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SHORT REPORT

A new glutarimide compound from *Streptomyces* sp. JCM 4793

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Abstract: In this study, a previously undescribed glutarylimide compound was isolated from *Streptomyces* sp. JCM 4793. Its structure was evaluated through examinations of the NMR, HREIMS data and ECD calculation. Compound **1** was measured for its cytotoxicities against A549, K562, HepG2, SW480 and MDA-MB-231 cells. Compound **1** exhibited significant inhibitory activity against both K562 and A549 tumor cell lines, with IC_{50} values of 4.840 ± 0.329 μmol/L and 6.036 ± 0.157 μmol/L, respectively.

Keywords: *Streptomyces*, glutarimide, configuration, cytotoxicities

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1 Strain Source

The actinomycetes strain *Streptomyces* sp. JCM 4793 was purchased from Japan by the Guangdong Microbial Culture and Collection Center (GDMCC), and its genomic information can be obtained on NCBI. The genome information is available at NCBI website with gene bank assembly No. GCA_014656115.1.

2 Previous Studies

The genus *Streptomyces*, as the core group of actinomycetes, is hailed as a "natural medicine factory" for its extraordinary secondary metabolic capacity. More than 60% of clinical anti-tumor antibiotics, such as doxorubicin, bleomycin, and actinomycin D, are directly sourced from strains of this genus (Bérdy, 2012; Chen et al., 2023; Cragg & Pezzuto, 2016). These structurally diverse molecules exert potent cytotoxicity through different mechanisms of action. Such as, doxorubicin can target DNA topoisomerase, calicamycin can induce DNA breakage, and bleomycin can inhibit tubulin polymerization (Demain & Sanchez, 2009; Groll et al., 2006).

In recent years, glutarimide-containing compounds, as characteristic metabolites of *Streptomyces*, have received extensive attention due to their significant tumor-selective inhibitory activity. This type of molecule can exert potent killing on drug-resistant tumor cells by targeting the proteasome (such as inhibiting the 20*S* β5 subunit), blocking NF-κB signal transduction or inducing the mitochondrial apoptotic pathway (Ju et al., 2005). It has been established that streptimidone and its derivatives induce G2/M phase arrest in leukemia cells and activate caspase-dependent apoptosis via the ROS/JNK pathway (Lee et al., 2020; Ling et al., 2025). However, it is currently known that the structure-activity relationship (SAR) between the spatial configuration diversity of glutarimide compounds and their activity regulation has not been systematically elucidated, especially the influence of the hydroxyl configuration at the C-5 position on activity lacks in-depth research (Mosmann, 1983).

This study focuses on *Streptomyces* as the research object to explore its bioactive components via multi-step chromatographic techniques. Specifically, it emphasizes the isolation and identification of glutarimide derivatives with unknown stereoconfigurations, followed by evaluating their antitumor potential. Compound **1** was screened for cytotoxic activity against leukemia (K562) and lung cancer (A549) cells to assess its potential for anti-tumor activity.

3 Present Study

A 200 μL aliquot of actinomycete spore suspension was inoculated into a 250 mL small fermentation flask containing 50 mL of ISP2 liquid medium. The flask was incubated on

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a shaker at 220 and 28°C for 24 hours to prepare the seed culture. Then, 20 mL of the seed culture was measured using a 50 mL centrifuge tube and transferred into a 1000 mL large fermentation flask loaded with 300 mL of M3′ liquid medium. A total of 117 flasks (containing 35 L of M3′ liquid medium in total) were cultured on a shaker at 220 rpm and 28°C for 7 days. Subsequently, the fermentation broth was subjected to centrifugation for separation. An equal volume of EtOAc was added to the supernatant for extraction; after thorough shaking to ensure sufficient mixing, the mixture was allowed to stand for phase separation. This extraction process was repeated three times. The EtOAc extracts were combined and concentrated under reduced pressure to obtain 85 g of crude extract.

The EtOAc extract was treated with normal-phase silica gel (60–80 mesh) and eluted with a gradient of dichloromethane-methanol (CH_2Cl_2-MeOH, 100:0 to 0:100, v/v) to obtain six fractions (A–F). Fraction E was further subjected to an octadecyl-bonded silica gel (C_{18}) column and eluted stepwise with 20%, 40%, 60%, 80%, and 100% methanol-water (MeOH-H_2O, v/v) sequentially, resulting in the isolation of five subfractions.

Fraction E-2 (300 mg) was purified by continuous preparative high performance liquid chromatography (using Agilent C_{18} column). Compound **1** (13.0 mg, t_R = 15.9 min) and compound **4** (6.0 mg, t_R = 19.8 min) were obtained under the conditions of isostatic elution with 35% CH_3CN-H_2O for 40 min, flow rate: 3.0 mL/min, ultraviolet detection wavelength: 236 nM, and temperature: 25°C. Compound **2** (21.5 mg, t_R = 13.6 min) and compound **3** (25.0 mg, t_R = 16.5 min) were obtained under the conditions of isostatic elution with 16% CH_3CN-H_2O for 30 min, flow rate: 3.0 mL/min, ultraviolet detection wavelength: 363 nM, and temperature: 25°C.

A rotary shaker (YTHW-903D; Yataikelong, Beijing) was used to shake the culture broth. For column chromatography, commercially available silica gel (SiO_2; 100–200 mesh and 200–300 mesh, Qingdao Haiyang Chemical Co., China) and Lobar LiChroprep RP-18 (40–63 μM, Merck, Darmstadt) were used. Preparative HPLC was performed using an HPLC system equipped with LC-20AD pumps (Shimadzu, Kyoto, Japan), an SPD-M20A UV detector (Shimadzu), and a CTO-20A column oven (Shimadzu). HR-ESI-MS spectra were recorded on a mass spectrometer (Triple TOF 6600$^+$; AB Sciex, USA). NMR experiments were performed using a spectrometer (AVANCE III 500 MHz; Bruker, Billerica, MA, USA). The circular dichroism spectrum was recorded through a Chirascan circular dichroism spectrometer (Applied Photophysics, USA).

(E)-*4-(2-hydroxy-5,7-dimethyl-4-oxonona-6,8-dien-1-yl) piperidine-2,6-dione* (***1***): Yeleow oil; $[\alpha]_D^{25}$ = 302.80 (*c* 0.10, MeOH). ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) = 8.38 (1H, s, NH), 6.35 (1H, m, H-11), 5.32 (1H, m, H-9), 5.33 (1H, d, *J* = 10.1 Hz, H-9), 5.20 (1H, d, *J* = 17.4 Hz, H-12), 5.05 (1H, d, *J* = 10.8 Hz, H-12), 4.86 (1H, m, H-5), 3.49 (1H, dq, *J* = 9.7, 6.8 Hz, H-8), 3.01 (1H, dd, *J* = 17.5, 6.0 Hz, H-6), 2.63 (1H, ddd, *J* = 17.7, 10.8, 6.4 Hz, H-6), 2.63 (1H, ddd, *J* = 17.7, 10.8, 6.4 Hz, H-2′), 2.56 (m, H-3), 2.32 (m, H-3), 2.32 (2H, m, H-4), 2.32 (1H, m, H-2′), 1.81 (2H, m, H-2), 1.16 (3H, d, *J* = 6.9 Hz, H-14); ^{13}C NMR (125 MHz, $CDCl_3$): δ (ppm) = 207.9 (C, C-7), 172.8 (C, C-1′), 171.3 (C, C-1), 140.6 (CH, C-11), 137.0 (C, C-10), 130.2 (CH, C-9), 113.3 (CH_2, C-12), 73.1 (CH, C-5), 47.1 (CH, C-8), 45.6 (CH_2, C-6), 40.8 (CH_2, C-4), 35.1 (CH_2, C-2′), 32.7 (CH_2, C-2), 26.2 (CH, C-3), 16.2 (CH_3, C-14).

The molecular formula was determined as $C_{16}H_{23}NO_4$ by HR-ESI-MS (*m/z* 294.1708 $[M + H]^+$, calculated 294.1700). The ^{1}H NMR data (Table 1) showed the presence of four olefinic protons [δ_H 5.33 (1H, d, *J* = 10.1 Hz), δ_H 6.35 (1H, m), δ_H 5.20 (1H, d, *J* = 17.4 Hz), δ_H 5.05 (1H, d, *J* = 10.8 Hz)], a oxymethine proton [δ_H 4.86 (1H, m)], three allylic protons [δ_H 1.81 (3H, m)] and three aliphatic methyl protons [δ_H 1.16 (3H, d, *J* = 6.9 Hz)]. The ^{13}C NMR spectrum (Table 1) showed 16 carbon resonances, which were categorized by DEPT and HSQC spectra as two methines, five methylenes (one double bond) and four quaternary carbons (one double bond, three carbonyls), five methylene carbons (two double bonds).

Subsequently, the complete structure of **1** was analyzed by combining ^{1}H-^{1}H COSY, HSQC and HMBC spectra (Figure 1). In the ^{1}H-^{1}H COSY spectrum, there are correlations between H_2-2/H-3, H-3/H_2-4, H_2-4/H-5, H-5/H_2-6 explain that C-2/C-3/C-4/C-5/C-6 are connected in sequence; there are correlations between H_3-13/H-8, H-8/H-9 explain that C-13/C-8/C-9 are connected in sequence; there are correlations between H-11/H-12 explain that C-11/C-12 are connected in sequence. Furthermore, it was observed that H-5/H-9 were correlated with C-7, and H_3-13 were correlated with C-7/C-8/C-9. H_3-14 was correlated with C-9/C-10/C-11 in terms of HMBC. Based on the above correlations between ^{1}H-^{1}H and HMBC, the connection relationship of C-2-C-12 was established. The two amide carbonyl carbons C-1/C-1′ are respectively associated with HMBC with two pairs of methylene hydrogen H_2-2/ H_2-2′. In the ^{1}H-^{1}H COSY spectrum, C1/C1′ are also associated with methylene hydrogen H-3 related. Therefore, a glutarylimide ring is formed.

Except that the chemical shift at the C-5 position in compound **1** (δ_C 73.08 ppm, δ_H 4.86) is significantly different from that of streptimidone (δ_C 64.6 ppm, δ_H 4.10) reported in the literature. All other attributable hydrocarbon signals (including glutarimide rings, side-chain alkene bonds and methyl groups) were highly consistent with streptimidone. By comparing the molecular formula of streptimidone (Shoemaker, 2006) as $C_{16}H_{23}NO_4$ (*m/z* 294.1707 $[M + H]^+$, calculated 294.1705), as well as the ultraviolet absorption characteristics (λ_{max} 232 nM). It was established that compound **1** shares an identical planar structure with streptim idone, and the structural difference resides solely in the altered stereochemistry of the C-5 hydroxyl group.

Neither the ROESY electronic spectrum analysis nor the subsequent Mosher esterification experiments using chiral reagents (*R*)-(+)- and (*S*)-(-)-*α*-methoxy-*α*-(trifluoromethyl) phenylacetic acid (MTPA) could determine the absolute configuration at the C-5 position (Figure 2). To determine the absolute configuration of compound **1**, two possible enantiomers ((5*S*, 8*S*-**1**) and (5*R*, 8*S*-**1**)) were subjected to ECD calculations using the TD-DFT method. As shown in Figure 3, the experimental

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Table 1. Comparison of chemical shift values of compound **1** with those of streptimidone

Position	1		Streptimidone (Urakawa et al., 1993)	
	δ_C	δ_H (*J* in Hz)	δ_C	δ_H (*J* in Hz)
1	171.3	–	172.6	–
2	32.7	1.81 (2H, m)	37.0	2.27 (1H, m); 2.70 (1H, m)
3	26.2	2.56 (m); 2.32 (m)	27.0	2.45 (1H, m)
4	40.8	2.32 (2H, m)	40.8	1.32 (1H, ddd, 14.0, 8.7, 3.0); 1.57 (1H, ddd, 14.0, 10.3, 5.0)
5	73.1	4.86 (1H, m)	64.6	4.10 (1H, m)
6	45.6	3.01 (1H, dd, 17.5, 6.0); 2.63 (1H, ddd, 17.7, 10.8, 6.4)	47.5	2.53 (1H, dd, 17.9, 3.3); 2.61 (1H, dd, 17.9, 8.4)
7	207.9	–	211.9	–
8	47.1	3.49 (1H, dq, 9.7, 6.8)	46.8	3.48 (1H, dq, 9.7, 6.8)
9	130.2	5.33 (1H, d, 10.1)	130.1	5.31 (1H, d, 9.7)
10	137.0	–	136.5	–
11	140.6	6.35 (1H, m)	140.4	6.33 (1H, dd, 17.4, 10.7)
12	113.3	5.20 (1H, d, 17.4); 5.05 (1H, d, 10.8)	112.9	5.18 (1H, d, 17.4); 5.03 (1H, d, 10.7)
13	16.2	1.16 (3H, d, 6.9)	16.6	1.14 (3H, d, 6.7)
14	12.4	1.81 (3H, m)	12.5	1.81 (3H, s)
1′	172.8	–	172.7	–
2′	35.1	2.63 (1H, ddd, 17.7, 10.8, 6.4); 2.32 (1H, m)	38.2	2.27 (1H, m); 2.70 (1H, m)

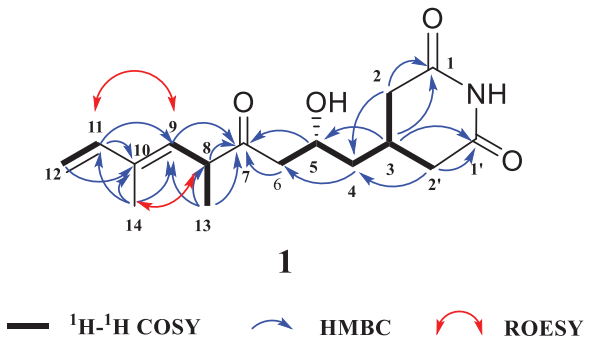

Figure 1. Key ^{1}H-^{1}H COSY, HMBC and ROESY correlations of compound **1**

ECD spectrum of compound **1** was similar to that calculated for the isomers with 5*S* and 8*S* configurations. Therefore, the absolute configurations of **1** were determined to be 5*S* and 8*S*. Consequently, the structure of **1** was determined and named as (E)-4-(2-hydroxy-5,7-dimethyl-4-oxonona-6,8-dien-1-yl) piperidine-2,6-dione.

The ^{13}C NMR data of compounds **2**, **3**, and **4** revealed that their C-5 chemical shifts all fall within the range of 65.0 ± 2.1 ppm: compound **2** (δ_C 65.5), compound **3** (δ_C 65.5), compound **4** (δ_C 66.2) (Urakawa et al., 1993). The C-5 positions of these compounds all possess a *β*-hydroxy configuration. In contrast, the C-5 chemical shift of compound **1** (δ_C 73.0 ppm) differs from that of all known glutarimide compounds with a *β*-configuration, including streptimidone (δ_C 64.6) (Shoemaker, 2006), hydroxyiso-9-methylstreptimidone (δ_C 66.8) (Stoddart, 2011), 9-methylstreptimidone (δ_C 64.8) (Tang et al., 2024), cycloheximide (δ_C 65.2) (Wang et al., 2021), lactimidomycin (δ_C 67.1) (Wang et al., 2021), iso-migrastatin (Wei et al., 2024) and gladiostatin (δ_C 65.8) (Zhao et al., 2019) (Table 2). On the basis of these findings, the structure of compound **1** was established as depicted in Figure 4, representing a novel natural glutarimide with a proposed *α*-configuration for the C-5 hydroxyl group.

12-amidestreptimidone (***2***): Yellowish-white powder; ^{1}H NMR (500 MHz, D_2O/CD_3OD = 3/1) : δ (ppm)= 7.57 (1H, s, NH), 7.15 (1H, d, *J* = 15.6 Hz, H-11), 6.07 (1H, d, *J* = 15.6 Hz, H-12), 5.78 (1H, d, *J* = 9.8 Hz, H-9), 4.15 (1H, m, H-5), 3.73 (1H, dq, *J* = 9.6, 6.8 Hz, H-8), 2.72 (2H, m, H-6), 2.72 (2H, m, H-2), 2.72 (2H, m, H-2′), 2.39 (1H, m, H-3), 2.39 (2H, m, H-2), 2.39 (2H, m, H-2′), 1.85 (3H, d, *J* = 1.3 Hz, H-15), 1.55 (2H, ddd, *J* = 14.1, 9.6, 4.7 Hz, H-4), 1.44 (2H, ddd, *J* = 14.1, 7.9, 3.8 Hz, H-4), 1.18 (3H, d, *J* = 6.8 Hz, H-14); ^{13}C NMR(125 MHz, D_2O/CD_3OD = 3/1): δ (ppm) = 214.9 (C, C-7), 177.5 (C, C-1′), 177.3 (C, C-1), 172.2 (C, C-13), 147.2 (CH, C-11), 139.2 (CH, C-9), 136.3 (C, C-10), 119.7 (CH, C-12), 65.5 (CH, C-5), 49.1 (CH_2, C-6), 48.1 (CH, C-8), 41.7 (CH_2, C-4), 38.2 (CH_2, C-2′), 37.1 (CH_2, C-2), 27.6 (CH, C-3), 16.3 (CH_3, C-14), 12.9 (CH_3, C-15). The above data is consistent with literature data (Urakawa et al., 1993).

12-carboxylstreptimidone (***3***): Yellow oil; ^{1}H NMR (500 MHz, D_2O/CD_3OD = 3/1): δ (ppm) = 8.38 (1H, s, NH), 7.27 (1H, d, *J* = 15.7 Hz, H-11), 5.91 (1H, d, *J* = 15.7 Hz, H-12), 5.80 (1H, d, *J* = 9.8 Hz, H-9), 4.12 (1H, dp, *J* = 11.5, 4.2 Hz, H-5), 3.71 (1H, dq, *J* = 9.9, 6.8 Hz, H-8), 2.69 (2H, m, H-6), 2.69 (2H, m, H-2), 2.69 (2H, m, H-2′), 2.36 (1H, m, H-3), 2.36 (2H, m, H-2), 2.36 (2H, m, H-2′), 1.84 (3H, s, H-15), 1.52 (2H, ddd, *J* = 13.8, 9.6, 4.3 Hz, H-4), 1.41 (2H, ddd, *J* = 14.0, 7.5, 3.7 Hz, H-4), 1.16 (3H, d, *J* = 6.8 Hz, H-14); ^{13}C NMR (125 MHz, D_2O/CD_3OD = 3/1): δ (ppm) = 214.2 (C, C-7), 177.2 (C, C-1′), 177.0 (C, C-1), 172.3 (C, C-13), 150.6 (CH,

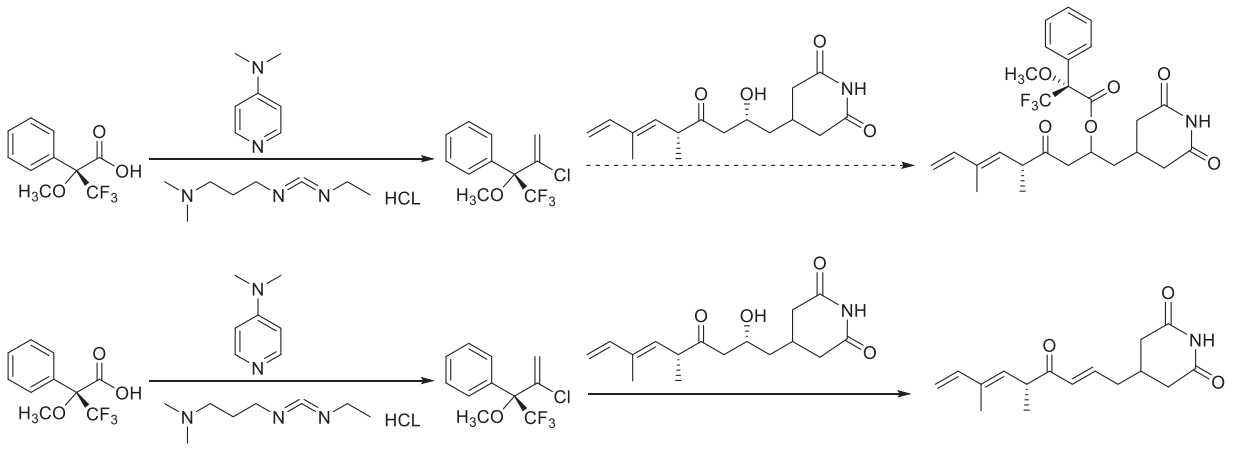

Figure 2. Reaction of Mosher's method

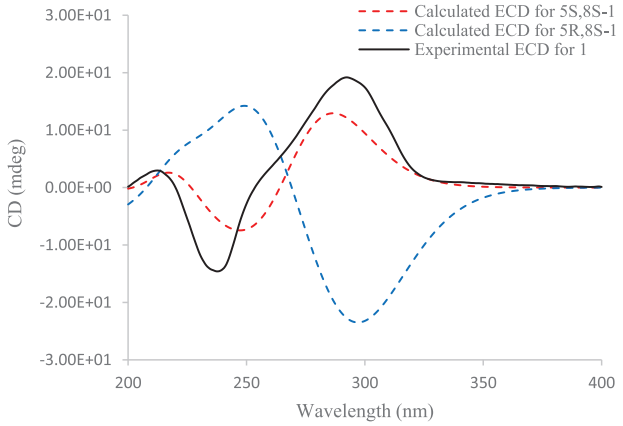

Figure 3. Experiment and calculate the ECD fitting graph

C-11), 140.1 (CH, C-9), 136.4 (C, C-10), 118.3 (CH, C-12), 65.5 (CH, C-5), 49.3 (CH_2, C-6), 48.2 (CH, C-8), 41.8 (CH_2, C-4), 38.3 (CH_2, C-2′), 37.2 (CH_2, C-2), 27.7 (CH, C-3), 16.3 (CH_3, C-14), 12.8 (CH_3, C-15). The above data is consistent with literature data (Urakawa et al., 1993).

3-(5S,8R)-(2-amino-2-oxoethyl-2′-methoxy-2′-oxoethyl)-8, 10-dimethyl-7-oxododeca-5-hydroxy-9E,11-diolefin (***4***): color less oil; ^{1}H NMR (500 MHz, $CDCl_3$): δ (ppm) = 7.47 (2H, s, 1-NH_2), 6.35 (1H, ddd, J = 17.4, 10.7, 0.8 Hz, H-11), 5.32 (1H, m, H-9), 5.19 (2H, dd, J = 17.4, 0.9 Hz, H-12), 5.05 (2H, dt, J = 10.6, 0.9 Hz, H-12), 4.10 (1H, m, H-5), 3.67 (3H, s, 1′-OCH_3), 3.49 (1H, dq, J = 9.7, 6.8 Hz, H-8), 2.58 (2H, m, H-6), 2.44 (1H, m, H-3), 2.44 (2H, m, H-2′), 2.30 (2H, dd, J = 14.1, 6.0 Hz, H-2), 2.30 (2H, dd, J =14.1, 6.0 Hz, H-4), 1.81 (3H, d, J =1.4 Hz, H-14), 1.56 (2H, ddd, J = 14.4, 9.7, 6.0 Hz, H-2), 1.56 (2H, ddd, J = 14.4, 9.7, 6.0 Hz, H-4), 1.43 (2H, ddd, J = 14.4, 6.7, 3.0 Hz, H-2), 1.43 (2H, ddd, J = 14.4, 6.7, 3.0 Hz, H-4), 1.16 (3H, d, J = 6.8 Hz, H-13); ^{13}C NMR (125 MHz, $CDCl_3$): δ (ppm) = 212.6 (C, C-7), 174.3 (C, C-1), 173.6 (C, C-1′), 140.7 (CH, C-11), 136.7 (C, C-10), 130.6 (CH, C-9), 113.1 (CH_2, C-12), 66.2 (CH, C-5), 51.8 (-OCH_3, C-1′), 47.9 (CH_2, C-6), 47.1 (CH, C-8), 40.3 (CH_2, C-4), 40.2 (CH_2, C-2), 38.3 (CH_2, C-2′), 30.3 (CH, C-3), 16.4 (CH_3, C-13), 12.4 (CH_3, C-14). The above data is consistent with literature data (Urakawa et al., 1993).

The Compound **1** was dissolved in DMSO and initially screened at a concentration of 40 μM. The two positive compounds control, DOX and TAX (Newman, 2016; Newman & Cragg, 2020), were tested at a concentration of 10 μM. Each well had a final volume of 200 μL, and each treatment was set up performed in triplicate. The inhibitory activity of the compound on against five tumor cell lines was detected evaluated by the MTT method assay. It was found that compound **1** exhibited signifficant significant inhibitory activity against the in vitro tumor growth of A549 and K562 cells, so further screening was conducted. Compound **1** displayed significant inhibitory effects on the in vitro tumor growth of A549 (human lung adenocarcinoma cell line) and K562 (human chronic myeloid leukemia cell line) cells, therefore warranting additional screening to explore its potential. Cells were seeded at a density of 5 × 10^3 per well in 96-well plates (A549 in DMEM and K562 in RPMI-1640, both containing 10% FBS), and pre-cultured for 24 hours. A549 and K562 cells were separately seeded into 96-well plates at a density of 5 × 10^3 cells per well. A549 cells were maintained in DMEM medium, while K562 cells were cultured in RPMI-1640 medium, with both media supplemented with 10% FBS. The cells were then preincubated for 24 hours prior to subsequent treatments. Then, compound **1** at gradient concentrations was added to each well with a final volume of 200 μL (DMSO final concentration ≤ 0.1%). Compound **1** was added to each well at a range of concentrations (40, 8, 1.6, 0.32, 0.064 μM) to achieve a final volume of 200 μL (final DMSO concentration ≤ 0.1%).

After incubation at 37°C for 48 hours, the supernatant was aspirated from adherent A549 cells, and 110 μL of a mixture of fresh medium and 20 μL MTS reagent was added to each well, while 100 μL of the supernatant was removed from suspension K562 cells followed by the addition of 20 μL MTS reagent per well. The cells were then incubated further for 4 hours, and the absorbance (OD) at 492 nM was measured using a microplate reader (MULTISKAN FC). Cell viability was calculated using the formula: Viability (%) = [($OD_{treatment}$ −

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Table 2. Comparison Table of C5 chemical shift values of glutarimide compounds

Compound name	δ_c (ppm)	Configuration	Solvent
1	73.1	α-OH	$CDCl_3$
Streptimidone (Shoemaker, 2006)	64.6	β-OH	$CDCl_3$
Hydroxyiso-9-methylstreptimidone (Stoddart, 2011)	66.8	β-OH	CD_3OD
9-Methylstreptimidone (Tang et al., 2024)	64.8	β-OH	$CDCl_3$
Lactimidomycin (Wang et al., 2021)	67.1	β-OH	$CDCl_3$
Cycloheximide (Wang et al., 2021)	65.2	β-OH	DMSO-d_6
Iso-Migrastatin (Wei et al., 2024)	67.1	β-OH	$CDCl_3$
Gladiostatin (Zhao et al., 2019)	65.8	β-OH	$CDCl_3$
2 (Urakawa et al., 1993)	65.5	β-OH	D_2O/CD_3OD = 3/1
3 (Urakawa et al., 1993)	65.5	β-OH	D_2O/CD_3OD = 3/1
4 (Urakawa et al., 1993)	66.2	β-OH	$CDCl_3$

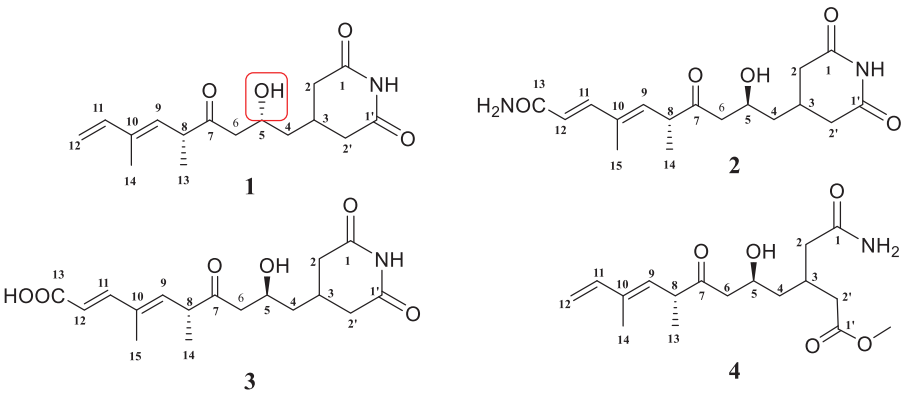

Figure 4. Structures of compounds **1–4**

Table 3. Cytotoxic activities of compound **1** (IC_{50}, μmol/L)

Compound	K562	A549
1	4.840 ± 0.329	6.036 ± 0.157
DOX	0.256 ± 0.020	0.569 ± 0.021
Taxol	<0.016	<0.016

$OD_{solvent})/(OD_{control} - OD_{solvent})] \times 100$. The half-maximal inhibitory concentration (IC_{50}) values were determined by fitting the dose-response curves with GraphPad Prism 9.0 software (Sciaccotta et al., 2024).

More precisely, compound **1** potently inhibited the proliferation of K562 (IC_{50} = 4.840 ± 0.329 μmol/L) and A549 (IC_{50} = 6.036 ± 0.157 μmol/L) cell lines. Doxorubicin was used as the positive control, which showed IC_{50} values of 0.256 ± 0.020 μmol/L and 0.569 ± 0.021 μmol/L against the two cell lines, respectively (Table 3).

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Author Contributions

Zi-Kang Zhao and Lin-Fang Tang conducted the experiments, processed the data. Zi-Kang Zhao, Yuan Chen, and Han-Jun Guo wrote the original draft. Mingming Cao supplied the experimental support and guided the experiments. Meng-Meng Hu, Yu-Bing Hong, and Rong Zhao reviewed the manuscript for errors. Lin-Fang Tang and Jia Chen verified the spectral data of the compounds. Jia Chen and Yan-Yun Che supervised and guided the experiments.

Availability of Data and Materials

The authors declare that the data supporting the findings of this study are available within the paper and its Supplementary Information files. Should any raw data files be needed in another format they are available from the corresponding author upon reasonable request. Source data are provided with this paper.

Conflicts of Interest

The authors declare that they have no competing financial interests.

Supporting Information

Supporting Information accompanies this paper on http://www.acgpubs.org/journal/records-of-natural-products.

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