were obtained from the Microbiology Laboratory, Tourabi Boudjamaa Hospital, Be char (SouthWest Algeria). Conventional bacteriological methods such as colony morphology, gram staining (Table 2) and biochemical tests (Table 3) were used for identification of the clinical isolates [7, 16, 17].

Table 2. Colony morphology and gram staining of the clinical isolates

Bacterial strain	Gram	Microscopic observation
Escherichia coli (vaginal Infection)	-	Bacilli
Escherichia coli (urinary tract infection)	-	Bacilli
Staphylococcus aureus (skin infections)	+	Cocci in grape-like clusters

Table 3. Biochemical tests reaction for *E. coli* and *S. aureus* species

Escherichia coli												
Lactose fermentation	Catalase	Simmon's Citrate	Indole Production	Nitrate Reduction	Methyl Red	Voges-Proskauer	Urease	Glucose	Mannitol	Lactose	Salicin	Sucrose
+	+	-	+	+	+	-	-	+	+	+	+	+
Staphylococcus aureus												
Oxidase	Catalase	Indole Production	Nitrate Reduction	Methyl Red	Voges-Proskauer	Glucose	Mannitol	Maltose	Lactose	Raffinose	Sucrose	Haemolysis	Coagulase
-	+	-	+	+	+	+	+	+	+	-	+	+	+

Antibacterial activity evaluation

In-vitro antibacterial screening was generally performed by paper disc diffusion method for the primary selection of the compound as therapeutic agent. Table 4 summarizes the bacterial growth

inhibition of both aqueous and hydromethanolic extracts of the screened plant species.

The results revealed that the most plant extracts were potentially effective in suppressing microbial growth of the tested bacteria with variable potency. The different extracts of *H. scoparia* red, *P. laevigata*, *R. tripartita*, and *T. gallica* showed significant antibacterial activity against the most investigated bacteria as assessed by the inhibition zone diameter of each extract (Figure 1). The extracts of *T. gallica* were found more effective against most tested bacteria, showing a significant inhibition zone ranges between 13.3 and 15.6mm, recorded against the reference gram-negative bacteria (*Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*). The extracts of *R. tripartite* were also found effective against the reference gram-negative bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*) showing a significant inhibition zone ranges between13.3 and 14.6 mm. The most significant inhibition zone recorded against the reference gram-positive was detected by the hydromethanolic extracts of *P. laevigata* and *H. scoparia* green against *Staphylococcus aureus* (13.0±1.7 and 13.3±2.0 mm, respectively).

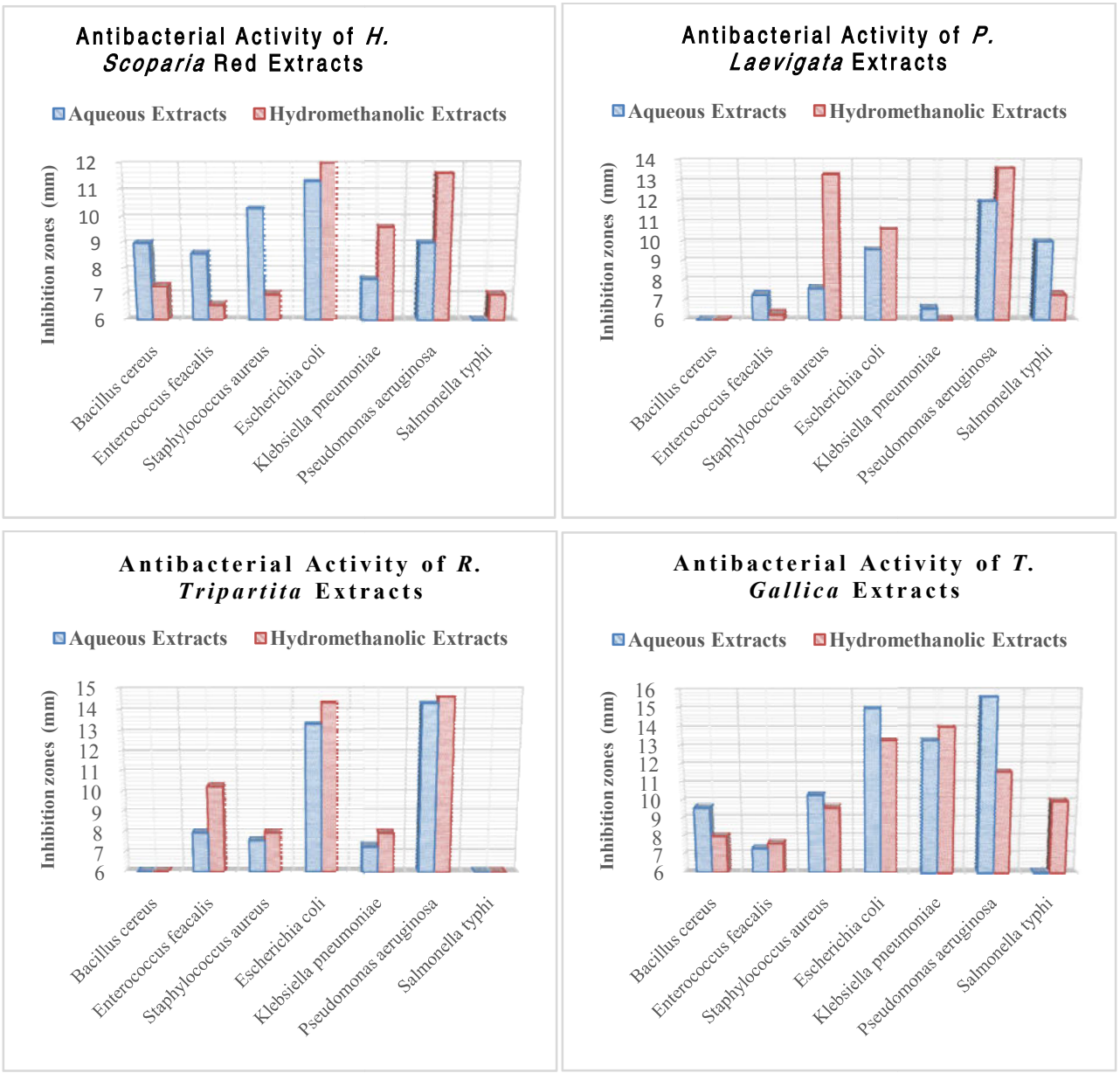

Figure 1. Antibacterial activity of the most active extracts

The weakest antibacterial activity was recorded by the extracts of *A. nardus* and *T. nudatum* which exhibited an activity in the range of 6.3-9.6mm and 6.3-10.0 mm respectively.

In the meanwhile, the most plants extracts exhibited a modest activity against the three clinical isolates strains. The most significant inhibition zones were detected by the aqueous and hydromethanolic extracts of *H. scoparia* red against the clinical gram-positive strain *Staphylococcus aureus* and the hydromethanolic extract of *H. scoparia* green against the clinical gram-negative strain Escherichia coli (11.3 ± 0.5 mm each).

On the other hand, the species of *H. Scoparium* exhibited inhibitory effect against all the tested pathogenic strains (100%), *A. schoenanthus*, *P. laevigata*, and *T. gallica* were effective against nine of them (90%). Whereas *A. nardus*, *R. tripartita* and *T. nudatum* were effective against seven photogenic species only (70%).

The proportion index of antibacterial activity of different plant extracts on pathogenic bacterial strains under investigation was evaluated using the number of positive results obtained for aqueous and hydromethanolic extracts of plant species and total number tests carried out. As shown in Figure 2, the proportion index reached its highest value (1), recorded by the aqueous extract of *H. Scoparium* green, followed by the both extracts of *A. schoenanthus*, the hydromethanolic extracts of the two species of *H. Scoparium*, *T. gallica* and the aqueous extract of *P. laevigata* (0.9 each).

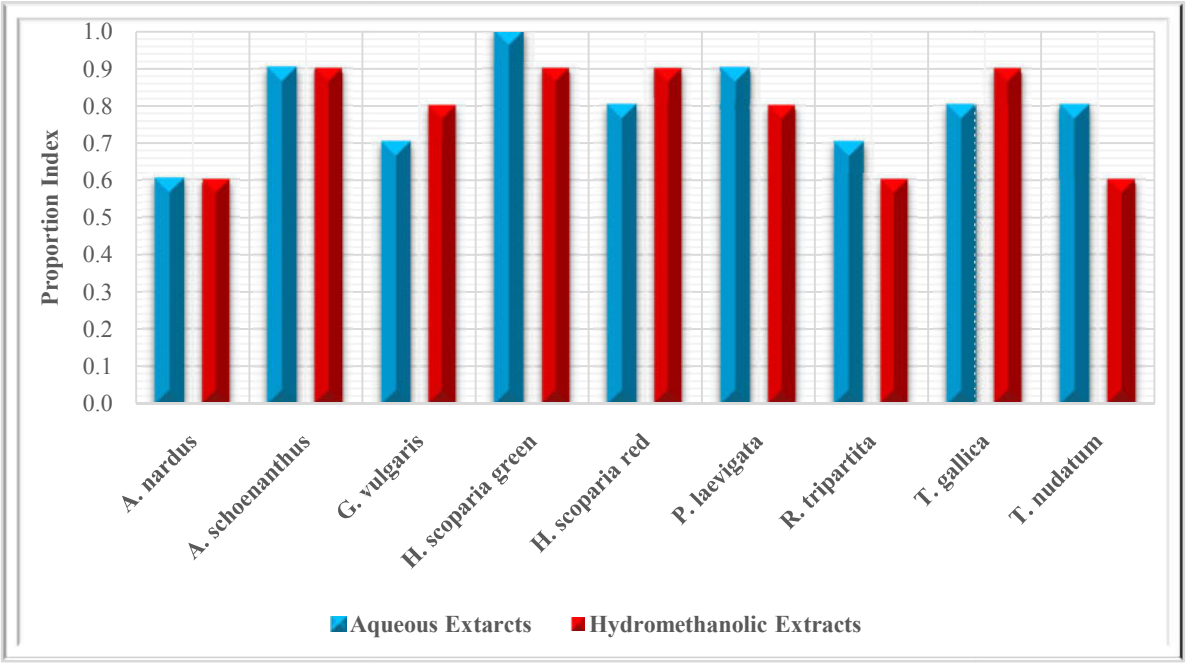

Figure 2. Proportion Index of Antibacterial activity of the investigated plants

The maximum antibacterial activity was recorded against Escherichia coli,Klebsiella pneumoniae and Staphylococcus aureus with a maximum inhibition diameter of 15.0 ± 1.4, 14.0 ± 1.0 and13.3 ± 2.0 mm, respectively. Whereas, the lowest antibacterial activity was recorded against the two clinical isolates Escherichia coli species with a maximum inhibition diameter of 11.3 ± 0.4 mm.

Table 4. Antibacterial screening test of the investigated plants extracts

		Plant extracts	*A. nardus*	*A. schoenanthus*	*G. vulgaris*	*H. scoparia green*	*H. scoparia red*	*P. laevigata*	*R. tripartita*	*T. gallica*	*T. nudatum*
Standard	Gram positive bacteria	***Bacilluscereus***	**Aq. Ext**	9.6±0.5	9.6±0.5	**11.3±0.5**	**10.0±1.0**	9.0±1.7	6.0±0.0	6.0±0.0	9.6±0.5	8.0±2.0
			Mth. Ext	8.0±0.0	9.3±1.1	8.6±0.5	8.0±1.7	7.3±0.5	6.0±0.0	6.0±0.0	8.0±0.0	6.0±0.0
		Enterococcus feacalis	**Aq. Ext**	7.0±1.0	7.3±2.3	8.3±0.5	6.6±0.5	8.6±1.5	7.3±1.1	8.0±0.0	7.3±1.1	6.6±0.5
			Mth. Ext	6.0±0.0	6.6±0.5	6.3±0.5	8.0±0.0	6.6±1.1	6.3±0.5	**10.3±1.5**	7.6±1.1	6.0±0.0
		Staphylococcus aureus	**Aq. Ext**	7.3±0.5	8.6±0.5	8.6±0.5	9.0±1.0	**10.3±1.5**	7.6±0.5	7.6±1.5	**10.3±0.5**	9.6±0.5
			Mth.Ext	7.6±0.5	9.3±1.5	9.6±0.5	**13.0±1.7**	7.0±1.7	**13.3±2.0**	8.0±0.0	9.6±1.5	7.3±0.5
	Gram negative bacteria	***Escherichia coli***	**Aq. Ext**	9.3±0.5	**10.3±0.5**	6.0±0.0	7.6±0.5	**11.3±1.1**	9.6±0.5	**13.3±2.0**	**15.0±1.4**	7.6±0.5
			Mth.Ext	6.3±0.5	7.6±1.5	6.3±0.5	8.3±0.5	**12.0±2.0**	**10.6±1.5**	**14.3±0.5**	**13.3±1.1**	7.6±1.5
		Klebsiella pneumoniae	**Aq. Ext**	9.3±0.5	8.0±0.0	10.0±1.0	9.3±0.5	7.6±1.5	6.6±2.9	7.3±1.5	**13.3±2.5**	9.3±1.1
			Mth.Ext	8.0±2.0	9.6±1.5	9.0±1.0	9.3±2.0	9.6±2.3	6.0±0.0	8.0±1.7	**14.0±1.0**	6.6±0.5
		Pseudomonas aeruginosa	**Aq. Ext**	6.0±0.0	9.6±1.1	6.6±1.1	8.3±0.5	9.0±2.0	**12.0±0.0**	**14.3±2.0**	**15.6±0.5**	6.0±0.0
			Mth.Ext	6.0±0.0	7.6±2.8	**12.6±2.5**	7.0±0.0	**11.6±2.0**	**13.6±1.1**	**14.6±1.2**	**11.6±0.5**	6.0±0.0
		Salmonella typhi	**Aq. Ext**	6.0±0.0	7.0±0.0	8.3±1.5	8.0±1.0	6.0±0.0	**10.0±1.0**	6.0±0.0	6.0±0.0	7.3±0.5
			Mth.Ext	6.0±0.0	7.0±1.0	8.0±0.0	6.0±0.0	7.0±0.0	7.3±0.5	6.0±0.0	**10.0±1.0**	7.3±0.5
Clinical isolates		***Escherichia coli*** (urinary tract infection)	**Aq. Ext**	6.0±0.5	6.0±0.0	6.6±0.5	6.3±0.5	7.3±0.5	8.6±0.5	6.0±0.0	6.0±0.0	6.3±0.5
			Mth. Ext	6.6±0.5	6.0±0.0	7.6±0.5	6.6±0.5	6.0±0.0	8.0±1.0	6.0±0.0	6.0±0.0	8.3±0.5
		Escherichia coli(vaginal Infection)	**Aq. Ext**	6.0±0.0	6.3±0.5	6.0±0.0	**10.3±0.5**	6.0±0.0	7.3±0.5	8.0±1.0	8.3±1.5	6.0±0.0
			Mth. Ext	6.0±0.0	7.6±0.5	6.0±0.0	**11.3±0.5**	9.3±0.5	8.0±0.0	6.0±0.0	9.6±0.5	6.0±0.0
		Staphylococcus aureus (skin infections)	**Aq. Ext**	8.3±0.5	6.6±0.5	6.0±0.0	8.6±0.5	**11.3±0.5**	**10.3±0.5**	9.6±0.5	9.6±0.5	7.3±0.5
			Mth.Ext	9.0±0.0	**10.3±0.5**	6.0±0.0	**11.0±1.0**	**11.3±0.5**	**10.6±1.1**	**10.3±0.5**	**10.0±1.0**	**10.0±0.0**

Antibacterial susceptibility pattern of tested microorganism

The antimicrobial susceptibility pattern of bacterial strains was determined using disc diffusion method. Table 5 revealed the antibiotic susceptibility pattern of the tested bacteria. As per the results, *Salmonella typhi, Klebsiella pneumoniae, Bacilluscereus*and *Staphylococcus aureus* showed the maximum susceptibility to antibiotic Ofloxacin, producing inhibition zones of 35.0 ± 0.0; 31.0 ± 2.6; 31.0±1.0 and 29.6 ± 0.5mm , respectively. On the contrary, all the tested microorganism (except *Enterococcus faecalis*) were found to be resistant against Fosfomycine and Oxacillin.

Table 5. Antibacterial susceptibility pattern of tested microorganism

	Gram positive bacteria			Gram negative bacteria			
	Bacillus cereus	*Enterococcus feacalis*	*Staphylococcus aureus*	*Escherichia coli*	*Klebsiella pneumoniae*	*Pseudomonas aeruginosa*	*Salmonella typhi*
Ampicillin	11.3±0.5	21.3±1.1	10.3±0.5	9.3±0.5	12.0±0.0	6.0±0.0	14.0±1.7
Ofloxacin	31.0±1.0	21.6±0.5	29.6±0.5	26.3±0.5	31.0±2.6	24.6±0.5	35.0±0.0
Fosfomycine	6.0±0.0	20.0±0.0	6.0±0.0	6.0±0.0	8.0±0.0	6.0±0.0	6.0±0.0
Cefoxitin	20.6±0.5	6.0±0.0	15.6±1.1	12.6±0.5	20.3±0.5	6.0±0.0	27.3±0.5
Gentamycin	20.6±1.1	11.3±1.1	23.6±1.5	25.6±0.5	23.0±0.0	20.3±1.5	25.3±0.5
Oxacillin	6.0±0.0	6.0±0.0	6.0±0.0	6.0±0.0	7.3±0.5	6.0±0.0	6.0±0.0
Tetracycline	16.6±0.5	9.6±0.5	19.6±0.5	18.3±1.1	20.0±0.0	26.3±2.3	20.6±1.1

Discussion

The usage of medicinal plants for primary health care needs by millions of people in developing world is still occupying a prominent position. The folk remedies are considered readily available, cheap and time tested [18]. The medicinal plants are important source of potentially bioactive constituents for the development of new chemotherapeutic agents. These phytochemicals may act individually, additively or in synergy to improve health [19]. The first step towards this goal is the in vitro antimicrobial activity [20].

The different plant extracts have different modes of action for curing diseases [21]. The therapeutic efficacy of plants is because the existence of phytochemicals such as, alkaloids, flavonoids, saponins, terpenoids, steroids, glycosides, tannins, etc. All these secondary metabolites are known for curing one or other diseases. For instance, alkaloids are known for antispasmodic, antimalarial, analgesic and diuretic activity. Tannin is reported to exhibit antiviral, antibacterial, antitumor and antimicrobial activities. Terpenoids are reported to have antiviral, anthelmintic, antibacterial, anticancer, antimalarial, anti-inflammatory properties. Saponins are known for anti-inflammatory, antiviral, plant defense and for cholesterol reducing property. Phenols and flavonoids have a strong experimental evidence of their inherent ability to modify the body's reaction to allergies, virus and carcinogens. They show antiallergic, anti-inflammatory, antioxidant, anticancer and antimicrobial activities [22-24].

In the present study, nine plants which are traditionally used in curing or treating many diseases and disorders were screened for their preliminary antibacterial activity. The extracts of *H. scoparia* red, *P. laevigata*, *R. tripartita,* and *T. gallica* was found significantly active against the tested bacteria, where the most antibacterial activity was recorded against the gram negative reference strains *Pseudomonas aeruginosa* and *Escherichia coli* with a maximum inhibition diameter of 15.6 ± 0.5 and 15.0 ± 1.4 mm respectively displayed by the aqueous extract of *T. gallica*, followed by the activity detected by the hydromethanolic extract of *R. tripartita* against the gram negative reference strain *Pseudomonas aeruginosa* (14.6 ± 1.2 mm) and the aqueous and hydromethanolic extracts of *R. tripartita* against the gram negative reference strains *Pseudomonas aeruginosa* and *Escherichia coli* with a maximum inhibition diameter of 14.3 ± 2.0 and 14.3 ± 0.5 mm, respectively.

Comparing the activity of extracts with reference antibiotics using diffusion method, the extracts of *H. scoparia* red, *P. laevigata*, *R. tripartita*, and *T. gallica* have an activity comparable to that of Ampicillin and Cefoxitin. However, the activity of the most plant extracts was higher than that of Fosfomycine and Oxacillin on all the tested microorganism (except *Enterococcus faecalis*).

Some plant extracts were unable to exhibit antibacterial activity against tested bacterial strains. These bacterial strains may have some kind of resistance mechanisms e.g. enzymatic inactivation, target sites modification and decrease intracellular drug accumulation or the concentration of the compound used may not be sufficient [25].

Although, the low values recorded for some plant extracts may be attributed to the fact that the extracts being in crude form, contain very small amounts of bioactive compounds. At the same time, several workers have reported bioactivity of crude extracts of medicinal plants within such range of diameter zone of inhibition [10, 26].

The antibacterial activity of the studied plants varied with different extraction solvents. Aqueous extracts were found to be effective as well as the hydromethanolic extracts. These results were not in accordance to some researchers who had reported that the organic extracts had better antimicrobial activity as compared to aqueous extracts especially against *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* [27]. The antibacterial action of the aqueous extracts could be attributed to the anionic components such as thiocyanate, nitrate, chlorides and sulfates apart from other water-soluble components which were naturally occurring in the plant material [28, 29]. While the antibacterial activity of the hydromethanolic extracts may be due to the high tendency of the organic solvents to dissolve more organic and active antimicrobial compounds such as phenols and flavonoids [30].

Knowing the phytochemical profile of different parts and different plants is desirable so that one can decide the part to be explored for any particular activity and it can also help one to decide the part(s) to be chosen for any synergistic evaluation. Knowing the phytochemical profile in the beginning of any experiment is desirable than random selection of the plants [31].

The phytochemical analysis of the potent plant extracts of *H. scoparia red, P. laevigata, R. tripartita,* and *T. gallica,* conducted in our previous work, confirms the presence of Alkaloids, tannin, flavonoids, phenols, carbohydrate and glycosides in all of them. Phenolic compounds are the potent inhibitors of microbial growth. Some of these phytochemicals may inhibit the attachment of bacteria on host cell surface membranes and act as potential antiadhesive agents. It has been also reported that the alkaloids and flavonoids are the responsible compounds for antibacterial activity in various plants. Therefore, this high activity of these plants can be attributed to the presence of these phytochemicals that have inhibitory effect on the positive and negative gram bacteria.

Conclusion

The rich biodiversity of plants makes them a treasure house for obtaining new and novel compounds either themselves as drugs or lead molecules for drugs with different mechanism of action. In this study, in-vitro antibacterial screening was performed by paper disc diffusion method to investigate the activity of aqueous and hydromethanolic extracts of nine plant species.

The results revealed that the most plant extracts were potentially effective in suppressing microbial growth of the tested bacteria with variable potency. The different extracts of *H. scoparia* red, *P. laevigata, R. tripartita*, and *T. gallica* showed significant antibacterial activity against the most investigated bacteria as assessed by the inhibition zone diameter of each extract. Further chemical and pharmacological investigations may be carried out to isolate and identify the antimicrobial agents in the selected plants.

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