December 1995 Communications to the Editor *Chem. Pharm. Bull.* **43**(12) 2273—2275 (1995)

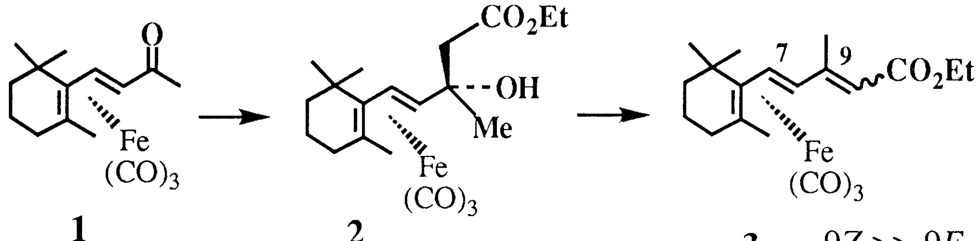
STEREOSELECTIVE SYNTHESIS OF *Z,E,E*- and *E,Z,E*-TRIENYLESTERS USING TRICARBONYLIRON COMPLEX

Akimori WADA, Yukiko TANAKA, Saeko HIRAISHI and Masayoshi ITO*
Kobe Pharmaceutical University, 4-19-1, Motoyamakita-machi, Higashinada, Kobe 658, Japan

Stereoselective synthesis of *Z,E,E*- and *E,Z,E*-trienylesters was accomplished by the condensation reaction of *E,E*- and *Z,E*-dienylketone-tricarbonyliron complexes with lithium enolate of ethyl acetate and subsequent dehydration with thionyl chloride.

KEY WORDS *E,E*-dienylketone; *E,Z*-dienylketone; tricarbonyliron complex; polyolefin; stereoselective synthesis

Dienylaldehyde (or ketone)-tricarbonyliron complexes are very useful compounds in organic synthesis, not only for protecting the diene system but also for preparing the chiral synthons1) which are employed in the synthetic approach of certain natural products.2) Recently, we reported the stereoselective synthesis of ethyl 7*E*,9*Z*-β-ionylideneacetate **3** from the dehydration of **2**, which was easily prepared from **1** and lithium enolate of ethyl acetate.3) As an extension of this reaction, we describe herein the condensation of dienylketone-tricarbonyliron complexes with carbanions.



1 **2** **3** 9*Z* >> 9*E*

Initially, we investigated the reaction of *E,E*-dienylketone-tricarbonyliron complexes **4**4) with carbanions. As shown in Table 1, treatment of **4** with lithiated acetonitrile (LDA and MeCN) in THF at −70 ℃ afforded **6**5) directly in good yields, *via* addition and subsequent dehydration (Runs 1 and 3). The geometry of the newly produced double bond in **6** was determined as *E* after oxidative decomplexation using copper(II) chloride in ethanol.6) The reaction of **4** with lithium enolate of ethyl acetate (LDA and AcOEt) in THF at −70 ℃ gave the adduct **5**7) as a single product in excellent yields (Runs 2 and 4-9). Dehydration of **5** by thionyl chloride afforded the ester **6** as a mixture of isomers; however, in all cases the *Z*-isomer was produced predominantly.8) Previously,3) we speculated that the chelation between the iron and the ester group in the reaction intermediate **10** plays an important role in the predominant formation of *Z*-isomer. The substituted moiety on the diene has a significant effect on the ratio of regioisomers formed. This fact indicates that the degree of chelation between the iron and the ester group strongly depends upon the steric bulkiness of substituents in the diene-iron complex.

---

* To whom correspondence should be addressed.

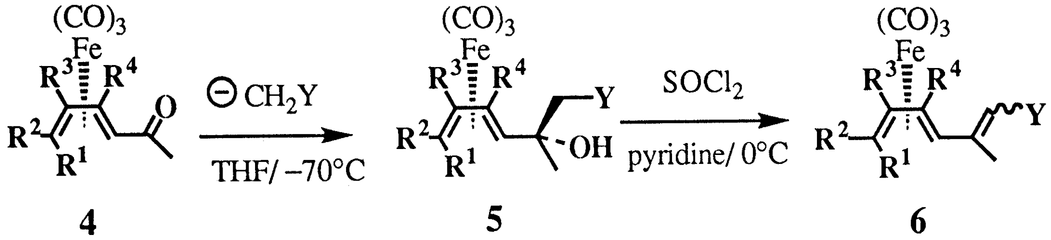
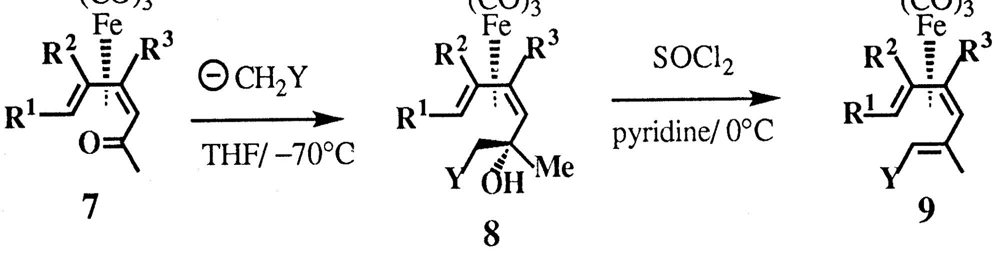


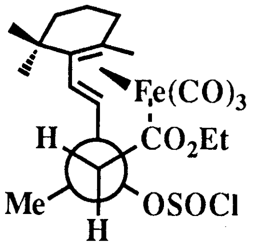
Table 1. Condensation of *E,E*-Dienylketone-tricarbonyliron Complexes with Carbanions

Run	R1	R2	R3	R4	Y	Yield of 5 (%)	Yield of 6 (%)	Ratio (*E* : *Z*)
1	H	Me	H	H	CN	-	100	1 : 0
2	H	Me	H	H	CO_2Et	91	50	1 : 3
3	H	CO_2Et	H	H	CN	-	66	1 : 0
4	H	CO_2Et	H	H	CO_2Et	100	29	1 : 2
5	H	Me	Me	H	CO_2Et	91	28	1 : 5
6	H	$-(CH_2)_4-$		H	CO_2Et	63	19	2 : 3
7	H	$-(CH_2)_3CMe_2-$		H	CO_2Et	98	74	2 : 3
8	Me	$-(CH_2)_3CMe_2-$		H	CO_2Et	89	75	1 : 6
9	Et	$-(CH_2)_3CMe_2-$		H	CO_2Et	97	65	1 : 6

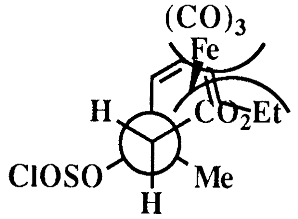
Next, we focused our attention on the reaction of *Z,E*-dienylketone-tricarbonyliron complex **7**9) with carbanions. In contrast to **4**, all these reactions gave the addition product **8**5,7) as a single isomer; in dehydration, only the *E*-isomer **9**5) was obtained exclusively except in one case (Run 6, Table 2). The regioselectivity in the formation of **9** was easily rationl based on consideration of the reaction intermediate. Thus, in the case of **8**, chelation between the iron and the ester is impossible due to the steric repulsion (**11A**) compared to the corresponding intermediate (**10**), and dehydration would proceed from the most stable conformation (**11B**).



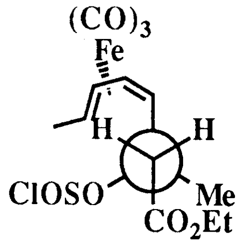
In summary, we developed the stereoselective synthesis of *Z,E,E*- and *E,Z,E*-trienyl esters from the reaction of dienylketone-tricarbonyliron complexes with lithium enolate of ethyl acetate. This method will provide a novel route for the stereoselective synthesis of conjugated polyene compounds such as retinoids, carotenoids, and related compounds.



10



11A



11B

Table 2. Condensation of *Z,E*-Dienylketone-tricarbonyliron Complexes with Carbanions

Run	R1	R2	R3	Y	Yield of **8** (%)	Yield of **9** (%)
1	Me	H	H	CN	86	16
2	Me	H	H	CO_2Et	74	52
3	H	Me	H	CN	75	26
4	H	Me	H	CO_2Et	66	49
5	Me	H	Me	CO_2Et	63	60
6	CO_2Et	H	H	CO_2Et	83	49[b)]
7	H	Me	Me	CO_2Et	50 (95)[a)]	55
8	Me	Me	H	CO_2Et	37 (95)[a)]	32

a) Calculated from the consumed material. b) A mixture of *E*- and *Z*-isomers (*E*:*Z*=3:2).

ACKNOWLEDGMENT This work was supported in part by a Grant-in-Aid for Scientific Research from the Ministry of Education, Science, and Culture (Japan).

REFERENCES AND NOTES

1) Grée R., *Synthesis*, **1989**, 341 — 355.

2) a) Donaldson W. A. , Tao C., Bennet D. W., Grubisha D. G., *J. Org. Chem.*, **56**, 4563 — 4568 (1991); b) Nunn K., Mosset P., Grée R., Saalfrank R. W., *J. Org. Chem.*, **57**, 3359 — 3364 (1992); c) Roush W. R., Wada C. K., *J. Am. Chem. Soc.*, **116**, 2151 — 2152 (1994); d) Donaldson W. A., BellP. T., Wang Z., Bennet D. W., *Tetrahedron Lett.*, **35**, 5829 — 5832 (1994).

3) WadaA., Hiraishi S., Ito M., *Chem. Pharm. Bull.*, **41**, 757 — 758 (1994).

4) These are prepared from the corresponding *E,E*-dienylketone with triiron dodecacarbonyl in benzene.

5) Satisfactory ^{1}H-NMR, IR and MS spectral data were obtained.

6) Pearson A. J. , Lai Y. S., Lu W., Pinkerton A. A., *J. Org. Chem.*, **54**, 3882 — 3893 (1989).

7) The stereochemistry was deduced from the reaction mechanism of dienone complex having the s-*cis* conformation of enone, Clinton N. A., Lillya C. P., *J. Am. Chem. Soc.*, **92**, 3058 — 3064 (1970); Framk-Neuman M., Chemla P., Martina D., *Synlett,* **1990**, 641 — 642; Framk-Neuman M., Abdali A., Colson P. -J., Sedrati M., *Synlett,* **1991**, 331 — 334 .

8) It is very difficult to obtaine *Z,E,E*-triene compound from the dehydration of adduct without iron complex or Wittig reaction of dienyl ketone, Eiter K., Truscheit E., Oedeger H., *Angew. Chem.*, **72**, 948 — 955 (1960); Bohlmann F., Bax H. -J., *Chem. Ber.*, **107**, 1773 — 1776 (1974).

9) Framk-Neuman M., Sedrati M., Mokhi M., *New J. Chem.*, **14**, 471 — 480 (1991).

(Received October 2, 1995; accepted October 31, 1995)