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Short communication

Isolation of erythrinan alkaloids from the leaves and flowers of *Erythrina speciosa*

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ABSTRACT

In this paper, we describe the extraction of three alkaloids from the leaves and flowers of *Erythrina speciosa*, a plant documented in the literature to possess a range of potential medicinal applications. Two alkaloids were isolated from both leaves and flowers, with erythrartine being isolated from both plant parts. In agreement with the literature, we also isolated erysotrine from the flowers. The second alkaloid isolated from the leaves, and reported in this species for the first time, was (+)-11β-hydroxyerysotramidine.

Introduction

The genus *Erythrina*, containing about 110 species, is a division of the Fabaceae with a wide distribution across tropical and sub-tropical regions of the world (Medina et al., 2009; Krukoff and Barneby, 1974; Hussain et al., 2016). The genus is rich in bioactive secondary metabolites, notably alkaloids (Soto-Hernandez and Jackson, 1994), but also terpenes and phenolics, particularly flavonoids. Members of the genus are used in traditional medicine throughout South America for a diverse array of indications, including analgesic and anti-inflammatory effects. We were particularly interested in *Erythrina speciosa*, a member of the genus distributed throughout southern and south-eastern Brazil. This particular species is used traditionally for anti-microbial, anti-parasitic, respiratory, digestive and fertility purposes (Daniel et al., 2014) and has been scientifically investigated for its anti-trypanosomal potential (Graça de Souza et al., 2011). *E. speciosa* is known to contain alkaloids in both its leaves and flowers and a galactose-binding lectin in its seeds (Konozy et al., 2003), but has not been completely profiled phytochemically to date.

Materials and methods

The fresh leaves and flowers of *Erythrina speciosa*, Andrews, Fabaceae, were collected from the university botanic collection at UNESC (longitude 49.4084° W and latitude 28.7013° S), Criciúma, Santa Catarina, Brazil, in November 2015. The plant was authenticated and a voucher specimen (CRI 468) deposited at the UNESC Herbarium Pe. Raulino Reitz. The plant material (leaves and flowers, separately) was washed under running water, air-dried at room temperature and coarsely ground. Before extraction, the comminuted plant material was immersed in cyclohexane for two 24-h periods. Thereafter, the plant material was extracted using 50 ml of ethanol (70% v/v) over 72 h. The hydroalcoholic extract thus obtained was acidified with acetic acid. The material was then subject to mechanical agitation for several hours, filtered, and the filtrate basified with NH_4OH to pH 10, extracted with dichloromethane (2× 30 ml) and the organic layer evaporated to afford a crude residue, which was dried *in vacuo*. The dried extracts were weighed, yielding 9.8 mg from the flowers and 11.8 mg from the leaves. The ^{1}H and ^{13}C NMR spectra of the isolated compounds were recorded on a Bruker Avance 400 spectrometer at 400 MHz and 100 MHz, respectively, in $CDCl_3$, using tetramethylsilane (TMS) as the internal standard. MS data were recorded on an LC–MS spectrometer using a Waters 2690 instrument.

Results and discussion

The ethanolic extracts of the leaves and flowers of *E. speciosa* were acidified with acetic acid, filtered, basified with NH_4OH, sequentially extracted with dichloromethane and evaporated, and the organic extracts thus obtained were separated using a combination of flash and micro-scale column chromatography to yield three alkaloids, two each from the leaves and flowers. In agreement

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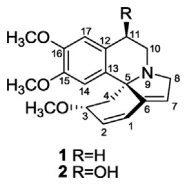

Fig. 1. Erythrinan alkaloids isolated from leaves and flowers of *E. speciosa*.

with the work of Faria et al. (2007), the floral alkaloids proved to be erysotrine **1** and erythrartine **2** (Fig. 1).

Compounds **1** and **2** had very similar proton NMR spectra, broadly in agreement with literature values (see supplementary material for complete spectroscopic data). The key distinctions between the proton spectra of the two compounds were firstly the signal at 4.64 ppm in **2** for H-11, with a coupling constant suggestive of a β-disposition of the hydroxyl group (Isobe et al., 1994) and secondly, the downfield shift of H-17 in the aromatic region of **2**, due to its proximity to the benzylic hydroxyl. The carbon NMR of compounds **1** and **2** each had 19 signals, consistent with the MS results (molecular ion peaks for **1** and **2** corresponding to the molecular formulae $C_{19}H_{23}NO_3$ and $C_{19}H_{23}NO_4$). In both spectra, six were quaternary signals, including that of the characteristic spiro carbon 5 at 66.7 and 66.2 ppm, respectively. Inspection of the DEPT spectra revealed **1** to have three methoxyl carbons, four methylenes and one methine signal, while **2** had one less methylene and one additional methine signal for C-11 at 64.7 ppm. The more polar of the two isolated alkaloids in both flowers and leaf extracts proved upon isolation to be the same alkaloid, namely erythrartine **2**. To our knowledge, this alkaloid has been previously reported from the flowers of *E. speciosa*, but not the leaves. The second leaf alkaloid isolated displayed further functionalisation of the erythrinan skeleton. Aligned with the observations of Juma and Majinda (2004), the ^{1}H and ^{13}C NMR data of **3** are very similar to those of erysotramidine (Fig. 2) (Amer et al., 1991), including the key lactam carbonyl for C-8 at 171.2 ppm.

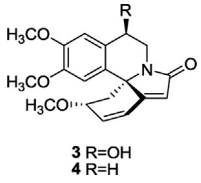

Fig. 2. Erysotramidine.

Also, analogously to comparing **1** with **2**, the C-11 methylene signal of erysotramidine at 27.0 ppm (L'Homme et al., 2014) is replaced by an oxymethine signal, confirmed in the DEPT90, at 66.9 ppm, while the C-11 proton signal at 4.77 ppm, with a coupling pattern very similar to that in **2**, also suggested a β-disposition at this position. The resonance positions of protons of H-1, H-2 and H-7 in **3**, when compared to those of **1** and **2**, are seen to be shifted downfield, due to the influence of the carbonyl, as are the signals for the other neighbouring protons at C-10. The literature (Isobe, 1994; Juma and Majinda, 2004) reports H-1 and H-2 at 6.85 and 6.32 ppm, respectively, both following the detailed observations of Tsuda et al. (1993). The downfield shift of H-17 due to the C11-hydroxy as seen in **2** is mirrored in the spectrum of **3**. The complete assignment of this alkaloid, identified as (+)-11β-hydroxyerysotramidine (**3**), was performed by amalgamating the information drawn from the COSY, HMBC and HSQC spectra. Key HH-COSY and HMBC correlations for compound **3** are shown in the supplementary material.

Erysotrine (**1**): This compound was obtained as a brown oil; NMR: see Tables S1 and S2 (Supporting Information); $C_{19}H_{23}O_3N$; HRMS-ESI: $[M+H]^+$ for $C_{19}H_{24}O_3N$: 314.1751; found: 314.1761.

Erythrartine (**2**): This compound was obtained as a brown oil; NMR: see Tables S1 and S2 (Supporting Information); $C_{19}H_{23}O_4N$; HRMS-ESI: $[M+H]^+$ for $C_{19}H_{24}O_4N$: 330.1700; found: 330.1716.

Hydroxyerysotramidine (**3**): This compound was obtained as a brown oil; NMR: see Tables S1 and S2 (Supporting Information); $C_{19}H_{21}O_5N$; HRMS-ESI: $[M+Na]^+$ for $C_{19}H_{21}O_5NNa$: 366.1312; found: 366.1317.

Previously, Faria et al. (2007) has described the isolation of **1** and **2** from the flowers of *E. speciosa*; however, in their work the only isolated leaf alkaloid reported was the tetrahydroisoquinoline nororientaline. Our paper presents the first isolation of (+)-11β-hydroxyerysotramidine (**3**) from *E. speciosa*. To date, this alkaloid has only been documented in the African species *E. lysistemon* (Juma and Majinda, 2004) and *E. latissimi* (Cornelius et al., 2009); in the latter of these works it was demonstrated to possess anti-feedant activity.

Author contributions

PA conceptualised the study and contributed to isolation and purification. AA participated in collection of the plant sample and identification. JB contributed to purification, structure elucidation studies and preparation of the manuscript. All the authors have read the final manuscript and approved the submission.

Conflicts of interest

The authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.bjp.2019.01.007.

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