Mushrooms are a good source of functional foods and traditional therapeutic agents [1]. They produce a wide range of biologically active compounds with unique chemical structures [2–4]. The mushroom *Irpex consors*, belonging to the family Meruliaceae, is distributed in India and East Asian countries such as Korea and Japan [5]. Previous investigations of *I. consors* have reported that it possesses tricyclic sesquiterpene derivatives with anti-bacterial and anti-tumor activities [6–8]. In our ongoing search for new secondary metabolites from fungal strains, three new zwitterionic alkaloids (1–3) together with five known compounds identified as stereumamide E (4), stereumamide G (5), stereumamide H (6), stereumamide D (7), and sterostrein H (8). This is the first report of the zwitterionic alkaloids in the culture broth of *I. consors*. Three new zwitterionic alkaloids were named as consoramides A–C (1–3).

The culture broth (about 16 l) was filtered to remove mycelia. The culture filtrate was fractionated by Diaion HP-20 column chromatography eluted with a mixture of methanol-water (30:70–100:0, v/v, step-wise), followed by silica gel column chromatography with stepwise chloroform-methanol (30:1–0:100, v/v) to afford four fractions (Fractions A-D). Fraction A was subjected to Sephadex LH-20 column chromatography, followed by medium pressure liquid chromatography (MPLC) to give two fractions A1 and A2. Fraction A1 was purified by Sep-Pak C18 cartridge eluted with 20% aqueous methanol to obtain two compounds 1 (4.3 mg) and 2 (12.9 mg). Fraction A2 was further separated by a Sep-Pak C18 cartridge eluted with 15% aqueous methanol to obtain compound 7 (4.5 mg). Fraction B was fractionated by Sephadex LH-20 column chromatography, followed by preparative reversed-phase high pressure liquid chromatography (HPLC) eluted with 18% aqueous methanol to yield two compounds 4 (9.3 mg) and 6 (9.5 mg). Fraction C was subjected to MPLC, followed by preparative reversed-phase HPLC eluted with 18% aqueous methanol to

**CONTACT** Bong-Sik Yun bisyun@jbnu.ac.kr

These authors contributed equally to this paper.

Supplemental data for this article can be accessed here.

© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group on behalf of the Korean Society of Mycology.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial License (http://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.
provide two compounds 5 (12.0 mg) and 8 (9.0 mg). Fraction D was separated by MPLC eluted with a gradient of increasing methanol (20–100%) in water, followed by preparative reversed-phase HPLC eluted with 27% aqueous methanol to obtain a compound 3 (4.8 mg).

Compound 1 was obtained as a brown powder with a specific rotation value of −92.8° (c = 0.1, 24.5°C, methanol). Its molecular formula was established as C_{24}H_{25}NO_{4} by a high-resolution fast atom bombardment (FAB)-mass measurement (m/z 392.1849 [M + H]^{+}, Δ 1.2 mmu). The {^1}H NMR spectrum of 1 revealed the presence of a substituted benzene moiety at δ 7.18 (× 2), 7.14, and 7.09 (× 2), a 3,4-disubstituted pyridine moiety at δ 9.05, 8.99, and 8.27, a olefinic methine at δ 6.93, two methines at δ 5.59 and 3.69, two methylenes at δ 3.88/3.47 and 2.10/1.97, and three methyls at δ 1.28, 1.24, and 1.19 (Table 1). In the {^1}H-{^1}H correlated spectroscopy (COSY) spectrum, correlations between H-3 and H-4 and between H-13 and H-14 were observed, and the long-range correlations from H-1 to C-8 and C-9, from H-3 to C-5 and C-9, from H-10 and H-11 to C-1, C-2, and C-3, from H-12 to C-4, C-5, and C-6, from H-13 to C-5 and C-7, from H-14 to C-6 and C-15, and from H-15 to C-6 and C-8 established the presence of sterostrein Q moiety. The long-range correlations from H-2' to C-1', C-3' and C-4', from H-8' to C-4', and from H-9' to C-3' and C-7' as well as {^1}H-1'H COSY correlations of H-5'/H-6'/H-7'/H-8'/H-9' and H-2'/H-3' revealed the presence of a phenylalanine moiety. Finally, the long-range correlations from H-14 and H-15 to C-2' and from H-2' to C-14 and C-15 indicated that the phenylalanine moiety was connected to sterostrein Q via carbon-nitrogen bond.

**Figure 1.** Structures of compounds 1-8.
The partial relative stereochemistry of 1 was established by the NOESY correlations. The cross peaks of H-4/H-3a and H-4/H-11 indicated the same face, while those of H-10/3b and H-3b/H-12 confirmed the other face. Therefore, the structure of 1 was determined as a new zwitterionic alkaloid and named consoramide A.

Compound 2 was purified as a yellow oil with specific rotation of $\lbrack \alpha \rbrack_{D}^{107.2} = 1.0, 25.0^\circ \text{C, methanol}$ and exhibited UV maxima ($\log \epsilon$) at 203 (3.34) and 238 (3.61) nm. Its molecular formula was determined to be C$_{18}$H$_{21}$NO$_{4}$ by the high-resolution FAB-mass measurement ($m/z$ 316.1531 [M + H]$^+$, $\Delta$ 1.8 mmu). The 1D NMR spectra of 2 revealed that the hydroxymethyl group in 5 was replaced by a methyl group (Table 1). The long-range correlations from H-3$_0$ to C-1$_0$ and C-2$_0$ as well as 1H-1H COSY correlations between H-2$_0$ and H-3$_0$ supported the presence of an alanine moiety in 2 (Figure 2). Therefore, compound 2 was determined to be a new zwitterionic alkaloid and named consoramide B.

Compound 3 was obtained as a yellow powder with the specific rotation of $\lbrack \alpha \rbrack_{D}^{89.2} = 1.0, 25.0^\circ \text{C, methanol}$ and showed UV maxima ($\log \epsilon$) at 202 (3.37) nm. Its molecular formula was established as C$_{20}$H$_{24}$N$_{2}$O$_{5}$ by the high-resolution FAB-mass measurement ($m/z$ 373.1745 [M + H]$^+$, $\Delta$ 1.9 mmu). The NMR spectra revealed that 3 was consisted of sterostrein Q and glutamine (Table 1). The glutamine moiety was determined by the 1H-1H COSY correlations and the long-range correlations from H-2$_0$ to C-1$_0$ and C-3$_0$ and from H-3$_0$ and H-4$_0$ to C-5$_0$ (Figure 2). Thus, compound 3 was determined to be a new zwitterionic alkaloid and named consoramide C.

The configuration of all amino acid moieties in 1-3 was tentatively deduced as L-form, because the L-amino acids are abundant in nature literature [9,11].

Compounds 4-8 were identified as stereumamide E (4), stereumamide G (5), stereumamide H (6),...
stereumamide D (7), and sterostrein H (8), respectively, by the comparison of their spectroscopic data with the literatures previously reported [9–11].

The antioxidant activities of these compounds (1–8) were evaluated by the ABTS (2,2’-azinobis [3-ethylbenzothiazoline-6-sulonate]) and DPPH (1,1-diphenyl-2-picrylhydrazyl) radical-scavenging assays [12]. All compounds (1–8) displayed no radical scavenging activity up to 200 μM. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL. In the present study, all compounds exhibited no antibacterial activity up to 200 μg/mL.