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Synthesis of Schiff Bases of Coumarin and their Antifungal Activity

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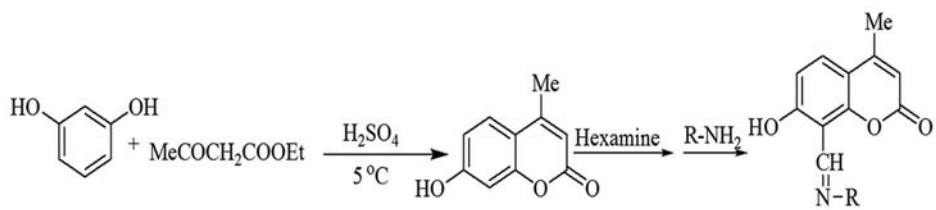
ABSTRACT A series of Schiff bases have been synthesized from 7-hydroxy-4-methylcoumarin and aromatic amines. The Schiff bases were structurally characterized based on Fourier transform infrared, nuclear magnetic resonance (^{1}H and ^{13}C NMR), UV-visible studies, microanalytical data, and mass spectrometry. The synthesized compounds have been evaluated *in vitro* for their antifungal activity against *Helminthosporium* sp. and *Fusarium* sp. at 10–1000 µg/mL. The compound 8-((4-chlorophenylimino) methyl)-7-hydroxy-4-methyl-2*H*-chromen-2-one showed significant antifungal potential against test fungi.



KEY WORDS 7-Hydroxy-4-methylcoumarin, Schiff bases, Antifungal activity, *Helminthosporium* sp., *Fusarium* sp.

INTRODUCTION

Nowadays, due to wide spectrum of biological activities, heterocyclic compounds commanded medicinal chemistry.[1] Among these heterocyclic moieties, coumarin ring is most important moiety found in many pharmacological activities.[2] Coumarin (2*H*-chromen-2-one) has been reported for photodynamic, analgesic, anticoagulant, anti-inflammatory, and antimicrobial properties.[2,3] These are also used in certain perfumes, fabric conditioners, aroma enhancer, in tobacco pipe, and in certain alcoholic drinks.[4] Novobiocin and chlorobiocin are proved to be better antimicrobial agents containing a common coumarin skeleton.[5] In recent years, many structural modifications have been done at different positions of coumarin ring to synthesize more biologically active coumarin derivatives. Due to their wide range of biological activities and interesting structural features, coumarin and its Schiff bases have attracted much attention of many researchers from last decades.[6]

Synthesis of Schiff bases having novel structural features and unusual physicochemical properties are of considerable importance in biological processes and constitute an active area of research in modern coordination chemistry. Schiff bases are nitrogen analog of aldehyde and ketone which contains C=N-R group and have been reported for wide range of biological properties such as antifungal, antitubular, antimicrobial, anti-inflammatory, antifertility, antipyretic, nematicidal, and herbicidal activities.[6-12] Schiff bases act as dyes and give fast color to leather, food packages, wool, etc., and depict versatile application in biological, inorganic, and analytical chemistry.[13]

Furthermore, food safety of crops is very important because it contributes 23% of the calories consumed by the global human population and the most important food product in Asia.[14] Some of the most common fungal diseases include damping off, leaf spot, anthracnose, and rust caused by *Helminthosporium* sp. and *Fusarium* sp.[15] Estimated annual

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yield loss in world's major crops due to plant parasitic fungi is about 20–40%.[16] Although a number of fungicides have been synthesized by the scientists to control such diseases, but due to their less cost-effectiveness, non-availability, and environment hazardous, there is still a need to synthesize new eco-friendly and easily available fungicides.

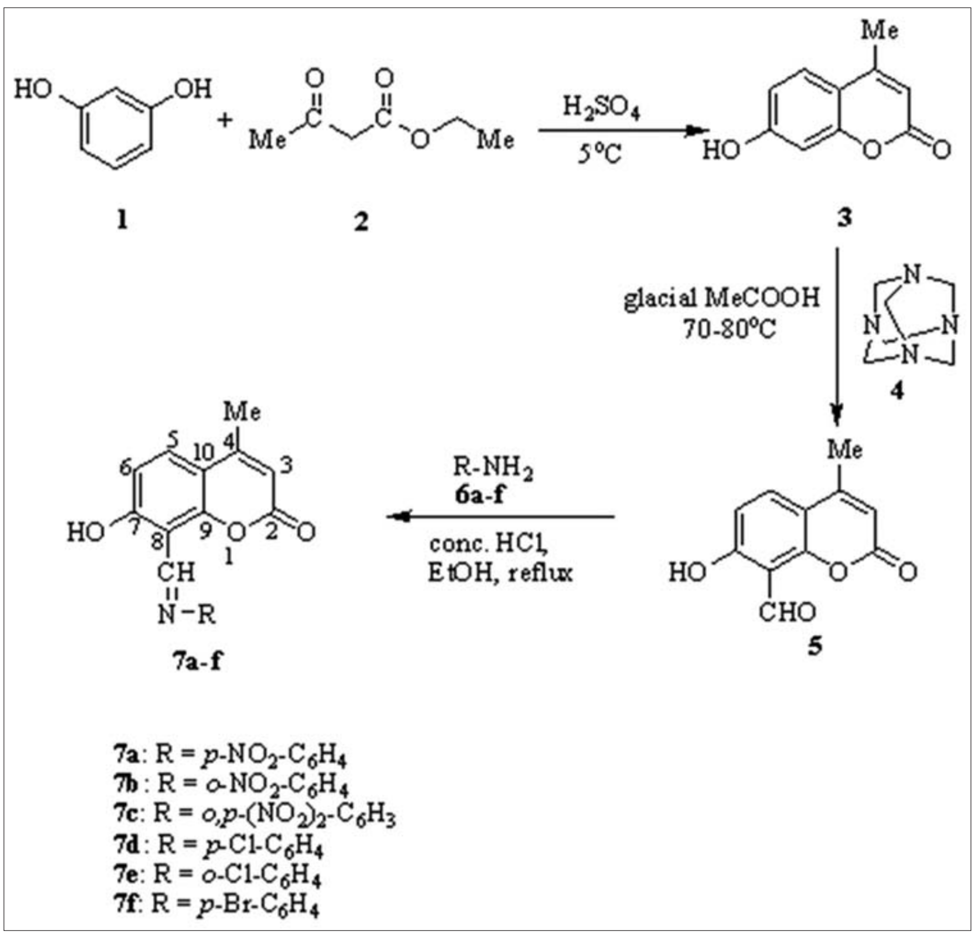
RESULTS AND DISCUSSION

In the present investigation, a new series of Schiff bases were synthesized by three-step procedure. The synthetic pathways for the synthesis of target compounds are shown in **Scheme 1**. The synthesized compounds were evaluated for antifungal activity against *Helminthosporium* sp. and *Fusarium* sp.

The synthesized compounds were analyzed by Fourier transform infrared (FT-IR), nuclear magnetic resonance (^{1}H and ^{13}C NMR), UV-visible studies, and mass spectrometry and their purity was checked by elemental analysis. In the ^{1}H NMR spectra (dimethyl sulfoxide) of the synthesized compounds, a singlet peak appeared at δ 10.23–10.30 ppm region due to phenolic proton which is D_2O exchangeable. A characteristic singlet signal appeared at δ 9.17–9.61 ppm region assigned to azomethine group indicating the formation of Schiff base. Multiplet signals in 6.56–8.07 ppm range were due to aromatic protons. The structure of all the synthesized compounds was confirmed by spectral analysis and the results are presented in the experimental section. **Table 1** represents the physical parameters of the synthesized compounds.

7-Hydroxy-4-methylcoumarin **3** and Schiff bases **7a-f** were screened *in vitro* for their antifungal potential against *Helminthosporium* sp. and *Fusarium* sp. by spore inhibition technique[17] at different concentration levels ranging from 10 to 1000 µg/mL. The results have also been expressed in terms of ED_{50} and ED_{90}, that is, the effective dose at which 50% and 90% inhibition has occurred, respectively.

Percent spore inhibition at different concentrations was calculated and the results are presented in **Table 2**. Almost all the compounds significantly differ from each other at higher concentrations, but at lower concentration, some compounds showed significant differences from each other. Compound **7e** showed 94% inhibition at 1000 µg/mL. Furthermore, on decreasing the concentration, inhibition also decreases. However, at lower concentration, almost all the compounds were found to be inactive except compounds **7b** and **7d**. Furthermore, it was observed that all the test compounds possess ED_{50} values <950 µg/mL. 8-((4-Chlorophenylimino) methyl)-7-hydroxy-4-methyl-2*H*-chromen-2-one **7d** showed promising antifungal activity with the ED_{50} value of 40 µg/mL and ED_{90} value of 790 µg/mL. Compounds such as 7-hydroxy-4-methyl-8-((2-nitrophenylimino)



Scheme 1: Synthesis of Schiff bases 7a-f

Table 1: Physical characterizes of synthesized compounds

Entry	Molecular formula	Color	Molecular weight	Yield (%)	m.p. (°C)
3	$C_{10}H_8O_3$	White	176.00	86	176–178
7a	$C_{17}H_{12}N_2O_5$	Brick red	324.00	78	230–232
7b	$C_{17}H_{12}N_2O_5$	Orange	324.00	60	200–202
7c	$C_{17}H_{11}N_3O_7$	Yellow	369.00	50	250–252
7d	$C_{17}H_{12}NO_3Cl$	Red	313.05	70	280–282
7e	$C_{17}H_{12}NO_3Cl$	Orange	313.05	68	230–232
7f	$C_{17}H_{12}NO_3Br$	Red	357.00	50	240–242

methyl)-2*H*-chromen-2-one **7b** and 8-((2-chlorophenylimino) methyl)-7-hydroxy-4-methyl-2*H*-chromen-2-one **7e** also showed excellent potential with ED_{50} value of 180 and 200 µg/mL and ED_{90} value of 1002 and 1018 µg/mL, respectively. Compounds **3**, **7a**, **7c,** and **7f** had shown moderate potential against the test fungus with ED_{50} values of 250, 250, 400, and 250 µg/mL, respectively.

From **Table 2,** that is, percent spore germination inhibition (SGI) against *Helminthosporium* sp., it is clear that the compounds at particular concentration are significantly different from each other at critical difference (CD) of 2.57, for example, the compound **7d** at 10 µg/mL showed significant difference from all other compounds except compound **7b,** but at 1000 µg/mL, the compounds **7d** and **7b** have shown significant difference from each other. Likewise, the compound **7a** at 50 µg/mL showed significant difference from all other compounds except compounds **7c** and **7f**. Similarly, the compound **7c** at 500 µg/mL showed significant difference from all other compounds at CD of 2.57. Furthermore, the compound **3** showed significant difference from all compounds apart from the compounds **7a** and **7f**.

Percent SGI at different concentrations had been calculated and the results are presented in **Table 3**. Compounds **7d** and **7e** showed 90% inhibition at 1000 µg/mL. On decreasing the concentration, inhibition also decreases. However, at lower concentration, almost all the compounds were found to be inactive except compound **3**, **7d,** and **7e**. It was also found that all the test compounds possess ED_{50} values <950 µg/mL except 7-hydroxy-4-methyl-8-((4-nitrophenylimino) methyl)-2*H*-chromen-2-one **7a**. 8-((2-Chlorophenylimino) methyl)-7-hydroxy-4-methyl-2*H*-chromen-2-one **7e** showed promising antifungal activity with ED_{50} and ED_{90} value of 99 and 1010 µg/mL, respectively. Compounds such as 7-hydroxy-4-methylcoumarin **3** and 8-((2-chlorophenylimino)methyl)-7-hydroxy-4-methyl-2*H*-chromen-2-one **7e** also showed excellent potential with ED_{50} value of 110 and 105 µg/mL and ED_{90} value of 1031 and 1020 µg/mL, respectively. Compounds **7a**, **7b**, **7c,** and **7f** had shown moderate potential against the test fungus with ED_{50} values of 1000, 200, 400, and 250 µg/mL, respectively. **Tables 2-5** represent the results of antifungal activity of synthesized compounds. Graphical representation of synthesized compounds against test fungi in terms of ED_{50} and ED_{90} is given in **Figures 1** and **2**.

All the synthesized compounds are significantly different from each other and results of Duncan multiple range test (DMRT) reveal that the values with same superscripts are non-significant from each other, for example, in **Table 2**, the compound **7d** is significantly different from all other compounds at 1000 µg/mL, while the compounds **3** and **7b** are at par from each other but are significantly different from remaining compounds at 1000 µg/mL. Similarly, the compounds **7c** and **7f** are equivalent from each other but are significantly different from persisting compounds at 500 µg/mL. In the same way, in **Table 3**, DMRT result exposed that the compounds **3**, **7b**, **7d,** and **7e** are non-significant from each other but are significantly different from the rest of the compounds at 1000 µg/mL.

In the same way, the compounds **7b** and **7f** are at par from each other but substantial from staying compounds at 500 µg/mL.

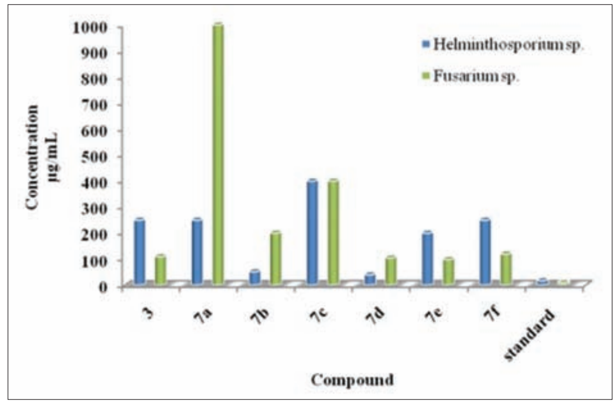


Figure 1: ED_{50} values of synthesized compounds against test fungi

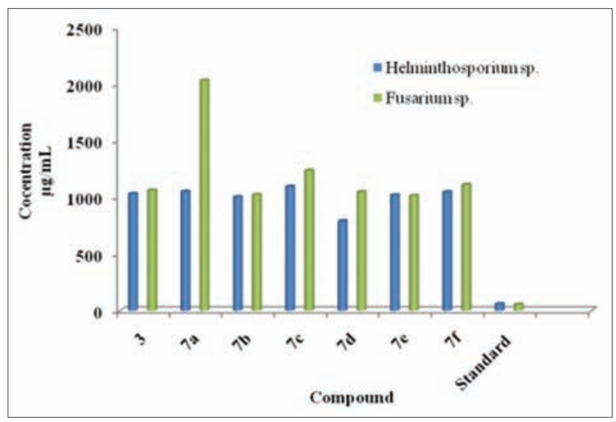


Figure 2: ED_{90} values of synthesized compounds against test fungi

Table 2: Antifungal activity of synthesized compounds 3 and 7a-f against *Helminthosporium* sp

Compound	Percent spore inhibition (µg/mL)±standard deviation						
	10	25	50	100	250	500	1000
3	7.6±0.5 (16.06)	8.66±0.6 (17.09)	18.66±0.3 (25.58)	28.33±0.3 (32.14)	50.00±0.3 (44.98)	69.00^c±0.5 (56.14)	85.66^b±0.3 (67.73)
7a	9.66±0.2 (18.06)	13.33±0.4 (21.38)	27.00±0.5 (31.29)	39.33±0.3 (38.82)	50.00±0.3 (44.98)	68.66^c±0.2 (59.93)	81.66^c±0.1 (68.66)
7b	17.66±0.3 (24.84)	37.66±0.4 (37.84)	49.33±0.5 (44.60)	59.33±0.5 (50.35)	66.66±0.4 (54.72)	80.33^b±0.1 (63.65)	89.66^b±0.1 (71.22)
7c	8.66±0.3 (17.10)	15.33±0.3 (23.22)	26.33±0.3 (30.85)	31.66±0.5 (34.21)	41.66±0.3 (40.18)	61.66^d±0.3 (51.73)	80.00^c±0.2 (63.40)
7d	18.33±0.6 (25.58)	37.66±0.5 (37.84)	55.66±0.5 (51.98)	66.00±0.5 (54.52)	76.33±0.2 (63.52)	89.33^a±0.2 (70.92)	94.00^a±0.3 (75.87)
7e	8.33±0.4 (16.76)	18.66±0.5 (25.58)	28.66±0.5 (32.35)	39.33±0.4 (38.82)	56.33±0.5 (48.62)	66.00^c±0.3 (54.32)	81.66^c±0.3 (64.66)
7f	7.00±0.4 (15.25)	19.00±0.3 (25.81)	28.33±0.3 (32.12)	36.66±0.4 (37.24)	50.00±0.2 (44.98)	63.33^d±0.2 (52.71)	80.00^c±0.1 (63.40)
Propiconazole (Tilt 25 EC*)	49.00±0.5 (37.15)	67.16±0.5 (51.73)	81.33±0.3 (71.53)	87.17±0.2 (69.66)	100.00±0.1 (88.66)	-	-

*Standard fungicide for *Helminthosporium* sp. Figures in parentheses are arcsine transformed values. CD (5%) Compounds: 0.973069. Concentrations: 0.973059, Interaction: 2.57

Likewise, from **Table 3,** that is, percent SGI against *Fusarium* sp., it is clear that the compounds showed significant difference from each other at particular concentration at CD of 2.00, for example, the compound **7e** showed significant difference at 10 µg/mL from all compounds but do not possess significant difference at 1000 µg/mL from the compounds **7d**, **7b,** and **3**. Similarly, the compound **7a** showed a significant difference from all other compounds at all concentrations and showed the least percent SGI against test fungus. Furthermore, the compound **7f** showed a significant difference from all compounds at 250 µg/mL. In the same way, the compound **7c** showed a significant difference from all compounds at 50 µg/mL at CD of 2.00.

EXPERIMENTAL SECTION

All chemicals used were of reagent grade. Solvents were distilled and dried before use according to standard procedures. FT-IR spectra of synthesized compounds were recorded on a Perkin Elmer Spectrum two IR Fourier transform spectrophotometer in the range of 400–4000 cm^{-1} using KBr pellets. The ^1H NMR and ^{13}C NMR spectra of synthesized compounds were recorded in $CDCl_3$ and DMSO on a BRUKER 400 MHz and 100 MHz spectrometer, respectively, at room temperature using tetramethylsilane as an internal standard and chemical shift are given in δ. Melting points were recorded in open capillaries and are uncorrected.

General procedure for the synthesis of 7-hydroxy-4-methylcoumarin (3)

To a precooled concentrated sulfuric acid (15 mL) at 5°C (ice bath) in a round bottom flask (RBF), a mixture of resorcinol **1 (**3.7 g, 33.6 mmol) and ethyl acetoacetate **2 (**4.5 mL, 35.2 mmol) were added dropwise with continuous stirring, while maintaining the temperature of reaction mixture below 10 °C. After the completion of the reaction (thin-layer chromatography [TLC], 30–40 min), the reaction mixture was poured onto the crushed ice (200 g). The solid product was filtered, dried, and recrystallized from absolute alcohol to obtain pure product 7-hydroxy-4-methyl coumarin **3**.

GENERALPROCEDUREFORTHESYNTHESISOF SCHIFF BASES (7a-f)

Formylation of 7-hydroxy-4-methylcoumarin was achieved by refluxing a mixture of 7-hydroxy4-methylcouma rin **3 (**1 g, 5.6 mmol) and 1,3,5,7-tetraazatricyclo[3.3.1.1] decane/hexamine **4 (**2 g, 14.2 mmol) in the presence of glacial acetic acid (50 mL) in RBF at a temperature of 70–80 °C. After the completion of the reaction (TLC, 4–5 h), 75 mL of 20% HCl was added and heated (40–50 °C) for 40–45 min with continuous stirring. The product 8-formyl-7-hydroxy-4-methyl coumarin **5** so obtained could not be isolated. Therefore, in the same reaction mixture, hot ethanolic solution (30 ml) of aromatic amine **6** (15.6 mmol) was added followed by addition of 2–3 drops of concentrated

Table 3: Antifungal activity of synthesized compounds 3 and 7a-f against *Fusarium* sp

Compound	Percent spore inhibition (µg/mL)±standard deviation						
	10	25	50	100	250	500	1000
3	17.66±0.2 (24.84)	28.66±0.6 (32.35)	39.66±0.2 (39.02)	48.66±0.3 (46.51)	59.66±0.4 (50.55)	79.66^{a}±0.3 (63.17)	88.33^{a}±0.2 (70.08)
7a	8.00±0.1 (16.42)	12.00±0.3 (20.24)	17.00±0.2 (24.32)	24.33±0.2 (29.54)	27.33±0.3 (31.50)	39.66^{d}±0.2 (39.02)	50.33^{d}±0.2 (45.17)
7b	17.66±0.3 (24.84)	27.00±0.3 (31.28)	28.66±0.3 (32.35)	39.66±0.2 (39.02)	55.33±0.1 (48.04)	69.66^{b}±0.4 (56.55)	88.33^{a}±0.3 (70.08)
7c	8.00±0.2 (16.76)	17.33±0.2 (24.59)	24.00±0.4 (29.31)	30.66±0.3 (33.61)	41.00±0.3 (39.72)	61.66^{c}±0.3 (51.73)	70.66^{c}±0.1 (57.18)
7d	14.33±0.2 (22.22)	17.00±0.2 (24.32)	36.67±0.3 (37.25)	49.00±0.3 (44.40)	65.66±0.2 (54.10)	80.66^{a}±0.3 (63.89)	89.66^{a}±0.3 (71.22)
7e	19.33±0.6 (26.06)	28.66±0.3 (32.35)	39.33±0.3 (38.82)	50.66±0.2 (45.36)	69.33±0.3 (56.35)	80.66^{a}±0.3 (63.89)	89.66^{a}±0.5 (71.22)
7f	8.66±0.2 (15.25)	27.26±0.2 (25.81)	39.33±0.3 (32.12)	50.33±0.2 (37.24)	60.33±0.3 (32.35)	71.66^{b}±0.3 (52.71)	80.00^{b}±0.1 (63.04)
Carbendazim (**Bavistin) (50 WS)	60.12±0.5 (50.72)	71.66±0.3 (55.10)	85.83±0.2 (68.10)	92.00±0.2 (72.16)	100.00±0.1 (88.17)	-	-

**Standard fungicide for *Fusarium* sp. Figures in parentheses are arc sine transformed values. CD (5%) Compounds: 0.78. Concentrations: 0.74. Interaction: 2.0

HCl. After completion of the reaction (TLC, 4–5 h), the solid product so obtained was filtered and washed with diethyl ether to remove unreacted amine. Recrystallization of the crude product from absolute alcohol offered the pure Schiff bases **7a-f**.

SPECTRAL DATA

7-Hydroxy -4-methylcoumarin (3)

^{1}HNMR (DMSO-d_6, 400 MHz): δ ppm 2.34 (s, 3H, CH_3), 6.01 (d, 1H, J = 1.08 Hz, C3-H), 6.65 (d, 1H, J = 2.4 Hz, ArH), 6.73–6.76 (m, 1H, ArH), 7.48 (d, 1 H, J = 8.68 Hz, ArH) and 10.23 (br, 1H, OH, D_2O exchangeable). ^{13}CNMR (DMSO-d_6, 100 MHz): δ ppm 18.04, 102.12, 110.18, 111.96, 112.81, 126.52, 153.48, 154.77, 160.27 and 161.10. Yield 86%, m.p. 176–178°C. IR ν_{max} (cm^{-1}): 1270 (C-O str), 1567 (C=C str), 1672 (C=O) and 3117 (C-OH). Analytical calculated for $C_{10}H_8O_3$ (%): C, 68.18; H, 4.54. Found: C, 68.11; H, 4.44. ES-MS: *m/z* 176 (M^+).

7-Hydroxy-4-methyl-8-((4-nitrophenylimino)methyl)-2H-chromen-2-one (7a)

^{1}HNMR (DMSO-d_6, 400 MHz): δ ppm 2.56 (s, 3H, CH_3), 5.16 (s, 1H, C3-H), 6.58–6.74 (m, 3H, ArH), 7.96–8.07 (m, 3H, ArH), 9.24 (s, 1H, CH=N) and 10.23 (s, 1H, D_2O exchangeable, OH). Yield 78%, m.p. 230–232°C. IR: ν_{max} (cm^{-1}): 1278 (C-O str), 1330 (N-O str), 1555 (N=O str), 1599 (C=C str), 1614 (C=N str), 1713 (C=O str) and 3626 (O-H str). Analytical calculated for $C_{17}H_{12}N_2O_5$ (%): C, 62.96; H, 3.70; N, 8.64. Found: C, 62.82; H, 3.59; N, 8.49. ES-MS: *m/z* 324 (M^+).

7-Hydroxy-4-methyl-8-((2-nitrophenylimino)methyl)-2H-chromen-2-one (7b)

^{1}HNMR (DMSO-d_6, 400 MHz): δ ppm 2.50 (s, 3H, CH_3), 6.25 (s, 1H, C3-H), 6.64–8.07 (m, 6H, ArH), 9.17 (s, 1H, CH=N) and 10.30 (s, 1H, D_2O exchangeable, OH). ^{13}CNMR (DMSO-d_6, 100 MHz): δ ppm 16.80, 115.29, 119.66, 124.68, 125.68, 129.81, 130.94, 135.68, 137.31, 144.84 and 145.43. Yield 60%, m.p. 200–202°C. IR: ν_{max} (cm^{-1}) 1270 (C-O str), 1329 (N-O str), 1517 (N=O str), 1565 (C=C str), 1628 (CH=N str), 1728 (C=O str) and 3400 (O-H str). Analytical calculated for $C_{17}H_{12}N_2O_5$ (%): C, 62.96; H, 3.70; N, 8.64. Found: C, 62.79; H, 3.47; N, 8.48. ES-MS: *m/z* 324 (M^+).

8-((2,4-Dinitrophenylimino)methyl)-7-hydroxy-4-methyl-2H-chromen-2-one (7c)

^{1}HNMR (DMSO-d_6, 400 MHz): δ ppm 2.54 (s, 3H, CH_3), 6.64 (m, C3-H, 1H), 6.66–7.97 (m, 5H, Ar-H), 9.33 (s, 1H, CH=N) and 10.30 (s, 1H, D_2O exchangeable, OH). ^{13}CNMR (DMSO-d_6, 100 MHz): δ ppm 16.78, 115.29, 119.66, 124.43, 125.68, 129.81, 130.94, 135.68, 137.31, 144.84 and 145.43. Yield 50%, m.p. 250–252°C. IR: ν_{max} (cm^{-1}): 1239 (C-O str), 1337 (N-O str), 1504 (N=O str), 1566 (C=C str), 1615 (C=N str), 1714 (C=O str) and 3346 (O-H str). Analytical calculated for $C_{17}H_{11}N_3O_7$ (%): C, 55.28; H, 2.98; N, 11.38. Found: C, 55.18; H, 2.94; N, 11.14. ES-MS: *m/z* 369 (M^+).

Table 4: Results of antifungal activity against *Helminthosporium* sp. of compounds 3 and 7a-f

Compound	ED_{50} (μg/mL)	ED_{90} (μg/mL)
3	250	1030
7a	250	1050
7b	52	1002
7c	400	1093
7d	40	790
7e	200	1018
7f	250	1046
Tilt 25 EC* (Propiconazole)	18	60

Table 5: Results of antifungal activity against *Fusarium* sp. of compounds 3 and 7a-f

Compound	ED_{50} (μg/mL)	ED_{90} (μg/mL)
3	110	1031
7a	1000	2031
7b	200	1046
7c	400	1235
7d	105	1020
7e	99	1010
7f	120	1110
Bavistin 50WP** (Carbendazim)	10	55

8-((4-Chlorophenylimino)methyl)-7-hydroxy-4-methyl-2H-chromen-2-one (7d)

^{1}HNMR (DMSO-d_6, 400 MHz): δ ppm 2.09 (s, 3H, CH_3), 6.08 (m, 1H, C3-H), 7.01–8.32 (m, 6H, ArH), 9.61 (s, 1H, CH=N) and 10.28 (s, 1H, D_2O exchangeable, OH). ^{13}CNMR (DMSO-d_6, 100 MHz): δ ppm 16.78, 122.92, 122.42, 126.23, 128.51, 129.06, 129.51, 134.41, 134.66, 145.04, 147.11, 147.97, 149.10, 153.50, 155.40, 156.50 and 163.33. Yield 70%, m.p. 280–282°C. IR ν_{max} (cm^{-1}): 773 (C-Cl str), 1258 (C-O str), 1578 (C=C str), 1617 (C=N str), 1717 (C=O str) and 3400 (C-OH str). Analytical calculated for $C_{17}H_{12}NO_3Cl$ (%): C, 65.17; H, 3.83; N, 4.47. Found: C, 65.04; H, 3.72; N, 4.32. ES-MS: *m/z* 313 (M^+).

8-((2-Chlorophenylimino)methyl)-7-hydroxy-4-methyl-2H-chromen-2-one (7e)

^{1}HNMR (DMSO-d_6, 400 MHz): δ ppm 2.09 (s, 3H, CH_3), 6.08 (m, 1H, C3-H), 6.56–8.32 (s, 6H, ArH), 9.61 (s, 1H, CH=N) and 10.28 (s, 1H, D_2O exchangeable, OH). Yield 68%, m.p. 230–232°C. IR ν_{max} (cm^{-1}): 785 (C-Cl str), 1266 (C-O str), 1586 (C=C str), 1605 (C=N str), 1701 (C=O str) and S3400 (C-OH str). Analytical calculated for $C_{17}H_{12}NO_3Cl$ (%): C, 65.17; H, 3.83; N, 4.47. Found: C, 65.02; H, 3.76; N, 4.39. ES-MS: *m/z* 313 (M^+).

8-((4-Bromophenylimino)methyl)-7-hydroxy-4-methyl-2H-chromen-2-one (7f)

^{1}HNMR (DMSO-d_6, 400 MHz): δ ppm 2.43 (s, 1H, CH_3), 6.20 (m, 1H, C3-H), 6.87–8.50 (m, 6H, ArH), 9.23 (s, 1H, CH=N) and 10.30 (s, 1H, D_2O exchangeable, OH). ^{13}CNMR (DMSO-d_6, 100 MHz): δ ppm 18.09, 120.14, 123.07, 129.39, 135.65, 150.26, 154.77, 160.27 and 161.38. Yield 50%, m.p. 240–242°C. IR ν_{max} (cm^{-1}): 525 (C-Br str), 1217 (C-O str), 1517 (C=C str), 1608 (C=N str), 1749 (C=O str) and 3627 (C-OH str). Analytical calculated for $C_{17}H_{12}NO_3Br$ (%): C, 56.98; H, 3.35; N, 3.91. Found: C, 56.86; H, 3.14; N, 3.77. ES-MS: *m/z* 358 (M^+).

ANTIFUNGAL ACTIVITY

Antifungal activity of all the synthesized compounds **3** and **7a-f** was conducted using Spore germination technique.[17] All the test compounds were screened against two phytopathogenic fungi, namely *Helminthosporium* sp. and *Fusarium* sp., causing leaf spot and foot rot disease on rice, respectively. Spore suspension was made by adding distilled water to the fresh culture of *Helminthosporium* sp. and *Fusarium* sp. The spore suspension was diluted with sterilized water to the level of not more than 10 conidia per microscopic field. Small droplets (0.02 mL) of test solution and spore suspension in equal amount were seeded in the cavity of the cavity slides. These slides were placed in Petri plates lined with moist filter paper and were incubated at 25 ± 2°C. Observations on spore germination were taken at 2 h interval and percent SGI (%) was calculated using the following formula:

$$SGI\,(\%) = \frac{\text{Spore germination in control} - \text{Spore germination in treatment}}{\text{Spore germination in control}} \times 100$$

CONCLUSION

The Schiff bases of 7-hydroxy-4-methylcoumarin have been synthesized in good yield. The synthesized compounds were characterized by various spectroscopic techniques, that is, ^{1}H and ^{13}C NMR, FT-IR, UV-visible, mass spectrometry, and CHN analysis. Antifungal activity of **3** and **7a-f** was conducted using SGI technique.[17] The *in vitro* antifungal screening revealed that all tested compounds possessed good antifungal property. The Schiff base **7d** was found to be the most potent antifungal agent against test fungi.

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