

STRUCTURE OF SARGASSUMLACTAM, A NEW β,γ -UNSATURATED- γ -LACTAM, FROM
THE MARINE ALGA *SARGASSUM KJELLMANIANUM*

Hiroshi NOZAKI, Yoshie FUKUOKA, Akihiko MATSUO,
Osamu SOGA,⁺ and Mitsuru NAKAYAMA^{*}

Department of Chemistry, Faculty of Science, Hiroshima University,
Higashisenda-machi, Naka-Ku, Hiroshima 730

REPRINTED FROM

CHEMISTRY LETTERS

The Chemical Society of Japan

1980

STRUCTURE OF SARGASSUMLACTAM, A NEW β,γ -UNSATURATED- γ -LACTAM, FROM
THE MARINE ALGA *SARGASSUM KJELLMANIANUM*Hiroshi NOZAKI, Yoshie FUKUOKA, Akihiko MATSUO,
Osamu SOGA,⁺ and Mitsuru NAKAYAMA^{*}Department of Chemistry, Faculty of Science, Hiroshima University,
Higashisenda-machi, Naka-Ku, Hiroshima 730⁺Department of Chemistry, Faculty of Science, Shimane University,
Nishikawazu-cho, Matsue 690

A new dehydro- γ -lactam, sargassumlactam, has been isolated from the brown alga *Sargassum kjellmanianum*, and its structure was determined to be 4,5-dehydro-3-methoxy-3,5-dimethoxycarbonyl-2-pyrrolidone by the spectroscopic and X-ray diffraction analysis.

In a previous paper, we reported the isolation and structure determination of kjellmanianone (1), a highly oxygenated cyclopentenone, from the brown alga *Sargassum kjellmanianum*.¹⁾ Our continuous investigation on this seaweed resulted in the isolation of a new β,γ -unsaturated- γ -lactam, named sargassumlactam (2), which displayed a moderate antibacterial effect against *Staphylococcus aureus* FDA 209P and *Escherichia coli* K12. We described here the evidence for the proposed structure.

Sargassumlactam (2) was isolated as colorless plates, mp 140-141.5°C, $[\alpha]_D^{+20}$, from the methanol extract by repeated chromatography. The molecular formula of (2), $C_9H_{11}NO_6$, was established by high resolution mass spectrometry (M^+ 229.0565, calcd 229.0585) and elemental analysis (Found: C 47.38, H 4.89, N 6.23. Calcd: C 47.16, H 4.84, N 6.11). The IR ($CHCl_3$) and UV (EtOH) spectra showed absorption bands at 3430 (N-H), 1770 (C=O), 1740, 1150 (COO), and 1635 (C=C) cm^{-1} and at 208 (ϵ 6100) and 293 (ϵ 3400) nm, respectively. Its 1H NMR spectrum ($CDCl_3$) exhibited signals due to three methoxyl groups [δ 3.43, 3.77 and 3.90 (each 3H, s)] and one olefinic proton [δ 6.22 (1H, d, $J=2$)] showing a long-range coupling with an amide proton [δ 7.72 (1H, broad; this signal disappeared when D_2O was added, and the olefinic proton signal was sharpened)]. Catalytic hydrogenation (Pd-C, EtOH) yielded a dihydro derivative, $C_9H_{13}NO_6$, whose spectrum indicated the disappearance of the olefinic function and the presence of γ -lactam [$\nu(CHCl_3)$: 3430, 1725 cm^{-1} ; δ 6.90 (1H, brs)]. In addition to the above evidence, ^{13}C NMR spectrum suggested the gross structure (2) for this compound, that is, three methoxyl carbons [δ 53.00, 53.31 and 54.08 (each q)], three carbonyl carbons [δ 159.64, 166.27 and 172.74 (each s)], one fully substituted carbon [δ 85.90 (s)] bearing a methoxyl group, and two olefinic carbons [one at δ 138.53 (s), the other at δ 113.26 (d)].²⁾

In order to confirm the molecular structure, a single crystal X-ray analysis was, furthermore, carried out. Sargassumlactam (2) crystallized in the triclinic

crystal class with $a=6.503(1)$, $b=8.230(1)$, $c=10.229(1)$ Å, $\alpha=99.60(1)$, $\beta=97.71(1)$, and $\gamma=97.66(1)$ °. All unique diffraction intensities with $2\theta < 55.0^\circ$ were collected in a variable speed ω -scan mode on a Syntex R3 four-circle diffractometer with graphite-monochromated MoK α radiation (0.7107 Å). Of the 2422 reflections surveyed in this manner, 1906 (78.7 %) were judged to be observed after correction for Lorentz, polarization, and background effects. The distribution of normalized structure factors for observed reflections indicated the centrosymmetric space group $P\bar{1}$, and the density (ρ_{obsd} : 1.46, ρ_{calcd} : 1.44 g cm $^{-3}$) showed the presence of one molecule of (2) per asymmetric unit. A phasing model which was obtained from the program MULTAN³⁾ was refined using Syntex XTL program system. Full-matrix least-squares refinements with anisotropic temperature factors for the non-hydrogen atoms and isotropic ones for the hydrogen atoms converged to a final R factor of 0.055 for 1906 reflections.

Figure 1 shows a perspective drawing of the molecular structure, and the structure of sargassumlactam is represented as 4,5-dehydro-3-methoxy-3,5-dimethoxycarbonyl-2-pyrrolidone (2).⁴⁾ Dehydro γ -lactam ring is almost coplanar, and all bond distances and angles agree well with generally accepted values within experimental error. The only short intermolecular contact is the hydrogen bond $\text{N-H}\cdots\text{O}(5)^{\text{I}}$ (2.079 Å).⁵⁾

We thank Professor Shûichi Hayashi, Okayama University of Science, for helpful discussion during this work. Thanks are also due to Dr. Yoshihiko Kushi (X-ray analysis), Hiroshima University, and Dr. Yoshiaki Hara (identification of the alga), Tsukuba University.

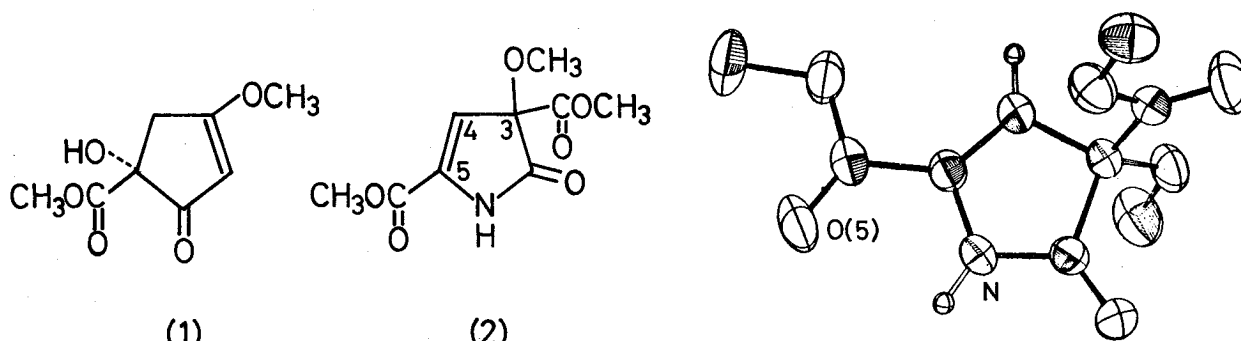


Fig. 1. A diagram of molecule (2)

References and Notes

- 1) M. Nakayama, Y. Fukuoka, H. Nozaki, A. Matsuo, and S. Hayashi, *Chem. Lett.*, in press.
- 2) The ^{13}C NMR spectrum was taken in CDCl_3 solution on a Hitachi R42-FT spectrometer (22.6 MHz).
- 3) G. Germain, P. Main, and M. M. Woolfson, *Acta Crystallogr.*, Sect B, **24**, 274 (1970).
- 4) We also isolated this compound from *Sargassum thunbergii* (collected at Hiroshima bay and Oki island). The compound (2) was isolated as a racemate, and its details are now under investigation.
- 5) Roman numeral, I, as superscript refers to the equivalent position, 1-x, 1-y, 1-z, relative to the reference molecule at x, y, z. The atomic co-ordinates for this work are available on request from CSJ.

(Received September 16, 1980)