



Isolation and crystal structure of 11 α -hydroxy- β -amyrin from the shell of *Celastrus orbiculatus*

Chuan-Jin Wang*, Guang-Jun Zhu, Bai-Hui Shi

Institute of Chemical Engineering, Nanjing University of Science and Technology, Nanjing, (CHINA)

E-mail : wangchuanjin302@sohu.com

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ABSTRACT

The title compound, 11 α -hydroxy- β -amyrin is a pentacyclic triterpenes which was first isolated from the acetyl acetate fraction of *Celastrus Orbiculatus* shell and characterized by ¹H-NMR and ¹³C-NMR. Besides, the crystal of the compound was acquired, and the relative configuration of 11 α -hydroxy- β -amyrin was determined by single-crystal X-ray diffraction analysis. It crystallizes in orthorhombic system, space group *P212121*, $a=13.280(3)$, $b=32.096(6)$, $c=6.7260(13)\text{\AA}$, $\alpha=90^\circ$, $\beta=90^\circ$, $\gamma=90^\circ$, $Z=4$, $C_{30}H_{50}O_2$, $M_r=442.73$, $D_c=1.100\text{g/cm}^3$, $V=2866.9(10)\text{\AA}^3$, $\mu(\text{MoK}\alpha)=0.068\text{mm}^{-1}$, $F(000)=1056$, the final $R=0.0696$ and $wR=0.1745$ for 5242 independent reflections ($R_{\text{int}}=0.0825$) and 2793 observed ones ($I>2^\circ(I)$). The bond lengths, bond angles, partial values of torsional angles, atomic coordinates and isotropic equivalent displacement parameters of the molecule are also given. Intramolecular van der Waals force contribute to the stability of the structure. © 2012 Trade Science Inc. - INDIA

KEYWORDS

Celastrus orbiculatus shell;
11 α -hydroxy- β -amyrin;
Single-crystal X-ray
structure;
Crystal structure.

INTRODUCTION

Celastrus Orbiculatus is a medicinal plant belonging to the family Celastraceae widely distributed in China^[1]. The fruits of *Celastrus Orbiculatus* has been used as the traditional Chinese medicine in the treatment of insomnia^[2]. In order to find new and bioactive compounds, the chemical constituents of the *Celastrus Orbiculatus* fruits shell were investigated and one compound, named 11 α -hydroxy- β -amyrin was isolated for the first time. It has been reported that 11 α -hydroxy- β -amyrin, which was previously isolated from *Elaeodendron Croceum* leaves, is highly toxic in vitro against Vero cells, Hela cells, SNO cells and MCF-7 cells^[6]. The isolated compound was fully characterized

by means of ¹H-NMR and ¹³C-NMR as well as X-ray crystallographic studies. To our knowledge, its crystal structure has not been reported up to now. In this paper we report the X-ray crystallographic studies on the title compound.

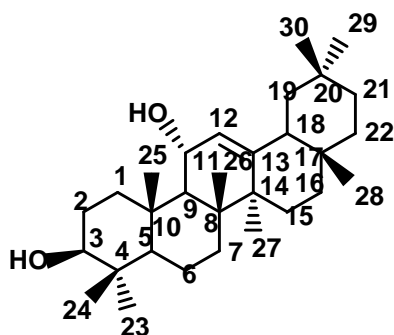
RESULTS AND DISCUSSION

¹H-NMR and ¹³C-NMR spectra showed the typical pattern of pentacyclic triterpene. Especially, the ¹H-NMR spectrum of compound was characteristic of the presence of an vinyl protons at $\delta 5.24$ (1H, d) and 4.21 (1H, dd). Two C singlets at $\delta 147.1$ and 120.7 indicated the presence of C-C double bond. On the basis of the above evidences, the structure of compound was

TABLE 1 : Selected bond distances (Å) and bond angle(°)

Bond	Dist.	Bond	Dist.	Bond	Dist.
O(1)-C(11)	1.428(4)	C(16)-C(15)	1.521(6)	C(6)-C(5)	1.515 (5)
C(19)-C(18)	1.520(7)	C(14)-C(13)	1.516(5)	C(5)-C(10)	1.556(5)
O(2)-C(3)	1.441(4)	C(14)-C(27)	1.548(6)	C(10)-C(25)	1.532(6)
C(20)-C(29)	1.481(9)	C(14)-C(8)	1.592(5)	C(10)-C(1)	1.534(5)
C(20)-C(21)	1.517 (8)	C(13)-C(12)	1.325(5)	C(4)-C(3)	1.539 (5)
C(20)-C(30)	1.543 (8)	C(8)-C(26)	1.531 (6)	C(4)-C(23)	1.539(6)
C(21)-C(22)	1.517(8)	C(8)-C(7)	1.551(5)	C(4)-C(24)	1.549(6)
C(22)-C(17)	1.540(6)	C(8)-C(9)	1.564(5)	C(3)-C(2)	1.516(6)
C(17)-C(16)	1.523(7)	C(9)-C(11)	1.534(5)	C(2)-C(1)	1.520(6)
C(17)-C(28)	1.530(7)	C(9)-C(10)	1.594(5)	C(7)-C(6)	1.507(6)
C(20)-C(19)-C(18)	116.0(5)	C(15)-C(14)-C(27)	107.2(4)	C(6)-C(5)-C(4)	114.6(3)
C(29)-C(20)-C(19)	109.3(5)	C(15)-C(14)-C(8)	109.9(3)	C(4)-C(5)-C(10)	117.7(3)
C(21)-C(20)-C(30)	110.3(6)	C(12)-C(13)-C(18)	120.1(4)	C(1)-C(10)-C(5)	107.6(3)
C(20)-C(21)-C(22)	112.9(5)	C(26)-C(8)-C(7)	107.4(3)	C(1)-C(10)-C(9)	108.1(3)
C(21)-C(22)-C(17)	115.5(5)	C(26)-C(8)-C(9)	110.9(3)	C(5)-C(10)-C(9)	107.0(3)
C(28)-C(17)-C(22)	107.5(5)	C(11)-C(9)-C(8)	109.7(3)	C(23)-C(4)-C(24)	107.7(3)
C(13)-C(18)-C(19)	112.5(4)	C(8)-C(9)-C(10)	116.4(3)	O (2)-C(3)-C(2)	110.5(3)
O(13)-C(18)-C(17)	111.8(3)	O(1)-C(11)-C(12)	108.2(3)	O(2)-C(3)-C(4)	111.4(3)
C(19)-C(18)-C(17)	113.2(4)	O(1)-C(11)-C(9)	112.8(3)	C(2)-C(3)-C(4)	112.6(3)
C(16)-C(15)-C(14)	113.6(4)	C(13)-C(12)-C(11)	127.7(4)	C(2)-C(1)-C(10)	113.3(3)
C(13)-C(14)-C(27)	106.8(3)	C(7)-C(6)-C(5)	111.3(3)		

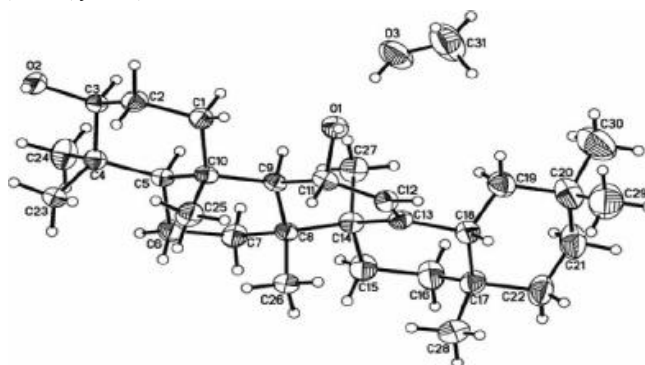
Symmetry transformation: a: $-x+1/2, -y, z+1/2$; b: $x+1/2, -y+1/2, -z$; c: $-x, y+1/2, -z+1/2$

Figure 1 : Chemical structure of 11 α -hydroxy- β -amyrin

suggested to 11 α -hydroxy- β -amyrin. The NMR data of compound was in good agreement with the previous data of 11 α -hydroxy- β -amyrin (Figure 1)^[6].

The selected bond lengths, bond angles, partial values of torsional angles in TABLE 1 and 2, respectively. Figure 2 shows the molecular structure of the title compound.

It was seen from Figure 2 that the title compound has four five-membered rings, 3, 11-hydroxy and 23,

Figure 2 : X-ray crystal structure of 11 α -hydroxy- β -amyrin

24, 25, 26, 27, 28, 29, 30-methyl. There exists a trans conformation between rings A/B and B/C. There exists a cis conformation between rings D/E. It is noteworthy that in the molecule ring A(C(1)-C(2)-C(3)-C(4)-C(5)-C(10)), ring B(C(5)-C(6)-C(7)-C(8)-C(9)-C(10)), ring C(C(8)-C(9)-C(11)-C(12)-C(13)-C(14)), ring D(C(13)-C(14)-C(15)-C(16)-C(17)-C(18)) and ring E(C(17)-C(18)-C(19)-C(20)-C(21)-C(22)) exhibits a chair conformation.

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TABLE 2 : Partial values of torsional angles (°)

Angle	(°)	Angle	(°)
C(18)-C(19)- C(20)-C(29)	-69.7(6)	C(8)-C(9)- C(11)-O(1)	155.1(3)
C(18)-C (19)-C(20)-C(21)	52.6(7)	C(10)-C(9)- C(11)-O(1)	-71.5(4)
C(30)-C(20)- C(21)-C(22)	-174.4(6)	C(18)-C(13)- C(12)-C(11)	171.4(4)
C(21)-C(22)- C(17)-C(16)	70.8(6)	C(9)-C(11)- C(12)-C(13)	1.5(6)
C(20)-C(19)- C(18)-C(13)	-179.4(4)	C(14)-C(8)- C(7)-C(6)	-165.4(4)
C(20)-C(19)- C(18)-C(17)	-51.4(6)	C(8)-C(7)- C(6)-C(5)	58.5 (5)
C(18)-C(17)- C(16)-C(15)	-60.6(6)	C(4)-C(5)- C(10)-C(9)	-167.6(3)
C(22)-C(17)- C(16)-C(15)	179.2(4)	C(11)-C(9)- C(10)-C(25)	-55.6(4)
C(16)-C(15)- C(14)-C(8)	-158.1(4)	C(11)-C(9)- C(10)-C(5)	179.1(3)
C(27)-C(14)- C(13)-C(18)	-81.9(4)	C(10)-C(5)- C(4)-C(23)	-70.8(5)
C(19)-C(18)- C(13)-C(14)	84.4(5)	C(5)-C(4)- C(3)-O(2)	-179.2(3)
C(27)-C(14)- C(6)-C(26)	-177.8(3)	C(24)-C(4)- C(3)-C(2)	-170.8(4)
C(15)-C(14)- C(8)-C(9)	-176.0(4)	C(9)-C(10)- C(1)-C(2)	166.7(3)
C(27)-C(14)- C(8)-C(9)	-56.6(4)	O(2)-C(3)- C(2)-C(1)	-175.9(3)
C(14)-C(8)- C(9)-C(10)	164.9(3)	C(8)-C(9)- C(10)-C(1)	-166.3(3)

The C–C bond distances in the five rings ranging from 1.326(5) to 1.594(5)Å and the C–C–C angles from 105.5(5) to 127.7(4)° are normal^[5]. The distance between C(12) and C(13) is 1.326(5)Å, within the normal range of double bond (C=C), revealing it is a normal C=C.

EXPERIMENTAL

Instrument

Melting point was obtained in an X-6 digital melt-

ing point instrument without correction. The elemental analysis was performed on a CHN-O-Rapid auto analyzer. The ¹HNMR(500MHz) and ¹³CNMR(500MHz) spectra were recorded on a Bruker Avance ϕ 6-500 spectrometer and tetramethylsilane(TMS) was used as an internal standard. Silica gel(200-300 mesh for column chromatography(CC) and GF₂₅₄ for TLC) was obtained from Qingdao Marine Chemical Company(Qingdao, China). Cromasil C₁₈(40-60 μ m for column chromatography) was obtained from Boshi Company(Shanghai, China). Single-crystal structures of compound were measured on an Enraf-Nonius CAD4 diffractometer etc.

Extraction and isolation

The shell of *Celastrus Orbiculatus* was collected in Chuzhou County, Anhui Province, China, in January 2011. The plant was identified by Prof. Jianwei Chen of Nanjing University of Chinese Medicine. A voucher specimen (No.PA110101) has been deposited at the Department of Pharmaceutical Engineering, Institute of

Chemical Engineering, Nanjing University of Science and Technology, Nanjing, China.

The dried shell of *Celastrus Orbiculatus*(100g) was cut into small pieces and extracted with EtOAc (1liter \times 3). The solvent was removed by rotary evaporation and the yellow brown extract (2.0g) was obtained. The EtOAc extract was subjected to silica gel chromatography using stepwise elution with petroleum ether-CH₃COCH₃(100:0, 100:1, 100:2, 100:4, 100:8, 100:16, 100:32, 100:100, and 0:100) to afford 90 fractions(A1-A90). A31-A40were permeated through Cromasil C₁₈ using stepwise elution with H₂O-CH₃COCH₃(30:70, 40:60, 50:50, 45:55, 40:60, 35:65, 30:70, 25:75, 20:80, 15:85, 10:90, 5:95, and 0:100) to give 13 subfractions F1-F13. Fraction of F8 was further purified with recrystallization with CH₃Cl- CH₃COCH₃-MeOH(1:1:1) system to afford 11 α -hydroxy- β -amyrin(30mg) with a yield of about 0.03%.

The acicular crystal of 11 α -hydroxy- β -amyrin was recrystallized in the mixture solution of CH₃Cl-CH₃COCH₃-MeOH(1:1:1), and single crystal was obtained in constant temperature(25 \pm æ) on the basis of this. m. p. :234~236 \pm æ. Elemental Anal. Calcd. (%)

for $C_{30}H_{50}O_2$: C, 81.39; H, 11.38; O, 7.23. Found (%): C, 81.20; H, 11.48; O, 7.32.

1H -NMR(500 MHz, $CDCl_3$) δ_H = 5.24 (1H, d, H-12), 4.21 (1H, dd, H-11), 3.22 (1H, dd, H-3), 2.06 (1H, m, H-18), 1.94 (2H, m, H-21), 1.23 (3H, s, H-23), 1.08 (3H, s, H-27), 1.02 (3H, s, H-25), 1.02 (3H, s, H-26), 0.88 (3H, s, H-29), 0.88 (3H, s, H-30), 0.86 (3H, s, H-24), 0.81 (3H, s, H-28); ^{13}C -NMR (500 MHz, $CDCl_3$) δ_C = 147.1 (C-13), 120.7 (C-12), 78.7 (C-3), 67.6 (C-11), 55.8 (C-9), 55.2 (C-5), 46.9 (C-18), 46.6 (C-19), 45.6 (C-14), 42.8 (C-8), 40.7 (C-1), 39.0 (C-4), 38.8 (C-10), 37.0 (C-22), 34.6 (C-21), 33.2 (C-29), 33.0 (C-7), 32.1 (C-17), 31.1 (C-20), 28.5 (C-23), 28.1 (C-28), 27.5 (C-2), 27.2 (C-15), 25.6 (C-16), 25.2 (C-27), 23.6 (C-30), 21.0 (C-6), 20.1 (C-26), 18.5 (C-25), 15.6 (C-24).

Physical and spectra data of the title compound were almost identical with those reported in the literatures^[7]. Its relative configuration was further established by X-ray cry-stallographic analysis.

Crystallographic data collection and structure determination

A colorless transparent crystal with dimensions 0.3mm×0.20mm×0.10mm was used for data collection. Unit cell parameters and 5242 intensities were measured on an Enraf-Nonius CAD-4 diffractometer with graphite-monochromated $MoK\alpha$ radiation ($\lambda=0.71073\text{\AA}$) in the range of $1.27^\circ < \theta < 25.38^\circ$ by $\omega/2\theta$ scanning. Corrections for LP and absorption with empirical ψ scanning technique were applied and 2793 independent reflections with $[I > 2\sigma(I)]$ were used in the structure determination. The structure was solved by the direct method using the program SHELXS-97^[3] and refined on F^2 by full-matrix least-squares procedure with Bruker SHELXL-97 packing^[4]. All non-hydrogen atoms were refined with anisotropic thermal parameters. The hydrogen atoms refined with riding model position parameters isotropically were located from difference Fourier map and added theoretically. The final full-matrix least-squares refinement gave $R=0.0696$, $\omega R=0.1745$ ($\omega=1/[\sigma^2(F_o^2)+(0.0600P)^2+0.8000P]$), where $P=(F_o^2+2F_c^2)/3$. $S=1.004$, $(\sigma^2 S/\sigma)_{\max}=0.000$, $(\sigma^2 S/\rho)_{\max}=0.278$ and $(\sigma^2 S/\rho)_{\min}=-0.153e/\text{\AA}^3$.

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