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▶ **To cite this version:**

Xilong Liu, Haibo Wu, Xiaojun Tao, Xixiang Ying, Didier Stien. Two amide glycosides from Portulaca oleracea L. and its bioactivities. Natural Product Research, 2021, 35, pp.2655-2659. 10.1080/14786419.2019.1660333 . hal-02331754

**HAL Id: hal-02331754**
**https://hal.science/hal-02331754**

Submitted on 24 Oct 2019

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**Two amide glycosides from *Portulaca oleracea* L. and its bioactivities**

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**Abstract**

Two novel amide glycosides, named oleraciamide E (**1**) and oleraciamide F (**2**), were isolated from the *Portulaca oleracea* L. Their structures were determined by means of 1D and 2D NMR spectroscopic and UHPLC-ESI-TOF-MS methods. Oleraciamide E (**1**) exhibited anticholinesterase activity with IC50 values of 52.43 ± 0.33 μM, and presented scavenging activity in 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical quenching assay with the $IC_{50}$ values of 24.64 ± 0.33 μM.

**Keywords**: *Portulaca oleracea* L.; amide glycosides; anticholinesterase activity; antioxidant activity

## 1. Introduction

*Portulaca oleracea* L. is an annual succulent herb belonging to a member of the Portulacaceae family, which is widely distributed in different geographical environments all over the world (Zheng et al. 2018). In China, *P. oleracea* L. has been used as a traditional Chinese medicine (TCM) for thousands of years (Lei et al. 2015) because it exhibits many pharmacological effects, such as anti-inflammatory (Meng et al. 2016), antibacterial (Chan et al. 2015), anticholinesterase (Xiu et al. 2018), antioxidant (Lim et al. 2007), antitumor (Shen et al. 2013), neuroprotective (Sumathi et al. 2016), and so on. Therefore, more and more scholars paid more attention on its therapeutic substances, until now, many active ingredients have been isolated from the plants, for instance, alkaloids (Jiao et al. 2015, Li et al. 2016, Li et al. 2017, Xu et al. 2017, Jiang et al. 2018, Zhao et al. 2018, Zhao et al. 2019, Ma et al. 2019), flavonoids (Yang et al. 2018, Yang et al. 2018), organic acids (Wang et al. 2017), terpenoids (Xin et al. 2008), lignans (Ma et al. 2018), etc. This study is aim to isolate the bioactive substance from *P. oleracea* L. and investigate their activities. As a result, two novel amide glycosides named oleraciamide E (**1**) and oleraciamide F (**2**), shown in Figure 1, were isolated from the *P. oleracea* L., furthermore, the antioxidant and anticholinesterase activities of oleraciamide E (**1**) were studied.

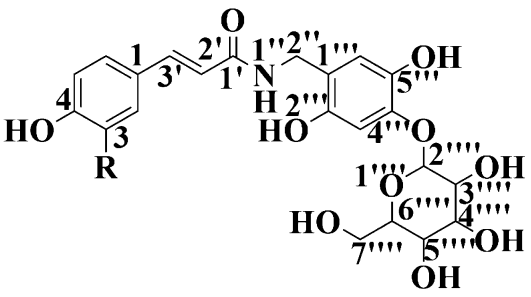


**Figure 1**. Structure of compounds **1** and **2**.

## 2. Results and discussion

Compound **1** was obtained as yellow green powder turned orange when sprayed Dragendorff's reagent. UV (MeOH) $\lambda_{max}$ 310 nm. IR (KBr) $\nu_{max}$ 3382，3256，2920，2849，1607，1514，1490，1443，1389，1175，1028，998，831 and 773 $cm^{-1}$. The molecular formula of compound **1** was identified as $C_{22}H_{25}NO_{10}$ with 11 degrees of unsaturation, which was deduced from the NMR data (Table S1, in supplementary material) and UHPLC-ESI-TOF-MS at *m/z* 464.1547 $[M+H]^+$ (calcd 464.1552). According to the $^{13}C$ NMR, the DEPT 135 and the HSQC spectra, Compound **1** possesses 22 carbon signals, including 2 methylenes ($\delta_C$ 33.5, 62.6), 13 methines including 5 aliphatic carbons ($\delta_C$ 69.2, 73.5, 76.0, 77.0, 104.2) and 8 olefinic carbons ($\delta_C$ 108.6, 111.7, 115.7, 118.0, 129.4, 139.9, in which 115.7 and 129.4 were overlapped), 7 quaternary carbons, including 1 carbonyl carbon ($\delta_C$ 163.9) and 6 olefinic carbons ($\delta_C$ 126.1, 126.2, 136.1, 143.2, 143.6, 159.1). The $^1H$ NMR (600 MHz, DMSO-$d_6$) and $^{13}C$ NMR (150 MHz, DMSO-$d_6$) data are listed in (Table S1, in supplementary material). An AA′BB′ spin was established by the hydrogen signals at $\delta_H$ 6.78 (2H, d, J = 8.28Hz), $\delta_H$ 7.41 (2H, d, J = 9.36 Hz) and the carbon signals at $\delta_C$ 115.7 (C-3 and C-5, overlapped), $\delta_C$ 129.4 (C-2 and C-6, overlapped). The $^{13}C$ NMR signal C-4 ($\delta_C$ 159.1) locates at low field area indicated that C-4 connected with a hydroxyl. The HMBC correlations from H-3′ to C-2, C-6, and from H-2′ to C-1, and from H-3, H-5 to C-1, revealed direct connection of H-3′ with C-1. The $^1H$ NMR signal indicated that H-2′ ($\delta_H$ 6.68, 1H, d, J = 15.24 Hz), H-3′ ($\delta_H$ 7.39, 1H, d, J = 15.50 Hz) belonged to trans double bond. The HMBC correlations from H-2′, H-3′ to the

carbonyl at C-1′ ($\delta_C$ 163.9) indicated that the double bond linked to the amide carbonyl (δC 163.9). The HMBC correlations from H-2′ to C-2″ indicated that C-2″ linked to the amide group. The signals at H-3‴ (1H, s, $\delta_H$ 8.12), H-6‴ (1H, s, $\delta_H$ 6.64) are typical of a tetrasubstituted aromatic ring. The $^{13}$C NMR signal C-2‴ ($\delta_C$ 143.6), C-5‴ ($\delta_C$ 143.2) at low field area indicated that C-2‴, C-5‴ linked to hydroxyl. The HMBC correlations from H-6‴ to C-2″ and from H-2″ to C-2‴, and from H-2″ to C-1‴, indicated that C-2″ linked to C-1‴. The HMBC correlations from H-2⁗ to the carbon at C-4‴ ($\delta_C$ 104.2), the NOESY correlations from H-2⁗ to H-3‴ and the coupling constant of H-2⁗, 6.84 indicated that C-4‴ linked to β-D-glucose. Overall, compound **1** was identified as the (*E*)-*N*-(2,5-dihydroxy-4-((3,4,5-trihydroxy-6-(hydroxymethyl)tetrahydro-2*H*-pyran-2- yl)oxy)benzyl)-3-(4-hydroxyphenyl)acrylamide, named oleraciamide E (**1**) (Experimental section, in supplementary material).

Compound **2** was obtained as yellow green powder turned orange when sprayed Dragendorff's reagent. its molecular formula was identified as $C_{23}H_{27}NO_{11}$ with 11 degrees of unsaturation only by comparing the $^1$H-$^1$H COSY and ROESY data with compound **1** due to its low content (Table S2, in supplementary material), additionally, it was deduced from the UHPLC-ESI-TOF-MS at *m/z* 314.1024 [M-$C_6H_{12}O_6$+H]$^+$ (calcd 314.1023) (Figure S21, in supplementary material). Compared the $^1$H NMR and $^1$H-1H COSY signal with compound **1**, H-2′ ($\delta_H$ 6.73, 1H, d, J = 15 Hz), H-3′ ($\delta_H$ 7.39, 1H, d, J = 15 Hz) belonged to trans double bond of the compound **2**, and the H-2 (1H, s, $\delta_H$ 7.16), H-5 (1H, d, $\delta_H$ 7.02) and H-6 (1H, d, $\delta_H$ 6.79) were the signals of 1,3,4-tribstituted aromatic ring. The signals $\delta_C$ 55.0/$\delta_H$ 3.80 (3H, s) are typical of a methoxy group, and a methoxy group can be placed in C-3 based on the

ROESY correlation of the methyl protons with H-2 also indicated that the compound has a 3-spin system. Taken together, compound **2** was identified as the (*E*)-*N*-(2,5-dihydroxy-4-((3,4,5-trihydroxy-6-(hydroxymethyl)tetrahydro-2*H*-pyran-2-yl)oxy)benzyl)-3-(4-hydroxy-3-methoxyphenyl)acrylamide, named oleraciamide F (**2**) (Experimental section, in supplementary material).

Alzheimer's disease (AD), an irreversible progressive neurodegenerative disorder of the central nervous system (CNS), is characterized by a gradual loss of cognitive ability in the elderly (Jiang et al. 2018). At present, clinical treatment strategies for AD are used mainly to improve cholinergic neurotransmission in the brain, and these treatments are mostly based on the cholinergic hypothesis (Hu et al. 2019). Acetylcholinesterase (AChE) plays a significant role in the termination of nerve impulse transmission at the cholinergic synapses by rapid hydrolysis of acetylcholine (ACh) (Yang et al. 2012), AChE inhibitors are therefore being the first choice of drugs for the treatment of AD (Kaufmann et al. 2016). In this study, compound **1** exerted an inhibitory activity against the AChE with dose-dependent (Figure S14, in supplementary material) with the $IC_{50}$ values of 52.43 ± 0.33 μM (Table S3, in supplementary material). The antioxidant activity of the compound **1** was performed using the DPPH radical scavenging method (María I. Gil et al. 2000). The results indicated that compound **1** presented higher antioxidant activity than that of BHA (Table S4, in supplementary material) as its phenolic hydroxyl groups played an important role in scavenging DPPH radical (Yang et al. 2009), and the antioxidant activity of compound **1** was dose-dependent (Figure S15, in supplementary material).

## 3. Conclusion

In this study, two novel amide glycosides, oleraciamide E and oleraciamide F possessing similar structures, were isolated from *P. oleracea* L. for the first time, and compound **1** presented remarkably anticholinesterase and antioxidant effects.

## Supplementary material

Supporting information can be found in the online version of this article.

## Disclosure statement

The authors have no conflicts of interest to disclose.

## Acknowledgements

This work was supported by the National Natural Science Foundation of China (Grant 81573546).

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