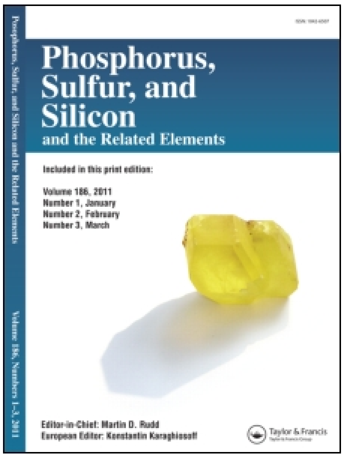

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REACTION OF HYDRAZONOYL HALIDES WITH 5-ARYLMETHYLENE-3-PHENYL-2-THIOXOTHIAZOLIDIN-4-ONE. SYNTHESIS OF 4,9-DITHIA-1,2,6-TRIAZASPIRO[4,4]NONAN-2-EN-7-ONE

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REACTION OF HYDRAZONOYL HALIDES WITH 5-ARYLMETHYLENE-3-PHENYL-2-THIOXOTHIAZOLIDIN-4-ONE. SYNTHESIS OF 4,9-DITHIA-1,2,6-TRIAZASPIRO[4,4]NONAN-2-EN-7-ONE

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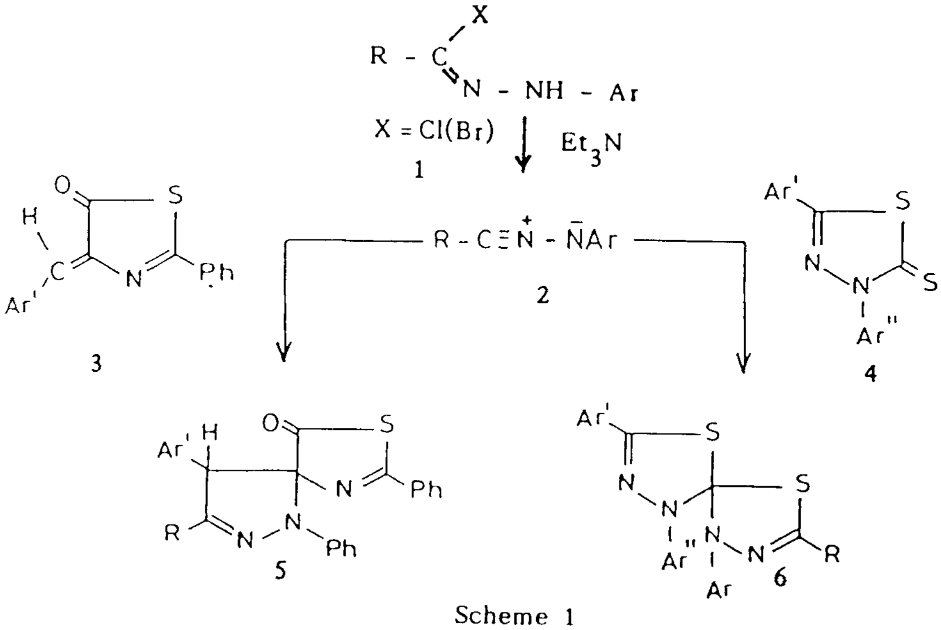
Nitrilimines **2** cycloadd to the C═S double bond rather than the exocyclic C═C double bond of 3-phenyl-5-arylmethylene-2-thioxothiazolidin-4-one **7** to give the corresponding spiro cycloadducts **8** in good yield.

Key words: Cycloaddition, hydrazonoyl halides, nitrilimines, 3-phenyl-5-arylmethylene-2-thioxothiazolidin-4-one.

Nitrilimines **2** were reported to react with (z)-4-arylmethylene-2-phenyl-5(4H)-thiazolones **3** and 3,5-diaryl-1,3,4-thiadiazolines-2-thione **4** to give the spiro cycloadducts **5** and **6**, respectively (Scheme 1).[1,2] In this paper we wish to report the results



Scheme 1

TABLE I

Melting points and analytical data of products 8a–p

No.	mp.(°C)	Solvent	Mol. formula	Analysis Calcd./Found C %	H %	N %	S %
8a	194	DMF	$C_{30}H_{23}N_3O_2S_2$	69.1 69.2	4.4 4.5	8.1 8.3	12.3 12.0
8b	207	Acetic acid	$C_{32}H_{25}N_3O_2S_2$	70.2 69.9	4.6 4.3	7.7 7.6	11.7 11.5
8c	196	Acetic acid	$C_{31}H_{23}N_3O_3S_2$	67.8 68.1	4.2 4.4	7.7 7.7	11.7 11.5
8d	206	Acetic acid	$C_{35}H_{25}N_3O_3S_2$	70.1 70.2	4.1 4.0	7.0 6.8	10.6 10.4
8e	186	Dioxane	$C_{29}H_{21}N_3O_3S_3$	62.7 62.3	3.8 4.1	7.6 7.7	17.3 17.1
8f	230	Dioxane	$C_{26}H_{21}N_3O_3S_2$	64.1 64.3	4.3 4.1	8.6 8.5	13.1 13.0
8g	202	Acetic acid	$C_{27}H_{23}N_3O_4S_2$	62.7 62.7	4.4 4.1	8.1 8.0	12.4 12.4
8h	225	Acetic acid	$C_{31}H_{24}N_4O_3S_2$	65.9 65.6	4.3 4.6	9.9 9.7	11.3 11.2
8i	205	DMF	$C_{30}H_{23}N_3OS_2$	71.3 70.9	4.6 5.0	8.3 8.3	12.7 12.7
8j	210	DMF	$C_{32}H_{25}N_3OS_2$	72.3 72.5	4.7 4.7	7.9 7.7	12.1 12.1
8k	195	Acetic acid	$C_{31}H_{23}N_3O_2S_2$	69.8 69.5	4.3 4.6	7.9 7.7	12.0 12.1
8l	195	Acetic acid	$C_{35}H_{25}N_3O_2S_2$	72.0 72.0	4.3 4.4	7.2 7.3	11.0 10.9
8m	187	Acetic acid	$C_{29}H_{21}N_3O_2S_3$	64.6 64.2	3.9 3.7	7.8 7.7	17.8 17.7
8n	162	Acetic acid	$C_{26}H_{21}N_3O_2S_2$	66.2 65.9	4.5 4.6	8.9 8.7	13.6 13.4
8o	140	Acetic acid	$C_{27}H_{23}N_3S_2O_3$	64.6 64.5	4.6 4.7	8.4 8.4	12.8 12.9
9p	215	Acetic acid	$C_{31}H_{24}N_4O_2S_2$	67.8 67.7	4.4 4.5	10.2 10.1	11.7 11.8

of the study of the reaction of 3-phenyl-5-arylmethylene-2-thioxothiazolidin-4-one **7** with a series of nitrilimines. This study was undertaken with the objective of identifying the site selectivity in the reactions of **7** with 1,3-dipoles, as such reactions can lead to cycloadducts **8** and **9** and/or **10**.

RESULTS AND DISCUSSION

Reactions of nitrilimines **2**, generated *in situ* by the action of triethylamine on the corresponding hydrazonoyl halides **1** in refluxing chloroform, with **7** gave, in each case, a single compound as evidenced by TLC analysis of the crude reaction product.

TABLE II

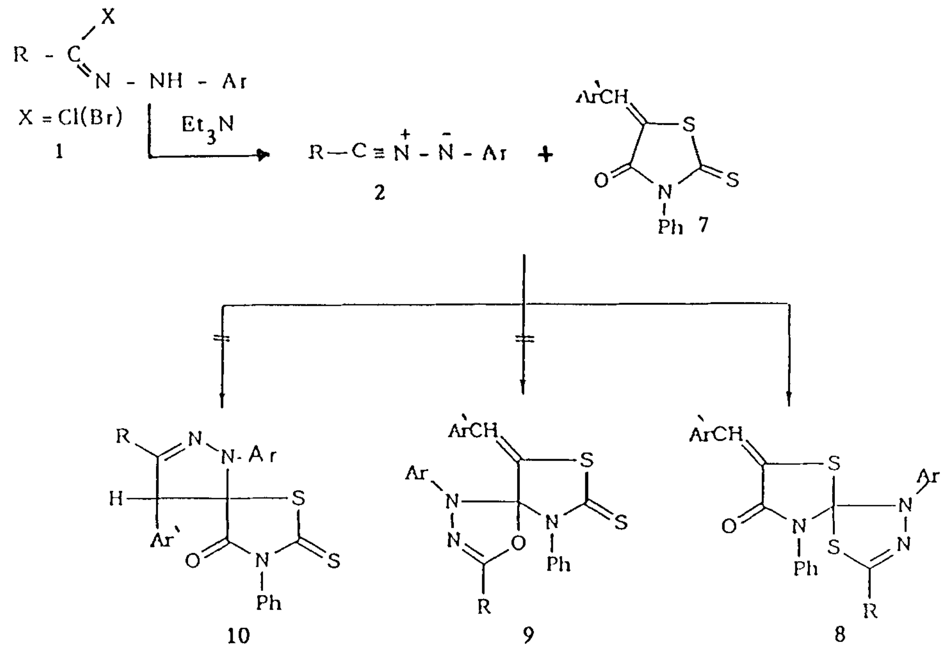
Characteristic IR, ^{1}H NMR and MS spetral data of products **8a–p**

No.	IR	^{1}H-NMR	m/z
8a	1690 (C=O)	3.9 (s, 3 H); 6.9-8.0 (m, 20 H)	
8b	1690 (C=O)	3.9 (s, 3 H), 6.9-8.1 (m, 22 H)	
8c	1685 (C=O), 1670 (C=O)	3.8 (s, 3 H), 7.0-8.1 (m, 20 H)	
8d	1690 (C=O), 1660 (C=O)	3.8 (s, 3 H), 7.1-8.0 (m, 21 H), 9.1 (s, 3 H).	
8e	1690 (C=O), 1650 (C=O)	3.8 (s, 3 H), 7.0-7.9 (m, 18 H)	555, 364, 164, 111, 77, 51
8f	1700 (C=O), 1684 (C=O)	2.2 (s, 3 H), 3.8 (s, 3 H), 7.0-8.1 (m, 15 H).	
8g	1715 (C=O), 1690 (C=O)	1.4 (t, J = 7Hz, 3 H), 2.2 (s, 3 H), 4.3 (q J = 7Hz, 2 H) 7.0-7.9 (m, 10 H)	517, 325, 164, 91, 77,51
8h	3350 (NH), 1685 (broad C=O).	3.9 (s, 3 H), 7.0-7.8 (m, 21 H)	
8i	1690 (C=O)	2.3 (s, 3 H); 7.0-7.9 (m, 20 H)	505, 396, 330, 194, 148, 91.
8j	1690 (C=O)	2.3 (s, 3 H), 6.9-8.0 (m, 22 H)	
8k	1690 (C=O), 1670 (C=O)	2.3 (s, 3 H), 7.0-8.1 (m, 20 H)	
8l	1690 (C=O), 1650 (C=O).	2.4 (s, 3 H), 7.0-8.0 (m, 21 H), 9.0 (s, 1 H).	
8m	1690 (C=O), 1660 (C=O).	2.4 (s, 3 H), 7.0-7.8 (m, 18 H)	
8n	1700 (C=O), 1690 (C=O)	2.3 (s, 3 H), 2.4 (s, 3 H), 7.2-7.9 (m, 15 H)	
8o	1715 (C=O), 1690 (C=O).	1.3 (t, J = 7Hz, 3 H), 2.4 (s, 3 H), 4.3 (q, J = 7 Hz, 2H), 7.1-7.9 (m, 15 H).	
8p	3399 (NH), 1695 (C=O), 1678 (C=O).	2.3 (s, 3 H), 7.0-7.9 (m, 12 H)	

Mass spectra and elemental analyses of the pure products isolated supported the structures to be 1:1 cycloadducts (Tables I and II).

Three structures namely **8–10** can be written for each of such products (Scheme 2). However, the latter two structures **9** and **10** were discarded on the basis of IR and ^{1}H NMR spectra. Thus, each of the products isolated exhibits a carbonyl absorption near 1690 cm^{-1} assignable to α, β-unsaturated carbonyl groups, similar to that of the starting dipolarophiles **7** (ν = 1960 cm^{-1}). Furthermore, the ^{1}H NMR spectra of the isolated products showed a common one proton singlet near δ 7.8 ppm assignable to the vinylic proton resonance. The starting thiazolines **7** exhibited such a singlet near δ 7.8 ppm. Consequently, the products of the reaction studied were assigned structure **8**. The latter structure was also evidenced by the observation that all products **8a–h** showed the color of a bromine solution in chloroform. The exclusion of structure **10** was supported by the absence of a methine proton signal near δ 6.0 ppm in their ^{1}H NMR spectra. Spiropyrazolines of type **10** were reported to exhibit a characteristic methine proton signal near δ 6.0 ppm.[3]

The foregoing results indicate that the studied reactions are site selective leading to the exclusive formation of products **8**, that is the C=S bond is more dipolarophilic



	R/Ar/Ar'		R/Ar/Ar'
a	$C_6H_5/C_6H_5/4\text{-}CH_3OC_6H_4$	j	$C_6H_5/C_6H_5/4\text{-}CH_3C_6H_4$
b	$C_6H_5CH{=}CH/C_6H_5/4\text{-}CH_3OC_6H_4$	j	$C_6H_5CH{=}CH/C_6H_5/4\text{-}CH_3C_6H_4$
c	$C_6H_5CO/C_6H_5/4\text{-}CH_3OC_6H_4$	k	$C_6H_5CO/C_6H_5/4\text{-}CH_3C_6H_4$
d	2-naphthoyl/$C_6H_5/4\text{-}CH_3OC_6H_4$	l	2-naphthoyl/$C_6H_5/4\text{-}CH_3C_6H_4$
e	2-thienoyl/$C_6H_5/4\text{-}CH_3OC_6H_4$	m	2-thienoyl/$C_6H_5/4\text{-}CH_3C_6H_4$
f	$CH_3CO/C_6H_5/4\text{-}CH_3OC_6H_4$	n	$CH_3CO/C_6H_5/4\text{-}CH_3C_6H_4$
g	$C_2H_5OCO/C_6H_5/4\text{-}CH_3OC_6H_4$	o	$C_2H_5OCO/C_6H_5/4\text{-}CH_3C_6H_4$
h	$C_6H_5NHCO/C_6H_5/4\text{-}CH_3OC_6H_4$	p	$C_6H_5NHCO/C_6H_5/4\text{-}CH_3C_6H_4$

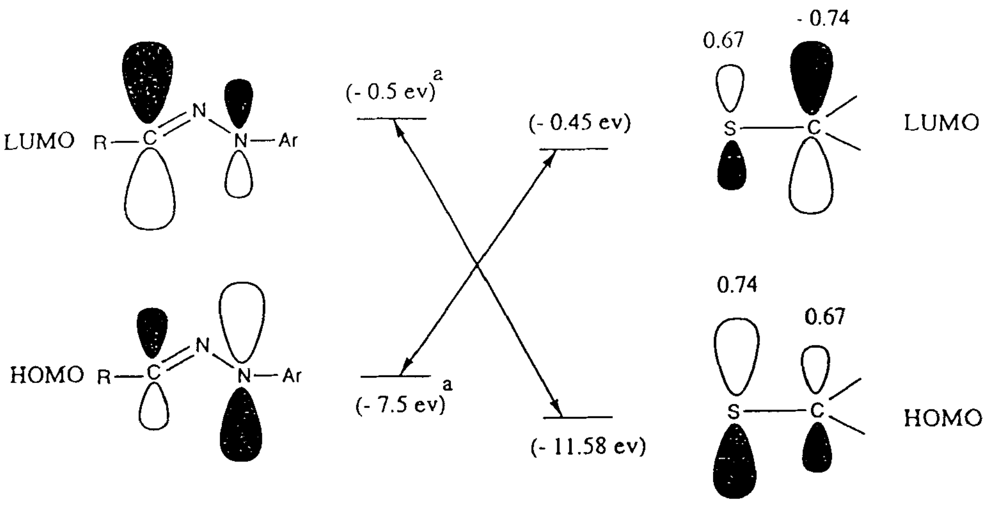
Scheme 2

toward nitrilimines **2** than to both the C=C and C=O bonds. This observed site selectivity can be rationalized in terms of FMO theory. As the cycloaddition reactions of nitrilimines with various dipolarophiles are known to be controlled by HOMO (nitrilimine)-LUMO (dipolarophile) interaction, it would be expected that the reactivity of the dipolarophile would increase with decrease of the energy to its LUMO. Molecular orbital calculations[4] indicate that the energy of the LUMO of $H_2C{=}S$, $H_2C{=}O$, $H_2C{=}CH_2$ dipolarophiles (Scheme 3) decrease in the order:

$$C{=}C\ (1.44\ \text{eV}) > C{=}O\ (1.79\ \text{eV}) > C{=}S\ (-0.45\ \text{eV})$$

Accordingly, it would be expected that nitrilimine would preferably attack the C=S site more than the other two reactive sites present in **7** thus leading to **8**.

The regiochemistry assigned for the latter product **8** isolated from the cycloaddi-



The relative magnitudes of orbital coefficients of the FMOs of nitrilimine and thione dipolarophile. (a, taken from ref. 3)

Scheme 3

tion of **2** with the C═S group of **7** agrees with the principle of maximum gain of bond energy of the two new bonds,[5] as well with FO interaction.[6] In Scheme 3 the relative size of the aromatic orbital coefficients of both the nitrilimine **2** and C═S dipolarophilic group are shown. According to Fukui[7] a cycloaddition reaction takes place in the direction of maximal HOMO-LUMO overlap as such an overlap will lead to a product of higher stability. As the maximal HOMO-LUMO overlap results from the overlap of orbitals of similar magnitude, i.e. large with large and small with small, the cycloaddition of **2** to C═S occurs via the formation of C—S and C—N bonds leading thus to **8**.

EXPERIMENTAL

Melting points were determined on a Gallenkamp electrothermal melting point apparatus and are uncorrected. Infrared spectra were determined on a Pye Unicam SP-300 infrared spectrophotometer. ^{1}H NMR spectra were recorded on a Varian gemini 200 instrument with TMS as internal standard. Elemental analyses were carried out at the microanalytical laboratory at the University of Cairo, Giza, Egypt. 5-Arylmethylene-3-phenyl-2-thioxothiazolidin-4-ones **7**[8] and hydrazonoyl halides **1a**,[9] **1b**,[10] **1c**,[11] **1d**,[12] **1e**,[13] **1f**,[14] **1g**,[15] and **1h**[16] were prepared as previously described.

4,9-Dithia-1,2,6-triazaspiro[4,4]nonan-2-en-7-one **8**: *General method.* To a solution of 5-arylmethylene-3-phenyl-2-thioxothiazolidin-4-one **7** (5 mmol) and the appropriate hydrazonoyl halides (5 mmol) in chloroform (40 ml) was added triethylamine (0.7 ml, 5 mmol) at room temperature. The reaction mixture was refluxed until the hydrazonoyl halides disappeared (6 h) as indicated by TLC analysis. The solvent was evaporated and the residue was treated with methanol. The solid formed was collected and crystallized from suitable solvents to give the corresponding 4,9-dithia-1,2,6-triazaspiro[4,4]nonan-2-en-7-one **8**.

REFERENCES

1. E. Argyropoulou and E. Thessalonikeos, *Ann. Chem.*, 1097 (1990).
2. R. Huisgen, R. Grashey, M. Seidel, H. Knupfer and R. Schmidt, *Ann. Chem.*, 169 (1962).
3. A. S. Shawali, A. M. Farag and M. S. Algharib, *J. Chem. Res., (S)*, 80 (1993).
4. K. N. Houk and Yamaguchi, "1,3-Dipolar Cycloaddition Chemistry," A. Padwa, ed., John Wiley and Sons, New York 1984, Vol. 2, Chap. 13.
5. R. Huisgen, *Angew. Chem. Intern. Ed.*, **2,** 633 (1963).
6. K. N. Houk, J. Sims, C. R. Watts and L. J. Lusks, *J. Amer. Chem. Soc.*, **95,** 7301 (1973).
7. K. Fukui, *Bull. Chem. Soc. Jpn.*, **39,** 498 (1966).
8. A. Zipser, *Monatsheffe für chemie*, **24,** 509 (1893).
9. P. Wolkoff, *Can. J. Chem.*, **53,** 1333 (1975).
10. H. M. Hassaneen, N. M. Elwan, A. Harhash and A. S. Shawali, *J. Heterocycl. Chem.*, **21,** 1013 (1984).
11. A. S. Shawali and A. O. Abdelhamid, *Bull. Chem. Soc. Jpn.*, **49,** 321 (1976).
12. H. M. Hassaneen, A. S. Shawali, N. M. Elwan and N. M. Abounada, *Sulfur Letters*, **13,** 273 (1992).
13. A. M. Farag and M. S. Algharib, *Org. Prep. Procd. Int.*, **20,** 421 (1988).
14. N. F. Eweiss and A. Osman, *J. Heterocycl. Chem.*, **17,** 1713 (1980).
15. A. S. Shawali, N. F. Eweiss, H. M. Hassaneen and M. S. Algharib, *Bull. Chem. Soc. Jpn.*, **48,** 305 (1975).
16. A. S. Shawali and A. Osman, *Tetrahedron*, **27,** 2517 (1971).