ANTIBACTERIAL ACTIVITY OF SOME MEDICINAL PLANTS AGAINST SELECTED HUMAN PATHOGENIC BACTERIA

Usman Ali Khan¹, Hazir Rahman^{2,*}, Zeeshan Niaz¹, Muhammad Qasim², Jafar Khan², Tayyaba² and Bushra Rehman²

¹Department of Microbiology, Hazara University, Mansehra, Khyber Pakhtunkhwa, Pakistan

²Department of Microbiology, Kohat University of Science and Technology, Kohat, Khyber Pakhtunkhwa, Pakistan

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Medicinal plants are traditionally used for the treatment of human infections. The present study was undertaken to investigate *Bergenia ciliata*, *Jasminum officinale*, and *Santalum album* for their potential activity against human bacterial pathogens.

B. ciliata, *J. officinale*, and *S. album* extracts were prepared in cold and hot water. The activity of plant extracts and selected antibiotics was evaluated against five bacterial pathogens including *Staphylococcus aureus*, *Bacillus subtilis*, *Proteus vulgaris*, *Pseudomonas aeruginosa*, and *Escherichia coli* using agar well diffusion method.

Among the three medicinal plants, *B. ciliata* extracts displayed potential activity against bacterial pathogens. Cold water extract of *Bergenia ciliata* showed the highest activity against *B. subtilis*, which is comparable with a zone of inhibition exhibited by ceftriaxone and erythromycin. *J. officinale* and *S. album* extracts demonstrated variable antibacterial activity. Further studies are needed to explore the novel antibacterial bioactive molecules.

Keywords: plant extracts, antibacterial activity, *Bergenia ciliata*, *Jasminum officinale*, *Santalum album*

Introduction

Plants are prospective source of antimicrobial agents in different countries [1]. About 60 to 90% of populations in the developing countries use plant-derived medicine. Traditionally, crude plant extracts are used as herbal medicine for the treatment of human infectious diseases [1–3]. Plants are rich in a variety of phytochemicals including tannins, terpenoids, alkaloids, and flavonoids which have been found *in vitro* to have antimicrobial properties [4, 5]. Although the mechanism of action and efficacy of these herbal extracts in most cases is still needed to be validated scientifically, these preparations mediate important host responses [6, 7].

Global prevalence of infectious diseases caused by bacteria is a major public health problem [3, 8]. The bacterial agents including *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, and *Proteus vulgaris* cause several human infections [9, 10]. Recent emergence of antibiotic resistance and related toxicity issues limit the use of antimicrobial agents [11] and is prompting a revival in research of the antimicrobial role of plants against resistant strains due to comparable safety and efficacy [1]. In Pakistan, a diverse flora of medicinal plants is grown naturally [12, 13].

The present study investigated the activity of three medicinal plants including *Bergenia ciliata*, *Jasminum officinale*, and *Santalum album* against human pathogenic bacteria.

Materials and methods

The antibacterial activity of medicinal plants was carried out against pathogenic bacterial strains in Microbiology Research Laboratory, Hazara University, Mansehra, Pakistan.

Subculturing of bacterial strains

Nutrient broth was used for subculturing of bacterial strains. The media was prepared according to manufacturer's instructions (Oxoid, UK). Bacterial cultures were inoculated on nutrient broth and incubated overnight at 37 °C.

Collection of plant material and preparation of powder

Plant materials from three medicinal plants including *B. ciliata* (roots), *J. officinale* (leaves), and *S. album* (wood)

*Corresponding author: Dr. Hazir Rahman; Department of Microbiology, Kohat University of Science and Technology, Kohat, Pakistan; E-mail: hazirrahman@hotmail.com

were obtained from different locations of Hazara division. The ethnobotanical study of these plants was studied and confirmed by botany expert at Hazara University Herbarium, Mansehra. The collected plant materials were dried under shade and then mashed with the help of mortar and pestle.

Extraction procedure and antibacterial activity of plant extracts

The powder of plants was processed for cold and hot water extraction. For cold water, 10 g dried powder of each plant was soaked in 100 ml distilled water and rotated on shaker at 150 rpm for 24 h. For hot water, 10 g of dried powder was soaked in 100 ml distilled water and then heated at 60 °C in incubator for 24 h. The extracts were sieved through a muslin cloth and then centrifuged at 4400 rpm for 7 min. The supernatant was collected and then filtered. Centrifugation and filtration process were repeated three times. Following plant extraction, antibacterial activity of these extracts against *B. subtilis*, *E. coli*, *P. vulgaris*, *P. Aeruginosa*, and *S. aureus* was determined by agar well diffusion method as described [14]. Ceftriaxone (CRO) and erythromycin (E) were incorporated as positive control while cold and hot water without plant extract was incorporated as negative control.

Data analysis

All the experiments were independently repeated three times, and average zone of inhibition of test extracts relative to negative control was calculated using Microsoft Excel 2007 software.

Results

In the present study, antibacterial activity of *B. ciliate*, *J. officinale*, and *S. album* was recorded against *B. subtilis*, *E. coli*, *P. vulgaris*, *P. Aeruginosa*, and *S. aureus*.

Plant extracts dissolved in cold and hot water showed variable antibacterial activity against selected bacterial pathogens.

The extract of *B. ciliata* (root) was evaluated for *in vitro* antibacterial activity against *B. subtilis*, *E. coli*, *P. vulgaris*, *P. Aeruginosa*, and *S. aureus*. The zones of inhibition (mm) exhibited by plant extracts are listed in Table 1. The zone of inhibition (if any) by negative control (agar well containing cold and hot water without plant extract) was subtracted from the zone of inhibition showed by plant extracts. Extracts dissolved in cold water showed maximum *B. subtilis* (19 mm), *E. coli* (17 mm), *S. aureus* (16 mm), *P. aeruginosa* (16 mm), and *P. vulgaris* (15 mm). Similarly, in hot water extracts, the results were as follows: *E. coli* (19 mm), *P. aeruginosa* (17 mm), *P. vulgaris* (16 mm), *B. subtilis* (14 mm), and *S. aureus* (13 mm).

The cold water extract of *J. officinale* (leaves) showed 16 mm zone of inhibition against *P. aeruginosa* followed by *B. subtilis* (13 mm), *E. coli* (7 mm), and *P. vulgaris* (7 mm) (Table 1).

The cold water extract of *S. album* (wood) showed a zone of inhibition (15 mm) against *P. vulgaris* followed by *B. subtilis* (14 mm), *E. coli* (10 mm), and *P. aeruginosa* (9 mm). Plant extracts in hot water showed inhibition zone of 16 mm and 11 mm against *P. aeruginosa* and *P. vulgaris*, respectively, while no activity was observed against *B. subtilis*, *E. Coli*, and *S. aureus* (Table 1).

Discussion

Global burden of infectious diseases caused by bacterial agents is a serious threat to public health [11]. Antibiotic treatment is a preferred choice to treat bacterial infections; however, emergence of antimicrobial resistance and toxicity issues subside the use of antibacterial agents [2, 3]. Safety- and efficacy-related limitations to antibiotics augment biological research on the antimicrobial role of plants due to comparable toxicity and efficacy [1].

In Pakistan, a diverse flora of medicinal plants is grown naturally [12]. In the present study, we have investigated the antibacterial activity of three naturally growing plants:

Table 1. Comparison of cold and hot water plant extracts against pathogenic bacteria

Bacterial strains	<i>Bergenia ciliata</i> (mm)*		<i>Jasminum officinale</i> (mm)*		<i>Santalum album</i> (mm)*		Control (mm)	
	Cold water	Hot water	Cold water	Hot water	Cold water	Hot water	CRO**	E***
<i>Bacillus subtilis</i>	19	14	13	Nil	14	Nil	20	19
<i>Escherichia coli</i>	17	19	7	Nil	10	Nil	24	35
<i>Proteus vulgaris</i>	15	16	7	Nil	15	11	23	19
<i>Pseudomonas aerogenosa</i>	16	17	16	9	9	16	20	19
<i>Staphylococcus aureus</i>	16	13	Nil	Nil	Nil	Nil	20	20

*Average zone of inhibition in mm relative to negative control (only hot or cold water); **CRO: ceftriaxone;

***E: erythromycin

B. ciliata, *J. officinale*, and *S. album*. The biological activity of these plant extracts was tested against known human bacterial pathogens.

Findings from the current study revealed that *B. ciliata* extract has potential inhibitory effects on all tested bacteria in both cold water and hot water while the extracts of *J. officinale* and *S. album* show limited inhibitory effects on few tested bacteria in both cold and hot water. The cold water extract of *B. ciliate* showed maximum activity against *B. subtilis* (19 mm), which is comparable with a zone of inhibition exhibited by ceftriaxone (20 mm) and erythromycin (19 mm).

Root extract of *B. ciliata* dissolved in cold water showed maximum activity against *B. subtilis* while hot water extract showed maximum inhibitory effect on *E. coli*. Similarly, *P. aeruginosa* and *S. aureus* in cold water extract have experienced maximum inhibition. Our observation is in line with a previous study using different extracts of *B. ciliate* activity against *B. subtilis* and *P. aeruginosa* [15].

A study of zone of inhibition against bacterial strains with leaves extracts of *J. officinale* revealed that all bacteria subjected to cold water extract showed minimum zone of inhibition except for *S. aureus*, which showed resistance. However, all bacteria against hot water extract showed resistance except for *P. aeruginosa*. A previous study conducted by Ertürk [16] assessed the antibacterial activities of crude ethanolic extracts of *J. officinale* against *B. subtilis*, *E. coli*, *S. Aureus*, and *P. aeruginosa*. They observed impending antimicrobial activity of *J. officinale* extracts. These contrasting findings show that antibacterial substance produced by *J. officinale* might be more soluble in ethanolic extract as compared to water.

The third plant assessed for antibacterial activity was *S. album*. The zone of inhibition against bacterial strains with extracts of *S. album* presented that all tested bacteria except for *S. aureus* were inhibited in cold water extracts while in hot water extract only *P. aeruginosa* showed maximum inhibition zone. *P. vulgaris* showed minimum inhibition zone while other bacteria were resistant to plant extract dissolved in hot water. A previous study [17] observed that *S. album* leaves and stem aqueous extracts have prospective activity against *E. coli*, *S. Aureus*, and *P. aeruginosa*. *S. album* leaves extract showed inhibition to *E. coli* (0.8 mm), *S. aureus* (1.0 mm), and *P. aeruginosa* (1.4 mm) while stem extract showed inhibition to *E. coli* (0.6 mm), *S. aureus* (0.4 mm), and *P. aeruginosa* (1.0 mm). Findings of Giriram Kumar et al. (2006) are different from the current work. This might be due to difference in extraction method, media used, environmental conditions and metabolic stress on plant, and soil, plant, and bacterial diversity in that region.

Conclusions

It was investigated that *B. ciliata*, *J. officinale*, and *S. album* showed potential antibacterial activity against human pathogens. Further phytochemical analysis of

these plants will be helpful for elucidation of lead molecules.

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