X-ray powder diffraction data for norethisterone enanthate, $C_{27}H_{38}O_3$

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X-ray powder diffraction data, unit-cell parameters, and space group for norethisterone enanthate, $C_{27}H_{38}O_3$, are reported [$a = 6.191(4)$ Å, $b = 12.711(3)$ Å, $c = 31.396(2)$ Å, $\alpha = 90°$, $\beta = 90°$, $\gamma = 90°$, unit-cell volume $V = 2471.16$ Å^3, $Z = 4$, $\rho_{cal} = 1.104$ g cm^{-3}, 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 impurities were observed. © *The Author(s), 2021. Published by Cambridge University Press on behalf of International Centre for Diffraction Data.* [doi:10.1017/S0885715620000743]

Key words: norethisterone enanthate, steroid, X-ray powder diffraction

I. INTRODUCTION

Norethisterone enanthate (Figure 1), a fatty acid ester of norethisterone, is a widely used long-acting intramuscular depot contraceptive drug (Ravinder *et al.*, 1997). It can prevent conception by inhibiting ovulation. This drug also can result in high suppression of spermatogenesis, which could be attributed to its constant suppression of gonadotropins on testis (Behre *et al.*, 2016).

In order to better understand the difference between norethisterone enanthate and norethindrone acetate in their binding ability to human serum albumin, we analyzed the single-crystal structure of norethisterone enanthate (Wang *et al.*, 2015b). The single crystallographic data at 110 K of norethisterone enanthate [$a = 6.09236(14)$ Å, $b = 12.7347(3)$ Å, $c = 30.1234(8)$ Å, $\alpha = 90°$, $\beta = 90°$, $\gamma = 90°$, unit-cell volume $V = 2337.10(10)$ Å^3, $Z = 4$, $\rho_{cal} = 1.167$ g cm^{-3}, and space group $P2_12_12_1$] had been deposited with the Cambridge Crystallographic Data Center (CCDC) with a supplementary publication number of CCDC-1030994 (Wang *et al.*, 2015a). To date, the detailed X-ray powder diffraction (PXRD) data for norethisterone enanthate have not been reported.

II. EXPERIMENTAL

A. Sample preparation

The sample was purchased from J&K Scientific (Beijing, People's Republic of China). The melting point and measured density of norethisterone enanthate are 69–70 °C and 1.083 g cm^{-3}, respectively. The crystallization of norethisterone enanthate at room temperature was successful using a mixture of 75% ethanol in water as a solvent. The crystals have a prismatic and transparent crystal structure. Then, the crystals were dried, smashed, screened through 75 μm mesh size, and pressed flat to a zero background plate.

B. Diffraction data collection and reduction

PXRD was performed at 298 K using an X'Pert PRO diffractometer (PANalytical Co., Ltd., the Netherlands) with a PIXcel 1D detector and Cu$K\alpha$ radiation (generator setting: 40 kV and 40 mA). The diffraction data were collected over the angular range from 4° to 50° 2θ with a step size of 0.01313° 2θ and a counting time of 30 ms step^{-1}. Some peaks in the diffraction pattern display asymmetry may be due to stacking faults (Langford and Louër, 1991).

The software package Material Studio 8.0 (Accelrys Co., Ltd., CA, USA) was used to process the data in the Analytical & Testing Center (Sichuan University, Chengdu, China). The PXRD pattern was pre-treated by subtracting the background, smoothing, and stripping off the $K\alpha_2$ component. The Peaks tab was used to automatically search for peaks in the diffraction pattern. Automatic indexing results were obtained by X-cell method (Neumann, 2003). The indexing results were then refined using Pawley ($R_{wp} = 9.34\%$) (Pawley, 1981), which involves assigning the Miller indices (h, k, l) to each observed peak in the experimental PXRD pattern. All measured lines in the raw data were indexed. The method of determination of intensity was peak height above background.

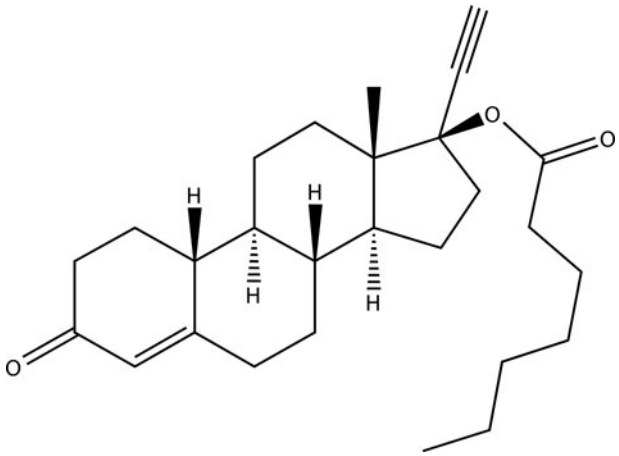

Figure 1. Molecular diagram of norethisterone enanthate.

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TABLE I. Indexed X-ray powder diffraction data for norethisterone enanthate

$2\theta_{obs}$ (°)	d_{obs} (Å)	I_{obs}	h	k	l	$2\theta_{cal}$ (°)	d_{cal} (Å)	$\Delta 2\theta$
5.6316	15.6800	25	0	0	2	5.6251	15.6981	0.0065
7.4961	11.7836	9	0	1	1	7.4966	11.7827	−0.0005
8.9404	9.8829	29	0	1	2	8.9439	9.8790	−0.0035
10.9362	8.0834	44	0	1	3	10.9414	8.0795	−0.0052
11.2382	7.8668	21	0	0	4	11.2638	7.8490	−0.0256
13.2603	6.6714	6	0	1	4	13.2461	6.6785	0.0141
13.9431	6.3462	8	0	2	0	13.9217	6.3559	0.0214
14.5339	6.0895	100	1	0	1	14.5694	6.0748	−0.0355
15.3611	5.7634	9	1	0	2	15.3705	5.7599	−0.0094
15.7157	5.6342	17	0	1	5	15.7279	5.6298	−0.0122
15.9257	5.5603	18	1	1	0	15.9078	5.5665	0.0179
16.1358	5.4884	42	1	1	1	16.1576	5.4811	−0.0218
16.6216	5.3291	9	1	0	3	16.6220	5.3289	−0.0004
16.8449	5.2590	14	1	1	2	16.8853	5.2465	−0.0404
18.0528	4.9097	19	1	1	3	18.0347	4.9146	0.0181
18.2629	4.8537	46	1	0	4	18.2342	4.8613	0.0288
18.3154	4.8399	37	0	1	6	18.3197	4.8388	−0.0043
19.5366	4.5400	17	1	1	4	19.5342	4.5406	0.0024
19.9699	4.4425	22	1	2	0	20.0033	4.4351	−0.0334
20.1274	4.4081	31	1	0	5	20.1239	4.4088	0.0035
21.0072	4.2254	15	0	1	7	20.9861	4.2296	0.0211
21.1647	4.1943	20	0	3	1	21.1397	4.1992	0.0250
21.3223	4.1637	30	1	1	5	21.3132	4.1654	0.0091
21.7556	4.0817	9	0	3	2	21.7063	4.0909	0.0493
21.9657	4.0432	19	0	2	6	21.9843	4.0398	−0.0186
22.1758	4.0053	37	1	0	6	22.2246	3.9966	−0.0488
22.6222	3.9273	31	0	3	3	22.6205	3.9276	0.0017
22.6222	3.9273	31M	0	0	8	22.6383	3.9245	−0.0161
23.0292	3.8588	7	1	2	4	23.0137	3.8613	0.0155
24.2503	3.6672	6	0	2	7	24.2675	3.6646	−0.0172
24.5523	3.6227	8	1	2	5	24.5531	3.6226	−0.0008
25.3533	3.5101	6	0	3	5	25.3364	3.5124	0.0169
25.4715	3.4941	6	1	1	7	25.4828	3.4925	−0.0113
25.6159	3.4747	5	1	3	1	25.6108	3.4754	0.0051
26.0886	3.4128	4	1	3	2	26.0854	3.4132	0.0032
26.3118	3.3843	5	1	2	6	26.3197	3.3833	−0.0079
26.4694	3.3645	7	0	1	9	26.4731	3.3641	−0.0037
26.6532	3.3418	4	0	2	8	26.6736	3.3393	−0.0204
26.8764	3.3145	4	1	0	8	26.8743	3.3148	0.0021
27.8218	3.2040	5	1	1	8	27.7907	3.2075	0.0311
28.2551	3.1558	4	1	2	7	28.2750	3.1537	−0.0200
29.2398	3.0518	8	1	3	5	29.2075	3.0551	0.0324
29.3843	3.0371	7	2	0	2	29.3813	3.0374	0.0030
30.0802	2.9684	5	2	0	3	30.0767	2.9687	0.0034
30.2246	2.9545	5	2	1	2	30.2278	2.9542	−0.0032
30.8943	2.8920	5	2	1	3	30.9060	2.8909	−0.0117
31.0256	2.8801	5	0	3	8	31.0341	2.8793	−0.0085
31.9578	2.7981	3	1	0	10	31.9336	2.8002	0.0242
32.7982	2.7283	4	1	4	3	32.7843	2.7295	0.0139
33.0082	2.7114	4	2	1	5	32.9917	2.7128	0.0165
33.2971	2.6886	3	2	2	3	33.2819	2.6898	0.0152
33.6647	2.6601	3	1	4	4	33.6655	2.6600	−0.0008
34.1374	2.6243	3	2	2	4	34.1518	2.6232	−0.0143
34.3738	2.6068	4	0	2	11	34.4157	2.6037	−0.0419
35.9363	2.4970	4	2	1	7	35.9180	2.4982	0.0182
36.0676	2.4882	3	1	4	6	36.0785	2.4874	−0.0109
37.5907	2.3908	4	1	4	7	37.5745	2.3918	0.0162
37.9977	2.3661	3	2	2	7	38.0172	2.3649	−0.0194
38.1684	2.3559	3	0	5	5	38.1577	2.3565	0.0108
39.3764	2.2864	4	0	5	6	39.3695	2.2867	0.0069
39.5340	2.2776	4	2	1	9	39.5262	2.2780	0.0078
39.9148	2.2568	3	0	2	13	39.8992	2.2576	0.0155
40.0329	2.2504	3	1	0	13	40.0400	2.2500	−0.0071
41.3066	2.1839	4	2	3	7	41.3135	2.1835	−0.0070
41.5429	2.1720	4	2	1	10	41.5428	2.1720	0.0001
41.6086	2.1687	4	2	4	3	41.5949	2.1694	0.0137

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TABLE I. Continued

$2\theta_{obs}$ (°)	d_{obs} (Å)	I_{obs}	h	k	l	$2\theta_{cal}$ (°)	d_{cal} (Å)	$\Delta 2\theta$
42.5277	2.1240	3	0	4	11	42.5375	2.1235	−0.0098
43.4205	2.0823	3	1	5	7	43.4089	2.0829	0.0117
43.5519	2.0764	3	0	6	3	43.5482	2.0765	0.0037
43.6700	2.0710	3	2	1	11	43.6824	2.0704	−0.0124
45.1144	2.0080	3	1	4	11	45.0991	2.0086	0.0153
45.3770	1.9970	3	3	0	4	45.3991	1.9961	−0.0221
48.4494	1.8773	3	0	3	15	48.4679	1.8766	−0.0185

The d-values were calculated using Cu$K\alpha_1$ radiation ($\lambda = 1.5405981$ Å).

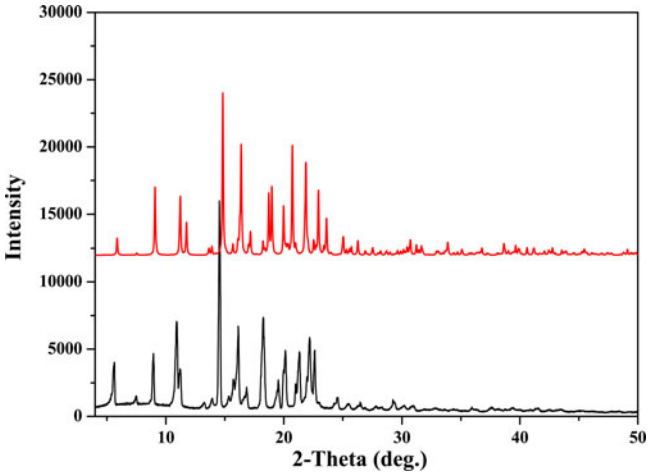

Figure 2. X-ray powder diffraction pattern of norethisterone enanthate using Cu$K\alpha$ radiation at 298 K (black line) and the simulated pattern of the crystal structure at 110 K (red line).

III. RESULTS

Pawley refinement results confirmed that norethisterone enanthate is orthorhombic with space group $P2_12_12_1$ and unit-cell parameters: $a = 6.191(4)$ Å, $b = 12.711(3)$ Å, $c = 31.396(2)$ Å, $\alpha = 90°$, $\beta = 90°$, $\gamma = 90°$, unit-cell volume $V = 2471.16$ Å^3, $Z = 4$, $\rho_{cal} = 1.104$ g cm^{-3}, and space group $P2_12_12_1$. The values of $2\theta_{obs}$, d_{obs}, I_{obs}, h, k, l, $2\theta_{cal}$, d_{cal}, $\Delta 2\theta$ are listed in Table I.

Due to the powder diffraction data being collected at 298 K and the single-crystal diffraction data being measured at 110 K, the cell parameters, volume, and calculated density exhibit slight differences. The deviation in results observed for the two methods were between 0.10% and 5.74%. Based on the single-crystal diffraction data, the simulated pattern of norethisterone enanthate was generated by using Mercury. The comparison of the experimental PXRD pattern with the simulated pattern is shown in Figure 2. The shifts in peak positions for the calculated pattern were due to differences in the temperature of measurement.

IV. DEPOSITED DATA

The $C_{27}H_{38}O_3$_diffraction_pattern.raw data file has been deposited with ICDD. You may request this data from ICDD at info@icdd.com.

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