Research Article

Antibacterial activity of selected medicinal plants and its economic importance of Khyber agency, Pakistan

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Abstract

The current study is focused to explore the economic importance of selected medicinal plants of Khyber agency, Pakistan. A total of 58 medicinal plants species was collected, out of which 47 species were economically used and 5 medicinal species were checked for their antibacterial activity. The results of antibacterial activity revealed that these plants have good antibacterial potential which needs further phytochemically, biological and pharmaceutical investigations.

Keywords: Antibacterial activity; Medicinal species; Economic value; Khyber Agency; Pakistan

Introduction

Plants are the excellence of nature and these plants have incredible restorative and monetary significance all through the world. All day by day human essential and rich

prerequisites like encouraging, garments, haven, nursing, and chasing are satisfied by plants. As plants are wellsprings of pharmaceuticals, they have shaped the reason for creative and conventional frameworks

and consistently giving humankind new cures. In the past couple of years, the enthusiasm for customary pharmaceutical has exceptionally expanded. This teach is picking up the logical reason for its suitable application [1]. The vegetation of Pakistan because of its assorted climatic and soil conditions and numerous natural locales are exceptionally rich in restorative plants. As per a general review of Pakistan, around 6000 types of blossoming plants have existed; out of 6000, around 400 to 600 are therapeutically imperative species [2-4].

Numerous plants can possibly be utilized as a characteristic cure against ailments [5]. Homegrown pharmaceuticals have been the fundamental wellspring of essential social insurance in all countries. The plants as medication are utilized as a part of the distinctive arrangement of drugs, for example, Ayurveda, Allopathy, Unani, Homeopathy and even in different frameworks. The historical backdrop of plants to be used as medications is a huge number of years old [6].

Around 80% of the total populace is as yet subject to the conventional solution. From old circumstances, plants have been a rich wellspring of viable and safe solutions. Because of their sheltered, viable and modest nature, indigenous cures are mainstream among individuals. We may call homegrown solution as the medication in which plant-based details are utilized to mitigate ailments. It is otherwise called organic pharmaceutical or phytomedicine [7,8]. The term phytotherapy has been, be that as it may, presented as of late as a more precise equivalent word of natural or plant drug. In the mid-twentieth century, natural pharmaceuticals were wellsprings of the prime medicinal services framework, before the disclosure of anti-toxins or analgesics. With the approach of an allopathic arrangement of prescription, homegrown pharmaceutical step by step lost its fame

among individuals, which depends on the quick helpful activities of engineered drugs [8].

In the eighteenth century, a society therapeutic specialist Reverend Edward Stone used to treat a fever by using the bark of white willow (*Salix alba*) with a similar severe have an aftertaste like Cinchona. The rule in charge of controlling fever in willow bark was salicin, a simple of salicylic corrosive. Other firmly related characteristic mixes were progressively found and found to assuage fever, torment, swelling, gout, rheumatic fever, and joint pain. A medication reserpine secluded from foundations of *Rauvolfia serpentinae* was utilized as a part of the treatment of hypertension, snakebite and dysfunctional behavior. Cases of other profitable medications from characteristic sources incorporate sedatives and pilocarpine utilized for glaucoma, dry-mouth disorder while vincristine and vinblastine got from *Catharanthus roseus* recommended for pediatric leukemia and Hodgkin's sickness, individually, which demonstrates that therapeutic plants have the important wellspring of restorative specialists since time immemorial and keep on playing an overwhelming part in essential human services [9].

Keeping in view the importance of medicinal plants, some medicinal plants were selected from Khyber agency to expose the economic benefits and to explore the medicinal potential of these plants. The current paper will enlist the important plant in the local area, economical plants in the local area and antimicrobial activity of five species.

Materials and methods

Collection of plant

The fresh flower and leaves of selected plants, viz., *Justicia adhatoda*, *Datura stramonium*, *Boerhavia procumbens*, *Chenopodium murle* and *Euphorbia helioscopia* free from pathogenic diseases were collected from the research area.

These plants were washed 4 times thoroughly with distilled water.

Preparation of extract

Washed dried leaves and flower of selected plant *J. adhatoda*, *D. stramonium*, *B. procumbens*, *C. murle* and *E. helioscopia* were first dried in shade for 3 days. These plants were placed in an oven at 35°C and then converted into powder with mortar and pestle. 100 grams of each respective plant parts and 200 ml of methanol were placed in a mortar and it was ground thoroughly with the pestle. The extract of methanol was kept at room temperature for 33 h. The prepared extract was filtered using filter paper and then dried at temperature of 40°C for methanol removal to obtain the dense extract and then they were kept in sterile bottles under refrigerated conditions until use.

Antibacterial activity

In this biological evaluation, a total of six bacterial species were chosen to be used. The bacterial species used were classified as Gram-negative bacteria such as *Escherichia coli*, *Pseudomonas fluorescens* and *Xanthomonas axonopodis* and gram-positive such as *Bacillus subtilis* and *Staphylococcus aureus*. All these organisms were sustained on agar slant at 4°C and the slant was allowed to activate at a temperature of 37°C for one day on nutrient agar (NA) before any screening was carried out. The organisms were kept in Müller-Hinton agar (MHA) in the refrigerator at 4°C prior to subculture. Antibacterial testing was conducted out on the already developed agar well diffusion method to study the effectiveness of the extracts of selected medicinal plants. Broth media was primed and the test organisms were moved to the broth media from agar plate and were grown-up at 37°C for one day. After 24 h, 25 ml of MHA were discharged into each Petri plate and cooled in sterile condition. The fresh culture was primed from day old culture, after solidification of MHA in the plate; 0.6 ml of a fresh culture of test

organism was emptied onto MHA. Wells of 6 mm diameter were dug into the medium by using sterile borer and 20mg of the extracts of selected medicinal plants were used against each organism. DMSO and standard antibiotic (*Streptomycin sulphate*) were mixed into other wells. The plates were kept in pasteurized inoculation chambers for 60 min to facilitate diffusion of the antimicrobial agent into the medium. The plates were then incubated at 37°C for one day and the diameters of the zone of inhibition of microbial progression were measured in millimeters [10].

Economic value

Khyber Agency is rich in varieties of flora and has a diverse habitat. The flora is economically very important to the local people, who use it in caring for various diseases. Herbalists make traditional medicines which are the most common way available of caring for the most frequent diseases. The regional plant dealers sell the plants to local markets and export them to the International market as a way of earning money. The economic data collected from the local market sellers and analyzed it.

Results and discussion

In Khyber Agency, 58 plants were collected in the current survey from 2015 to 2016. These medicinal plants are sold locally as well as internationally in markets and support the economy of the local people. Only 11 medicinal plants are currently trading in national and international markets while the rest of the medicinal plants were used and sold locally. The local people of the area use indigenous medicinal flora for the treatment of many diseases and also sell many of them in the local market for earning their livelihood [3, 11, 12]. The use of the whole plant of the herb was the most frequent practice, which is present in the market for medicinal purpose. Different parts of plants are first dried and then converted into powder form which is then sold to markets (Table 1).

Plants like *Cuscuta reflexa* L., *Foeniculum vulgare*, *Medicago sativa* L., *Morus alba* L., *Morus indica* L., *Ficus palmata* Forssk. and *Ficus carica* L. are the plants which are frequently sold in the market for their medicinal value in the current survey, which is also cited by Sher and Hassan [13] in their research article in Northern part of Pakistan. In the current study, some plants were also reported, which are used for fuel purposes besides their medicinal values, viz., *Dodonaea viscosa* L., *Zizphus jujba* Mill. and *Zizphus nummularia* (Burn.f.). Ali et al. [14] also reported that these plants are sources of medicine and fuelwood which endorse our research work. The native families of the area are farmers, collection and selling of medicinal plants are their supplementary source of income. Earlier researchers like [3, 13-15] also conducted similar research studies and their research is in analogy with current research. Khyber agency contains some important medicinal flora for various disorders. The present survey documented some important medicinal flora for their international export like *Ammi visnaga*, *Artemisia Vulgaris*, *B. procumbens* L., and *Berberis lycium*, *Helianthus annuus* L., *Diospyrus lotus*, *Juglan sregia*, *Mentha arvensis* L., *Mentha logifolia* and *F. vulgare* to many other countries for medicinal purposes (Table 2). Khan and Khan, [16] also reported the same plants in the Mountain Region of Abbottabad and also documented the aforesaid plants export to different countries of the world. Other research scientists [16-18] also reported the export of medicinal plant to national and international markets which is mentioned in the current research study.

Antimicrobial activity of plants

In the present research study, the antimicrobial activity of some selected plants

was tested which showed a significant effect against different bacterial strains (Table 3). *B. procumbens*, *Chenopodium murale* and *E. helioscopia* were selected for antimicrobial activity. The leaves and flower extract of the aforementioned plants were tested against five bacterial species, viz., *B. subtilis*, *E. coli*, *P. fluorescens*, *S. aureus* and *X. axonopodis*. The extract of each plant showed a significant effect against all the selected five different species of bacteria. The extract of *J. adhatoda*, both the flower and leaves showed significant result against all selected species of bacteria, even higher than the standard antibiotic. *J. adhatoda* flower and leaves extract showed significant antimicrobial activity against the *B. subtilis* (18 ± 0.76 and 17 ± 0.10 respectively); the flower extract expressed an antimicrobial activity of 13 ± 0.16 against *E. coli*, while leaves extract 12.01 ; more also, the flower and leaf extracts exhibited antimicrobial activities of 12 ± 0.23 and 11 ± 0.03 against *P. fluorescens*, respectively. The present report showed the similarity with [19, 20]. The extract of *D. stramonium* showed significant antimicrobial activity against each bacterial species except *E. coli* to which the extract was not much effective. The leaves extract of *B. procumbens* exhibited significantly high antimicrobial activity but the flower extract was not much effective as compared to the leaves extract. The extract of *C. morale* was quite effective against *S. aureus* species while its antimicrobial activity against other species of bacteria was low compared to the other plants. The *E. helioscopia* leaves extract has a high potential for all bacterial species except *X. axonopodis* to which its antimicrobial effect was significantly low [21, 22].

Table 1. Marketing medicinal plants of Khyber agency

S. No.	Plant name	Local name	Family	Part use	Collection method	References
1	<i>Ajugabracteosa wall. ex. Benth</i>	Gotty	Lamiaceae	Whole plant	-	[3]
2	<i>Ammi visnaga</i>	Kaaga	Mimosaceae	Bark	Plucking	[3]
3	<i>Artemissia vulgaris</i>	Tarkha	Mimosaceae	Bark	Digging	[3]
4	<i>Bauhinia variegata L.</i>	Kachnar	-	Whole plant	Cutting	
5	<i>Boerhaviaprocumbens L.</i>	-	Nyctagianaceae	Whole plant	Cutting	
6	<i>Berberis lycium</i>	Goray	-	Latex	Digging, cutting	[3]
7	<i>Chenopodium botryst L.</i>	Surmahy	Chenopodiaceae	Whole plant	Picking	
8	<i>Chenopodium murale L.</i>	Toorsur Makhay	Chenopodiaceae	Whole plant	Picking	
9	<i>Convolvulus arvensisL.</i>	Prewata	Convolvulaceae	Roots and Leaves	Picking	
10	<i>Corindrum sativum L.</i>	Daria	Apiaceae	Leaves and Seeds	Picking	[3]
11	<i>CuscutareflexaL.</i>	Pachy	Cuscutaceae	Whole plant	Cutting	
12	<i>Carthamus oxycantha M. bieb</i>	-	Asteraceae	Seed	Cutting	
13	<i>Cyperus rotundus</i>	Dela	Cyperaceae	Whole plant	Digging	
14	-	Tor Amlok	Ebenaceae	Wood/Fruit	Cutting	
15	<i>Cucurbita pepo L.</i>	Kado	Cucurbitaceae	Fruit	Cutting	
16	<i>Calendula officinalis L.</i>	Ziar gul	Asteraceae	Shoot/ flower	Plucking	
17	<i>Diospyrus lotus L.</i>	SoorAmlok	Ebenaceae	Wood/fruit	Cutting, Plucking	[3]
18	<i>Datura stramonium L.</i>	Datura	Solanaceae	Seed/ leaves	Plucking	
19	<i>Helianthus annus L.</i>	Nwar parst	Compositae	Whole plant	Plucking	
20	<i>Hederanepalensis K. Koch</i>	Perwathe	Araliaceae	Fruit leave	Plucking	
21	<i>Dodonea viscosa (L.)</i>	Khamba	Sapindaceae	Whole plant	Plucking	
22	<i>Diospyrus lotus</i>	-	-	Leaves	Plucking	[3]
23	<i>Euphorbia helioscopia Mewski</i>	Gandabotay	Euphorbiaceae	Whole plant	Plucking	
24	<i>Euphorbia prostrata L.</i>	Gandabotay	Euphorbiaceae	Whole plant	Plucking	
25	<i>Eryobotrya japonica (Thunb) Lindle</i>	Lokat	Rosaceae	Wood/ fruit	Cutting, plucking	
26	<i>Fumaria indica L.</i>	Nelay	Fumariaceae	Whole plant	Digging	
27	<i>Ficus palmata Forssk.</i>	Enzar	Moraceae	Whole plant	Plucking	
28	<i>Ficus carica L.</i>	Baghe inzar	Moraceae	Whole plant	Plucking	
29	<i>Ficus religiosa Roxb.</i>	Peepal	Moraceae	Wood	Cutting	
30	<i>Foeniculum vulgare Mill.</i>	Kaga	Apiaceae	Seed and leaves	Plucking	[3]
31	<i>Jusitcia adhatoda L.</i>	Baikaar	Acanthaceae	Leave, root	Digging	
32	<i>Jasminum humile L.</i>	Chamba	Oleaceae	Root, leaves	Plucking	
33	<i>Juglans regia</i>	Guz	-	Root, leaves	Plucking, cutting	
34	<i>Luffa cylindrical (L.) Room</i>	Torai	Cucurbetaceae	Whole plant	Cutting, plucking	
35	<i>Lactuca serriola L.</i>	Shenaygul	Asteraceae	Leaves	Plucking	
36	<i>Melia azedarach L.</i>	Bakyane	Meliaceae	Whole plant	Cutting	

37	<i>Mentha arvensis</i> L.	Podina	Lamiaceae	Leaves	Cutting, plucking	
38	<i>Mentha longifolia</i> (L.) Huds	Wenaly	Lamiaceae	Leaves	Plucking	
39	<i>Morus alba</i> L.	Speen tooth	Moraceae	Fruit	Plucking, cutting	
40	<i>Morus indica</i> L.	Toor Tooth	Moraceae	Fruit	Plucking, cutting	
41	<i>Medicago sativa</i> L.	Peshtary	Papilionaceae	Whole plant	Picking	
42	<i>Malva neglecta</i> Wallr	Panderak	Malvaceae	Whole plant	Picking	
43	<i>Narcissus tazetta</i> L.	Gul-e- nargis	Amaryllidaceae	Flower	Plucking	
44	<i>Nostorium officinale</i> R.Br.	Tarmeera	Brassicaceae	Seed	Plucking	
45	<i>Zizphus jujba</i> Mill.	Bari	Rhamnaceae	Fruit	Plucking	
46	<i>Zizphus nummularia</i> (Burn.f.) Wight	Karkara	Rhamnaceae	Fruit	Plucking	
47	<i>Oxalis corniculata</i> L.	Gulbusho	Oxalidaceae	Whole plant	Plucking	

Note. The other plant species and collection method is first reported in the present survey. No literature was found for collection of the plants or plants part in country before same is also in export

Table 2. List of plants traded in National and International Markets from Khyber agency, Pakistan

S. No.	Plant names	Local name	Family	Parts used and export	Export locally	Export to international market	Price per kg	Amount transport per season	References
1	<i>Ammi visnaga</i>	Kaga	Mimosaceae	Bark	Peshawar, Lahore	-	180	10,00	
2	<i>Artemisia vulgaris</i>	-	Mimosaceae	Bark	Lahore	-	100	50,000	
3	<i>Berberis lyceum</i>	Koray, zairlargay	Berberidaceae	Latex	Peshawar, Lahore, Karachi	India, Germany, Iran, Europe	300	100,000	
4	<i>Boerhavia procumbens</i> L.	-	Nyctagianceae	Whole plant	-	-	-	30,000	
5	<i>Diospyrus lotus</i>	Perseman	Ebenaceae	Leaves	Peshawar, Lahore	-	40	100,000	[18]
6	<i>Diospyrus kaki</i>	Tooramlook	Ebenaceae	Leaves	Peshawar, Lahore	-	40	100,000	[18]
7	<i>Foeniculumvulgare</i>	Kaga	Umbelliferae	Seeds	Peshawar, Karachi, Lahore	India, Europe	400	10,000	[18]
8	<i>Helianthus annus</i> L.	Nwarparst	Compositae	Whole plant	Lahore, Karachi, Faisalabad	Belgium, France, India	100	20,000	[18]
9	<i>Juglans regia</i>	Guzz	Juglandaceae	Root/Leaves	Peshawar, Lahore	Saudi Arabia, Dubai, China	1000	1,80,000	[18]
10	<i>Mentha arvensis</i> L.	Podina	Lamiaceae	Leaves	Peshawar, Lahore	China, Afghanistan	100	100,000	[18]
11	<i>Mentha logifolia</i> (L) Huds	Wenaly	Lamiaceae	Leaves	Peshawar, Lahore	China, Saudi Arabia	100	80,000	[18]

Table 3. Antibacterial activity of some medicinal plants, methanol extract (100µg/ml) and antibiotic (80µg/ml) against bacterial species tested by the disc diffusion assay

Bacterial strain	<i>Justicia adhatoda</i>		<i>Datura stramonium</i>		<i>Boerhaviaprocumbens</i>		<i>Chenopodium murle</i>		<i>Euhorbia helioscopia</i>		<i>Streptomycin sulphate</i>
	Flower	Leaves	Flower	Leaves	Flower	leaves	Flower	Leaves	Flower	Leaves	
<i>Bacillus subtilis</i>	18±0.76	17±0.10	16±0.06	15±0.27	14±0.26	13±0.16	12±0.18	11±0.27	10±0.21	16±0.36	15±0.16
<i>Escherichia coli</i>	13±0.16	12±0.11	11±0.10	10±0.10	7±0.70	11±0.02	13±0.21	14±0.26	13±0.03	16±0.03	17±0.18
<i>Pseudomonas fluorescens</i>	12±0.23	11±0.03	12±1.21	16±1.90	10±0.43	12±0.01	11±0.56	13±0.16	11±0.21	11±0.31	13±0.14
<i>Staphylococcus aureus</i>	13±0.27	11±0.12	14±0.08	16±0.01	10±0.53	13±0.24	13±0.13	13±0.76	11±0.03	11±0.44	14±0.15
<i>Xanthomonasaxo nopodis</i>	11±0.27	10±0.12	14±0.07	14±0.28	13±0.22	15±0.01	11±0.10	14±0.25	11±0.23	10±0.08	16±0.16

Conclusion

The current study was initiated because of the increasing resistance to antibiotics including bacteria. In Khyber Agency, 58 plants were collected in the current survey during 2015 to 2016. These medicinal plants are sold locally as well as internationally in markets and support the economy of the local peoples. Only 11 medicinal plants are currently trading in national and international markets, while the rest of the medicinal plants were used and sold locally. *J. adhatoda*, *D. stramonium*, *B. procumbens*, *C. murale* and *E. helioscopia* were selected for antimicrobial activity. The leaves and flowers extracts of each plant showed a significant effect against all the selected five different species of bacteria. The emergence of new infectious diseases, the resurgence of several infections that appeared to have been controlled and the increase in bacterial resistance have created the necessity for studies of more and more plants for their antimicrobial activity. In future these six medicinal species need to explore for the novel compounds, to play role in modern medicine against bacteria.

Authors' contributions

Conceived and designed the experiments: M Arif & M Shuaib. Performed the experiments: K Ali, U Zeb & Z Urooj, Analyzed the data: SQ Shah, AB Khan & F Hussain. Contributed reagents/materials/ analysis tools: S Hussain, SS Shah, S Ahmed T Aslam & M Shah. Wrote the paper: M Shuaib, I Khan & F Hussain.

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