

Mechanism of the Reaction of Lawesson's Reagent with *N*-Alkylhydroxamic Acids

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Keywords: Reaction mechanisms / Reactive intermediates / Chemoselectivity / Reduction

The mechanism of the reaction under discussion has been established by investigating the products of the reaction between 2,4-bis(4-methoxyphenyl)-1,3,2,4-dithiadiphosphetane 2,4-disulfide (Lawesson's reagent, LR) and *N*-alkylhydroxamic acids HAs **1**. The primary intermediate is an adduct, *O*-dithiophosphonylated hydroxamic acid **19**, which decomposes to yield metathiophosphonate (AnsPOS), a sulfur atom, and an amide. At the same time, owing to the co-existence of **19** and metadithiophosphonate (AnsPSS) in equilibrium, the carbonyl group is thionated. It has also been established that monomeric AnsPOS formed in both reduction and

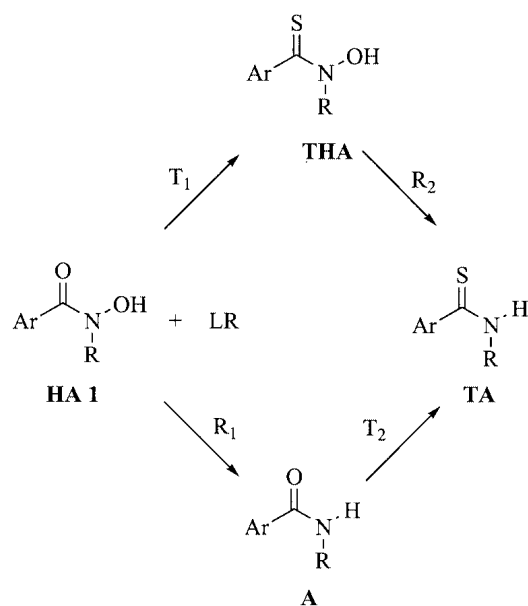
thionation processes does not undergo oligomerisation to cyclic trimer **5** and linear oligomers, which is typical for amides reacting with LR. Since there is unreacted HA **1** in the reaction mixture, AnsPOS takes part in a controlled transformation to form a dimer, the corresponding pyrothiophosphonate **3**, together with the intermediate *O*-thiophosphonylated hydroxamic acid **2**. A hydrolysed product of AnsPOS, namely (4-methoxyphenyl)thiophosphonic acid **4**, participates in the last reaction.

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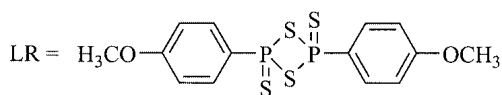
Introduction

It has often been reported that 2,4-bis(4-methoxyphenyl)-1,3,2,4-dithiadiphosphetane 2,4-disulfide (Lawesson's reagent, LR) is a very effective thionating reagent of carbonyl compounds.^[1] The key issue here is the chemoselectivity of the LR reaction when there is a nucleophilic centre other than a carbonyl group in the molecule. Direct thionation of hydroxamic acids (HAs) could potentially be very useful in the synthesis of the thioanalogues of natural hydroxamates and *N*-hydroxythiopeptides.^[2] It is evident that this reaction could be of synthetic importance as it gives reasonable yields of thiohydroxamic acids (THAs).^[3] As we have demonstrated before,^[4] the action of LR in THF causes *N*-alkylbenzohydroxamic acids **1** to transform into three products: THAs, amides (A) and thioamides (TA). The reaction can be thought of as involving four stages of which two are competitive and two are subsequent. Thus, initially thionation (T_1) gives THA and reduction (R_1) affords A. Subsequent reduction (R_2) and thionation (T_2) ultimately yield TA (Scheme 1).

We have proved that both the stoichiometry and the solvent used, as well as the temperature, have an effect on the distribution of the reaction products and the yield of THA. In our experiments the maximum yield of THA was 55–60%.



Ar, R: Ph, *i*Pr
Ar, R: 2,3-(BzlO)₂C₆H₃, Et



Scheme 1.

The reactions of LR with selected representatives of compounds with a N–O bond, excluding HAs, have been investigated previously. Based on the presence of sulfur in the post-reaction mixture, Lawesson and co-workers as-

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