

Ethyl (3-nitro-2-oxo-1,2-dihydropyridin-1-yl)acetate

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Key indicators

Single-crystal X-ray study

$T = 295\text{ K}$

Mean $\sigma(\text{C}-\text{C}) = 0.004\text{ \AA}$

R factor = 0.045

wR factor = 0.143

Data-to-parameter ratio = 12.8

For details of how these key indicators were automatically derived from the article, see <http://journals.iucr.org/e>.

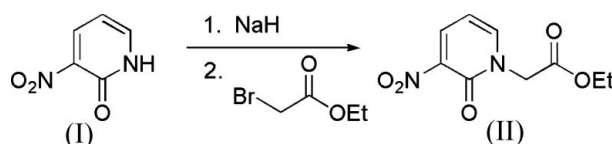
The title compound, $\text{C}_9\text{H}_{10}\text{N}_2\text{O}_5$, crystallizes with two crystallographically independent molecules in the asymmetric unit. In the crystal structure, the nitropyridone rings are connected by weak $\text{C}-\text{H}\cdots\text{O}$ interactions, forming sheet-like arrays, which are in turn linked by $\text{C}-\text{H}\cdots\pi$ and $\pi-\pi$ interactions between the nitropyridone rings on one side, and by $\text{C}-\text{H}\cdots\text{O}$ and van der Waals interactions between the ester groups on the other.

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Comment

Pyridones can act as a P3 to P2 conformational restraint in the design of inhibitors of serine protease enzymes (Loughlin *et al.*, 2004). This is often facilitated by the presence of a 3-amino group, which acts as a hydrogen-bonding site. Typically, 3-nitropyrid-2-ones (I) and (II) are used as synthetic precursors to 3-aminopyrid-2-ones (Breslin *et al.*, 2003; Huang *et al.*, 2003; Reiner *et al.*, 2002; Warner *et al.*, 1994). Compound (II) lacks the hydrogen-bonding site at the 3 position and solid-state structures for 3-nitropyridones (without C4 to C6 substituents) are restricted to a report of the complex of (I) with 2-amino-5-nitropyridine (Velikova *et al.*, 1997). Here, we report the first solid-state structure of the title compound, (II). Compound (II) was prepared by *N*-alkylation of (I) with sodium hydride and ethyl bromoacetate, as reported elsewhere (Warner *et al.*, 1994; Breslin *et al.*, 2003).



The crystal structure of (II) contains two crystallographically independent molecules in the asymmetric unit (Figs. 1 and 2). Relevant bond lengths and angles are listed in Table 1 and are in accord with those reported for 3-nitro-2-pyridone (Velikova *et al.*, 1997). The nitro groups are twisted slightly out of the plane of the pyridone ring, with torsion angles $\text{O}32-\text{N}3-\text{C}3-\text{C}2 = -18.5(4)^\circ$ and $\text{O}132-\text{N}13-\text{C}13-\text{C}12 = 22.4(4)^\circ$.

In the crystal structure, the nitropyridone rings are connected by weak $\text{C}-\text{H}\cdots\text{O}$ interactions between the aromatic and aliphatic H atoms and the carbonyl and nitro group O atoms, forming sheet-like arrays in the *bc* plane. These sheets are in turn linked together by $\text{C}-\text{H}\cdots\pi$ and $\pi-\pi$ interactions between the nitropyridone rings on one side, and by $\text{C}-\text{H}\cdots\text{O}$ and van der Waals interactions between the ester groups on the other (Fig. 2).

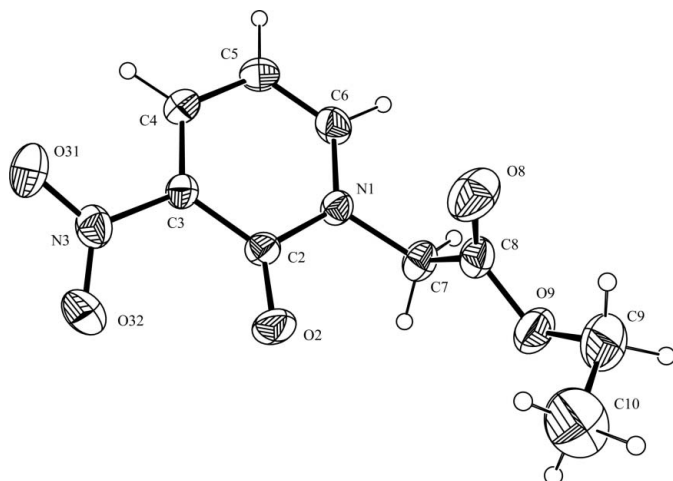


Figure 1

A view of one of the two independent molecules of (II), with the atom-numbering scheme. Displacement ellipsoids are drawn at the 30% probability level.

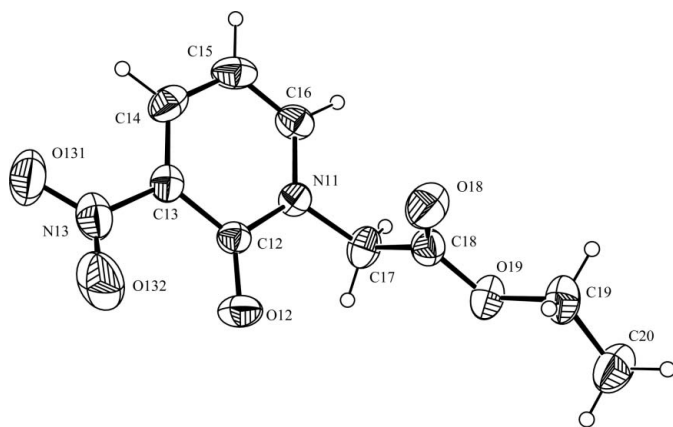


Figure 2

A view of the second of the two independent molecules of (II), with the atom-numbering scheme. Displacement ellipsoids are drawn at the 30% probability level.

Experimental

Sodium hydride (1.38 g, 57.8 mmol) was added in portions over a period of 30 min to compound (I) (6.75 g, 48.2 mmol) in dry tetrahydrofuran (100 ml). The resulting suspension was stirred for 30 min. Ethyl bromoacetate (5.86 ml, 53.0 mmol) was added dropwise over a period of 30 min. The resulting yellow suspension was heated to 328 K under nitrogen for 24 h. The red reaction mixture was filtered and the solid thoroughly washed with ethyl acetate. The filtrate was concentrated under reduced pressure and the resulting red oil purified by silica-gel column chromatography (ethyl acetate–dichloromethane gradient from 0–40% ethyl acetate, with 0.4% triethylamine). Pale-yellow crystals of compound (II) (m.p. 327–329 K; yield 10.7 g, 98%) were isolated by slow evaporation of an ethyl acetate solution of (II). Analysis, found: C 47.82, H 4.44, N 12.34%; calculated for $C_9H_{10}N_2O_5$: C 47.79, H 4.46, N 12.38%. Spectroscopic analysis: 1H NMR (400 MHz, $CDCl_3$, δ , p.p.m.): 1.293

(3H, *t*, $J = 7.2$ Hz, CH_3), 4.251 (2H, *q*, $J = 7.2$ Hz, CH_2), 4.769 (2H, *s*, NCH_2), 6.380 (1H, *dd*, $J = 7.6$ and 6.8 Hz, H5), 7.712 (1H, *dd*, $J = 6.8$ and 2.0 Hz, H6), 8.387 (1H, *dd*, $J = 7.6$ and 2.0 Hz, H4); ^{13}C NMR (100 MHz, $CDCl_3$, δ , p.p.m.): 14.3 (CH_3), 51.4 (NCH_2), 62.6 (CH_2), 103.8 (C5), 138.9 (C3), 139.7 (C4), 145.2 (C6), 154.5 (C2), 166.8 (CO); MS (ES^+): 248.8 (MNa^+ , 60%) 226.8 (MH^+ , 70%) 180.7 ($MH^+ - NO_2$, 100%).

Crystal data

$C_9H_{10}N_2O_5$
 $M_r = 226.19$
 Monoclinic, $P2_1/c$
 $a = 20.175$ (4) Å
 $b = 8.333$ (3) Å
 $c = 12.729$ (4) Å
 $\beta = 100.49$ (2)°
 $V = 2104.2$ (11) Å³

$Z = 8$
 $D_x = 1.428$ Mg m⁻³
 Mo $K\alpha$ radiation
 $\mu = 0.12$ mm⁻¹
 $T = 295$ K
 Prism, yellow
 $0.40 \times 0.30 \times 0.20$ mm

Data collection

Rigaku AFC-7R diffractometer
 $\omega/2\theta$ scans
 Absorption correction: none
 4183 measured reflections
 3689 independent reflections
 1988 reflections with $I > 2\sigma(I)$

$R_{int} = 0.027$
 $\theta_{max} = 25.0^\circ$
 3 standard reflections
 every 150 reflections
 intensity decay: 1.1%

Refinement

Refinement on F^2
 $R[F^2 > 2\sigma(F^2)] = 0.045$
 $wR(F^2) = 0.143$
 $S = 1.03$
 3689 reflections
 289 parameters
 H-atom parameters constrained

$w = 1/[\sigma^2(F_o^2) + (0.058P)^2 + 0.4402P]$
 where $P = (F_o^2 + 2F_c^2)/3$
 $(\Delta/\sigma)_{max} = 0.010$
 $\Delta\rho_{max} = 0.17$ e Å⁻³
 $\Delta\rho_{min} = -0.18$ e Å⁻³

Table 1

Selected geometric parameters (Å, °).

| | | | |
|---------------|-------------|-------------|-----------|
| O2–C2 | 1.220 (3) | O131–N13 | 1.228 (4) |
| O8–C8 | 1.188 (4) | O132–N13 | 1.212 (5) |
| O9–C8 | 1.319 (3) | N1–C2 | 1.408 (3) |
| O9–C9 | 1.448 (4) | N1–C6 | 1.347 (3) |
| O31–N3 | 1.218 (4) | N1–C7 | 1.463 (3) |
| O32–N3 | 1.226 (3) | N3–C3 | 1.446 (4) |
| O12–C12 | 1.221 (3) | N11–C12 | 1.396 (3) |
| O18–C18 | 1.196 (4) | N11–C16 | 1.342 (4) |
| O19–C19 | 1.471 (4) | N11–C17 | 1.464 (4) |
| O19–C18 | 1.328 (4) | N13–C13 | 1.458 (4) |
| C8–O9–C9 | 118.6 (2) | N3–C3–C4 | 117.6 (2) |
| C18–O19–C19 | 116.4 (2) | N1–C6–C5 | 121.7 (2) |
| C2–N1–C6 | 123.5 (2) | N1–C7–C8 | 111.0 (2) |
| C6–N1–C7 | 120.73 (19) | O8–C8–C7 | 124.9 (3) |
| C2–N1–C7 | 115.72 (19) | O9–C8–C7 | 110.4 (2) |
| O31–N3–O32 | 122.3 (3) | O8–C8–O9 | 124.7 (3) |
| O32–N3–C3 | 119.2 (2) | O9–C9–C10 | 111.1 (3) |
| O31–N3–C3 | 118.6 (2) | O12–C12–N11 | 118.9 (2) |
| C12–N11–C17 | 116.8 (2) | O12–C12–C13 | 128.1 (2) |
| C16–N11–C17 | 119.0 (3) | N11–C12–C13 | 112.9 (2) |
| C12–N11–C16 | 124.1 (3) | N13–C13–C12 | 118.5 (2) |
| O132–N13–C13 | 119.7 (3) | N13–C13–C14 | 119.1 (3) |
| O131–N13–O132 | 123.8 (4) | N11–C16–C15 | 121.6 (3) |
| O131–N13–C13 | 116.5 (3) | N11–C17–C18 | 110.8 (3) |
| O2–C2–N1 | 118.0 (2) | O18–C18–O19 | 124.7 (3) |
| O2–C2–C3 | 129.3 (2) | O18–C18–C17 | 124.8 (3) |
| N1–C2–C3 | 112.7 (2) | O19–C18–C17 | 110.5 (3) |
| N3–C3–C2 | 119.1 (2) | O19–C19–C20 | 108.2 (3) |

Table 2Hydrogen-bond geometry (\AA , $^\circ$).

| $D-H\cdots A$ | $D-H$ | $H\cdots A$ | $D\cdots A$ | $D-H\cdots A$ |
|-------------------------|-------|-------------|-------------|---------------|
| $C4-H4\cdots O2^i$ | 0.95 | 2.24 | 3.117 (3) | 154 |
| $C5-H5\cdots O32^i$ | 0.95 | 2.64 | 3.457 (4) | 145 |
| $C16-H16\cdots O12^i$ | 0.95 | 2.17 | 3.049 (4) | 153 |
| $C17-H172\cdots O132^i$ | 0.95 | 2.67 | 3.536 (4) | 152 |
| $C9-H91\cdots O8^{ii}$ | 0.95 | 2.57 | 3.517 (5) | 173 |

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

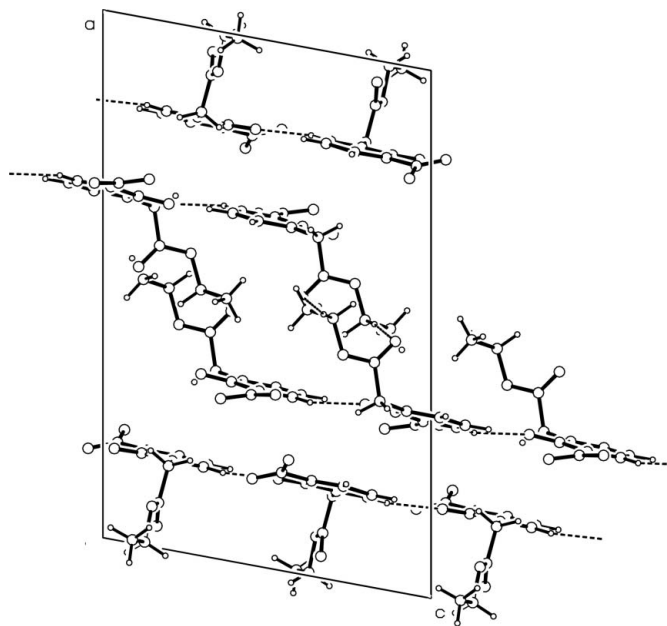
H atoms were constrained as riding atoms, with $C-H = 0.95 \text{ \AA}$, and with $U_{\text{iso}}(H) = 1.2U_{\text{eq}}(C)$.

Data collection: *MSC/AFC7 Diffractometer Control Software* (Molecular Structure Corporation, 1999); cell refinement: *MSC/AFC7 Diffractometer Control Software*; data reduction: *TEXSAN for Windows* (Molecular Structure Corporation, 2001); program(s) used to solve structure: *TEXSAN for Windows*; program(s) used to refine structure: *TEXSAN for Windows* and *SHELXL97* (Sheldrick, 1997); molecular graphics: *ORTEP-3* (Farrugia, 1997); software used to prepare material for publication: *TEXSAN for Windows* and *PLATON* (Spek, 2003).

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**Figure 3**

The crystal packing of (I), viewed down the b axis. Dashed lines indicate hydrogen bonds.