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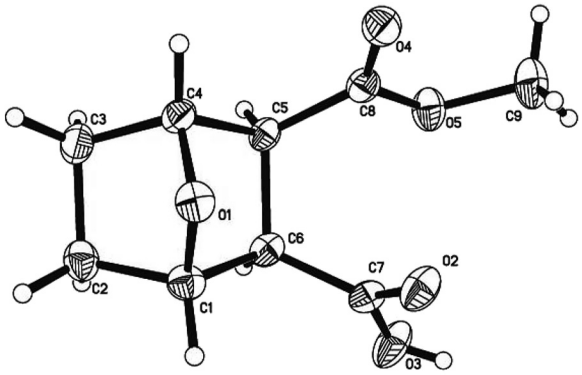
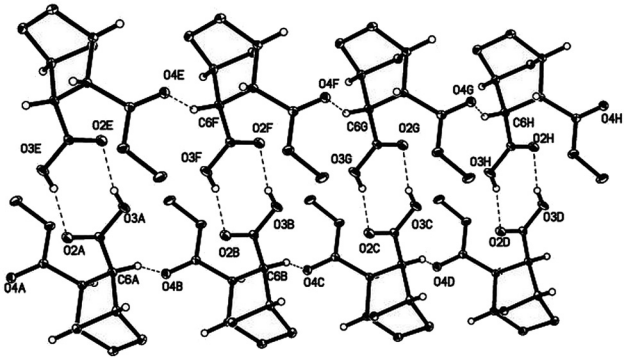
# Crystal structure of 3-(methoxycarbonyl)-7-oxabicyclo[2.2.1]heptane-2-carboxylic acid, $C_9H_{12}O_5$

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**Abstract**

$C_9H_{12}O_5$, triclinic, $P\bar{1}$ (no. 2), $a$ = 5.6537(6) Å, $b$ = 7.7954(8) Å, $c$ = 10.6841(9) Å, $\alpha$ = 102.238(8)°, $\beta$ = 95.381(8)°, $\gamma$ = 90.940(9)°, $V$ = 457.83(8) Å$^3$, $Z$ = 2, $R_{gt}(F)$ = 0.0673, $wR_{ref}(F^2)$ = 0.2279, T = 293(2) K.

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**Table 1:** Data collection and handling.

| | |
|---|---|
| Crystal: | Colourless block |
| Size: | 0.15 × 0.12 × 0.09 mm |
| Wavelength: | Cu $K\alpha$ radiation (1.54184 Å) |
| $\mu$: | 1.02 mm$^{-1}$ |
| Diffractometer, scan mode: | Xcalibur, $\omega$ |
| $\theta_{max}$, completeness: | 67.1°, 99% |
| $N(hkl)_{measured}$, $N(hkl)_{unique}$ | 3149 |
| Criterion for $I_{obs}$, $N(hkl)_{gt}$: | 2411 |
| $N(param)_{refined}$: | 132 |
| Programs: | CrysAlis$^{PRO}$ [1], Olex2 [2, 3], SHELX [4] |

The asymmetric unit of the molecular structure is shown in the upper part of the Figure. Table 1 contains crystallographic data and Table 2 contains the list of the atoms including atomic coordinates and displacement parameters.

## Source of material

The Dies-Alder reaction of furan (3.74 g, 55 mmol) with maleic anhydride (4.90 g, 50 mmol) was conducted in toluene (50 mL) at room temperature for 2 h. The Dies-Alder product was purified by recrystallization in acetone with 95% yield. Then the intermediate product (1.66 g, 10 mmol) was stirred in 10% methanol solution (10 mL) at 40 °C for 30 min to obtain the target product in 90% yield. The crystals of target product were obtained by slow evaporation from 5% methanol aqueous solution (10 mL, containing title compound 50 mg) at 25 °C within three days.

## Experimental details

All H atoms were placed in calculated positions with C—H = 0.93–0.98 Å and refined as riding, with $U_{iso}$(H) = 1.2 $U_{eq}$(C) or 1.5 $U_{eq}$(C) for all C(H), C(H, H), O(H) and C(H, H, H) groups.

The title compound was refined as a 2-component twin. Twinned data refinement scales: 0.652(3) and 0.348(3).

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

| Atom | *x* | *y* | *z* | $U_{iso}$*/$U_{eq}$ |
|---|---|---|---|---|
| O1 | 0.0546 (4) | 1.1100 (3) | 0.6853 (3) | 0.0410 (7) |
| O2 | −0.0577 (5) | 0.7088 (4) | 0.5760 (3) | 0.0517 (8) |
| O3 | 0.2902 (6) | 0.5800 (4) | 0.5636 (4) | 0.0649 (10) |
| H3 | 0.206 (11) | 0.505 (8) | 0.530 (6) | 0.078* |
| O4 | −0.1939 (5) | 0.8982 (4) | 0.8723 (3) | 0.0475 (7) |
| O5 | 0.0380 (5) | 0.6669 (3) | 0.8405 (3) | 0.0508 (8) |
| C1 | 0.2580 (6) | 1.0339 (5) | 0.6267 (4) | 0.0406 (9) |
| H1 | 0.2371 | 1.0082 | 0.5325 | 0.049* |
| C2 | 0.4569 (7) | 1.1704 (5) | 0.6848 (4) | 0.0466 (10) |
| H2A | 0.4583 | 1.2654 | 0.6390 | 0.056* |
| H2B | 0.6113 | 1.1181 | 0.6854 | 0.056* |
| C3 | 0.3857 (7) | 1.2340 (5) | 0.8223 (4) | 0.0484 (10) |
| H3A | 0.5052 | 1.2080 | 0.8863 | 0.058* |
| H3B | 0.3587 | 1.3590 | 0.8409 | 0.058* |
| C4 | 0.1554 (7) | 1.1262 (5) | 0.8162 (3) | 0.0385 (8) |
| H4 | 0.0493 | 1.1798 | 0.8798 | 0.046* |
| C5 | 0.2086 (6) | 0.9352 (4) | 0.8203 (3) | 0.0341 (8) |
| H5 | 0.3396 | 0.9324 | 0.8867 | 0.041* |
| C6 | 0.2944 (6) | 0.8689 (5) | 0.6838 (3) | 0.0376 (8) |
| H6 | 0.4642 | 0.8454 | 0.6928 | 0.045* |
| C7 | 0.1598 (7) | 0.7092 (5) | 0.6033 (3) | 0.0403 (9) |
| C8 | −0.0075 (6) | 0.8362 (5) | 0.8467 (3) | 0.0372 (8) |
| C9 | −0.1669 (9) | 0.5516 (6) | 0.8394 (6) | 0.0660 (13) |
| H9A | −0.2946 | 0.5783 | 0.7817 | 0.099* |
| H9B | −0.2162 | 0.5685 | 0.9246 | 0.099* |
| H9C | −0.1252 | 0.4316 | 0.8112 | 0.099* |

## Comment

Cantharidin ($C_{10}H_{12}O_4$) is an important natural defense product. It has exhibited good antitumor activity, which has been used to treat liver and lung tumors [5–7]. However, its applications are blocked by its severe nephrotoxic and inflammatory side effects. In recent years, in order to find efficient and low toxic antitumor drugs, more and more pharmaceutical chemist have modified the structure of cantharidin [8–10] and evaluated the corresponding biological activity. The title compound is one example of this class of compounds.

Molecular structure of the title compound is shown in the upper part of the Figure. Crystal packing of the title compound is shown in the lower part of the Figure. The crystal structure of the title compound consists of two fused tetrahydrofuran rings having the cis-arrangement at the ring junctions, giving a V-shaped molecule. From the X-ray studies it was deduced that intermolecular hydrogen bonds (O3—H3···O2 and C6—H6···O4) link molecules into chains (see lower part of the Figure).

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