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Methyl 4-(3-chloropropoxy)-3-methoxybenzoate

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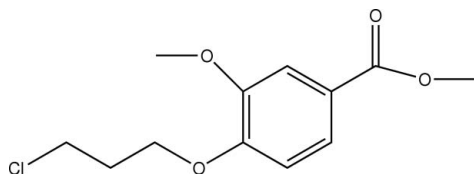
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 Key indicators: single-crystal X-ray study; $T = 294$ K; mean $\sigma(\text{C}-\text{C}) = 0.006$ Å;
 R factor = 0.068; wR factor = 0.176; data-to-parameter ratio = 14.8.

 In the title compound, $\text{C}_{12}\text{H}_{15}\text{ClO}_4$, the molecules are linked by $\text{C}-\text{H}\cdots\text{O}$ interactions.

Related literature

 For general background, see: Knesl *et al.* (2006). For bond-length data, see: Allen *et al.* (1987).


Experimental

Crystal data

 $\text{C}_{12}\text{H}_{15}\text{ClO}_4$
 $M_r = 258.69$

 Monoclinic, $P2_1/c$
 $a = 8.4980$ (17) Å

 $b = 17.349$ (4) Å

 $c = 8.8440$ (18) Å

 $\beta = 106.46$ (3)°

 $V = 1250.5$ (5) Å³
 $Z = 4$

 Mo $K\alpha$ radiation

 $\mu = 0.31$ mm⁻¹
 $T = 294$ (2) K

 $0.30 \times 0.20 \times 0.10$ mm

Data collection

Enraf-Nonius CAD-4

diffractometer

 Absorption correction: ψ scan

 (North *et al.*, 1968)

 $T_{\min} = 0.914$, $T_{\max} = 0.970$

2431 measured reflections

2274 independent reflections

 1575 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.048$

3 standard reflections

frequency: 120 min

intensity decay: 1%

Refinement

 $R[F^2 > 2\sigma(F^2)] = 0.068$
 $wR(F^2) = 0.176$
 $S = 1.01$

2274 reflections

154 parameters

H-atom parameters constrained

 $\Delta\rho_{\text{max}} = 0.35$ e Å⁻³
 $\Delta\rho_{\text{min}} = -0.29$ e Å⁻³

Table 1

Hydrogen-bond geometry (Å, °).

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
$\text{C1}-\text{H1B}\cdots\text{O2}^{\text{i}}$	0.97	2.56	3.429 (6)	149
$\text{C2}-\text{H2A}\cdots\text{O3}^{\text{ii}}$	0.97	2.41	3.358 (6)	164

 Symmetry codes: (i) $-x + 1, -y + 1, -z + 1$; (ii) $x + 1, -y + \frac{3}{2}, z - \frac{1}{2}$.

 Data collection: *CAD-4 Software* (Enraf-Nonius, 1989); cell refinement: *CAD-4 Software*; data reduction: *XCAD4* (Harms & Wocadlo, 1995); program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *ORTEP-3 for Windows* (Farrugia, 1997) and *PLATON* (Spek, 2003); software used to prepare material for publication: *SHELXTL* (Sheldrick, 2008).

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: HK2602).

References

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supporting information

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Methyl 4-(3-chloropropoxy)-3-methoxybenzoate

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S1. Comment

As part of our ongoing studies on quinazoline derivatives (Knesl *et al.*, 2006), we report herein the crystal structure of the title compound.

In the molecule of the title compound (Fig 1), the bond lengths (Allen *et al.*, 1987) and angles are within normal ranges. Ring A (C4-C9) is, of course, planar. The intramolecular C-H \cdots O hydrogen bond (Table 1) results in the formation of a five-membered ring B (O1/C1-C3/H1A), having envelope conformation with C2 atom displaced by -0.668 (3) Å from the plane of the other ring atoms.

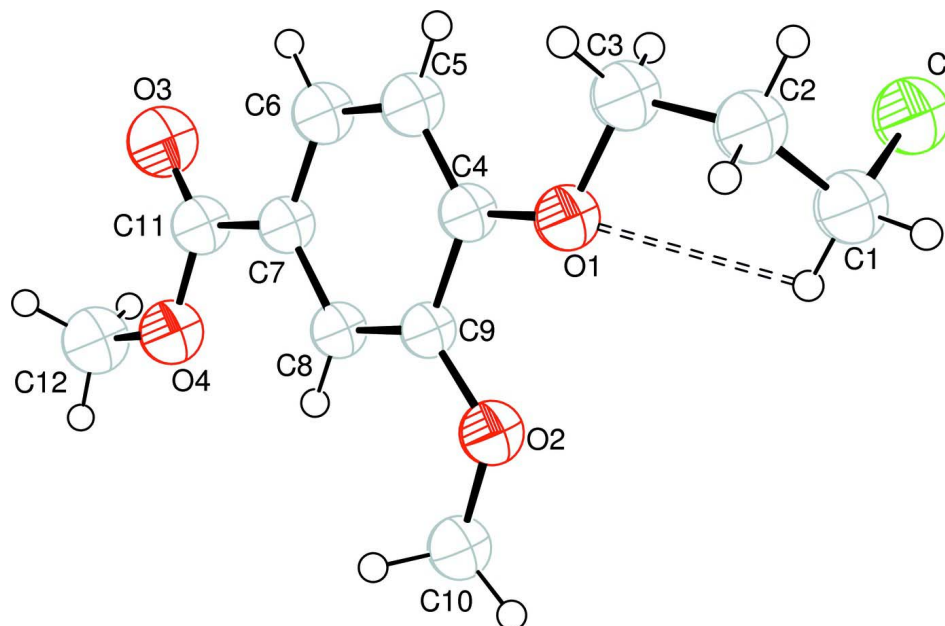
In the crystal structure, intermolecular C-H \cdots O hydrogen bonds (Table 1) link the molecules (Fig. 2), in which they may be effective in the stabilization of the structure.

S2. Experimental

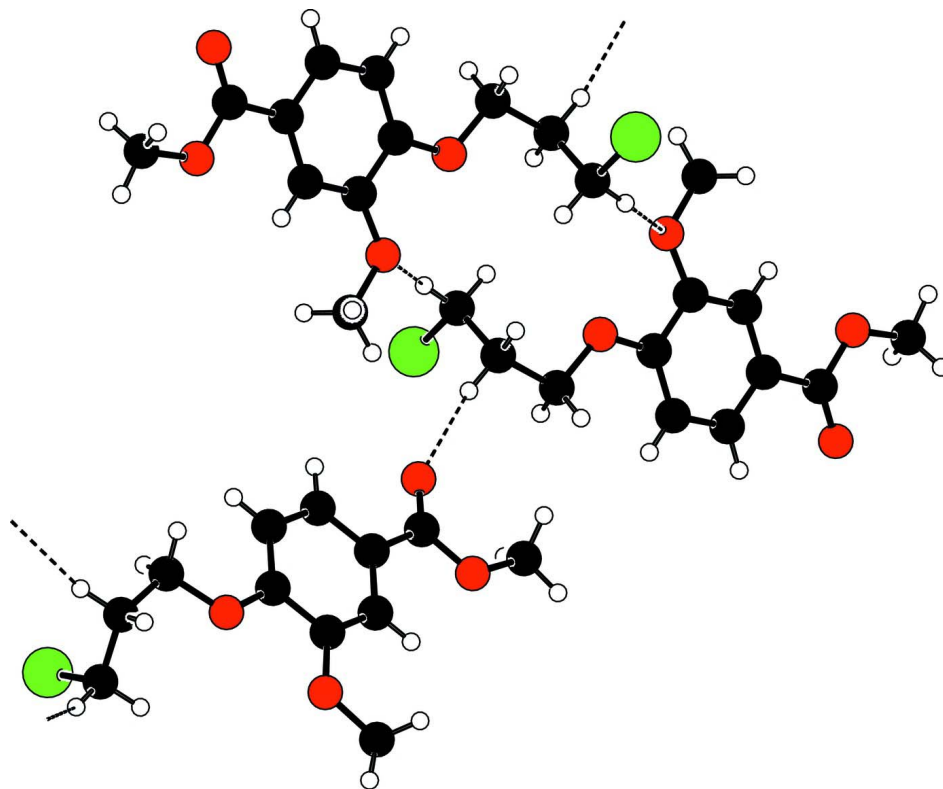
For the preparation of the title compound, methyl 3-methoxy-4-hydroxybenzoate (55 mmol), 1-bromo-3-chloropropane (165 mmol) and potassium carbonate (275 mmol) were mixed with DMF (60 ml), and then the mixture was heated to reflux for 2 h. Reaction progress was monitored by TLC. After cooling and filtration, the title compound was obtained (yield; 93.7%, m.p. 384 K). Crystals suitable for X-ray analysis were obtained by slow evaporation of an ethyl acetate solution.

S3. Refinement

H atoms were positioned geometrically, with C-H = 0.93, 0.97 and 0.96 Å for aromatic, methylene and methyl H, respectively, and constrained to ride on their parent atoms, with $U_{\text{iso}}(\text{H}) = xU_{\text{eq}}(\text{C})$, where $x = 1.5$ for methyl H and $x = 1.2$ for all other H atoms.

**Figure 1**

The molecular structure of the title molecule, with the atom-numbering scheme. Hydrogen bond is shown as dashed line.

**Figure 2**

A partial packing diagram of the title compound. Hydrogen bonds are shown as dashed lines.

Methyl 4-(3-chloropropoxy)-3-methoxybenzoate*Crystal data*C₁₂H₁₅ClO₄ $M_r = 258.69$ Monoclinic, $P2_1/c$

Hall symbol: -P 2ybc

 $a = 8.4980$ (17) Å $b = 17.349$ (4) Å $c = 8.8440$ (18) Å $\beta = 106.46$ (3)° $V = 1250.5$ (5) Å³ $Z = 4$ $F(000) = 544$ $D_x = 1.374$ Mg m⁻³

Melting point: 384 K

Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å

Cell parameters from 25 reflections

 $\theta = 10$ – 13° $\mu = 0.31$ mm⁻¹ $T = 294$ K

Block, colorless

 $0.30 \times 0.20 \times 0.10$ mm*Data collection*

Enraf–Nonius CAD-4

diffractometer

Radiation source: fine-focus sealed tube

Graphite monochromator

 $\omega/2\theta$ scansAbsorption correction: ψ scan(North *et al.*, 1968) $T_{\min} = 0.914$, $T_{\max} = 0.970$

2431 measured reflections

2274 independent reflections

1575 reflections with $I > 2\sigma(I)$ $R_{\text{int}} = 0.048$ $\theta_{\max} = 25.3^\circ$, $\theta_{\min} = 2.4^\circ$ $h = 0 \rightarrow 10$ $k = 0 \rightarrow 20$ $l = -10 \rightarrow 10$

3 standard reflections every 120 min

intensity decay: 1%

*Refinement*Refinement on F^2

Least-squares matrix: full

 $R[F^2 > 2\sigma(F^2)] = 0.068$ $wR(F^2) = 0.176$ $S = 1.01$

2274 reflections

154 parameters

0 restraints

Primary atom site location: structure-invariant

direct methods

Secondary atom site location: difference Fourier map

Hydrogen site location: inferred from neighbouring sites

H-atom parameters constrained

 $w = 1/[\sigma^2(F_o^2) + (0.050P)^2 + 3.3P]$ where $P = (F_o^2 + 2F_c^2)/3$ $(\Delta/\sigma)_{\max} < 0.001$ $\Delta\rho_{\max} = 0.35$ e Å⁻³ $\Delta\rho_{\min} = -0.29$ e Å⁻³*Special details*

Geometry. All esds (except the esd in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell esds are taken into account individually in the estimation of esds in distances, angles and torsion angles; correlations between esds in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell esds is used for estimating esds 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 (Å²)

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
Cl	0.27901 (16)	0.58276 (8)	0.10729 (14)	0.0679 (4)
O1	0.3056 (3)	0.60776 (15)	0.5453 (3)	0.0480 (7)
O2	0.1798 (3)	0.50211 (15)	0.6779 (3)	0.0491 (7)

O3	-0.2908 (4)	0.74808 (19)	0.7610 (4)	0.0711 (10)
O4	-0.2715 (3)	0.62804 (17)	0.8531 (4)	0.0578 (8)
C1	0.4233 (6)	0.5519 (3)	0.2872 (5)	0.0580 (12)
H1A	0.3693	0.5170	0.3424	0.070*
H1B	0.5119	0.5239	0.2627	0.070*
C2	0.4929 (5)	0.6187 (3)	0.3921 (5)	0.0554 (11)
H2A	0.5409	0.6546	0.3337	0.066*
H2B	0.5803	0.6000	0.4807	0.066*
C3	0.3697 (5)	0.6615 (2)	0.4548 (5)	0.0532 (11)
H3A	0.4223	0.7043	0.5207	0.064*
H3B	0.2819	0.6817	0.3684	0.064*
C4	0.1809 (5)	0.6315 (2)	0.6028 (4)	0.0401 (9)
C5	0.1190 (5)	0.7053 (2)	0.5911 (5)	0.0488 (10)
H5A	0.1656	0.7438	0.5444	0.059*
C6	-0.0123 (5)	0.7224 (2)	0.6489 (5)	0.0489 (10)
H6A	-0.0547	0.7722	0.6390	0.059*
C7	-0.0814 (5)	0.6657 (2)	0.7216 (4)	0.0424 (9)
C8	-0.0174 (5)	0.5915 (2)	0.7335 (4)	0.0404 (9)
H8A	-0.0638	0.5533	0.7811	0.048*
C9	0.1129 (4)	0.5731 (2)	0.6768 (4)	0.0378 (8)
C10	0.1078 (5)	0.4411 (2)	0.7422 (5)	0.0495 (10)
H10A	0.1631	0.3937	0.7342	0.074*
H10B	-0.0061	0.4366	0.6849	0.074*
H10C	0.1176	0.4517	0.8511	0.074*
C11	-0.2236 (5)	0.6865 (2)	0.7781 (5)	0.0478 (10)
C12	-0.4095 (6)	0.6411 (3)	0.9117 (6)	0.0670 (14)
H12A	-0.4308	0.5957	0.9646	0.101*
H12B	-0.5039	0.6531	0.8255	0.101*
H12C	-0.3865	0.6835	0.9846	0.101*

Atomic displacement parameters (\AA^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
C1	0.0710 (8)	0.0750 (8)	0.0547 (7)	0.0031 (6)	0.0130 (6)	0.0007 (6)
O1	0.0477 (16)	0.0459 (16)	0.0542 (17)	-0.0020 (12)	0.0206 (13)	0.0082 (13)
O2	0.0481 (16)	0.0364 (15)	0.0657 (19)	0.0022 (12)	0.0211 (14)	0.0077 (13)
O3	0.079 (2)	0.057 (2)	0.086 (2)	0.0270 (17)	0.037 (2)	0.0083 (18)
O4	0.0487 (17)	0.0563 (19)	0.074 (2)	0.0088 (14)	0.0267 (16)	-0.0028 (16)
C1	0.060 (3)	0.055 (3)	0.062 (3)	0.006 (2)	0.022 (2)	0.006 (2)
C2	0.048 (2)	0.063 (3)	0.057 (3)	-0.003 (2)	0.018 (2)	0.008 (2)
C3	0.059 (3)	0.044 (2)	0.054 (3)	-0.009 (2)	0.012 (2)	0.004 (2)
C4	0.041 (2)	0.043 (2)	0.036 (2)	-0.0010 (17)	0.0103 (16)	-0.0003 (16)
C5	0.063 (3)	0.034 (2)	0.050 (2)	-0.0083 (19)	0.016 (2)	-0.0017 (18)
C6	0.056 (3)	0.035 (2)	0.051 (2)	0.0081 (18)	0.006 (2)	-0.0028 (18)
C7	0.043 (2)	0.042 (2)	0.041 (2)	0.0039 (17)	0.0092 (17)	-0.0063 (17)
C8	0.039 (2)	0.040 (2)	0.040 (2)	-0.0037 (16)	0.0073 (16)	0.0028 (17)
C9	0.041 (2)	0.0330 (19)	0.040 (2)	0.0027 (16)	0.0114 (16)	-0.0013 (16)
C10	0.057 (3)	0.034 (2)	0.062 (3)	0.0011 (18)	0.023 (2)	0.0053 (19)

C11	0.054 (2)	0.042 (2)	0.043 (2)	0.0044 (19)	0.0058 (19)	-0.0037 (18)
C12	0.052 (3)	0.083 (4)	0.073 (3)	0.007 (2)	0.030 (2)	-0.014 (3)

Geometric parameters (Å, °)

Cl—C1	1.794 (5)	C4—C5	1.378 (5)
O1—C3	1.433 (5)	C4—C9	1.415 (5)
O1—C4	1.362 (4)	C5—C6	1.385 (6)
O2—C9	1.355 (4)	C5—H5A	0.9300
O2—C10	1.420 (4)	C6—C7	1.394 (6)
O3—C11	1.201 (5)	C6—H6A	0.9300
O4—C11	1.336 (5)	C7—C8	1.390 (5)
O4—C12	1.429 (5)	C7—C11	1.478 (6)
C1—C2	1.498 (6)	C8—C9	1.377 (5)
C1—H1A	0.9700	C8—H8A	0.9300
C1—H1B	0.9700	C10—H10A	0.9600
C2—C3	1.512 (6)	C10—H10B	0.9600
C2—H2A	0.9700	C10—H10C	0.9600
C2—H2B	0.9700	C12—H12A	0.9600
C3—H3A	0.9700	C12—H12B	0.9600
C3—H3B	0.9700	C12—H12C	0.9600
C4—O1—C3	118.1 (3)	C5—C6—C7	120.5 (4)
C9—O2—C10	116.9 (3)	C5—C6—H6A	119.8
C11—O4—C12	117.1 (3)	C7—C6—H6A	119.8
Cl—C1—H1A	109.3	C8—C7—C6	118.9 (4)
Cl—C1—H1B	109.3	C8—C7—C11	122.7 (4)
C2—C1—Cl	111.6 (3)	C6—C7—C11	118.4 (4)
C2—C1—H1A	109.3	C9—C8—C7	121.6 (4)
C2—C1—H1B	109.3	C9—C8—H8A	119.2
H1A—C1—H1B	108.0	C7—C8—H8A	119.2
C1—C2—C3	114.5 (4)	O2—C9—C8	125.9 (3)
C1—C2—H2A	108.6	O2—C9—C4	115.4 (3)
C1—C2—H2B	108.6	C8—C9—C4	118.6 (3)
C3—C2—H2A	108.6	O2—C10—H10A	109.5
C3—C2—H2B	108.6	O2—C10—H10B	109.5
H2A—C2—H2B	107.6	H10A—C10—H10B	109.5
O1—C3—C2	107.3 (3)	O2—C10—H10C	109.5
O1—C3—H3A	110.3	H10A—C10—H10C	109.5
O1—C3—H3B	110.3	H10B—C10—H10C	109.5
C2—C3—H3A	110.3	O3—C11—O4	122.5 (4)
C2—C3—H3B	110.3	O3—C11—C7	125.4 (4)
H3A—C3—H3B	108.5	O4—C11—C7	112.1 (3)
O1—C4—C5	125.0 (3)	O4—C12—H12A	109.5
O1—C4—C9	114.8 (3)	O4—C12—H12B	109.5
C5—C4—C9	120.2 (4)	H12A—C12—H12B	109.5
C4—C5—C6	120.2 (4)	O4—C12—H12C	109.5
C4—C5—H5A	119.9	H12A—C12—H12C	109.5

C6—C5—H5A	119.9	H12B—C12—H12C	109.5
C1—C1—C2—C3	65.9 (4)	C10—O2—C9—C4	-176.1 (3)
C4—O1—C3—C2	-174.3 (3)	C7—C8—C9—O2	-177.5 (4)
C1—C2—C3—O1	60.5 (5)	C7—C8—C9—C4	-0.9 (6)
C3—O1—C4—C5	-5.2 (6)	O1—C4—C9—O2	-0.9 (5)
C3—O1—C4—C9	173.8 (3)	C5—C4—C9—O2	178.2 (4)
O1—C4—C5—C6	177.6 (4)	O1—C4—C9—C8	-177.9 (3)
C9—C4—C5—C6	-1.3 (6)	C5—C4—C9—C8	1.2 (6)
C4—C5—C6—C7	1.1 (6)	C12—O4—C11—O3	0.8 (6)
C5—C6—C7—C8	-0.7 (6)	C12—O4—C11—C7	-179.4 (3)
C5—C6—C7—C11	-178.7 (4)	C8—C7—C11—O3	-174.5 (4)
C6—C7—C8—C9	0.6 (6)	C6—C7—C11—O3	3.4 (6)
C11—C7—C8—C9	178.5 (4)	C8—C7—C11—O4	5.6 (5)
C10—O2—C9—C8	0.6 (6)	C6—C7—C11—O4	-176.5 (4)

Hydrogen-bond geometry (Å, °)

<i>D</i> —H... <i>A</i>	<i>D</i> —H	H... <i>A</i>	<i>D</i> ... <i>A</i>	<i>D</i> —H... <i>A</i>
C1—H1A...O1	0.97	2.56	2.906 (5)	101
C1—H1B...O2 ⁱ	0.97	2.56	3.429 (6)	149
C2—H2A...O3 ⁱⁱ	0.97	2.41	3.358 (6)	164

Symmetry codes: (i) $-x+1, -y+1, -z+1$; (ii) $x+1, -y+3/2, z-1/2$.