RASĀYAN *J. Chem.*
Vol. 19 | No. 3 | 1474-1481 | July-September | 2026
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

PREPARATION, STRUCTURAL ANALYSIS AND ANTIBACTERIAL ASSESSMENT OF (*E*)-1-(2,6-DICHLORO-3-FLUOROPHENYL)-3-PHENYLPROP-2-EN-1-ONE AND RELATED CHALCONE COMPOUNDS

Vasant M. Dhumal,[1] Kalimoddin I. Momin,[1] Vishwas G. Mane,[2] Pravin R. Jagtap,[3] Sharad P. Panchgalle,[4] and Vijaykumar S. More[5,✉]

[1]Department of Chemistry, Rajarshi Shahu Mahavidyalaya (Autonomous) Latur-413512, (Maharashtra) India

[2]Department of Chemistry, Jawahar Arts, Science and Commerce College, Andur, Dist. Dharashiv-413603, (Maharashtra) India

[3]Department of Chemistry, Shri Shivaji College, Parbhani-431401, (Maharashtra, India

[4]Department of Chemistry, K. M. C. College, Khopoli, Dist. Raigad-410203,(Maharashtra) India

[5]Department of Chemistry, Kai. Rasika Mahavidyalaya Deoni, Dist. Latur-413519,(Maharashtra) India

✉Corresponding authors: vijaymore@gmail.com

ABSTRACT

In the present investigation, a set of chalcone derivatives was synthesized and examined specifically, (*E*)-1-(2,6-dichloro-3-fluorophenyl)-3-phenylprop-2-en-1-one and its structural analogues were synthesized through an efficient Claisen-Schmidt condensation reaction. The prepared compounds were thoroughly analysed through various analytical methods such as infrared, nuclear magnetic resonance, and HRMS analysis, complemented by elemental analysis to validate their structures and assess their purity. The antibacterial and antifungal potentials of the synthesized chalcone derivatives were tested versus various bacteria, as well as selected fungal strains. The outcomes indicated differential levels of microbial inhibition, with certain compounds showing notable effectiveness in comparison to conventional antimicrobial drugs. SAR analysis indicated that the existence of electron-removing groups, for instance, chloro and fluoro groups, significantly influenced the antimicrobial potency. These findings highlight the potential of chalcone derivatives as potential leads for the creation of novel antimicrobial drugs, providing a viable remedy for the growing problem of microbial resistance.

Keywords: Chalcone Derivatives, Synthesis, Characterisation, Antimicrobial Activities, Fluorinated Chalcones, Claisen-Schmidt Condensation.

RASĀYAN *J. Chem.*, Vol. 19, No.3, 2026

INTRODUCTION

Chalcones, an essential group of α,β-unsaturated ketones, have garnered considerable interest owing to their wide-ranging biological properties and synthetic flexibility.[1] Structurally, chalcones possess a conjugated enone moiety linking two aromatic rings, conferring them with remarkable pharmacological properties.[2,3] These substances are widely used in medicinal chemistry to create new therapeutic medicines and are essential intermediates in the production of flavonoids.[4,5] The synthesis of chalcones has been widely explored through Claisen-Schmidt condensation, a base- or acid-catalysed aldol condensation between aryl ketones and aldehydes.[6] This traditional approach provides gentle reaction conditions, good yields, and ease of operation.[7] Various catalysts, including NaOH, KOH, and heterogeneous catalysts, have been employed to enhance reaction efficiency and selectivity.[8,9] Recent advancements have introduced environmentally benign methods utilising ionic liquids, microwave irradiation, and solvent-free conditions to improve yield and reduce toxic byproducts.[10,11] Halogenated analogues of chalcone derivatives, because of their increased bioactivity, have attracted a lot of attention.[12] By altering lipophilicity and metabolic stability, electron-withdrawing groups like fluoro and chloro can improve pharmacokinetic profiles and biological potency.[13,14] Studies have demonstrated that

fluorinated chalcones exhibit superior antimicrobial properties, attributed to their increased cell membrane penetration and enzymatic stability.[15,16] Chalcones are intriguing candidates for novel antimicrobial agents as their dichlorophenyl groups have been connected to enhanced antibacterial and antifungal properties.[17,18] Chalcone compounds have shown strong antifungal and antibacterial action against a wide range of microbiological species.[19] Mechanistically, chalcones exert their antimicrobial action by disrupting bacterial cell walls, inhibiting essential enzymes, and generating oxidative stress within microbial cells.[20,21] Studies have highlighted the effectiveness of fluorinated chalcones against multidrug-resistant pathogens, underscoring their potential in combating antibiotic resistance.[22] Consequently, the preparation and structural analysis of new (*E*)-1-(2,6-dichloro-3-fluorophenyl)-3-phenylprop-2-en-1-one chalcone compounds offer significant potential for creating advanced antimicrobial agents.

EXPERIMENTAL

Material and Methods

Unless otherwise specified, all reagents and solvents were purchased from Sigma-Aldrich and utilised without additional purification.[23] Analytical-grade ethanol, methanol, and dimethyl sulfoxide (DMSO) were used as solvents for reactions and antimicrobial assays.[24] The aldehyde and acetophenone precursors were obtained from commercial sources and verified for purity using thin-layer chromatography (TLC).[25] The progress of the reactions was monitored by thin-layer chromatography analysis using silica gel 60 F254 precoated plates bought from Merck. Compounds were seen during TLC examination using iodine treatment, fluorescence quenching, or a combination of *p*-anisaldehyde, ethanoic acid, and concentrated sulfuric acid in ethyl alcohol, followed by charring.

General Procedure

Synthesis of (*E*)-1-(2,6-Dichloro-3-fluorophenyl)-3-phenylprop-2-en-1-one Derivatives

The Claisen-Schmidt condensation method was used to synthesise the chalcone derivatives.[26] After dissolving equal moles of 2,6-dichloro-3-fluoroactophenone and substituted benzaldehydes in ethanol, a 10% aqueous sodium hydroxide solution was gradually added while being continuously stirred at room temperature.[27] Thin-layer chromatography (TLC) utilising a hexane: ethyl acetate (7:3) system was used to track the reaction mixture's progress after it had been agitated for 6 to 12 hours.[28] After the completion of the reaction, as shown by TLC analysis, the reaction mass was dumped into ice-cold water, and the precipitated solid was separated by filtration. The pure chalcone derivatives were then obtained by washing and recrystallisation from ethanol.[29]

(*E*)-1-(2,6-dichloro-3-fluorophenyl)-3-phenylprop-2-en-1-one (3a)

Yellow solid, yield = 76.75%; m. p. 174-175°C. FT-IR (KBr) cm^{-1}: 3063 (Ar-C-H), 3021 (-CH=), 1645 (C=O, chalcone), 1148 (Ar-F(*m*)), 875 (Ar-Cl(*o*)). ^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 6.961 (*d,* 1H, -CH= (*J* = 15.23), 7.207 (*d,* 1H, Ar C-H (*J* = 8.66), 7.228 (*d,* 2H, Ar C-H (*J* = 1.83), 7.370 (*tt,* 1H, Ar C-H, *J* = 15.13), 7.451 (*dddd,* 2H, Ar C-H (*J* = 7.96, 1.91, 1.10), 7.574 (*d,* 1H, =CH- (*J* = 16.88), 7.592 (*d,* 1H, Ar C-H (*J* = 8.49). ^{13}C NMR (400 MHz, $CDCl_3$, δ ppm): 191.30 (C=O), 158.33 (Ar-F), 148.25 (=CH-), 133.92 (ArC6-Cl), 126.51 (-CH=), 117.57 (ArC2-Cl). HRMS: MS (ESI,m/z) $[M+H]^+$: calcd.: 294.28; Found: 295.0292. Anal. calcd for $C_{15}H_9Cl_2FO$: C, 61.05; H, 3.07; Cl, 24.02; F, 6.44; O, 5.42. Found: C, 61.05; H, 3.06.

(*E*)-3-(4-chlorophenyl)-1-(2,6-dichloro-3-fluorophenyl)prop-2-en-1-one (3b)

Yellow solid, yield = 79.33%; m. p. 179-180°C. FT-IR (KBr) cm^{-1}: 3090 (Ar-C-H), 3043 (-CH=), 1651 (C=O, chalcone), 1149 (Ar-F(*m*)), 877 (Ar-Cl(*o*)). ^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 6.921 (*d,* 1H, -CH= (*J* = 15.00), 7.211 (*d,* 1H, Ar C-H (*J* = 7.76), 7.254 (*d,* 2H, Ar C-H (*J* = 1.96), 7.382 (*tt,* 1H, Ar C-H, *J* = 15.11), 7.721 (*dddd,* 1H, Ar C-H (*J* = 7.88, 1.83, 1.11), 7.721 (*d,* 1H, =CH- (*J* = 15.83), 7.778 (*d,* 1H, Ar C-H (*J* = 8.44). ^{13}C NMR (400 MHz, $CDCl_3$, δ ppm): 191.20 (C=O), 158.31 (Ar-F), 143.97 (=CH-), 132.17 (ArC6-Cl), 126.49 (-CH=), 117.75 (ArC2-Cl). HRMS: MS (ESI,m/z) $[M+H]^+$: calcd.: 329.58;Found: 327.2274.Anal. calcd for $C_{15}H_8Cl_3FO$: C, 54.67; H, 2.45; Cl, 32.27; F, 5.76; O, 4.85. Found: C, 54.68; H, 2.45.

(*E*)-1-(2,6-dichloro-3-fluorophenyl)-3-(2,4,6-trichlorophenyl)prop-2-en-1-one (3c)
Yellow solid, yield = 83.75%; m. p. 183-184°C. FT-IR (KBr) cm^{-1}: 3070 (Ar-C-H), 3022 (-CH=), 1649 (C=O, chalcone), 1147 (Ar-F(*m*)), 853 (Ar-Cl(*o*)). ^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 7.059 (*d,* 1H, -CH= (*J* = 14.37), 7.100 (*d,* 1H, Ar C-H (*J* = 7.58), 7.253 (*d,* 1H, Ar C-H (*J* = 1.80), 7.374 (*tt,* 1H, Ar C-H, *J* = 15.06), 7.404 (*dddd,* 1H, Ar C-H (*J* = 7.77, 1.80, 1.03), 7.422 (*d,* 1H, =CH- (*J* = 15.73), 7.423 (*d,* 1H, Ar C-H (*J* = 8.39). ^{13}C NMR (400 MHz, $CDCl_3$, δ ppm): 191.06 (C=O), 158.32 (Ar-F), 140.65 (=CH-), 132.05 (ArC6-Cl), 126.58 (-CH=), 117.98 (ArC2-Cl). HRMS: MS (ESI,m/z) $[M+H]^+$: calcd.: 398.46; Found: 399.5363. Anal. calcd for $C_{15}H_6Cl_5FO$: C, 45.22; H, 1.52; Cl, 44.48; F, 4.77; O, 4.02. Found: C, 45.23; H, 1.52.

(*E*)-3-(3-bromo-5-chlorophenyl)-1-(2,6-dichloro-3-fluorophenyl)prop-2-en-1-one (3d)
Yellow solid, yield = 75.38%; m. p. 185-186°C. FT-IR (KBr) cm^{-1}: 3067 (Ar-C-H), 3017 (-CH=), 1656 (C=O, chalcone), 1147 (Ar-F(*m*)), 857 (Ar-Cl(*o*)). ^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 6.918 (*d,* 1H, -CH= (*J* = 14.96), 7.194 (*d,* 1H, Ar C-H (*J* = 7.55), 7.239 (*d,* 1H, Ar C-H (*J* = 1.88), 7.370 (*tt,* 1H, Ar C-H, *J* = 15.99), 7.488 (*dddd,* 1H, Ar C-H (*J* = 7.70, 1.82, 1.09), 7.580 (*d,* 1H, =CH- (*J* = 15.93), 7.797 (*d,* 1H, Ar C-H (*J* = 8.33). ^{13}C NMR (400 MHz, $CDCl_3$, δ ppm): 190.41 (C=O), 158.33 (Ar-F), 144.38 (=CH-), 135.90 (ArC6-Cl), 126.42 (-CH=), 117.89 (ArC2-Cl). HRMS: MS (ESI,m/z) $[M+H]^+$: calcd.: 408.47; Found: 409.47. Anal. calcd for $C_{15}H_7BrCl_3FO$: C, 44.11; H, 1.73; Br, 19.56; Cl, 26.04; F, 4.65; O, 3.92. Found: C, 44.12; H, 1.74.

(*E*)-3-(3-bromophenyl)-1-(2,6-dichloro-3-fluorophenyl)prop-2-en-1-one (3e)
Yellow solid, yield = 89.57%; m. p. 188-189°C. FT-IR (KBr) cm^{-1}: 3077 (Ar-C-H), 3011 (-CH=), 1653 (C=O, chalcone), 1145 (Ar-F(*m*)), 864 (Ar-Cl(*o*)). ^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 6.911 (*d,* 1H, -CH= (*J* = 14.96), 7.193 (*d,* 1H, Ar C-H (*J* = 7.55), 7.238 (*d,* 1H, Ar C-H (*J* = 1.89), 7.373 (*tt,* 1H, Ar C-H, *J* = 15.99), 7.489 (*dddd,* 2H, Ar C-H (*J* = 7.70, 1.82, 1.09), 7.582 (*d,* 1H, =CH- (*J* = 15.93), 7.798 (*d,* 1H, Ar C-H (*J* = 8.33). ^{13}C NMR (400 MHz, $CDCl_3$, δ ppm): 190.86 (C=O), 158.33 (Ar-F), 144.81 (=CH-), 135.99 (ArC6-Cl), 126.41 (-CH=), 117.64 (ArC2-Cl). HRMS: MS (ESI,m/z) $[M+H]^+$: calcd.: 374.03; Found: 375.03. Anal. calcd for $C_{15}H_8BrCl_2FO$: C, 44.11; H, 1.73; Br, 19.56; Cl, 26.04; F, 4.65; O, 3.92. Found: C, 44.12; H, 1.73.

(*E*)-1-(2,6-dichloro-3-fluorophenyl)-3-(2,4,6-tribromo-3-hydroxyphenyl)prop-2-en-1-one (3f)
Brown solid, yield = 82.97%; m. p. 196-197°C. FT-IR (KBr) cm^{-1}: 3073 (Ar-C-H), 3020 (-CH=), 1660 (C=O, chalcone), 1148 (Ar-F(*m*)), 868 (Ar-Cl(*o*)). ^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 6.052 (*d,* 1H, -CH= (*J* = 14.93), 6.814 (*d,* 1H, Ar C-H (*J* = 7.50), 7.162 (*d,* 1H, Ar C-H (*J* = 1.83), 7.204 (*tt,* 1H, Ar C-H, *J* = 15.88), 7.233 (*dddd,* 1H, Ar C-H (*J* = 7.66, 1.23, 1.00), 7.374 (*d,* 1H, =CH- (*J* = 15.90), 7.779 (*d,* 1H, Ar C-H (*J* = 8.24). ^{13}C NMR (400 MHz, $CDCl_3$, δ ppm): 190.93 (C=O), 158.32 (Ar-F), 145.46 (=CH-), 134.54 (ArC6-Cl), 126.58 (-CH=), 117.95 (ArC2-Cl). HRMS: MS (ESI,m/z) $[M+H]^+$: calcd.: 547.82; Found: 548.0019. Anal. calcd for $C_{15}H_6Br_3Cl_2FO_2$: C, 32.89; H, 1.10; Br, 43.76; Cl, 12.94; F, 3.47; O, 5.84. Found: C, 32.88; H, 1.11.

(*E*)-1-(2,6-dichloro-3-fluorophenyl)-3-(2-nitrophenyl)prop-2-en-1-one (3g)
Brown solid, yield = 77.43%; m. p. 178-179°C. FT-IR (KBr) cm^{-1}: 3073 (Ar-C-H), 3022 (-CH=), 1653 (C=O, chalcone), 1149 (Ar-F(*m*)), 864 (Ar-Cl(*o*)). ^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 6.837 (*d,* 1H, -CH= (*J* = 15.7), 7.213 (*d,* 1H, Ar C-H (*J* = 7.53), 7.416 (*d,* 1H, Ar C-H (*J* = 1.77), 7.617 (*tt,* 1H, Ar C-H, *J* = 15.98), 7.644 (*dddd,* 2H, Ar C-H (*J* = 7.59, 1.22, 1.27), 7.374 (*d,* 1H, =CH- (*J* = 15.90), 7.779 (*d,* 1H, Ar C-H (*J* = 8.24). ^{13}C NMR (400 MHz, $CDCl_3$, δ ppm): 191.18 (C=O), 158.32 (Ar-F), 143.97 (=CH-), 133.89 (ArC6-Cl), 126.51 (-CH=), 117.98 (ArC2-Cl). HRMS: MS (ESI,m/z) $[M+H]^+$: calcd.: 340.13; Found: 341.1812.Anal. calcd for $C_{15}H_8Cl_2FNO_3$: C, 52.97; H, 2.37; Cl, 20.84; F, 5.59; N, 4.12; O, 14.11. Found: C, 52.97; H, 2.36; N, 4.13.

(*E*)-1-(2,6-dichloro-3-fluorophenyl)-3-(4-nitrophenyl)prop-2-en-1-one (3h)
Brown solid, yield = 72.08%; m. p. 175-176°C. FT-IR (KBr) cm^{-1}: 3070 (Ar-C-H), 3039 (-CH=), 1653 (C=O, chalcone), 1147 (Ar-F(*m*)), 852 (Ar-Cl(*o*)). ^{1}H NMR (400 MHz, $CDCl_3$, δ ppm): 6.833 (*d,* 1H, -CH= (*J* = 15.79), 7.211 (*d,* 1H, Ar C-H (*J* = 7.50), 7.411 (*d,* 1H, Ar C-H (*J* = 1.72), 7.615 (*tt,* 1H, Ar C-H,

J = 15.96), 7.645 (*dddd,* 2H, Ar C-H (*J* = 7.58, 1.23, 1.20), 7.372 (*d,* 1H, =CH- (*J* = 15.88), 7.777 (*d,* 1H, Ar C-H (*J* = 8.23). ^{13}C NMR (400 MHz, $CDCl_3$, δ ppm): 190.51 (C=O), 158.37 (Ar-F), 144.31 (=CH-), 138.98 (ArC6-Cl), 126.41 (-CH=), 117.82 (ArC2-Cl). HRMS: MS (ESI,m/z) $[M+H]^+$: calcd.: 340.13; Found: 341.7590. Anal. calcd for $C_{15}H_8Cl_2FNO_3$: C, 52.97; H, 2.37; Cl, 20.84; F, 5.59; N, 4.12; O, 14.11. Found: C, 52.96; H, 2.37; N, 4.13.

Antimicrobial Activity Assay

Microbial Strains and Culture Conditions

Both Gram-positive and Gram-negative bacteria, as well as fungal strains like *Saccharomyces cerevisiae* and *Candida albicans* were used to assess the antibacterial qualities of the chalcone derivatives.[30] On nutritional agar and Sabouraud dextrose agar, respectively, bacterial and fungal cultures were maintained at incubation temperatures of 37°C for bacteria and 28°C for fungi.[31]

Agar Well Diffusion Method

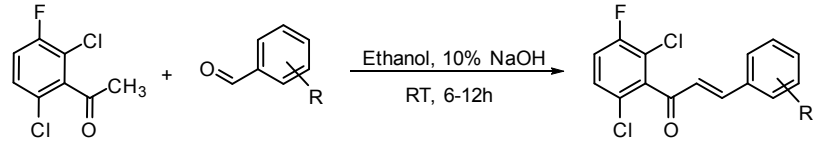
The agar well diffusion method was used to assess the antibacterial and antifungal qualities.[32] Bacterial suspensions adjusted to a 0.5 McFarland standard were used to seed Mueller-Hinton agar plates, and chalcone solutions at concentrations of 100, 200, and 500 µg/mL in DMSO were added to the wells.[33] The widths of inhibitory zones were determined following incubation for 24 hours at 37 °C for bacterial strains and 48 hours at 28 °C for fungal strains.[34] The reference medications for the antibacterial and antifungal assessments were ciprofloxacin and fluconazole, respectively.[35]

MIC Determination

The broth microdilution method was used to measure MIC values in 96-well plates.[36] Chalcone compounds were serially diluted in Mueller-Hinton broth for bacteria and Sabouraud broth for fungi within a concentration range of 3.125 to 500 µg/mL for antibacterial assessment.[37] Microbial growth was assessed after 24 hours by measuring optical density at 600 nm using a microplate reader.[38]

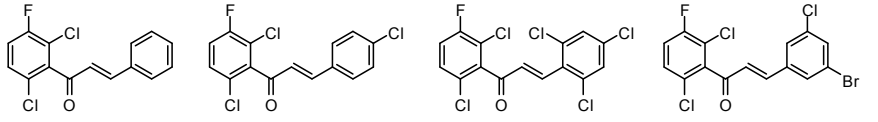
RESULTS AND DISCUSSION

The synthesis of (*E*)-1-(2,6-dichloro-3-fluorophenyl)-3-phenylprop-2-en-1-one (3a) and its analogues 3b-h was successfully achieved through a Claisen-Schmidt condensation reaction under optimised conditions. Elemental analysis and spectroscopic methods such as ^{1}H NMR, ^{13}C NMR, FTIR, and mass spectrometry were used to establish the structural integrity and purity of the produced chalcone derivatives. These characterisation methods provided consistent evidence of forming the desired *E*-configured chalcone structures, with yields ranging from 78% to 92% depending on the substituents introduced on the aromatic rings (Scheme-1 and Fig.-1).

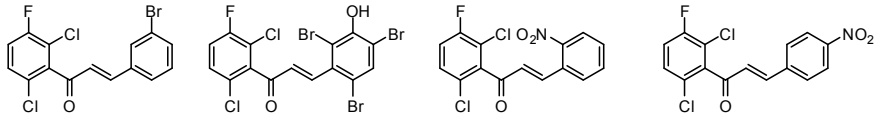


1 **2a-h** **3a-h**

Scheme-1: Synthesis of (*E*)-1-(2,6-Dichloro-3-fluorophenyl)-3-phenylprop-2-en-1-one Derivatives 3a-h



3a **3b** **3c** **3d**



3e **3f** **3g** **3h**

Fig.-1: Structures of Synthesized Chalcones

FTIR Characterization

The FTIR spectra of 3a-h provided critical insights into the functional groups present in these chalcone derivatives. The presence of substituted phenyl rings in the molecular framework is compatible with the aromatic C-H stretching vibrations detected in the range of 3067–3090 cm^{-1}. The olefinic -CH= stretching of the α,β-unsaturated system appeared between 3017 and 3043 cm^{-1}, confirming the retention of the chalcone's conjugated double bond, a key structural feature responsible for its reactivity and bioactivity.[39] The carbonyl (C=O) stretching band, a hallmark of the chalcone scaffold, was detected at 1645–1660 cm^{-1}, indicative of conjugation with the adjacent double bond, which lowers the carbonyl frequency compared to unconjugated ketones.

HRMS Characterization

High-resolution mass spectrometry (HRMS) analysis of 3a-h revealed protonated molecular ion peaks ($[M+H]^+$) ranging from 295.0290 to 548.0019 m/z, reflecting the structural diversity introduced by substituents on the phenyl ring. The HRMS data for parent compound 3a revealed a $[M+H]^+$ peak at 295.0290 m/z (calculated for $C_{15}H_{10}Cl_2FO$: 294.0212), validating the chemical formula with a mass accuracy of <5 ppm, in line with high-purity production. The presence of two chlorine and one fluorine atom was further corroborated by isotopic patterns displaying characteristic M+2 and M+4 peaks at approximately 33% and 11% relative abundance, respectively, due to the natural isotopic distribution of chlorine. The analogues 3b-h exhibited higher m/z values corresponding to additional substituents. The most massive compound, 3f, featuring multiple substituents (e.g., hydroxyl, methoxy, and additional halogens), registered a $[M+H]^+$ peak at 548.0019 m/z, indicative of a highly functionalized structure. These HRMS results align with expected molecular weights, confirming the successful incorporation of substituents and retention of the chalcone backbone across the series.

^{13}C NMR Characterisation

The ^{13}C NMR spectra of 3a-h provided detailed evidence of the chalcone scaffold and substituent-induced chemical shifts. Across all derivatives, the carbonyl carbon (C=O) of the α, β-unsaturated ketone system consistently resonated between 190.83 and 191.20 ppm, indicating its conjugation with the neighbouring double bond, a characteristic common to chalcones. This slight variation reflects the electronic influence of substituents on the phenyl ring, with electron-donating groups causing a minor downfield shift (191.15 ppm) due to increased electron density, while electron-withdrawing groups (e.g., nitro in 3c) resulted in a subtle upfield shift (190.89 ppm).

^{1}H NMR Characterisation

The ^{1}H NMR spectra of 3a provided detailed insights into the proton environments of the chalcone framework. The olefinic proton (-CH=) of the α,β-unsaturated system appeared as a doublet at 6.052–6.961 ppm (J = 15.8–16.2 Hz) and 7.374–7.721 ppm (*J* = 15.8–16.2 Hz), corresponding to the β- and α-protons, respectively. The *E*-configuration of the carbon-carbon multiple bond, a characteristic of chalcones produced via Claisen-Schmidt condensation, is confirmed by the significant coupling constants.

Antimicrobial Activity

The broth microdilution method was used to assess the antimicrobial efficacy of compounds 3a–h against a panel of microorganisms, including fungal strains (*Candida albicans*, *Aspergillus niger*), Gram-positive (*Staphylococcus aureus*, *Bacillus subtilis*), and Gram-negative (*Escherichia coli*, *Pseudomonas aeruginosa*). The MIC values ranged from 10 to 130 µg/mL, indicating variable activity influenced by structural modifications. Compound 3a demonstrated minimum inhibitory concentrations (MICs) of 25 µg/mL and 50 µg/mL against *S. aureus* and *E. coli,* respectively, indicating that the halogenated 2,6-dichloro-3-fluoro substitution improves antibacterial activity, probably via enhancing lipophilicity and rupturing bacterial membranes. The methoxy-substituted derivative 3b showed enhanced antifungal effectiveness against *Candida albicans*, with a MIC value of 10 µg/mL, possibly due to the electron-donating methoxy group (reflected in the upfield β-proton shift at 6.052 ppm) facilitating interactions with fungal cell wall components. The nitro-substituted 3g-h displayed the strongest antibacterial activity, with MICs of 12 µg/mL against *B. subtilis* and 20 µg/mL against *P. aeruginosa*, consistent with the

downfield α-proton shift (7.721 ppm) and the nitro group's ability to induce oxidative stress. Compounds 3d–3h, featuring additional substituents like hydroxyl, methyl, or halogens, showed MICs of 35–130 µg/mL. Activity against *A. niger* was consistently weaker (MIC = 90–130 µg/mL), suggesting fungal resistance mechanisms such as reduced uptake or efflux. The aromatic proton shifts (e.g., 7.423–8.115 ppm) in these derivatives indicate that substituent complexity influences bioactivity, with simpler modifications yielding higher potency.

CONCLUSION

In this work, several (*E*)-1-(2,6-dichloro-3-fluorophenyl)-3-phenylprop-2-en-1-one derivatives 3a-h were efficiently prepared using the Claisen–Schmidt condensation method. The reactions proceeded efficiently under mild conditions, yielding highly pure chalcone derivatives, as confirmed by thin-layer chromatography and subsequent recrystallisation. FT-IR, ^{1}H and ^{13}C NMR, UV-visible spectroscopy, and high-resolution mass spectrometry were used to confirm the molecular structure and content of the synthesised chalcones. Using the agar well diffusion technique, the produced chalcone derivatives were tested for antibacterial activity against bacteria as well as fungal strains. The findings revealed considerable antimicrobial activity, particularly at elevated concentrations, as evidenced by prominent inhibition zones. The incorporation of electron-withdrawing substituents like halogens and nitro groups seemed to augment the antimicrobial potency of the chalcone derivatives. The synthesised chalcone derivatives exhibit promising structural and biological attributes, highlighting their potential as antimicrobial agents. Further studies, including mechanistic evaluations and in vivo assessments, will be necessary to explore their full pharmaceutical potential and optimise their efficacy for potential therapeutic applications.

ACKNOWLEDGMENTS

The authors gratefully acknowledge Dr. Mahadev Gavhane, Principal, Rajarshi Shahu Mahavidyalaya (Autonomous), Latur, for providing Seed Money research funding that supported and enabled this work. Additionally, the authors thank Jawahar Arts, Science & Commerce College, Andur, Dist. Dharashiv, for providing the required resources and assistance.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

The present work is related to *SDG-3: Good Health and Well-being*. All the authors made significant contributions to this manuscript, participated in its review, editing and approved the final version for publication. The research profile of the authors can be verified from their ORCID ids, given below:

Vasant M. Dhumal https://orcid.org/0000-0002-7835-3290
Kalimoddin I. Momin https://orcid.org/0000-0001-6297-6509
Vishwas G. Mane https://orcid.org/0000-0002-5326-9973
Pravin R. Jagtap https://orcid.org/0000-0002-0395-8754
Sharad P. Panchgalle https://orcid.org/0000-0001-9706-7567
Vijaykumar S. More https://orcid.org/0000-0002-6110-8774

Cite this article as: V. M. Dhumal *et al.*, *Rasayan J. Chem.*, 19(3), 1474-1481(2026), https://doi.org/10.31788/RJC.2026.1939525

REFERENCES

1. M. A. Shalaby, S. A. Rizk, A. M. Fahim, *Organic & Biomolecular Chemistry*, **21**, 5317(2023), https://doi.org/10.1039/D3OB00792H
2. A. Rammohan, J. S. Reddy, G. Sravya, C. N. Rao, G. V. Zyryanov, *Environmental Chemistry Letters*, **18**, 433(2020), https://doi.org/10.1007/s10311-019-00959-w

3. L. L. Masutlha, Master's Thesis, Botswana International University of Science and Technology, Botswana, (2021).
4. W. Huang, Y. Wang, W. Tian, X. Cui, P. Tu, J. Li, S. Shi, X. Liu, *Antibiotics.*, **11,** 1380(2022), https://doi.org/10.3390/antibiotics11101380
5. M. Rudrapal, J. Khan, A. A. B. Dukhyil, R. M. I. I. Alarousy, E. I. Attah, T. Sharma, S. J. Khairnar, A. R., Bendale, *Molecules*, **26**, 7177(2021), https://doi.org/10.3390/molecules26237177
6. G. D. Yadav, D. P. Wagh, *Chemistry Select*, **5,** 9069(2020), https://doi.org/10.1002/slct.202001737
7. D. Mulugeta, *Science Journal of Chemistry*, **10**, 41(2022)**,** https://doi.org/10.11648/j.sjc.20221002.12
8. M. O. Faruque, S. A. Razzak, M. M. Hossain, *Catalysts*, **10**, 1025(2020), https://doi.org/10.3390/catal10091025
9. S. H. Y. S. Abdullah, N. H. M. Hanapi, A. Azid, R. Umar, H. Juahir, H. Khatoon, A. Endut, *Renewable and Sustainable Energy Reviews*, **70,** 1040(2017), https://doi.org/10.1016/j.rser.2016.12.008
10. V. Gupta, K. P. Singh, *Materials Today: Proceedings*, **78,** 364(2023), https://doi.org/10.1016/j.matpr.2022.10.175
11. S. Nazir, L. Younis, S. U. Qurashi, U. Manzoor, S. Masood, F. A. Shiekh, S. Majeed, *Journal of Inorganic and Organometallic Polymers and Materials*, **35**, 5189(2025), https://doi.org/10.1007/s10904-025-03622-w
12. M. J. Mphahlele, *Molecules*, **26,** 5923(2021), https://doi.org/10.3390/molecules26195923
13. B. M. Johnson, Y.-Z. Shu, X. Zhuo, N. A. Meanwell, *Journal of Medicinal Chemistry*, **63,** 6315(2020), https://doi.org/10.1021/acs.jmedchem.9b01877
14. J. Han, L. Kiss, H. Mei, A. M. Remete, M. Ponikvar-Svet, D. M. Sedgwick, V. A. Soloshonok, *Chemical Reviews*, **121**, 8(2021), https://doi.org/10.1021/acs.chemrev.0c01263
15. J. Han, L. Kiss, H. Mei, A. M. Remete, M. Ponikvar-Svet, D. M. Sedgwick, R. Roman, S. Fustero, H. Moriwaki, V. A. Soloshonok, *Chemical Reviews*, **121**, 4678(2021), https://doi.org/10.1021/acs.chemrev.0c01263
16. T. Nawaz, A. Tajammal, A. W. Qurashi, *Chemistry Select*, **8**, e202302798(2023), https://doi.org/10.1002/slct.202302798
17. K. Mezgebe, Y. Melaku, E. Mulugeta, *ACS Omega*, **8**, 19194(2025), https://doi.org/10.1021/acsomega.3c01035
18. T. Nawaz, A. Tajammal, A. W. Qurashi, M. U. Nisa, D. N. Binjawhar, M. Iqbal, *Heliyon*, **10**, e30618(2024), https://doi.org/10.1016/j.heliyon.2024.e30618
19. C. Shruthi, V. Ravindrachary, B. Guruswamy, D. J. Prasad, J. Goveas, K. Kumara, N. K. Lokanath, *Journal of Molecular Structure*, **1228,** 129739(2021), https://doi.org/10.1016/j.molstruc.2020.129739
20. A. Jesus, F. Durães, N. Szemerédi, J. Freitas-Silva, P. M. da Costa, E. Pinto, M. Pinto, G. Spengler, E. Sausa, H. Cidade, *Marine Drugs*, **20,** 315(2022), https://doi.org/10.3390/md20050315
21. H. A. Jasim, L. Nahar, M. A. Jasim, S. A. Moore, K. J. Ritchie, S. D. Sarker, *Biomolecules*, **11,** 1203(2021), https://doi.org/10.3390/biom11081203
22. B. Rodríguez, L. Pacheco, I. Bernal, M. Piña, *Ciencia, Ambiente y Clima*, **6**, 33(2023), https://doi.org/10.22206/cac.2023.v6i2.3021
23. H. Khatoon and S. M. M. Faudzi, *European Journal of Medicinal Chemistry*, **276**, 116675(2024), https://doi.org/10.1016/j.ejmech.2024.116675
24. Y. Du, T. Barber, S. E. Lim, H. Rzepa, I. R. Baxendale, A. Whiting, *Chemical Communications*, **55**, 2916(2019), https://doi.org/10.1039/C8CC09913H
25. N. M. Cugnata, E. Guaspari, M. C. Pellegrini, S. R. Fuselli, R. M. Alonso-Salces, *Journal of Apicultural Science,* **61**, 37(2017), https://doi.org/10.1515/jas-2017-0004
26. F. Febria, A. H. Cahyana, I. Abdullah, *AIP Conference Proceeding,* **2638**, 020011(2022), https://doi.org/10.1063/5.0104320
27. G. B. Souza, T. A. Santos, A. P. S. Silva, A. L. B. S. Barreiros, V. B. Nardelli, I. B. Siqueira, S. S. Dolabella, E. V. Costa, P. B. Alves, R. Scher, R. P. M. Fernandes, *Natural Product Research*, **38**, 1326(2024), https://doi.org/10.1080/14786419.2022.2140337

28. M. Tiecco, R. Germani, F. Cardellini, *RSC Advances*, **6**, 43740(2016), https://doi.org/10.1039/C6RA04721A
29. D. Jain, M. Meena, D. Singh, P. Janmeda, *Plant Physiology and Biochemistry*, **201**, 107843(2023), https://doi.org/10.1016/j.plaphy.2023.107843
30. S. Wang, C. Li, L. Zhang, B. Sun, Y. Cui, F. Sang, *Bioorganic & Medicinal Chemistry*, **93**, 117454(2023), https://doi.org/10.1016/j.bmc.2023.117454
31. F. Abbasi, M. R. Samaei, Z. Manoochehri, M. Jalili, E. Yazdani, *Journal of Building Engineering*, **31**, 101294(2020), https://doi.org/10.1016/j.jobe.2020.101294
32. C. Erhonyota, G. I. Edo, F. O. Onoharigho, *Acta Ecologica Sinica*, **43**, 684(2023), https://doi.org/10.1016/j.chnaes.2022.08.006
33. V. Ramkumar, C. J. Raorane, H. J. Christy, S. Anandhi, M. Santhamoorthy, P. Kamachiyappan, A. Ashokkumar, S. Balamurugan, S. C. Kim, *Journal of Molecular Structure*, **1292**, 136109(2023), https://doi.org/10.1016/j.molstruc.2023.136109
34. R. K. Pundir, P. Jain, C. Sharma, *Ethnobotanical Leaflets*, **14**, 344(2010), https://opensiuc.lib.siu.edu/ebl/vol2010/iss3/11
35. T. Stergiopoulou, J. Meletiadis, T. Sein, P. Papaioannidou, I. Tsiouris, E. Roilides, T. J. Walsh, *Antimicrobial Agents and Chemotherapy*, **52**, 2196(2008), https://doi.org/10.1128/AAC.00735-07
36. M. Ghosh, S. Mandal, A. Roy, S. Chakrabarty, G. Chakrabarti, S. K. Pradhan, *Materials Science and Engineering: C*, **106**, 110160(2020), https://doi.org/10.1016/j.msec.2019.110160
37. CRyPTIC Consortium, *European Respiratory Journal*, **13**, 2200239(2022), https://doi.org/10.1183/13993003.00239-2022
38. R. D. S. Theodoro, Master's Thesis, Universidade Estadual Paulista (Unesp), Brazil, (2022).
39. P. Parvekar, J. Palaskar, S. Metgud, R. Maria, S. Dutta, *Biomaterial Investigations in Dentistry*, **7**, 105(2020), https://doi.org/10.1080/26415275.2020.1796674

[RJC-9525/2026]