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New polyhydroxy derivative of cyclohexane produced by *Streptomyces* sp. CS, a commensal microbe of *Maytenus hookeri*

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Abstract: The chemical investigation on the fermentation extracts of *Streptomyces* sp. CS has resulted in the isolation of one derivative of oxygen substituted cyclohexane(**1**). The structure elucidation for **1** was carried out on the basis of HRFAB-MS and NMR data, and it was identified as 1-isobutyroxymethyl cyclohex-1(6)-ene-2, 3, 4, 5-tetrol-2-isobutyrate.

Key words: medicinal chemistry; structure elucidation; NMR; HRFAB-MS; *Streptomyces* sp. CS; *Maytenus hookeri* Loes

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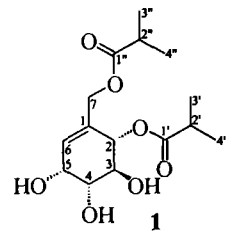
A strain CS was obtained from the callus of *Maytenus hookeri*, and it was identified to be *Streptomyces* sp. on the genus level. Investigation on the secondary metabolites of this strain had led to the isolation of a new compound **1** from the crude extracts of the solid state fermentation by column chromatography and which was identified based on the NMR (HMBC, HMQC) and HRFAB-MS data.

Compound **1**, $[\alpha]_D^{20}$ + 30.7°(*c* 1.27, MeOH), was determined to have the molecular formula $C_{15}H_{24}O_7$ based on the high resolution positive fast atom bombardment mass spectrometry (HRFAB-MS *m/z*: 317.160 028, calcd: 317.159 864), and showed carbon-carbon double bond(1739 cm^{-1}) in the IR spectra. The ^{13}C-NMR and DEPT spectra of **1** showed 15 carbon signals for four methyl, one methylene, seven methines, and three quaternary carbons, including two carboxyls at δ 177.3 and δ 176.5, respectively. A typical AB system characteristic signals at δ 4.63 and δ 4.50(d, each 1H, *J* = 13.2 Hz) were correlated with one methylene carbon at δ 63.0 in the HMQC experiment. The HMBC experiment showed that the protons at δ 4.63 and δ 4.50 had ^1H-^{13}C long-range correlations with the carbons at δ: 135.6(C-1), 73.0 (C-2) and 126.4(C-6), and that the proton at δ 5.49 correlated with the carbons at δ: 177.3(C-1′), 135.6(C-1), 126.4(C-6). The HMBC experiment further showed the ^1H-^{13}C long-range correlations between the proton at δ 5.97 and the carbons at δ 63.0(C-7) and δ 71.2(C-4), and between the proton at δ 4.34 and the carbons at δ: 135.6(C-1), 126.4(C-6), 71.2(C-4), and between the proton at δ 3.96 and δ 71.2(C-4) and δ 73.0(C-2), and between the proton at δ 5.49 and δ 135.6(C-1), δ 126.4(C-6) and δ 71.0(C-3), indicating that a six member ring unit existed in this structure, and that the methylene at δ_C 63.0(δ_H 4.50 and 4.63)



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was directly contacted with the carbon-carbon double bond. All these indicated a 2,3,4,5-tetraoxygen substituted cyclohexene moiety[1,2]. The coupling constants between the protons at δ 5.97 and 4.34 (J = 4.4, 4.8 Hz); δ 4.34 and 3.68 (J = 4.4, 4.0 Hz); δ 3.68 and 3.96 (J = 10.4 Hz); δ 3.96 and 5.49 (J = 8.4, 7.6 Hz) (Table 1) indicated the oxygen substitutions at C-2, C-3, C-4 and C-5 to be α, β, α and α, respectively, indicating that **1** had the same relative stereochemistry as piperenol A[2]. In addition, the NMR and MS data revealed two isobutyryl groups in **1**. The ^{1}H-^{13}C long-range correlations between the proton at δ 5.49 and the carbon at δ 177.3 (C-1′), and the protons at δ 4.50 and δ 4.63 and the carbon at δ 176.5 indicated that those two isobutyryls were linked with the carbons at δ 73.0 (C-2) and δ 63.0 (C-7), respectively. Therefore, compound **1** was elucidated to be 1-isobutyroxymethyl cyclohex-1(6)-ene-2, 3, 4, 5-tetrol-2-isobutyrate.

Table 1 The HMQC and HMBC data for 1 in $CDCl_3$

No.	^{13}C-NMR (100 MHz)	^{1}H-NMR (400 MHz)	HMBC (400 MHz)
1	135.6(s)		
2	73.0(d)	5.49(d, 1H, J = 7.6 Hz)	C-1, C-3, C-1′
3	71.0(d)	3.96(dd, 1H, J = 8.4, 10.4 Hz)	C-2, C-4
4	71.2(d)	3.68(dd, 1H, J = 4.0, 10.4 Hz)	
5	65.8(d)	4.34(dd, 1H, J = 4.4, 4.4 Hz)	C-1, C-4, C-6
6	126.4(d)	5.97(d, 1H, J = 4.8 Hz)	C-4, C-7
7	63.0(t)	4.63(d, 1H, J = 13.2 Hz)	C-1″, C-2, C-6
		4.50(d, 1H, J = 13.6 Hz)	
1′	177.3(s)		
2′	34.0(d)	2.63(m, 1H)	C-1′, C-3′
3′	18.8(q)	1.147(d, 1H, J = 7.2 Hz)	C-1′, C-2′, C-4′
4′	18.8(q)	1.152(d, 1H, J = 7.2 Hz)	C-1′, C-2′, C-3′
1″	176.5(s)		
2″	33.8(d)	2.55(m, 1H)	C-1″, C-3″
3″	18.8(q)	1.18(d, 1H, J = 7.2 Hz)	C-1″, C-2″, C-4″
4″	18.8(q)	1.18(d, 1H, J = 7.2 Hz)	C-1″, C-2″, C-3″

Polyhydroxyl cyclohexanes are only found in few plant families[3,4], some *Streptomyces* and fungus[5], and are reported to have tumour inhibitory, antileukemic and antibiotic activities[6]. Compound **1** was a new polyhydroxyl cyclohexane derivative isolated from the fermentation of the title microorganism.

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云南美登木共生放线菌菌株 CS 产生的新多羟基环己烷衍生物

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摘 要: 从云南美登木共生放线菌菌株(*Streptomyces* sp.)CS 的发酵产物中分离得一个新的多羟基环己烷衍生物, 并通过波谱学特征鉴定化合物的结构为 1-isobutyroxymethyl cyclohex-1(6)-ene-2, 3, 4, 5-tetrol-2-isobutyrate。

关键词: 药物化学; 结构鉴定; 核磁共振波谱; 高分辨质谱; 放线菌菌株 CS; 云南美登木