

2-Methyl-2-(4-nitrophenylsulfanyl)-propanoic acid

Gabriel Navarrete-Vázquez,^a Rafael Villalobos-Molina,^b Samuel Estrada-Soto,^a Rolffy Ortiz-Andrade^a and Hugo Tlahuext^{c*}

^aFacultad de Farmacia, Universidad Autónoma del Estado de Morelos, Avenida Universidad 1001 Col., Chamilpa, CP 62100, Cuernavaca Mor., Mexico, ^bUnidad de Biomedicina, FES Iztacala, Universidad Nacional Autónoma de México, Tlalnepantla, México 54090, Mexico, and ^cCentro de Investigaciones Químicas, Universidad Autónoma del Estado de Morelos, Avenida Universidad 1001 Col., Chamilpa, CP 62100, Cuernavaca Mor., Mexico
Correspondence e-mail: tlahuext@ciq.uaem.mx

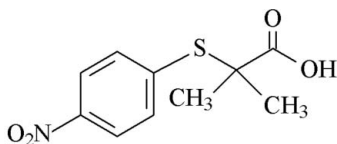
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Key indicators: single-crystal X-ray study; $T = 273$ K; mean $\sigma(\text{C}-\text{C}) = 0.004$ Å; R factor = 0.048; wR factor = 0.123; data-to-parameter ratio = 13.8.

The title compound, $\text{C}_{10}\text{H}_{11}\text{NO}_4\text{S}$, is of interest with respect to its biological activity. The molecules are linked into centrosymmetric dimers by intermolecular $\text{O}-\text{H}\cdots\text{O}$ hydrogen bonds and the dimers are further connected into chains by weak $\text{C}-\text{H}\cdots\text{O}$ interactions.

Related literature

For related literature on fibrates structures and biological activity, see: Henry *et al.* (2003); Rath *et al.* (2005); Djinović *et al.* (1989); Thorp (1962); Thorp & Waring (1962); Miller & Spence (1998); Forcheron *et al.* (2002). For related literature, see: Bernstein *et al.* (1995); Desiraju (2002).



Experimental

Crystal data

$\text{C}_{10}\text{H}_{11}\text{NO}_4\text{S}$
 $M_r = 241.26$
 Triclinic, $P\bar{1}$
 $a = 6.9382$ (8) Å
 $b = 9.4500$ (11) Å
 $c = 9.6395$ (11) Å
 $\alpha = 66.371$ (2)°
 $\beta = 87.995$ (2)°
 $\gamma = 88.298$ (2)°
 $V = 578.60$ (12) Å³
 $Z = 2$
 Mo $K\alpha$ radiation
 $\mu = 0.28$ mm⁻¹
 $T = 273$ (2) K
 $0.32 \times 0.23 \times 0.18$ mm

Data collection

Bruker SMART CCD area detector
 diffractometer
 Absorption correction: multi-scan
 (SADABS; Sheldrick, 2003)
 $T_{\min} = 0.92$, $T_{\max} = 0.95$
 5660 measured reflections
 2036 independent reflections
 1718 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.020$

Refinement

$R[F^2 > 2\sigma(F^2)] = 0.048$
 $wR(F^2) = 0.123$
 $S = 1.08$
 2036 reflections
 148 parameters
 H-atom parameters constrained
 $\Delta\rho_{\text{max}} = 0.28$ e Å⁻³
 $\Delta\rho_{\text{min}} = -0.17$ e Å⁻³

Table 1

Hydrogen-bond geometry (Å, °).

$D-\text{H}\cdots A$	$D-\text{H}$	$\text{H}\cdots A$	$D\cdots A$	$D-\text{H}\cdots A$
$\text{O4}-\text{H4}\cdots\text{O3}^{\text{i}}$	0.82	1.84	2.656 (3)	175
$\text{C2}-\text{H2}\cdots\text{O2}^{\text{ii}}$	0.93	2.46	3.211 (3)	138

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

Data collection: SMART (Bruker, 2000); cell refinement: SAINT-Plus NT (Bruker, 2000); data reduction: SAINT-Plus NT; program(s) used to solve structure: SHELXS97 (Sheldrick, 1997); program(s) used to refine structure: SHELXL97 (Sheldrick, 1997); molecular graphics: SHELXTL-NT (Bruker, 2000); software used to prepare material for publication: PLATON (Spek, 2003) and publCIF (Westrip, 2007).

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: LN2010).

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supplementary materials

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Comment

Fibrates, such as bezafibrate, clofibrac acid and fenofibrate (Henry *et al.*, 2003; Rath *et al.*, 2005; Djinović *et al.*, 1989), which are ligands for the nuclear receptor PPAR (peroxisome proliferator-activated receptor), are used as therapeutic agents in the treatment of hyperlipidemia, heart disease and diabetic complications in humans. The fibrates are a widely used class of lipid-modifying agents that decrease plasma triglycerides (Thorp, 1962; Miller & Spence, 1998; Forcheron *et al.*, 2002). The fibric acid pharmacophore has been of interest to medicinal chemists ever since the initial discovery that ethyl chlorophenoxyisobutyrate possessed hypolipidemic properties (Thorp & Waring, 1962).

In order to assist our knowledge about the electronic and steric requirements for such compounds to show antihyperlipidemic activity, we have determined the crystal structure of the title compound, (I), which is an analogue of clofibrac acid with a thioisobutyrate side chain. A view of the molecular structure of (I) and hydrogen bonded dimers is given in Fig. 1. The crystal structure is permeated by strong O—H···O hydrogen-bonding interactions, as well as weak C—H···O interactions (Table 1) (Desiraju, 2002). The O—H···O hydrogen bonding interactions form centrosymmetric dimers and generate rings that can be described as having a graph set motif of $R_2^2(8)$ (Bernstein *et al.*, 1995).

Experimental

A mixture of 4-nitrothiophenol (1.0 g, 6.40 mmol), potassium carbonate (1.94 g, 14.1 mmol) in acetonitrile, was added dropwise to 1.04 ml of ethyl 2-bromo-2-methylpropionate (1.37 g, 7.04 mmol). The mixture was stirred and heated under reflux for 6 h. After that, the mixture was poured onto cold water. The resulting oil was treated with a mixture of tetrahydrofuran/methanol/H₂O (3:2:1, v/v/v, 6 ml/mmol), and LiOH was added (5 equiv). The mixture was stirred at room temperature for 3 h. Then, HCl solution (10% v/v) was added, and most of the organic solvents removed *in vacuo*. The partly solid residue was extracted with CH₂Cl₂ (3 x 10 ml), dried with Na₂SO₄, filtered, and concentrated *in vacuo* to give a yellow solid (m.p. 394.9 K). Single crystals of (I) were obtained from acetonitrile.

Refinement

All the H atoms were constrained using the riding-model approximation [$C-H_{\text{aryl}} = 0.95 \text{ \AA}$, $U_{\text{iso}}(H_{\text{aryl}}) = 1.2 U_{\text{eq}}(C_{\text{aryl}})$; $C-H_{\text{methyl}} = 0.98 \text{ \AA}$, $U_{\text{iso}}(H_{\text{methyl}}) = 1.5 U_{\text{eq}}(C_{\text{methyl}})$]; $O-H = 0.82 \text{ \AA}$, $U_{\text{iso}}(H_{\text{hydroxyl}}) = 1.5 U_{\text{eq}}(O)$].

Figures

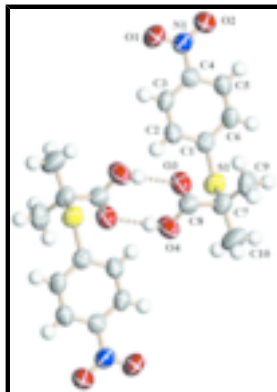


Fig. 1. The molecular structure of (I) showing 50% probability displacement ellipsoids and the atomic numbering. H atoms are shown as small spheres of arbitrary radius. The intermolecular hydrogen bonds O4—H4···O3 forming the $R_2^2(8)$ motif are shown as dotted lines.

2-Methyl-2-(4-nitrophenylsulfanyl)propanoic acid

Crystal data

$C_{10}H_{11}NO_4S$	$Z = 2$
$M_r = 241.26$	$F_{000} = 252$
Triclinic, $P\bar{1}$	$D_x = 1.385 \text{ Mg m}^{-3}$
Hall symbol: -P 1	Melting point: 394.9 K
$a = 6.9382 (8) \text{ \AA}$	Mo $K\alpha$ radiation
$b = 9.4500 (11) \text{ \AA}$	$\lambda = 0.71073 \text{ \AA}$
$c = 9.6395 (11) \text{ \AA}$	Cell parameters from 2036 reflections
$\alpha = 66.371 (2)^\circ$	$\theta = 2.3\text{--}25^\circ$
$\beta = 87.995 (2)^\circ$	$\mu = 0.28 \text{ mm}^{-1}$
$\gamma = 88.298 (2)^\circ$	$T = 273 (2) \text{ K}$
$V = 578.60 (12) \text{ \AA}^3$	Plate, colourless
	$0.32 \times 0.23 \times 0.18 \text{ mm}$

Data collection

Bruker CCD area detector diffractometer	2036 independent reflections
Radiation source: fine-focus sealed tube	1718 reflections with $I > 2\sigma(I)$
Monochromator: graphite	$R_{\text{int}} = 0.020$
$T = 273(2) \text{ K}$	$\theta_{\text{max}} = 25.0^\circ$
φ and ω scans	$\theta_{\text{min}} = 2.3^\circ$
Absorption correction: multi-scan (SADABS; Sheldrick, 2003)	$h = -8 \rightarrow 8$
$T_{\text{min}} = 0.92, T_{\text{max}} = 0.95$	$k = -11 \rightarrow 11$
5660 measured reflections	$l = -11 \rightarrow 11$

Refinement

Refinement on F^2	Secondary atom site location: difference Fourier map
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Least-squares matrix: full

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

$$wR(F^2) = 0.123$$

$$S = 1.08$$

2036 reflections

148 parameters

Primary atom site location: structure-invariant direct methods

Hydrogen site location: inferred from neighbouring sites

H-atom parameters constrained

$$w = 1/[\sigma^2(F_o^2) + (0.06P)^2 + 0.156P]$$

$$\text{where } P = (F_o^2 + 2F_c^2)/3$$

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

$$\Delta\rho_{\max} = 0.28 \text{ e } \text{\AA}^{-3}$$

$$\Delta\rho_{\min} = -0.17 \text{ e } \text{\AA}^{-3}$$

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 $F^2 > 2\sigma(F^2)$ 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>	$U_{\text{iso}}^*/U_{\text{eq}}$
C1	0.1054 (3)	0.1894 (3)	0.6403 (2)	0.0531 (5)
C2	0.1738 (3)	0.0380 (3)	0.6935 (3)	0.0580 (6)
H2	0.3037	0.0168	0.7153	0.070*
C3	0.0525 (3)	-0.0797 (3)	0.7141 (3)	0.0576 (6)
H3	0.0982	-0.1813	0.7509	0.069*
C4	-0.1375 (3)	-0.0462 (3)	0.6797 (2)	0.0524 (5)
C5	-0.2096 (4)	0.1026 (3)	0.6234 (3)	0.0608 (6)
H5	-0.3388	0.1231	0.5988	0.073*
C6	-0.0871 (3)	0.2196 (3)	0.6045 (3)	0.0599 (6)
H6	-0.1336	0.3210	0.5669	0.072*
C7	0.2702 (4)	0.3441 (3)	0.8037 (3)	0.0624 (6)
C8	0.3733 (3)	0.1963 (3)	0.9005 (3)	0.0568 (6)
C9	0.0695 (4)	0.3533 (4)	0.8653 (3)	0.0837 (9)
H9A	0.0023	0.2602	0.8821	0.125*
H9B	0.0011	0.4402	0.7936	0.125*
H9C	0.0773	0.3653	0.9592	0.125*
C10	0.3903 (5)	0.4859 (3)	0.7791 (4)	0.0940 (10)
H10A	0.4076	0.4928	0.8745	0.141*
H10B	0.3247	0.5773	0.7119	0.141*
H10C	0.5140	0.4764	0.7354	0.141*
N1	-0.2678 (3)	-0.1730 (3)	0.7030 (2)	0.0674 (6)
O1	-0.2015 (3)	-0.3028 (2)	0.7498 (3)	0.0997 (7)

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O2	-0.4350 (3)	-0.1430 (3)	0.6715 (3)	0.1118 (9)
O3	0.2868 (2)	0.0840 (2)	0.98479 (19)	0.0724 (5)
O4	0.5595 (3)	0.1977 (2)	0.8833 (2)	0.0839 (6)
H4	0.6034	0.1101	0.9283	0.126*
S1	0.26504 (9)	0.34147 (7)	0.61287 (7)	0.0636 (2)

Atomic displacement parameters (\AA^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
C1	0.0654 (14)	0.0463 (12)	0.0439 (11)	0.0029 (10)	-0.0021 (10)	-0.0142 (9)
C2	0.0524 (13)	0.0544 (14)	0.0660 (14)	0.0081 (11)	-0.0043 (11)	-0.0233 (11)
C3	0.0646 (15)	0.0425 (12)	0.0637 (14)	0.0088 (10)	0.0004 (11)	-0.0201 (10)
C4	0.0580 (13)	0.0509 (12)	0.0505 (12)	0.0010 (10)	0.0029 (10)	-0.0230 (10)
C5	0.0566 (13)	0.0572 (14)	0.0687 (15)	0.0103 (11)	-0.0110 (11)	-0.0252 (12)
C6	0.0675 (15)	0.0447 (12)	0.0632 (14)	0.0124 (11)	-0.0135 (11)	-0.0170 (11)
C7	0.0765 (16)	0.0474 (13)	0.0621 (14)	0.0032 (11)	-0.0115 (12)	-0.0203 (11)
C8	0.0599 (15)	0.0550 (14)	0.0535 (13)	-0.0011 (11)	-0.0059 (11)	-0.0192 (11)
C9	0.090 (2)	0.084 (2)	0.0815 (19)	0.0282 (16)	-0.0080 (15)	-0.0396 (16)
C10	0.126 (3)	0.0560 (16)	0.102 (2)	-0.0089 (16)	-0.0276 (19)	-0.0311 (16)
N1	0.0681 (14)	0.0593 (13)	0.0789 (14)	-0.0041 (11)	0.0051 (11)	-0.0323 (11)
O1	0.0975 (15)	0.0514 (12)	0.144 (2)	-0.0033 (10)	-0.0158 (13)	-0.0309 (12)
O2	0.0606 (13)	0.0851 (15)	0.197 (3)	-0.0033 (11)	-0.0088 (14)	-0.0639 (16)
O3	0.0667 (11)	0.0628 (11)	0.0653 (11)	-0.0002 (9)	0.0036 (8)	-0.0026 (9)
O4	0.0596 (11)	0.0673 (12)	0.0976 (15)	-0.0026 (9)	-0.0058 (9)	-0.0041 (10)
S1	0.0762 (5)	0.0503 (4)	0.0543 (4)	-0.0081 (3)	-0.0034 (3)	-0.0100 (3)

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

C1—C6	1.384 (3)	C7—C10	1.531 (4)
C1—C2	1.387 (3)	C7—S1	1.851 (2)
C1—S1	1.769 (2)	C8—O3	1.208 (3)
C2—C3	1.361 (3)	C8—O4	1.296 (3)
C2—H2	0.9300	C9—H9A	0.9600
C3—C4	1.368 (3)	C9—H9B	0.9600
C3—H3	0.9300	C9—H9C	0.9600
C4—C5	1.374 (3)	C10—H10A	0.9600
C4—N1	1.462 (3)	C10—H10B	0.9600
C5—C6	1.364 (3)	C10—H10C	0.9600
C5—H5	0.9300	N1—O2	1.206 (3)
C6—H6	0.9300	N1—O1	1.207 (3)
C7—C8	1.508 (3)	O4—H4	0.8200
C7—C9	1.508 (4)		
C6—C1—C2	119.0 (2)	C9—C7—S1	111.51 (18)
C6—C1—S1	120.86 (17)	C10—C7—S1	103.62 (19)
C2—C1—S1	120.08 (18)	O3—C8—O4	122.9 (2)
C3—C2—C1	120.5 (2)	O3—C8—C7	121.8 (2)
C3—C2—H2	119.7	O4—C8—C7	115.3 (2)
C1—C2—H2	119.7	C7—C9—H9A	109.5

C2—C3—C4	119.0 (2)	C7—C9—H9B	109.5
C2—C3—H3	120.5	H9A—C9—H9B	109.5
C4—C3—H3	120.5	C7—C9—H9C	109.5
C3—C4—C5	122.1 (2)	H9A—C9—H9C	109.5
C3—C4—N1	118.9 (2)	H9B—C9—H9C	109.5
C5—C4—N1	119.0 (2)	C7—C10—H10A	109.5
C6—C5—C4	118.4 (2)	C7—C10—H10B	109.5
C6—C5—H5	120.8	H10A—C10—H10B	109.5
C4—C5—H5	120.8	C7—C10—H10C	109.5
C5—C6—C1	120.9 (2)	H10A—C10—H10C	109.5
C5—C6—H6	119.6	H10B—C10—H10C	109.5
C1—C6—H6	119.6	O2—N1—O1	123.1 (2)
C8—C7—C9	111.5 (2)	O2—N1—C4	118.7 (2)
C8—C7—C10	111.5 (2)	O1—N1—C4	118.2 (2)
C9—C7—C10	112.9 (2)	C8—O4—H4	109.5
C8—C7—S1	105.22 (16)	C1—S1—C7	102.66 (11)
C6—C1—C2—C3	-1.8 (3)	C9—C7—C8—O4	-160.9 (2)
S1—C1—C2—C3	-179.55 (18)	C10—C7—C8—O4	-33.6 (3)
C1—C2—C3—C4	0.8 (4)	S1—C7—C8—O4	78.0 (2)
C2—C3—C4—C5	0.8 (4)	C3—C4—N1—O2	-179.4 (2)
C2—C3—C4—N1	-179.5 (2)	C5—C4—N1—O2	0.3 (4)
C3—C4—C5—C6	-1.3 (4)	C3—C4—N1—O1	-1.1 (3)
N1—C4—C5—C6	179.0 (2)	C5—C4—N1—O1	178.6 (2)
C4—C5—C6—C1	0.3 (4)	C6—C1—S1—C7	97.2 (2)
C2—C1—C6—C5	1.2 (4)	C2—C1—S1—C7	-85.1 (2)
S1—C1—C6—C5	178.97 (19)	C8—C7—S1—C1	68.65 (18)
C9—C7—C8—O3	20.9 (3)	C9—C7—S1—C1	-52.4 (2)
C10—C7—C8—O3	148.1 (3)	C10—C7—S1—C1	-174.16 (18)
S1—C7—C8—O3	-100.2 (2)		

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

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
O4—H4 \cdots O3 ⁱ	0.82	1.84	2.656 (3)	175
C2—H2 \cdots O2 ⁱⁱ	0.93	2.46	3.211 (3)	138

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

Fig. 1

