Antimicrobial and Antibiofilm Activity of *Jasminum officinale* Extracts against Dental Plaque forming Microflora

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Abstract: Dental plaques are a common factor in many oral diseases such as dental caries, gingivitis and periodontal infections. They are composed of diverse microbial communities which persist by forming biofilms in the oral cavity. Although several chemical based remedies are available for plaque control, their prolonged use is often associated with adverse effects. In an attempt to find a natural remedy, the present study evaluated the antimicrobial and anti-biofilm forming potential of aqueous extracts of *Jasminum officinale* leaves and flowers. Their activity was determined against plaque-forming microorganisms isolated in this study from oral cavity of individuals suffering from dental plaques. In total, 12 isolates were obtained from 25 samples, and included 5 gram negative (*Acinetobacter baumannii*, *Pseudomonas fluorescens*, *Stenotrophomonas maltophilia*, *Serratia marcescens* and *Enterobacter hormaechei*), 3 gram positive (*Micrococcus luteus*, *Staphylococcus hominis* and *Kocuria kristinae*), 2 yeasts (*Candida parapsilosis* and *Candida albicans*) and 2 anaerobic gram-positive bacteria (*Paraclostridium bifermentans*, *Schaalia odontolytica*). The biochemical profiles of plant samples were also evaluated based on Gas Chromatography–Mass Spectrometry (GC–MS) analysis. The GC–MS chromatogram identified 69 compounds in the leaf extract and 65 compounds in the flower extracts of *J. officinale*. Both extracts showed efficient antimicrobial and antibiofilm potential against the test organisms, which can be attributed to the rich biochemical profile of the plant. Overall, our findings suggest that *J. officinale* based anti-plaque formulations such as mouthwashes, toothpastes, gels and chewing gums may be an effective alternative to chemical-based agents available in the market.

IndexTerms **- antibiofilm, antimicrobial activity, bioactive compounds, dental plaque, *Jasminum officinale*, natural dental care, oral health, phytochemicals**

I. INTRODUCTION

Oral hygiene is a part of overall health of an individual. Oral health is considered as critical since the oral cavity serves as the primary entry point for microorganisms (Barranca-Enríquez and Romo-González, 2022). In absence of proper oral hygiene practices, the pathogenic strains of microorganisms often overgrow causing dysbiosis in the natural flora of oral cavity (Rajasekaran et al., 2024). Among the oral health challenges, the dysbiosis primarily leads to dental plaque formation. The plaques can be described as a complex biofilm network which is sticky and gelatinous, and formed as a result of microbial activity of sugar metabolism (Valm, 2019). Additionally, they also contain salivary glycoproteins and diverse species of microorganisms tolerant to low pH conditions (Rajasekaran et al., 2024; Valm, 2019). Plaque accumulation leads to more complex oral problems such as dental caries, gingivitis and periodontitis, and in severe cases may lead to systemic infections such as infective endocarditis (Bumm and Folwaczny, 2021).

Normally, dental plaques can be remained in check with simple brushing and flossing. However, many health conditions such as diabetes, HIV/AIDS, cancer, rheumatoid arthritis, Alzheimer's, and thyroid issues significantly increase the susceptibility of individuals to oral diseases (Fu et al., 2025). Many chemical-based plaque- control agents such as chlorhexidine mouthwash or toothpaste are available in the market. However, their long-term use leads to adverse side-effects including thinning and discoloration of tooth, altered taste perception and mucosal irritation (Inchingolo et al., 2025). The use of these agents is also associated with development of antimicrobial resistance and increased dysbiosis in the natural flora of oral cavity (Bartsch et al., 2024).

More recently, a biological approach of probiotic-based replacement of pathogenic oral microflora is emerging as a suitable strategy for plaque control (Shirbhate et al., 2023). However, presently it suffers limitations associated with strain colonization, stability and long-term efficacy (Baddouri and Hannig, 2024). Another strategy for combating dental plaques includes the use of plant-based alternatives. These strategies are increasingly supported by consumers who are aware of the side effects of chemical-based agents. Besides, the plant-based strategies defined as 'herbal remedies' are deeply rooted in traditional healthcare systems, and many communities still reliably depend on these remedies without any associated side effects (Anwar et al., 2025). One such medicinal plant is *Jasminum officinale* L., commonly known as 'Spanish jasmine' or 'Chameli'. It belongs to the family Oleaceae and is widely used in cosmetics, perfumery and food industries due to its aromatic properties (Wu et al., 2021). *J. officinale* is further associated with a wide range of medicinal properties, including antimicrobial, antifungal, antioxidant, anti-inflammatory, antidiabetic and antiseptic effects (Sahu et al., 2022). The leaves and flowers of *J. officinale* consist of bioactive compounds including alkaloids, tannins, flavonoids, terpenoids and saponins, which contribute to their antimicrobial and antioxidant potential through mechanisms such as disruption of microbial cell membranes, inhibition of enzymatic activity, suppression of quorum sensing, and interference with biofilm formation (Balkrishna et al., 2021). Many studies have previously reported inhibitory effects of essential oils and solvent extracts of *J. officinale* against dental plaque-related bacteria, and suggested their promising potential in herbal dental product formulations (Shubhama and Moniket, 2023; Mangtani et al., 2019). Additionally, there are reports of use of *J. officinale* extracts for the treatment of skin infections, wounds and inflammatory diseases in traditional medicinal systems (Zhao et al., 2009; Sahu et al., 2022).

Despite the promising potential of *J. officinale*, very few studies have evaluated its efficacy against the broad-spectrum plaque microflora. Hence, the present study was carried out with an aim to isolate microorganisms from dental plaque, and study their susceptibility to aqueous extracts of *J. officinale* leaves and flowers. In addition the anti- biofilm potential and phytochemical profile of the extracts were also studied.

II. RESEARCH METHODOLOGY

2.1 Collection of dental plaque samples

A total of 25 dental plaque samples were collected from individuals aged 30–60 years. Samples were obtained from both supra-gingival and sub-gingival sites in sterile curettes and transferred into sterile Eppendorf tubes containing sterile saline. All samples were immediately transported to the laboratory under cold conditions and stored at 4°C until further processing.

2.2 Isolation and identification of isolates

Each plaque sample was homogenized in saline to prepare suspensions. These suspensions were streaked onto nutrient agar, Sabouraud's dextrose agar and anaerobic agar plates for isolation of plaque microorganisms. The plates were incubated at 37°C for 48 h under appropriate aerobic or anaerobic conditions. Distinct colonies were sub-cultured and maintained on slants of the corresponding media at 4°C. The gram nature of all isolates was noted based on standard Gram staining method. The isolates were identified using the Vitek-2 automated microbial identification system.

2.3 Collection and processing of plant samples

Fresh leaves and flowers of *J. officinale* were collected from a home garden. Plant materials were washed first with 0.5% citric acid solution followed by rinsing with distilled water. The cleaned plant materials were dried in a hot-air oven and ground into fine powder.

2.4 Preparation of aqueous plant extracts

Aqueous extracts of powdered leaves and flowers were prepared by mixing them with distilled water in 1:5 (w/v) ratio, and keeping them on a rotary shaker at 125 rpm for 3 h. The extracts were then filtered through Whatman No. 1 filter paper. The extraction process was repeated three times using the residual plant material. The filtrates were combined and autoclaved, following which they were dried in a hot-air oven until a semi-solid extract was obtained. These extracts were stored in airtight containers until use.

2.5 GC–MS analysis of extracts

Gas Chromatography–Mass Spectrometry (GC–MS) analysis of the extracts was carried out at SAIF, IIT Bombay. Samples were analyzed using an HP-5MS capillary column (30 m × 0.25 mm ID; 0.25 µm film thickness). The oven temperature was programmed as follows: initial temperature of 40°C for 10 min, which was raised to 230°C at the rate of 5°C/min, and further increased to 300°C at 20°C/min with a hold of 10 min in between. Helium was used as the carrier gas at a constant flow rate of 1 mL/min.

2.6 Antimicrobial activity of plant extracts

The antimicrobial activity of aqueous extracts of *J. officinale* leaves and flowers were evaluated based on the observed zones of inhibition in agar well diffusion assays, and by determining the Minimum Inhibitory Concentration (MIC) of extracts. For agar well diffusion method, Mueller–Hinton agar plates were prepared and wells (6mm diameter) were punched after solidification of the medium. Varying concentrations of extracts were prepared in dimethyl sulphoxide (DMSO) and 50 µL volumes were added to the wells (CLSI, 2015). Amoxicillin and metronidazole (25 µg/mL) were used as reference antibiotics for the assay. Zones of inhibition were measured after incubation at 37°C for 24 h. For determination of MIC, tubes with varying concentrations of extracts were prepared in nutrient broth, and the isolated plaque organisms were inoculated in these tubes. The tubes were observed for visible turbidity after incubation at 37°C for 24 h. The lowest concentration of plant extract in tube showing no visible turbidity was noted as MIC for the test isolate (CLSI, 2015).

2.7 Antibiofilm activity of plant extracts

Antibiofilm activity of plant extracts was assessed using the Christensen tube method. The test isolates were grown in Tryptone soya broth (TSB) for 24 h to allow them to form biofilms on the sides of the tubes. After incubation, the growth medium was carefully collected in a large test tube and autoclaved before discarding. The biofilms formed on the sides of the tubes were stained with 0.1% crystal violet for 5 mins, and then destained with 30% acetic acid. The intensity of the dissolved stain indicated the corresponding biofilm biomass, which was quantified calorimetrically at 620 nm (Christensen et al., 1982).

III. RESULTS AND DISUSSION

3.1 Isolation and identification of isolates

In the present study, 12 isolates were obtained from 25 dental plaque samples. It included both aerobic and anaerobic microbial strains. Among the aerobic isolates, five were gram negative bacteria identified as *Acinetobacter baumannii*, *Pseudomonas fluorescens*, *Stenotrophomonas maltophilia*, *Serratia marcescens* and *Enterobacter hormaechei*. In addition, 3 isolates were gram positive bacteria identified as *Micrococcus luteus*, *Staphylococcus hominis* and *Kocuria kristinae*, and two isolates were identified as yeasts (*Candida parapsilosis* and *Candida albicans*). The two anaerobic isolates were gram positive bacteria identified as *Paraclostridium bifermentans* and *Schaalia odontolytica*.

The dental plaque consists of diverse species of bacteria, fungi and yeasts. However, relatively few of these species can be cultured under laboratory conditions, whereas most of dental plaque associated microorganisms are fastidious or obligate anaerobes (Marsh, 2006). Among yeasts, Candida species are commonly isolated from plaques, and some studies have indicated their synergistic interactions with oral bacterial pathogens such as *S. mutans*, in biofilm formation (Falsetta et al., 2014; Kim et al., 2021; Yang et al., 2022). Also, typically, *A. baumannii* and *S. maltophilia* are associated with poor oral hygiene conditions, underlying diseases and prolonged antibiotic use (Prates et al., 2020; Girija et al., 2024). Their presence is also an indicative of oral dysbiosis (Aitken et al., 2021; Girija et al., 2024). Isolates including *P. fluorescens* and *S. marcescens* are also commonly associated with oral diseases and are known to form robust biofilms (Zarei et al., 2022; Barbosa et al., 2006). Both anaerobic isolates obtained in this study were normal commensals of the oral cavity, but they also act as opportunistic pathogens in cases of tissue damage or immune compromise (Paulino et al., 2024; Zhao et al., 2022). Hence, although few microbial species were isolated in this study compared to total plaque samples collected, it represented broad taxonomic and physiological diversity of plaque flora, which was sufficient for evaluating the antimicrobial and antibiofilm activity of *J. officinale* extracts.

3.2 GC–MS analysis of extracts

The Fig. 1 represents the plant of *J. officinale*. The phytochemical profile of leaves and flowers of this plant detected in GC–MS analysis (Table 1) confirmed a rich biochemical profile and presence of bioactive compounds in the extracts. Precisely, 69 compounds were identified in aqueous leaf extracts and 65 compounds in flower extracts.

Among the bioactive compounds of the plant, 16 polyphenols were identified in leaf extracts and 14 in flower extracts of *J. officinale*. The polyphenols such as eugenol, thymol, catechol and guaiacol, identified in these extracts, show potent antibacterial activity against dental plaque bacteria, and are hence incorporated in many commercially available mouthwashes (Yazicioglu et al., 2024). They inhibit quorum sensing and prevent bacterial adhesion, thereby proving effective as antibiofilm agents (Mishra et al., 2020). Eugenol, particularly, is reported to exhibit strong antibacterial activity against *S. mutans*, *C. albicans* and many periodontal anaerobes (Mak et al., 2019). It also shows synergistic activity with antimicrobial agents that have been used to eradicate biofilms of oral pathogens (Jafri et al., 2020). Its mechanism of action involves disruption of cell membranes and inhibition of essential enzymes (Fajdek-Bieda et al., 2025). Zingerone is another polyphenol that shows broad-spectrum antibacterial and anti-inflammatory activity. It is reported to suppress bacterial virulence factors, reduce biofilm biomass, and modulate inflammatory responses associated with periodontal infections (Kharga et al., 2023). Among other class of compounds identified, phytol is a diterpenoid alcohol, which exhibits strong antibacterial action and inhibits biofilm formation by interfering with bacterial fatty acid synthesis (Silva et al., 2014). Additionally, several glycosides (lactose; melezitose; α-d-glucopyranoside), isoprenoids, flavonoids (2-coumaranone), alcohols and alkaloids were also detected in the GC–MS analysis of the extracts. Overall, the presence of diverse classes of compounds in the leaves and flowers of *J. officinale* indicate the therapeutic potential of this plant not only against oral diseases but also against other health conditions.

Fig. 1: *Jasminum officinale* plant

Table 1: GCMS analysis of plant extracts

Sr. No.	Biochemical profile of *J. officinale* leaves					Biochemical profile of *J. officinale* flowers				
1	Compound name	Molecular formula	M/Z	RT	Area	Compound name	Molecular formula	M/Z	RT	Area
2	Syringylacetone	$C_{11}H_{14}O_4$	167.07	38.79	0.12	4-Benzyl-3-(p-nitrophenyl)sydnone	$C_{15}H_{11}N_3O_4$	91.05	49.67	0.15
3	4,7-Epoxycyclobuta[b] naphthalene, 1,2,4,7-tetrahydro-	$C_{12}H_{10}O$	141.07	30.32	0.19	Acetic acid, 4-methylphenyl ester	$C_9H_{10}O_2$	60.02	36.41	48.0
4	Ethanol, 1-(1-	$C_8H_{14}O$	93.07	28.16	0.53	4-Vinylbenzene-1,2-diol	$C_8H_8O_2$	136.05	43.77	0.16

	cyclohexenyl)-									
5	Phenol, 5-methyl-2-(1-methylethyl)-	$C_{10}H_{14}O$	135.08	27.61	0.18	Methyl para hydroxy benzoate	$C_8H_8O_3$	121.03	31	0.35
6	endo-2-Methyl-2-norbornanol	$C_8H_{14}O$	93.07	32.95	0.17	4-(Pyridin-4-yl)butanal	$C_9H_{11}NO$	106.07	15.47	0.37
7	(S)-tert-Butyl 1-methylpiperidin-3-ylcarbamate	$C_{11}H_{22}N_2O_2$	97.06	30.13	0.10	Shikimic acid, methyl ester	$C_8H_{12}O_5$	97.03	37.55	1.79
8	o-Cymene	$C_{10}H_{14}$	119.09	18.38	1.92	Methyl cinnamate	$C_{10}H_{10}O_2$	131.05	28	0.03
9	[(1S)-3-ethyl-1-methyl-1-cyclopent-2-enyl]methoxymethylbenzene	$C_{16}H_{22}O$	109.06	32.53	0.16	Hydroxytyrosol	$C_8H_{10}O_3$	123.04	36.77	22.45
10	2-Coumaranone	$C_8H_6O_2$	78.05	25.59	0.12	Isopropyl pyroglutamate	$C_8H_{13}NO_3$	84.04	29.67	0.12
11	1-(3-Methoxy-4,5-dihydroxybenzene)propene	$C_{10}H_{12}O_3$	180.08	34.29	0.12	Propylene carbonate	$C_4H_6O_3$	57.03	16.97	0.25
12	2-Cyclohexen-1-one, 2-methyl-5-(1-methylethyl)-, (S)-	$C_{10}H_{16}O$	82.04	26.08	0.39	Benzoic acid, 4-formyl-, methyl ester	$C_9H_8O_3$	133.03	29.38	1.94
13	4H-Pyran-4-one, 3-hydroxy-2,6-dimethyl-	$C_7H_8O_3$	122.04	24.25	0.10	Benzeneacetic acid, 3,4-dihydroxy-	$C_8H_8O_4$	123.04	36.98	10.93
14	Terephthalaldehydic acid methyl ester	$C_9H_8O_3$	133.03	29.39	0.69	(2E,4E)-6-Methyl-octa-2,4,6,7-tetraenoic acid methyl ester	$C_{10}H_{12}O_2$	107.05	52.8	0.37
15	2-tert-Butyl-5-methyl-1,4-benzoquinone	$C_{11}H_{14}O_2$	111.04	38.3	0.38	1,3-Benzenediol	$C_6H_6O_2$	110.04	27.03	0.39
16	p-hydroxystyrene	C_8H_8O	120.06	25.28	1.35	(5R)-5-(aminomethyl)-3-[(1S)-1-phenylethyl]-1,3-oxazolidin-2-one	$C_{12}H_{16}N_2O_2$	105.07	49.69	1.13
17	Dibutyl phthalate	$C_{16}H_{22}O_4$	149.02	42.72	0.54	DL-alpha-Tocopherol	$C_{29}H_{50}O_2$	165.09	55.72	0.13
18	2-Propanone, 1-(4-hydroxy-3-methoxyphenyl)-	$C_{10}H_{12}O_3$	137.06	33.4	0.25	3-Ethenylphenol	C_8H_8O	120.06	25.27	0.41
19	2,4(1H,3H)-Pyrimidinedione, 1,3-dimethyl-	$C_6H_8N_2O_2$	140.06	29.99	0.54	4H-1-Benzopyran-4-one, 3,8-dihydroxy-2-methyl-	$C_{10}H_8O_4$	192.04	38.77	0.20
20	2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-, (R)-	$C_{11}H_{16}O_2$	111.04	33.53	0.17	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	$C_{20}H_{40}O$	95.09	61.09	0.11
21	3-trsns-(1,1-dimethylethyl)-4-trans-methoxycyclohexanol	$C_{11}H_{22}O_2$	57.03	30.06	0.14	Valeric anhydride	$C_{10}H_{18}O_3$	85.03	24.21	0.22
22	2,3-Bornanediol	$C_{10}H_{18}O_2$	151.08	33.8	0.14	2-Propanone, 1-hydroxy-	$C_3H_6O_2$	43.02	5.67	0.17
23	Zingerone	$C_{11}H_{14}O_3$	137.06	36.17	0.09	Benzaldehyde, 4-methyl-	C_8H_8O	120.06	34.35	0.47
24	3-(Dimethylamino)-2-methylpropan-1-ol, Ac derivative	$C_8H_{17}NO_2$	58.07	21.84	2.32	Phenol	C_6H_6O	94.04	16.76	1.01
25	Guaiacol, 4-ethyl-	$C_9H_{12}O_2$	137.06	26.83	0.18	4-Oxo-4,5,6,7-tetrahydrobenzofuran-3-carboxylic acid, methyl ester	$C_{10}H_{10}O_4$	108.06	47.2	0.11
26	Eugenol	$C_{10}H_{12}O_2$	164.08	29.02	0.04	2H-Pyran-2-one, 4-methyl-6-(2-methyl-1-propenyl)-	$C_{10}H_{12}O_2$	164.08	52.72	0.12
27	2-Methoxy-4-vinylphenol	$C_9H_{10}O_2$	135.04	28.34	1.08	(2E,4E)-6-Methyl-octa-2,4,6,7-tetraenoic acid methyl ester	$C_{10}H_{12}O_2$	164.08	51.98	0.84
28	para-Anisaldehyde diethyl acetal	$C_{12}H_{18}O_3$	137.06	34.3	0.21	2-Phenylsulfanylethyl ethanoate	$C_{10}H_{12}O_2S$	123.04	37.86	0.39
29	Homosyringaldehyde	$C_{10}H_{12}O_4$	167.07	37.39	0.14	Ethyl (9Z,12Z)-9,12-octadecadienoate	$C_{20}H_{36}O_2$	79.05	52.7	0.28
30	3-Ethoxy-4-hydroxy-benzaldehyde	$C_9H_{10}O_3$	137.06	31.66	1.13	4-Vinylbenzene-1,2-diol	$C_8H_8O_2$	136.05	39.36	11.07
31	Melezitose	$C_{18}H_{32}O_{16}$	73.03	27.62	0.28	(4,5-dimethoxy-2-nitro-phenyl)methyl decanoate	$C_{19}H_{29}NO_6$	167.07	53.83	0.23
32	Phenol, 5-ethenyl-2-methoxy-	$C_9H_{10}O_2$	150.07	27.87	1.06	Maltol	$C_6H_6O_3$	126.03	21.57	0.73
33	2-Hydroxy-1-phenylethanone	$C_8H_8O_2$	105.03	21.11	0.45	2H-1-Benzopyran-3-ol, 2-(3,4-dimethoxyphenyl)-3,4-dihydro-5,7-dimethoxy-, (2R-trans)-	$C_{19}H_{22}O_6$	167.07	53.77	0.10
34	Lactose	$C_{12}H_{22}O_{11}$	60.02	32.52	2.23	Benzyl alcohol	C_7H_8O	79.05	18.85	0.11
35	α-D-Glucopyranoside, β-D-fructofuranosyl	$C_{12}H_{22}O_{11}$	73.03	29.74	0.13	Homovanillyl alcohol	$C_9H_{12}O_3$	137.06	33.52	0.39
36	Indolin-2-one, 1-methyl-3-t-butyl-	$C_{13}H_{17}NO$	147.07	35.44	0.11	Isophytol	$C_{20}H_{40}O$	71.05	42.57	0.29
37	3,6-Heptadien-2-ol, 2,5,5-trimethyl-, (E)-	$C_{10}H_{18}O$	59.05	27.05	0.18	2H-Pyran-5-carboxylic acid, 2-oxo-, methyl ester	$C_7H_6O_4$	98.04	27.09	0.13
38	Ethyl L-menthyl carbonate	$C_{13}H_{24}O_3$	81.07	36.28	0.26	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	60.02	42.87	0.26
39	trans-5-Methyl-2-isopropyl-2-hexen-1-al	$C_{10}H_{18}O$	139.11	30.77	0.59	Benzoic acid, 2,3-dimethoxy-, methyl ester	$C_{10}H_{12}O_4$	164.05	39.22	0.19

40	Methyl isoferulate	$C_{11}H_{12}O_4$	208.07	40.9	0.21	1,2-Cyclopentanedione	$C_5H_6O_2$	70.04	13.57	0.25
41	9-Hydroxymegastigm-7-ene-3,9-dione	$C_{13}H_{20}O_2$	95.05	35.51	1.74	Homovanillyl alcohol	$C_9H_{12}O_3$	137.06	33.86	0.33
42	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-	$C_6H_8O_4$	43.02	22.79	0.08	8,8-Dimethoxy-1,4-dioxaspiro[4.5]deca-6,9-diene	$C_{10}H_{14}O_4$	43.02	42.74	0.12
43	Monotrimethylsilyl derivative of Mepivacaine metabolite	$C_{16}H_{26}N_2O_2Si$	98.10	5.31	6.44	3-Pyridinol	C_5H_5NO	95.04	21.98	0.19
44	4-(2-hydroxy-ethyl)-2-methoxy-phenol	$C_9H_{12}O_3$	137.06	33.49	0.25	squalene	$C_{30}H_{50}$	81.07	53.37	0.35
45	2-Dodecen-1-yl(-)succinic anhydride	$C_{16}H_{26}O_3$	97.10	37.33	0.11	2-Cyclohexen-1-one, 4-hydroxy-	$C_6H_8O_2$	68.03	18.04	0.43
46	Thymol	$C_{10}H_{14}O$	135.08	27.38	0.16	Benzene, methyl-	C_7H_8	91.05	21.73	0.19
47	3-(2,2-Dimethylbutanoylthio)propionic acid methyl ester	$C_{10}H_{18}O_3S$	71.05	32.55	0.13	L-(-)-Fucose, tetrakis(trifluoroacetate), benzyloxime (isomer 2)	$C_{21}H_{15}F_{12}NO_9$	91.05	50.2	0.18
48	Phenol	C_6H_6O	94.04	16.89	0.79	N-Methoxy-N-methylbenzamide	$C_9H_{11}NO_2$	105.03	23.71	0.28
49	1,4:3,6-Dianhydro-α-d-glucopyranose	$C_6H_8O_4$	69.03	25.02	0.22	(5Z)-5-Ethylidene-4-(2-hydroxyethyl)tetrahydro-2H-pyran-2-one	$C_9H_{14}O_3$	67.05	36.62	0.52
50	6-Hydroxy-4,4,7a-trimethyl-5,6,7,7a-tetrahydrobenzofuran-2(4H)-one	$C_{11}H_{16}O_3$	111.04	38.95	0.44	o-Cresol	C_7H_8O	107.05	20.53	0.17
51	(3R,6R)-2,2,6-Trimethyl-6-vinyltetrahydro-2H-pyran-3-ol	$C_{10}H_{18}O_2$	67.05	29.96	0.28	5-(1-hydroxyethyl)-3-pyridinecarboxylic acid methyl ester	$C_9H_{11}NO_3$	166.05	34.49	0.17
52	(3R,6R)-2,2,6-Trimethyl-6-vinyltetrahydro-2H-pyran-3-ol	$C_{10}H_{18}O_2$	67.05	29.88	0.43	Catechol	$C_6H_6O_2$	110.04	24.67	1.70
53	N-[2-[3,5-bis(trimethylsilyloxy)phenyl]-2-trimethylsilyloxy-ethyl]-N-tert-butyl-2,2,2-tris(fluoranyl)ethanamide	$C_{23}H_{42}F_3NO_4Si_3$	285.01	22.69	0.12	1,1,1,2,3,3,7,7,8,9,9,9-Dodecafluoro-4,6-dimethylnonan-4,6-diyl diacetate	$C_{15}H_{16}F_{12}O_4$	43.02	37.67	0.23
54	2,3-Butanediol	$C_4H_{10}O_2$	45.03	6.1	46.79	1-(2-Hydroxy-5-isopropylphenyl)ethanone, acetate	$C_{13}H_{16}O_3$	163.04	29.55	0.21
55	6-(2,6-Dimethylheptyl)-4-methyl-5,6-dihydro-2H-pyran-2-one	$C_{15}H_{26}O_2$	111.04	39.6	0.15	2',4'-Dimethoxyacetophenone	$C_{10}H_{12}O_3$	165.05	37.49	0.17
56	2-Propanone, 1-hydroxy-3-(4-hydroxy-3-methoxyphenyl)-	$C_{10}H_{12}O_4$	137.06	37.88	0.41	Benzyl β-d-glucoside	$C_{13}H_{18}O_6$	91.05	49.8	1.38
57	Hexadecanoic acid, methyl ester	$C17H_{34}O_2$	87.04	42.16	0.19	γ-Sitosterol	$C_{29}H_{50}O$	105.07	57.87	0.09
58	1,2-Cyclohexanedione	$C_6H_8O_2$	70.04	17.3	0.37	2,4-Hexadienedioic acid, 3,4-diethyl-, dimethyl ester, (E,Z)-	$C_{12}H_{18}O_4$	167.07	37.27	0.45
59	2-Thiopheneacetic acid, benzyl ester	$C_{13}H_{12}O_2S$	91.05	27.88	0.17	(Furan-2-yl)methanol	$C_5H_6O_2$	97.03	9.09	0.11
60	t-Butyl (3S)-7-(t-Butyldimethylsilyl)-5-hydroxy-3-oxo-6-heptynoate	$C_{17}H_{30}O_4Si$	45.03	5.79	1.32	Phytol	$C_{20}H_{40}O$	71.05	45.66	0.12
61	1-Butanol, 3-methyl-, formate	$C_6H_{12}O_2$	55.02	21.15	0.40	3,5-Octadienoic acid, 7-hydroxy-2-methyl-, [R*,R*-(E,E)]-	$C_9H_{14}O_3$	79.05	38.7	0.10
62	4-Methoxyphenol	$C_7H_8O_2$	109.03	20.82	0.45	1,2-Cyclohexanedione	$C_6H_8O_2$	70.04	17.14	0.12
63	methyl (2'S,4'bS,8'aR,10'aR)-4'b,8',8',10'a-tetramethyl-1'-oxo-spiro[1,3-dioxolane-2,7'-3,5,6,8a,9,10-hexahydro-2H-phenanthrene]-2'-carboxylate	$C_{22}H_{32}O_5$	99.01	33.62	0.15	(S)-2-((S)-Pyrrolidine-2-carboxamido)pentanedioic acid, 3TMS	$C_{19}H_{40}N_2O_5Si_3$	142.04	23.72	0.14
64	1,2-Dimethylcyclopentane-1,2-diol	$C_7H_{14}O_2$	43.02	22.21	0.18	Methyl 2-O-benzyl-d-arabinofuranoside	$C_{13}H_{18}O_5$	91.05	48.1	6.05
65	3-Hydroxy-4,4-dimethyldihydro-2(3H)-furanone	$C_6H_{10}O_3$	71.05	19.14	0.20	Carbonic acid, eicosyl vinyl ester	$C_{23}H_{44}O_3$	57.07	52.68	0.12
66	Methyl phenidate	$C_{14}H_{19}NO_2$	84.08	19.2	1.44	-	-	-	-	-
67	1,2-Butanediol, 2-phenyl-, 1-carbamate	$C_{11}H_{15}NO_3$	85.03	24.23	0.33	-	-	-	-	-
68	1,3-Dioxolan-4-one, 2-(1,1-dimethylethyl)-5-(1-hydroxy-1-methylethyl)-5-methyl-, (2S-trans)-	$C_{11}H_{20}O_4$	43.02	24.16	0.10	-	-	-	-	-
69	Guaiacol, 4-ethyl-	$C_9H_{12}O_2$	137.06	26.97	0.27	-		-	-	-

3.3 Antimicrobial and antibiofilm activity of plant extracts

The average antimicrobial (based on well diffusion assay) and antibiofilm activity of the leaves and flower extract of *J. officinale* against test isolates is represented in Fig. 2. Both leaf and flower extracts exhibited significant zones of inhibition as well as antibiofilm activity. In the well diffusion assay, the activity of extracts was better than commercial antibiotics such as amoxicillin and metronidazole at concentrations above 50mg/mL. Across all tested organisms, a dose-dependent increase in zone of inhibition and reduction in biofilm formation was observed. This broad-spectrum activity can be attributed to the synergistic action among polyphenolics, terpenoids and other bioactive compounds present in the extract (Sitarek et al., 2020). Previously, similar to our observation, Mangtani et al. (2019) reported zones of inhibition between 15mm and 19mm against gram positive and gram-negative oral pathogens on using aqueous *J. officinale* extracts. In contrast, Anupama et al. (2018) reported 2-4mm zones of inhibition against laboratory isolates of gram positive and gram-negative bacteria.

A low MIC of 30 mg/mL was observed for eight isolates. This included three gram negative bacteria (*P. fluorescens*, *A. baumannii*, *S. maltophilia*), three gram positive bacteria (*M. luteus*, *S. hominis*, *K. kristinae*) and 2 yeasts (*C. parapsilosis*, and *C. albicans*). The significant antimicrobial activity against these isolates can be attributed to phenolic compounds including eugenol, thymol, guaiacol, zingerone, catechol and their derivatives (Tafesh et al., 2011). In contrast, 2 gram negative (*S. marcescens*, *E. hormaechei*) and 2 anaerobic isolates (*P. bifermentans* and *S. odontolytica*) showed MIC of 200 mg/mL. The relatively higher MIC observed for these isolates may be due to reasons such as dense biofilm-forming ability and more effective membrane barrier mechanisms of these strains (Sharma et al., 2023).

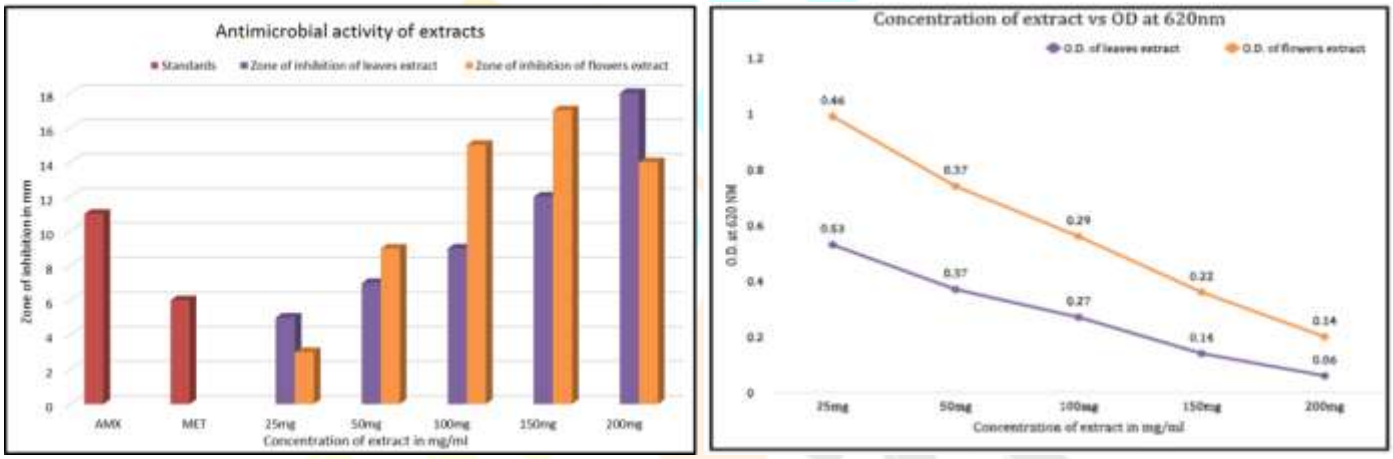

Fig. 2: Antimicrobial and antibiofilm activity of *J. officinale* extracts

IV. CONCLUSION

J. officinale is widely recognised in Ayurvedic and traditional medicine for its antimicrobial, antioxidant and anti-inflammatory properties. However, this plant is relatively less explored for its efficiency in oral care. Typically, the presence of diverse dental plaque microflora, many of which form stable and chemical/drug resistant biofilms, makes chemical plaque control challenging. However, the multi-target antimicrobial action and ability to disrupt biofilms of the bioactive compounds in *J. officinale* suggest its strong potential for preventing plaque, reducing biofilm accumulation, and supporting overall oral health. Hence, suitable herbal formulations can be prepared using *J. officinale* plant extracts as a substitute for chemical-based mouthwashes, toothpastes, gels, sprays, or chewing gums.

REFERENCES

[1] Aitken, S.L.; Sahasrabhojane, P.V.; Kontoyiannis, D.P.; Savidge, T.C.; Arias, C.A.; Ajami, N.J.; Shelburne, S.A.; Galloway-Peña, J.R. 2021. Alterations of the oral microbiome and cumulative carbapenem exposure are associated with *Stenotrophomonas maltophilia* infection in patients with acute myeloid leukemia receiving chemotherapy. *Clinical Infectious Diseases* 72(9): 1507–1513.

[2] Anwar, M.A.; Sayed, G.A.; Hal, D.M.; Hafeez, M.S.A.E.; Shatat, A.S.; Salman, A.; Eisa, N.M.; Ramadan, A.; El-Shiekh, R.A.; Hatem, S.; Aly, S.H. 2025. Herbal remedies for oral and dental health: A comprehensive review of their multifaceted mechanisms including antimicrobial, anti-inflammatory, and antioxidant pathways. Inflammopharmacology 33(3): 1085–1160.

[3] Baddouri, L.; Hannig, M. 2024. Probiotics as an adjunctive therapy in periodontitis treatment—Reality or illusion: A clinical perspective. npj Biofilms and Microbiomes 10: 148.

[4] Balkrishna, A.; Rohela, A.; Kumar, A.; Kumar, A.; Arya, V.; Thakur, P.; Oleksak, P.; Krejcar, O.; Verma, R.; Kumar, D.; Kuca, K. 2021. Mechanistic insight into antimicrobial and antioxidant potential of *Jasminum* species: A herbal approach for disease management. Plants 10(6): 1089.

[5] Barbosa, F.C.; Irino, K.; Carbonell, G.V.; Mayer, M.P. 2006. Characterization of *Serratia marcescens* isolates from subgingival biofilm, extraoral infections, and environment by prodigiosin production, serotyping, and genotyping. *Oral Microbiology and Immunology* 21(1): 53–60.

[6] Barranca-Enríquez, A.; Romo-González, T. 2022. Your health is in your mouth: A comprehensive view to promote general wellness. Frontiers in Oral Health 3: 971223.

[7] Bartsch, S.; Kohnert, E.; Kreutz, C.; Woelber, J.P.; Anderson, A.; Burkhardt, A.S.; Hellwig, E.; Buchalla, W.; Hiller, K.A.; Ratka-Krueger, P.; Cieplik, F.; Al-Ahmad, A. 2024. Chlorhexidine digluconate mouthwash alters the oral microbial composition and affects the prevalence of antimicrobial resistance genes. Frontiers in Microbiology 15: 1429692.

[8] Bumm, C.V.; Folwaczny, M. 2021. Infective endocarditis and oral health—A narrative review. Cardiovascular Diagnosis and Therapy 11(6): 1403–1415.

[9] Christensen, G.D.; Simpson, W.A.; Bisno, A.L.; Beachey, E.H. 1982. Adherence of slime-producing strains of *Staphylococcus epidermidis* to smooth surfaces. Infection and Immunity 37(1): 318–326.

[10] Clinical and Laboratory Standards Institute (CLSI). 2015. Performance standards for antimicrobial susceptibility testing: 25th informational supplement (M100-S23). CLSI, Wayne, PA.

[11] Fajdek-Bieda, A.; Pawlińska, J.; Wróblewska, A.; Żwierełło, W.; Łuś, A.; Klimowicz, A. 2025. Antibacterial and preservative potential of eugenol and isoeugenol in cosmetics: A natural solution for product stability. *Applied Sciences* 15(4): 2129.

[12] Falsetta, M.L.; Klein, M.I.; Colonne, P.M.; Scott-Anne, K.; Gregoire, S.; Pai, C.H.; Gonzalez-Begne, M.; Watson, G.; Krysan, D.J.; Bowen, W.H.; Koo, H. 2014. Symbiotic relationship between *Streptococcus mutans* and *Candida albicans* synergizes virulence of plaque biofilms in vivo. *Infection and Immunity* 82(5): 1968–1981.

[13] Fu, D.; Shu, X.; Zhou, G.; Ji, M.; Liao, G.; Zou, L. 2025. Connection between oral health and chronic diseases. MedComm 6(1): e70052.

[14] Inchingolo, A.M.; Marinelli, G.; Colonna, V.; Pennacchio, B.F.P.; Giorgio, R.V.; Inchingolo, F.; Di Venere, D.; Palermo, A.; Minervini, G.; Inchingolo, A.D.; Dipalma, G. 2025. Efficacy and safety of natural versus conventional toothpastes and mouthwashes in gingivitis management: A systematic review. Hygiene 5(3): 38.

[15] Jafri, H.; Banerjee, G.; Khan, M.S.A.; Ahmad, I.; Abulreesh, H.H.; Althubiani, A.S. 2020. Synergistic interaction of eugenol and antimicrobial drugs in eradication of single and mixed biofilms of *Candida albicans* and *Streptococcus mutans*. *AMB Express* 10(1): 185.

[16] Kapase, S.; Gawali, M. 2023. Determination of antibacterial activity of leaf extract of *Jasminum officinale* against oral pathogens in ulcer treatment. Journal of Emerging Technologies and Innovative Research 10(11).

[17] Kharga, K.; Dhar, I.; Kashyap, S.; Sengupta, S.; Kumar, D.; Kumar, L. 2023. Zingerone inhibits biofilm formation and enhances antibiotic efficacy against *Salmonella* biofilm. *World Journal of Microbiology and Biotechnology* 39(10): 268.

[18] Kim, H.E.; Liu, Y.; Dhall, A.; Bawazir, M.; Koo, H.; Hwang, G. 2021. Synergism of *Streptococcus mutans* and *Candida albicans* reinforces biofilm maturation and acidogenicity in saliva: An in vitro study. *Frontiers in Cellular and Infection Microbiology* 10: 623980.

[19] Mak, K.K.; Kamal, M.B.; Ayuba, S.B.; Sakirolla, R.; Kang, Y.B.; Mohandas, K. 2019. A comprehensive review on eugenol's antimicrobial properties and industry applications: A transformation from ethnomedicine to industry. *Pharmacognosy Reviews* 13: 1–9.

[20] Mangtani, K.N.; Morey, S.S.; Bhalekar, U.K. 2019. Determination of antibacterial activity of leaf extract of *Jasminum officinale* against oral pathogens in ulcer treatment. International Journal of Scientific Development and Research 4(6).

[21] Mangtani, K.N.; Morey, S.S.; Bhalekar, U.K. 2019. Determination of antibacterial activity of leaf extract of *Jasminum officinale* against oral pathogens in ulcer treatment. *International Journal of Scientific Development and Research* 4(6): 237–247.

[22] Marsh, P.D. 2006. Dental plaque as a biofilm and a microbial community—implications for health and disease. *BMC Oral Health* 6(Suppl 1): S14.

[23] Mishra, R.; Panda, A.K.; De Mandal, S.; Shakeel, M.; Bisht, S.S.; Khan, J. 2020. Natural anti-biofilm agents: Strategies to control biofilm-forming pathogens. *Frontiers in Microbiology* 11: 566325.

[24] Pathak, A.; Kedari, A.; Narute, D.; Kulkarni, A.; Ashturkar, A.; Khattar, E. 2018. Antimicrobial activity of *Ocimum sanctum* and *Jasminum officinale* on selected bacteria. *Bioscience Discovery* 9(4): 485–488.

[25] Paulino, S.; Duran, M.; Allena, N.; Sosa, F.; Singhal, R. 2024. Understanding *Actinomyces odontolyticus*: A rare culprit of bacteremia. *Cureus* 16(8): e66086.

[26] Prates, M.; Fernandes, F.; Proença, F.; Mussá, Y.; Tavares, A.; Pereira, A. 2020. Oral infection caused by *Stenotrophomonas maltophilia*: A rare presentation of an emerging opportunistic pathogen. *Case Reports in Infectious Diseases* 2020: 6346120.

[27] Rajasekaran, J.J.; Krishnamurthy, H.K.; Bosco, J.; Jayaraman, V.; Krishna, K.; Wang, T.; Bei, K. 2024. Oral microbiome: A review of its impact on oral and systemic health. Microorganisms 12(9): 1797.

[28] Sahu, R.; Arya, V.; Joshi, R.; Kaushik, P.; Chauhan, M. 2022. Pharmacological and therapeutic properties of *Jasminum officinale* L.: A review. Indian Journal of Ecology 49(3): 1122–1128.

[29] Sharma, S.; Mohler, J.; Mahajan, S.D.; Schwartz, S.A.; Bruggemann, L.; Aalinkeel, R. 2023. Microbial biofilm: A review on formation, infection, antibiotic resistance, control measures, and innovative treatment. *Microorganisms* 11(6): 1614.

[30] Shirbhate, U.; Bajaj, P.; Chandak, M.; Jaiswal, P.; Sarangi, S.; Suchak, D.; Bharti, L. 2023. Clinical implications of probiotics in oral and periodontal health: A comprehensive review. Cureus 15(12): e51177.

[31] Silva, R.O.; Sousa, F.B.; Damasceno, S.R.; Carvalho, N.S.; Silva, V.G.; Oliveira, F.R.; Sousa, D.P.; Aragão, K.S.; Barbosa, A.L.; Freitas, R.M.; Medeiros, J.V. 2014. Phytol, a diterpene alcohol, inhibits the inflammatory response by reducing cytokine production and oxidative stress. *Fundamental and Clinical Pharmacology* 28(4): 455–464.

[32] Sitarek, P.; Merecz-Sadowska, A.; Kowalczyk, T.; Wieczfińska, J.; Zajdel, R.; Śliwiński, T. 2020. Potential synergistic action of bioactive compounds from plant extracts against skin-infecting microorganisms. *International Journal of Molecular Sciences* 21(14): 5105.

[33] Smiline, A.S.; Girija. 2024. *Acinetobacter baumannii* as an oro-dental pathogen: A red alert!! *Journal of Applied Oral Science* 32: e20230382.

[34] Tafesh, A.; Najami, N.; Jadoun, J.; Halahlih, F.; Riepl, H.; Azaizeh, H. 2011. Synergistic antibacterial effects of polyphenolic compounds from olive mill wastewater. *Evidence-Based Complementary and Alternative Medicine* 2011: 431021.

[35] Valm, A.M. 2019. The structure of dental plaque microbial communities in the transition from health to dental caries and periodontal disease. Journal of Molecular Biology 431(16): 2957–2969.

[36] Wu, L.C.; Lin, C.L.; Peng, C.C.; Huang, T.L.; Tsai, T.H.; Kuan, Y.E.; Chung, Y.C. 2021. Development from *Jasminum sambac* flower extracts of products with floral fragrance and multiple physiological activities. Evidence-Based Complementary and Alternative Medicine 2021: 7657628.

[37] Yang, F.; Dinis, M.; Haghighi, F.; He, X.; Shi, W.; Tran, N.C. 2022. Oral colonization of *Candida albicans* and *Streptococcus mutans* in children with or without fixed orthodontic appliances: A pilot study. *Journal of Dental Sciences* 17(1): 451–458.

[38] Yazicioglu, O.; Ucuncu, M.K.; Guven, K. 2024. Ingredients in commercially available mouthwashes. *International Dental Journal* 74(2): 223–241.

[39] Zarei, M.; Rahimi, S.; Saris, P.E.J.; Yousefvand, A. 2022. *Pseudomonas fluorescens* group bacterial strains interact differently with pathogens during dual-species biofilm formation on stainless steel surfaces in milk. *Frontiers in Microbiology* 13: 1053239.

[40] Zhao, G.; Yin, Z.; Dong, J. 2009. Antiviral efficacy against hepatitis B virus replication of oleuropein isolated from *Jasminum officinale* L. Phytotherapy Research 23: 265–268.

[41] Zhao, H.; Wang, J.; Peng, Y.; Cai, X.; Liu, Y.; Huang, W.; Huang, H.; Nie, Y. 2022. Genomic insights from *Paraclostridium bifermentans* HD0315_2: General features and pathogenic potential. *Frontiers in Microbiology* 13: 928153.