X-ray powder diffraction data for norethindrone

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Experimental X-ray powder diffraction data, unit-cell parameters, and space group for norethindrone, $C_{20}H_{26}O_2$, are reported [$a = 20.7484(12)$ Å, $b = 12.1678(9)$ Å, $c = 6.5561(2)$ Å, $\alpha = \beta = \gamma = 90°$, unit-cell volume $V = 1655.17(16)$ Å^3, $Z = 4$ and space group $P2_12_12_1$]. All measured lines were indexed and are consistent with the $P2_12_12_1$ space group. No detectable impurity was observed. © *2013 International Centre for Diffraction Data.* [doi:10.1017/S0885715613000729]

Key words: X-ray powder diffraction, norethindrone

I. INTRODUCTION

The title compound norethindrone (Figure 1), systematic name 17-alpha-ethynyl-17-beta-hydroxyoestr-4-en-3-one, an anabolic steroid drug used as short-acting oral contraceptives, post coital contraceptives, treatment of dysfunctional uterine bleeding and infertility, is a chemical synthetic drug. As time flies, there have turned up a number of different methods of birth control, but oral contraceptives still accounts for about 14% of those modern means (The United Nations Population Division, 2001). In the process of obtaining norethindrone from intermediates like norandrostenedione, the reactant makes the synthesized compounds impurity and residues in norethindrone tablets (Walker *et al.*, 2009). So it is very important to detect and control the percentage of norethindrone as well as make certain of its powder diffraction data.

Our laboratory has reported the crystal structure of normethisterone, gestonoronacetat (Wu *et al.*, 2013) and norandrostenedione (Tang *et al.*, 2013). Both of them are steroid progestational hormone. The four compounds have similar parent structure, but their crystal structures have many differences.

At present, the single-crystal structure of norethindrone can be seen from a search in the Cambridge Structural Database (CSD). But the powder diffraction data has not been published.

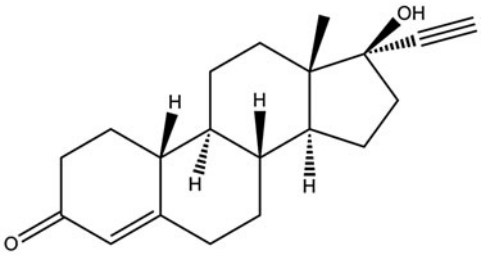

Figure 1. Structural formula of norethindrone.

II. EXPERIMENTAL

A) Sample preparation

The title compound was obtained from Hubei Sanjing Bio-Tech Co., Ltd. It was re-crystallized in 95% ethanol, then, dried and grinded into powder. The structure of norethindrone was characterized by IR, UV, high-performance liquid chromatography (HPLC) and P4 single x-ray diffractometer.

B) Diffraction data collection and reduction

The diffraction pattern for the title compound was collected at room temperature using an X'Pert PRO diffractometer (PANalytical) with an X'celerator detector and Cu$K\alpha_1$ radiation (λ = 1.540 56 Å, generator setting: 40 kV, 40 mA). The diffraction data were collected over the angular range from 5 to 50 °2θ with a step size of 0.013 13 °2θ and a counting time of 10.16 ms/step. Data evaluation was performed using the software package Material Studio 6.0 (Accelrys Co., Ltd. USA).

The first stage of structure determination involves determination of the unit cell {*a, b, c, α, β, γ*} by analysis of the peak positions in the powder X-ray diffraction (XRD) pattern

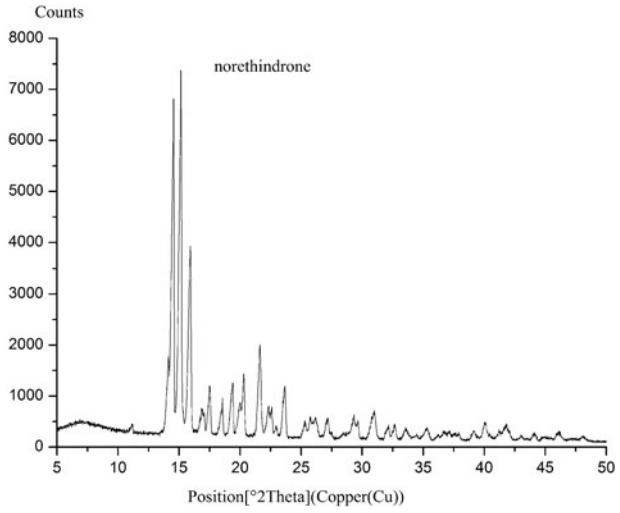

Figure 2. X-ray powder diffraction pattern of the norethindrone, using Cu$K\alpha_1$ radiation (λ = 1.540 56 Å).

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TABLE I. Indexed X-ray powder diffraction data of norethindrone, $C_{20}H_{26}O_2$. Only the peaks with I_{rel} of 1 or greater are presented reported [$a = 20.7484(12)$ Å, $b = 12.1678(9)$ Å, $c = 6.5561(2)$ Å, $\alpha = \beta = \gamma = 90°$, unit-cell volume $V = 1655.17(16)$ Å^3, $Z = 4$ and space group $P2_12_12_1$]. All measured lines were indexed and are consistent with the $P2_12_12_1$ space group. The d-values were calculated using Cu$K\ \alpha_1$ radiation ($\lambda = 1.540\ 56$ Å).

$2\theta_{obs}$(°)	d_{obs}(Å)	I_{obs}	h	k	l	$2\theta_{cal}$(°)	d_{cal}(Å)	$\Delta 2\theta$
11.1647	7.9225	2	2	1	0	11.1617	7.9246	0.0030
14.1059	6.2765	17	1	0	1	14.1045	6.2771	0.0014
14.4998	6.1069	92	0	2	0	14.4945	6.1091	0.0053
15.1038	5.8640	100	1	2	0	15.1076	5.8625	−0.0038
15.9178	5.5659	50	2	0	1	15.9187	5.5656	−0.0009
16.8107	5.2722	4	2	2	0	16.8163	5.2705	−0.0056
17.0208	5.2076	6	4	0	0	17.0151	5.2093	0.0057
17.5066	5.0642	15	2	1	1	17.5026	5.0653	0.0040
18.5045	4.7933	10	4	1	0	18.5080	4.7924	−0.0035
19.3448	4.5869	18	3	2	0	19.3401	4.5880	0.0047
19.9488	4.4494	8	3	1	1	19.9425	4.4508	0.0063
20.2771	4.3781	20	1	2	1	20.2719	4.3792	0.0052
21.5901	4.1147	30	2	2	1	21.5873	4.1152	0.0028
22.2204	3.9994	7	1	3	0	22.2265	3.9983	−0.0061
22.5355	3.9442	9	5	1	0	22.5304	3.9450	0.0051
22.9425	3.8751	4	4	1	1	22.9420	3.8752	0.0005
23.6253	3.7646	19	3	2	1	23.6248	3.7647	0.0005
25.2797	3.5219	4	5	0	1	25.2783	3.5221	0.0014
25.6999	3.4652	5	0	3	1	25.7038	3.4647	−0.0039
26.2251	3.3970	5	4	2	1	26.2268	3.3968	−0.0017
27.1180	3.2872	7	2	3	1	27.1127	3.2878	0.0053
29.2582	3.0514	7	5	2	1	29.2561	3.0516	0.0021
29.5733	3.0196	6	6	2	0	29.5701	3.0199	0.0032
30.9914	2.8846	8	4	3	1	30.9854	2.8851	0.0060
32.1469	2.7835	2	4	0	2	32.1464	2.7835	0.0005
32.6064	2.7453	6	6	2	1	32.6097	2.7450	−0.0033
33.6306	2.6640	3	5	3	1	33.6246	2.6645	0.0060
34.4184	2.6048	2	8	0	0	34.4133	2.6052	0.0051
35.2981	2.5419	3	1	3	2	35.2996	2.5418	−0.0015
36.7162	2.4469	2	4	4	1	36.7145	2.4470	0.0017
39.0534	2.3057	2	3	5	0	39.0515	2.3058	0.0019
39.1847	2.2982	2	4	3	2	39.1858	2.2982	−0.0011
40.0250	2.2519	8	8	2	1	40.0256	2.2519	−0.0006
41.6926	2.1656	6	9	2	0	41.6997	2.1652	−0.0071
43.1106	2.0976	2	4	5	1	43.1129	2.0975	−0.0023
44.0692	2.0542	4	10	1	0	44.0684	2.0542	0.0008
46.2488	1.9623	2	0	5	2	46.2473	1.9624	0.0015
48.0214	1.8939	1	9	0	2	48.0260	1.8937	−0.0046

[this task is referred to as "indexing" the powder pattern, and involves assigning the Miller indices (*h, k, l*) to each observed peak in the experimental powder XRD pattern] (Harris, 2012). Indexing was carried out using peak positions obtained from the powder diffraction profiles by X-Cell method then the indexing result was refined with the type of Pawley (Pan *et al.*, 2012). After Pawley refinement of the unit cell, the final R_{wp} of the structure was converged at 8.30%.

III. RESULTS

The experimental powder diffraction pattern is depicted in Figure 2. Indexing results show that norethindrone is orthorhombic with space group $P2_12_12_1$ and unit-cell parameters: $a = 20.7484(12)$ Å, $b = 12.1678(9)$ Å, $c = 6.5561(2)$ Å, $\alpha = \beta = \gamma = 90°$, unit-cell volume $V = 1655.17(16)$ Å^3, $Z = 4$, space group $P2_12_12_1$ (Table I). After Pawley refinement, the unit-cell parameters of norethindrone were solved. The results were compared with single-crystal data [$a = 20.7713(12)$ Å, $b = 12.1600(9)$ Å, $c = 6.5448(2)$ Å, $\alpha = \beta = \gamma = 90°$, unit-cell volume $V = 1653.06(16)$ Å^3, $Z = 4$, space group $P2_12_12_1$] which were collected on an Oxford Diffraction Xcalibur Nova system with Mo$K\alpha$ radiation ($\lambda = 0.710\ 73$ Å) at room temperature and the 2θ from 6.528 to 52.696°, the deviations of the two methods were between 0.064 to 0.128%. All lines of powder and single-crystal data were indexed and are consistent with the $P2_12_12_1$ space group.

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