

Acta Crystallographica Section E

Structure Reports

Online

ISSN 1600-5368

(E)-Ethyl 2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylate

 Shi-Jie Zhang,^a Xian-Ming Zheng^b and Wei-Xiao Hu^{a*}
^aCollege of Pharmaceutical Science, Zhejiang University of Technology, Hangzhou 310032, People's Republic of China, and ^bHisoar Pharmaceutical Co. Ltd, Taizhou 318000, Zhejiang Province, People's Republic of China

Correspondence e-mail: huyang@mail.hz.zj.cn (W.-X. Hu)

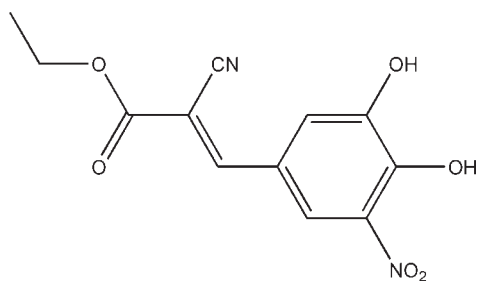
Received 11 August 2009; accepted 1 September 2009

 Key indicators: single-crystal X-ray study; $T = 93$ K; mean $\sigma(\text{C}-\text{C}) = 0.003$ Å; R factor = 0.048; wR factor = 0.118; data-to-parameter ratio = 14.3.

The title compound, $\text{C}_{12}\text{H}_{10}\text{N}_2\text{O}_6$, was synthesized *via* a Knoevenagel condensation and crystallized from ethanol. In the crystal, strong classical intermolecular $\text{O}-\text{H}\cdots\text{O}$ hydrogen bonds and weak $\text{C}-\text{H}\cdots\text{N}$ contacts link the molecules into ribbons extending along [010]. Intramolecular $\text{O}-\text{H}\cdots\text{O}$ and $\text{C}-\text{H}\cdots\text{N}$ contacts support the planar conformation of the molecules (mean deviation 0.0270 Å).

Related literature

For the syntheses of some potent and selective catechol *O*-methyltransferase inhibitors, see: Bäckström *et al.* (1989). For structure–activity relationships of catechol *O*-methyltransferase inhibitors, see: Tervo *et al.* (2003). For Entacapone-related crystal structures, see: Zheng *et al.* (2007). For the synthesis and anticancer evaluation of *E*-2-cyano-(3-substituted phenyl)acrylamides, see: Zhou *et al.* (2009).



Experimental

Crystal data

 $\text{C}_{12}\text{H}_{10}\text{N}_2\text{O}_6$
 $M_r = 278.22$

 Monoclinic, $C2/c$
 $a = 24.983$ (9) Å
 $b = 13.485$ (5) Å
 $c = 7.312$ (3) Å
 $\beta = 105.911$ (4)°
 $V = 2369.0$ (16) Å³
 $Z = 8$
 Mo $K\alpha$ radiation
 $\mu = 0.13$ mm⁻¹
 $T = 93$ K
 $0.40 \times 0.20 \times 0.10$ mm

Data collection

 Rigaku AFC10/Saturn724+
 diffractometer
 Absorption correction: none
 9288 measured reflections

 2714 independent reflections
 2134 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.042$

Refinement

 $R[F^2 > 2\sigma(F^2)] = 0.048$
 $wR(F^2) = 0.118$
 $S = 1.00$
 2714 reflections
 190 parameters

 H atoms treated by a mixture of
 independent and constrained
 refinement
 $\Delta\rho_{\text{max}} = 0.30$ e Å⁻³
 $\Delta\rho_{\text{min}} = -0.31$ e Å⁻³

Table 1

Hydrogen-bond geometry (Å, °).

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
$\text{O1}-\text{H1O}\cdots\text{O6}^i$	0.91 (3)	1.76 (3)	2.6692 (18)	176 (2)
$\text{C5}-\text{H5}\cdots\text{N1}^{\text{ii}}$	0.95	2.57	3.467 (3)	159
$\text{O2}-\text{H2O}\cdots\text{O3}$	0.96 (3)	1.72 (3)	2.584 (2)	149 (2)
$\text{C1}-\text{H1}\cdots\text{N1}$	0.95	2.62	3.474 (3)	150

 Symmetry codes: (i) $-x + \frac{1}{2}, y + \frac{1}{2}, -z + \frac{1}{2}$; (ii) $-x + \frac{1}{2}, y - \frac{1}{2}, -z + \frac{1}{2}$

Data collection: *CrystalClear* (Rigaku/MS, 2008); cell refinement: *CrystalClear*; data reduction: *CrystalClear*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *ORTEP-3* (Farrugia, 1997) and *PLATON* (Spek, 2009); software used to prepare material for publication: *publCIF* (Westrip, 2009).

The authors thank Dr F. Xu (Taizhou Vocational & Technical College) and Mr G. Chen for their help.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: SI2196).

References

- Bäckström, R., Honkanen, E., Pippuri, A., Kairisalo, P., Pystynen, J., Heinola, K., Nissinen, E., Linden, I.-B., Männistö, P. T., Kaakkola, S. & Pohto, P. (1989). *J. Med. Chem.* **32**, 841–846.
- Farrugia, L. J. (1997). *J. Appl. Cryst.* **30**, 565.
- Rigaku/MS (2008). *CrystalClear*. Rigaku/MS Inc., The Woodlands, Texas, USA.
- Sheldrick, G. M. (2008). *Acta Cryst.* **A64**, 112–122.
- Spek, A. L. (2009). *Acta Cryst.* **D65**, 148–155.
- Tervo, A. J., Nyrönen, T. H., Rönkkö, T. & Poso, A. (2003). *J. Comput. Aid. Mol. Des.* **17**, 797–810.
- Westrip, S. P. (2009). *publCIF*. In preparation.
- Zheng, X.-M., Hu, W.-X. & Xu, F. (2007). *Acta Cryst.* **E63**, o1317–o1318.
- Zhou, W., Li, H.-B., Xia, C.-N., Zheng, X.-M. & Hu, W.-X. (2009). *Bioorg. Med. Chem. Lett.* **19**, 1861–1865.

supplementary materials

Acta Cryst. (2009). E65, o2351 [doi:10.1107/S1600536809035132]

(*E*)-Ethyl 2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylate

S.-J. Zhang, X.-M. Zheng and W.-X. Hu

Comment

Entacapone has been found to possess anticancer activity. Structure-activity relationships of entacapone revealed that catechol, cyano moieties and *trans* double-bond are necessary to sustain the activity and a nitro group substituted at C₅ phenyl ring is preferable, and the amide group could be modified. (Bäckström *et al.*, 1989 & Tervo *et al.*, 2003) In continuation of our work on synthesis, crystal structure and anticancer evaluation of *E*-2-cyano-(3-substituted phenyl)acrylamides, (Zheng *et al.*, 2007 & Zhou *et al.*, 2009) we synthesized *E*-2-cyano-substituted phenyl acrylic acid or its esters under Knoevenagel condensation, among which only *E*-2-cyano-3-(3,4-dihydroxyphenyl)acrylic acid had good *in vitro* KB inhibitory activity at IC₅₀ 36 μM. Herein, we present the structure of the title compound (I).

The molecular structure of (I) is illustrated in Fig. 1. The phenyl ring, atoms C7 > C9, O1 > O6 and N2 are almost coplanar, which makes dihedral angles of 14.2 (2)° and 8.72 (2)° with the planes C8/N10/C1 and O5/C11/C12, respectively. As shown in Fig. 2, the molecules are linked into chains along the *b* axis to form ribbons which are oriented parallel to the *a, b* plane. There are two intermolecular and two intramolecular (O—H⋯O and C1—H⋯N) hydrogen bonds (Table 1) which contribute to the formation of parallel ribbons in the crystal lattice.

Experimental

To a stirred ethanol solution, was added 3,4-dihydroxy-5-nitrobenzaldehyde (4.9 g, 27 mmol), ethyl 2-cyanoacetate (3.4 g, 30 mmol) and ammonium acetate (0.75 g, 9.7 mmol). The mixture was heated to reflux for 6 h before filtration and the solid obtained was recrystallized from ethanol to afford the title compound as yellow solid, 6.1 g (81.9%); mp: 484–485 K; IR (KBr): 3446, 3232, 2223, 1687, 1602, 1543, 1284, 1221 cm⁻¹; ¹H NMR (DMSO-*d*₆, 400 MHz) p.p.m.: 8.29, 8.10, 7.89, 4.32–4.28, 1.31–1.28; EIMS (%): 278 (*M*⁺, 17), 250 (31), 233 (23), 202 (55), 174 (31), 158 (34), 130 (25), 102 (28). The title compound was dissolved in ethanol and the solution evaporated gradually at r.t. to give single crystals of (I).

Refinement

H atoms of the O—H groups were located from difference Fourier maps, they were freely refined. All H atoms of parent C atoms were placed in calculated positions and treated as riding, with C—H = 0.95 Å, and their displacement parameters set to $U_{\text{iso}}(\text{H}) = 1.2U_{\text{eq}}(\text{C})$.

Figures

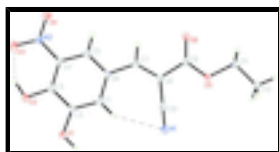


Fig. 1. : The molecular structure of (I) shown with 50% probability displacement ellipsoids.

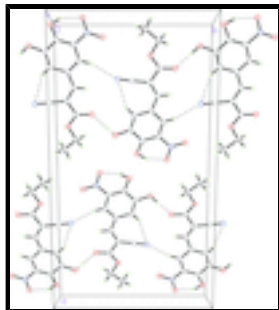


Fig. 2. : A section of the crystal structure of (I), viewed down the *c* axis.

(E)-Ethyl 2-cyano-3-(3,4-dihydroxy-5-nitrophenyl)acrylate

Crystal data

$C_{12}H_{10}N_2O_6$

$M_r = 278.22$

Monoclinic, $C2/c$

Hall symbol: $-C\ 2yc$

$a = 24.983\ (9)\ \text{\AA}$

$b = 13.485\ (5)\ \text{\AA}$

$c = 7.312\ (3)\ \text{\AA}$

$\beta = 105.911\ (4)^\circ$

$V = 2369.0\ (16)\ \text{\AA}^3$

$Z = 8$

$F_{000} = 1152$

$D_x = 1.560\ \text{Mg m}^{-3}$

Mo $K\alpha$ radiation, $\lambda = 0.71073\ \text{\AA}$

Cell parameters from 3450 reflections

$\theta = 3.0\text{--}27.5^\circ$

$\mu = 0.13\ \text{mm}^{-1}$

$T = 93\ \text{K}$

Prism, yellow

$0.40 \times 0.20 \times 0.10\ \text{mm}$

Data collection

Rigaku AFC10/Saturn724+
diffractometer

Radiation source: Rotating Anode

Monochromator: graphite

Detector resolution: $28.5714\ \text{pixels mm}^{-1}$

$T = 93\ \text{K}$

multi-scan

Absorption correction: none

9288 measured reflections

2714 independent reflections

2134 reflections with $I > 2\sigma(I)$

$R_{\text{int}} = 0.042$

$\theta_{\text{max}} = 27.6^\circ$

$\theta_{\text{min}} = 3.0^\circ$

$h = -28 \rightarrow 32$

$k = -17 \rightarrow 17$

$l = -9 \rightarrow 6$

Refinement

Refinement on F^2

Least-squares matrix: full

$R[F^2 > 2\sigma(F^2)] = 0.048$

$wR(F^2) = 0.118$

$S = 1.00$

Secondary atom site location: difference Fourier map

Hydrogen site location: inferred from neighbouring sites

H atoms treated by a mixture of independent and constrained refinement

$w = 1/[\sigma^2(F_o^2) + (0.0596P)^2 + 0.69P]$

where $P = (F_o^2 + 2F_c^2)/3$

$(\Delta/\sigma)_{\text{max}} < 0.001$

2714 reflections $\Delta\rho_{\max} = 0.30 \text{ e } \text{\AA}^{-3}$
 190 parameters $\Delta\rho_{\min} = -0.31 \text{ e } \text{\AA}^{-3}$
 Primary atom site location: structure-invariant direct methods Extinction correction: none

Special details

Geometry. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

Refinement. Refinement of F^2 against ALL reflections. The weighted R -factor wR and goodness of fit S are based on F^2 , conventional R -factors R are based on F , with F set to zero for negative F^2 . The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating R -factors(gt) *etc.* and is not relevant to the choice of reflections for refinement. R -factors based on F^2 are statistically about twice as large as those based on F , and R -factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (\AA^2)

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
O1	0.39296 (5)	0.60992 (8)	0.12800 (18)	0.0219 (3)
O2	0.45623 (5)	0.47578 (9)	0.04941 (17)	0.0222 (3)
O3	0.47644 (5)	0.28865 (9)	0.03118 (18)	0.0269 (3)
O4	0.41766 (5)	0.17833 (9)	0.07290 (19)	0.0292 (3)
O5	0.13633 (5)	0.39925 (8)	0.35194 (16)	0.0196 (3)
O6	0.17659 (5)	0.25177 (9)	0.32497 (17)	0.0251 (3)
N1	0.20946 (6)	0.59192 (11)	0.2676 (2)	0.0237 (3)
N2	0.43188 (6)	0.26508 (11)	0.0670 (2)	0.0222 (3)
C1	0.32709 (7)	0.48910 (12)	0.1768 (2)	0.0179 (4)
H1	0.3033	0.5391	0.2023	0.022*
C2	0.37531 (7)	0.51576 (12)	0.1344 (2)	0.0174 (4)
C3	0.41109 (7)	0.44238 (13)	0.0937 (2)	0.0180 (4)
C4	0.39609 (7)	0.34321 (12)	0.1026 (2)	0.0178 (4)
C5	0.34721 (7)	0.31586 (12)	0.1455 (2)	0.0189 (4)
H5	0.3379	0.2477	0.1489	0.023*
C6	0.31215 (7)	0.38778 (12)	0.1831 (2)	0.0177 (4)
C7	0.26290 (7)	0.35205 (12)	0.2309 (2)	0.0186 (4)
H7	0.2601	0.2819	0.2352	0.022*
C8	0.22018 (7)	0.40137 (12)	0.2704 (2)	0.0182 (4)
C9	0.17571 (7)	0.34244 (12)	0.3181 (2)	0.0188 (4)
C10	0.21410 (7)	0.50688 (13)	0.2690 (2)	0.0189 (4)
C11	0.09158 (7)	0.34963 (13)	0.4102 (2)	0.0216 (4)
H11A	0.1072	0.3013	0.5129	0.026*
H11B	0.0668	0.3138	0.3013	0.026*
C12	0.05971 (7)	0.42919 (13)	0.4796 (3)	0.0248 (4)
H12A	0.0840	0.4609	0.5927	0.030*
H12B	0.0276	0.3995	0.5119	0.030*
H12C	0.0467	0.4789	0.3795	0.030*

supplementary materials

H2O	0.4735 (10)	0.4161 (19)	0.024 (3)	0.055 (7)*
H1O	0.3692 (11)	0.659 (2)	0.139 (3)	0.063 (8)*

Atomic displacement parameters (\AA^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
O1	0.0197 (6)	0.0149 (6)	0.0348 (7)	-0.0012 (5)	0.0136 (5)	0.0001 (5)
O2	0.0176 (6)	0.0218 (7)	0.0314 (7)	-0.0007 (5)	0.0138 (5)	0.0004 (5)
O3	0.0211 (7)	0.0268 (7)	0.0379 (7)	0.0035 (5)	0.0169 (6)	0.0005 (6)
O4	0.0312 (7)	0.0163 (6)	0.0449 (8)	0.0022 (5)	0.0184 (6)	-0.0011 (5)
O5	0.0177 (6)	0.0184 (6)	0.0259 (6)	-0.0003 (5)	0.0115 (5)	0.0015 (5)
O6	0.0243 (7)	0.0172 (6)	0.0395 (8)	-0.0008 (5)	0.0183 (6)	0.0000 (5)
N1	0.0206 (8)	0.0207 (8)	0.0323 (8)	0.0006 (6)	0.0117 (6)	0.0001 (6)
N2	0.0214 (8)	0.0199 (7)	0.0268 (8)	0.0047 (6)	0.0094 (6)	-0.0005 (6)
C1	0.0162 (8)	0.0175 (8)	0.0215 (8)	0.0014 (6)	0.0076 (7)	-0.0003 (6)
C2	0.0180 (9)	0.0144 (8)	0.0206 (8)	0.0010 (6)	0.0067 (7)	0.0008 (6)
C3	0.0154 (8)	0.0203 (8)	0.0195 (8)	0.0004 (6)	0.0068 (7)	0.0000 (6)
C4	0.0173 (8)	0.0164 (8)	0.0208 (8)	0.0039 (6)	0.0069 (7)	-0.0003 (6)
C5	0.0192 (8)	0.0176 (8)	0.0211 (8)	-0.0004 (7)	0.0074 (7)	-0.0004 (6)
C6	0.0169 (8)	0.0176 (8)	0.0198 (8)	-0.0014 (6)	0.0070 (7)	-0.0004 (6)
C7	0.0204 (9)	0.0157 (8)	0.0211 (8)	-0.0019 (6)	0.0081 (7)	0.0003 (6)
C8	0.0188 (8)	0.0170 (8)	0.0202 (8)	-0.0005 (6)	0.0076 (7)	-0.0003 (6)
C9	0.0183 (9)	0.0193 (8)	0.0206 (8)	-0.0007 (7)	0.0085 (7)	-0.0013 (7)
C10	0.0146 (8)	0.0216 (9)	0.0223 (8)	-0.0013 (7)	0.0082 (7)	-0.0005 (7)
C11	0.0194 (9)	0.0221 (9)	0.0274 (9)	-0.0044 (7)	0.0133 (7)	-0.0010 (7)
C12	0.0224 (10)	0.0227 (9)	0.0346 (10)	-0.0005 (7)	0.0167 (8)	-0.0016 (7)

Geometric parameters (\AA , $^\circ$)

O1—C2	1.3491 (19)	C3—C4	1.395 (2)
O1—H1O	0.90 (3)	C4—C5	1.391 (2)
O2—C3	1.334 (2)	C5—C6	1.384 (2)
O2—H2O	0.95 (3)	C5—H5	0.9500
O3—N2	1.2528 (19)	C6—C7	1.450 (2)
O4—N2	1.2266 (19)	C7—C8	1.354 (2)
O5—C9	1.322 (2)	C7—H7	0.9500
O5—C11	1.463 (2)	C8—C10	1.431 (2)
O6—C9	1.224 (2)	C8—C9	1.484 (2)
N1—C10	1.152 (2)	C11—C12	1.505 (2)
N2—C4	1.451 (2)	C11—H11A	0.9900
C1—C2	1.372 (2)	C11—H11B	0.9900
C1—C6	1.420 (2)	C12—H12A	0.9800
C1—H1	0.9500	C12—H12B	0.9800
C2—C3	1.419 (2)	C12—H12C	0.9800
C2—O1—H1O	117.0 (17)	C1—C6—C7	125.12 (15)
C3—O2—H2O	102.7 (15)	C8—C7—C6	131.17 (16)
C9—O5—C11	117.16 (13)	C8—C7—H7	114.4
O4—N2—O3	122.12 (14)	C6—C7—H7	114.4

O4—N2—C4	119.20 (15)	C7—C8—C10	125.13 (15)
O3—N2—C4	118.68 (14)	C7—C8—C9	118.16 (16)
C2—C1—C6	120.95 (15)	C10—C8—C9	116.71 (15)
C2—C1—H1	119.5	O6—C9—O5	125.26 (15)
C6—C1—H1	119.5	O6—C9—C8	122.58 (15)
O1—C2—C1	124.76 (15)	O5—C9—C8	112.16 (15)
O1—C2—C3	114.74 (15)	N1—C10—C8	179.64 (18)
C1—C2—C3	120.49 (15)	O5—C11—C12	106.83 (14)
O2—C3—C4	126.20 (15)	O5—C11—H11A	110.4
O2—C3—C2	116.01 (15)	C12—C11—H11A	110.4
C4—C3—C2	117.79 (15)	O5—C11—H11B	110.4
C5—C4—C3	121.88 (15)	C12—C11—H11B	110.4
C5—C4—N2	118.04 (15)	H11A—C11—H11B	108.6
C3—C4—N2	120.08 (15)	C11—C12—H12A	109.5
C6—C5—C4	120.10 (15)	C11—C12—H12B	109.5
C6—C5—H5	119.9	H12A—C12—H12B	109.5
C4—C5—H5	119.9	C11—C12—H12C	109.5
C5—C6—C1	118.76 (15)	H12A—C12—H12C	109.5
C5—C6—C7	116.10 (15)	H12B—C12—H12C	109.5
C6—C1—C2—O1	-179.03 (15)	C4—C5—C6—C1	0.1 (2)
C6—C1—C2—C3	0.7 (2)	C4—C5—C6—C7	-178.53 (15)
O1—C2—C3—O2	-1.9 (2)	C2—C1—C6—C5	0.0 (2)
C1—C2—C3—O2	178.35 (14)	C2—C1—C6—C7	178.44 (15)
O1—C2—C3—C4	178.37 (14)	C5—C6—C7—C8	-178.25 (17)
C1—C2—C3—C4	-1.4 (2)	C1—C6—C7—C8	3.3 (3)
O2—C3—C4—C5	-178.26 (15)	C6—C7—C8—C10	1.4 (3)
C2—C3—C4—C5	1.4 (2)	C6—C7—C8—C9	-178.89 (16)
O2—C3—C4—N2	1.8 (3)	C11—O5—C9—O6	2.8 (2)
C2—C3—C4—N2	-178.46 (14)	C11—O5—C9—C8	-176.96 (13)
O4—N2—C4—C5	1.1 (2)	C7—C8—C9—O6	0.8 (3)
O3—N2—C4—C5	-178.91 (14)	C10—C8—C9—O6	-179.52 (16)
O4—N2—C4—C3	-179.01 (15)	C7—C8—C9—O5	-179.44 (14)
O3—N2—C4—C3	1.0 (2)	C10—C8—C9—O5	0.3 (2)
C3—C4—C5—C6	-0.8 (2)	C9—O5—C11—C12	168.12 (14)
N2—C4—C5—C6	179.10 (14)		

Hydrogen-bond geometry (\AA , $^\circ$)

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
O1—H10 \cdots O6 ⁱ	0.91 (3)	1.76 (3)	2.6692 (18)	176 (2)
C5—H5 \cdots N1 ⁱⁱ	0.95	2.57	3.467 (3)	159
O2—H20 \cdots O3	0.96 (3)	1.72 (3)	2.584 (2)	149 (2)
C1—H1 \cdots N1	0.95	2.62	3.474 (3)	150

Symmetry codes: (i) $-x+1/2, y+1/2, -z+1/2$; (ii) $-x+1/2, y-1/2, -z+1/2$.

Fig. 1



Fig. 2

