Regioselective Synthesis of 3(or 5)-Styryl-/(4-Aryl-1,3-butadienyl)-/(6-Aryl-1,3,5-hexatrienyl)-5(or 3)-(methylthio)isoxazoles and Pyrazoles *via* α-Oxoketene Dithioacetals

M. L. Purkayastha, B. Patro, H. Ila* and H. Junjappa*

Department of Chemistry, North-Eastern Hill University,
Shillong - 793003, Meghalaya, India

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The regioselective synthesis of the title isoxazoles and pyrazoles through cyclocondensation of oxoketene dithioacetals with either hydroxylamine or hydrazine hydrate under controlled conditions is reported.

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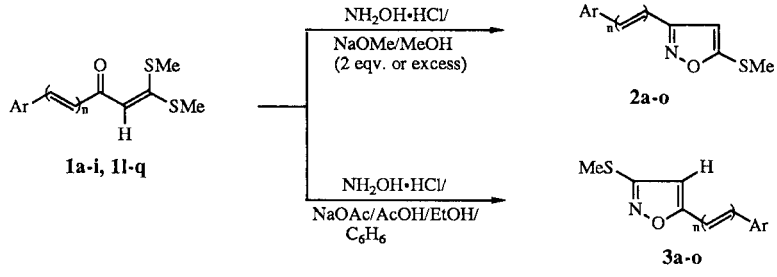
Introduction.

Although a large number of isoxazoles with a variety of substituents and functionalities are reported [1] in the literature only a few styryl isoxazoles are known [2-4]. These isoxazoles have been prepared by base catalysed condensation of aromatic aldehydes with 5-methylisoxazoles activated by electron withdrawing groups (NO_2, CN, acyl, CO_2H, Me_3N^+-) at the 4-position [1,5,6]. Similarly, the methodologies for the synthesis of styrylpyrazoles are few in number [7]. Generally, they are obtained by reacting phenylhydrazine with either γ,δ-unsaturated β-keto compounds or 2,3-dihydro-4-pyrones [8,9]. On the other hand, the homologous dienyl or trienyl isoxazoles and pyrazoles remain unreported probably due to the lack of suitable open-chain precursors. During the course of our studies on oxoketene dithioacetals, we synthesized a series of α-cinnamoyl, **1a-k**, 5-aryl-2,4-pentadienoyl, **1l-n**, ketenedithioacetals, which were shown to be useful precursors for the synthesis of a number of heterocycles and polyene esters [10-13]. We have now utilized these intermediates and the homologous 7-aryl-2,4,6-heptatrienoyl ketene dithioacetals **1o-q** for the synthesis of the title isoxazoles and pyrazoles by their reaction with hydroxylamine and hydrazine hydrate respectively under controlled conditions. The results of these studies are now reported in the present paper.

Results and Discussion.

We recently reported [14] that the reaction of hydroxylamine with aroylketene dithioacetals under different reaction conditions afforded highly regioselective 3- or 5-alkylthioisoxazoles in high yields. Thus the regioselective formation of 5-alkylthioisoxazoles was achieved by using sodium methoxide or barium hydroxide (equivalent or excess) in the *p*H range of 5-9. The role of base in these reactions is limited to the release of free NH_2OH from its salt which attacks α-oxoketene dithioacetals through the oxime pathway under these conditions to yield exclusively 3-aryl-5-alkylthioisoxazoles. On the other hand, the reaction of α-oxoketene dithioacetals with hydroxylamine hydrochloride in the presence of sodium acetate/acetic acid (*p*H 2) afforded 3-alkylthio-5-arylisoxazoles exclusively. The dominant species under this *p*H range is the hydroxylammonium ion with only a small amount of hydroxylamine which attacks the more electrophilic C-3 of

Scheme 1



1-3a, Ar = C_6H_5, n = 1
b, Ar = 4-MeC_6H_4, n = 1
c, Ar = 4-ClC_6H_4, n = 1
d, Ar = 4-$MeOC_6H_4$, n = 1
e, Ar = 4-$(Me_2N)C_6H_4$, n = 1
f, Ar = 2-ClC_6H_4, n = 1
g, Ar = 2,6-$Cl_2C_6H_3$, n = 1
h, Ar = 2,4-$Cl_2C_6H_3$, n = 1
i, Ar = 3,4-methylenedioxy C_6H_3, n = 1

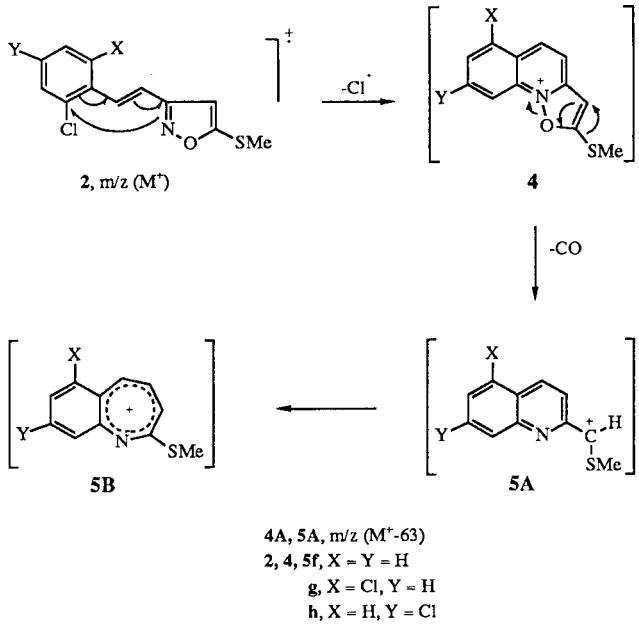
1l, **2-3j**, Ar = C_6H_5, n = 2
1m, **2-3k**, Ar = 4-$MeOC_6H_4$, n = 2
1n, **2-3l**, Ar = 3,4-methylenedioxy C_6H_3, n = 2
1o, **2-3m**, Ar = C_6H_5, n = 3
1p, **2-3n**, Ar = 4-$MeOC_6H_4$, n = 3
1q, **2-3o**, Ar = 3,4-methylenedioxy C_6H_3, n = 3

the protonated dithioacetal (1,4-addition) in the rate determining step to afford 3-alkylthioisoxazoles after cyclization. In the present study, when the α-cinnamoyl ketene dithioacetal **1a** reacted with hydroxylamine hydrochloride in the presence of sodium methoxide (2 equivalents) in refluxing methanol, the product isolated after work-up (37%) was characterized as 5-methylthio-3-styrylisoxazole (**2a**) on the basis of its spectral and analytical data (Scheme 1). The yield of **2a** could not be increased by varying the reaction conditions or bases (barium hydroxide, sodium acetate and pyridine, *etc.*), however in no case was the 3-methylthio regioisomer **3a** detected in the reaction mixture. The other substituted 3-styrylisoxazoles **2b-i** were similarly obtained from the corresponding α-oxoketene dithioacetals **1b-i** in moderate yields (35-49%) under identical conditions. The reaction was equally facile for the synthesis of 3-(4-aryl-1,3-butadienyl) (**2j-l**), and 3-(6-aryl-1,3,5-hexatrienyl) isoxazoles **2m-o** which were obtained from the respective ketene dithioacetals **1l-q** in 38-44% overall yields under identical conditions. In all these reactions the formation of isoxazoles was accompanied with an intractable polymeric mixture, however, in no case was the formation of the 3-methylthio regioisomers **3** observed in the reaction mixture on the basis of tlc and ^{1}H nmr spectral analysis.

Next, the synthesis of the regioisomeric 3-methylthio-5-substituted isoxazoles **3a-o** was investigated (Scheme 1). Thus, treatment of **1a** with hydroxylamine hydrochloride in the presence of sodium acetate in refluxing acetic acid/ethanol afforded a product (56%) which was characterized as 3-methylthio-5-styrylisoxazole (**3a**) on the basis of its spectral and analytical data. The other substituted 5-styrylisoxazoles **3b-i** and their higher enyl homologs **3j-o** were similarly prepared in 35-66% overall yields from the corresponding α-oxoketene dithioacetals **1b-i** and **1l-q** under identical conditions. In these reactions formation of regioisomeric isoxazoles **2** was not observed in the reaction mixture tlc and ^{1}H nmr spectral analysis.

The isoxazoles **2** and **3** were found to have similar R_f under various solvent combinations. The reaction mixture was analyzed by ^{1}H nmr spectroscopy after passing through a short silica gel column to remove the tarry contents. A comparison of the ^{1}H nmr spectra of regioisomers **2** and **3** showed that the signal due to the H-4 proton in 3-(methylthio)isoxazoles **3** appears 0.1 ppm upfield (δ 5.91-6.15) than in that of 5-methylthioisoxazoles (δ 6.15-6.28). However, a clearer distinction between the 5- and 3-methylthio regioisomers could be made from their mass spectral fragmentation pattern (Table 3) [14]. Thus 5-(methylthio)isoxazoles **2** show characteristic peaks due to loss of SCH_3 (M^+ -47) and $COSCH_3$ (M^+ -75) fragments (except in the case of 2-chlorostyrylisoxazoles **2f-h**) suggesting that the methylthio group is adjacent to the ring oxygen atom. The mass spectra of the 3-methylthio isomers **3** exhibit an absence of a (M^+-75) peak, instead, a medium or high intensity peak due to [Ar-(CH=CH)$_n$CO] fragments was present (m/z 131 in the case of **3a**) showing that the styryl or arylenyl group is adjacent to the ring oxygen in these isoxazoles. The ^{13}C nmr spectra of a few selected isoxazoles **2b**, **3b**, **2d**, **3d**, **2l**, **3l** and **2o**, **3o** (Table) also exhibit some generalized trends. Thus in the 5-methylthio series **2**, the C-3, C-4 and C-5 carbon signals appear at δ 162, 99 and 167 respectively whereas in the corresponding 3-methylthioisoxazoles, the signals due to these carbon atoms are present at δ 168, 100 and 160 which may prove helpful in distinguishing the two regioisomers.

Scheme 2



In the mass spectra of 3-(2-chlorostyryl)isoxazoles **2f-h**, a prominent peak at m/z (M^+-63) (m/z 188 in **2f**) was present instead of the M^+-$COSCH_3$ peak. Appearance of this peak is attributed to the fragment ion **5** formed by loss of 2-chlorine and CO group through intramolecular rearrangement as shown in the Scheme 2. The presence of *o*-substituents is shown to have appreciable influence on fragmentation pattern of many compounds [15]. The facile loss of an *o*-chlorine substituent through intramolecular bond formation has also been observed in the mass spectral fragmentation of *N*-(*o*-chlorophenyl)urea derivatives [16]. The corresponding 3-methylthio-5-(2-chlorostyryl)isoxazoles **3f-h** on the other hand, did not show any peak due to M^+-63 fragment in their mass spectra and the prominent peaks due to [Ar-(CH=CH)$_n$CO] fragments were present.

Table 1

Physical and Analytical Data for the Products **2,3**

Compound	Yield (%)	MP (°C)	Molecular Formula	Analysis (%) Calcd./Found C	H	N
2a	37	91-92	$C_{12}H_{11}NOS$	66.36 (66.48)	5.10 (5.22)	6.44 (6.71)
2b	35	93-94	$C_{13}H_{13}NOS$	67.52 (67.31)	5.66 (5.81)	6.05 (5.93)
2c	40	133-134	$C_{12}H_{10}ClNOS$	57.27 (57.41)	4.00 (4.15)	5.56 (5.68)
2d	49	96-97	$C_{13}H_{13}NO_2S$	63.15 (62.93)	5.29 (5.36)	5.66 (5.38)
2e	46	124-125	$C_{14}H_{16}N_2OS$	65.58 (65.48)	6.15 (6.28)	10.76 (10.92)
2f	40	69-70	$C_{12}H_{10}ClNOS$	57.27 (57.31)	4.00 (4.20)	5.56 (5.72)
2g	42	94-95	$C_{12}H_9Cl_2NOS$	50.36 (50.61)	3.17 (3.28)	4.89 (5.11)
2h	42	111-112	$C_{12}H_9Cl_2NOS$	50.36 (50.17)	3.17 (3.34)	4.89 (4.73)
2i	46	128-129	$C_{13}H_{11}NO_3S$	59.75 (60.01)	4.24 (4.38)	5.36 (5.20)
2j	41	102-103	$C_{14}H_{13}NOS$	69.10 (69.30)	5.38 (5.54)	5.75 (5.83)
2k	44	112-113	$C_{15}H_{15}NO_2S$	65.90 (65.88)	5.53 (5.68)	5.12 (4.96)
2l	41	118-119	$C_{15}H_{13}NO_3S$	62.70 (62.87)	4.56 (4.67)	4.87 (5.12)
2m	44	133-134	$C_{16}H_{15}NOS$	71.34 (71.18)	5.57 (5.48)	5.19 (5.20)
2n	40	135-136	$C_{17}H_{17}NO_2S$	68.19 (67.98)	5.73 (5.72)	4.68 (4.81)
2o	38	150-151	$C_{17}H_{15}NO_3S$	65.16 (65.33)	4.82 (4.86)	4.46 (4.13)
3a	56	78-79	$C_{12}H_{11}NOS$	66.36 (66.28)	5.10 (5.24)	6.44 (6.31)
3b	60	98-99	$C_{13}H_{13}NOS$	67.52 (67.80)	5.66 (5.81)	6.05 (6.34)
3c	64	133-134	$C_{12}N_{10}ClNOS$	57.27 (57.51)	4.00 (4.16)	5.56 (5.39)
3d	65	84-85	$C_{13}H_{13}NO_2S$	63.15 (63.01)	5.29 (5.41)	5.66 (5.60)
3e	62	108-109	$C_{14}H_{16}N_2OS$	64.58 (64.38)	6.19 (6.38)	10.76 (10.81)
3f	56	70-71	$C_{12}H_{10}ClNOS$	57.25 (57.39)	4.00 (4.31)	5.56 (4.71)
3g	63	62-63	$C_{12}H_9Cl_2NOS$	50.36 (50.61)	3.17 (3.26)	4.89 (4.68)
3h	35	115-116	$C_{12}H_9Cl_2NOS$	50.36 (50.41)	3.17 (3.31)	4.89 (4.71)
3i	62	120-121	$C_{13}H_{11}NO_3S$	59.75 (60.00)	4.24 (4.31)	5.36 (5.16)
3j	66	90-91	$C_{14}H_{13}NOS$	69.10 (69.01)	5.38 (5.48)	5.75 (5.87)
3k	58	102-103	$C_{15}H_{15}NO_2S$	65.90 (65.80)	5.53 (5.61)	5.12 (5.32)
3l	63	108-109	$C_{15}H_{13}NO_3S$	62.70 (62.56)	4.56 (4.58)	4.87 (5.01)
3m	59	123-124	$C_{16}H_{15}NOS$	71.34 (71.53)	5.61 (5.81)	5.20 (5.36)
3n	47	139-140	$C_{17}H_{17}NO_2S$	68.19 (68.08)	5.73 (5.86)	4.68 (4.91)
3o	51	144-145	$C_{17}H_{15}NO_3S$	65.16 (65.26)	4.82 (4.91)	4.46 (4.36)

Table 2
Physical and Analytical Data for the Products **8**

Compound	Yield (%)	MP (°C)	Molecular Formula	Analysis (%) Calcd./Found C	H	N
8a	79	viscous liquid	$C_{12}H_{12}N_2S$	66.63 (66.39)	5.59 (5.81)	12.95 (12.73)
8b	72	142-143	$C_{12}H_{11}ClN_2S$	57.47 (57.21)	4.42 (4.66)	11.17 (10.90)
8c	73	112-113	$C_{13}H_{14}N_2OS$	63.38 (63.70)	5.72 (5.99)	11.38 (11.63)
8d	69	149-150	$C_{14}N_{17}N_3S$	64.83 (65.11)	6.60 (6.79)	16.20 (16.06)
8e	64	101-102	$C_{12}H_{11}ClN_2S$	57.47 (57.26)	4.42 (4.67)	11.17 (11.44)
8f	63	110-111	$C_{12}H_{10}Cl_2N_2S$	50.53 (50.23)	3.53 (3.78)	9.82 (9.62)
8g	69	143-144	$C_{13}H_{12}N_2O_2S$	59.98 (60.23)	4.64 (4.90)	10.76 (11.01)
8h	80	90-91	$C_{14}H_{16}N_2O_2S$	60.84 (61.11)	5.84 (6.07)	10.14 (9.93)
8i	78	150-151	$C_{15}H_{18}N_2O_3S$	58.81 (59.01)	5.92 (6.11)	9.15 (9.33)
8j	74	119-120	$C_{14}H_{14}N_2S$	69.39 (69.63)	5.82 (5.93)	11.56 (11.78)
8k	74	105-106	$C_{15}H_{16}N_2OS$	66.14 (65.99)	5.92 (6.16)	10.29 (10.47)
8l	77	131-132	$C_{15}H_{14}N_2O_2S$	62.92 (63.11)	4.93 (5.18)	9.79 (10.07)
8m	75	140-141	$C_{16}H_{16}N_2S$	71.60 (71.93)	6.01 (6.28)	10.44 (10.59)
8n	74	158-159	$C_{17}H_{18}N_20S$	68.42 (68.66)	6.08 (6.32)	9.39 (9.60)
8o	71	162-163	$C_{17}H_{16}N_2O_2S$	65.36 (65.16)	5.16 (5.39)	8.97 (9.16)

The probable mechanism for the formation of **2** and **3** from **1** appears to be similar to that discussed in the previous paper [14]. The reaction provides a facile entry to the hitherto unreported 3- and 5-styrylisoxazoles and their higher enyl homologs in a highly regioselective manner. The lower yields of **2** and **3** in comparison to those of 3- and 5-arylisoxazoles appear to be due to competetive attack of hydroxylamine on styryl double bond yielding polymeric reaction mixture.

The reactivity of enoylketene dithioacetals **1** towards hydrazine and its derivatives could be of interest since the carbonyl functionality in these systems is flanked by two 1,3-electrophilic centres. It is likely that the hydrazine could react with these systems by first adding to mercapto functionality followed by intramolecular cyclocondensation to afford the appropriate styryl or higher polyenyl pyrazoles (Route a, Scheme 3). Alternatively, the cyclization might proceed by addition of hydrazine to the styryl double bond to give pyrazolines (route b). Therefore, it was contemplated to examine the reaction of hydrazine hydrate with various cinnamoyl and their homologous oxoketene dithioacetals, Thus when **1a** reacted with hydrazine hydrate in refluxing ethanol, the reaction mixture after work-up turned into an intractable tar, from which no well defined compound could be isolated. In an another experiment, the worked-up reaction mixture was immediately treated with acetic anhydride and acetic acid to yield two different compounds which were identified as 1(2)-acetyl-3(5)styryl-5(3)methylthiopyrazole (**6a**) (18%) and 1-acetyl-3[2-bis(methylthio)ethenyl)-5-phenyl-2-pyrazoline (**7a**) (54%) on the basis of their spectral properties and analytical data. The reaction of substituted ketene dithioacetals **1d** also gave a mixture of **6b** and **7b** with pyrazoline **7b** as the major product which could only be isolated as the acetyl derivative. The mechanism governing the formation of **6** and **7** could be explained involving a competative Michael addition either on the styryl β-carbon of the bis-

Table 3

Spectral Data for Compounds **2a-o** and **3a-o**

Compound	IR (KBr) cm^{-1}	^1H NMR δ (ppm)	MS m/e (%)
2a	1638, 1525, 1420	2.58 (s, 3H, SC*H*$_3$), 6.20 (s, 1H, *H*-4), 7.00 (s, 2H, olefinic) 7.15-7.58 (m, 5H, Ar*H*)	217 (M^+, 38), 170 (59), 142 (32), 114 (30), 103 (100)
2b [a]	1638, 1604, 1534, 1422	2.33 (s, 3H, C*H*$_3$), 2.52 (s, 3H, SC*H*$_3$), 6.18 (s, 1H, *H*-4), 6.92 (s, 2H, olefinic), 7.08 (d, J = 8 Hz, 2H, Ar*H*), 7.35 (d, J = 8 Hz, 2H, Ar*H*)	231 (M^+, 99), 184 (100), 156 (100), 117 (100)
2c	1600, 1570, 1509, 1440, 1361, 1310, 1248, 1173, 960	2.59 (s, 3H, SC*H*$_3$), 6.18 (s, 1H, *H*-4), 7.00 (s, 2H, olefinic), 7.21-7.50 (m, A_2B_2, 4H, Ar*H*)	253 (23), 251 (M^+, 59), 206, 204 (33, 94), 178, 176 (14, 38), 139, 137 (95, 35)
2d [b]	1608, 1540, 1510, 1428, 1303, 1260, 1240	2.53 (s, 3H, SC*H*$_3$), 3.78 (s, 3H, OC*H*$_3$), 6.15 (s, 1H, *H*-4), 6.79 (d, J = 9 Hz, 2H, Ar*H*), 6.84 (brs, 2H, olefinic), 7.38 (d, J = 9 Hz, 2H, Ar*H*)	247 (M^+, 100), 200 (85), 172 (78), 133 (77)
2e	1600, 1528, 1418, 1360, 1182, 960, 808	2.55 (s, 3H, SC*H*$_3$), 2.95 [s, 6H, N(C*H*$_3$)$_2$], 6.15 (s, 1H, *H*-4), 6.55 (d, J = 9 Hz, 2H, Ar*H*), 6.78 (distorted d, 2H, olefinic), 7.25 (d, J = 9 Hz, 2H, Ar*H*)	260 (M^+, 100), 213 (39), 185 (57)
2f	1532, 1422	2.55 (s, 3H, SC*H*$_3$), 6.28 (s, 1H, *H*-4), 6.98 (d, J = 18 Hz, 1H, olefinic), 7.13-7.84 (m, 5H, Ar*H* + olefinic)	253 (16), 251 (M^+, 47), 206, 204 (13, 41), 188 (72, 139 (40)
2g	1532, 1425, 958, 770	2.58 (brs, 1H, SC*H*$_3$), 6.28 (brs, 1H, *H*-4), 7.09-7.50 (m, 5H, Ar*H* + olefinic)	287 (18), 285 (M^+, 38), 240 (23), 238 (38), 224 (28), 222 (74)
2h	1582, 1539, 1475, 1430, 960, 858	2.56 (s, 3H, SC*H*$_3$), 6.23 (s, 1H, H-4), 6.92 (d, J = 18 Hz, 1H, olefinic), 7.11-7.63 (m, 4H, ArH + olefinic)	287 (36), 285 (M^+, 44), 201 (66), 199 (100)
2i	1640, 1600, 1540, 1500, 1448, 1426, 1260, 1038, 960, 928, 840, 800	2.58 (s, 3H, SC*H*$_3$), 5.85 (s, 2H, -O-C*H*$_2$-O-), 6.19 (s, 1H, *H*-4), 6.68-7.04 (m, 5H, Ar*H*, + olefinic)	261 (M^+, 43), 214 (100), 186 (40), 156 (55)
2j [c]	1625, 1537, 1425, 988, 900, 743	2.58 (brs, 3H, SC*H*$_3$), 6.19 (s, 1H, *H*-4), 6.40-6.86 (m, 4H, olefinic), 7.13-7.48 (m, 5H, Ar*H*)	243 (M^+, 71), 196 (98), 168 (77)
2k	1600, 1530, 1500, 1420, 1250, 968, 830	2.58 (s, 3H, SC*H*$_3$), 3.79 (s, 3H, OC*H*$_3$), 6.13 (s, 1H, *H*-4), 6.40-6.91 (m, 6H, Ar*H* + olefinic), 7.34 (d, J = 8 Hz, 2H, Ar*H*)	273 (M^+, 19), 226 (26), 198 (14)
2l	1625, 1525, 1498, 1440, 1420, 1242, 1038, 974	2.58 (s, 3H, SC*H*$_3$), 5.82 (s, 2H, -O-C*H*$_2$-O-), 6.11 (s, 1H, *H*-4), 6.40-7.08 (m, 7H, Ar*H* + olefinic)	287 (M^+, 85), 240 (80) 212 (67)
2m [d]	1600, 1530, 1425, 1318, 1100, 990, 955, 880	2.57 (s, 3H, SC*H*$_3$), 6.14 (s, 1H, *H*-4), 6.33-6.88 (m, 6H, olefinic), 7.18-7.50 (m, 5H, Ar*H*)	269, (M^+, 36), 222 (100), 194 (55)
2n	1610, 1600, 1538, 1510, 1428, 1300, 1248, 990, 960, 890, 860	2.57 (s, 3H, SC*H*$_3$), 3.80 (s, 3H, OC*H*$_3$), 6.18 (s, 1H, *H*-4), 6.33-6.74 (m, 6H, olefinic), 6.87 (d, J = 8 Hz, 2H, Ar*H*), 7.50 (d, J = 8 Hz, 2H, Ar*H*)	299 (M^+, 15), 252 (21), 251 (100), 224 (60)
2o	1605, 1500, 1440, 1420, 1259, 980	2.58 (s, 3H, SC*H*$_3$), 5.96 (s, 2H, -O-C*H*$_2$-O-), 6.21 (s, 1H, *H*-4), 6.38-7.00 (m, 9H, Ar*H* + olefinic)	313 (M^+, 79), 266 (100), 238 (69), 208 (48)
3a	1640, 1578, 1548, 1442, 1408, 1360, 1268	2.57 (s, 3H, SC*H*$_3$), 6.00 (s, 1H, *H*-4), 6.75 (d, J = 18 Hz, 1H, olefinic), 7.13-7.49 (m, 6H, Ar*H* + olefinic)	217(M^+, 42), 131 (80), 103 (51)
3b [e]	1640, 1600, 1568, 1545, 1410, 1360	2.33 (s, 3H, C*H*$_3$), 2.56 (s, 3H, SC*H*$_3$), 5.97 (s, 1H, *H*-4), 6.75 (d, J = 16 Hz, 1H, olefinic), 6.93-7.48 (m, 5H, Ar*H* + olefinic)	231 (M^+, 50), 145 (100), 117 (29)
3c	1600, 1580, 1360, 960	2.58 (s, 3H, SC*H*$_3$), 6.00 (s, 1H, *H*-4), 6.75 (d, H = 18 Hz, 1H, olefinic) 7.09-7.58 (m, 5H, Ar*H* + olefinic)	253 (24), 251 (M^+, 52), 167 (49), 165 (100)
3d [f]	1600, 1558, 1508, 1360, 1310, 1245	2.56 (s, 3H, SC*H*$_3$), 3.81 (s, 3H, OC*H*$_3$), 5.95 (s, 1H, *H*-4), 6.64 (d J = 18 Hz, 1H, olefinic), 6.79 (d, J = 10 Hz, 2H, Ar*H*), 7.18 (d, J = 18 Hz, 1H, olefinic), 7.37 (d, J = 10 Hz, 2H, Ar*H*)	247 (M^+, 50), 161 (100)
3e	1600, 1560, 1358, 960, 804	2.56 (s, 3H, SC*H*$_3$), 3.00 [s, 6H, N(C*H*$_3$)$_2$], 5.91 (s, 1H, H-4), 6.43-6.66 (m, 4H, Ar*H* + olefinic), 7.43 (d, J = 10 Hz, 2H, Ar*H*)	260 (M^+, 63), 202 (100), 174 (23), 146 (38)
3f	1640, 1567, 1550, 1468, 1428	2.58 (s, 3H, SC*H*$_3$), 6.10 (s, 1H, *H*-4), 6.81 (d, J = 18 Hz, 1H, olefinic), 7.12-7.50 (m, 4H, Ar*H*), 7.78 (d, J = 18 Hz, 1H, olefinic)	253 (20), 251 (M^+, 56), 167 (36), 165 (100)
3g	1546, 1420, 1358, 1258, 1248, 958, 760	2.60 (s, 3H, SC*H*$_3$), 6.15 (s, 1H, *H*-4), 6.90-7.49 (m, (m, 5H, Ar*H* + olefinic)	287 (12), 285 (M^+, 17), 201 (26), 199 (46)
3h	1568, 1460, 1400, 1358, 1100, 958	2.60 (s, 3H, SC*H*$_3$), 6.12 (s, 1H, *H*-4), 6.75 (d, J = 18 Hz, 1H, olefinic), 7.12-7.78 (m, 4H, Ar*H* + olefinic)	287 (26), 285 (M^+, 41), 240 (21), 238 (33), 224 (39), 222 (100), 173 (87), 171 (87)
3i	1600, 1570, 1500, 1490, 1450, 1410, 1355, 1260	2.57 (s, 3H, SC*H*$_3$), 5.92 (s, 3H, -O-C*H*$_2$-O- and H-4), 6.33-7.30 (m, 5H, Ar*H* + olefinic)	261 (M^+, 87), 175 (100), 147 (60)

Table 3 (continued)

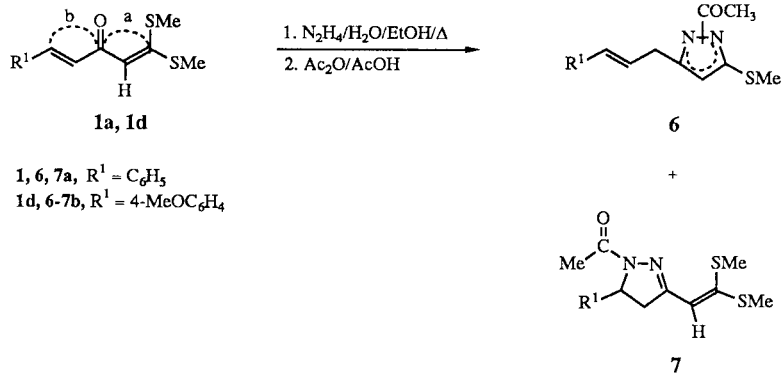
Spectral Data for Compounds **2a-o** and **3a-o**

Compound	IR (KBr) cm^{-1}	^1H NMR δ (ppm)	MS m/e (%)
3j [g]	1630, 1565, 1546, 1410, 1368, 990, 981, 960	2.57 (s, 3H, SC*H*$_3$), 5.93 (s, 1H, *H*-4), 6.33 (d, J = 8 Hz, 1H, olefinic), 6.66-6.98 (m, 3H, olefinic), 7.10-7.48 (m, 5H, Ar*H*)	243 (M^+, 94), 196 (73), 157 (100), 129 (75)
3k	1579, 1547, 1507, 1462, 1358, 1280, 1250, 1162, 998	2.60 (s, 3H, SC*H*$_3$), 3.81 (s, 3H, OC*H*$_3$), 6.00 (s, 1H, *H*-4), 6.32 (d, J = 16 Hz, 1H, olefinic), 6.63-7.20 (m, 5H, Ar*H* + olefinic), 7.34 (d, J = 8 Hz, 2H, Ar*H*)	273 (M^+, 39), 226 (21), 187 (20)
3l	1612, 1499, 1484, 1446, 1441, 1254, 1038, 989	2.60 (s, 3H, SC*H*$_3$), 5.93 (s, 2H, -O-C*H*$_2$-O-), 5.95 (s, 1H, H-4), 6.35 (d, J = 18 Hz, 1H, olefinic), 6.61-7.30 (m, 6H, ArH + olefinic)	287 (M^+, 100), 240 (39), 201 (32), 173 (25)
3m [h]	1627, 1597, 1530, 1362, 1268, 990, 745	2.58 (s, 3H, SCH$_3$), 5.92 (s, 1H, H-4), 6.31 (d, J = 16 Hz, 1H, olefinic), 6.42-6.89 (m, 5H, olefinic), 7.10-7.48 (m, 5H, Ar*H*)	269 (M^+, 100), 222 (27), 183 (18), 155 (30)
3n	1605, 1585, 1508, 1364, 1303, 1252, 1171, 992	2.57 (s, 3H, SC*H*$_3$), 3.80 (s, 3H, OC*H*$_3$), 6.00 (s, 1H, *H*-4), 6.11-6.92 (m, 8H, Ar*H* + olefinic), 7.31 (d, J = 8Hz, 2H, Ar*H*)	299 (M^+, 20), 298 (100), 252 (27), 224 (18), 185 (25)
3o	1600, 1578, 1485, 1469, 1355, 1258, 992	2.58 (s, 3H, SC*H*$_3$), 5.95 (s, 2H, -O-C*H*$_2$-O-), 6.03 (s, 1H, *H*-4), 6.18-7.13 (m, 9H, Ar*H* + olefinic)	313 (M^+, 100), 266 (20), 238 (15), 208 (17)

[a] ^{13}Cnmr (deuteriochloroform) δ 15.42(SCH$_3$), 21.33 (CH$_3$), 99.04 (*C*-4), 114.66 (*C*H=), 126.93 (*C*H, Ar), 129.54 (*C*H, Ar), 132.94 (*C*-4', Ar), 136.02 (*C*H=), 139.1 (*C*-1'), 162.41 (*C*-3), 167.35 (*C*-5). [b] (deuteriochloroform) δ 15.44 (SCH$_3$), 55.34 (OCH$_3$), 99.00 (*C*-4), 113.42 (*C*H=), 114.28 (*C*H, Ar), 128.39 (*C*H, Ar), 128.48 (*C*-1', Ar), 135.62 (*C*H=), 160.32 (*C*-4', Ar), 162.52 (*C*-3), 167.24 (*C*-5). [c] (deuteriochloroform) δ 15.42 (SCH$_3$), 99.06 (*C*-4), 119.01 (*C*H=), 126.76, 127.69, 128.74 (*C*H, Ar), 128.37, 136.22, 136.34 (*C*H=), 136.29 (*C*-1', Ar), 162.20 (*C*-3), 167.34 (*C*-5). [d] (deuteriochloroform) δ 15.41 (SCH$_3$), 99.08 (*C*-4), 118.73 (*C*H=), 126.58, 128.35, 128.70 (*C*H, Ar), 118.73, 128.02, 131.81, 134.76, 136.15, 136.75 (=*C*H), 136.88 (*C*-1', Ar), 162.33 (*C*-3), 167.29 (*C*-5). [e] (deuteriochloroform) δ 13.92 (SCH$_3$), 21.44 (CH$_3$), 100.69 (*C*-4), 111.84 (*C*H=), 127.15, 129.64 (*C*H, Ar), 135.27 (*C*H=), 139.51 (*C*-1' arom), 132.69 (*C*-4' arom), 168.70 (*C*-3), 160.66 (*C*-5). [f] (deuteriochloroform) δ 13.88 (SCH$_3$), 55.35 (OCH$_3$), 100.26 (*C*-4), 114.30, 128.61 (*C*H, Ar), 110.60, 134.85 (*C*H=), 128.17 (*C*-1', Ar), 160.50 (*C*-4', Ar), 168.83 (*C*-3), 160.51 (*C*-5). [g] (deuteriochloroform) δ 13.98 (SCH$_3$), 100.91 (*C*-4), 126.93, 127.46, 128.86 (*C*H, Ar), 116.05, 128.61, 135.66, 137.38 (*C*H=), 136.50 (*C*-1', Ar), 168.49 (*C*-3), 160.68 (*C*-5). [h] (deuteriochloroform) δ 13.87 (SCH$_3$), 100.76 (*C*-4), 126.64, 128.28, 128.70 (*C*H, Ar), 115.58, 128.11, 131.46, 135.25, 135.37, 137.83 (*C*H=), 136.83 (*C*-1', Ar), 168.43 (*C*-3), 160.50 (*C*-5).

methylthio carbon leading to a mixture of **6** and **7**. Apparently, under neutral reaction conditions, Michael addition on the styryl double bond predominates, while the 3(5)-styrylpyrazoles **7a-b** are formed as minor products. It was considered of interest that the reaction of **1** with hydrazine hydrate in the presence of acetic acid should afford only styrylpyrazoles **8**, which can be explained through attack of hydrazine on protonated **1** at the β-carbon with a positive charge which is stabilized by two methylthio groups. Indeed, the 3-styrylpyrazole **8a** was isolated as the sole product (79%) when **1a** was reacted with hydrazine hydrate in an ethanol/acetic acid mixture (Scheme 4). Thus the reaction is regioselective in acidic medium. The cinnamoyl oxoketene dithioacetals were similarly reacted in the presence of acetic acid to afford the corresponding 3(5)-styrylpyrazoles **8a-i** in 63-80%

Scheme 3



1a, 1d

1, 6, 7a, $R^1 = C_6H_5$
1d, 6-7b, $R^1 = 4\text{-}MeOC_6H_4$

6

7

Table 4
Spectral data for Compound **8**

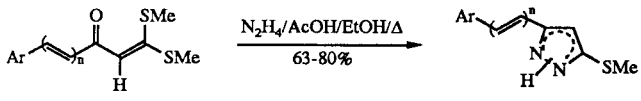
Compound	IR (KBr) cm^{-1}	^1H NMR δ (ppm)	MS m/e (%)
8a	3320, 1638, 1430	2.45 (s, 3H, SC*H*$_3$), 6.39 (s, 1H, *H*-4), 7.08 (s, 2H, olefinic), 7.23-7.62 (m, 5H, Ar*H*), 11.10 (brs, exchangeable with deuterium oxide, 1H, N*H*)	216 (M^+, 100), 215 (71), 183 (49), 119 (35)
8b	3150, 1540, 1480	2.48 (s, 3H, SC*H*$_3$), 6.44 (s, 1H, *H*-4), 7.00 (s, 2H, olefinic), 7.17 (m, 4H, Ar*H*), 8.94 (brs, 1H, exchangeable with deuterium oxide, N*H*)	252 (37), 250 (M^+, 100), 249 (75), 217 (41)
8c	3100, 1600, 1400	2.48 (s, 3H, SC*H*$_3$), 3.78, (s, 3H, OC*H*$_3$), 6.40 (s, 1H, *H*-4), 6.82 (d, J = 8 Hz, 2H, Ar*H*), 6.98 (s, 2H, olefinic), 7.40 (d, J = 8Hz, 2H, Ar*H*), 10.00 (brs, 1H, exchangeable with deuterium oxide, N*H*)	246 (M^+, 100), 245 (43), 213 (30), 198 (16)
8d	3180, 1600, 1440	2.46 (s, 3H, SC*H*$_3$), 2.93 [s, 6H, N(CH$_3$)$_2$], 6.48 (s, 1H, *H*-4), 6.68 (d, J = 8 Hz, 2H, Ar*H*), 6.82 (d, J = 6 Hz, 2H, olefinic), 7.30 (d, J = 8 Hz, 2H, Ar*H*), 10.10 (brs, 1H, exchangeable with deuterium oxide, N*H*)	259 (M^+, 100), 258 (28), 211 (14)
8e	3100, 1540, 1460	2.40 (s, 3H, SC*H*$_3$), 6.42 (s, 1H, *H*-4), 6.82-7.62 (m, 6H, Ar*H* + olefinic), 10.80 (s,1H, exchangeable with deuterium oxide, N*H*)	252 (19), 250 (M^+, 49)
8f	1546, 1420, 1350	2.47 (s, 3H, SC*H*$_3$), 6.45 (s, 1H, *H*-4), 7.14 (s, 2H, olefinic), 6.95-7.35 (m, 3H, Ar*H*), 9.40 (brs, 1H, exchangeable with deuterium oxide, N*H*)	284 (M^+, 28), 249 (100), 202 (46)
8g	3250, 1600, 1540, 1500, 1480, 1419	2.43 (s, 3H, SC*H*$_3$), 5.92 (s, 2H, -O-C*H*$_2$-O-), 6.38 (s, 1H, *H*-4), 6.65-7.18 (m, 5H, Ar*H* + olefinic), 10.10 (brs, 1H, exchangeable with deuterium oxide, N*H*)	260 (M^+, 100), 259 (43), 232 (22), 227 (23)
8h [a]	3220, 1582, 1510, 1455	2.50 (s, 3H, SC*H*$_3$), 3.90 (s, 6H, OC*H*$_3$), 6.45 (s, 1H, *H*-4), 6.72-7.32 (m, 5H, Ar*H* + olefinic), 8.93 (brs, exchangeable with deuterium oxide, N*H*)	276 (M^+, 100), 275 (40)
8i	3310, 1589, 1551, 1503, 1462, 1420	2.48 (s, 3H, SC*H*$_3$), 3.86 (s, 9H, OC*H*$_3$), 6.47 (s, 1H, *H*-4), 6.82 (s, 2H, olefinic), 7.07 (s, 2H, Ar*H*), 11.07 (brs, 1H, exchangeable with deuterium oxide, N*H*)	306 (M^+, 45), 305 (13), 231 (5)
8j	3250, 1600, 1540, 1500, 1480, 1419	2.42 (s, 3H, SC*H*$_3$), 6.38 (s, 1H, *H*-4), 6.50-6.88 (m, 4H, Ar*H* + olefinic), 7.13-7.50 (m, 5H, Ar*H*), 11.20 (brs, 1H, exchangeable with deuterium oxide, N*H*)	242 (M^+, 100), 241 (33), 195 (31), 165 (90)
8k [b]	3190, 1590, 1500, 1438	2.52 (s, 3H, SC*H*$_3$), 3.87 (s, 3H, OC*H*$_3$), 6.40 (s, 1H, *H*-4), 6.49-6.80 (m, 4H, olefinic), 6.91 (d, J = 8 Hz, 2H, Ar*H*), 7.32 (d, J = 8 Hz, 2H, Ar*H*), 10.51(brs, exchangeable with deuterium oxide, N*H*)	272 (M^+, 100), 271 (28), 225 (14)
8l	3265, 1540, 1498, 1480, 1440	2.47 (s, 3H, SC*H*$_3$), 5.90 (s, 2H, -O-C*H*$_2$-O-), 6.30 (s, 1H, *H*-4), 6.50-7.11 (m, 7H, Ar*H* + olefinic), 10.20 (brs, 1H, exchangeable with deuterium oxide, N*H*)	286 (M^+, 29), 285 (8)
8m [c]	3275, 1530, 1440, 1360	2.50 (s, 3H, SC*H*$_3$), 6.34 (s, 1H, *H*-4), 6.41-7.01 (m, 6H, olefinic), 7.15-7.53 (m, 5H, Ar*H*), 10.20 (brs, 1H, exchangeable with deuterium oxide, N*H*)	268 (M^+, 100), 267 (39), 221 (21)
8n	3180, 1595, 1510, 1442	2.50 (s, 3H, SC*H*$_3$), 3.79 (s, 3H, OC*H*$_3$), 6.28 (s, 1H, *H*-4), 6.20-6.81(m, 6H, olefinic), 6.85 (d, J = 8.5 Hz, 2H, Ar*H*), 7.30 (d, J = 8.5 Hz, 2H, Ar*H*), 11.00 (brs, 1H, exchangeable with deuterium oxide, N*H*)	298 (M^+, 100), 297 (33)
8o	3220, 1593, 1550, 1500, 1450	2.48 (s, 3H, SC*H*$_3$), 5.92 (s, 2H, -O-C*H*$_2$-O-), 6.30 (s, 1H, *H*-4), 6.31-6.93 (m, 9H, Ar*H* + olefinic), 9.50 (brs, 1H, exchangeable with deuterium oxide, N*H*)	312 (M^+, 100), 311 (36), 265 (12)

[a] ^{13}C nmr (deuteriochloroform/DMSO-d_6): δ 17.42 (*S*CH$_3$), 55.66, 55.73 (O*C*H$_3$), 103.08 (*C*H-4), 108.41, 110.93, 131.18 (*C*H, Ar), 114.42 131.18 (*C*H=), 129.38 (C-1', Ar), 148.92, 149.13 (*C*-3 and *C*-5), 157.83, 157.95 (*C*-3', *C*-4', Ar). [b] ^{13}C nmr (deuteriochloroform/DMSO-d_6): δ 15.80 (*S*CH$_3$), 53.83 (OCH$_3$), 101.47 (*C*H-4), 112.79, 126.34 (*C*H, Ar), 125.18, 126.25, 129.70, 131.71 (*C*H=), 128.30 (C-1', Ar), 147.11, 148.92 (*C*-3, *C*-5), 157.92 (*C*-4', Ar). [c] ^{13}C nmr (deuteriochloroform/DMSO-d_6): δ 15.92 (*S*CH$_3$), 102.43 (*C*H-4), 125.42, 127.73, 132.04 (*C*H, Ar), 126.79, 127.82, 128.02, 129.78, 133.31 (*C*H=), 136.25 (C-1', Ar), 146.23, 149.20 (*C*-3, *C*-5).

overall yields. The dienoyl **1l-n** and trienoyl **1o-q** oxoketene dithioacetals also afforded the corresponding 3(5)-(4-aryl-1,3-butadienyl)/(6-aryl-1,3,5-hexatrienyl)pyrazoles **8j-o** regioselectively in 71-77% overall yields under identical conditions (Scheme 4). The spectral and analytical data of these compounds were consistent with the assigned structures.

This highly regioselective synthesis of 3-styryl, 3-(4-aryl-1,3-butadienyl) and 3-(6-aryl-1,3,5-hexatrienyl)-pyrazoles is of practical utility, since the introduction of such enyl side-chains in the preconstructed pyrazole is not possible.

Scheme 4



1 8a-o

1a, 8a, Ar = C_6H_5, n = 1
1c, 8b, Ar = 4-ClC_6H_4, n = 1
1d, 8c Ar = 4-$MeOC_6H_4$, n = 1
1e, 8d, Ar = 4-$(Me_2N)C_6H_4$, n = 1
1f, 8e, Ar = 2-ClC_6H_4, n = 1
1g, 8f, Ar = 2,6-$Cl_2C_6H_3$, n = 1
1i, 8g, Ar = 3,4-methylenedioxy C_6H_3, n = 1
1j, 8h, Ar = 3,4-$(MeO)_2C_6H_3$, n = 1
1k, 8i, Ar = 3,4,5-$(MeO)_3C_6H_2$, n = 1
1l, 8j, Ar = C_6H_5, n = 2
1m, 8k, Ar = 4-$MeOC_6H_4$, n = 2
1n, 8l, Ar = 3,4-methylenedioxy C_6H_3, n = 2
lo, 8m, Ar = C_6H_5, n = 3
1p, 8n, Ar = 4-$MeOC_6H_4$, n = 3
1q, 8o, Ar = 3,4-methylenedioxy C_6H_3, n = 3

EXPERIMENTAL

Melting points were determined on Thomas Hoover apparatus and are uncorrected. The reaction mixtures were monitored by tlc on silica gel. The ir spectra were recorded on a Perkin Elmer 297 spectrophotometer and the ^1H nmr spectra on a Varian EM-390 spectrometer using TMS as the internal standard. The mass spectra were obtained on Jeol D-300 mass spectrometer, while the ^{13}C nmr spectra were obtained on a Brooker WM-400 spectrometer. The starting cinnamoyl ketene dithioacetals **1a-k** and their higher homologs **1l-g** were prepared according to the reported procedure [17].

General Procedure for Synthesis of 5-Methylthio-3-styryl/(4-aryl-1,3-butadienyl)/(6-aryl-1,3,5-hexatrienyl)isoxazoles **2a-o**.

To a stirred suspension of sodium methoxide [prepared by dissolving sodium (0.9 g, 0.04 g-atom) in absolute methanol (30 ml)], hydroxylamine hydrochloride (2.80 g, 0.04 mole) was added and the reaction mixture was further stirred for 10 minutes followed by addition of an appropriate ketenedithioacetal **1** (0.01 mole). The reaction mixture was then refluxed for 6 hours, the solvent was removed under reduced pressure and the residue poured over ice-cold water (200 ml) to give brownish solids, which showed on tlc (benzene as mobile phase, R_f 0.60) single spot due to isoxazoles **2** along with polymeric material at base. The crude isoxazoles were purified by passing through a silica gel column using hexane/ethyl acetate (20:1) as eluent and recrystallyzed from chloroform/hexane to give pure **2a-o** (Table 1 and 3). The ^1H nmr spectra of crude isoxazoles **2a-o** obtained after passing through a silica gel column did not show the presence of regioisomeric isoxazoles **3**.

General Procedure for Synthesis of 3-Methylthio-5-styryl/-(4-aryl-1,3-butadienyl)/(6-aryl-1,3,5-hexatrienyl)isoxazoles **3a-o**.

A solution of hydroxylamine hydrochloride (2.80 g, 0.04 mole) and sodium acetate (2.80 g, 0.034 mole) in water (10 ml) was added to a solution of oxoketene dithioacetal **1** (0.01 mole) in benzene (100 ml) and glacial acetic acid (100 ml). The reaction mixture was made homogeneous by addition of ethanol (55 ml) and refluxed for 12 hours. It was then evaporated to dryness in vacuum, extracted with chloroform (2 x 50 ml), washed with water (2 x 100 ml), dried (sodium sulfate) and evaporated to give a dark brown residue which showed on tlc (benzene as the mobile phase) only one spot due to isoxazole **3** (R_f 0.60) along with some polymeric impurities at the base. These crude isoxazoles were filtered through a short neutral alumina column using ethyl acetate/hexane (1:20) as eluent to give isoxazoles **3a-o** which were pure enough for spectral data. The products **3a-o** were recrystallyzed from chloroform/hexane for elemental analysis (Table 1 and 3). The ^1H nmr spectra of the isoxazoles **3a-o** obtained after passing through neutral alumina column did not show the presence of regioisomeric isoxazoles **2**.

General Procedure for Synthesis of 3(5)-Styryl/(4-aryl-1,3-butadienyl)/(6-aryl-1,3,5-hexatrienyl)-5(3)-methylthiopyrazoles **8a-o**.

To a solution of oxoketene dithioacetal **1** (10 mmoles) in ethanol (40 ml) and acetic acid (40 ml), hydrazine hydrate (2 g) was added and the reaction mixture was refluxed (110°) for 20 hours. The solvent was removed under reduced pressure, and the residue poured over ice cold water (100 ml). The crude pyrazoles **8b-o** separated as light yellow solids and were filtered, dried and recrystallized from chloroform/hexane (Tables 2 and 4).

The pyrazole **8a** was obtained as a viscous oil after pouring the residue over water. It was extracted with chloroform (2 x 20 ml), the organic layer dried (sodium sulfate) evaporated and the residue passed through a small column of silica gel using hexane as eluent to give **8a** as a pale yellow viscous liquid.

1(2)-Acetyl-3(5)styryl-5(3)methylthiopyrazoles (**6a-b**) and 1-Acetyl-3-[2-bis(methylthio)ethenyl]-5-aryl/styryl-2-pyrazolines **7a-b**. General Procedure.

To a solution of dithioacetal **1a** or **1d** (10 mmoles) in ethanol (30 ml), hydrazine hydrate (2 g) was added and the reaction mixture was refluxed for 6 hours. The solvent was removed under reduced pressure. The residue was dissolved in chloroform (300 ml) and washed with water (2 x 200 ml), dried (sodium sulfate) and concentrated to a volume of 100 ml. To this chloroform extract, a mixture of acetic anhydride (5 ml) and acetic acid (5 ml) was added and the reaction mixture was stirred at room temperature for 12 hours. It was then poured over ice cooled water (200 ml), the chloroform layer was separated, washed with saturated sodium bicarbonate solution (200 ml), water (200 ml), dried and evaporated to give a crude residue which was subjected to column chromatography over silica gel. Elution with ethyl acetate/hexane (1:10) gave first pyrazoles **6a-b** followed by pyrazolines **7a-b** on further elution with the same solvent.

1(2)-Acetyl-3(5)-Styryl-5(3)methylthiopyrazole (**6a**).

This compound was obtained as white crystals, 18%, mp 123-124°; ir (potassium bromide): ν max 1730, 1518, 1420 cm^{-1}; ^1H nmr (carbon tetrachloride): δ 2.46 (s, 3H, SCH_3), 2.66 (s, 3H, CH_3CO), 6.23 (s, 1H, *H*-4), 7.06 (brs, 2H, olefinic), 7.23-8.14 (m, 5H, ArH); ms: m/z 258 (M^+, 55%), 216 (100), 183 (59).

Anal. Calcd. for $C_{14}H_{14}N_2OS$: (258.3): C, 65.11; H, 5.42; N, 10.85. Found: C, 64.87; H, 5.66; N, 10.78.

1(2)-Acetyl-3(5)-(4-methyoxystyryl)-5(3)methylthiopyrazole (**6b**).

This compound was obtained as a white solid, 21%, mp 134-135°; ir (potassium bromide): δ max 1720, 1600, 1518 cm^{-1}; ^1H nmr (deuteriochloroform): δ 2.48 (s, 3H, SCH_3), 2.67 (s, 3H, CH_3CO), 3.83 (s, 3H, CH_3O), 6.35 (s, 1H, *H*-4), 6.80-7.15 (m, 4H, ArH and olefinic), 7.50 (d, J = 8 Hz, 2H, Ar*H*); ms: m/z 288 (M^+,

93%), 246 (100).

Anal. Calcd. for $C_{15}H_{16}N_2O_2S$ (288.4): C, 62.50; H, 5.55; N, 9.72. Found: C, 62.71; H, 5.61; N, 9.56.

1-Acetyl-3[2-bis(methylthio)ethenyl]-5-phenyl-2-pyrazoline (**7a**).

This compound was obtained as a white solid, 65%, mp 50-51°; ir (potassium bromide): ν max 1650, 1413 cm^{-1}; ^1H nmr (deuteriochloroform): δ 2.30 (s, 3H, SCH_3), 2.37 (s, 3H, SCH_3), 2.80 (s, 3H, CH_3CO), 3.20 (dd, J = 5, 18 Hz, 1H, *H*-4), 3.72 (dd, J = 10, 18 Hz, 1H, *H*-4), 5.45 (dd, J = 5, 10 Hz, 1H, *H*-5), 6.31 (s, 1H, olefinic), 7.25 (brs, 5H, ArH); ms: m/z 306 (M^+, 100%).

Anal. Calcd. for $C_{15}H_{18}N_2OS_2$ (306.4): C, 58.82; H, 5.88; N, 9.15. Found: C, 58.72; H, 6.03; N, 9.33.

1-Acetyl-3[2-bis(methylthio)ethenyl]-5-(4-methoxyphenyl)-2-pyrazoline (**7b**).

This compound was obtained as a white solid, 61%, mp 102°; ir (potassium bromide): ν max 1657, 1405 cm^{-1}; ^1H nmr (deuteriochloroform): δ 2.13 (s, 3H, SCH_3), 2.36 (s, 3H, SCH_3), 2.40 (s, 3H, CH_3CO), 3.20 (dd, J = 6, 18 Hz, 1H, *H*-4), 3.73 (s, 3H, OCH_3), 3.72 (dd, partially, merged with OCH_3 signal, J = 10, 18 Hz, 1H, *H*-4), 5.48 (dd, J = 6, 10 Hz, 1H, *H*-5), 6.32 (s, 1H, olefinic), 6.85 (d, J = 8 Hz, 2H, ArH), 7.20 (d, J = 8 Hz, 2H, ArH); ms: m/z 336 (M^+, 100%); 294 (41).

Anal. Calcd. for $C_{16}H_{20}N_2O_2S$ (336.5): C, 57.14; H, 5.95; N, 8.33. Found: C, 56.88; H, 6.12; N, 8.41.

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