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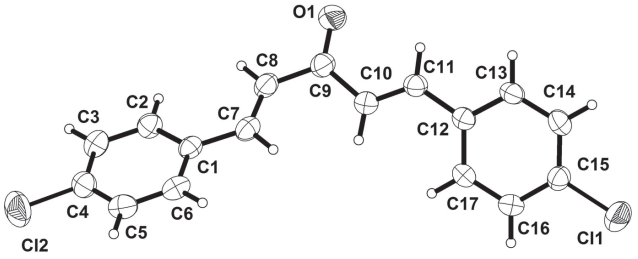
Crystal structure of (1*E*,4*E*)-1,5-bis(4-chlorophenyl)penta-1,4-dien-3-one, $C_{17}H_{12}Cl_2O$



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Abstract

$C_{17}H_{12}Cl_2O$, monoclinic, $P2_1/c$, $a = 17.2845(14)$ Å, $b = 14.2007(11)$ Å, $c = 5.8795(5)$ Å, $\beta = 99.088(3)°$, $V = 1425.0(2)$ Å^3, $Z = 4$, $R_{gt}(F) = 0.0567$, $wR_{ref}(F^2) = 0.1395$, $T = 263$ K.

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The crystal structure is shown in the figure. Tables 1 and 2 contain details on crystal structure and measurement conditions and a list of the atoms including atomic coordinates and displacement parameters.

Source of material

A mixture of acetone (1.00 g, 17.2 mmol), 4-chlorobenzaldehyde (4.80 g, 34.5 mmol) and KOH (50%) in methanol 50 (mL) was stirred at room temperature for 2 h and then quenched with ice-cold water. The resultant precipitate was filtered on a sintered funnel and then recrystallized from ethanol to afford the title compound as an orange solid (4.31 g, 83%), m.p. 263 K (EtOH); **IR** ν_{max} (ATR) 601, 708, 823, 979, 1012, 1217, 1365, 1407, 1490, 1585, 1648 cm^{-1}; **^{1}H-NMR:** δ_H (500 MHz, $CDCl_3$) 7.03 (2H, d, $J = 16.0$ Hz, α-H), 7.39 (4H, d, $J = 8.0$ Hz, Ar), 7.53 (4H, d, $J = 7.5$ Hz, Ar), 7.67

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Table 1: Data collection and handling.

Crystal:	Brown, block
Size:	0.47 × 0.39 × 0.18 mm
Wavelength:	Mo $K\alpha$ radiation (0.71073 Å)
μ:	0.45 mm^{-1}
Diffractometer, scan mode:	Bruker APEXII, φ and ω-scans
2θ, completeness:	28°, >99%
$N(hkl)_{measured}$, $N(hkl)_{unique}$, R_{int}:	42558, 3435, 0.075
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\ \sigma(I_{obs})$, 2804
$N(param)_{refined}$:	181
Programs:	Bruker programs [1], WinGX [2], SHELX [3]

Table 2: Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å^2).

Atom	*x*	*y*	*z*	U_{iso}*/U_{eq}
C1	0.61986(13)	0.12231(15)	0.2819(4)	0.0380(5)
C2	0.68207(14)	0.16086(16)	0.1870(4)	0.0429(5)
H2	0.6723	0.1887	0.0421	0.051*
C3	0.75795(14)	0.15824(17)	0.3055(4)	0.0470(6)
H3	0.7992	0.1832	0.2407	0.056*
C4	0.77126(14)	0.11781(17)	0.5218(4)	0.0462(5)
C5	0.71169(16)	0.07918(17)	0.6194(4)	0.0481(6)
H5	0.7219	0.0517	0.7646	0.058*
C6	0.63620(15)	0.08159(17)	0.4990(4)	0.0456(5)
H6	0.5956	0.0554	0.5646	0.055*
C7	0.53826(14)	0.12290(16)	0.1603(4)	0.0428(5)
H7	0.4995	0.1062	0.2461	0.051*
C8	0.51484(14)	0.14464(18)	−0.0575(4)	0.0461(6)
H8	0.5526	0.1665	−0.1411	0.055*
C9	0.43368(14)	0.13719(17)	−0.1798(4)	0.0445(5)
C10	0.36899(14)	0.13437(17)	−0.0432(4)	0.0445(5)
H10	0.3791	0.1501	0.1122	0.053*
C11	0.29709(13)	0.11013(16)	−0.1362(4)	0.0389(5)
H11	0.2907	0.0883	−0.2871	0.047*
C12	0.22634(13)	0.11380(15)	−0.0283(4)	0.0357(4)
C13	0.15572(13)	0.08123(16)	−0.1481(4)	0.0404(5)
H13	0.155	0.0528	−0.2908	0.049*
C14	0.08632(14)	0.09002(17)	−0.0603(4)	0.0452(5)
H14	0.0395	0.0683	−0.1434	0.054*
C15	0.08789(13)	0.13147(17)	0.1517(4)	0.0415(5)
C16	0.15760(14)	0.16321(16)	0.2785(4)	0.0399(5)
H16	0.158	0.1904	0.4225	0.048*
C17	0.22622(13)	0.15406(15)	0.1892(4)	0.0387(5)
H17	0.273	0.1749	0.2744	0.046*
O1	0.42181(11)	0.13427(15)	−0.3897(3)	0.0605(5)
Cl1	0.00210(4)	0.14457(6)	0.26720(14)	0.0703(3)
Cl2	0.86568(5)	0.11711(7)	0.67445(15)	0.0759(3)

[a]Occupancy: 0.854(7).

(2H, d, $J = 16.0$ Hz, β-H); **^{13}C-NMR:** δ_C (125 MHz, $CDCl_3$) 125.7 (2xC), 129.3 (2xC), 129.5 (2xC), 133.1, 133.2, 136.5, 142.0 (2xC), 147.4, 188.3; **HRMS** (ES): MH^+, found. 306.0236 $C_{17}H_{13}Cl_2O^+$ requires: 302.0265.

Experimental details

Hydrogen atoms were positioned geometrically and allowed to ride on their respective parent atoms with d(C–H) = 0.95 Å and $U_{iso}(H) = 1.2U_{eq}(C)$.

Discussion

Curcumin (1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione) was first isolated from the plant *Curcuma longa* two centuries ago and has the potential to treat a wide variety of inflammatory diseases including diabetes, cardiovascular diseases, arthritis and Alzheimer's disease [4, 5]. Its antioxidant properties and its ability to inhibit the nuclear factor-kappaB (NFkB), which modulates several pro-inflammatory and profibrotic cytokines provide a rational molecular basis to use it in hepatic disorders [4]. The enone analogues with the 5-carbon spacer (1,1′-distyryl ketones) were found to significantly inhibit the TNFα-induced activation of the transcription factor NFkB more so than curcumin [6]. Analogues of 1,1′-distyryl ketones devoid of phenolic groups have also been found to exhibit significant anti-oxidant properties [7]. The analogous (1*E*,4*E*)-1,5-bis(4-hydroxyphenyl)penta-1,4-dien-3-one and (1*E*,4*E*)-1-(2-hydroxyphenyl)-5-phenylpenta-1,4-dien-3-one, on the other hand, have been found to exhibit significant larvicidal activity against mosquito *Aedes aegypti* (L), [8] a known vector in the transmission of yellow fever, dengue haemorrhagic fever, and the re-emerging disease chikungunya. These compounds have also been found to inhibit binding of cholesterol to *Aedes aegypti* SCP-2 (AeSCP-2) *in vitro* [9]. To-date, the structures of the 1,1′-distyryl ketones have only been fully characterised using ^{1}H-NMR, ^{13}C-NMR, IR and UV spectrometric techniques and their *trans* stereochemistry was assigned based on the coupling constant values, $J_{trans} = 15.0–16.5$ Hz [10]. We have been able to prepare (1*E*,4*E*)-1,5-bis(4-chlorophenyl)penta-1,4-dien-3-one *via* a base catalysed Claisen-Shmidt condensation of acetone (1 equivalent) with 4-chlorobenzaldehyde (2 equivalents) and obtained crystals of this compound.

The two aryl rings in the title structure (*cf*. the figure) are planar with the torsion angle about the C(1)—C(7)—C(8)—C(9) backbone (174.7°) nearly equal to but opposite in sense to that about the C(9)—C(10)—C(11)—C(12) backbone (−173.1°). The C=O bond length (1.220(3) Å) is in the typical range for chalcones [11].

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References

1. Bruker. SAINT+, version 6.02 (Includes XPREP and SADABS), Bruker AXS Inc., Madison, Wisconsin, USA, (2004).
2. Farrugia, L. J.: WinGX suite for small-molecule single-crystal crystallography. J. Appl. Crystallogr. **3** (2012) 837–838.
3. Sheldrick, G. M.: A Short History of SHELX. Acta Crystallogr. A *:* **64** (2008) 112–122.
4. Zhang, A.; Sun, H.; Wang, X.: Recent advances in natural products from plants for treatment of liver diseases. Eur. J. Med. Chem. **63** (2003) 570–577.
5. Schlesier, K.; Harwat, M.; Bohm, V.; Bitsch, R.: Assessment of antioxidant activity by using different in vitro methods. Free Radic. Res. **36** (2002) 177–187.
6. Weber, W. M.; Hunsaker, L. A.; Roybal, C. N.; Bobrovnikova-Marjon, E. V.; Abcouwer, S. F.; Royer, R. R.; Deck, L. M.; Vander Jagt, D. L.: Activation of NFκB is inhibited by curcumin and related enones. Bioorg. Med. Chem. **14** (2006) 2450–2461.
7. Weber, W. M.; Hunsaker, L. A.; Abcouwer, S. F.; Deck, L. M.; Vander Jagt, D. L.: Anti-oxidant activities of curcumin and related enones. Bioorg. Med. Chem. **13** (2005) 3811–3820.
8. Anstrom, D. M.; Zhou, X.; Kalk, C. N.; Song, B.; Lan, Q.: Mosquitocidal properties of natural product compounds isolated from Chinese herbs and synthetic analogs of curcumin. J. Med. Entomology. **49** (2012) 350–355.
9. Simon, F.; Savini, H.; Parola, P.: Chikungunya: a paradigm of emergence and globalization of vector-borne diseases. Med. Clin. North Am. **92** (2008) 1323–1343.
10. Al-Kadhimi, A. A.; AL-Hamdany, A. J.; Jasim, S. S.: Synthesis and antibacterial evaluation of bis-pyrrolidinyl ketones. Res. J. Pharm. Biol. Chem. Sci. **3** (2012) 908–921.
11. Payton-Stewart, F.; Pingalib, S. R. K.; Donahuec, J. P.: The chalcone derivative (*E*)-1-(4-fluorophenyl)-3-(4-hydroxy-3-methoxyphenyl)-prop-2-en-1-one monohydrate. Acta Crystallogr. **E64** (2013) 558–559.