STUDIES ON THE ADDITION OF NUCLEOPHILES TO ISOTHIOCYANATES

A THESIS

Submitted By

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ADDITION OF SOME NEUCLEOPHILES INCLUDING SUGARS TO ISOTHIOCYANATES AND SOME REACTIONS ON THE PRODUCTS

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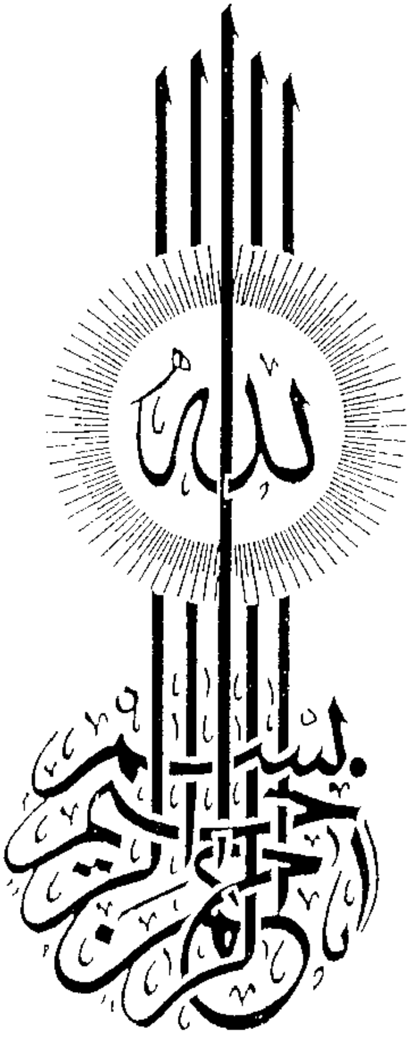
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SUMMARY

The thesis describes the nucleophilic addition of S-benzylthiourea hydrochloride, in presence of sodium hydroxide, to benzoyl, styryl and p-chlorobenzoyl isothiocyanates (IXa-c), respectively. Formation of 2(4)-benzylmercapto-1,6-dihydro-6-thiono-4(2)-phenyl(CXXVa), styryl (CXXVb) and p-chlorophenyl (CXXVc)-1,3,5-triazines, respectively, infers that, the nucleophile attacks the >C=S function of the dielectrophilic reagents (IXa-c) exclusively, by the unsubstituted nitrogen atom, i.e., $-NH_2$ group of S-benzyl-thiourea hydrochloride.

Reactions of morpholine, piperidine, n-butylamine, benzylamine and some aromatic amines such as p-toluidine, p-anisidine and aniline, as nucleophiles, with 2(4)-benzyl-mercapto-1,6-dihydro-6-thiono-4(2)-phenyl (CXXVa), styryl (CXXVb) and p-chlorophenyl (CXXVc)-1,3,5-triazines, respectively, gave 2(4)-substituted amino-1,6-dihydro-6-thiono-4(2)-phenyl (CXXVIa;1a-7a), styryl (CXXVIb,1b-7b) and p-chlorophenyl (CXXVIc; 1c-7c)-1,3,5-triazines, respectively, with liberation of benzyl thiol group.

Methylation of 2(4)-substituted amino-1,6-dihydro-6-thiono-4(2)-phenyl (CXXVIa; 1a-7a), styryl (CXXVIb; 1b-7b) and p-chlorophenyl (CXXVIc; 1c-7c)-1,3,5-triazines with methyl iodide in presence of sodium hydroxide afforded the corresponding 2-substituted amino-4-phenyl (CXXVIIIa; 1a-7a), styryl (CXXVIIIb; 1b-7b) and p-chlorophenyl

(CXXVIII*c*; 1*c*-7*c*)-6-methylmercapto-1,3,5-triazines, respectively.

Cyanoethylation of 2(4)-substituted amino-1,6-dihydro-6-thiono-4(2)-phenyl (CXXVI*a*; 3*a*-7*a*), styryl (CXXVI*b*; 3*b*-7*b*) and *p*-chlorophenyl (CXXVI*c*; 3*c*-7*c*)-1,3,5-triazines with acrylonitrile, gave 2-substituted amino-4-phenyl (CXXIX*a*;1*a*-5*a*), styryl (CXXIX*b*; 1*b*-5*b*) and *p*-chlorophenyl (CXXIX*c*; 1*c*-5*c*)-6-(β-cyanoethyl)-mercapto-1,3,5-triazines, respectively.

Formation of 1-acetyl-2(4)-substituted amino-1,6-dihydro-6-thiono-4(2)-phenyl (CXXXa;1*a*-5*a*), styryl (CXXX*b*; 1*b*-5*b*) and *p*-chlorophenyl (CXXX*c*; 1*c*-5*c*)-1,3,5-triazines from action of acetic anhydride on 2(4)-substituted amino-1,6-dihydro-6-thiono-4(2)-phenyl (CXXVIa; 3*a*-7*a*), styryl (CXXVI*b*; 3*b*-7*b*) and *p*-chlorophenyl (CXXVI*c*;3*c*-7*c*)-1,3,5-triazines are also investigated.

The structures of all of the products were substantiated from their spectra as well as analytical data.

INTRODUCTION

GENERAL INTRODUCTION

The Chemistry of Heterocumulenes

(A) Definition and classification of heterocumulenes

Cumulenes are compounds with double bonds adjacent to each other. The parent compound of the gem.cumulenes is allene (I), in which the centers as well as the terminal atoms are carbon. If one or more of the atoms of the cumulative system are heteroatoms, such as oxygen, nitrogen or sulphur, they are known to heterocumulenes.

The heterocumulenes can be divided into the groups:

(A) heterocumulenes having one or two heteroatoms in the cumulative arrangement (by this definition one or two carbon atoms are part of the cumulative system) and;
(B) heterocumulenes in which all three atoms in the cu cumulative arrangement are heteroatoms.

Group (A) (can be subdivided into three groups: 1) systems with two carbons and one heteroatom; (2) systems with one carbon and two like heteroatoms, and (3) systems with one carbon and two different heteroatoms. Examples of group (A) heterocumulenes are ketene (II), carbon dioxide (III) carbonyl sulphide (IV), isocyanates (V) and isothiocyantes (VI).

$CH_2 = C = CH_2$ (I) $CH_2 = C = O$ (II) $O = C = O$ (III)

$O = C = S$ (IV) $R - N = C = O$ (V) $R - N = C = S$ (VI)

Group (B) can also be subdivided into two groups: 1) systems with two like heteroatoms; and 2) systems with three different heteroatoms. Typical examples of these two groups are sulphur dioxide (VII) and N-sulphinylamines (VIII).

$O = S = O$ (VII) $R - N = S = O$ (VIII)

The heterocumulenes falling within the scope of this definition are listed in Table 1. The three divisions falling under group (A) are denoted A_1, A_2 and A_3 ; B_1 and B_2 are defined similarly.

Table 1

Summary of the different classes of the heterocumulenes

Group	System		Representation
A_1	$C=C=X$	$X=O$	Ketenes, carbon suboxide
		$X=NR$	Ketenimines
		$X=S$	Thicketones
	$C=X=C$	$X=S$	Sulphilidenes
A_2	$C=X=X$	$X=N$	Diazo compounds
	$X=C=X$	$X=O$	Carbon dioxide
		$X=NR$	Carbodiimide
		$X=S$	Carbon disulphide
A_3	$C=X=Y$	$X=N, Y=O$	Nitrile oxide
		$X=NR, Y=O$	Nitrones
		$Y=N, Y=NR$	Nitrile imines
		$X=NR, Y=NR$	Azomethine imines
		$X=S, Y=O$	Sulphines
		$X=SO, Y=O$	Sulphenes
	$X=C=Y$	$X=O, Y=S$	Carbonyl sulphide
		$X=O, Y=NR$	Cyanates
		$X=NR, Y=O$	Isocyanates
		$X=NR, Y=S$	Isothiocyanates
		$X=SR, Y=N$	Thiocyanates

P.T.O.

Table 1 (cont...)

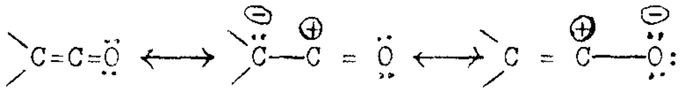
B_1	$X=Y=X$	$X=O, Y=N$	Nitric dioxide
		$X=O, Y=S$	Sulphur dioxide
		$X=NR, Y=S$	Sulphur diimide
	$X=X=Y$	$X=N, Y=O$	Nitrous oxide
		$X=NR, Y=O$	Azoxy compounds
		$X=NR, Y=S$	Azo sulphides
		$X=N, Y=NR$	Azides
B_2	$X=Y=Z$	$X=N, Y=S, Z=O$	N-Sulphinylamines
		$X=N, Y=SO, Z=O$	N-Sulphurylamines
		$X=S, Y=N, Z=O$	8-Nitroso compounds

(B) Reactivity[1] of heterocumulenes

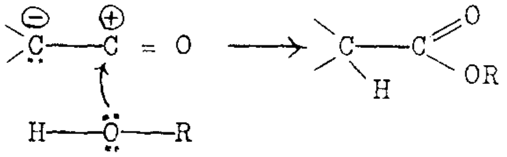
The chemical reactivity of the heterocumulenes ranges from highly reactive species to almost inert compounds. While some heterocumulenes can only be generated *in situ*, others are indefinitely stable at room temperature.

The broad range of reactivity observed in heterocumulenes is perhaps best exemplified by the fact that hitherto sulphenes have only been generated *in situ*, whereas carbon dioxide is an almost inert gas. Other heterocumulenes such as sulphur dioxide and carbon disulphide are often used as solvents, thereby demonstrating their relative inertness. While ketenes and isocyanates undergo nucleophilic reactions with active hydrogen compounds rapidly, ketenimines, isothiocyanates and carbodiimides react considerably slower. For example, the reaction of isothiocyanates with amines can be conducted in an alcoholic solvent.

Taking ketene (II) as an example, it is quite obvious that its central carbon atom is electrophilic as shown from the resonating structures of ketene.



The negative charge can be stabilized on the terminal carbon atom as well as on the oxygen, thus leaving the central carbon atom electrophilic in both polar structures. The electrophilicity of the central carbon atom may account for the rapid nucleophilic reactions of ketenes as exemplified in the reaction with alcohol.



In isocyanates (V) the contral carbon atom is also electrophilic and the effect is as follows: electron-withdrawing groups, e.g., the phenyl group attached to the isocyanate group increases the electrophicity of the central carbon atom, whereas electron-donating groups, e.g., alkyl groups reduce its electrophilicity. Furthermore, introduction of an electron-withdrawing groups into phenyl nucleus of aryl isocyanates increases the reactivity, whereas electron-donating groups reduce their reactivity.

The reactivity of the isocyanate group towards