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REACTION OF N,N'-CARBONYLDIIMIDAZOLE AND N,N'-THIONYLDIIMIDAZOLE WITH AMIDES: AN IMIDAZOLE TRANSFER REACTION

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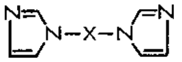
Abstract — Reaction of N,N'-thionyldiimidazole with amides effects the formation of imidoylimidazoles in moderate yield under neutral conditions. The hydrogen bonding in o-hydroxybenzamides activates the amide group (carbonyl function) in its reaction with N,N'-carbonyldiimidazole.

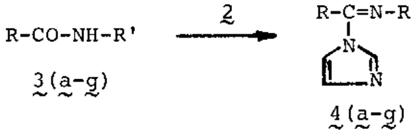
Although much attention has been paid to the usefulness of the diimidazolides such as N,N'-carbonyldiimidazole (1)[1] and N,N'-thionyldiimidazole (2),[2-4] the imidazole transfer reaction[5] has been little explored. Our particular interest was focused on the imidazole transfer reaction using these reagents 1 and 2, in connection with methodology for N-alkylation of imidazole. The present paper describes the imidazole transfer reaction to amide group.

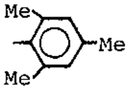


1: X = CO
2: X = SO

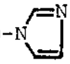
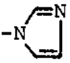
The reaction of 2, which is formed in situ, and N-methylbenzamide (3a) at room temperature in dichloromethane afforded the imidoylimidazole (4a) in 72% yield. However, 1 was inert towards the reaction with 3a.[6] Under analogous conditions, a variety of imidoylimidazoles (4b-g) was successfully obtained from the secondary amides (3b-g) as listed in the Table I. Next, attempts were made to apply this reaction to the other amide. Upon reaction with benzamide (5), 2 afforded benzonitrile in 21% yield and 1 did not lead to any product. Reaction of N,N'-dimethyl benzamide (6) with 1 or 2 failed and the starting material was recovered. These results eliminate the pathway through the addition intermediate (7)[7] and the reaction can reasonably be depicted as follows. The facile

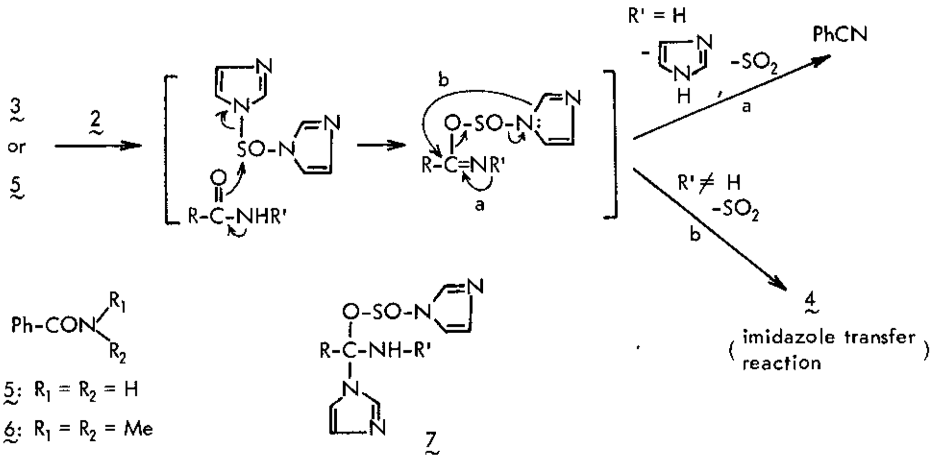
Table I. Synthesis of imidoyl imidazoles



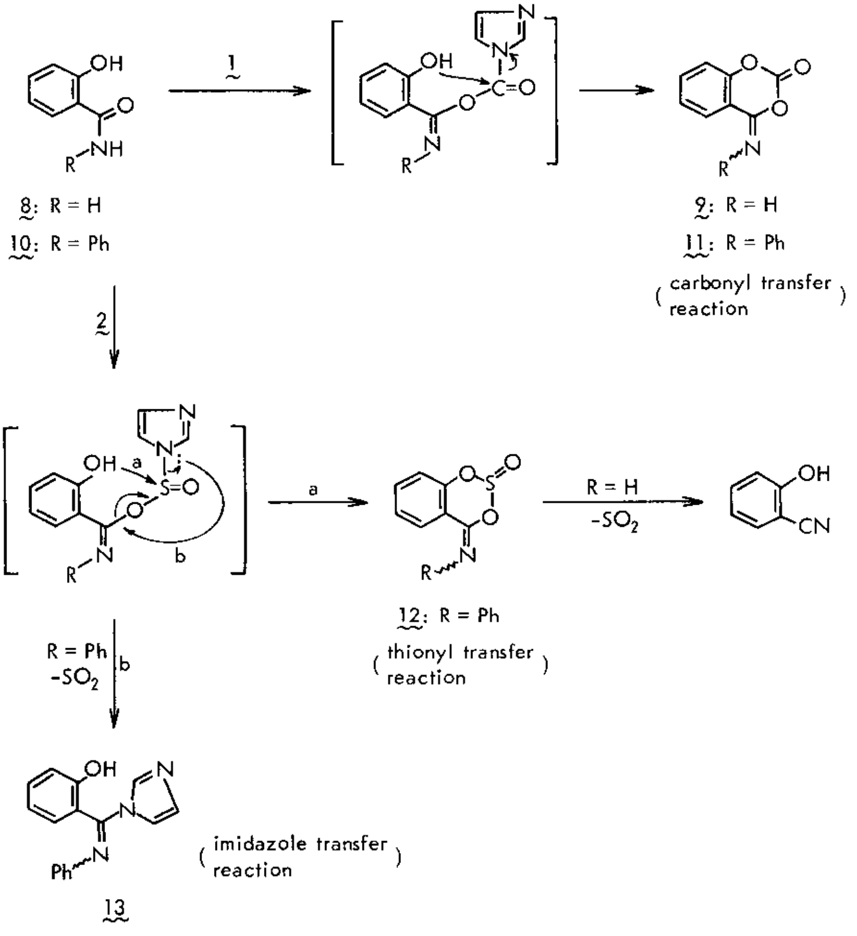
Entry	R	R'	4 (Yield, %)[a]
a	Ph	Me	71.5
b	Ph	Ph	56.8 (7.6)[b]
c	$CH_3-(CH_2)_3-$		66.5[c]
d	$PhCH_2OCH_2-$	"	37.8 (14.6)[b]
e	PhOCH(Me)-	"	76.3 (17.2)[b]
f	$PhSCH_2-$	"	24.7
g	$(Ph)_2C=CH-$	Ph	84.0

[a] No attempt was made to obtained maximum yields.
[b] Values in parentheses indicate the yield of recovery.
[c] Japanese unexamined patent publication No. 15372 (1978).

conversion of R-O-SO- to R- and SO_2 is well recognized.[1] With this mechanistic consideration in mind, the reaction of 1 and 2 with a variety of salicylamides were examined.



Although the amide group could not react with 1 as mentioned above, when OH was situated ortho to the amide function on the phenyl ring, the reaction of 1 with the amide proceeded. Namely, salicylamide (8) reacted with 1 to give the 1,3-benzodioxane (9) in 72% yield (carbonyl transfer reaction[8]), though the imidazole derivative was not obtained.[9] This interesting result prompted us to examine the reaction of o-hydroxybenzanilide (10) with 1. Reaction of 10 with 1 resulted in the formation of the 1,3-benzodioxane (11) in 81% yield. These results indicate the importance of internal hydrogen bonding between the carbonyl and phenolic OH groups for the reactivity of these amide groups, and this observation was consistent with the facts that the internal hydrogen bonding in salicylaldehyde activates the carbonyl function towards reduction as reported by Pandit.[10,11]



As expected from the above mentioned reactivity of 2, the reaction of 2 with 8 and with 10 were successful, namely, 8 afforded salicylonitrile in 41% yield and 10 gave the two products of the 1,3-benzodioxane (12, 40%) (thionyl transfer reaction[12]) and the imidoylimidazole (13, 15%) (imidazole transfer reaction).

Further studies of these imidazole transfer reaction to the other functional groups[7] are now in progress. Analytical data obtained for all the new compounds agreed with the structures assigned.

REFERENCES

1. H. A. Staab, *Angew. Chem. Internat. Edn.*, 1962, **I**, 351, and references quoted therein.
2. S. Bast and K. K. Andersen, *J. Org. Chem.*, 1968, **33**, 846.
3. H. A. Staab and K. Wendel, *Justus Liebigs Ann. Chem.*, 1966, **694**, 86.
4. Soon after our research succeeded, we found the reaction concerning the use of N,N'-thionyldiimidazole for thioamides. This has prompted us to summarize our results at this stage [Japanese unexamined patent publication No. 39674 (1977)].
5. We would like to use the term "imidazole transfer reaction" in comparison with "thiocarbonyl transfer reaction" by N,N'-thiocarbonyldiimidazole (C. Larsen, K. Stelion and P. N. Harpp, *J. Org. Chem.*, 1978, **43**, 337). The conversion of triphenylcarbinol into triphenylmethyl imidazole is an example of "the imidazole transfer reaction" (K. H. Büchel, W. Draber, E. Regal, and M. Plempel, *Arzneim. Forsch.*, 1972, **22**, 1260).
6. The greater reactivity of N,N'-thionyldiimidazole compared to that of N,N'-carbonyldiimidazole is described in reference 1.
7. Some evidence of addition intermediate was observed in the reaction of ketones and aldehydes with **2**. Details will be published elsewhere.
8. J. P. Kutney and A. H. Ratcliffe, *Synth. Commun.*, 1975, **5**, 47.
9. Treatment of N,N'-dimethylsalicylamide with 1 leads to the recovery of starting material.
10. U. K. Pandit and F. R. Mas Cabré, *J.C.S. Chem. Commun.*, 1971, 552.
11. K. Horiki, *J. Synth. Org. Chem. Jpn.*, 1979, **37**, 93.
12. H. A. Staab and K. Wendel, *Justus Liebigs Ann. Chem.*, 1966, **694**, 86.

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