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# Disappearance of inter-and intramolecular stacking due to one-atom addition in 'propylene-linker' in a pyrazolo[3,4-*d*]pyrimidine-based flexible molecule

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**Key indicators**

Single-crystal X-ray study
*T* = 293 K
Mean σ(C–C) = 0.003 Å
*R* factor = 0.036
*wR* factor = 0.101
Data-to-parameter ratio = 14.2

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



In the crystal structure of 1,1′-(butane-1,4-diyl)bis(5-methyl-6-methylthio-4,5-dihydro-1*H*-pyrazolo[3,4-*d*]pyrimidin-4-one), $C_{18}H_{22}N_8O_2S_2$, (6), the pyrazolo[3,4-*d*]pyrimidine rings do not show any inter- or intramolecular stacking due to aromatic $\pi$–$\pi$ interactions. There is a crystallographic inversion centre at the midpoint of the central C—C bond of the chain linking the two ring systems.

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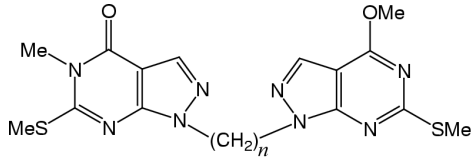
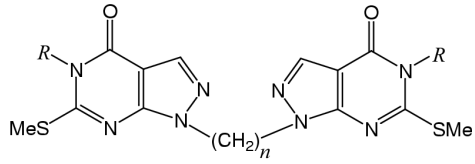
## Comment

Interactions between aromatic units play a significant role in chemistry (Hunter *et al.*, 2001), crystal engineering (Desiraju, 1995) and biology. Recently, we have reported a convenient synthesis of 1-[3-(4-methoxy-6-methylthio-4,5-dihydro-1*H*-pyrozolo[3,4-*d*]pyrimidin-1-yl)propyl]-5-methyl-6-methylthio-4,5-dihydro-1*H*-pyrazolo[3,4-*d*]pyrimidin-4-one, (1), 1-[3-(4-methoxy-6-methylthio-4,5-dihydro-1*H*-pyrazolo[3,4-*d*]pyrimidin-1-yl)butyl]-5-methyl-6-methylthio-4,5-dihydro-1*H*-pyrazolo[3,4-*d*]pyrimidin-4-one, (2), and 1,1′-(1,3-propanediyl)bis(5-methyl-6-methylthio-4,5-dihydro-1*H*-pyrazolo-[3,4-*d*]pyrimidin-4-one), (3) (Avasthi *et al.*, 1998).



(1) $n = 3$
(2) $n = 4$



(3) $R$ = Me; $n = 3$
(4) $R$ = Et; $n = 3$
(5) $R$ = Bzl; $n = 3$
(6) $R$ = Me; $n = 4$

X-ray crystallographic studies (Maulik *et al.*, 1998) on the 'propylene-linker' compound, (1), show the presence of inter- and intramolecular stacking. However, compound (2), which has one extra methylene group in its linker, shows only intermolecular stacking (Maulik *et al.*, 2000). Additionally, the symmetrical compound, (3), which is isomeric with compound (1), also shows inter- and intramolecular stacking (Maulik *et al.*, 1998). Robustness of the *U*-motif, formed as a result of

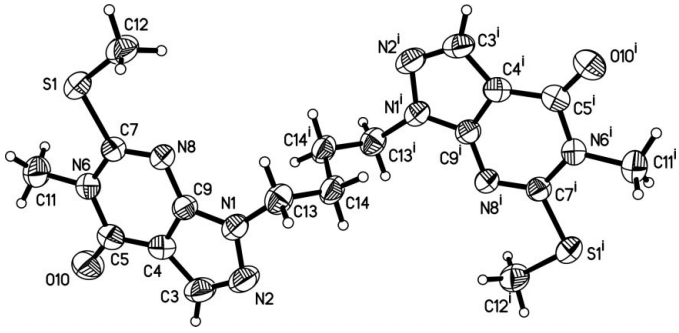



**Figure 1**
Displacement ellipsoid plot (50% probability), showing the molecular structure of (6) with the atomic labelling scheme. [Symmetry code: (i) $-x$, $1-y$, $1-z$.]

intramolecular stacking in compound (3), has been further established by X-ray studies on compounds (4) and (5) (Avasthi *et al.*, 2001, 2002), which are ethyl and benzyl analogs of compound (3). Compounds (1) and (2) form a unique pair, demonstrating convincingly that, for intramolecular stacking, the 'trimethylene linker' (propylene linker) is favoured over the tetramethylene linker. Thus, it was of interest to see if 1,1′-(butane-1,4-diyl)bis(5-methyl-6-methylthio-4,5-dihydro-1*H*-pyrazolo[3,4-*d*]pyrimidin-4-one, (6), also has a similar relationship with compound (3). The synthesis of compound (6) has been described previously (Avasthi *et al.*, 1998).

The conformation of (6) is shown in Fig. 1. The asymmetric unit contains one-half of (6), the other half being related by a centre of symmetry at the midpoint of the central C—C bond of the chain linking the two ring systems. The angle at the centre of the bridge (C13—C14—C14$^{i}$) is 113.3 (2)° (symmetry code as in Fig. 1). The pyrazolo[3,4-*d*]pyrimidine rings are nearly planar [maximum deviation = −0.022 (1) Å for C5]. The crystal structure does not show any intramolecular stacking (torsion angle C13—C14—C14$^{i}$—C13$^{i}$ = 180.0°), confirming an earlier conclusion drawn on the basis of $^{1}$H NMR analysis (Avasthi *et al.*, 1998). In addition, this molecule adopts a fully extended conformation, unlike the isomeric compound, (2), most likely due to the absence of intermolecular stacking. In conclusion, the X-ray structure of compound (6), together with the X-ray structure of compound (3), form a unique pair, differing by only one methylene group, but showing the disappearance of inter- and intramolecular stacking in (6), compared with the propylene-linker compound, (3); this once again highlights the significance of 'propylene linkers' for intramolecular stacking (Leonard, 1979).

## Experimental

Compound (6) was synthesized as described in the literature (Avasthi *et al.*, 1998). Diffraction quality crystals were obtained by slow evaporation of a benzene–methanol solution at room temperature.

*Crystal data*

| | |
|---|---|
| $C_{18}H_{22}N_8O_2S_2$ | $Z = 1$ |
| $M_r = 446.56$ | $D_x = 1.455$ Mg m$^{-3}$ |
| Triclinic, $P\overline{1}$ | Mo $K\alpha$ radiation |
| $a = 7.433$ (1) Å | Cell parameters from 38 reflections |
| $b = 8.117$ (1) Å | $\theta = 4.9$–$18.9°$ |
| $c = 9.646$ (1) Å | $\mu = 0.30$ mm$^{-1}$ |
| $\alpha = 71.43$ (1)° | $T = 293$ (2) K |
| $\beta = 72.43$ (1)° | Block, colourless |
| $\gamma = 71.36$ (1)° | 0.30 × 0.25 × 0.18 mm |
| $V = 509.6$ (1) Å$^3$ | |

*Data collection*

| | |
|---|---|
| Bruker *P*4 diffractometer | $h = -8 \rightarrow 1$ |
| $\theta$–$2\theta$ scans | $k = -9 \rightarrow 9$ |
| Absorption correction: none | $l = -11 \rightarrow 11$ |
| 2453 measured reflections | 3 standard reflections |
| 1966 independent reflections | every 97 reflections |
| 1699 reflections with $I > 2\sigma(I)$ | frequency: 60 min |
| $R_{int} = 0.018$ | intensity decay: none |
| $\theta_{max} = 26.0°$ | |

*Refinement*

| | |
|---|---|
| Refinement on $F^2$ | $w = 1/[\sigma^2(F_o^2) + (0.0492P)^2 + 0.1328P]$ where $P = (F_o^2 + 2F_c^2)/3$ |
| $R[F^2 > 2\sigma(F^2)] = 0.036$ | $(\Delta/\sigma)_{max} < 0.001$ |
| $wR(F^2) = 0.101$ | $\Delta\rho_{max} = 0.23$ e Å$^{-3}$ |
| $S = 1.05$ | $\Delta\rho_{min} = -0.23$ e Å$^{-3}$ |
| 1966 reflections | |
| 138 parameters | |
| H-atom parameters constrained | |

H atoms were treated as riding, with C—H distances of 0.93 (CH) or 0.97 ($CH_3$).

Data collection: *XSCANS* (Siemens, 1996); cell refinement: *XSCANS*; data reduction: *XSCANS*; program(s) used to solve structure: *SHELXTL-NT* (Bruker, 1997); program(s) used to refine structure: *SHELXTL-NT*; molecular graphics: *SHELXTL-NT*; software used to prepare material for publication: *SHELXTL-NT*.

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