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# Synthesis of a New Type of $N_2S_2$ Tetradentate Ligand

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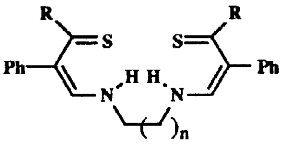
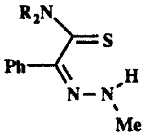
**Abstract** : Synthesis of a new type of $N_2S_2$ tetradentate ligand **3** possessing the bis-(hydrazonothioamide) structure based on condensation of the dihydrazines **8** with an α-ketoester is described.

Polyamine tetradentate ligands and their metal complexes have attracted considerable attention as models for natural tetraazamacrocycles such as porphyrins and corrins and have been extensively described in the literature [1]. $N_2S_2$ Tetradentate ligands are more rare and only a few of these structures have been reported. The most common $N_2S_2$ ligands are of the type bis-(aminopropenethione) **1** [2], first prepared by R.H.Holm [3].

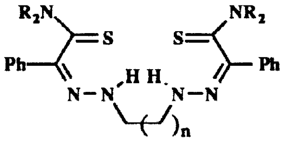
In the course of our studies on 4-amino-1-thia-4-azabutadienes, we have shown that α-hydrazonothioamides **2** are stable and can easily be synthesized in high yield [4]. This stability prompted us to prepare a new type of $N_2S_2$ tetradentate ligand **3**. We report here the first synthesis of these bis-(hydrazonothioamide) ligands.



**1**

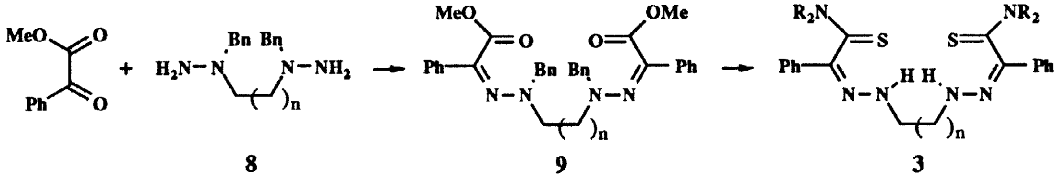


**2**



**3**

Bis-(hydrazonothioamides) **3** could be obtained from bis-(hydrazonoesters) **9** by classical functional group transformations as described in Scheme 1. These latter compounds were prepared in the key step of our strategy by condensation of two equivalents of an α-ketoester with the dihydrazines **8**.



Scheme 1

We decided to prepare the dihydrazines via the corresponding dinitrosamines in a two-step sequence well known to give high yields from secondary amines [5]. Reaction of the diamines **4**, with benzaldehyde gave the diimines **5** which were reduced with sodium borohydride to give the N,N'-dibenzyldiamines **6** in 95% yield [6] (Scheme 2). The protected diamines **6** were then transformed into the dinitrosamines **7** in 94-98% yield by addition of sodium nitrite to the dihydrochlorides of the diamines [7]. Reduction of the dinitrosamines **7** with a titanium complex, generated *in situ* by the action of magnesium on titanium IV chloride, gave the corresponding

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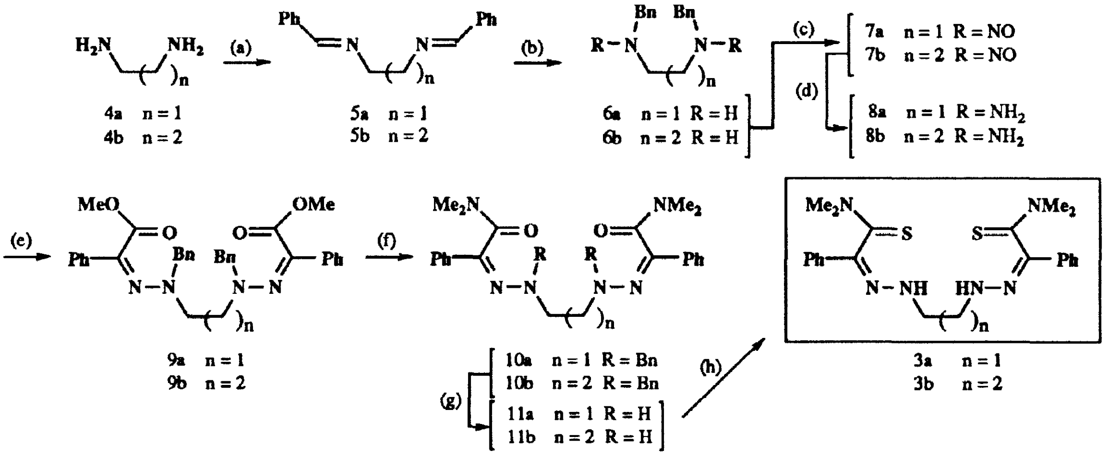
dihydrazines **8** in 91-98% yield [8]. The protected dihydrazines **8** were then reacted with two equivalents of methyl benzoylformate to afford the bis-(hydrazonoesters) **9** in 72-81% yield. Thionation of these precursors of the $N_2S_2$ ligands using Lawesson's Reagent proved to be unsuccessful. We have shown that α-hydrazonoamides are easily converted into their thionated analogs using Lawesson's Reagent [4], and so the bis-(hydrazonoesters) **9** were transformed into the bis-(hydrazonoamides) **10** by the action of dimethylaluminium dimethylamide, formed *in situ* by addition of dimethylamine to trimethylaluminium [9]. The compounds **10** were prepared in 85-91%. Hydrogenolysis of the benzyl protecting groups was complicated by concomitant N-N bond cleavage. Optimal conditions for yielding the deprotected $N_2O_2$ ligands **11** in 51-53% yield were found to be use of 4.5 equivalents of formic acid in methanol with an equal amount of 10% palladium on charcoal [10]. Thionation of the compounds **11** with Lawesson's Reagent finally afforded the $N_2S_2$ tetradentate ligands **3** in 84-90% yield.

To summarise, the first examples of a new type of $N_2S_2$ ligand **3** possessing the structure bis(hydrazonothioamide) have been synthesized. These ligands were prepared in 22-30% overall yield from the diamines **4**.



(a). 2 eq. PhCHO, EtOH, 98%. (b). $NaBH_4$, EtOH, 95%. (c). $NaNO_2$ / HCl, $H_2O$, 94-98%. (d). $TiCl_4$ / Mg, $CH_2Cl_2$ / $Et_2O$, 91-98%. (e). 2 eq. MeOCOCOPh, MeOH, 72-81%. (f). $Me_2NAlMe_2$, $C_6H_6$, 85-91%. (g). 4.5 eq. HCOOH, 10% Pd / C, MeOH, 51-53%. (h). LR, $C_6H_6$, 84-90%.


Lawesson's Reagent (LR) : $p\text{-}CH_3OC_6H_4(S)P\overset{S}{\underset{S}{\langle\,\rangle}}P(S)C_6H_4OCH_3\text{-}p$

Scheme 2

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