European Journal of Chemistry 4 (3) (2013) 207-210

European Journal of Chemistry

Journal homepage: www.eurjchem.com

Synthesis, characterization and antibacterial activity of (*E*)-chalcone derivatives

Ahmed Mutanabbi Abdula

Chemistry Department, College of Science, Al-Mustansiriyah University, Baghdad, 00964, Iraq

**Corresponding author at: Chemistry Department, College of Science, Al-Mustansiriyah University, Baghdad, 00964, Iraq. Tel.: +964.780.8838128; fax: +964.780.8838128. E-mail address: ahm.chem@yahoo.com (A.M. Abdula).*

ARTICLE INFORMATION

Received: 20 March 2013
Received in revised form: 23 April 2013
Accepted: 23 April 2013
Online: 30 September 2013

KEYWORDS

Furan derivatives
Meerwein's reaction
Chalcone derivatives
Antibacterial activity
Claisen-Schmidt condensation
1,3-Diphenyl-2-propen-1-ones

ABSTRACT

(*E*)-Chalcone derivatives were synthesized by the Claisen-Schmidt condensation of aromatic aldehydes with methyl ketones. 5-Arylfuran-2-carboxaldehydes (1a-b) were synthesized by Meerwein´s method and condensed with 2-acetylpyrole or 2-acetylfuran to produce the new chalcone derivatives (2a-d). The new chalcones were characterized using FT-IR and GC-MS. The synthesized compounds were also screened against some bacterial species to evaluate their activity as promising antibacterial agents.

1. Introduction

Chalcones or 1,3-diphenyl-2-propen-1-one derivatives are a class of open chain flavonoids in which two aromatic rings are linked by a three carbon α,β-unsaturated carbonyl skeleton. Chalcones and their derivatives have shown a wide variety of therapeutic activities such as anti-oncogenic [1], anti-inflammatory [2], anti-ulcerative [3], analgesic [4], antiviral [5], anti-fungal [6], anti-malarial [7], and anti-bacterial activities [8]. During the last decade, the antimicrobial resistant represent the major problem facing the world, so that several new antibiotics and antifungal agents are accepted each year to help treatment the infectious diseases. In order to discovering new antimicrobial agents, this research illustrated the synthesis novel (*E*) chalcone derivatives and screening their activities against some gram positive and game negative bacterial species.

2. Experimental

2.1. Materials and method

All starting materials and solvents were purchased from Sigma-Aldrich and Fluka and used without further purification. Melting points were determined on Electro-thermal capillary apparatus and are uncorrected. FT-IR measurements were recorded on Shimadzu model FT-IR-8400S. Mass spectra were recorded on a Shimadzu GCMS-QP2010 Ultra apparatus.

2.2. General procedure for the preparation of 5-arylfuran-2-carboxaldehydes (1a-b)

These compounds were synthesized as mentioned in the reference [9,10]. 4-Substituted aniline (0.136 mol) was dissolved in a mixture of concentrated HCl (33.7 mL) and H_2O (22.5 mL). The solution was cooled to 0 °C and diazotized at 0-5 °C with sodium nitrite (9.5 g, 0.138 mol) dissolved in H_2O (25 mL). The solution was stirred for another 10 min, filtered and then furan-2-carboxaldehyde (15.4 g, 0.16 mol) in H_2O (50 mL) was added along with a solution of $CuCl_2{\cdot}2H_2O$ (5 g, 0.04 mol) in H_2O (25 mL) at a temperature of 10-15 °C. The reaction mixture was slowly warmed up to 40 °C and stirred at this temperature for 4h. The precipitate was filtered with suction, washed with water and an aqueous solution of sodium hydrogen carbonate (5%) and water. The products were dried at room temperature and recrystallized from ethanol (Scheme 1).

2.3. General procedure for the preparation of (2E)-3-[5-(substituted phenyl)-furan-2-yl]-1-(aryl)prop-2-en-1-ones (2a-d)

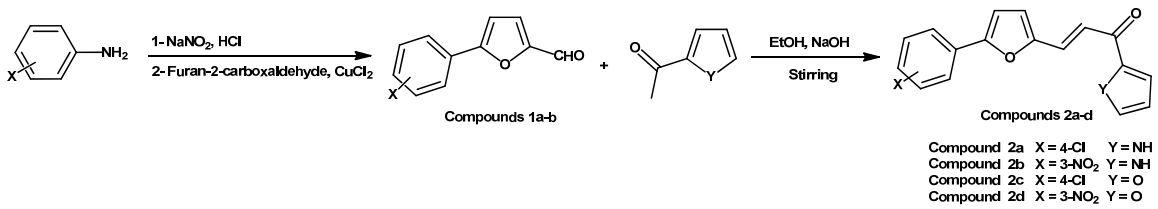
These derivatives were synthesized according to procedure described in reference [11-14]. A mixture of 2-acetylfuran or 2-acetylpyrrol (0.004 mol), aromatic aldehyde (0.004 mol), and some pellets of solid NaOH in 20 mL of ethanol was stirred at room temperature for 6 h. The resulting solid was washed, dried, and crystallized from ethanol (Scheme 1).

(2E)-3-[5-(4-Chlorophenyl)-furan-2-yl]-1-(1H-pyrrol-2-yl) prop-2-en-1-one (**2a**): Color: Dark yellow powder. Yield: 75%. M.p.: 158-160 °C. FT-IR (KBr, ν, cm^{-1}): 3229 (pyrrole N-H), 3132 (aromatic C-H), 2969 (aliphatic C-H), 1641 (C=O), 1578, 1551 (C=C). GC-MS (EI, *m/z*): 297 (M^+), 186, 158, 139, 111, 94, 66, 44.

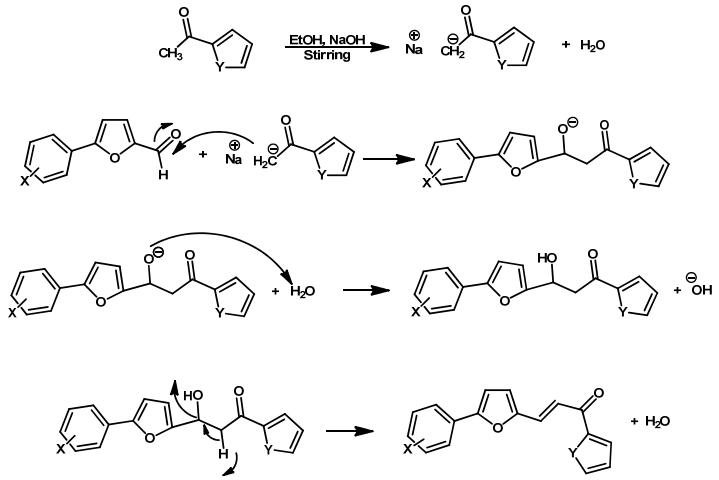
(2E)-3-[5-(3-Nitrophenyl)-furan-2-yl]-1-(1H-pyrrol-2-yl) prop-2-en-1-one (**2b**): Color: Yellow powder. Yield: 73%. M.p.: 168-170 °C. FT-IR (KBr, ν, cm^{-1}): 3241 (pyrrole N-H), 3121 (aromatic C-H), 2965, 2866 (aliphatic C-H), 1643 (C=O), 1589, 1529 (C=C). GC-MS (EI, *m/z*): 308 (M^+), 281, 207, 191, 186, 158, 133, 96, 73, 44.

(2E)-3-[5-(4-Chlorophenyl)-furan-2-yl]-1-(furan-2-yl)prop-2-en-1-one (**2c**): Color: Gray powder. Yield: 50%. M.p.: 94-96 °C. FT-IR (KBr, ν, cm^{-1}): 3123 (aromatic C-H), 2926, 2857 (aliphatic C-H), 1651 (C=O), 1591, 1468 (C=C). GC-MS (EI, *m/z*): 298 (M^+), 263, 241, 187, 139, 111, 95, 76, 67.

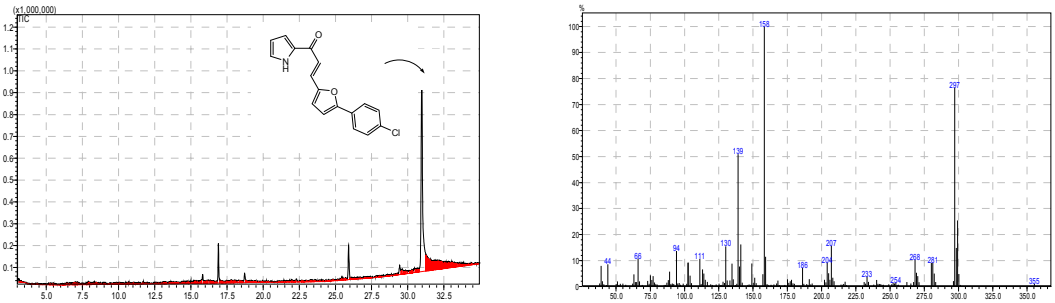
ISSN 2153-2249 (Print) / ISSN 2153-2257 (Online)
DOI:10.5155/eurjchem.4.3.207-210.780



Scheme 1



Scheme 2



a **b**

Figure 1. GC spectra (a) and GC-MS spectra (b) of chalcone derivative **2a**.

(2E)-3-[5-(3-Nitrophenyl)-furan-2-yl]-1-(furan-2-yl)prop-2-en-1-one (**2d**): Color: Dark brown powder. Yield: 40%. M.p.: 115-118 °C. FT-IR (KBr, ν, cm-1): 3124 (aromatic C-H), 2928, 2862 (aliphatic C-H), 1665 (C=O), 1597, 1528(C=C). GC-MS (EI, *m/z*): 308 (M^+), 281, 207, 191, 158, 133, 96, 73, 44.

2.4. Antimicrobial studies

The (*E*)-chalcone derivatives (**2a-d**) were tested for their antibacterial activity against *Escherichia coli*, *Klebsiella SPP* (Gram -) as well as *Staphylococcus aureus* and *Enterococcus faecalis* (Gram +) using well diffusion method [15]. DMSO was run as a control and test was performed at 10 mg/mL concentration using DMSO solvent. Tetracycline and amoxicillin were used as standard drugs. Each experiment was made in triplicate and the average reading was taken.

3. Results and discussion

The starting materials 5-(4-chlorophenyl)furan-2-carboxaldehyde (**1a**) and 5-(3-nitrophenyl)furan-2-carboxaldehyde (**1b**) were prepared under the conditions of Meerwein´s reaction from 4-chloroaniline or 3-nitroaniline and furan-2-carboxaldehyde as described in Scheme 1. Claisen-Schmidt condensation of aldehyde derivatives (**1a-b**) with 2-acetylfuran or 2-acetylpyrrol in the presence of sodium hydroxide gives chalcone derivatives **2a-d** in good yield (Scheme 1).

The mechanism of Claisen-Schmidt reaction can be summarized in Scheme 2.

The structures of chalcone derivatives (**2a-d**) were characterized by recording their IR and GC-MS spectra. The IR spectrum of compound **2a** showed absorption at 3229 cm^{-1} which is due to the pyrrole N-H stretching, while the aromatic C-H stretching frequency absorption appear at 3132 cm^{-1}.

Table 1. Inhibition zone of (E)-chalcone derivatives against some bacterial species.

Compound	Inhibition zone (mm) at 10 mg/mL against			
	Gram (-)		Gram (+)	
	Escherichia coli	*Klebsiella SPP*	*Staphylococcus aureus*	*Enterococcus faecalis*
2a	-	-	-	-
2b	10	7	22	-
2c	-	-	28	-
2d	8	7	14	-
Tetracycline	19	10	-	20
Amoxicillin	-	8	30	19

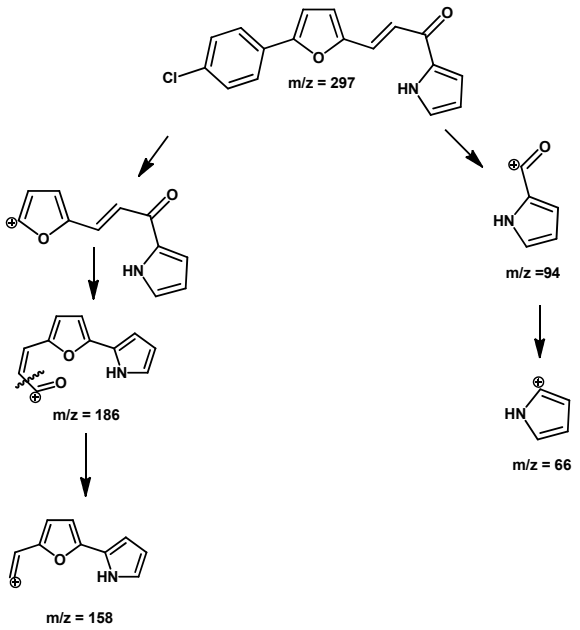


Figure 2. Mass fragments of compound **2a**.

The aliphatic C-H sterching appear at 2969 cm^{-1}. The carbonyl group C=O frequency band appeared at 1641 cm^{-1}. Bands at 1578 and 1551 cm^{-1} related to C=C absorption further confirm the structure of compound.

The GC-MS spectrum of **2a** as illustrated in Figure 1 showed the parent ion peak at an *m/z* value of 297 (M^+) and the fragments at 186, 158, 94 and 66 strongly enhanced the elucidation of compound. The physical properties, spectral data and mass analysis of all the synthesized compounds are given in the experimental section.

The suggested fragments for the compound **2a** depicted in Figure 2.

This research included the *in vitro* assay of the synthesized compounds against several microbial species to evaluate their activities as promising antimicrobial agents. The antibacterial activity results revealed that (2*E*)-3-[5-(substituted phenyl)-furan-2-yl]-1-(aryl)prop-2-en-1-ones (**2a-d**) exhibited moderate to potent bacterial growth inhibition against some gram positive and gram negative strains. Compound **2c** exhibited the portentous activity against *Staphylococcus aureus* comparing with Amoxicillin as standard while compound **1** show no activity against all bacterial species. Table 1 shows the Inhibition zone in mm at 10 mg/ mL concentration of tested compounds.

4. Conclusions

(E)-Chalcone derivatives were prepared by the Claisen-Schmidt condensation. The synthesized derivatives were confirmed using FT-IR and GC-MS analysis. The new compounds were tested against several of gram positive and gram negative bacterial species and exhibited potent to moderate activity as antimicrobial species.

Acknowledgements

This study was supported by Chemistry Department, College of Science, Al-Mustansiriyah University, Baghdad, Iraq.

Supplementary Materials: FT-IR and GC-MS data for compounds **2a-d**. This material is available free of charge via the Internet at http://www.eurjchem.com.

References

[1]. Kumar, S. K.; Hager, E.; Pettit, C.; Gurulingappa, H.; Davidson, N. E.; Khan, S. R. *J. Med. Chem.* **2003**, *46*, 2813-2815.
[2]. Hsieh, H. K.; Lee, T. H.; Wang, J. P.; Wang, J. J.; Lin, C. N. *Pharm. Res.* **1998**, *15(1)*, 39-46.
[3]. Murakami, S.; Muramatsu, M.; Aihara, H.; Otomo, S. *Biochem. Pharmacol.* **1991**, *42(7)*, 1447-1451.
[4]. Viana, G. S.; Bandeira, M. A.; Matos, F. J. *Phytomedicine* **2003**, *10(2)*, 189-195.
[5]. Wu, J. H.; Wang, X. H.; Yi, Y. H.; Lee, K. H. *Bioorg. Med. Chem. Lett.* **2003**, *13(10)*, 1813-1815.
[6]. Lopez, S. N.; Castelli, M. V.; Zacchino, S. A.; Dominguez, J. N.; Lobo, G.; Cortes, J. C.; Ribas, J. C.; Devia, C.; Rodriguez, A. M.; Enriz, R. D. *Bioorg. Med. Chem.* **2001**, *9(8)*, 1999-2004.
[7]. Liu, M.; Go, P.; Wilairat, M. L. *J. Med. Chem.* **2001**, *44(25)*, 4443-4452.
[8]. Bekhit, A. A.; Habib, N. S.; Bekhit, A. *Boll. Chim. Farm.* **2001**, *140(5)*, 297-301.
[9]. Puterova, Z.; Krutosikova, A.; Lycka, A.; Durcekova, T. *Molecules* **2004**, *9*, 241-255.
[10]. Puterova. Z.; Sterk, H.; Krutosikova, A. *Molecules* **2004**, *9(1)*, 11-21.

[11]. Basaif, S. A.; Sobahi, T. R.; Khalil, A. K.; Hassan, M. A. *Bull. Korean Chem. Soc*. **2005**, *26 (11)*, 1677-1681.
[12]. Radwan, M. A. A.; Abbas, E. M. H. *Monatsh. Chem.* **2009**. *140 (2)*, 229-233.
[13]. Yadav, N.; Dixit, S. K.; Bhattacharya, A.; Mishra, L. C.; Sharma, M.; Awasthi, S. K.; Bhasin, V. K. *Chem. Biol. Drug Des*. **2012**, *80(2)*, 340-347.
[14]. Sid, A.; Lamara, K.; Mokhtari, M.; Ziani, N.; Mosset, P. *Eur. J. Chem.* **2011**, *2(3)* 311-313.
[15]. Tomi, I. H. R.; Al-Daraji, A. H. R.; Al-Qaysi, R. R. T.; Hasson, M. M.; Al-Dulaimy, K. H. D. *Arab. J. Chem*. **2010**. doi:10.1016/j.arabjc.2010.12.003. In press.