Asian Pub. Corp.

www.asianpubs.org

ARTICLE

Synthesis and Characterization of Some Novel Chalcone Derivatives and its Antimicrobial Activity

Sikha Pahare[1] and Archana Asatkar[2,✉]

Asian Journal of Organic & Medicinal Chemistry

Volume: 6 Year: 2021
Issue: 4 Month: October–December
pp: 327–329
DOI: https://doi.org/10.14233/ajomc.2021.AJOMC-P410

Received: 16 December 2021
Accepted: 28 December 2021
Published: 31 December 2021

ABSTRACT

A novel route for the synthesis of chalcone derivatives by using Claisen-Schmidt condensation between substituted acetophenones and substituted aromatic aldehyde in the presence of aqueous solution of KOH and ethyl alcohol at room temperature. The synthesized compound were analyzed by IR and ^{1}H spectral data. All compounds were evaluated for their antibacterial and antifungal activities by cup-plate method.

KEYWORDS

Chalcones derivative, Claisen-Schmidt condensation, Antibacterial activity, Antifungal activity.

INTRODUCTION

Chalcone are the versatile intermediates for the synthesis different hetero compounds. The compound with the backbone of chalcone has a report to hold different biological activities for instance antimicrobial [1-3], anti-inflammatory [4], anti-malarial [5,6], antioxidant [7,8], anti-tubercular [9,10], *etc*. A occurrence of a imprudent α,β-unsatutated keto role in the chalcone derivative was establish to be conscientious for their antimicrobial activities [11]. In current work, we reported the reaction of different acetophenone and various aromatic aldehydes to form chalcone derivatives (**IIIa-k**). The skeleton of the different syntheized products were characterized by means of IR, ^{1}H NMR spectral data. Finally, the effect of these compounds evaluated for *in vitro* antibacterial activities against on Gram-negative (*Escherichia coli* and *Pseudomonas aeruginosa*) bacteria and as well as antifungal activities against *Aspergillus niger* and *Aspergillus flavus*.

EXPERIMENTAL

All the chemicals and reagents in this work were procured from Merck Ltd., India and used without purification. The melting point was determined without correction in open capillaries. The development of the reaction was observed by TLC. ^{1}H NMR spectrum recorded at 400 MHz with TMS as standard and DMSO-d_6 solvent on Bruker nuclear magnetic reasonance spectrometer and Fourier transform infrared (IR) spectra were obtained in KBr discs to the Bruker FT-IR/FT-FIR spectrometer.

Author affiliations:

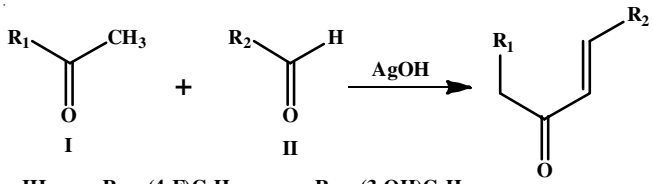
[1]Department of Botany, D.P. Vipra Post Graduate College, Bilaspur-495001, India
[2]Department of Chemistry, Shaheed Veer Narayan Singh Government College, Jobi-Barra-496665, Distt. Raigarh, India

✉To whom correspondence to be addressed:

E-mail: asatkar@gmail.com

Available online at: http://ajomc.asianpubs.org

General procedure for the synthesis of chalcones derivatives (IIIa-k): A mixture of substituted acetophenone (0.01 mol) and aromatic aldehyde (0.01 mol) was stimulated in 90% ethyl alcohol (35 mL) and added aqueous solution of silver hydroxide (15 mL). The reaction mixture was left overnight at room temperature and then poured into ice and acidified with dilute HCl. The chalcones derivatives as precipitated out as solid, which was filtered and recrystallization in ethyl alcohol (**Scheme-I**).



IIIa:	$R_1 = (4\text{-F})C_6H_4$	$R_2 = (3\text{-OH})C_6H_4$
IIIb:	$R_1 = (4\text{-F})C_6H_4$	$R_2 = (3\text{-NO}_2)C_6H_4$
IIIc:	$R_1 = (4\text{-F})C_6H_4$	$R_2 = (3\text{-Cl})C_6H_4$
IIId:	$R_1 = (4\text{-F})C_6H_4$	$R_2 = (4\text{-F})C_6H_4$
IIIe:	$R_1 = (4\text{-F})C_6H_4$	$R_2 = (4\text{-CH}_3)C_6H_4$
IIIf:	$R_1 = (4\text{-F})C_6H_4$	$R_2 = (3,4\text{-OCH}_3)C_6H_4$
IIIg:	$R_1 = (4\text{-NO}_2)C_6H_4$	$R_2 = (3\text{-NO}_2)C_6H_4$
IIIh:	$R_1 = (4\text{-NO}_2)C_6H_4$	$R_2 = (3\text{-Cl})C_6H_4$
IIIi:	$R_1 = (4\text{-NO}_2)C_6H_4$	$R_2 = (4\text{-F})C_6H_4$
IIIj:	$R_1 = (4\text{-NO}_2)C_6H_4$	$R_2 = (4\text{-CH}_3)C_6H_4$
IIIk:	$R_1 = (4\text{-NO}_2)C_6H_4$	$R_2 = (3,4\text{-OCH}_3)C_6H_4$

Scheme-I: Preparation of chalcone derivatives

Compound IIIa: Yield: 60.8%, m.p.: 74-76 ºC, m.f. : $C_{15}H_{11}FO_2$ (m.w.: 242); R_f: 0.73. IR (KBr, ν_{max}, cm^{-1}): 3360, 3070, 1675, 1600, 833; ^{1}H NMR(DMSO-d_6) δ ppm: 7.2 (1H, d, CH-Ar), 7.39 (1H, d, -CO-CH), 6.5-8.0 (8H, m, Ar-H), 6.2 (1H, s, C-OH).

Compound IIIb: Yield: 79.0%, m.p.: 206-208 ºC, m.f. : $C_{15}H_{10}FNO_3$ (m.w.: 271); R_f: 0.66. IR (KBr, ν_{max}, cm^{-1}): 3072, 1675, 1605, 844.

Compound IIIc: Yield: 74.6%, m.p.: 78-80 ºC, m.f. : $C_{15}H_{10}OFCl$ (m.w.: 260); R_f: 0.85. IR (KBr, ν_{max}, cm^{-1}): 3072, 1665, 1605, 844, 814; ^{1}H NMR (DMSO-d_6) δ ppm: 7.2 (1H, d, CH-Ar), 7.39 (1H, d, CO-CH), 6.5-8.0 (8H, m, Ar-H).

Compound IIId: Yield: 65.4%, m.p.: 114-116 ºC, m.f. : $C_{15}H_{10}F_2O$ (m.w.: 244); R_f: 0.87. IR (KBr, ν_{max}, cm^{-1}): 3075, 1658, 1600, 821; ^{1}H NMR (DMSO-d_6) δ ppm: 7.4 (1H, d, CH-Ar), 7.74 (1H, d, -CO-CH), 6.7-8.0 (8H, m, Ar-H).

Compound IIIe: Yield: 68.7%, m.p.: 136-138 ºC, m.f. : $C_{16}H_{13}FO$ (m.w.: 240); R_f: 0.80. IR (KBr, ν_{max}, cm^{-1}): 3074, 1658, 1600, 1334, 821; ^{1}H NMR (DMSO-d_6) δ ppm: 7.4 (1H, d, CH-Ar), 7.54 (1H, d, -CO-CH), 7.1-8.1 (8H, m, Ar-H), 2.4 (3H, s, CH_3).

Compound IIIf: Yield: 65.5%, m.p.: 76-78 ºC, m.f. : $C_{17}H_{15}FO_3$ (m.w.: 286); R_f: 0.74. IR (KBr, ν_{max}, cm^{-1}): 3070, 1662, 1598, 1141, 837; ^{1}H NMR (DMSO-d_6) δ ppm: 7.4 (1H, d, CH-Ar), 6.93 (1H, d, -CO-CH), 6.5-8.0 (7H, m, Ar-H), 3.86 (6H, s, OCH_3).

Compound IIIg: Yield: 55.5%, m.p.: 206-208 ºC, m.f. : $C_{15}H_{10}N_2O_5$ (m.w.: 298); R_f: 0.82. IR (KBr, ν_{max}, cm^{-1}): 3476, 1354, 3085, 1690, 1595; ^{1}H NMR (DMSO-d_6) δ ppm: 7.4 (1H, d, CH-Ar), 6.7 (1H, d, -CO-CH), 7.1-8.4 (8H, m, Ar-H).

Compound IIIh: Yield: 58.7%, m.p.: 166-168 ºC, m.f. : $C_{15}H_{10}NO_3Cl$ (m.w.: 288); R_f: 0.62. IR (KBr, ν_{max}, cm^{-1}): 3482, 1333, 2975, 1690, 1591, 815; ^{1}H NMR (DMSO-d_6) δ ppm: 7.3 (1H, d, CH-Ar), 7.25 (1H, d, -CO-CH), 6.7-8.0 (8H, m, Ar-H).

Compound IIIi: Yield: 50.0%, m.p.: 122-124 ºC, m.f. : $C_{15}H_{10}FNO_3$ (m.w.: 271); R_f: 0.66. IR (KBr, ν_{max}, cm^{-1}): 3365, 3340, 2981, 1660, 1590, 825; ^{1}H NMR($CDCl_3$) δ ppm: 7.1 (1H, d, CH-Ar), 7.68 (1H, d, -CO-CH), 6.7-8.0 (8-H,m,Ar-H).

Compound IIIj: Yield: 46.5%, m.p.: 154-156 ºC, m.f. : $C_{16}H_{13}NO_3$ (m.w.: 267); R_f: 0.80. IR (KBr, ν_{max}, cm^{-1}): 3459, 3310, 2974, 1715, 1590, 1344; ^{1}H NMR (DMSO-d_6) δ ppm: 7.83 (1H, d, CH-Ar), 7.58 (1H, d, -CO-CH), 6.7-8.0 (8H, m, Ar-H), 2.38 (3H, s, CH_3).

Compound IIIk: Yield: 50.3%, m.p.: 96-98 ºC, m.f. : $C_{17}H_{15}NO_5$ (m.w.: 313); R_f: 0.64. IR (KBr, ν_{max}, cm^{-1}): 3492, 3310, 2935, 1720, 1580, 1170; ^{1}H NMR (DMSO-d_6) δ ppm: 7.8 (1H, d, CH-Ar), 6.8 (1H, d, -CO-CH), 6.7-7.9 (7H, m, Ar-H), 4.2 (6H, s, OCH_3).

Antimicrobial activity: All the synthesized compounds were evaluated for *in vitro* antibacterial activities against *Escherichia coli* and *Pseudomonas aeruginosa* as well as antifungal activities against *Aspergillus niger* and *Aspergillus flavus* by measuring the zone of inhibition [12,13]. The antimicrobial activities were performed by filtered paper disc plates methods [14,15] at 100 µg/mL. Streptomycins and fluconazoles were used as standard drugs for antibacterial and antifungal activities, respectively.

RESULTS AND DISCUSSION

Antimicrobial activity: All the synthesized compounds were evaluated for *in vitro* antibacterial activities against *Escherichia coli* and *Pseudomonas aeruginosa* as well as antifungal activities against *Aspergillus niger* and *Aspergillus flavus* by measuring the zone of inhibition [12,13]. The antimicrobial activities were performed by filtered paper disc plates methods [14,15] at 100 µg/mL and the results are shown in Table-1. Streptomycins and fluconazoles were used as standard drugs for antibacterial and antifungal activities, respectively.

TABLE-1
ANTIMICROBIAL ACTIVITIES OF CHALCONE DERIVATIVE

Compound	Zone of inhibition (mm)			
	Antibacterial		Antifungal	
	E. coli	*P. aeruginosa*	*A. niger*	*A. flavus*
IIIa	13	15	11	14
IIIb	09	09	13	12
IIIc	11	09	05	07
IIId	09	11	11	09
IIIe	09	12	11	12
IIIf	08	11	10	12
IIIg	10	12	10	09
IIIh	12	10	12	11
IIIi	11	10	12	12
IIIj	12	08	14	13
IIIk	14	12	12	14
Streptomycin	16	17	–	–
Fluconazole	–	–	17	14

Compounds **IIIa**, **IIIc**, **IIIg**, **IIIh** and **IIIk** show excellent antibacterial activities as compared to the rest of the compounds, which showed moderate to good activity. Fungicidal

screening data indicated that compounds **IIIa**, **IIIb**, **IIIc**, **IIIe**, **IIIj** and **IIIk** imparted the highest activities, while rest of the compounds compounds showed fair to good activities.

Conclusion

The structure of all the synthesized substituted chalcone derivatives (**IIIa-k**) was characterized with their respective IR and ^{1}H NMR spectral studies. The synthesized substituted chalcone derivatives have shown significant antimicrobial activity against Gram negative bacteria and fungi. Thus this paper proves to be significant for further research work on the bioactive substituted chalcones for the development of newer antimicrobial agents.

ACKNOWLEDGEMENTS

The authors are grateful to Department of Chemistry, Shaheed Veer Narayan Singh Government College and Department of Botany, D.P. Vipra Post Graduate College, for their support. Thanks are also due to Central Instrumentation Facility, CSMCRI -CSIR, Bhavnagar and Guru Ghasidas Central University Bilaspur, India for providing the spectral analysis data.

REFERENCES

1. Y. Rajendraprasad, A. Lakshmana Rao and R. Rambabu, Synthesis and Antimicrobial Activity of Some Chalcone Derivatives, E-J. Chem., **5**, 461 (2008); https://doi.org/10.1155/2008/876257
2. S.N. López, M.V. Castelli, S.A. Zacchino, J.N. Domínguez, G. Lobo, J. Charris-Charris, J.C.G. Cortés, J.C. Ribas, C. Devia, A.M. Rodríguez and R.D. Enriz, *Bioorg. Med. Chem*., **9**, 1999 (2001); https://doi.org/10.1016/s0968-0896(01)00116-x
3. B. Baviskar, S. Patel, B. Baviskar, S.S. Khadabadi and M. Shiradkar, Design and Synthesis of Some Novel Chalcones as Potent Antimicrobial Agent, *Asian J. Res. Chem.*, **1**, 67 (2008).
4. F. Herencia, M. Luisa-Ferrandiz, A. Ubeda, N. Domínguez, J.E. Charris, G.M. Lobo and M. Jose-Alcaraz, Synthesis and Anti-inflammatory Activity of Chalcone Derivatives, *Bioorg. Med. Chem. Lett*., **8**, 1169 (1998); https://doi.org/10.1016/S0960-894X(98)00179-6
5. X. Wu, P. Wilairat and M.-L. Go, Antimalarial Activity of Ferrocenyl Chalcones, *Bioorg. Med. Chem. Lett*., **12**, 2299 (2002); https://doi.org/10.1016/S0960-894X(02)00430-4
6. T. Narender, T. Khaliq, Shweta, Nishi, N. Goyal and S. Gupta, Synthesis of Chromenochalcones and Evaluation of their *in vitro* Antileishmanial Activity, *Bioorg. Med. Chem*., **13**, 6543 (2005); https://doi.org/10.1016/j.bmc.2005.07.005
7. J.-H. Cheng, C.-F. Hung, S.-C. Yang, J.-P. Wang, S.-J. Won and C.-N. Lin, Synthesis and Cytotoxic, Anti-Inflammatory and Anti-Oxidant Activities of 2′,5′-Dialkoxylchalcones as Cancer Chemopreventive Agents, *Bioorg. Med. Chem.*, **16**, 7270 (2008); https://doi.org/10.1016/j.bmc.2008.06.031
8. Y.-M. Lin, Y. Zhou, M.T. Flavin, L.-M. Zhou, W. Nie and F.-C. Chen, *Bioorg. Med. Chem.*, **10**, 2795 (2002); https://doi.org/10.1016/S0968-0896(02)00094-9
9. P.M. Sivakumar, S.P. Seenivasan, V. Kumar and M. Doble, Synthesis, Antimycobacterial Activity Evaluation and QSAR Studies of Chalcone Derivatives, *Bioorg. Med. Chem. Lett*., **17**, 1695 (2007); https://doi.org/10.1016/j.bmcl.2006.12.112
10. P.G. Kumdale and N.V. Shitole, Synthesis of Pyrazole Compounds by Using Sonication Method, *Orient. J. Chem.*, **38**, 198 (2022); https://doi.org/10.13005/ojc/380125
11. D. Gupta and D.K. Jain, Chalcone Derivatives as Potential Antifungal Agents: Synthesis and Antifungal Activity, *J. Adv. Pharm. Technol. Res.*, **6**, 114 (2015); https://doi.org/10.4103/2231-4040.161507
12. S. Saisivam and V.B. Kishan, Standard Method of Antifungal Activity, *Indian J. Microbiol*., **46**, 13 (2006).
13. S.J. Wadher, A.R. Tapas and P.G. Yeole, Studies on Synthesis and Antioxidant Activity of Some New Flavones, *Int. J. Chem. Sci*., **4**, 761 (2006).
14. A.R. Tapas, D.M. Sakarkar and R.B. Kakde, Flavonoids as Nutraceuticals: A Review, *Tropical J. Pharm. Res.*, **7**, 1089 (2008); https://doi.org/10.4314/tjpr.v7i3.14693
15. A.R. Tapas, D.M. Sakarkar and R.B. Kakde, The Chemistry and Biology of Bioflavonoids, *Res. J. Pharm. Tech*., **1**, 132 (2008).