



Addition of dibutyltin chlorhydride on unsaturated diesters of taddol

Darío C. Gerbino,[#] Liliana C. Koll,^{*} Sandra D. Mandolesi and Julio C. Podestá^{*}

INIQQ, Departamento de Química, Universidad Nacional del Sur, Avenida Alem 1253,
8000 Bahía Blanca, Argentina. E-mail: lckoll@criba.edu.ar

Introduction

The addition of organostannic hydrides on carbon-carbon double bonds was discovered by Van der Kerk *et al.* (1956). The importance of this reaction relies on the possibility of obtaining organostannic compounds with functional substituents unlike other traditional methods of synthesis of organostannic compounds. The latter involve the transfer of organic groups from metals such as lithium and magnesium to tin, which can not be used when some functional groups are present. For a long time our research group has been devoted to the study of the effect of the steric volume and the chirality of the organic ligands attached to the tin atom in

reactions of radical addition of organostannic hydrides to unsaturated systems (Mandolesi *et al.*, 1998, 1999). On the basis of previous results we were able to determine that the radicalary hydrostannation of unsaturated diesters to TADDOL (1) with different organostannic hydrides leads only to the formation of intramolecular cyclization products. The fact that cyclization products are exclusively formed, and the expected products of dual addition are not detected, suggests that the addition of the radical A (Fig. 1) is faster than the addition of another trialkylstannyl radical to the second unsaturated ester group. The proposed mechanism for these radicalary hydrostannations is shown in Fig. 1.

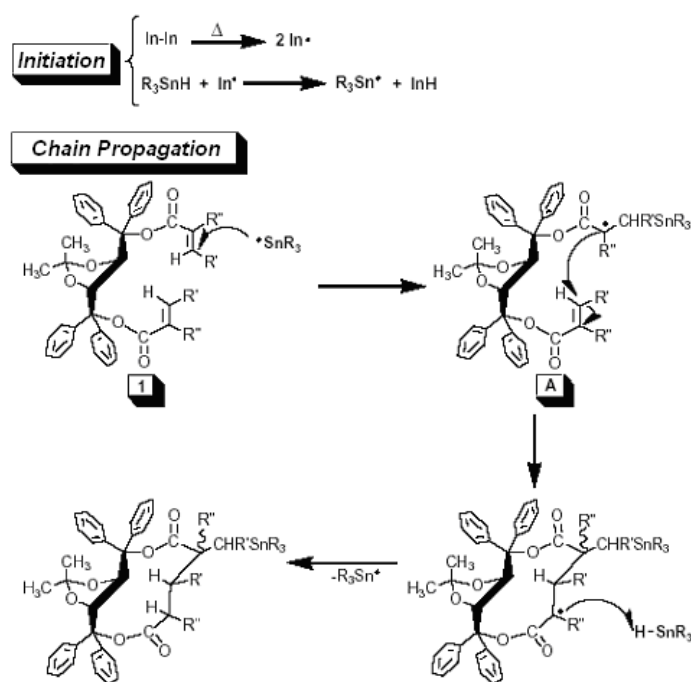


Figure 1

Taking into account these results and in order to obtain new organostannic compounds with functional substituents we considered of interest

to study the stereochemical behaviour of the reactions of radical addition of dibutyltin chlorhydride on unsaturated type-1 diesters.



Methodology

Reactions were carried out under nitrogen atmosphere in dry toluene by photostimulation and at room temperature in the presence of azo-*bis*-isobutyronitrile (ABIN). In the case of irradiated reactions a reactor built in our laboratory was used composed of four mercury lamps (2 x 250 W and 2 x 400 W). To avoid possible cyclopolymerization a 0.05 M concentration was used.

The generation of dibutyltin chlorhydride occurred by the reaction of an equimolecular mixture of dibutyltin dichloride and dibutyltin dihydride at room temperature (ν Sn-H 1853 cm^{-1}). The progress of the reactions was monitored by IR spectroscopy (observing the Sn-H band disappearance), and by TLC. In all cases the reaction times and the optimal Bu_2SnClH /diester relationship to get the best yields were determined. The purification and separation of the diastereoisomers was carried out by column chromatography using silica gel 60 as stationary phase. Structural features were determined by IR spectroscopy, and multinuclear magnetic resonance (^1H , ^{13}C and ^{119}Sn -NMR).

Discussion of results

The reactions were carried out under conditions that favour the radicalary mechanism. Two methods were used:

➤ **Method A:** The mixture of diester (**1**), dibutyltin chlorhydride and ABIN in dry toluene, and under nitrogen atmosphere was kept under stirring at room temperature until total reaction of the substrate and/or disappearance of the Sn-H band in the IR spectrum.

➤ **Method B:** The mixture of Bu_2SnClH and diester (**1**) in dry toluene and under nitrogen atmosphere was irradiated until total reaction of the substrate (temperature inside the photochemical irradiator is about 25 °C).

Upon analysis of both methods used for radical generation it was found that while the product composition is the same, the reactions initiated by irradiation are faster and require a chlorhydride/diester relationship lower than those initiated at room temperature in the presence of ABIN. The reaction temperature should remain close to 25 °C to avoid decomposition of chlorhydride.

The addition of dibutyltin chlorhydride to type-**1** diesters led at all cases to the formation of type-**2** intramolecular cyclization adducts with high stereoselectivity. ^{119}Sn -NMR spectra indicated the occurrence of a single chlorodibutylstannyl group in each product.

The results indicate that the addition of Bu_2SnClH to TADDOL diacrylate (**1a**) (Gerbino *et al.*, 2005) generates a new stereogenic center with formation of a single diastereoisomer. In the case of the addition to TADDOL dimethacrylate (**1b**) owing to the formation of an additional stereogenic center the addition of Bu_2SnClH leads to the formation of a mixture of two diastereoisomers with high diastereoselectivity. In this case the separation of the main diastereoisomer was possible by column chromatography. Finally the addition of dibutyltin chlorhydride on the diesters (**1c** and **1d**) leads to the formation of a mixture of four diastereoisomers, two of them in higher proportion.

The introduction of the chlorine atom as a ligand attached to the tin atom makes more electropositive the metal center, which favours the intramolecular coordination between the ester carbonyl group and the tin atom through a cycle of five centers, as shown in Fig. 2.

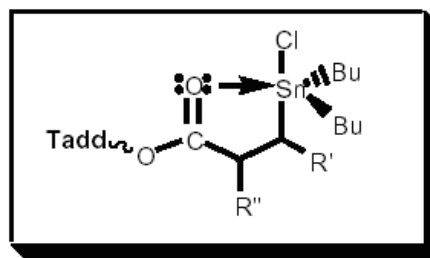


Figure 2

The fact that the frequency of carbonyl stretching does not change if the spectrum of the pure substance or in solution is recorded shows that the coordination is intramolecular. Intramolecular coordination in the reaction adduct restricts the access by one side, thus causing a decrease in the number of diastereoisomers and an increase in the diastereoselectivity of the reaction. The results of the radical addition of dibutyltin chlorhydride on some unsaturated diesters of TADDOL are shown in Fig. 3.

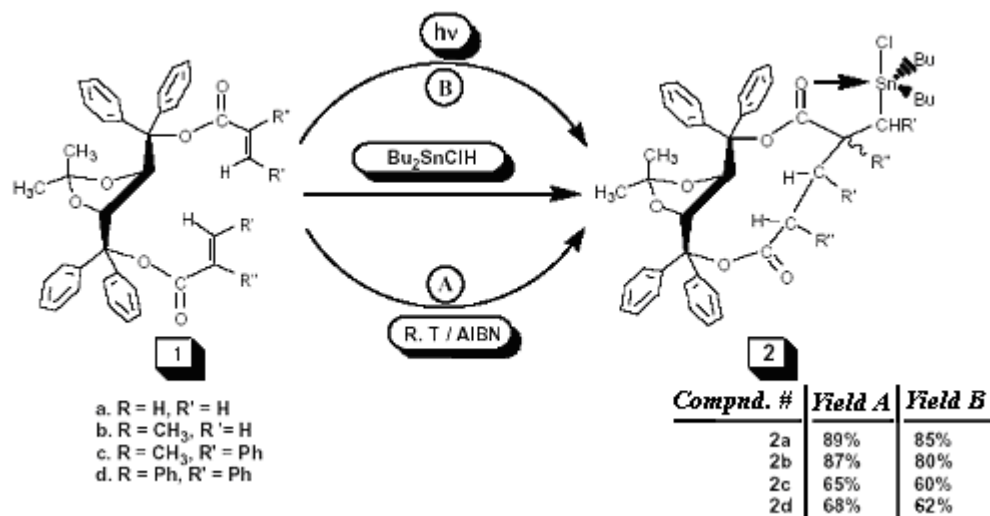


Figure 3

Conclusions

The developed studies have shown that the addition of dibutyltin chlorhydride to unsaturated diesters of TADDOL (**1**) takes place stereoselectively leading in all cases to the products of intramolecular cyclization with very good yields. Intramolecular coordination between the ester carbonyl group and the tin atom allow to obtain new organostannic adducts with high diastereoselectivity. Moreover, the results suggest that the addition of Bu₂SnClH to unsaturated type-(**1**) systems follows the same steric course that the additions of organostannic hydrides to substrates of the same type.

* Research Member of CONICET

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