Pterocarpus indicus Willd : A lesser known tree species of medicinal importance

ABSTRACT

Barks of *Pterocarpus indicus* were extracted with the organic solvents viz., methanol and acetone and yielded the extract of 35.5 mg/g in methanol and 27 mg/g in acetone. Among the phyto constituents, the terpenoids content was found to be maximum with1.78 mg/g and the steroids with 1.404 mg/gm in methanol extracts. Secondary metabolites such as Campesterol, Cyclopropane, 2,6-bis(1,1-dimethylethyl)-4-methyl were identified through GCMS analysis which were reported to have antibacterial and antifungal activities, the other secondary metabolites like Halfordinol and Butylated hydroxytoluene were also identified and are known to have high antioxidant property. The antibacterial activity of the methanol and acetone extracts of *P.indicus* were evaluated against various human pathogens such as *Bacillus subtilus* (Bs) *Staphylococcus aureuss* (Sa) (gram positive bacteria) and a gram negative bacterium *Escherichia coli* (Ec). The methanol extract of bark of *P. Indicus* gave promising result than the acetone extract. The bark extract was used against the plant pathogenic fungus *Nigrospora oryzea and found to* inhibit the growth of the organism. Therefore, it is suggested that indepth pharmacological study would evident for commercial utilisation of *P. indicus* as a potential source of medicinal tree for the treatment of various infectious diseases.

Key word: *Pterocarpus indicus,* medicinal tree, infectious diseases.

1. INTRODUCTION

Various therapeutic values of the sub species of *Pterocarpus* have been reviewed most importantly *Pterocarpus marsupium. P. marsupium* extracts showed high level response against diabetic problem [1,2]. The phenolic constituents of the heartwood of *P. marsupium* as antidiabetic activity was demonstrated by [3] in rat and significantly lowered the blood glucose level. *Pterocarpus indicus* Willd is one such species of the genus *Pterocarpus* found in India. Decoctions of the various parts of the tree found curing various ailments such as boils, ulcers, prickly heat, stone in the bladder, diarrhoea, dysentery, thrush and syphilitic sores [4]. The root extract has been used to treat syphilitic sores and mouth ulcers [5]. However, there is paucity of information on the bioactive compounds of the bark of *P. indicus* and antimicrobial properties thereof, and hence the present study has been undertaken.

2. Materials and methods

2.1 Sample collection

The bark samples of *P. indicus* Willd were collected from Saibaba colony, Coimbatore, Tamil Nadu, India situated between latitude 11° 1’ 25.01’’ N and longitude 76° 56’ 30.96’’E. The collected samples were brought to the laboratory (Fig.1), cleaned thoroughly with a brush to remove dust and debris, shade dried followed by stored in tightly closed containers till extraction at room temperature.

2.2 Extraction

The dried barks were made into coarse powder using mechanical grinder. 20 grams of dry powder was extracted with the 200 ml of organic solvents such as methanol and acetone (50- 60^{0}C) by hot

continuous percolation using soxhlet apparatus. The extractions were continued for 48 hours. The extracts have been recovered from the solvents by evaporation process using rotary evaporator; the crude extracts thus obtained were stored in sterilized amber coloured bottles maintained at 4°C in a refrigerator till further analysis. The recovered extracts were weighed after complete evaporation of the solvents to ascertain the yield.by the following formula.

Calculation:

$$\text{Percentage of extract (\%)} = \{(Y_g - X_g) / W_{gs}\} \times 10$$ Where,

Yg = Weight of extract with beaker, Xg = Empty weight of beaker,

Wg = Weight of Bark.

2.3 Phytochemical Screening

Phytochemical constituents such as alkaloids, flavanoids, tannin, saponin, quinone, sterols and phenols of bark extract of *P. indicus* was screened using standard procedure [6]. The separation and characterization of active compounds in *P.indicus* was also carried out using GC-MS analysis [7].

2.4 Gas chromatography and Mass Spectroscopy analysis of methanol and acetone extract of *P. indicus.*

The samples were dissolved in the respective organic solvents (methanol and acetone), till dissolved completely and analyzed by GC-MS (Thermo GC- Trace Ultra Version 5.0). For GC-MS analysis, a 30 m×0.25 m MS capillary standard non polar column with a film thickness of 0.25 µm was used. The carrier gas was helium maintained at a column flow of 1 ml/min. A 1.0 µl sample of the extract was injected and the column temperature was maintained at 70^0C /min to 260^0C for 6 min. This was raised to 260 ^{0}C at a rate of 6^0C min for x min, and finally to 300^0C at a rate of 35^0C /min for 2 min [7]. The individual constituents showed by GC were identified by comparing their MS with standard compound of NIST library.

2.5 Antimicrobial activity: Agar well diffusion method

The effect of extracts on the several microbial strains was assayed by agar well diffusion method. The pure microbial cultures were maintained on nutrient agar medium and stored at 4 ºC for till further assay. The extracts were allowed to diffuse out into the medium already seeded with test organisms [8]. The diameter of the zone of inhibition was measured in millimetres (mm), against the human pathogens viz., *Escherichia coli, Staphylococcus aureus, Bacillus subtilis, Nigrospora oryzae* [9].

2.6 Media preparation

The media employed in the present study were nutrient agar and Muller Hinton agar. Nutrient broth was composed of Beef extract 3.0 g, Peptone 5.0 g and Distilled water 1000 ml (pH 7.4). Muller Hinton agar is composed of beef infusion 300 g, Casein acid hydrolysate 17.50 g, Starch 1.50 g, Agar 17 g and distilled water 1000 ml (pH 7.3), sterilized using autoclave at 15 lbs pressure (121^0C) for 15 minutes. All glassware were also sterilized in autoclave and further placed in hot air oven at

60^0C for 1 hour prior to use. The growth media for the fungal culture was used with Potato Dextrose Agar.

2.7 Procedure

Autoclaved molten Muller Hinton agar medium was poured in sterilized petri plates and allowed to solidify. Test organisms were inoculated in sterilized nutrient broth and incubated at 37^0C for 24 hrs. Petri plates containing Muller Hinton medium were swabbed with microbial culture using sterile cotton swabs.

Wells of 5 mm diameter were made on Muller Hinton Agar plates using cork borer. Using a micro pipette, 20 µl of 100 ppm of each plant extract (separately for methanol and acetone extracts) was added into each well in all plates. Amoxicillin solution 1mg/ml was used as the positive control. Incubated at 37^0C for 24 hrs. The antimicrobial activity was ascertained by measuring the zone of inhibition formed around the well.

3. Results and discussion

P. indicus is commonly known as Rose wood. It is one of the most important multipurpose trees for timber and medicine [5]. It has many health care properties especially for fever, diarrhoea, dysentery and heavy menstruation. Thus the effective utilization of *P. indicus* with respect to medicinal values is warranted; hence the present study has been conducted to identify the active compounds present in the bark extract of P. Indicus and its biological properties especially antimicrobial activities.

Fig. 1 Barks of *Pterocarpus indicus*

The bark of *P. indicus* extracted with two different polar solvents such as methanol and yielded 0.71 and 0.54 mgs respectively (Table 1). The data search in relation to extract yield are similar with earlier observation made in a study on high yield of extract obtained by using methanol as solvent for extraction [10]. It was supported by the earlier studies of [10, 11].

Table 1. Methanol and Acetone extracts of *P. indicus* (Willd) using Soxhlet apparatus

Plant sample	Yield of extract (mg/20g)	
	Methanol	Acetone
Pterocarpus indicus (Willd) bark sample	0.710±0.026	0.540±0.022

3.1 Phytochemical analysis

Phytochemicals are secondary metabolites produced by all plants. The preliminary phytochemical screening of the extracts of *P. indicus* revealed the presence of various chemical substances such as alkaloids. flavonoids, tannins, phenols, terpenoids, sterols quinines, protein, steroids, anthocyanin, carbohydrate and stigma sterol (Table 2). [12] reported the presence of bioactive constituents such as saponins, tannins, flavonoids, steroids, terpenoids and phenolic compounds in stem and barks of *P.soyauxii*. The presence of wide range of phytochemical constituent indicated that the tree can be considered as a useful medicinal tree.

3.2 Quantitative analysis of secondary metabolites

Chemical investigation of the genus, *Pterocarpus* woods started more than 100 years ago, yet new compounds are still being discovered. There are variety of compounds with different carbon skeletons, some of which have been considered unique to the genus. A broad classification of these components is given below along with the special features of each group [13]. The plant *Pterocarpus* (Fabaceae) is important plant that contains various phytocontituents and is used traditionally for medicinal purpose such as protein, pterostilbene, epicatechin, pterosupin, maruspsin and five new flavonoids [14].

The results showed the presence of high quantity of terpenoids and steroids and the other phyto contituents such as the phenols, flavonoids, tannins and saponins were present in low quantity in both the extracts (Fig 2.). A red, gum-like resin from the bark is used in folk remedies for tumours and the leaf for cancers, especially the mouth cancer and the leaves significantly inhibited the growth of Ehrlich as cites carcinoma cell in mice [15]. Tannins (commonly referred to as tannic acid) are water-soluble polyphenols that are present in many plants and the structural analysis shows that the crystal is a macromolecular compound of tannic condensation and glucoside [16]. A mixture of loliolide (> 85%) and paniculatadiol (< 15%) was obtained from the ethyl acetate leaf extract of *P. indicus* [12].

Table 2. Phytochemical screening of secondary metabolites in the bark extracts of *P. indicus*

S. No	Phytochemical test	Methanol extract	Acetone extract
01.	Test for Alkaloids (Wagner's test)	-	-
02.	Test for Flavonoids (Sulphuric acid (H_2SO_4) test)	+	+
03.	Test for Tannins (Braymer's test)	+	+
04.	Test for Saponins	+	+
05.	Test for Quinines	-	-
06.	Test for Sterols (Sulphuric acid (H_2SO_4) test)	-	-
07.	Test for Phenols (Ferric chloride test)	+	+
08.	Test for proteins (Ninhydrin(acetone)	-	-

09.	Test for Carbohydrates (Fehling's test)	-	-
10.	Test for Terpenoids	+	+
11.	Test for Steroids	+	+
12	Test for Anthocyanin Sodium hydroxide (NaOH) test	-	-

(+): Present, (-): Absent

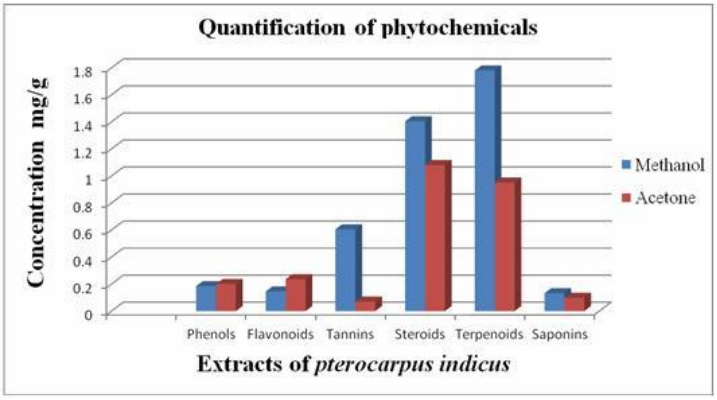

Fig. 2. Estimation of phytochemicals in the two different extracts of *P. indicus*

3.3 GC-MS analysis of *P. indicus* (Willd)

The Gas chromatography and mass spectrometry analysis of methanol and acetone extracts of bark of *P. indicus* elicited 60 individual compounds (Fig. 3) and (Fig. 4). The biological properties of the individual compounds were ascertained according to Tice Rules [7]. As per Tice rule compounds are more likely to have properties of antibacterial, antifungal, anti-inflammatory, anti-cancerous, antitumor, antioxidants, antiprotozoal, anti-diabetic, antiallergenic, antiviral, insecticide, germicide and anti-toxic activities [17]. If molecular weight falls within ≥ 150 and ≤ 500; theoretical logarithm of the noctanol/water partition coefficient (log P), is less than or equal to 5.0; hydrogen bond acceptor is within 1-8; hydrogen bond donar is less than or equal to 2 and the number of rotatable bond is less than or equal to 12 (Table 3) and (Table 4). [10] reported that DPPH and CUPRAC methods were used to determine the antioxidant capacity of MeOH extract, ethyl acetate and butanol fractions from *Pterocarpus erinaceus* roots. Free radical production is necessary during body aggression by pathogens, because free radicals are involved in defensive system against pathogens aggression; but their excessive production can cause cell damages and oxidative stress. Free radical-mediated oxidative stress in inflammatory diseases including cancer, diabetes, arthritis, infections, alzheimer and atherosclerosis, has been well documented [18] and the antioxidant power of extracts and fractions may inhibit free radical production. The compounds identified through GCMC such as flavonol - glycoside [(2R)-7-hydroxy-3-(3, 4, 5-trihydroxy-6-(hydroxymethyl) tetrahydro-2H-pyran-2- yloxy)-2-(3,4,5-trihydroxy phenyl) chroman-4-one] or ptevon-3-*D*- glycoside were reported to have antioxidant properties [19]. The heartwood of *Pterocarpus marsupium* contains flavonoids C-glucosides namely 6 – hydroxyl – 2, 4 - hydroxybenzyl – benzofuran – 7C – β – D - glucopyranoside, 3 α – methoxy – 4 - hydroxybenzylidene – 6 – hydroxybenzo – 2(3H) – furanone – 7C – β- D - glucopyranoside, 2 glucopyranoside, 8 C – β - D - glucopyranosyl - 7, 3, 4- trihydroxy flavone and 1, 2

– bis (2, 4 - dihydroxy, 3 – C glucopyranosyl) – ethanedione, C-β-D-glucopyranosyl-2,6-dihydroxyl benzene and sesquiterpene were reported to have antioxidant actives [20].

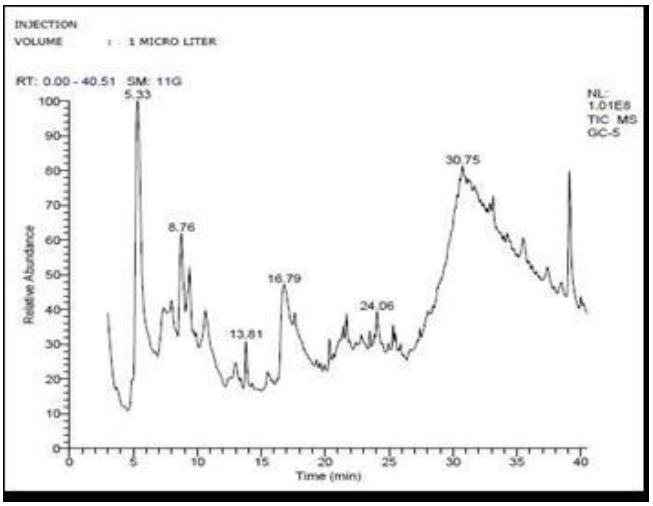

Fig. 3. GC-MS Chromatogram of methanol extract of *P. indicus*

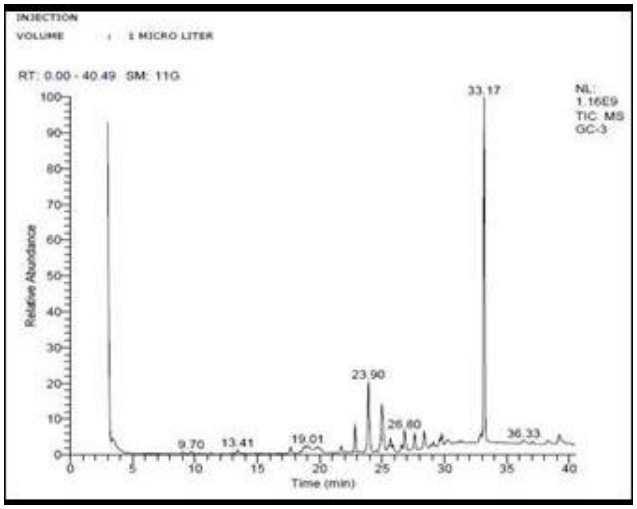

Fig.4 GC-MS Chromatogram of acetone extract of *P. indicus*

Table 3. GC-MS analysis of methanol extract of bark of *P. indicus*

S. No	RT (min)	Compound Name	Molecular Formula	Trivial Name	Group	Area (%)	Biological Importance
01	6.76	Dodecane	$C_{12}H_{26}$	Dihexyl	Alkane	0.62	Antifungal activity
02	13.55	17-Pentatriacontene	$C_{35}H_{70}$		Alkane	0.23	No activity
03	17.8	1-Tricosanol	$C_{23}H_{48}O$	Campesterol	Alcohol	0.9	Antibacterial , fungalactivity
04	19.27	1-[Bis(methylthio) methylene]acetyl]-2-(4-(4- methoxypheny l)-1,3-butadienyl) cyclopropane	$C_{19}H_{22}O_2S_2$	Cyclopropan e	Alkane	0.31	Antimicrobial activity
05	21.85	14-methyl-, methyl ester	$C_{17}H_{34}O_2$	Isopropyl myristate	Ester	0.5	Antioxidant, antimicrobial
06	22.98	1-ethoxycarbonyl-4,5-di(hydroxydimethylsilyl) -1H-azepine	$C_{13}H_{25}NO_4Si_2$		Amine	0.34	No activity

07	23.86	2,6-bis(1,1-dimethylethyl)-4-methyl	$C_{15}H_{24}O$	Butylated hydroxytoluene	Phenol	0.69	Antioxidant, Antimicrobial
08	25.59	methyl 9,9-dideutero-octadecanoate	$C_{19}H_{36}D_2O_2$		Ethyl ester	2.41	Antibacterial , Antifungal activity
09	26.65	4-Normethyl-9,19-cyclolanoststan-7-one,3-acetoxy	$C_{31}H_{50}O_3$	Momordicin	polyphenol	0.33	No activity
10	27.22	4-Normethyl-9,19-cyclolanoststan-7-one, 3s-acetoxy	$C_{31}H_{50}O_3$	Momordicin	Polyphenol	0.27	No activity
11	27.67	4-Normethyl-9,19-cyclolanoststan-7-one,3-acetoxy	$C_{31}H_{50}O_3$	Momordicin	Polyphenol	0.39	No activity
12	28.1	4-Normethyl-9,19-cyclolanoststan-7-one, 3-acetoxy-	$C_{31}H_{50}O_3$	Momordicin	polyphenol	0.34	No activity
13	28.45	Cholest-2-eno[2,3-b] naphthalene	$C_{35}H_{50}$		Ketone	0.36	No activity
14	28.77	Cholestano[7,8-a] cyclobutane,3- methoxy-6-oxo-2'-methylene	$C_{31}H_{50}O_2$	Sigmasterol acetate	Ketone	0.32	Antimicrobial, Antitumour, Antiinflammatory
15	29.06	Cholestano[7,8-a] cyclobutane,3- methoxy-6-oxo-2'-methylene	$C_{31}H_{50}O_2$	Sigmasterol acetate	Ketone	0.32	Antimicrobial, Antitumour, Antiinflammatory
16	30.1	Cholestano[7,8-a] cyclobutane,3- methoxy-6-oxo-2'-methylene	$C_{31}H_{50}O_2$	Sigmasterol acetate	Ketone	0.31	Antimicrobial, Antitumour, Antiinflammatory
17	30.32	Cholestano[7,8-a] cyclobutane,3- methoxy-6-oxo-2'-methylene	$C_{31}H_{50}O_2$	Sigmasterol acetate	Ketone	0.2	Antimicrobial, Antitumour, Antiinflammatory
18	30.75	17-(5-ethyl-6 methylheptan-2-yl)-10, 13-dimethyl-2,3,4,7,8,9, 11,12,14,15,16,17,-dodecahydro-1H-cyclopenta(a)phenanthren-3-ol	$C_{29}H_{50}O$	Prostasal	Alcohol	7.77	Antimicrobial, Antitumour, Antiinflammatory
19	31.2	Cholestano[7,8-a] cyclobutane,3- methoxy-6-oxo-2'-methylene	$C_{31}H_{50}O_2$	Sigmasterol acetate	Hydroxyl	0.24	Antimicrobial, Antitumour, Antiinflammatory
20	31.62	5Alpha-cyano-3alpha-formyl-3beta-methylcholestane	$C_{30}H_{49}NO$		Sterol, Alkane	1.5	Antiinflammatory Antidiabetic
21	32.42	Phenol, 4-[2-(3- pyridinyl)-5-oxazolyl]-	$C_{14}H_{10}N_2O_2$	Halfordinol	Pyridine heterocyclic	2.5	Antioxidant Antimicrobial
22	33.15	1,2-Benzenedi carboxylic acid, bis (2-ethylhexyl) ester	$C_{24}H_{38}O_4$	Dioctyltetra phthalate	Carboxilic acid, Ester	2.85	Oral toxicity during pragnancy and suckling in the long - evans rats
23	33.72	Cholestano[7,8-a] cyclobutane,3- methoxy-6-oxo-2'-methylene	$C_{31}H_{50}O_2$	Sigmasterol acetate	Ketone	0.22	Anticancer, Anti protozoal, antimicrobial, antiinflammatory
24	33.99	Cholestano[7,8-a]cyclobutane,3- methoxy-6-oxo-2'-	$C_{31}H_{50}O_2$	Sigmasterol acetate	Ketone	0.21	Anticancer, Anti protozoal, Antimicrobial,

		methylene					Antiinflamatory
25	34.56	Cholestano[7,8-a] cyclobutane,3-methoxy-6-oxo-2'-methylene13.11 454 5.51	$C_{31}H_{50}O_2$	Sigmasterol acetate	Ketone		Antimicrobial, Antitumor
26	35.58	Cholestano[7,8-a] cyclobutane,3-Methoxy -6-oxo-2'- methylene	$C_{31}H_{50}O_2$	Sigmasterol acetate	Ketone	2.53	Anticancer, Antiprotozoal, Antimicrobial, Antiinflamatory
27	37.15	1-Phenanthrene carboxaldehyde,7-ethenyl-1,2,3,4,4a,4b, 5,6,7,9,10,10a- dode cahydro-1,4a,7-tr imethyl-,[1R-(1a,4aa, 4ba, 7a,10aa)]-	$C_{20}H_{30}O$	Ferruginol	Anthracene	60.3	
28	38.41	(3S,8S,9S,10R,13R,14S, 17R)-17-[(E,2R,5S)-5-ethyl-6-methylhept-3- en-2-yl]-10,13-dimethyl-2,3,4,7,8,9,11, 12,14,15,16,17, -dode cahydro-1H-cyclopenta [a]phenanthre n-3-ol	$C_{29}H_{48}O$	Sigmasterol	Alcohol	5.37	Antimicrobial, Antioxidant
29	39.33	Methyl hexacosanoate	$C_{27}H_{54}O_2$	Cerotic acid	Ester	1.86	
30	40.02	(3S,10S,13R,14R,17R)-17-[(E,2R,5R)-5,6-Di methylhept-3-en-2yl]-10, 13-dimethyl-2,3,4,12, 14,15,16,17-octahydro- 1H-cyclopenta[a] phenanther en-3-ol	$C_{28}H_{42}O$	Dehydroergo sterol	Choleste rol	0.3	Antiallergy, Antiinflammatory

Table 4. GC-MS analysis of acetone extract of bark of *P. indicus*

S. No	RT (min)	Compound Name	Molecular Formula	Trivial Name	Group	Area (%)	Biological Importance
01	3.41	2-Pentanone,4-hydroxy- 4-methyl	$C_6H_{12}O_2$	Butyl acetate	Ester	1.34	Antibacterial activity
02	9.02	Azulene	$C_{10}H_8$	Naphthalene	Benzene derivative	0.47	Antibacterial activity
03	9.7	1-tetradecene	$C_{14}H_{28}$	Tetradecene	Alkene	0.41	Antimicrobial, antioxidant
04	11.22	7-Methoxychromone-2-carbonitrile	$C_{11}H_7NO_3$	Benzonitrile	Cyanide	0.21	Antibacterial, antiviral activity
05	13.06	2,5-Cyclohexadiene-1,4-dione, 2,6-bis (1,1-dimethylethyl)	$C_{14}H_{20}O_2$	Butibufen	Ester	0.27	Antioxidant, Antibacterial activity
6	13.41	Hexadecane	$C_{16}H_{32}$	Cetene	Alkene	0.95	Antibacterial activity
7	14.9	2,3-dihydro-1H-cyclopent[e]azulene	$C_{13}H_{12}$	Diphenylmeth ane	Alkane	0.21	Antimicrobial, Antiinflammatory activity
8	17.66	(E)-hebpadec-15-enal)	$C_{17}H_{32}O$	E-15-Heptadecenal	Aldehyde	1.2	Antioxidant, Antibacterial

9	18.8	1-(4-Methoxyphenyl)-3-methylazetidin-2-one	$C_{11}H_{13}NO_2$	Fenmetramide	Amide	2.27	Antibacterial, Antiinflammatory, Antifungal activity
10	19.84	(4-(2,4-dimethylheptan-3yl)phenol)	$C_{15}H_{24}O$	Butylatedhydroxytoluene	Phenol	1.45	Antioxidant activity
11	21.73	Cycloicosane	$C_{20}H_{40}$	Cetyl ethylene	Alkene	1	
12	22.52	N,N-Diethyl3,4-methylenedioxybenzamide	$C_{12}H_{15}NO_3$	Beta-keto-Methylbenzodioxolybutanamine	Amine	0.22	Anticancer
13	22.83	1,2-Benzenedicarboxylic acid,bis(2-methylpropyl) ester	$C_{16}H_{22}O_4$	Cholesterol	Sterol	3.41	Anticancer, Antimicrobial Antiinflammatory
14	23.21	Phthalic acid,isobutyl propyl ester	$C_{15}H_{20}O_4$	phthalic acid	Ester	0.24	Antimicrobial, Antimicrobial
15	23.9	1,2-Benzene dicarboxylic acid,bis(2-methylpropyl) ester	$C_{16}H_{22}O_4$		Ester	11.56	Antibacterial
16	24.96	Dibutyl phthalate	$C_{16}H_{22}O_4$	n-butyl phthalate	Ester	9.3	Antimicrobial
17	25.67	9,9-Dimethyl-8,10-dioxapentacyclo[5.3.0.0(2,5).0(3,5).0(3,6)]decane	$C_{10}H_{14}O_2$		Alkane	3.17	
18	26.8	Phthalic acid, butyl 3-methylbutyl ester	$C_{17}H_{24}O_4$	3-methylbutyl benzoate	Ester	4.23	Anticancer
19	27.61	Phthalicacid,3-methylbutyl pentyl ester	$C_{18}H_{26}O_4$	Isopentyl phthalate	Ester	2.53	Anticancer, antioxidant
20	28.36	Phthalic acid, 3-methylbutyl pentyl ester	$C_{18}H_{26}O_4$	Isopentyl phthalate	Ester	2.98	Anticancer
21	29.12	Phthalic acid, di(2-methylbutyl) ester	$C_{18}H_{26}O_4$	Diisopentyl phthalate	Ester	1.02	Anticancer
22	29.77	Phthalic acid, bis(2-pentyl) ester	$C_{18}H_{26}O_4$	Diisopentyl phthalate	Ester	2.38	Anticancer
23	30.26	1,30-Triacontanediol	$C_{30}H_{62}O_2$	Tricontane-130-diol	Alcohol	1.3	Anticancer
24	31.36	Phthalic acid, 2-cyclohexylethyl isobutyl ester	$C_{20}H_{28}O_4$	Carnosic acid	Ester	0.53	Antimicrobial, antiviral, Antioxidant
25	33.17	Di-(2-ethylhexyl) phthalate	$C_{24}H_{38}O_4$	Dicoctyle terephthalate	Ester	43.2	Antitoxic activity
26	34.5	Synaptogenin b	$C_{30}H_{46}O_4$	Glycyrrhetic acid	Carboxylic acid	0.22	Antiallergic, antibacterial, antiviral activity
27	36.33	1,3-Dithiane, 2-phenyl	$C_{10}H_{12}S_2$	Acetophenone ethane	Ester	0.82	
28	37.06	Decanedioic acid, bis(2-ethylhexyl) ester	$C_{26}H_{50}O_4$	di-(2-ethylhexyl)sebacate	Ester	0.34	
29	38.27	Cyclooctacosane	$C_{28}H_{56}$	1-Octacosene	Alkene	0.96	
30	39.18	13-Docosenamide	$C_{22}H_{43}NO$	Erucylamide	Amide	1.83	Germicide, insecticide activity

The compounds identified in the present study viz., 1-Tricosanol , Dodecane, 1-[Bis(methylthio)methylene]acetyl]-2-(4-(4-methoxyphenyl)-1,3-butadienyl) (Cyclopropane), 14- methyl-

, methyl ester , 2,6-bis (1,1-dimethylethyl)-4-methyl, methyl 9,9-dideutero-octadecanoate have antimicrobial and antifungal properties and the other compounds like Cholestano [7,8-a]cyclobutane,3-methoxy-6-oxo-2'-methylene- (Sigma sterol acetate), 3-methylbutyl benzoate (Phthalic acid), Isopentyl phthalate have anticancer activity. The compounds such as Halfordinols and Butylate dhydroxytoluene were reported to have antioxidant property.

3.4 Antibacterial activity of *P.indicus* (Willd)

The antibacterial activity of various plant extracts have been reported by many researchers and gaining due attention as they are environmentally safe and non-toxic [21, 22]. In the present study the antibacterial activity of the methanol and acetone extracts of *Pterocarpus indicus* was evaluated against two gram positive human pathogenic bacteria namely, *Bacillus subtilis* (Bs) and *Staphylococcus aureus (Sa) ,* and one gram negative bacterium, *Escherichia coli* (Ec) showed between 15 and 18 mm (Fig. 5 and Table 5). Methanol and acetone extracts showed positive antibacterial activity against these bacteria . *P. indicus may be considered as* a good antibacterial agent. The related plants from the same genus was studied for antibacterial activity against pathogenic bacteria such as *Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus subtilis* showed great antibacterial activity. The compounds Lupeol 3 and Phytol esters were identified from the air-dried flowers of *P. Indicus* have antimicrobial activity [23, 24]. The antimicrobial activity of heartwood extract of *P. marsupium* (EEPM) was demonstrated by [25]. The aqueous extract of *P. marsupium* inhibited growth of human pathogen bacteria with the inhibitory concentration ranging from 0.04 mg to 0.08 mg [14].Plants are rich in a wide variety of secondary metabolites such as tannins, terpenoids, flavonoids, phenols, etc., which have been found *in vitro* to have antimicrobial properties [26. Natural products of higher plants may give a new source of antimicrobial agents with possibly novel mechanisms of action.

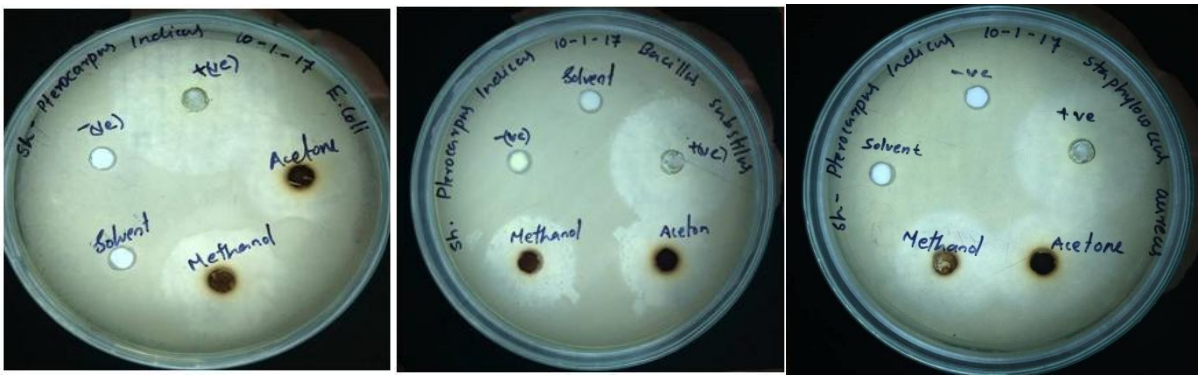

Fig. 5. Antibacterial activity of bark extract of *P. indicus*.

Table 5: Antibacterial activity of bark extract of *P. indicus*

S. No	Bacterial Strain	Zone of inhibition	
		Methanol Extract (mm)	**Acetone Extract (mm)**
01.	*E.coli*	18	15
02.	*Bacillus substilis*	15	14
03.	*Staphylococcus aureus*	16	15

4. Conclusion

Pterocarpus indicus (Willd) is commonly known as Rose wood tree. It is native to South Asia and East Indian regions. It is reported as very important tree in the forestry for wood and reported to have multiple uses in traditional medicine. The tree parts such as leaf, stem, and bark have various traditional medicinal uses. The shredded bark is boiled and the fluid is taken orally for treatment of dysentery, diarrhea, tuberculosis, headaches, sore, heavy menstruation, and gonorrhoea, cuts and wounds, stomach ache, leprosy, menstrual pain, flu, rheumatoid arthritis, and diabetes. Bark of *P. indicus* is endowed with many potent phytochemicals like alkaloids, flavonoids, tannins, terpenoids, saponins many others. The GC-MS analysis of the methanol and acetone extracts of barks of *P. indicus* revealed the presence of numerous biologically active compounds with potential medicinal properties especially antimicrobial and antioxidant, hence *P. indicus* may be considered as a potential medicinal tree for treatment of various infectious diseases and the bark extract may be considered for development of skin care product.

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