

Carbazomarin: A New Potential of α -Glucosidase Inhibitor From *Clausena excavata* Roots

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Abstract

Continuing our exploration for dual functions antidiabetic and antioxidant agents from Myanmar medicinal plant, a new carbazole-pyranocoumarin conjugate, carbazomarin-C (1) along with a known carbazole alkaloid, mukonine (2) and a pyranocoumarin, xanthoxyletin (3), was isolated from the roots of *Clausena excavata*. The chemical structures of these compounds were identified using a combination of spectroscopic methods. Among isolates, there was a strong inhibition of compounds (1) and (3) on yeast α -glucosidase in a dose-dependent manner. It was shown when *p*-nitrophenyl- α -D-glucopyranoside was used as a substrate in vitro with IC₅₀ values 0.22 and 4.81 mM, respectively. However, all isolated compounds displayed no inhibition against DPPH (2,2-diphenyl-1-picrylhydrazyl) radicals.

Keywords

Clausena excavata, coumarin, carbazole alkaloid, carbazomarin-C, α -glycosidase, DPPH

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Clausena excavata Burm. f. is commonly found in the tropical and subtropical regions such as India, China, and Southeast Asia countries. The plants are a member of *Rutaceae* family and they are in a form of wild shrubs. They are known to have medicinal properties since its leaves, twigs, and roots are widely used for the traditional treatment of cold, fever, wound, abdominal pain, snake-bite, a preliminary stage of AIDS, and skin diseases.¹ Previous phytochemical analyses found that *C. excavata* possesses an abundant amount of coumarins,²⁻⁴ carbazole alkaloids,⁵ and a few limonoids.⁶ The coumarins isolated from this plant raised the writers' attention due to its bioactive properties. For instance, clausactones A to J which were isolated from the leaves exhibited tumor promotion inhibitory effects. Nordentatin showed antibacterial and antioxidant properties, while pyranocoumarin and clausenidin which were isolated from roots displayed an anti-HIV-1 activity.^{4,7}

Diabetes mellitus (DM) is one of the complex chronic illness which demands constant medical checkup. As a consequence, many strategies are already developed in order to reduce the multifactorial risk through glycemic control.⁸ Elevated plasma glucose causes overproduction of free radicals and other reactive oxygen species that destroy cells through oxidative stress, which supports the goal of developing antidiabetic drugs with radical scavenging. Dual function agents which have both antidiabetic (α -glucosidase inhibitor) and radical scavenging capacities are

particularly relevant for the treatment of T2DM (Type 2 Diabetes Mellitus) and its complications. In this study, we searched for an antidiabetic and antioxidant agent having a dual mechanism from a medicinal plant.⁹ Here, we have been isolated 1 new carbazomarin-C (1) along with carbazole alkaloid, mukonine, and pyranocoumarin, xanthoxyletin. Carbazomarin-C (1) was obtained as a solid with yellowish color with a melting point of 251°C to 252°C. The absorption maxima shown by the UV spectrum were at 335, 278, and 227 nm due to 7-oxygenated coumarin. The ¹H NMR (Nuclear Magnetic Resonance) spectrum (Table 1; Supplemental Figure S1) displayed the presence of 2,7-dihydroxy-1,3,6-tri-substituted carbazole skeleton by 1 aldehydic proton δ_H 9.75 (1H, s, 3-CHO) and 3 aromatic singlet protons at δ_H 7.88 (1H, s, H-4), 7.41 (1H, s, H-5), and 6.97 (1H,

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Table 1. ^1H (600 MHz), ^{13}C (151 MHz) NMR and HMBC Spectral Data of **1** in CDCl_3 .

Position	δ_{H} multiplet/ J values	δ_{C} (ppm)	HMBC
1a	-	145.3	
1	-	108.9	
2	-	156.7	
3	-	114.8	
4	7.88 (s, 1H)	123.7	C-1a, C-2, C-4a, -CHO
4a	-	116.8	
5a	-	116.2	
5	7.41 (s, 1H)	117.2	C-6", C-7, C-8a
6	-	124.1	
7	-	153.8	
8	6.97 (s, 1H)	97.2	C-5a, C-6, C-7, C-8a
8a	-	140.9	
1'	3.54 (d, $J = 6.8$ Hz, 2H)	21.6	C-1, C-1a, C-2, C-2', C-3'
2'	5.30 (d, $J = 6.8$ Hz, 1H)	121.2	
3'	-	132.0	
3a'	1.68 (s, 3H)	23.6	C-2', C-3', C-3b'
3b'	1.83 (s, 3H)	16.8	C-2', C-3', C-3a'
3-CHO	9.75 (s, 1H)	195.8	
2"	-	162.6	
3"	6.00 (d, $J = 9.6$ Hz, 1H)	107.2	C-2", C-4a"
4"	8.04 (d, $J = 9.6$ Hz, 1H)	140.8	C-2", C-5"
4a"	-	103.9	
5"	-	152.6	
5a"	-	109.8	
6"	4.76 (dd, $J = 8.0, 10.0$ Hz, 1H)	29.5	C-5, C-6, C-5a", C-7"
7"	2.05 (dd, $J = 10.0, 13.6$ Hz, 1H)	40.8	C-5", C-8", C-8a", C-8b"
	2.31 (dd, $J = 8.0, 13.6$ Hz, 1H)		
8"	-	76.4	
8a"	1.34 (s, 3H)	22.3	C-7", C-8", C-8b"
8b"	1.41 (s, 3H)	27.4	C-7", C-8", C-8a"
9a"	-	159.5	
10"	-	114.8	
10a"	-	158.6	
1"	-	40.9	
1a"	1.72 (s, 3H)	28.9	C-1", C-1b", C-2", C-10"
1b"	1.72 (s, 3H)	28.9	C-1", C-1a", C-2", C-10"
2"	6.35 (dd, $J = 10.7, 17.4$ Hz, 1H)	150.8	C-1", C-3"
3a"	4.93 (dd, $J = 12.3, 10.7$ Hz, 1H)	106.6	C-1", C-2"
3b"	4.85 (dd, $J = 1.2, 17.4$ Hz, 1H)		

s, H-8). The 3-isomethyl prenyl group attached to the ring A of carbazole alkaloid was signified by 2 peaks at δ_{H} 3.54 (2H, d, $J = 6.8$ Hz, H-1'), δ_{H} 5.30 (1H, d, $J = 6.8$ Hz, H-2') and 2 isomethyl groups signals at δ_{H} 1.68 (3H, s, H-3a'), δ_{H} 1.83 (3H, s, H-3b'), respectively. Moreover, the existence of pyranocoumarin unit was revealed by 2 pairs of doublet protons at δ_{H} 6.00 (1H, d, $J = 9.6$ Hz, H-3") and δ_{H} 8.04 (1H, d, $J = 9.6$ Hz, H-4"), pyran ring at δ_{H} 4.76 (1H, dd, $J = 8.0, 10.0$ Hz, H-6"), 2 anisotropic protons at δ_{H} 2.05 (1H, dd, $J = 10.0, 13.6$ Hz, H-7"), δ_{H} 2.31 (1H, dd, $J = 8.0, 13.6$ Hz, H-7"), and gemdimethyl at δ_{H} 1.34 (3H, s, H-8a"),

δ_{H} 1.41 (3H, s, H-8b"). In addition, the characteristic of prenyl group attached to C-10 position of core coumarin has shown signals at δ_{H} 6.35 (1H, dd, $J = 17.4, 10.7$ Hz, H-2"), 4.93 (1H, dd, $J = 10.5, 1.2$ Hz, H-3a"), 4.85 (1H, dd, $J = 17.4, 1.2$ Hz, H-3b"), and 2 methyl groups at δ_{H} 1.72 (6H, s, H-1a" and -1b"). The ^{13}C -NMR (Nuclear Magnetic resonance) and DEPT (Distortionless Enhancement by Polarization Transfer) (90, 135) spectra of **1** indicated the presence of 1 aldehyde carbon δ_{C} 195.8, 1 cyclic lactone carbonyl carbon δ_{C} 162.6, 16 sp^2 quaternary carbons (δ_{C}

159.5, 158.6, 156.7, 153.8, 152.6, 145.3, 140.9, 132.0, 124.1, 116.8, 116.2, 2×114.8 , 109.8, 108.9, 103.9), 2 sp^3 quaternary carbons (δ_c 76.4, 40.9), 7 sp^2 methine carbons (δ_c 150.8, 140.8, 123.7, 121.2, 117.2, 97.2), sp^3 methine (δ_c 29.5), 1 exomethylene carbon (δ_c 106.6), 2 methylene carbons (δ_c 40.8, 21.6), and 6 methyl carbons (δ_c 2×28.9 , 27.4, 23.6, 21.6, 16.8) (Table 1; Supplemental Figure S2). The data presented above, also DQF-COSY (Double Quantum Filtered- 1H - 1H correlated spectroscopy), and HSQC (Heteronuclear Single Quantum Correlation) data indicate that **1** is the binary of carbazole-pyranocoumarin conjugate (Supplemental Figures S3 and S4). There are several correlations pointed out by the 1H - ^{13}C long range coupling of HMBC (Heteronuclear Multiple Bond Correlation) spectrum of **1**, which are between H-4/C-1a, C-2, C-4a, and -CHO. The location of H-4 proton and the group of aldehyde were confirmed to be attached to C-3 carbon of ring-A in carbazole unit. Another correlation was that a group of prenyl was attached to C-1 position of carbazole and it was revealed by H-1' to C-1, C-1a, C-2, C-2', and C-3'. Its pattern is also similar to heptaphylline. Moreover, the singlet proton, H-5 on ring-C of carbazole, gave correlation to C-6", C-7, C-8a, and again, H-6' of pyranocoumarin to C-5, C-6, C-5a", C-7" proved that 2 units are connected at C-6 of carbazole and C-6" of pyranocoumarin. The existence of typical pyranocoumarin lactone carbon was showing correlation H-2", H-3" to C-2", C-4a", and C-5". The attachment of prenyl group to C-10" of pyranocoumarin was confirmed by the cross peaks of H-1a" to C-1", C-1b", C-2", and C-10" by HMBC spectrum (Table 1; Figure 1 and Supplemental Figure S5). The spectrum of NOESY owned by **1** showed the cross-peaks of H-4 with H-5, 3-CHO, and another cross-peaks displayed H-5 to H-7", H-4 (Figure 1 and Supplemental Figure S6). This type of binary compounds previously has been reported from *C.*

excavata as carbazomarin-A¹⁰ and carbazomarin-B.¹¹ The spectral data of **1** in pyranocoumarin unit are the same as the previously reported compounds. However, the carbazole unit is different from **1**. The spectral data of **1** revealed that the carbazole unit is similar to 7-hydroxyheptaphylline. In addition, the previously reported binary compounds explained that the coumarin unit was substituted at ring A of carbazole, whereas **1** was substituted at ring C. Hence, the structure of **1** was assigned to be (5)-2,7-dihydroxy-6-(5-hydroxy-8,8-dimethyl-10-(2-methylbut-3-en-2-yl)-2-oxo-7,8-dihydro-2H,6H-pyrano[3,2-g]chromen-6-yl)-1-(3-methylbut-2-en-1-yl)-9H-carbazole-3-carbaldehyde (Figure 2). It was named as carbazomarin-C.

Careful analyses were carried out to determine the physico-chemical properties and spectroscopic data. Later on, a comparison step was carried out with the previously reported literatures where 2 known compounds were identified as mukonine^{2,6} and xanthoxyletin^{3,12} as shown in Figure 2. All of the isolated compounds were then undergone examination to measure antidiabetic activity. The examination was done by using yeast α -glucosidase inhibitory assay. Meanwhile, in order to measure the antioxidant activity, DPPH assay (Table 2) was carried out. There was a potent inhibition demonstrated by the isolated compounds **1** and **3** against yeast α -glucosidase with IC₅₀ values 0.22 and 4.81 mM. Both **1** and **3** have stronger inhibition activity than standard acarbose (IC₅₀ value 4.89 mM). Especially the new compound, carbazomarin-C (**1**), which has inhibitory effect exhibited the highest values. Unfortunately, there were no inhibition on antioxidant activity presented by all of the isolated compounds. Referring to the newest studies, the isolated components from the root of *C. excavata* possess the potentials to act as natural α -glucosidase inhibitors. More

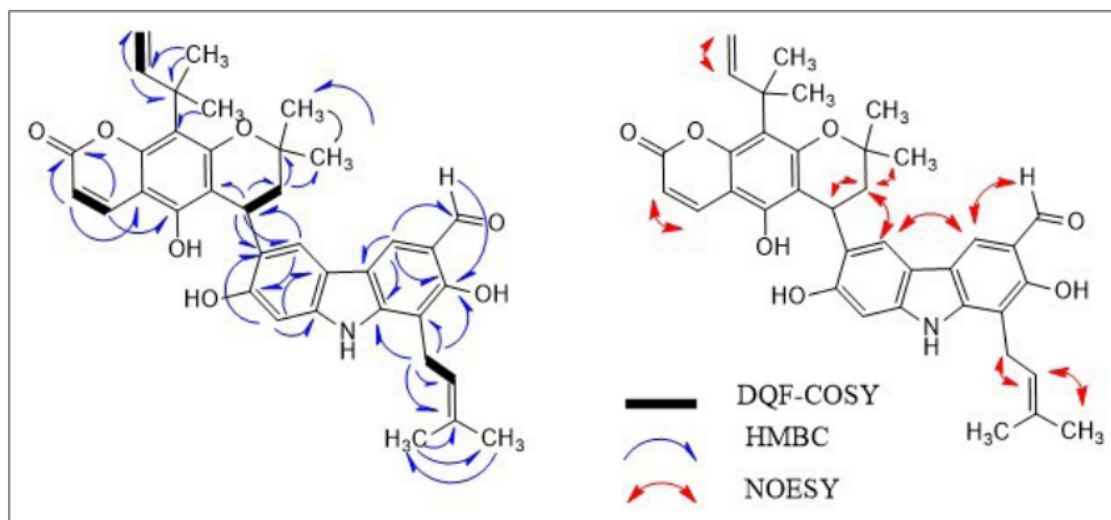


Figure 1. COSY (black bold), key HMBC (blue), and NOESY (red) correlation of **1**.

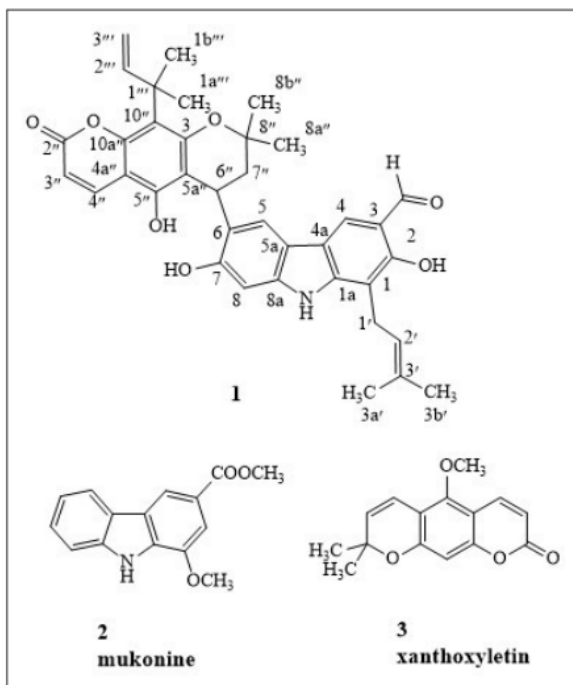


Figure 2. The structure of *Clausena excavata*'s isolated compounds.

researches on maltase and sucrase α -glucosidase inhibition activity are strongly recommended.

Experimental

Plant Material

The collection of *C. excavata* was done in Myanmar, precisely on Pyin Ma Nar Township. The plants' substantial (voucher specimen MU-22032018) were collected on October 2016 under the authentication of Prof. Soe Myint Aye. Prof. Aye works as a botanist in the Botany Department of Mandalay University in Myanmar.⁴

Extraction and Isolation

The roots sample of *C. excavata* (3.6 kg) was air-dried before finally being extracted with 95% EtOH (12.0 L) for 14 days under ambient temperature. After removing the solvent, 156 g of extract was obtained. Afterward, as much as 100 g of the extract was partitioned by liquid-liquid extraction. It was successfully done 3 times by using the solvent of *n*-hexane and MeOH with the ratio of 1:1 in volumes. Furthermore, a vacuum liquid chromatography (VLC) was exposed to as much as 80.4 g of methanol portion over silica gel which was eluted with different mixtures of *n*-hexane and ethylacetate. It was done by slowly intensifying the gradient polarity until 7 combined fractions (MF-1 to -7) were acquired. Fraction MF-3.2 was exposed to silica gel column

Table 2. α -Glucosidase Inhibitory and the Isolated Compounds' (1-3) Radical Scavenging Activities.

Compound	α -Glucosidase, yeast IC ₅₀ (mM)	DPPH IC ₅₀ (mM)
1	0.22	NI
2	NI	NI
3	4.81	NI
Acarbose	4.89	-
Ascorbic acid	-	0.01

NI, no inhibition.

chromatography. There were 3 different solvent systems precisely the mixture between *n*-hexane, CHCl₃, and EtOAc with the ratio 100:5:20. As a result, there were 300 fractions gained and produced 6.8 mg of compound (2) and 15.3 mg of compound (3). A total of 25.6 g of fraction MF-6 was exposed to VLC with the mixtures *n*-hexane:EtOAc (EtOAc, 10%-100%) with gradient polarity. The outcome produced 23 subfractions, and after combining the same component fractions, it created MF-6.1 to -6.7. Silica gel column chromatography was exposed to Fraction MF-6.2.1.3 with various solvents (CHCl₃:MeOH/MeOH 5%) which produced a total of 99 fractions. After the recrystallization of fraction 82 to 88, a new compound (1, 10.6 mg) was obtained.

Carbazomarin-C, yellowish solid, mp. 251°C-252°C; UV (MeOH), λ_{\max} (log ϵ) 335 (1.23), 279 (2.08), 228 (1.53). ¹H NMR (Methanol-*d*₄, 600 MHz), δ 9.75 (1H, s), 8.04 (1H, d, *J* = 9.6 Hz), 7.88 (1H, s), 7.41 (1H, s), 6.97 (1H, s), 6.35 (1H, dd, *J* = 17.4, 10.6 Hz), 6.00 (1H, d, *J* = 9.6 Hz), 5.41-5.24 (2H, m), 4.93 (2H, dd, *J* = 17.4, 1.2 Hz), 4.85 (2H, dd, *J* = 10.6, 1.2 Hz), 4.78-4.73 (3H, m), 3.54 (3H, d, *J* = 6.8 Hz), 3.35 (1H, s), 2.31 (2H, dd, *J* = 13.8, 7.8 Hz), 2.04 (3H, dd, *J* = 13.8, 10.1 Hz), 1.90 (OH, s), 1.83 (4H, s), 1.72 (6H, s), 1.68 (3H, s), 1.68 (3H, s), 1.41 (3H, s), 1.34 (3H, s) and ¹³C NMR (151 MHz, Methanol-*d*₄) δ 195.78, 162.58, 159.54, 158.62, 156.75, 153.87, 150.76, 145.26, 144.77, 140.83, 132.02, 124.08, 123.68, 121.22, 117.73, 116.80, 114.78, 110.12, 109.76, 108.93, 107.65, 106.63, 103.99, 97.20, 76.47, 42.78, 41.66, 40.88, 40.52, 29.41, 28.91, 28.15, 24.49, 24.49, 23.75, 23.03, 22.33, 16.66.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Supplemental Material

Supplemental material for this article is available online.

References

1. Manosroi A, Saraphanchotiwitthaya A, Manosroi J. Immunomodulatory activities of *Clausena excavata* Burm. f. wood extracts. *J Ethnopharmacol.* 2003;89(1):155-160.
2. Takemura Y, Nakamura K, Hirusawa T, Ju-ichi M, Ito C, Furukawa H. Four new furanone-coumarins from *Clausena excavata*. *Chem Pharm Bull.* 2000;48(4):582-584.
3. Peng W-W, Zheng Y-Q, Chen Y-S, Zhao S-M, Ji C-J, Tan N-H. Coumarins from roots of *Clausena excavata*. *J Asian Nat Prod Res.* 2013;15(3):215-220.
4. Thant TM, Aminah NS, Kristanti AN, Ramadhan R, Phuwapraisiran P, Takaya Y. A new pyrano coumarin from *Clausena excavata* roots displaying dual inhibition against α -glucosidase and free radical. *Nat Prod Res.* 2019;5(0):1-6.
5. Wu TS, Huang SC, Wu PL, Teng CM. Carbazole alkaloids from *Clausena excavata* and their biological activity. *Phytochemistry.* 1996;43(1):133-140.
6. Kongkathip N, Kongkathip B. Constituents and bioactivities of *Clausena excavata*. *Heterocycles.* 2009;79(1):121-144.
7. Sunthitikawinsakul A, Kongkathip N, Kongkathip B, et al. Coumarins and carbazoles from *Clausena excavata* exhibited antimycobacterial and antifungal activities. *Planta Med.* 2003;69(2):155-157.
8. Munhoz ACM, Frode TS. Isolated compounds from natural products with potential antidiabetic activity - A systematic review. *Curr Diabetes Rev.* 2018;14(1):36-106.
9. Damsud T, Chanwun T, Kaewpiboon C. "Antidiabetic agents with α -glucosidase inhibition and antioxidant capacity from the shoots of *clausena cambodiana* guill". *Int J Agric Technol.* 2017;13(4):449-456.
10. Wu T-S, Huang S-C, Wu P-L. Carbazole-pyranocoumarin dimer and binary carbazole alkaloid from *Clausena excavata*. *Tetrahedron Lett.* 1996;37(43):7819-7822.
11. Chakthong S, Bindulem N, Raknai S, Yodwaree S, Kaewsanee S, Kanjana-Opas A. Carbazole-pyranocoumarin conjugate and two carbazole alkaloids from the stems of *Clausena excavata*. *Nat Prod Res.* 2016;30(15):1690-1697.
12. Sripisut T, Laphookhieo S. Carbazole alkaloids from the stems of *Clausena excavata*. *J Asian Nat Prod Res.* 2010;12(7):614-617.

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Publication

41 KOMODA, Toshikazu, Yuta TAMIYA, and Masazumi NISHIKAWA. "10T024A, a New Phenazine Derivative, as a Radical Scavenger and a Prostaglandin, Leukotriene Release Suppressor", *Bioscience Biotechnology and Biochemistry*, 2011.

Publication

42 G. C. L. Ee, S. Daud, Y. H. Taufiq-Yap, N. H. Ismail, M. Rahmani. " Xanthones from (Guttiferae) ", *Natural Product Research*, 2006

Publication

43 Ghosh, S.K.. "A ketal-tethered RCM strategy toward the synthesis of spiroketal related natural products", *Tetrahedron*, 20061106

Publication

44

Va, P.. "Total synthesis of amphidinolide E and amphidinolide E stereoisomers", Tetrahedron, 20070625

Publication

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