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Research Article

Antibacterial activity of Mangrove Medicinal Plants against Gram positive Bacterial pathogens

K. A. Selvam* and K. Kolanjinathan

Division of Microbiology, Faculty of Science, Annamalai University,
Annamalai Nagar – 608 002, Tamil Nadu, India
*Corresponding author

Abstract

Ten mangrove medicinal plants *viz*., *Avicennia marina*, *Rhizophora mucuronata*, *Rhizophora mangle*, *Asparagus officinalis*, *Ceriops decandra*, *Aegiceras corniculatum*, *Acanthus ilicifolius*, *Bruguiera cylindrica*, *Rhizophora apiculata* and *Xylocarpus grantum* were collected from mangrove forest of Pichavaram, Tamil Nadu, India. The antibacterial activity of mangrove plant extracts (150 mg/ml and 300 mg/ml) were determined by Disc diffusion method. The zone of inhibition was more at 300 mg/ml of extracts when compared to 150 mg/ml of extracts. The antibacterial activity of selected mangrove plant leaf extracts was determined against pathogenic bacterial isolates. The methanol extract of *Ceriops decandra* showed maximum zone of inhibition against all the bacterial isolates followed by *Avicennia marina*, *Rhizophora mucronata*, *Aegiceras corniculatum*, *Rhizophora apiculata*, *Rhizophora mangle*, *Acanthus ilicifolius*, *Asparagus officinalis*, *Xylocarpus grantum* and *Bruguiera cylindrica* at 300 mg/ml**.** The hexane extract of mangrove plants showed minimum inhibition zone against bacterial pathogens when compared to the other solvent extracts. The DMSO was used as a blind control and the antibiotic Ampicillin (300 mg/ml) was used as a positive control. Minimum inhibitory concentration (MIC) of the mangrove plant extracts against bacterial isolates was tested in Mueller Hinton broth by Broth macro dilution method. The MIC of mangrove plants against bacterial pathogens was ranged between 20 mg/ml to 640 mg/ml.

Keywords: Mangrove medicinal plants, *Staphylococcus aureus*, *Bacillus cereus Streptococcus pyogenes* and Antibacterial activity.

Introduction

Infectious diseases are the world's leading cause of premature deaths (Emori and Gaynes, 1993). Furthermore, various hard work have been made to discover new antimicrobial compounds from many kinds of natural sources such as plants, animals, fungi, bacteria and other microorganism. It is because the phenomenon that many pathogenic bacteria become resistant to antibiotics. In addition, many synthetic antibiotics smoothly confirm the terrible effect in term of health and bacterial resistance. Contrary to the synthetic antibiotic, antimicrobials of plant origin are not associated with many side effects and have an enormous therapeutic potential to heal many infectious diseases (Iwu, 1999).

The indiscriminate use of commercial antimicrobial drugs has caused multiple drug resistance in human pathogenic microorganism in addition this problem, hypersensitivity, immune-suppression and allergic reactions are sometimes present from the adverse effects of antibiotics on the host (Nebedum *et al*. 2009). Plant based antimicrobial properties provide additional information in developing natural; antibiotics and discovering the alternative of antimicrobial drugs for the treatment of infective disease.

The problem of microbial resistance is growing and the outlook for the use of antimicrobial drugs in the future is still uncertain. Therefore, actions must be taken to reduce this problem, for example, to control the use of antibiotic, develop research to better understand the genetic mechanisms of resistance, and to continue studies to develop new drugs, either synthetic or natural. The ultimate goal is to offer appropriate and efficient antimicrobial drugs to the patient. Medicinal plants are known to produce certain bioactive molecules which react with other organisms in the environment, inhibiting bacterial or fungal growth (Chopra *et al*., 1992; Bruneton,1995).

Mangroves are woody trees or shrubs and the salt marsh halophytes are herbs and sledges. The mangrove plants are distributed in 121 countries and Pichavaram mangrove forest is one of the coastal ecosystems of Tamil Nadu, India with rich vegetation. Mangroves are used in traditional medicine for the treatment of many diseases (Kirtikar and Basu, 1991). Mangrove is an ecological term referring to a taxonomically diverse assemblage of trees and shrubs that form the dominant plant communities in tidal, saline wetlands along sheltered tropical and subtropical coasts. Economically, mangroves are a great source of timber, poles, thatch and fuel, and the bark is used for tanning materials; some species have food or medicinal value.

Mangrove plant extracts have been used for centuries as popular method for treating several health disorders. Plant-derived substances have recently become of great interest owing to their versatile applications. Besides, mangroves also provide many non timber products such as tannin, fish poison, medicine, food and fodder (Bandaranayake, 2002). Mangroves are biochemically unique, producing a wide array of novel natural products. Mangrove and mangrove associates contain biologically active antiviral, antibacterial and antifungal compounds (Bandaranayake, 1998).

Materials and Methods

Collection of mangrove medicinal plants leaves

The leaves of mangrove medicinal plants *viz*., *viz*., *Avicennia marina*, *Rhizophora mucuronata*, *Rhizophora mangle*, *Asparagus officinalis*, *Ceriops decandra*, *Aegiceras corniculatum*, *Acanthus ilicifolius*, *Bruguiera cylindrica*, *Rhizophora apiculata* and *Xylocarpus grantum* were collected from mangrove forest of Pichavaram, Tamil Nadu, India and the collected plants were used for the present investigation.

Collection of bacterial cultures

Three different Gram positive bacterial cultures *viz*., *Staphylococcus aureus* (MTCC), *Bacillus cereus* (MTCC) and *Streptococcus pyogenes* (MTCC) were procured from Microbial Type Culture Collection (MTCC), Chandigarh, India.

Disc Preparation

Six mm (6 mm) diameter discs were prepared using sterile Whatmann No.1 filter paper. The mangrove medicinal plants extracts (150 mg/ml and 300 mg/ml) obtained using solvents (hexane, chloroform, ethyl acetate, acetone and methanol) were mixed with 1 ml of 5% Dimethyl sulfoxide (DMSO). The discs were impregnate with 20 μl of different solvent extracts to check their antibacterial activity. The Ampicillin (300 mg/ml) was used as positive control and the 5% DMSO was used as a blind control.

Antibacterial assay

The antibacterial activity of mangrove medicinal plants was determined by Disc diffusion method proposed by Bauer *et al*. (1966). Petriplates were prepared by pouring 20 ml of Mueller Hinton agar and allowed to solidify for the use in susceptibility test against bacteria. Plates were dried and 0.1 ml of standardized inoculum suspension was poured and uniformly spreaded. The excess inoculum was drained and the plates were allowed to dry for five minutes. After drying, the discs with extract were placed on the surface of the plate with sterile forceps and gently pressed to ensure contact with the agar surface. The Ampicillin (300 mg/ml) was used as positive control and the 5% DMSO was used as a blind control in these assays. The plates were incubated at 37°C for 24 hours. The zone of inhibition was observed and measured in millimeters. Each assay in these experiments was repeated three times for concordance.

Minimum inhibitory concentration for bacteria

Minimum inhibitory concentration (MIC) of the mangrove medicinal plants extracts against bacterial isolates was tested in Mueller Hinton broth by Broth macro dilution method (Ericsson and Sherri, 1971). The mangrove plant extracts were dissolved in 5% DMSO to obtain 160 µg/ml stock solutions. 0.5 ml of stock solution was incorporated into 0.5 ml of Mueller Hinton broth for bacteria to get a concentration of 20, 40, 80, 160, 320 and 640 mg/ml for mangrove medicinal plants and 50 µl of standardized suspension of the test organism was transferred on to each tube. The control tube contained only organisms and devoid of mangrove plant extracts. The culture tubes were incubated at 37^{o}C for 24 hours. The lowest concentration, which did not show any growth of tested organism after macroscopic evaluation was determined as Minimum inhibitory concentration (MIC).

Results and Discussion

Mangrove plant extracts have been used for centuries as a popular method for treating several health disorders. Plant derived substances have recently become of great interest owing to their versatile applications. Mangroves are biochemically unique, producing a wide array of novel natural products. Mangrove and mangrove associates contain biologically active antiviral, antibacterial and antifungal compounds (Vadlapudi and Naidu, 2009). The effects of mangrove extracts on some microorganisms including *Shigella* sp., *Staphylococcus* sp. and *Pseudomonas* sp. has been reported in some studies in the area of pharmacology (Abeysinghe *et al*., 2006). Also different type of solvents including ethanol, chloroform, ethyl acetate have been used for extraction (Ravikumar *et al*., 2010).

Mangrove plants are the best choice to isolate bioactive natural products activity against bacteria and fungi. The antibacterial activity of mangroves against fish pathogens has already been studied by many author. The extracts of *Avicennia* species showed a broad spectrum antimicrobial activity against *Candida albicans*, *Mycobacterium vaccae*, *Mycobacterium aurum*, *Mycobacterium smegmatis*, *Mycobacterium fortuitum* and *Staphylococcus aureus*. The plant extract from various parts of *Avicennia marina* had growth inhibitory effects on fungus and gram positive bacteria. The minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC) and minimum fungicidal concentration (MFC) values were determined for some these extract (Han *et al*., 2007; Jun *et al.,* 2008).

The antibacterial activity of selected mangrove leaf extracts were determined against pathogenic bacteria *Staphylococcus aureus* and the results were furnished in Table **-** 1. The zone of inhibition was more at 300 mg/ml of extracts when compared to 150 mg/ml of extracts. The methanol extract of *Ceriops decandra* (300 mg/ml) showed maximum zone of inhibition against *Staphylococcus aureus* (19 ± 0.0 mm) followed by *Avicennia marina* (18 ± 0.3 mm), *Rhizophora mucronata* (16 ± 0.2 mm), *Aegiceras corniculatum* (15 ± 0.6 mm) *Rhizophora apiculata* (15 ± 0.6 mm), *Rhizophora mangle* (15 ± 0.4 mm), *Acanthus ilicifolius* (15 ± 0.3 mm), *Asparagus officinalis* (15 ± 0.0 mm), *Xylocarpus grantum* (14 ± 0.3 mm) and *Bruguiera cylindrica* (13 ± 0.6 mm) at 300 mg/ml**.** The hexane crude extract of *Ceriops decandra* showed minimum zone of inhibition against *Staphylococcus aureus* when compared to the other solvent extracts. No zone of inhibition was recorded in DMSO blind control and the positive control Ampicillin (300 mg) showed 22 ± 0.5 mm zone of inhibition against the *Staphylococcus aureus*.

The minimum inhibitory concentration (MIC) of mangrove plants against *Staphylococcus aureus* and it was ranged between 20 mg/ml to 640 mg/ml and the results were showed in Table **-** 2. The methanol extract of *Ceriops decandra, Avicennia marina, Rhizophora mucronata, Rhizophora mangle, Rhizophora apiculata* and *Aegiceras corniculatum* showed best MIC at 20 mg/ml against *Staphylococcus aureus*. *Acanthus ilicifolius*, *Asparagus officinalis* and *Xylocarpus grantum* showed best MIC at 40 mg/ml and *Bruguiera cylindrica* showed best MIC at (80 mg/ml).

Chandrasekaran *et al*. (2009) studied the antibacterial activity of aqueous and methanol extracts of leaves/shoots of five salt marsh halophytes and six mangroves against Methicillin resistant, clinical isolates of *Staphylococcus aureus*. There was a clear comparability between the salt marsh halophytes and mangroves in their antibacterial action. The mangrove plants possessed higher antibacterial potency than the salt marsh halophytes. The highest activity was recorded with the methanol extract of *Excoecaria agallocha* followed by the methanol extracts of *Aegiceras corniculatum*, *Lumnitzera racemosa* and *Ceriops decandra*. The minimum inhibitory concentration (MIC) values ranged from 0.125 to 4 mg/mL and 1 to 16 mg/ml for methanol and aqueous extracts.

The antibacterial activity of selected mangrove leaf extracts were evaluated against *Streptococcus pyogenes* and the results were given in Table - 3. The zone of inhibition was more at 300 mg/ml of extracts when compared to 150 mg/ml of plant extracts. The methanol extract of *Ceriops decandra* (300 mg/ml) showed maximum mean zone of inhibition against *Streptococcus pyogenes* (20 ± 0.4 mm) followed by *Avicennia marina* (17 ± 0.6 mm), *Rhizophora mucronata* (17 ± 0.3 mm), *Aegiceras corniculatum* (16 ± 0.9 mm), *Rhizophora apiculata* (16 ± 0.3 mm), *Rhizophora mangle* (15 ± 0.3 mm), *Acanthus ilicifolius* (14 ± 0.4 mm), *Asparagus officinalis* (14 ± 0.2 mm), *Xylocarpus grantum* (13 ± 0.8 mm) and *Bruguiera cylindrica* (13 ± 0.0 mm) at 300 mg/ml**.** The hexane crude extract of *Ceriops decandra* showed minimum zone of inhibition against *Streptococcus pyogenes* when compared to the other solvent extracts. No zone of inhibition was observed in DMSO blind control and the positive control Ampicillin (300 mg) showed 21±0.3 mm zone of inhibition against the *Streptococcus pyogenes*.

The minimum inhibitory concentration (MIC) of mangrove plants against *Streptococcus pyogenes* was ranged between 20 mg/ml to 640 mg/ml and the results were showed in Table - 4. The methanol extract of *Ceriops decandra* showed best MIC at 20 mg/ml against *Streptococcus pyogenes*. *Avicennia marina, Rhizophora mucronata, Aegiceras corniculatum, Rhizophora apiculata, Rhizophora mangle* and *Asparagus officinalis* showed best MIC at 40 mg/ml. *Acanthus ilicifolius, Bruguiera cylindrica* and *Xylocarpus grantum* showed best MIC at 80 mg/ml.
Ravikumar *et al*. (2011) tested the antibacterial activity of the mangrove leaves of *Avicennia marina, Ceriops decandra* and *Bruguiera cylindrica* against antibiotic resistant pathogens *viz*. *Staphylococcus aureus, Streptococcus pneumoniae, Klebsiella pneumoniae, Pseudomonas aeruginosa* and eye pathogens *viz. Escherichia coli, Proteus, Acinetobacter* and *Staphylococcus epidermidis.* Most of the plant extracts showed promising antibacterial activity against both the bacterial groups. However, Maximum antibacterial activity was observed with the leaf extract of *Avicennia marina* with the zone of inhibition 7.12±0.11 mm against *Pseudomonas aeruginosa* followed by *Bruguiera cylindrical* (6.8 ± 0.84 mm) and *Ceriops decandra* (6.02 ± 0.02). Moreover, the leaf extract of *Avicennia marina* (11.21 ± 0.74mm) showed highest zone of inhibition against eye pathogens of *Streptococcus epidermidis* followed by and against *Acinetobacter* 9.21 ± 0.94 and *Escherichia coli* 8.23 ± 0.86 respectively. The *Avicennia marina* has Minimum inhibitory concentration (MIC) value of 50 µg ml/L as against *Pseudomonas aeruginosa, Acinetobacter* sp. and *Escherichia coli* followed by MIC value of 100 µg ml/L against *Klebsiella pneumoniae* and *Staphylococcus epidermidis*.

The antibacterial activity of selected mangrove leaf crude extracts was tested against pathogenic bacteria *Bacillus cereus* and the results were tabulated in Table - 5. The zone of inhibition was more at 300 mg/ml of extracts when compared to 150 mg/ml of extracts. The methanol extract of *Ceriops decandra* (300 mg/ml) showed maximum mean zone of inhibition against *Bacillus cereus* (18 ± 0.3 mm) followed by *Avicennia marina* (18 ± 0.2 mm), *Rhizophora mucronata* (17 ± 0.5 mm), *Aegiceras corniculatum* (16 ± 0.6 mm), *Rhizophora apiculata* (16 ± 0.4 mm), *Rhizophora mangle* (15 ± 0.3 mm), *Acanthus ilicifolius* (14 ± 0.6 mm), *Asparagus officinalis* (13 ± 0.4 mm), *Xylocarpus grantum* (12 ± 0.5 mm) and *Bruguiera cylindrica* (12 ± 0.2 mm) at 300 mg/ml**.** The hexane crude extract of *Ceriops decandra* showed minimum zone of inhibition against *Bacillus cereus* when compared to the other solvent extracts. No zone of inhibition was observed in DMSO blind control and the positive control Ampicillin (300 mg) showed 20± 0.5 mm zone of inhibition against the *Bacillus cereus*.

The minimum inhibitory concentration (MIC) of mangrove plants against *Bacillus cereus* was ranged between 20 mg/ml to 640 mg/ml and the results were showed in Table - 6. The methanol extract of *Ceriops decandra, Avicennia marina, Rhizophora mucronata* and *Aegiceras corniculatum* showed best MIC at 20 mg/ml against *Bacillus cereus*. *Asparagus officinalis, Rhizophora apiculata, Rhizophora mangle* and *Acanthus ilicifolius* recorded best MIC at 40 mg/ml. *Xylocarpus grantum* and *Bruguiera cylindrica* showed best MIC at 80 mg/ml.

Table - 1: Antibacterial activity of mangrove medicinal plants against *Staphylococcus aureus*

Concentration of the mangrove leaf extracts (mg/ml) and Zone of inhibition (mm)											
Name of the plants	**Hexane**		**Chloroform**		**Ethyl acetate**		**Acetone**		**Methanol**		**Positive control***
	150 mg/ml	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**300 mg/ml**
Avicennia marina	9±0.5	12±0.4	9±0.5	13±0.4	10±0.3	12±0.6	15±0.3	18±0.3	15±0.5	18±0.3	22±0.5
Rhizophora mucronata	9±0.6	12±0.3	10±0.3	12±0.2	12±0.4	14±0.3	12±0.2	14±0.3	12±0.5	16±0.2	
Ceriops decandra	10±0.6	12±0.6	13±0.3	15±0.4	13±0.3	15±0.5	14±0.3	18±0.5	14±0.5	19±0.0	
Rhizophora mangle	8±0.6	11±0.5	10±0.4	12±0.6	11±0.6	13±0.3	13±0.2	15±0.2	13±0.5	15±0.4	
Asparagus officinalis	8±0.3	11±0.3	10±0.3	12±0.5	10±0.3	12±0.5	11±0.5	13±0.3	12±0.3	15±0.0	
Aegiceras corniculatum	8±0.2	12±0.7	9±0.3	11±0.4	9±0.4	12±0.3	12±0.8	15±0.3	13±0.5	15±0.6	
Acanthus ilicifolius	9±0.5	11±0.4	10±0.4	12±0.3	10±0.3	14±0.2	12±0.5	15±0.2	13±0.8	15±0.3	
Bruguiera cylindrical	8±0.3	10±0.2	9±0.3	11±0.6	9±0.5	11±0.3	10±0.5	12±0.6	11±0.6	13±0.6	
Rhizophora apiculata	8±0.5	12±0.3	9±0.3	13±0.7	10±0.3	14±0.6	10±0.3	15±0.5	11±0.3	15±0.6	
Xylocarpus grantum	8±0.5	10±0.4	8±0.2	10±0.5	9±0.3	11±0.3	10±0.3	13±0.3	11±0.5	14±0.3	

Table - 2: Minimum inhibitory concentration of medicinal plants against *Staphylococcus aureus*

Minimum inhibitory concentration (mg/ml)						
Name of the plants	**Hexane**	**Chloroform**	**Ethyl acetate**	**Acetone**	**Methanol**	**Positive Control***
Avicennia marina	320	160	80	40	20	20
Rhizophora mucronata	320	160	80	40	20	20
Ceriops decandra	160	80	40	20	20	20
Rhizophora mangle	320	160	80	40	20	20
Asparagus officinalis	640	320	160	80	40	20
Aegiceras corniculatum	320	160	80	40	20	20
Acanthus ilicifolius	320	320	80	80	40	20
Bruguiera cylindrica	640	320	160	160	80	20
Rhizophora apiculata	320	160	80	40	20	20
Xylocarpus grantum	640	320	160	80	40	20

Table - 3: Antibacterial activity of mangrove medicinal plants against *Streptococcus pyogenes*

Concentration of the mangrove leaf extracts (mg/ml) and Zone of inhibition (mm)											
Name of the plants	**Hexane**		**Chloroform**		**Ethyl acetate**		**Acetone**		**Methanol**		**Positive control***
	150 mg/ml	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**300 mg/ml**
Avicennia marina	9±0.6	11±0.7	10±0.5	12±0.3	11±0.6	15±0.6	12±0.3	14±0.8	15±0.4	17±0.6	21±0.3
Rhizophora mucronata	10±0.3	12±0.3	10±0.5	13±0.5	11±0.4	13±0.3	13±0.5	15±0.3	13±0.5	17±0.3	
Ceriops decandra	8±0.3	11±0.5	9±0.4	12±0.3	9±0.2	12±0.5	13±0.5	16±0.5	15±0.3	20±0.4	
Rhizophora mangle	9±0.5	11±0.3	10±0.2	12±0.5	11±0.3	13±0.6	13±0.4	15±0.6	13±0.4	15±0.3	
Asparagus officinalis	8±0.4	10±0.5	9±0.2	11±0.6	10±0.2	12±0.3	10±0.3	13±0.2	11±0.5	14±0.2	
Aegiceras corniculatum	7±0.6	10±0.6	8±0.4	12±0.3	10±0.6	13±0.5	13±0.3	15±0.5	13±0.3	16±0.9	
Acanthus ilicifolius	9±0.3	12±0.3	10±0.4	14±0.5	11±0.5	15±0.3	11±0.4	14±0.6	10±0.2	14±0.4	
Bruguiera cylindrical	7±0.3	9±0.2	8±0.2	10±0.5	9±0.3	12±0.4	9±0.3	11±0.5	11±0.5	13±0.0	
Rhizophora apiculata	9±0.3	12±0.3	10±0.2	6±0.5	11±0.2	14±0.2	12±0.3	14±0.4	14±0.3	16±0.3	
Xylocarpus grantum	8±0.4	10±0.5	9±0.2	11±0.6	10±0.2	12±0.3	10±0.3	13±0.2	11±0.5	13±0.8	

Table - 4: Minimum inhibitory concentration of medicinal plants against *Streptococcus pyogenes*

Minimum inhibitory concentration (mg/ml)						
Name of the plants	**Hexane**	**Chloroform**	**Ethyl acetate**	**Acetone**	**Methanol**	**Positive Control***
Avicennia marina	320	160	80	80	40	20
Rhizophora mucronata	320	160	80	80	40	20
Ceriops decandra	160	160	80	40	20	20
Rhizophora mangle	640	320	160	80	40	20
Asparagus officinalis	640	320	160	80	40	20
Aegiceras corniculatum	320	160	80	80	40	20
Acanthus ilicifolius	640	320	160	160	80	20
Bruguiera cylindrical	-	640	160	160	80	20
Rhizophora apiculata	640	320	160	80	40	20
Xylocarpus grantum	640	320	160	160	80	20

Table - 5: Antibacterial activity of mangrove medicinal plants against *Bacillus cereus*

Concentration of the mangrove leaf extracts (mg/ml) and Zone of inhibition (mm)											
Name of the plants	**Hexane**		**Chloroform**		**Ethyl acetate**		**Acetone**		**Methanol**		**Positive control***
	150 mg/ml	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**150 mg/ml**	**300 mg/ml**	**300 mg/ml**
Avicennia marina	12±0.5	14±0.3	12±0.6	15±0.4	13±0.6	16±0.5	14±0.3	17±0.8	14±0.4	18±0.2	20±0.5
Rhizophora mucronata	8±0.6	12±0.3	10±0.6	12±0.5	12±0.3	16±0.5	12±0.3	15±0.3	13±0.5	17±0.5	
Ceriops decandra	8±0.5	10±0.4	8±0.5	11±0.5	8±0.5	11±0.5	12±0.5	16±0.2	15±0.5	18±0.3	
Rhizophora mangle	9±0.5	11±0.6	10±0.8	12±0.2	10±0.6	13±0.6	11±0.3	12±0.3	13±0.5	15±0.3	
Asparagus officinalis	8±0.3	10±0.2	9±0.9	11±0.5	9±0.3	12±0.5	10±0.6	12±0.4	11±0.4	13±0.4	
Aegiceras corniculatum	7±0.5	9±0.3	8±0.2	10±0.5	9±0.5	11±0.4	10±0.3	13±0.5	12±0.4	16±0.6	
Acanthus ilicifolius	10±0.5	12±0.4	11±0.3	12±0.5	10±0.5	13±0.3	11±0.3	13±0.5	11±0.6	14±0.6	
Bruguiera cylindrical	7±0.3	9±0.5	8±0.6	10±0.3	9±0.2	11±0.2	9±0.6	11±0.5	10±0.3	12±0.2	
Rhizophora apiculata	9±0.2	11±0.2	10±0.2	12±0.3	12±0.6	14±0.3	12±0.5	15±0.5	13±0.2	16±0.4	
Xylocarpus grantum	8±0.4	10±0.6	9±0.3	11±0.6	19±0.5	11±0.6	10±0.5	12±0.7	10±0.3	12±0.5	

Table - 6: Minimum inhibitory concentration of medicinal plants against *Bacillus cereus*

Minimum inhibitory concentration (mg/ml)						
Name of the plants	**Hexane**	**Chloroform**	**Ethyl acetate**	**Acetone**	**Methanol**	**Positive Control***
Avicennia marina	160	80	80	20	20	20
Rhizophora mucronata	160	160	80	40	20	20
Ceriops decandra	160	80	40	20	20	20
Rhizophora mangle	320	160	160	80	40	20
Asparagus officinalis	640	320	320	80	40	20
Aegiceras corniculatum	160	80	40	40	20	20
Acanthus ilicifolius	640	320	160	80	40	20
Bruguiera cylindrica	-	640	320	160	80	20
Rhizophora apiculata	320	160	160	80	40	20
Xylocarpus grantum	640	640	320	160	80	20

Jaimini *et al*. (2011) evaluate the antibacterial potential of a mangrove plant. Acetone extract was prepared from the leaves and was tested against various bacterial pathogens. For this purpose, both Gram negative as well as Gram positive bacterial strains were tested in this study. Antibacterial potency of the extract was tested by standard growth inhibitory assay methods. The tested extract showed to varying degrees of antibacterial potential against tested Gram negative as well as Gram positive bacteria. These promising findings suggest antibacterial activity of the plant material indicating presence of bioactive compounds against bacterial pathogens and exhibiting an alternative source of antimicrobial compounds against diseases caused by these microorganisms.

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