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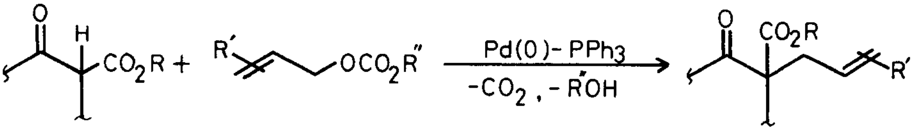
# A NEW ONE-POT METHOD FOR α,α-DIALLYLATION OF KETONES BASED ON THE PALLADIUM-CATALYZED REACTION OF ALLYLIC CARBONATES AND ALLYL β-KETO CARBOXYLATES UNDER NEUTRAL CONDITIONS

Isao SHIMIZU, Yukihiro OHASHI, and Jiro TSUJI*
Tokyo Institute of Technology, Meguro, Tokyo 152, JAPAN

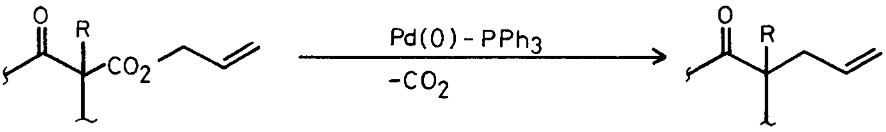
Summary: A new method for α,α-diallylation of ketones catalyzed by palladium-phosphine complexes under neutral conditions has been developed. Allylation of β-keto carboxylates with allylic carbonates, followed by the decarboxylation-allylation as a one-pot reaction affords diallylated ketones in good yields.

Alkylation of unsymmetrical ketones via regioselective enolization is an important reaction in organic synthesis, and a number of methods have been reported. On the other hand, the selective introduction of two alkyl groups at the α-position is rather difficult. This can be done by regioselective consecutive dialkylation. However, the regioselective generation of an anion at the same carbon after the first alkylation is difficult. As one solution, generation of α,α-dianion and its C- and O-disilylation reaction have been reported.[1] But so far no regioselective α,α-dialkylation of ketones as a one-pot reaction is known. In this paper we wish to report a novel one-pot tandem allylation of ketones based on the palladium-catalyzed reaction of allyl β-keto carboxylates and allylic carbonates under neutral conditions.

We have reported the palladium-catalyzed allylation of β-keto esters with allylic carbonates (reaction 1).[2] Also we found the decarboxylation-allylation of allyl β-keto carboxylates to give α-allyl ketones (reaction 2), and used this reaction for stepwise α,α-dialkylation.[3,4] These reactions proceed under very mild neutral conditions (without addition of a base to generate an anion).

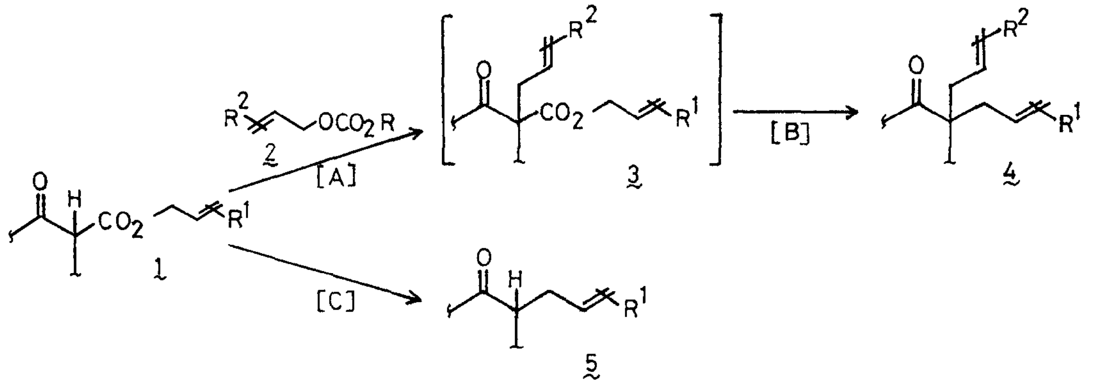


(1)



(2)

Furthermore, we confirmed that the reaction 1 is faster than the reaction 2.2) These results lead us to carry out the regioselective α,α-diallylation of ketones by the reaction of allyl β-keto carboxylates with allylic carbonates. We expected that the first reaction should be the allylation of β-keto esters (path A, reaction 1) to afford 3, and subsequently the decarboxylation-allylation of 3 proceeds to give α,α-diallylated ketones 4 (path B, reaction 2). If the reaction 2 is faster, simple allylation takes place to give 5 (path C), and the diallylation is impossible, but this is not the case



At first α,α-diallylation of cyclohexanone was examined (Table 1). Reaction of allyl 2-oxocyclohexanecarboxylate (6) and diallyl carbonate (7) using Pd(0)-PPh$_3$ as a catalyst in THF gave 2,2-diallylcyclohexanone (9) in 81-90% yields with small amounts of allyl 1-allyl-2-oxocyclohexanecarboxylate (8) and 2-allylcyclohexanone (10). When the reaction was carried out using P(OEt)$_3$, instead of PPh$_3$, the allylated ester 8 was obtained as a main product and the diallyl ketone 9 was hardly obtained showing that the phosphite as a ligand is active only for the reaction 1, but not for 2.

Reaction of allyl acetoacetate (11) (1 mmol) possessing two acidic hydrogens and diallyl carbonate (7) (4 mmol) gave α,α,α-triallylacetone (12) in 93% yield.

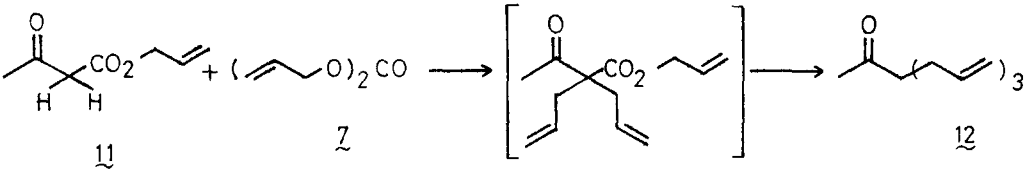
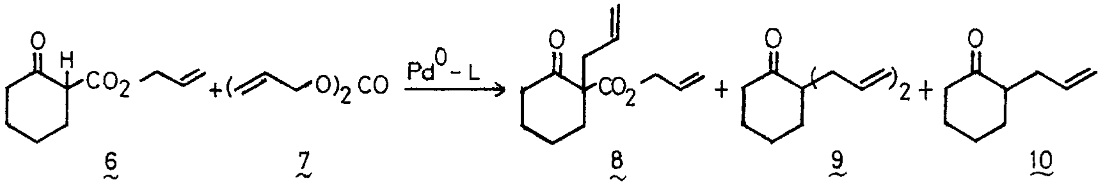


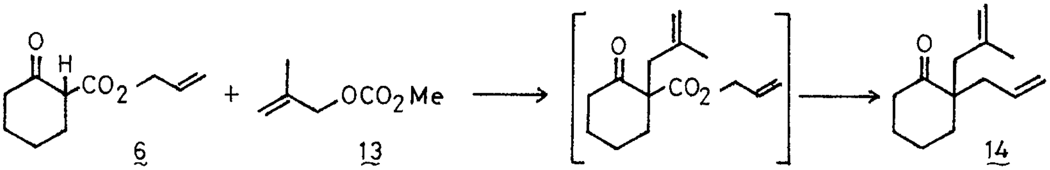
Table 1. Palladium-catalyzed reaction of allyl 2-oxocyclohexanecarboxylate (6) and diallyl carbonate (7)[a]



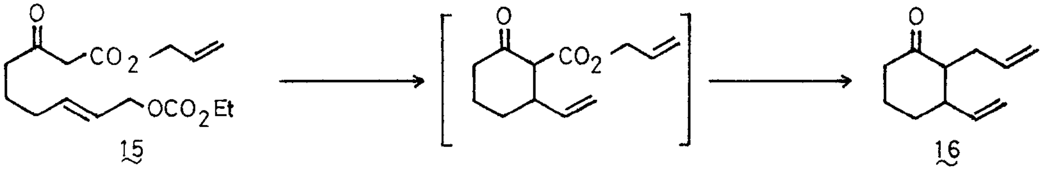
| Run | Ligand | Temp(°C) | Time(min) | Yield(%)[b] | | |
|---|---|---|---|---|---|---|
| | | | | 8 | 9 | 10 |
| 1 | $PPh_3$ | r.t. | 20 | 5 | 81 | 9 |
| 2 | | 65 | 30 | - | 90[c] | - |
| 3 | $P(OEt)_3$ | r.t. | 30 | 71[c] | - | - |
| 4 | | 65 | 30 | 79 | 2 | 11 |

a) The reactions were carried out using 6 (1 mmol), 7 (2 mmol), $Pd_2(dba)_3.CHCl_3$ (0.025 mmol), and ligand (0.2 mmol) in THF (3 mL) under argon. b) GLC analysis. c) Isolated yield.

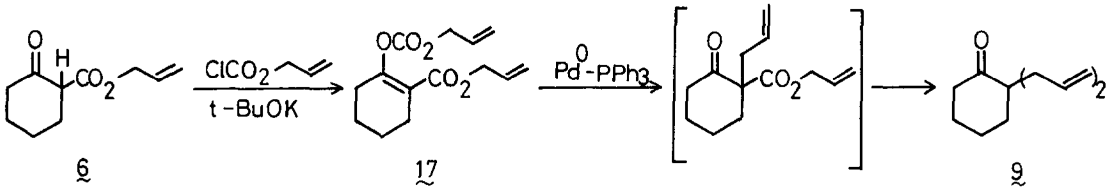
Different allyl groups can be introduced using appropriate allylic esters and allylic carbonates. As an example, when methallyl carbonate (13) and allyl ester 6 were used, methallylation-allylation was achieved in THF at 65°C to give 2-allyl-2-methallylcyclohexanone (14) in 63% yield.[5]



Intramolecular reaction offers an interesting synthetic method for α,β-disubstituted cyclic ketones.[6] Palladium-catalyzed reaction of 15[7] in *t*-BuOH at 80°C afforded 2-allyl-3-vinylcyclohexanone (16) in 54% yield after chromatographic purification.[8]



The palladium-catalyzed diallylation of cyclohexanone was also carried out using allyl enol carbonate 17 prepared from 6. Reaction of 17 in THF at 65°C gave the diallyl ketone 9 in 88% yield.[9)]



6 17 9

Overall transformation of β-keto esters to diallyl ketones as one-pot reaction means generation of α,α-dianion equivalent and its stepwise quenching with two alkyl groups. This transformation is difficult to carry out by the usual alkylation methods. Since the palladium-catalyzed tandem diallylation of ketones reported here proceeds selectively under neutral conditions, this method is useful in organic synthesis. Further extension of this method is in progress.

Acknowledgment:

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## References and notes:

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5. Small amounts of 2,2-diallylcyclohexanone (9) and 2,2-dimethallylcyclohexanone were obtained. Similar scrambling in the reaction of allylic β-keto carboxylates has been reported in the reference 4.
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7. Prepared from the butadiene telomer, 1-acetoxy-2,7-octadiene, according to a similar procedure reported from this laboratory. K. Yamamoto, J. Tsuji, Tetrahedron Lett., 23, 3089 (1982).
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