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Formation of β -Lactams from Tricarbonyliron Lactone Complexes

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Summary A number of tricarbonyliron lactam complexes were prepared from the corresponding lactone complexes by reaction with amines in the presence of $ZnCl_2$ and on subsequent oxidation with ${\rm Ce^{iv}}$ gave $\beta\text{-lactams}$ in excellent yield.

WE have recently shown that dienes can be converted into lactones via intermediate tricarbonyliron complexes^{1,2} and now show that these complexes can also be used as suitable precursors for β -lactams.

TABLE 1. Formation of tricarbonyliron lactam complex from lactone complexes with PhCH₂NH₂-ZnCl₂

Lactone complex ^a	Lactam complex	M.p. °C	Reaction time/h	Yield/ %
(1)	(8)	7668	0.5	81
(2)	(9)	98-100	1.5^{b}	75
(3)	(10)	80 - 86	3^{b}	82
(4)	(7)	95 - 98	24°	46
(6)	(5)	98 - 100	3 ^b	48

^a Prepared from vinyloxiran and Fe(CO)₅.¹ ^b In Et₂O at room temp. ^c In tetrahydrofuran-Et₂O at room temp.

A number of tricarbonyliron lactam complexes were prepared in moderate to high yield by treatment of the lactone complexes with benzylamine in the presence of ZnCl₂ (Table 1). The lactam complexes were fully characterised by spectral and microanalytical methods. For example, the i.r. spectra show the carbonyl group at,

TABLE 2. Oxidation of tricarbonyliron lactams using ceric ammonium nitrate

Lactam complex	Product(s)	Reaction conditions ^a	Yield/%
(8)	(11)	-30 °C \rightarrow room temp.	72
(9)	(14)	ſ	34
	(15)	$\int 0 ^{\circ}\mathrm{C} \rightarrow \mathrm{room \ temp}$.	56
(10)	(12)	_−5 °C	64 ^b
(7)	(16)	$-30 \ ^{\circ}\text{C} \rightarrow \text{room temp.}$	75
(5)	(13)	room temp.	88

^a 1 h in ethanol. ^b As a 50:50 mixture of *cis/trans* isomers.

value is consistent with many other examples in the literature.⁴ Only in one example, (2), did oxidation lead to a significant amount of a δ -lactam (15).

Finally, in an effort to produce β -lactams of potential biological interest, we allowed (1) to react with the protected amino acid (17), again in the presence of ZnCl₂. The tricarbonyliron lactam (18) (ν_{max} 1590 cm⁻¹) was produced in 81% yield after 2 h at room temperature. On oxidation, the β -lactam (19) was produced in 80% yield. This β lactam is clearly related to the nocardicins,⁵ a novel class of β -lactam antibiotics.



typically, 1580-1595 cm⁻¹. The reversal of the initial substitution pattern of the tricarbonyliron lactones on formation of the lactam complexes by an S_N2' -like mechanism has been shown previously.3

The lactam complexes, on oxidation with ceric ammonium nitrate, gave β -lactams in excellent yield (Table 2) which showed carbonyl absorption bands at $ca. 1750 \text{ cm}^{-1}$. This

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