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Antimicrobial Activity and Chemical Composition Analysis of *Jasminum sambac* L. and *Plumeria alba* L. Flower Extracts

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ABSTRACT

Jasminum sambac L. and *Plumeria alba* L. are known to have antimicrobial properties. This research was conducted to determine the antimicrobial activity and chemical composition of crude ethanol extracts from *J. sambac* and *P. alba* flowers. *J. sambac* and *P. alba* flowers were obtained, air-dried, and extracted with ethanol. The final *J. sambac* and *P. alba* flower ethanol extracts were prepared in ratios of 1:1, 1:2, and 2:1, with concentrations of 25 and 50 mg/mL, respectively. Antimicrobial activity was tested against *Staphylococcus aureus*, *Escherichia coli* and *Candida albicans*. Qualitative phytochemical and Gas Chromatography-Mass Spectrometry (GC-MS) analyses were conducted to determine the phytoconstituents of the flower extracts. The maximum inhibition zone of *J. sambac* and *P. alba* (1:2) ratio against *S. aureus* (8.68±0.15 mm) and *E. coli* (8.59±0.09 mm) was obtained at 50 and 25 mg/mL for 6 h, respectively. Furthermore, the highest *C. albicans* inhibition zone of 7.54±0.27 mm was achieved after 24 h using a 25 mg/mL *J. sambac*: *P. alba* (2:1) ratio. The phytochemical analysis showed that both flower extracts contained tannin, flavonoid, saponin, and phenol. After that, GC-MS analysis of *J. sambac* revealed 24 compounds, the majority of which were made up of 9,12,15-octadecatrienal, octadecanoic acid, and 9,12-octadecadienoic acid. There were 44 compounds with a higher percentage of cyclohexanol, octadecanoic acid, and squalene in the *Plumeria alba* GC-MS analysis. The findings of this study suggest that ethanol extracts of *J. sambac* and *P. alba* flowers could be employed as antibacterial agents.

***Keywords*:** Antimicrobial, Ethanol extract, *Jasminum sambac* L, Phytochemical, *Plumeria alba L.*

Introduction

The emergence and spread of antimicrobial resistance (AMR) among microbial pathogens is a serious threat to public health and presents major challenges worldwide.[1–3] A critical contributor to the increasing resistance against antimicrobial agents is the inappropriate and excessive use of antimicrobials.[4-5] Hence, several studies are currently ongoing to discover new antibiotics. The ultimate goal is to provide antimicrobial medicines that are both appropriate and effective. New antimicrobials from plants have become an interesting area of research. Plants are known to synthesize various secondary metabolites referred to as phytochemicals that have disease prevention properties. The essential benefits of plant-derived products are their clinical efficacy and minimal to no side effects.[6–10] Medicinal plants are rich in secondary metabolites, including alkaloids, flavonoids, glycosides, tannins, steroids, and other relatively active metabolites, which are used as medicine in the pharmaceutical industry.[11–13] *Jasminum sambac* L. belongs to the Oleaceae family that grows in the tropical and subtropical regions. This flower, which is also known as lily jasmine, is commonly used to make garlands, bouquets, perfumes, cosmetics, food products, and medicinal herbs.[14-15] Studies have shown that phytochemical analysis of *J. sambac* L. leaf extracts reveals the presence of alkaloids, flavonoids, glycosides, steroids, tannins, terpenoids, and saponins.[16]

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Plumeria alba L., one of the flowers in the Apocynaceae family, is an interesting plant to be explored for its ornamental characteristics, fragrant, and medicinal applications. *Plumeria* extract's structure, extraction, isolation, and chemical components must all be identified before it can be utilized for pharmacological uses.[17] Previously, the activities of a combination of *J. sambac* and *P. alba* flower extracts have not been comprehensively studied. Therefore, the present study was conducted to investigate the *in vitro* antimicrobial activities of a combination of crude ethanol extracts of *J. sambac* and *P. alba* flowers. The chemical composition of *J. sambac* and *P. alba* flowers was also determined.

Materials and Methods

Source of flowers

Jasminum sambac and *Plumeria alba* flowers were collected from the Sleman region of Yogyakarta, Indonesia (7° 43' 17.3" S and 110° 20' 04.7" E) in January 2021. Both flowers were identified at the Taxonomy Laboratory, Department of Biology Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia with identification numbers of 011/taxo/2021 and 012/taxo/2021, respectively.

Preparation of flower extracts

The air-dried *J. sambac* and *P. alba* flowers were extracted at room temperature with 96% ethanol (100 g of plant material in 500 mL of ethanol for each extraction). The final ethanol extract of each flower was filtered using a filter paper (Whatman No. 1) and evaporated at 40°C using a rotary vacuum evaporator (Buchi R-114, Switzerland).

Sources of bacterial and fungal strains and culture conditions

Two bacteria (*Staphylococcus aureus* ATCC 25923 and *E. coli* ATCC 32518) and one fungus (*Candida albicans* ATCC 10231) as test

organisms were obtained from the Microbiology Laboratory, Public Health, and Nursing Department, Faculty of Medicine, Universitas Gadjah Mada, Indonesia. Phenotypic characteristics were used to identify the test organisms. Bacterial and fungal growth were maintained in nutrient agar (NA, Oxoid) and potato dextrose agar (PDA, Oxoid), respectively. Before inoculum preparation, the bacteria were grown aerobically at 37°C for 24 h in nutrient broth (NB), and the fungus was grown aerobically at 37°C for 48 h in potato dextrose broth (PDB).

Antimicrobial activity of flower extracts

The antimicrobial sensitivity testing was conducted on the *J. sambac* and *P. alba* flower extracts using the agar disk diffusion method.[18] The ratios of *J. sambac*: *P. alba* flower ethanol extracts were 1:1, 1:2, and 2:1. This study used 25 and 50 mg/mL concentrations of *J. sambac* and *P. alba* flower ethanol extracts. In detail, each concentration consisted of 25 and 50 mg of flower ethanol extracts in 1 mL of 1 % dimethyl sulfoxide (DMSO, Merck). An aliquot of 100 µL of each bacterial and fungal culture was spread uniformly on NA and PDA plates. A paper disc (Oxoid) containing 100 µL of the extract solution was placed on the agar. The inhibition zone diameters around each disc were measured after incubating for 3, 6, and 9 h for the test bacteria and 16, 24, 32 h for the test fungi. The bioassay was performed in triplicate to calculate the mean value. For comparative purposes, chloramphenicol (1 mg/mL) and antifungal nystatin (100,000 IU/mL) were included as positive controls in the assay.

Chemical composition analysis of flower extracts

The chemical composition of the crude ethanol extracts of the *J. sambac* and *P. alba* flowers was determined by phytochemical screening and gas chromatography-mass spectrometry (GC-MS). Preliminary phytochemical screening for identifying tannin, flavonoid, saponin, and phenolic content was carried out according to a modified protocol.[19,20] Individual qualitative detections were performed to determine the presence of different constituents. The tannin test was carried out by dissolving 1 mL of the extract, which was heated for several minutes in the test tube. Then, a few drops of 1% $FeCl_3$ were added. Tannins were detected in the extract by the production of a greenish-brown or blackish-purple color. The flavonoids test was conducted by adding 1 mL of extract with a few drops of 10% NaOH. Flavonoids were present, as evidenced by the formation of the orange solution. Saponin content was determined by boiling 1 mL extract in 10 mL of water in a water bath. The filtrate was shaken and allowed to stand for 15 minutes. The formation of stable foam showed the presence of saponins. One milliliter of the extract was dissolved in 1% NaCl and 10% gelatin to perform the phenolic test. The presence of phenolic compounds was revealed by the production of a white precipitate.

The GC–MS analysis was conducted at the Organic Chemistry Laboratory of the Universitas Gadjah Mada, Indonesia. The extracts were evaluated with a modified GCMS-QP2010S (Shimadzu, Japan) to detect volatile chemicals, identify molecular weights, and determine molecular formulae.[21,22] A sample volume of 2 µL was injected in a splitless mode into the gas chromatograph fitted with an Rtx 5 MS coated with 5% diphenyl and 95% dimethyl polysiloxane with a film thickness of 0.25 µm, a length of 30.0 m, and a diameter of 0.25 mm. Helium was used as a carrier gas with a flow rate of 28 mL per minute. The injector temperature was set at 300°C. The electron impact of mass spectra has ionization energy of 70 eV. The initial oven temperature was set at 70°C and held for 8 min, and then increased at a rate of 5°C/min to attain 300°C (held for 26 min). The compounds were identified by comparison of mass spectra data obtained from the sample and purely commercially available standards injected under the same conditions. The overall spectrum was interpreted and the spectrum components were analyzed based on the database of the National Institute of Standards and Technology (NIST) available at the NIST library. Relative amounts of components, expressed in percentages, were calculated by a normalization procedure according to peak area in the total ion chromatogram.

Statistical analysis

The experiments were carried out in triplicates, and the values are expressed as the mean ± standard deviation (SD). Statistical analysis for antimicrobial activity was performed using SPSS 26.00 (IBM Corporation, Armonk, NY, USA). Comparisons among multiple groups were done using analysis of variance (ANOVA) with a p-value lower than 0.05 to be considered statistically significant.

Results and Discussion

Antimicrobial activity of flower extracts

The inhibition zones (Tables 1-3) against gram-positive bacterium (*S. aureus*), gram-negative bacterium (*E. coli*), and one fungus (*C. albicans*) were measured in millimeters (mm). The mean inhibition zones produced by the extracts in the disc diffusion ranged from 0 to 8.68 mm. These results show moderate antimicrobial activity (8 - 10 mm inhibition zone) for both test bacteria and fungus. The floral extracts significantly ($p < 0.05$) inhibited bacterial and fungal growth at a lower level than the positive controls, chloramphenicol, and nystatin. Since the majority of gram-positive and gram-negative bacteria are resistant to many antibiotics, chloramphenicol was used as the positive control in the antibacterial assay.[23] The negative control was the solvent (1% DMSO) used for each extract, and they showed no inhibition. This observation is consistent with a previous finding that discs treated with 1% DMSO solvents had no inhibitory zone. Meanwhile, ethanol-soluble extract and 70% aqueous ethanol extract had better antibacterial activity.[24] It was discovered that *S. aureus* had the strongest growth inhibition, followed by *E. coli* and *C. albicans*. In addition, the antibacterial activity of plant extracts against gram-positive bacterium was compared to gram-negative bacterium in this study. Antimicrobial activity is frequently linked to variations in cell wall structure between gram-positive and gram-negative bacteria. *E. coli* possesses an outer membrane that serves as a major barrier to prevent the permeability of antimicrobial molecules.[25,26] One of the most important parameters for efficient antibacterial agent application is extract concentration. The antibacterial properties of the plant extract increased with increasing concentration, according to the findings. For all of the test microorganisms, 50 mg/mL ethanol extracts of *J. sambac* and *P. alba* flower ethanol extracts inhibited growth more than 25 mg/mL. Ninkuu et al. published a study that supports these findings. It was reported that the inhibition zones decreased with decreasing extract concentration.[27] Because the presence of various chemicals effectively resists bacterial and fungal growth, a high concentration of plant extracts has a larger inhibitory effect. The results of the present investigation show that antibacterial activity is not proportional to incubation time. For bacteria and fungi, the antibacterial activity of ethanol extracts increased steadily with increasing contact time, up to 6 and 24 h. Nevertheless, antimicrobial activity did not increase and remained nearly constant after 12 and 32 h of incubation. As a result, it may be concluded that ethanol extracts of *J. sambac* and *P. alba* flowers inhibit (rather than kill) *S. aureus*, *E. coli*, and *C. albicans*. These extracts inhibited bacteria and fungi from growing or reproducing. The highest inhibition zone diameter of *S. aureus* (8.68 ± 0.15 mm) was obtained using a 1:2 ratio of *J. sambac* to *P. alba* at concentrations of 50 mg/mL for 6 h of incubation. The greatest *E. coli* inhibition zone diameter was 8.59 ± 0.09 mm when the ratio of *J. sambac*: *P. alba* was 1:2 and the concentration was 25 mg/mL for 6 h of incubation. Furthermore, the largest *C. albicans* inhibitory zone diameter (7.54 ± 0.27 mm) was achieved with a 2:1 ratio of *J. sambac* to *P. alba* at a dosage of 25 mg/mL for 24 h. The antimicrobial activity of the combined extracts is observed to be higher than that of each extract. Naturally occurring combinations of these compounds can be synergistic and often result in crude extracts having higher antimicrobial activity than the purified individual constituents. In another case, the mean zone of inhibition produced by *J. sambac* extract against *B. subtilis*, *B. cereus*, *S. aureus*, *E. coli*, *P. aeruginosa*, *A. niger*, *A. flavus*, and *C. albicans* was in the range of 5 - 27 mm.[28] It was observed that *P. alba* flower extract has antibacterial activities against *E. coli*, *P. vulgaris*, *S. aureus*, *K. pneumoniae*, *P. aeruginosa*, *S. saprophyticus*, *E. faecalis*, *S. marcescens*, *Propionibacterium acnes*, and *C. albicans*, up to 24 mm.[29]

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Table 1: Antibacterial activity of *Jasminum sambac* L. and *Plumeria alba* L. flower extracts in different combinations and concentrations against *Staphylococcus aureus* ATCC 25923 for 3, 6, and 9 h of incubation.

Treatment	Concentration (mg/mL)	Time (h)	Inhibition zone (mm)
A	25	3	6.49 + 0.07^{cd}
		6	7.23 + 0.25^{bc}
		9	6.79 + 0.20^{b}
	50	3	6.67 + 0.05^{d}
		6	7.96 + 0.12^{d}
		9	7.29 + 0.19^{cd}
B	25	3	6.50 + 0.10^{cd}
		6	7.06 + 0.09^{bc}
		9	7.33 + 0.31^{cd}
	50	3	7.05 + 0.02^{e}
		6	8.10 + 0.09^{d}
		9	8.17 + 0.13^{e}
C	25	3	6.12 + 0.10^{b}
		6	7.46 + 0.21^{c}
		9	7.13 + 0.26^{cd}
	50	3	6.62 + 0.09^{d}
		6	8.10 + 0.09^{d}
		9	7.29 + 0.07^{cd}
D	25	3	6.49 + 0.10^{cd}
		6	7.15 + 0.12^{bc}
		9	7.42 + 0.15^{d}
	50	3	7.23 + 0.12^{f}
		6	8.68 + 0.15^{e}
		9	8.19 + 0.07^{e}
E	25	3	6.55 + 0.12^{cd}
		6	6.89 + 0.31^{b}
		9	7.03 + 0.20^{bc}
	50	3	6.41 + 0.13^{c}
		6	7.89 + 0.13^{d}
		9	7.14 + 0.19^{cd}
Control (-)		3	0.00 + 0.00^{a}
		6	0.00 + 0.00^{a}
		9	0.00 + 0.00^{a}
Control (+)		3	10.32 + 0.22^{g}
		6	11.13 + 0.62^{g}
		9	10.18 + 0.25^{f}

Values are presented as mean ±SD. Different superscripts following values indicate significant difference ($p<0.05$); Combination treatments of *Jasminum sambac* L: *Plumeria alba* L flower ethanol extract are A: 3:0; B: 0:3; C: 1:1; D: 1:2; E: 2:1; Control (-): 1% DMSO; Control (+): Chloramphenicol (1 mg/mL)

Table 2: Antibacterial activity of *Jasminum sambac* L. and *Plumeria alba* L. flower extracts in different combinations and concentrations against *Escherichia coli* ATCC 32518 for 3, 6, and 9 h of incubation.

Treatment	Concentration (mg/mL)	Time (h)	Inhibition zone (mm)
A	25	3	6.06 ± 0.10^{b}
		6	7.38 + 0.12^{c}
		9	6.98 + 0.11^{c}
	50	3	7.21 + 0.09^{c}
		6	8.03 + 0.03^{d}
		9	6.98 + 0.11^{c}
B	25	3	7.08 + 0.08^{c}
		6	7.64 + 0.51^{c}
		9	6.87 + 0.20^{c}
	50	3	7.56 + 0.07^{d}
		6	8.12 + 0.15^{de}
		9	8.19 + 0.07^{f}
C	25	3	7.19 + 0.18^{c}
		6	7.80 + 0.23^{c}
		9	6.76 + 0.21^{bc}
	50	3	7.69 + 0.14^{d}
		6	8.08 + 0.12^{d}
		9	7.86 + 0.05^{e}
D	25	3	7.92 + 0.12^{e}
		6	8.59 + 0.09^{g}
		9	7.51 + 0.02^{d}
	50	3	8.20 + 0.19^{f}
		6	8.41 + 0.02^{f}
		9	8.57 + 0.42^{g}
E	25	3	7.13 + 0.09^{c}
		6	8.02 + 0.07^{d}
		9	6.49 + 0.07^{b}
	50	3	7.68 + 0.19^{d}
		6	8.27 + 0.08^{ef}
		9	6.66 + 0.34^{bc}
Control (-)		3	0.00 + 0.00^{a}
		6	0.00 + 0.00^{a}
		9	0.00 + 0.00^{a}
Control (+)		3	11.72 + 0.19^{g}
		6	13.12 + 0.51^{h}
		9	13.34 + 0.08^{h}

Values are presented as mean ±SD. Different superscripts following values indicate significant difference ($p<0.05$); Combination treatments of *Jasminum sambac* L: *Plumeria alba* L flower ethanol extract are A: 3:0; B: 0:3; C: 1:1; D: 1:2; E: 2:1; Control (-): 1% DMSO; Control (+): Chloramphenicol (1 mg/mL)

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Table 3: Antifungal activity of *Jasminum sambac* L. and *Plumeria alba* L. flower extracts in different combinations and concentrations against *Candida albicans* ATCC 10231 for 16, 24, and 32 h incubation.

Treatment	Concentration (mg/mL)	Time (h)	Inhibition zone (mm)
A	25	16	$0.00 + 0.00^{a}$
		24	$7.11 + 0.15^{def}$
		32	$6.60 + 0.13^{bcde}$
	50	16	$6.41 + 0.17^{c}$
		24	$7.11 + 0.10^{def}$
		32	$6.71 + 0.54^{bcde}$
B	25	16	$0.00 + 0.00^{a}$
		24	$6.78 + 0.17^{bcd}$
		32	$6.49 + 0.11^{bcd}$
	50	16	$7.02 + 0.14^{e}$
		24	$6.91 + 0.07^{cd}$
		32	$6.47 + 0.03^{bc}$
C	25	16	$0.00 + 0.00^{a}$
		24	$7.54 + 0.27^{g}$
		32	$7.00 + 0.24^{e}$
	50	16	$7.13 + 0.12^{e}$
		24	$7.33 + 0.32^{efg}$
		32	$6.98 + 0.19^{de}$
D	25	16	$0.00 + 0.00^{a}$
		24	$7.29 + 0.18^{fg}$
		32	$7.03 + 0.35^{e}$
	50	16	$6.67 + 0.15^{d}$
		24	$7.01 + 0.17^{de}$
		32	$6.96 + 0.39^{cde}$
E	25	16	$0.00 + 0.00^{a}$
		24	$6.52 + 0.10^{b}$
		32	$6.40 + 0.22^{b}$
	50	16	$6.13 + 0.15^{b}$
		24	$6.61 + 0.16^{bc}$
		32	$6.59 + 0.05^{bcde}$
Control (-)		16	$0.00 + 0.00^{a}$
		24	$0.00 + 0.00^{a}$
		32	$0.00 + 0.00^{a}$
Control (+)		16	$0.00 + 0.00^{a}$
		24	$8.13 + 0.23^{h}$
		32	$7.91 + 0.25^{f}$

Values are presented as mean±SD. Different superscripts following values indicate significant difference ($p<0.05$); Combination treatments of *Jasminum sambac* L: *Plumeria alba* L flower ethanol extract are A: 3:0; B: 0:3; C: 1:1; D: 1:2; E: 2:1; Control (-): 1% DMSO; Control (+): Chloramphenicol (1 mg/mL)

Different experimental conditions, such as microbial strain, cell state, temperature, pH, contact time, cell density, plant extracts' concentration, nature of biologically active chemicals, the extraction process, and solvent type, may account for the different results.

Chemical composition of flower extracts

The antimicrobial activity of the extract is due to the presence of phytochemical compounds. The qualitative chemical examinations of both *J. sambac* and *P. alba* flower ethanol extracts revealed the presence of tannin, flavonoid, saponin, and phenol. Many studies have investigated the phytochemicals of *J. sambac*, which reveal the presence of alkaloids, flavonoids, terpenoids, carbohydrates, proteins, phenols, tannins, saponins, and phytosterols.[30,31] The antibacterial mechanisms of flavonoids are primarily caused by inhibition of nucleic acid synthesis; inhibition of cytoplasmic membrane function, which affects biofilm formation, porins, permeability; and interaction with some key enzymes, such as quercetin, which increases bacterial cell membrane permeability.[32] Besides, flavonoid compounds showed a positive correlation with the extracts' antimicrobial activity.[33] Flavonoids produce complex compounds with extracellular proteins, causing bacterial and fungal cell membrane integrity to be disrupted. Tannin's antibacterial activity is based on its capacity to shrink bacterial and fungal cell walls or membranes after interfering with permeability. Cell permeability disruption prevents cells from performing vital functions, obstructing or even killing microbial development. By precipitating protein, phenolics possess antibacterial and antifungal properties.[19] Flavonoids, alkaloids, saponins, and tannins are the major antimicrobial metabolites found in crude ethanol fractions.[34] The antimicrobial activity of plant extracts is also caused by bioactive compounds that can inactivate several microbial enzymes and transmembrane transport proteins.[35]

The volatile chemical compositions were analyzed by GC-MS, and the components were identified using retention times, computer matching with the NIST library, comparison of the pattern with those described in the literature, and, in the case of major components, comparison with the authentic sample. The GC-MS chromatogram analysis of the ethanol extract of *J. sambac* flower showed 24 peaks, which indicates the presence of 24 phytochemical constituents (Figure 1). By comparing the mass spectra of the constituents with the NIST library, the 24 phytocompounds have been characterized and identified as presented in Table 4. The most prevalent compound was 9,12,15-octadecatrienal (19.40%), followed by octadecanoic acid (14.14%), 9,12-octadecadienoic acid (11.15%), silane (11.14%), and tetradecanoic acid (9.64%). The 9,12,15-octadecatrienal is in the class of organic compounds known as long-chain fatty alcohols that have antibacterial properties.[36,37] Silanes are the silicon homologs of carbon-based alkanes. It is an organic contact-killing agent that possesses a broad spectrum of antimicrobial activities with low cytotoxicity.[38,39] Tetradecanoic acid, as a result, is a common saturated fatty acid with antibacterial properties.[40] A total of 44 chemicals were identified in *P. alba* flowers using GC-MS analysis, as shown in Figure 2. Table 5 displays the chemical constituents with their retention time (RT), molecular weight (MW), and concentration (%), where the predominant compounds are cyclohexanol (25.77%), octadecanoic acid (11.77%), squalene (9.73%), 9,12-octadecadienoic acid (8.51%), and trans-2-tridecenal (7.89%). Cyclohexanol is often utilized as a promoter in the production of ester prodrugs. Several plant-derived cyclohexenes have been found to have biological activity, including antibacterial action.[41-43] Octadecanoic acid, which is also observed in *J. sambac* extract, has activity against microorganisms.[44,45] Squalene is a natural antimicrobial peptide that is also known as 2,6,10,14,18,22-tetracosahexaene.[46,47] The compound, 9,12-octadecadienoic acid, also has antibacterial and antifungal properties.[48,49] Trans-2-tridecenal is also an aldehydic, fatty, floral-tasting molecule with antibacterial activities.[50,51] The chemicals found in the *J. sambac* flower in this study differ slightly from those previously reported.[52–54] Moreover, these findings differ in certain ways from previous reports on the study of *P. alba* flower extract.[55–57] Compound diversity could be influenced by changes in plant species, geographic location, biotic and abiotic factors affecting plant growth, solvent type, and extraction procedures.

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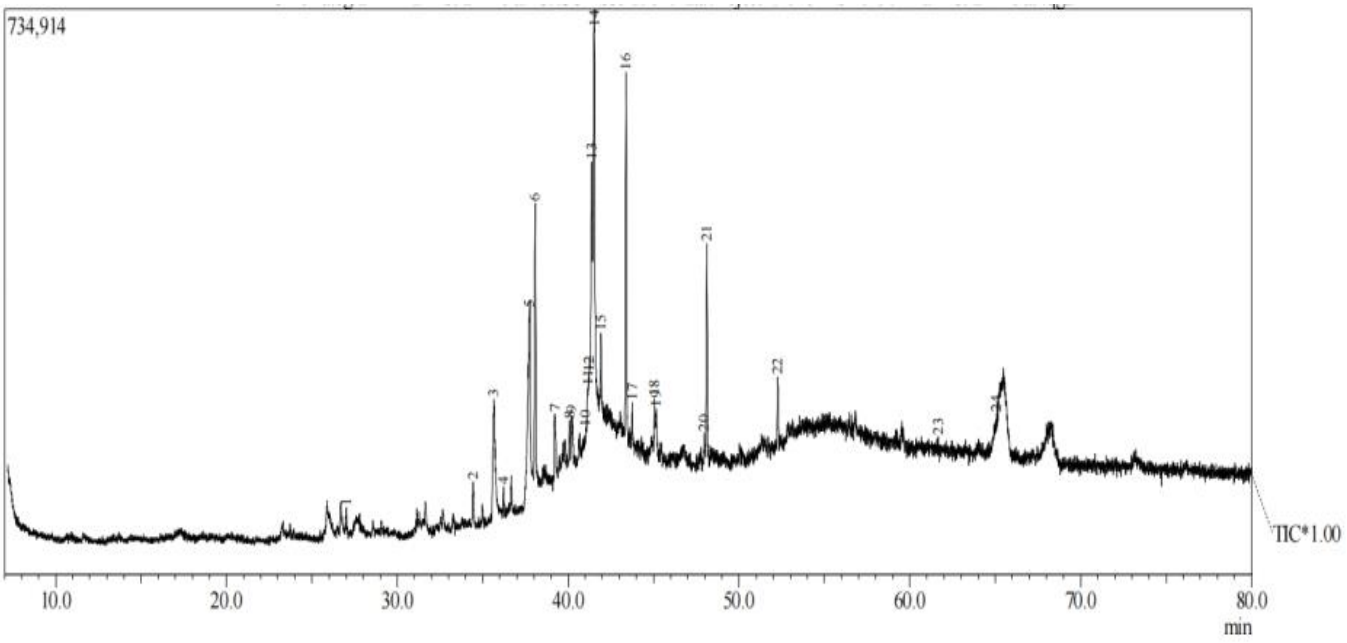

Figure 1: GC-MS chromatogram of *Jasminum sambac* L. ethanol flower extract.

Table 4: Phytochemical constituents of ethanol extract of *Jasminum sambac* L. flowers

No	RT	Identified components	Molecular weight	Peak (%)
1	27.006	1,3,6,10-Dodecatetraene	204	0.65
2	34.436	4-Acetoxy-3-methoxycinnamic acid	236	1.28
3	35.655	1H-Purine-2,6-dione	194	7.75
4	36.208	2-Nonanone	158	0.58
5	37.744	Octadecanoic acid	284	14.14
6	38.072	Tetradecanoic acid	256	9.64
7	39.214	1,6,10-Dodecatrien-3-o	222	2.66
8	40.093	Dodecyne	166	1.21
9	40.216	5-Octadecenoic acid	296	1.93
10	41.025	2-Octena	126	0.41
11	41.150	Propane	122	2.05
12	41.225	Bicyclo	124	0.53
13	41.376	9,12-Octadecadienoic acid	294	11.15
14	41.517	9,12,15-Octadecatrienal	262	19.40
15	41.924	Hexadecanoic acid	284	2.09
16	43.390	Silane	414	11.14
17	43.757	Dodecane	170	0.91
18	45.061	1-Hexacosanol	382	1.39
19	45.158	Octadecane	296	0.95
20	47.985	9-Octadecenamide	281	0.77
21	48.124	1,2-Benzenedicarboxylic acid	390	7.01
22	52.268	2,6,10-Dodecatrien-1-ol	222	2.06
23	61.650	9,12-Octadecadienoic acid	294	0.17
24	65.092	Acetaldehyde	112	0.12

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Table 5: Phytochemical constituents of ethanol extract of *Plumeria alba* L. flowers

No	RT	Identified components	Molecular weight	Peak (%)
1	18.841	Benzaldehyde	120	0.58
2	23.225	5-Methyl-1,3-cyclohexanedione	126	0.25
3	23.342	2-Pentene, 4-bromo	148	0.63
4	33.004	1,8-Nonadiyne	120	0.32
5	33.293	Octadecanoic acid	284	0.78
6	33.840	Hexadecanoic acid	284	0.55
7	34.575	4-Nonene	171	0.27
8	35.567	Silane	414	0.55
9	35.891	Benzoic acid	228	0.87
10	36.066	Tetradecane	198	0.45
11	36.682	Pentadecanoic acid	270	0.24
12	36.983	1-Hexadecen-1-ol	282	0.31
13	37.242	Octanoic acid	236	0.39
14	37.776	Octadecanoic acid	284	11.77
15	38.109	Tetradecanoic acid	256	6.58
16	38.924	1,6,10-Dodecatrien-3-ol	222	0.29
17	39.602	Hexadecane	260	0.51
18	40.089	1-Nonene	168	0.83
19	40.199	9-Hexadecenoic acid	268	0.26
20	40.642	Di-2-Benzothiazole disulfane	332	0.32
21	41.240	Oleic Acid	282	6.74
22	41.419	9,12-Octadecadienoic acid	294	8.51
23	41.530	Trans-2-Tridecenal	196	7.89
24	41.773	Oxacyclotetradecane-2	240	0.81
25	41.926	Tetradecanoic acid	256	1.21
26	44.250	1-Nonanol	144	0.50
27	45.050	1-Eicosanol	298	0.32
28	45.428	Hexadecanoic acid	284	0.59
29	47.975	Cyclopentadecanol	226	0.24
30	48.122	1,2-Benzenedicarboxylic acid	390	1.79
31	48.426	1-Decene	140	0.40
32	48.678	Hexadecanoic acid	284	0.52
33	49.893	1-Tetracosanol	354	0.27
34	51.310	Hexanoic acid	198	0.33
35	51.660	2-propenyl hexanoate	156	1.32
36	52.312	Squalene	410	9.73
37	52.849	1-Hexacosanol	382	1.06
38	54.474	2-propenyl octanoate	184	0.57
39	56.417	d-Nerolidol	222	0.37
40	62.519	9,12,15-Octadecatrienoic acid,	436	0.50
41	63.514	Cyclopentaneundecanoic acid	254	0.49
42	64.333	Farnesol	222	0.29
43	65.001	Acetic acid	102	3.00
44	66.581	Cyclohexanol	196	25.77

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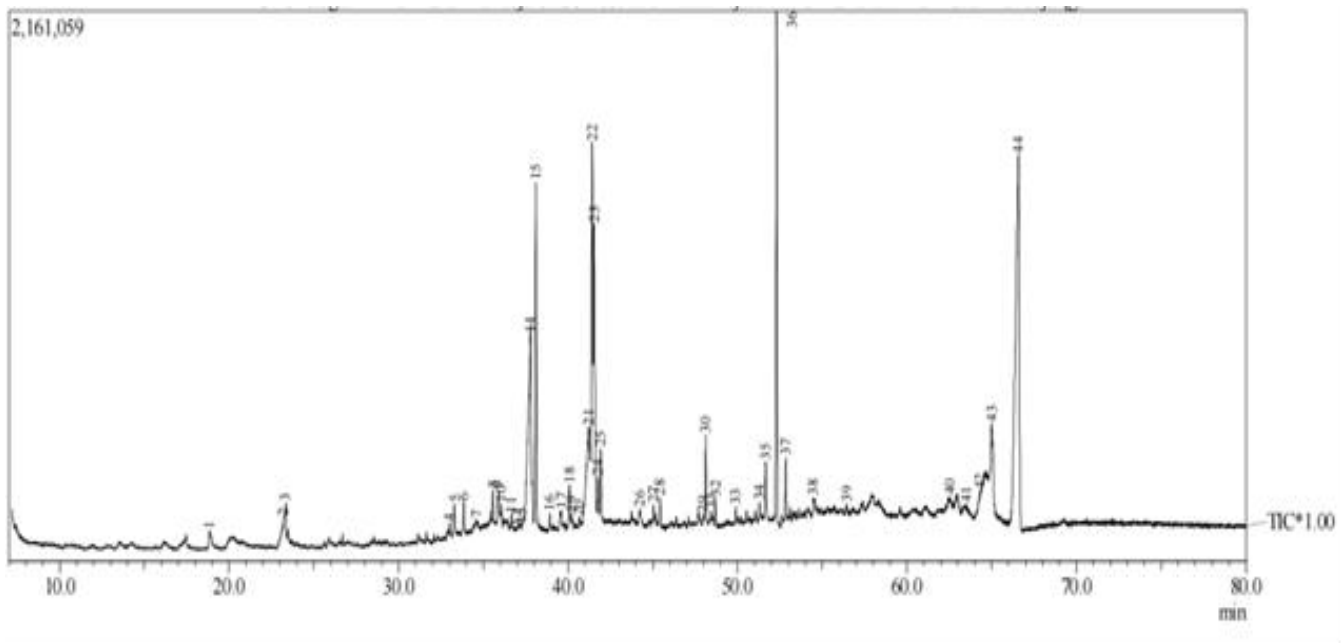

Figure 2: GC-MS chromatogram of *Plumeria alba* L. ethanol flower extract.

Conclusion

The findings of this study reveal that the combined *J. sambac* and *P. alba* flower extracts have different antimicrobial effects on bacteria and fungi. The highest inhibition zone diameter against *S. aureus* was obtained at 50 mg/mL of *J. sambac*: *P. alba* (1:2) for 6 h. Both flower extracts contained tannin, flavonoids, saponin, and phenolic compounds. The phytochemical screening of *J. sambac* and *P. alba* flower extracts reveals 24 and 44 compounds, respectively. Some of the identified compounds in the flower extracts are known to be bioactive compounds with antimicrobial activities. Although, the structure-activity relationship has yet to be proven, this study may serve as a basis for further investigation. Further studies are required to develop a suitable formulation and to determine the *in vivo* capabilities of *J. sambac* and *P. alba* flower extracts.

Conflict of Interest

The author declares that there is no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article are original and that any liability for claims relating to the content of this article will be borne by them.

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References

1. Gu Y. Raising awareness of antimicrobial resistance: comment on reducing expectations for antibiotics in primary care: a randomized experiment to test the response to fear-based messages about antimicrobial resistance. BMC Med. 2020; 18(1):1-2.
2. Azam F, Rahman MS, Amin GM Al, Miah I, Koh Y. Delafloxacin, a superior antibacterial agent to its competitor fluoroquinolones comparative activity of delafloxacin with other fluoroquinolones. Korean J Microbiol. 2021; 57(3):133-141.
3. Bhatia P, Sharma A, George AJ, Anvitha D, Kumar P, Dwivedi VP, Chandra, NS. Antibacterial activity of medicinal plants against ESKAPE : an update. Heliyon. 2021; 7:e06310.
4. Chanthasena P, Penkhrue W, Khowangklang P, Sritangos P, Nantapong N. Antimicrobial potential of fungi isolated from soils of a dry dipterocarp forest in northeast Thailand. Chiang Mai J Sci. 2021; 48(3):793-807.
5. Yau JW, Thor SM, Tsai D, Speare T, Rissel C. Antimicrobial stewardship in rural and remote primary health care: a narrative review. Antimicrob Resist Infect Contr. 2021; 10(1):1-33.
6. Su PW, Yang CH, Yang JF, Su PY, Chuang LY. Antibacterial activities and antibacterial mechanism of *Polygonum cuspidatum* extract against nosocomial drug-resistant pathogens. Molecules. 2015; 20(6):11119-11130.
7. Astuti P, Rollando R, Wahyuono S, Nurrochmad A. Antimicrobial activities of isoprene compounds produced by an endophytic fungus isolated from the leaves of *Coleus amboinicus* Lour. J Pharm Pharmacogn Res. 2020; 8(4):280-289.
8. Al-mamoori F, Al-tawalbe DM, Alnaqeeb M. Medicinal plants for the treatment and management of oral infections: a review. Trop J Nat Prod Res. 2021; 5(9):1528-1536.
9. Ankomah AD, Boakye YD, Agana TA, Adu F, Agyare C. Antimicrobial properties of *Cnestis ferruginea* Vahl ex DC. Heliyon. 2021; 7:e08266.
10. Gupta A, Jeyakumar E, Lawrence R. Journey of limonene as an antimicrobial agent. J Pure Appl Microbiol. 2021; 15(3):1094-1110.
11. Siva M, Shanmugam KR, Shanmugam B, Venkata SG, Ravi S, Sathyavelu RK, Mallikarjuna K. *Ocimum sanctum*: a review on the pharmacological properties. Int J Basic Clin Pharmacol. 2016; 5(3):558-565.
12. Egharevba, GO, Dosumu OO, Oguntoye SO, Njinga NS, Olatunde S, Hamid AA, Anand A, Amtul, Z, Priyanka, U. Antidiabetic, antioxidant and antimicrobial activities of extracts of *Tephrosia bracteolata* leaves. Heliyon. 2019; 5:e02275.
13. Primiani CN, Pujiati P, Setiawan MA. Phytochemical constituents and antimicrobial activity of *Elaeocarpus sphaericus* Schum seed extract. Trop J Nat Prod Res. 2021; 5(10):1775-1781.
14. Sabharwal S, Sudan S, Ranjan V. *Jasminum sambac* Linn (Motia): a review. Int J Pharm Res Bio-Science. 2013; 2(5):1

08-130.
15. Chen G, Mostafa S, Lu Z, Du R, Cui J, Wang Y, Liao, Q, L u J, Mao Q, Chang B, Wang L, Jia Z, Yang X, Zhu Y, Yan J, Jin B. The jasmine (*Jasminum sambac*) genome and flow er fragrances. bioRxiv. 2020. 1-25 p.
16. Kumar S, Vishwavidyalaya GK, Vishwavidyalaya GK, Gau tam SS. Screening of antimicrobial properties of *Jasminum samba*c Linn. leaf extracts against dental pathogens. Res J P hytochem. 2015; 9(4):195-200.
17. Idrees S, Hanif MA, Ayub MA, Jilani MI, Memon N. Frang ipani. Medicinal Plants of South Asia. Elsevier Ltd. 2020; 2 87-300p.
18. Balouiri M, Sadiki M, Ibnsouda SK. Methods for *in vitro* ev aluating antimicrobial activity: a review. J Pharm Anal. 201 6; 6(2):71-79.
19. Setyani W, Yakub J, Yandri O, Kawan VR. Phytochemical investigation and antibacterial activity ethanol extract of pa paya seeds (*Carica papaya* L.) applicated for gel product. J Ilmu Kefarmasian Indones. 2020; 18(1):96-100.
20. Rohmah J, Saidi IA, Rini CS, Putri ZA, Tiana KH, Putri CT R. Antioxidant activity assay of white Turi (*Sesbania grand iflora* (L.) Pers) extracts using DPPH radical scavenging me thod. Pharmaciana. 2020; 10(3):257-268.
21. Mensah-Agyei GO, Ayeni KI, Ezeamagu CO. GC-MS anal ysis of bioactive compounds and evaluation of antimicrobia l activity of the extracts of *Daedalea elegans*: A Nigerian m ushroom. Afr J Microbiol Res. 2020; 14(6):204-210.
22. Awang-Jamil Z, Aminuddin MF, Zaidi BQ, Basri AM, Ah mad N, Taha H. Phytochemicals and antimicrobial analysis of selected medicinal plants from *Brunei darussalam*. Biodi versitas. 2021; 22(2):601-606.
23. Nascimento GGF, Locatelli J, Freitas PC, Silva GL. Antiba cterial activity of plant extracts and phytochemicals on antib iotic-resistant bacteria. Braz J Microbiol. 2000; 31(4):247-2 56.
24. Jumpathong J, Suphrom N, Dell B. Screening of antibacteri al activity of *Goniothalamus calvicarpa* extracts against *Xa nthomonas axonopodis* pv. citri *in vitro*. CMU J Nat Sci. 2 020; 19(2):252-264.
25. Tangjitjaroenkun J, Tangchitcharoenkhul R, Yahayo W, Su pabphol R. In vitro antimicrobial and cytotoxic activities of mangrove actinomycetes from Eastern Thailand. Chiang M ai J Sci. 2017; 44(2):322-337.
26. Ranpariya B, Salunke G, Karmakar S, Babiya K, Sutar S, K adoo N, Kumbhakar P, Ghosh S. Antimicrobial synergy of s ilver-platinum nanohybrids with antibiotics. Front Microbio l. 2021; 11(2):1-12.
27. Ninkuu V, Adetunde LA, Sackey I, Opoku N, Diedong P. A ntifungal efficacy of crude extracts of *Azadirachta indica* an d *Vernonia amygdalina* against pathogenic *Aspergillus nige r* (ATCC 16404). J Med Plants Res. 2019; 13(17):408-412.
28. Gowdhami T, Rajalakshmi AK, Sugumar N, Valliappan R. Evaluation of antimicrobial activity of different solvent extr acts of aromatic plant: *Jasminum sambac* linn. J Chem Phar m Res. 2015; 7(11):136-143.
29. Barry A, Enade I, Maywan H. Future molecular medicine fr om white frangipani (*Plumeria alba* L.): a review. J Med Pl ants Res. 2020; 14(10):544-554.
30. Shekhar S and Prasad MP. Comparative analysis of antioxid ant properties of jasmine species by hydrogen peroxide assa y. Eur J Biotechnol Biosci. 2015; 3(2):26-29.
31. Senbagam D, Senthilkumar B, Amutha R, Arunt, Nagarajan G, Kalandar A. Phytotherapeutic control of foodborne patho gens by *Jasminum sambac* L. Flowers. Int J Pharm Pharm S ci. 2016; 8(3):188-193.
32. Adamczak A, Ożarowski M, Karpiński TM. Antibacterial a ctivity of some flavonoids and organic acids widely distribu ted in plants. J Clin Med. 2019; 9,109:1-17.
33. Sagar NA and Pareek S. Antimicrobial assessment of polyp henolic extracts from onion (*Allium cepa* L.) skin of fifteen cultivars by sonication-assisted extraction method. Heliyon. 2020; 6:e05478.
34. Joshi S, Amatya S, Pandey RD, Khadka P, Bhattarai J. Anti microbial, antioxidant, antidiabetic, cytotoxic activities and GC-MS analysis of methanolic extract of *Elaeocarpus spha ericus* leaves from Nepal. Int J Adv Res Chem Sci. 2020; 8(1):11-23.
35. Ezeonu IM and Chukwudozie IK. Antimicrobial activity, ph ytochemistry and acute toxicity profile of *Sarcocephalius la tifolius* root bark. Trop J Nat Prod Res. 2021; 5(3):576-581.
36. Sharma N, Samarakoon KW, Gyawali R, Park YH, Lee SJ, Oh SJ, Lee TH, Jeong DK. Evaluation of the antioxidant, an ti-inflammatory, and anticancer activities of *Euphorbia hirt a* ethanolic extract. Molecules. 2014; 19(9):14567-14581.
37. Olivia NU, Goodness UC, Obinna OM. Phytochemical prof iling and GC-MS analysis of aqueous methanol fraction of *Hibiscus asper* leaves. Futur J Pharm Sci. 2021; 7(59):1-5.
38. Daood U, Matinlinna JP, Pichika MR, Mak KK, Nagendrab abu V, Fawzy AS. A quaternary ammonium silane antimicr obial triggers bacterial membrane and biofilm destruction. S ci Rep. 2020; 10(1):1-14.
39. Kok ESK, Lim XJ, Chew SX, Ong SF, See LY, Lim SH, W ong LA, Davamani F, Nagendrababu V, Fawzy A, Daood U . Quaternary ammonium silane (k21) based intracanal medi cament triggers biofilm destruction. BMC Oral Health. 202 1; 21(1):1-17.
40. Abubakar M and Majinda R. GC-MS analysis and prelimin ary antimicrobial activity of *Albizia adianthifolia* (Schumac h) and *Pterocarpus angolensis* (DC). Med. 2016; 3(3):1-9.
41. Hussain HY, Osama M, Hussain W. Stereostructure, antimi crobial and cytotoxic activity of cyclohexene, cyclohexanol and pyridine derivatives synthesized from chalcones. Int J P harm Sci Res. 2014; 5(5):2084-2094.
42. Mamedov IG, Shikhaliyevaa IM, Mamedova YA, Maharra mov AM. Antibacterial and antifungal activities of thiosemi carbazone, pyrazole, indole, cyclohexanol derivatives of 2-h ydroxy-5-methyl- and 4-bromoacetophenones. Indian J Che m -Section B. 2019; 58(08):930-934.
43. Mamedov IG and Mamedova YV. Biological activity of no vel pentasubstituted cyclohexanol against some microorgani sms. Indian J Chem - Sect B Org Med Chem. 2021; 60 B(2) :283-286.
44. Shafie N 'Izzati, Samsulrizal N, Sopian NA, Rajion MA, M eng GY, Ajat MMM, et al. Qualitative phytochemical scree ning and GC-MS profiling of *Azadirachta excelsa* leaf extra ct. Malay Appl Biol. 2015; 44(3):87-92.
45. Iwara IA, Igile GO, Uboh FE, Eteng MU, Ebong PE. Analy sis of bioactive constituents of n-hexane and methanol fracti ons of *Vernonia calvoana* extracts using gas chromatograph y-mass spectrometry. Pharmacogn J. 2018; 10(5):854-858.
46. Bondaryk M, Staniszewska M, Zielińska P, Urbańczyk-Lip kowska Z. Natural antimicrobial peptides as inspiration for design of a new generation antifungal compounds. J Fungi. 2017; 3(46):1-36.
47. Kim BR, Kim HM, Jin CH, Kang SY, Kim JB, Jeon YG, Pa rk KY, Lee IS, Han AR. Composition and antioxidant activi ties of volatile organic compounds in radiation-bred coreops is cultivars. Plants. 2020; 9(717):1-9.
48. Casiglia S, Bruno M, Rosselli S, Senatore F. Chemical com position and antimicrobial activity of the essential oil from f lowers of *Eryngium triquetrum* (Apiaceae) collected wild in sicily. Nat Prod Commun. 2016; 11(7):1019-1024.
49. Yildiz H. Chemical composition, antimicrobial, and antioxi dant activities of essential oil and ethanol extract of *Corian drum sativum* L. leaves from Turkey. Int J Food Prop. 2016; 19(7):1593-1603.
50. Pragadheesh VPPS, Yadav A, Chanotiya CS, Rout PK, Uni yal GC. Monitoring the emission of volatile organic compo unds from flowers of *Jasminum sambac* using solid-phase micro-extraction fibers and gas chromatography with mass spectrometry detection. Nat Prod Commun. 2011; 6(9):1333 -1338.

ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

51. Khidzir KM, Cheng SF, Chuah CH. Interspecies variation o f chemical constituents and antioxidant capacity of extracts from *Jasminum sambac* and *Jasminum multiflorum* grown i n Malaysia. Ind Crops Prod. 2015; 74:635-641.
52. Mahmood MA, Saeed M, Ahmad N. Quantitative and qualit ative analysis of essential oil of Arabian jasmine (*Jasminum sambac*) flowers harvested from Pothohar region of Pakista n. J Ornam Plants. 2017; 7(1):17-24.
53. Rassem HH, Nour AH, Yunus RM. Analysis of bioactive co mpounds for jasmine flower via Gas chromatography-mass spectrometry (GC-MS). Malay J Fundam Appl Sci. 2018; 1 4(2):198-201.
54. Bera P, Kotamreddy JNR, Samanta T, Maiti S, Mitra A. Int er-specific variation in headspace scent volatiles compositio n of four commercially cultivated jasmine flowers. Nat Prod Res. 2015; 29(14):1328-1335.
55. Lawal OA, Ogunwande IA, Opoku AR. Constituents of ess ential oils from the leaf and flower of *Plumeria alba* grown in Nigeria. Nat Prod Commun. 2014; 9(11):1613-1614.
56. Anand U, Nandy S, Mundhra A, Das N, Pandey DK, Dey A . A review on antimicrobial botanicals, phytochemicals and natural resistance modifying agents from Apocynaceae fami ly: possible therapeutic approaches against multidrug resista nce in pathogenic microorganisms. Drug Resist Updat. 202 0; 51(100695):1-30.
57. Mohamad SA, Adzahar NS, Akhtar MN, Zareen S, Lee TC. Phytochemical analysis and GC-MS profiling in the flower of *Plumeria alba*. Mater Sci Forum. 2020; 981:280-284.