Structure of Sargassumketone, a Novel Highly Oxygenated Ketone from *Sargassum Kjellmanianum*

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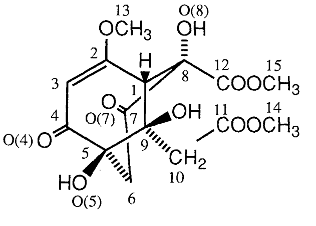
The structure and stereochemistry of sargassumketone, a novel highly oxygenated ketone isolated from *Sargassum kjellmanianum* (the marine brown algae), have been elucidated on the basis of the spectroscopic and X-ray diffraction analysis.

In our previous paper, we reported the isolation and structure determination of two new antibacterial compounds, kjellmanianone[1] and sargassumlactam[2], from the brown alga *Sargassum kjellmanianum.* Our continuous investigation on this seaweed resulted in the isolation of a novel diketone (**1**), named sargassumketone whose structure was determined from spectral[3] and X-ray crystal structure analysis.



(**1**)

Sargassumketone (**1**), mp 189.6-190.4 ℃, was obtained as colorless crystals (18mg) by repeated silicic acid chromatography of the methanol extract of the seaweed (ca. 17 kg), which were collected at the Bay of Hiroshima in March 1992. The composition of $C_{15}H_{18}O_{10}$ was determined by high resolution CI mass spectrometer (isobutane), M^++1, *m/z* 359.0968, and elemental analysis. The presence of a β-substituted-α,β-unsaturated ketone was exhibited by the IR (KBr) bands at ν 1647 and 1605 cm^{-1}, the UV (EtOH) absorption maximum at λ 255 nm (ε 7900), and a ^{1}H NMR signal at δ 5.79 (1H, d, J 1.8 Hz) showing a long-range coupling with a methine at δ 4.78 (1H, d, J 1.8 Hz). This was supported by characteristic ^{13}C NMR signals at δ 55.2 (d, C-1), 177.4 (s, C-2), 100.1 (d, C-3), and 197.9 (s, C-4). The compound (**1**), showing a sharp band at ν 3473 cm^{-1}, could not be esterified with acetic anhydride-pyridine under mild condition, and its ^{1}H NMR spectrum (C_5D_5N) showed no peak corresponding to protons on carbon atom [δ 80.5 (s, C-5), 82.1 (s, C-8), 77.0 (s, C-9)] bearing hydroxyl group. These facts suggested it contained three tertiary hydroxyl groups. The ^{13}C NMR spectrum, furthermore, showed signals corresponding to a carbonyl group [δ 203.2 (s, C-7)], a methoxyl group [δ 56.4 (q, C-13)], two methoxycarbonyl groups [δ 171.6 (s, C-11), 171.8 (s, C-12), 53.1 (q, C-14 or C-15), 51.6 (q, C-15 or C-14)], and two methylene groups [δ 49.6 (t, C-6), 37.3 (t, C-10)]. These methylene protons appeared as signals of AB system [^{1}H NMR δ 3.31, 3.81 (each 1H, d, J_{AB}=17.0 Hz, H-10A, H-10B), 3.18, 3.65 (each 1H, d, J_{AB}=15.8 Hz, H-6A, H-6B)], indicating them to be adjacent to quaternary carbons, respectively. Detailed peak assignments were based on the results of 2D NMR spectral measurements involving H-H COSY, H-C COSY, and COLOC spectra. In COLOC spectrum, the methine proton (H-1) at δ 4.78 showed cross peaks which were correlated with the carbon signals of δ_c 177.4(C-2), 100.1 (C-3), 80.5 (C-5), 203.2 (C-7), 82.1 (C-8), and 77.0 (C-9), indicating connectivity through these carbons to the proton. The olefinic proton (H-3) signal showed correlation peaks with the carbon signals of δ_c 55.2 (C-1) and 80.5 (C-5). Correlation peaks were also observed between the methylene signals (H-6) and the carbon signals of δ_c 197.9 (C-4), 80.5 (C-5), 203.2 (C-7) and 82.1 (C-8), and between another methylene signal (H-10) and the carbon signals of δ_c 55.2 (C-1), 77.0 (C-9) and 171.6 (C-11). The above evidence, when considered in conjunction with seven degrees of unsaturation, led to the conclusion that (**1**) was a new diketone of bicyclo[3.3.1]nonane ring system.

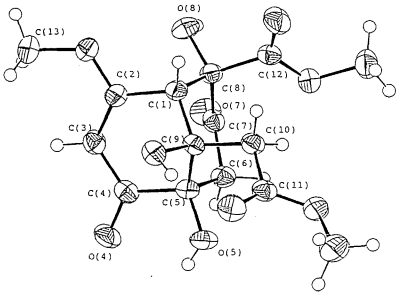


Figure1. Perspective drawing of an X-ray model sargassumketone.

The complete structure and stereochemistry of sargassumketone were confirmed by single-crystal x-ray analysis. Crystals were monoclinic, space group $P2_1/n$, a=17.790(2), b=10.870(1), c=8.232(1) Å, β=103.5(1)°, D_c=1.20 g cm^{-3}, Z=4. All unique diffraction intensities with 2θ < 60.0° were collected in the variable speed ω-scan mode on a Mac Science MXC 18 four-circle automatic diffractometer using graphite monochromated Mo-$K\alpha$ radiation (0.7107 Å). Of the 3550 reflections collected, 3295 were judged to be observed after correction for Lorentz, polarization, and background effects. The structure was solved by direct methods using CRYSTAN program system.[4,5] Full-matrix least-squares refinement with anisotropic temperature factors for the non-hydrogen atoms and isotropic factors for the hydrogen atoms converged to a final *R* factor of 0.049 for the 3295 reflections.

Figure 1 shows a perspective drawing of the X-ray structure, and sargassumketone thus has the stereochemistry shown in (**1**) having a novel highly oxidized structure. We also isolated this compound from *Sargassum thunbergii* (collected at Hiroshima bay and Oki island). This compound (**1**) was isolated as a racemate, and the details of its biogenesis are now under investigation.

References and Notes

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3 ^{13}C and ^{1}H NMR spectra were taken in C_5D_5N solution.
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