WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
Coden USA: WJPRAP
Impact Factor 8.63
Volume 15, Issue 10, 1155-1163.
Research Article
ISSN 2277–7105

INHIBITORY CAPACITY OF XANTHINE OXIDASE OF COMPOUNDS FROM ROOTS OF THE *BOEHMERIA NIVEA* (L.) GAUDICH

Thi-Ngoc Lanh[1], Thi-Lan Dinh[2], Quang-Ung Le*[1]

[1]Thai Nguyen University of Agriculture and Forestry, Vietnam.
[2]University of Science Thai Nguyen University, Vietnam.

Article Received on 15 April 2026,
Article Revised on 05 May 2026,
Article Published on 16 May 2026,

https://doi.org/10.5281/zenodo.20205844

***Corresponding Author**
Quang-Ung Le
Herbal Medicine expert, Thai Nguyen University of Agriculture and Forestry, Vietnam.

How to cite this Article: Thi-Ngoc Lanh, Thi-Lan Dinh, Quang-Ung Le. (2026). Inhibitory Capacity of Xanthine Oxidase of Compounds from Roots of the Boehmeria nivea (l.) Gaudich. World Journal of Pharmaceutical Research, 15(10), 1155–1163.

ABSTRACT

The roots of *Boehmeria Nivea* (L.) Gaudich is used to treat rheumatoid arthritis in Vietnam. The evaluation of the xanthine oxidase inhibitory capacity of compounds and root extracts was firstly studied in this work. Two compounds of (+)-isolariciresinol and gingerglycolipid A were identified in the roots. The EtOAc fraction exhibited the highest xanthine oxidase inhibitory activity compared to the n-hexan and water fractions. The capacity of xanthine oxidase enzyme inhibitory was detected from (+)-Isolariciresinol, Gingerglycolipid A and E70, with IC_{50} of 6.46 ± 0.22; 14.32 ± 0.36; 31.66 ± 0.13 µg/ml, respectively. The present work suggested that *Boehmeria Nivea* (L.) Gaudich could be a precious herb for gout patients.

KEYWORDS: *Boehmeria Nivea, enzyme xanthine oxidase, gout.*

INTRODUCTION

In the body, xanthine oxidase (XO) is a critical enzyme catalyzing the oxidation of xanthine to uric acid which may cause hyperuricemia.[1,2] The XO inhibitors reducing biosynthesis of uric acid have been used to prevent and treat gout. The study of useful natural products for gout prevention and treatment have highly required in order to replace synthesized antihyperuricemic drugs with side effects and toxicity.

Boehmeria nivea (L.) Gaudich, called La Gai in Vietnam, belongs to the family Urticaceae. Its leaves are used to make traditional cakes in Vietnamese cuisine, while the radices of the plant are used in traditional medicine to help stabilize pregnancy, stop bleeding, clear heat, detoxify the body, and promote urination. In particular, some ethnic minority communities use the radices to treat rheumatoid arthritis. However, the pharmacological effects of *Boehmeria nivea* (L.) Gaudich have not been extensively studied. Former works have revealed that this herb has some potential pharmacological properties incuding inflammatory[3]; oral cancer cells growth inhibitory[4]; antioxidant, neuroprotective, and estrogenic activity.[5]

This study is the first to evaluate the XO inhibitory of root ethanol extract of the Boehmeria Nivea (L.) Gaudich (BN), as well as its isolated chemical constituents. The present findings highlight the promise of Boehmeria Nivea (L.) Gaudich as a comprehensive therapeutic agent for gout treatment.

MATERIALS AND METHODS

Chemicals, reagents and instruments

The chemicals and reagents comprised xanthine oxidase (XO), xanthine (>99%), allopurinol. Organic solvents were used for extraction and chromatographic separation such as ethanol 95% (EtOH), methanol 95% (MeOH), ethyl acetate (EtOAc), and methylene chloride (DCM). The main instruments are such as rotary evaporator; normal-phase silica gel, reversed-phase silica gel (RP-18), and Sephadex LH-20 for column chromatography; TLC plates (silica gel 60 F254 and RP-18 F254s); and high-performance liquid chromatography (HPLC) systems, along with other equipments.

Plant materials

The Roots of BN were gathered from Thai Nguyen provinces, Vietnam. The plant materials were taxonomically authenticated by Dr. Quang Ung Le, in partnership with the Classification and Identification Committee of the Faculty of Agriculture Technology, Thai Nguyen University of Agriculture and Forestry.

Extraction and isolation

Two grams of the BN radices dry powder were extracted three times with ethanol 70% (v/v) (E70) by ultrasonic and then supernatant was filtered to combine filtrates that were concentrated in a vacuum evaporator at 45^{o}C. The solvent free extracts were dried to calculate yield of the dehydrated fractionation, then stabilized in DMSO to preparing for evaluating the XO inhibitory.

Five kilograms of BNR powder were exhaustively extracted with 15 L 95% MeOH by ultrasonic (three times, 90 min each at 40 °C). The combined MeOH extracts were condensed under reduced pressure to obtain a dark crude extract (BNM extract 430.0 g). The MeOH extract was suspended in water and successively extracted with n-hexane followed by ethyl acetate, affording the respective fractions: n-hexane fraction BNH (100 g), ethyl acetate fraction BNE (110 g), and water fraction BNW (198 g). After evaluating the xanthine oxidase (XO) inhibitory activity of the fractions, the ethyl acetate fraction was selected for further isolation and identification of the active compounds. EtOAc fraction was subjected to silica gel column chromatography with CH_2Cl_2/MeOH (50/1 → 1/1) as the elution solvent, yielding 7 fractions (BNE1-BNE7). Fraction BNE2 was further subjected to RP18 reversed-phase column chromatography with a MeOH/H_2O gradient (3/7→7/3) as the elution solvent, yielding 3 smaller fractions (BNE2.1-BNE2.3). Fraction BNE2.1 was recrystallized in acetone to obtain compound 1 (8.6 mg), a white, needle-shaped crystal with a melting point of 158-160°C. Fraction BNE3 was further subjected to RP18 reversed-phase column chromatography with a MeOH/H_2O (3/7→7/3) gradient elution solvent, yielding four sub-fractions (BNE3.1-BNE3.4). Fraction BNE3.3 was then subjected to silica gel column chromatography with CH_2Cl_2/MeOH (30/1→10/1) elution solvent, yielding sub-fraction BNE3.3B, which was recrystallized in acetone to obtain compound 2 (9.8 mg).

Xanthine oxidase inhibition assay

The XO inhibitory experiments of compounds and extracts were performed according to Chen et al. (2010).[6] Various concentrations of samples were prepared in 1% DMSO. The assay mixture comprised 40 µL of 1% DMSO (blank) or compound solution and 60 µL of XO enzyme solution (0.02 U/mL in 50 mM PBS, pH 7.5), freshly prepared before the experiment. After incubation at 37°C, the absorbance was determined at 295 nm after 45 min. The positive control compound is allopurinol. The XO inhibitory ability was quantified: inhibition (%) = $(A_0 - A_t)/A_0 \times 100\%$, in which A_0 and A_t correspond to the absorbance of the blank and the test sample, respectively. The IC_{50} value was calculated as the dosage required to inhibit XO by 50%.

Statistical analysis

The experimental data were analyzed using one-way analysis of variance (ANOVA) to evaluate statistically significant differences among treatment groups. Post-hoc comparisons were carried out using the least significant difference (LSD) test. All statistical procedures were performed with the SAS software package (SAS Institute, 1990), and significance was considered at $p < 0.05$.

RESULTS AND DISCUSSION

The results of the *in vitro* xanthine oxidase inhibitory activity test of BN extracts showed that the EtOAc fraction exhibited the highest xanthine oxidase inhibitory activity compared to the other fractions. Capacity of xanthine oxidase inhibitory are arranged in descending order: BNE (IC_{50} value of 18.16 µg/ml)>BNM (IC_{50} value of 24.5 µg/ml)>BNH (IC_{50} value of 46.22 µg/ml)>BNW (IC_{50} value of 58.43 µg/ml). Based on the *in vitro* xanthine oxidase inhibitory activity test, the ethyl acetate fraction was selected for analysis and chemical structure determination.

Compound 1 was a white amorphous, needle-shaped crystal, with a melting point of 158-160 °C. The ^{1}H-NMR spectrum shows signals of five aromatic protons at chemical shifts at δH 6.63 (1H, dd, J = 8.0, 1.0 Hz, H-6), 6.81 (1H, dd, J = 8.0 Hz, H-5), 6.60 (1H, d, J = 1.0 Hz, H-2), 6.26 (1H, s, H-5’) and 6.57 (1H, s, H-2’), which indicates that compound 1 molecule contains two aromatic rings. Additionally, the spectrum shows the presence of two methoxy group signals at chemical shifts at δH 3.81 s (3H, s, 3-OMe) and 3.85 (3H, s, 3’-OMe). The ^{13}C-NMR spectrum of compoud 1 indicates that the molecule contains a total of 20 carbon atoms, including: 7 quaternary carbon atoms, 8 methine carbons (CH_3), 3 methylene groups (CH_2), and 2 methyl groups (CH_3). Combining the 13C-NMR and HSQC spectra of compoud 1 revealed several characteristic signals: signals of two methyl carbons belonging to the methoxy group at δC 55.97 and 55.88, corresponding to protons at δH 3.81 and 3.85 ppm; and signals of five methine carbons belonging to two aromatic rings at δC 122.29, 114.30, 111.69, 115.61 and 115.61 ppm, corresponding to aromatic protons at δH 6.63, 6.81, 6.60, 6.26 and 6.57 ppm, respectively. Specifically, the spectrum also shows signals of two methylene carbons bonded to hydroxyl groups at δC 62.14 and 66.16 ppm with corresponding protons at δH 3.50/3.77 and 3.73/3.85, in addition to signals of four quaternary carbons bonded to substituents containing oxygen atoms at δC 146.78 (C-3), 144.72 (C-4), 144.94 (C-3’), and 143.53 ppm (C-4’).

The HMBC spectrum shows interactions between the proton of the methoxy 3'-OMe group (δH 3.81 ppm) and C-3 at δc 146.78 ppm, and between the proton of the methoxy 3'-OMe group (δH 3.85 ppm) and C-3' at δc 144.94 ppm. Interactions are also observed between the H-7 proton at δH 3.70 ppm and the carbons at C-1, C-2, C-6, C-8, and C-6. Similarly, interactions between H-5' (δH) and C-7, C-1', and C-3' demonstrate the bonding positions of the two substituted benzene rings and the methoxy groups. Analysis of the one-dimensional and two-dimensional spectra of compound 1, combined with comparisons to the NMR spectra of burselignan[7], revealed that the chemical shifts of the signals were mostly similar, although there were differences in the chemical shift of the proton at the C-7 position. Meanwhile, comparisons of the spectral data of compound 1 with the compound (+)-isolariciresinol showed complete agreement. Therefore, it can be confirmed that compound 1 is (+)-isolariciresinol.

The ^{1}H-NMR spectrum of compound 2 shows characteristic signals of the glyceroglycolipid group. Observations on the ^{1}H-NMR spectrum reveal characteristic signals of protons belonging to the first sugar molecule group with corresponding signals [δH 4.26 (1H, d, j=7.5 Hz, H-1’), 3.55 (1H, m, H-2’), 3.52 (1H, m, H-3’), 3.90 (1H, m, H-4’), 3.78 (1H, m, H-5’) and 3.70 (1H, m, H-6’a)/ 3.93 (1H, m, H-6’b)], the protons on the second sugar molecule are similar [δH 4.89 (1H, br s, H-1’’), 3.77 (1H, m, H-2’’), 3.92 (1H, m, H-3’’), 3.80 (1H, m, [H-4’’), 3.89 (1H,m, H-5’’) and 3.73 (2H,m, H-6’’)]. In addition, the CH2 signal group protons of the long chain and the signal [δH 2.37, t, j= 7.5 Hz, H-2'''], the signal of the methine group [δH 0.99, t, j= 7.5 Hz, H18'''] were also observed. The ^{13}C-NMR spectrum shows characteristic carbon signals for two sugar molecules with values of C-1' (δc 105.32), C-2' (δc 73.4), C-3' (δc 75.4), C-4' (δc 70.9), C-5' (δc 75.4), C-6' (δc 68.6), respectively; the corresponding carbon values for the second sugar molecule are identified as C-1" (δc 100.55), C-2" (δc 71.47), C-3" (δc 71.06), C-4" (δc 70.25), C-5" (δc 72.51), C-6" (δc 62.74).

The δC and δH values for each carbon position of compound 2 were clearly determined using interaction data from the HSQC spectrum. Specifically, the interactions between protons at [δH 4.26 (1H, d, J=7.5 Hz, H-1’), 3.55 (1H, m, H-2’), 3.52 (1H, m, H-3’), 3.90 (1H, m, H-4’), 3.78 (1H, m, H-5’) and 3.70 (1H, m, H-6’a)/ 3.93 (1H, m, H-6’b)] with carbons C-1' (δc 105.32), C-2' (δc 73.4), C-3' (δc 75.4), C-4' (δc 70.9), C-5' (δc 75.4), C-6' (δc 68.6), respectively; Interactions between [δH 4.89 (1H, br s, H-1’’), 3.77 (1H, m, H-2’’), 3.92 (1H, m, H-3’’), 3.80 (1H, m, H-4’’), 3.89 (1H, m, H-5’’) and 3.73 (2H, m, H-6’’)] with carbons C-1" (δc 100.55), C-2" (δc 71.47), C-3" (δc 71.06), C-4" (δc 70.25), C-5" (δc 72.51), C-6" (δc 62.74). In addition, there are interactions between proton [δH 2.37, t, j= 7.5 Hz, H-2'''] and C-

3''' (δc 34.93), and interactions between methyl group proton [δH 0.99, t, j= 7.5 Hz, H18''''] and C-18'''' (δc 14.64).

The data suggest that the structure of compound 2 is expected to consist of two sugar molecules, a long chain, and a glyceryl group. The HMBC spectrum shows an interaction between [δH 3.70 (1H, m, H-6'a)/ 3.93 (1H, m, H-6'b)] and the C-1'' carbon (δc 100.55), which may confirm that the two sugar molecules are linked via a -6'-O- bond. The interaction between the proton [δH 3.69 (1H, m, H-1a)/3.87 (1H, m, H-1b)] and the C-1' carbon (δc 105.32) confirms that the glyceryl group is attached to the sugar molecule at the C-1' position via an oxygen bridge. The interaction between the proton [δH4.16 (2H, m, H-3) of the glyceryl group and the carbonyl C-1''' (δc 175.47) suggests a long chain linking the glyceryl group at the C-3 position. Based on the obtained data, the NMR values of compound 2 were compared with those of compound Gingerglycolipid A[8], and the comparison showed complete agreement at all positions. Thus, compound 2 was identified as Gingerglycolipid A.

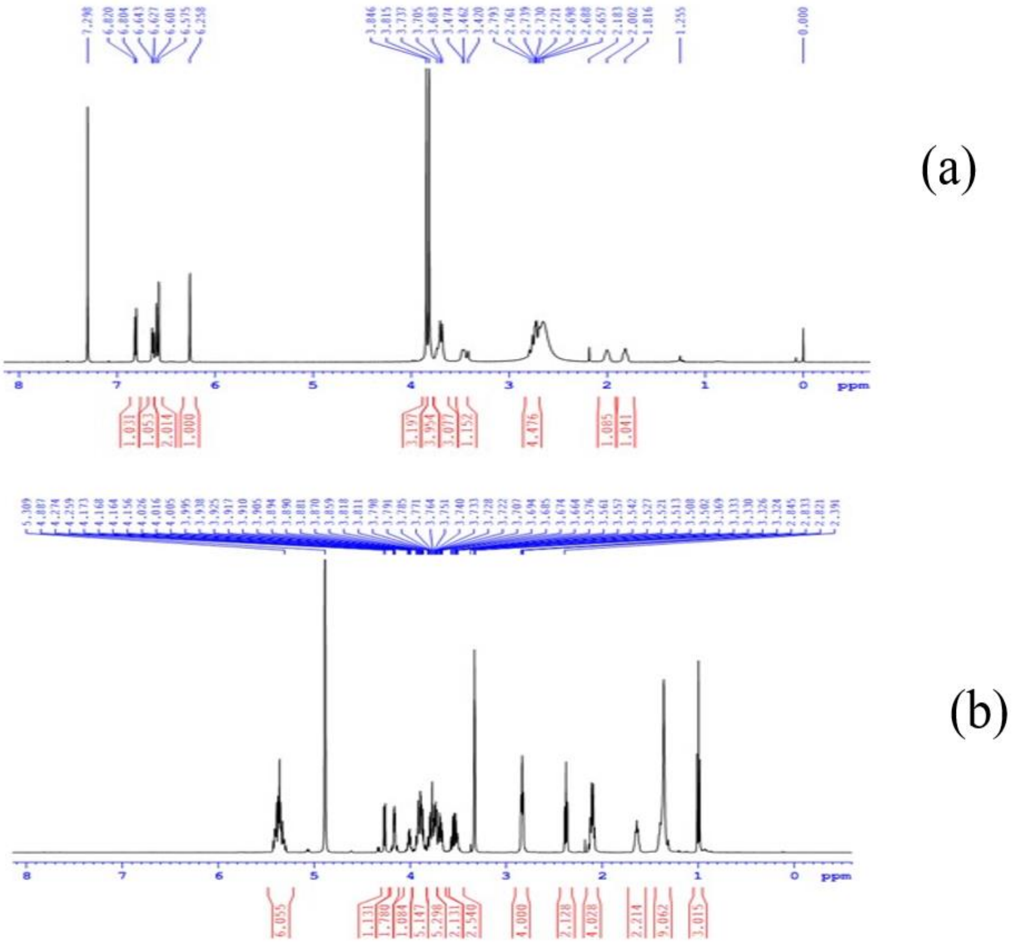

Figure 1. ^{1}H-NMR spectra of (+)-Isolariciresinol and Gingerglycolipid A.

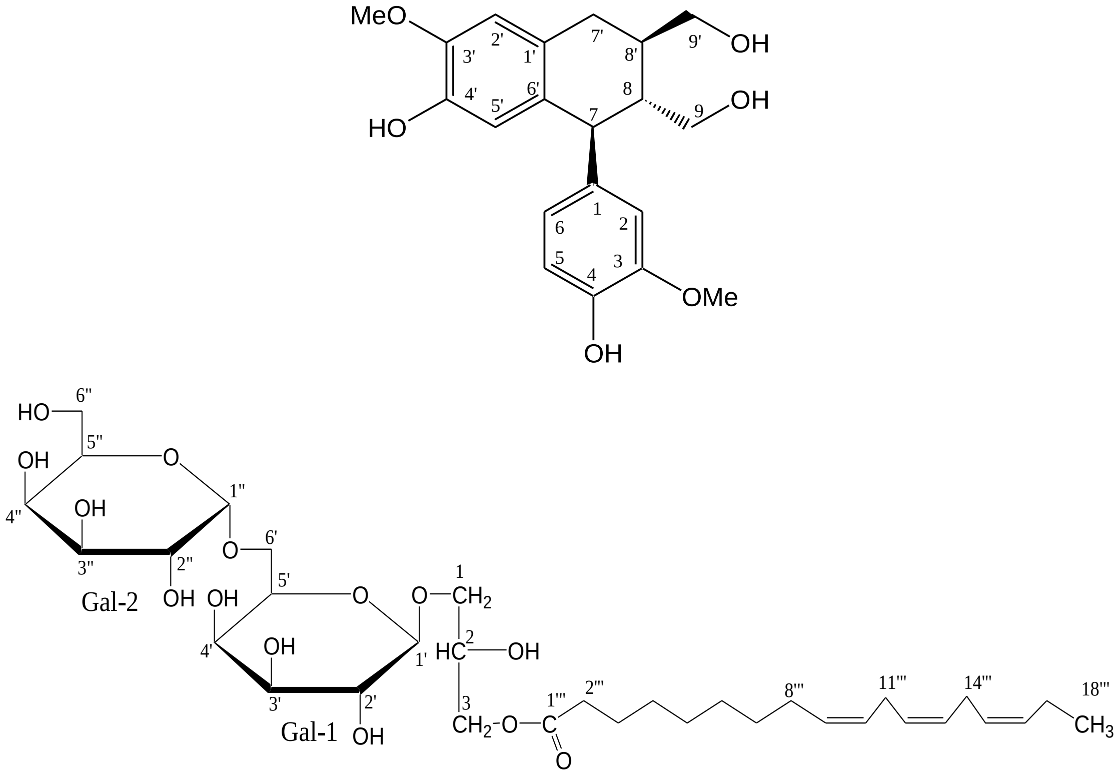

Figure 2. Chemical structure of (+)-Isolariciresinol and Gingerglycolipid A.

Xanthine oxidase enzyme inhibiting capacity of compounds

Xanthine oxidase (XO) enzyme inhibiting effect *in vitro* of E70 extract and two compounds was evaluated by IC$_{50}$ values in Table 1. The results shown that xanthine oxidase enzyme inhibitory capacity reduced in the following order: Allopurinol > (+)-Isolariciresinol > Gingerglycolipid A > E70.

Table 1: Xanthine oxidase enzyme inhibitting capacity of isolated compounds and E70.

Compounds	**IC$_{50}$ (µg/mL)**
Allopurinol*	$3.12^c \pm 0.34$
E70	$31.66^a \pm 0.13$
(+)-Isolariciresinol	$6.46^c \pm 0.22$
Gingerglycolipid A	$14.32^b \pm 0.36$

Note. Each data point represents the mean of triplicates ± SD; *Positive control substance

CONCLUSION

In conclusion, the results confirmed that xanthine oxidase enzyme inhibitting capacity of Isolariciresinol, Gingerglycolipid A and E70 from radices of the BN was firstly evaluated. The findings contribute value firm evidence for further clinical application to treat gout by *Boehmeria Nivea* (L.) Gaudich. The comprehensive pharmacological mechanisms related to gout treatment effects of the radices of *Boehmeria Nivea* (L.) Gaudich need to be elucidated in the future.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to the Classification and Identification Committee of the Faculty of Agriculture Technology, Thai Nguyen University of Agriculture and Forestry, for their valuable support.

CONLICT OF INTEREST

There are no competing financial interests.

REFERENCES

1. Le, U.Q, The review on medicinal herbs in the treatment of gout through xanthine oxidase inhibitory activity: Call for more research strategy in the future. Journal of Applied Pharmaceutical Science, 2024; 14(4): 001-013.
2. Wang, H., Zhang, H., Zhang, X., Yin, Y., Ding, G., Tang X, et al, Identification of coniferyl ferulate as the bioactive compound behind the xanthine oxidase inhibitory activity of *chuanxiong rhizome*. Journal of Functional Foods, 2023; 100: 105378.
3. Tran, V., Lanh, N., Le, U, Chemical composition and anti-inflammatory activities of *Boehmeria Nivea* in Thai Nguyen. Scientific Journal of Tan Trao university, 2023; 9(4).
4. Chen, S.L., Hu, S.W., Lin, Y.Y., Liao, W.L., Yang, J.J., *Boehmeria Nivea* Extract (BNE-RRC) Reverses Epithelial-Mesenchymal Transition and Inhibits Anchorage-Independent Growth in Tumor Cells. International Journal of Molecular Sciences, 2024; 25(17): 9572.
5. Choi, J., Nguyen, Q.N., Baek, J.Y., Cho, D.E., Kang, K.S., Hahm, D.H., Jang, T.W., Park, J.H., Lee, A.Y., Lee, S., Beneficial role of *Boehmeria nivea* in health and phytochemical constituents. Journal of Food Biochemistry, 2022; 46: e14474.
6. Chen, C.H., Chen, P.Y., Wang, K.C., Lee, C.K., Rapid identification of the antioxidant constituent of *Koelreuteria henryi*. Journal of the Chinese Chemical Society, 2010; 57: 404-410.
7. Zhang, B., Tiankui, Q., Caixia, G., Chemical constituents of *Tripterygium wilfordii* Hook F and proapoptotic molecular mechanism of burselignan on SMMC-7721 cells. Biomedical Research, 2016; 27(3): 938-943.
8. Yoshikawa, M., Yamaguchi, S., Kunimi, K., Matsuda, H., Okuno, Y., Yamahara, J., Murakami, N., Stomachic principles in ginger. III. An anti-ulcer principle, 6-

gingesulfonic acid, and three monoacyldigalactosylglycerols, gingerglycolipids A, B, and C, from *Zingiberis Rhizoma* originating in Taiwan. Chemical and Pharmaceutical Bulletin, 1994; 42(6): 1226-1230.