TẠP CHÍ KHOA HỌC
TRƯỜNG ĐẠI HỌC SƯ PHẠM TP HỒ CHÍ MINH
Tập 19, Số 6 (2022): 908-914
Website: https://journal.hcmue.edu.vn
ISSN: 2734-9918

HO CHI MINH CITY UNIVERSITY OF EDUCATION
JOURNAL OF SCIENCE
Vol. 19, No. 6 (2022): 908-914
https://doi.org/10.54607/hcmue.js.19.6.3413(2022)

Research Article

MEGASTIGMANE DERIVATIVES FROM FLOWERS OF *TECOMA STANS*

***Nguyen Thi Hoai Thu*[1], *Nguyen Tuan Dat*[2], *Pham Mai Dang Truong*[2], *Duong Thuc Huy*[2*]**

[1]*University of Medicine and Pharmacy at HCMC, Vietnam*

[2]*Ho Chi Minh City University of Education, Vietnam*

[*]*Corresponding author: Duong Thuc Huy – Email: huydt@hcmue.edu.vn*

Received: April 06, 2022; Revised: April 26, 2022; Accepted: April 28, 2022

ABSTRACT

*Tecoma stan is a tropical plant widely used in Asian folk medicine. However, little is known about the phytochemical data of the plant growing in Vietnam. In the present study, the phytochemical analysis of the flowers of T. stans collected in Vietnam was conducted using multiple chromatographic methods. The chemical structures of isolated compounds were identified by comprehensive spectroscopic methods. Three megastigmanes dehydrovomifoliol (**1**), vomifoliol (**2**), and dendranthemoside B (**3**) were isolated from the flowers of Tecoma stans (Bignoniaceae) by different chromatographic techniques. Their chemical structures were elucidated through the spectroscopic methods along with the comparison of their NMR data with the published data. To the best of our knowledge, compounds **1-3** were known to present in this species for the first time.*

Keywords: Bignoniaceae; megastigmane; *Tecoma stans*

1. Introduction

The genus *Tecoma* (Bignoniaceae) consists of 14 widely distributed species in tropical and subtropical regions (Anand et al., 2021). *Tecoma stans* (L.) is used as traditional medicine in many countries for treatments of pain, dysentery, gastrointestinal ulcers, urinary disorders, skin infection, parasitic infection, and rheumatic diseases (Taher et al. 2016, Mohamed et al. 2013, Anand et al. 2021). Its leaves and bark extracts have been proved for their effectiveness in hepatoprotective, cytotoxicity against breast cancer, wound healing, antioxidant, antibacterial, and anti-fungal activities (Kameshwaran et al., 2013, Mohamed et al., 2013, Anburaj et al., 2016, Robinson et al., 2017). Floral extracts exhibited

Cite this article as: Nguyen Thi Hoai Thu, Nguyen Tuan Dat, Pham Mai Dang Truong, & Duong Thuc Huy (2022). Megastigmane derivatives from flowers of *Tecoma stans*. *Ho Chi Minh City University of Education Journal of Science, 19*(6), 908-914.

nephrotoxicity (Raju et al., 2011), hepatoprotective (Kameshwaran et al., 2013), antioxidant, and cytotoxic activity (Robinson et al., 2017). The previously chemical investigation obtained seven flavonoids (Marzouk et al., 2006, Srivastava et al., 1995), two carotenoids, and four glycosides (Anand et al., 2021) from *Tecoma stans* flowers. From flowers of *Tecoma stans* growing in Vietnam, five compounds (ursolic acid, 3-oxours-12-en-28-oic acid, chrysoeriol, ferulic acid, and tecomine) were isolated (Ha et al., 2021). This paper reported the isolation and structural elucidation of three megastigmanes from flowers of *Tecoma stans* collected in Ho Chi Minh City.

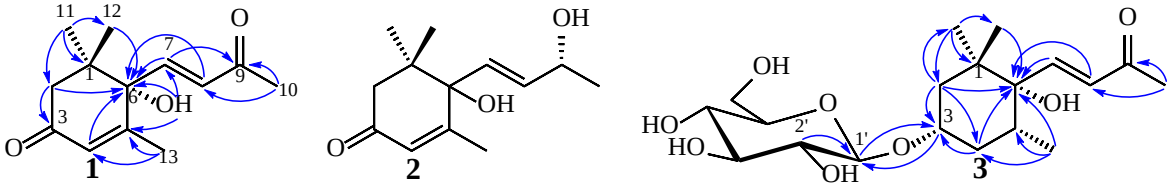

Figure 1. *Chemical structures of isolated compounds and some selected HMBC correlations of* ***1*** *and* ***3***

2. Experiments

2.1. General experimental procedures

The NMR spectra were recorded on a Bruker Avance 500 spectrometer (500 MHz for ^{1}H-NMR and 125 MHz for ^{13}C-NMR). *n*-Hexane, ethyl acetate (EtOAc), methanol (MeOH), and acetone were used to prepare extracts and to elute column chromatography and thin-layer chromatography. Thin-layer chromatography was carried out on silica gel 60 (Merck, 40-63 μm), and spots were visualized by spraying with 10% H_2SO_4 solution, followed by heating.

2.2. Plant material

Flowers of *Tecoma stans* (L.) were collected in Ho Chi Minh City, Vietnam between April and June 2020. The scientific name of the plant was authenticated by Dr. Dang Van Son, Institute of Tropical Biology, Vietnam. A voucher specimen (No. UP020) was deposited with the Department of Chemistry, Ho Chi Minh University of Education.

2.3. Extraction and isolation

Dried powder of *T. stans* flowers (4.5 kg) was macerated in acetone (3 x 10 L) for 24 hours, at ambient temperature. The filtrated solution was evaporated under reduced pressure to obtain a crude extract (207 g). This extract was separated into different polar extracts, including H (18 g), HEA (27 g), and EA (48.0 g) by the liquid-liquid partition method. Fraction HEA (27 g) was subjected to silica gel column chromatography (CC), using an isocratic mobile phase consisting of *n*-hexane: EtOAc: acetone (8:1:1, v/v/v) to obtain fractions HEA1 (3.3 g), HEA2 (7.1 g), HEA3 (8.2 g), HEA4 (5.9 g), and HEA5 (3.8 g).

Fraction HEA4 (5.9 g) was dissolved in methanol to obtain HEA4T as a solid and HEA4S in solution. The HEA4S (5.1 g) was subjected to Sephadex LH-20 gel chromatography, eluted with methanol, to obtain fractions S1-4. Fraction S2 (2.45 g) was subjected to silica gel CC using a solvent system of *n*-hexane: EtOAc (2:0.5, v/v), affording fractions S2.1-S2.9. Fraction S2.2 (1.12 g) was fractionated by silica gel CC eluted with the solvent system of *n*-hexane: EtOAc (5:0.5, v/v) to afford fractions S2.2.1-S2.2.9. Fraction S2.2.6 (142 g) was rechromatographed by silica gel CC using *n*-hexane: $CHCl_3$: EtOAc (2:0.4:0.6, v/v/v) as a mobile phase to give compounds **1** (7.6 mg) and **2** (4.2 mg). Fraction S4 (1.75 g) was subjected to silica gel CC and eluted with a gradient system of *n*-hexane: ethyl acetate (10:1-1:1, v/v), affording fractions S4.1- S4.5. Fraction S4.4 was applied to silica gel CC and eluted with *n*-hexane: $CHCl_3$: acetone: CH_3OH: H_2O (2:10:1:0.1:0.05, v/v/v/v/v) to obtain **3** (2.3 mg).

Dehydrovomifoliol (**1**). Colorless wax. $[\alpha]_D^{25}$ +295 (c 0.1, $CDCl_3$). The ^{1}H–NMR data (500 MHz, Acetone-d_6, δ ppm, J in Hertz): 7.02 (1H, d, 16.0 Hz, H-7), 6.40 (1H, d, 16.0 Hz, H-8), 5.86 (1H, s, H-4), 4.55 (1H, s, 6-OH), 2.58 (1H, d, 16.5 Hz, H-2a), 2.28 (3H, s, H-10), 2.24 (1H, d, 16.5 Hz, H-2b), 1.88 (3H, s, H-13), 1.08 (3H, s, H-11), 1.03 (3H, s, H-12). ^{13}C-NMR (125 MHz, Acetone-d_6, δ ppm): 197.6 (C-9), 197.0 (C-3), 161.5 (C-5), 147.1 (C-7), 131.7 (C-8), 128.0 (C-4), 79.3 (C-6), 50.2 (C-2), 41.8 (C-1), 27.5 (C-10), 24.7 (C-12), 23.5 (C-11), 18.9 (C-13) (Serra et al., 2007).

Vomifoliol (**2**). Colorless wax. $[\alpha]_D^{25}$ +187 (c 0.1, $CDCl_3$). The ^{1}H–NMR data (500 MHz, Acetone-d_6, δ ppm, J in Hertz): 5.86 (1H, dd, 15.5, 4.5 Hz, H-8), 5.84 (1H, d, 15.5 Hz, H-7), 5.78 (1H, m, H-4), 4.34 (1H, m, H-9), 4.11 (1H, s, 6-OH), 3.83 (1H, d, 4.0 Hz, 9-OH), 2.40 (1H, d, 16.5 Hz, H-2a), 2.12 (1H, d, 16.5 Hz, H-2b), 1.88 (1H, d, 1.5 Hz, H-13), 1.20 (3H, d, 6.5 Hz, H-10), 1.04 (3H, s, H-11), 1.00 (3H, s, H-12). ^{13}C-NMR (125 MHz, Acetone-d_6, δ ppm): 197.6 (C-3), 164.0 (C-5), 137.1 (C-7), 129.4 (C-8), 126.9 (C-4), 79.4 (C-6), 67.9 (C-9), 50.5 (C-2), 41.8 (C-1), 24.5 (C-12), 24.3 (C-10), 23.4 (C-11), 19.2 (C-13) (Tan et al., 2013).

Dendranthemoside B (**3**). $[\alpha]_D^{25}$ +93 (c 0.1, MeOH). Colorless wax. The ^{1}H–NMR data (500 MHz, Methanol-d_4, δ ppm, J in Hertz): 6.87 (1H, d, 16.0 Hz, H-7), 6.36 (1H, d, 16.0 Hz, H-8), 4.37 (1H, d, 8.0 Hz, H-1'), 3.89 (1H, m, H-3), 3.88 (1H, brd, 12.0 Hz, H-6'b), 3.66 (1H, dd, 12.0, 4.0 Hz, H-6'a), 3.14 (1H, dd, 9.0, 8.0 Hz, H-2'), 2.28 (3H, s, H-10), 2.12 (1H, m, H-5), 1.87 (1H, m, H-4a), 1.73 (1H, brd, 12.0 Hz, H-2a), 1.60 (1H, dd, 12.5, 4.0 Hz, H-2b), 1.50 (1H, m, H-4b), 1.05 (3H, s, H-11), 0.88 (3H, s, H-12), 0.81 (3H, d, 6.5 Hz, H-13). ^{13}C-NMR (125 MHz, Methanol-d_4, δ ppm): 200.9 (C-9), 154.3 (C-7), 131.6 (C-8), 102.7 (C-1'), 79.0 (C-6), 78.1 (C-3'), 77.9 (C-5'), 75.5 (C-3), 75.1 (C-2'), 71.7 (C-4'), 62.9 (C-6'),

42.4 (C-2), 40.9 (C-1), 37.9 (C-4), 35.3 (C-5), 27.4 (C-10), 25.9 (C-12), 25.1 (C-11), 16.5 (C-13) (Otsuka et al., 1992).

3. Results and discussion

Compound **1** was obtained as a colorless wax. At a low magnetic field, the ^{1}H-NMR spectrum of **1** displayed three olefinic methine proton signals, including two doublet signals possessing a large coupling constant at δ_H 7.02 (1H, d, 16.0 Hz, H-7) and 6.40 (1H, d, 16.0 Hz, H-8) of an E-configuration double bond which was adjacent to two quaternary carbons. The HMBC spectrum showed cross-peaks of two of these olefinic protons to an oxygenated carbon at δ_C 79.3 (C-6) and a carbonyl carbon at δ_C 197.6 (C-9) (Figure 1). Additionally, a deshielded methyl proton signal at δ_H 2.28 (3H, s, H-10) displayed the HMBC cross-peaks to both carbons at δ_C 131.7 (C-8) and 197.6 (C-9). These suggested the presence of a >C(OH)-CH=CH-CO-CH_3 moiety in the structure of compound **1**. The second deshielded methyl proton signal at δ_H 1.88 (3H, s, H-13) revealed the HMBC correlations to carbon C-6 and the remaining olefinic carbons at δ_C 161.5 (C-5, =C<) and 128.0 (C-4, =CH-); therefore, the connection of C-4, C-5, C-6, and C-13 were confirmed. The olefinic carbon C-5 (δ_C 161.5) resonating at a low magnetic field along with the observation of another carbonyl carbon at δ_C 197.0 (C-3) suggested the presence of a conjugated ketone (>C=CH-CO-) in its structure. At a high magnetic field, ^{1}H-NMR spectrum of **1** displayed two singlet gem–methyl signals at δ_H 1.08 (H-11) and 1.03 (H-12) of a >C(CH_3)$_2$ group. It also revealed two doublet gem–proton signals with a large coupling constant at δ_H 2.58 (1H, d, 16.5 Hz, H-2a) and 2.24 (1H, d, 16.5 Hz, H-2b), which had HSQC correlations with carbon signal at δ_C 50.2 (C-2) and HMBC correlations to carbons C–1 (δ_C 41.8, >C<), C-3, C-6, C-11, and C-12. Hence, the positions of these protons H-2, H-11, and H-12 were determined. The good correspondence of the ^{1}H, ^{13}C-NMR data of **1** with published data (Serra et al., 2007) suggested that **1** was 6-hydroxymegastigmane-4,7-diene-3,9-dione or dehydrovomifoliol.

Compound **2** was obtained as a colorless wax. The NMR spectral analysis of **2** indicated that it possessed a megastigmane skeleton due to 13 carbon signals. However, its ^{13}C-NMR spectrum showed one more oxygenated methine carbon at δ_C 67.9 of C-9 instead of a carbonyl carbon signal at δ_C 197.6 as in **1**. These suggested that the carbon C-9 of compound **2** was saturated by the addition of two hydrogens in comparison to that of **1**. It corresponded to the observation of the methyl proton signal H-10 appearing as a doublet signal and up-field shifting at δ_H 1.20 (3H, d, 6.5 Hz), along with the olefinic proton H-8 appearing as a doublet of doublets due to the coupling with the oxygenated methine proton H-9 and the olefinic proton H-7. Based on all data in the preceding text and the good compatibility of its NMR data with those published in the literature (Tan et al., 2013), **2** was determined to be vomifoliol.

Compound **3** was obtained as a colorless wax. Comparison of NMR data of **3** and **1** showed that they possessed many similar NMR signals of a 6-hydroxymegastigmane-7-ene-9-one. The difference was that **3** had one more sugar unit, which was demonstrated by the presence of an anomeric proton at δ_H 4.37 (1H, d, 8.0 Hz, H-1') with a large coupling constant of 8.0 Hz as well as a series of signals from 3.14 to 3.88 of carbinol protons of a β-sugar unit. It was further confirmed by the observation of six oxygenated carbon signals at δ_C 102.7 (C-1'), 75.1 (C-2'), 78.1 (C-3'), 71.7 (C-4'), 77.9 (C-5'), and 62.9 (C-6') which fitted nicely to those of β-D-glucose (Otsuka et al., 1992). Besides, the replacement of one carbonyl carbon (>C=O) and two olefinic carbons (-CH=CH<) by three saturated carbon signals at δ_C 75.5 (C-3, -CH(O)<), 37.9 (C-4, -CH_2-), and 35.3 (C-5, -CH<) suggested that **3** possessed a -CH(O)-CH_2-CH(CH_3)- moiety, instead of a -CO-CH=C(CH_3)- as in **1**. It corresponded to the methyl proton signal H-13 appearing as a doublet signal and resonating at a higher magnetic field at δ_H 0.81 (3H, d, 6.5 Hz). Moreover, these were further supported by the HMBC correlations of this methyl proton H-13 with carbons C-4, C-5, and C-6 (δ_C 79.0) and of both methylene protons at δ_H 1.87 (1H, m, H-4a) and 1.50 (1H, m, H-4b) with carbons C-3 and C-6. The position of the sugar unit was attached to C-3, which was demonstrated by the HMBC correlations of proton H-3 at δ_H 3.89 (1H, m, H-3) with the anomeric carbon C-1' and of the anomeric proton H-1' with carbon C-3. Based on aforementioned analysis and the good compatibility of NMR data of **3** with the published data (Otsuka et al., 1992), **3** was thus identified to be dendranthemoside B.

4. Conclusions

From the flower of *T. stans* in Ho Chi Minh City, three megastigmanes, including dehydrovomifoliol (**1**), vomifoliol (**2**), and dendranthemoside B (**3**) were isolated. Their chemical structures were determined by using NMR spectroscopic method as well as comparison with the literature. Compounds **1**-**3**, to the best of our knowledge, were isolated from the flower of *T. stans* for the first time. Further studies on this species are in progress.

❖ ***Conflict of Interest:*** *Authors have no conflict of interest to declare.*

❖ ***Acknowledgments:*** *This research was supported by University of Medicine and Pharmacy at Ho Chi Minh City, grant number 68/2022/HĐ-ĐHYD.*

REFERENCES

Anand, M., & Basavaraju, R. (2021). A review on phytochemistry and pharmacological uses of *Tecoma stans* (L.) Juss. ex Kunth. *Journal of Ethnopharmacology*, *265*, 113270.

Anburaj, G., Marimuthu, M., Rajasudha, V., & Manikandan Dr. R. (2016). *In vitro* anti-cancer activity *Tecoma stans* against human breast cancer yellow elder (*Tecoma stans*). *Journal of Pharmacognosy and Phytochemistry*, *5*(4), 331-334.

Ha, K. N., Nguyen, T. V. A., Mai, D. T., Tran, N. M. A., Nguyen, N. H., Vo, G. V., Duong, T. H., & Nguyen, H. T. (2021). Alpha-glucosidase inhibitors from *Nervilia concolor, Tecoma stans, and Bouea macrophylla*. *Saudi Journal of Biological Sciences*, *29*, 1029-1042.

Kameshwaran, S., Kothai, A. R., Jothimanivannan, C., & Senthikumar, R. (2013). Evaluation of hepatoprotective active of *Tecoma stans* flowers. *Pharmacologia*, *4*, 236-242.

Marzouk, M. S., Gamal-Eldeen, A. M., Mohamed, M. A., & El-Sayed, M. M. (2006). Antioxidant and anti-proliferative active constituents of *Tecoma stans* against tumor cell lines. *Natural Product Communications*, *1*, 735-743.

Salem, M. Z. M., Gohar, Y. M., Camacho, L. M., EI-Shanhorey, N. A., & Salem, A. Z. M. (2013). Antioxidant and antibacterial activities of leaves and branches extracts of *Tecoma stans* (L.) Juss. ex Kunth against nine species of pathogenic bacteria. *African Journal of Microbiology Research*, *7*(5), 418-426.

Otsuka, H., Takeda, Y., Yamasaki, K., & Takeda, Y. (1992). Structural elucidation of dendranthemosides A and B: Two new β-ionone glucosides from *Dendranthema shiwogiku*. *Planta Medica*, *58*(4), 373-375.

Raju, S., Kavimani, S., Uma Maheshwara rao, V., Sreeramulu Reddy, K., & Vasanth Kumar, G. (2011). Floral extract of *Tecoma stans*: A potent inhibitor of gentamicin-induced nephrotoxicity *in vivo*. *Asian Pacific Journal of Tropical Medicine*, *4*, 680-685.

Robinson, J. P., Suriya, K., Subbaiya, R., & Ponmurugan, P. (2017). Antioxidant and cytotoxic activity of *Tecoma stans* against lung cancer cell line (A549). *Brazilian Journal Pharmaceutical Sciences*, *53*, 1-5.

Serra, S., Barakat, A., & Fuganti, C. (2007). Chemoenzymatic resolution of *cis*- and *trans*-3,6-dihydroxy-α-ionone. Synthesis of the enantiomeric forms of dehydrovomifoliol and 8,9-dehydrotheaspirone. *Tetrahedron: Asymmetry*, *18*, 2573-2580.

Srivastava, B. K., & Reddy, M. V. R. K. (1995). Flavonoids from the flower extract of *Tecoma Stans*. *Asian Journal of Chemistry*, *7*, 679-680.

Taher, M. A. H., Dawood, D. H., Sanad, M. I., & Hassan, R. A. (2016). Searching for anti-hyperglycemic phytomolecules of *Tecoma stans*. *European Journal of Chemistry*, *7*, 397-404.

Tan, M. A., Eusebio, J. A., Villacorta, R. A. P., Kogure, N., Takayama, H., & Alejandro, G. J. D. (2013). Isolation and Identification of Vomifoliol from Two Endemic Philippine Rubiaceae Species, *Psychotria gitingensis* and *Villaria odorata*. *Asia Pacific Journal of Science, Mathematics and Engineering (APJSME)*, *1*(1), 1-3.

MỘT SỐ DẪN XUẤT MEGASTIGMANE TỪ HOA *TECOMA STANS*

***Nguyễn Thị Hoài Thu*[1], *Nguyễn Tuấn Đạt*[2], *Phạm Mai Đăng Trường*[2], *Dương Thúc Huy*[2*]**

[1]*Trường Đại học Y Dược Thành phố Hồ Chí Minh, Việt Nam*

[2]*Trường Đại học Sư phạm Thành phố Hồ Chí Minh, Việt Nam*

[*]*Tác giả liên hệ: Dương Thúc Huy – Email: huydt@hcmue.edu.vn*

Ngày nhận bài: 06-4-2022; ngày nhận bài sửa: 26-4-2022; ngày duyệt đăng: 28-4-2022

TÓM TẮT

*Tecoma stans là một loại cây nhiệt đới được sử dụng rộng rãi trong y học dân gian châu Á. Có rất ít về dữ liệu thành phần hóa học của loài cây sinh trưởng ở Việt Nam. Trong nghiên cứu này, thành phần hóa học của hoa T. stans thu hái ở Việt Nam được thực hiện bằng nhiều phương pháp sắc kí khác nhau. Cấu trúc hóa học của các hợp chất phân lập được xác định bằng phương pháp phổ nghiệm. Ba hợp chất megastigmane (bao gồm dehydrovomifoliol (**1**), vomifoliol (**2**), và dendranthemoside B (**3**)) được cô lập từ hoa Huỳnh liên Tecoma stans (họ Bignoniaceae) bằng các kĩ thuật sắc kí. Cấu trúc hóa học của các hợp chất được xác định bằng các phương pháp phổ nghiệm kết hợp so sánh với tài liệu tham khảo. Hợp chất **1-3** lần đầu tiên được biết có hiện diện trong hoa Tecoma stans*.

Từ khóa: Bignoniaceae; megastigmane; *Tecoma stans*