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Benzopyrans. 31[1]. Reaction of 1,1-Diacetyl-2-(6-methyl-4-oxo-4*H*-1-benzopyran-3-yl)ethylene with Phenyldiazomethane

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Abstract : Phenyldiazomethane yields with the title alkene **1** a mixture of the *trans*-cyclopropane **6**, benzopyran **8**, pyrazole **9**, and *cis*-dihydrofuran **12**. The cyclopropane **6** thermally rearranges to a *trans*-dihydrofuran tentatively assigned the structure **4**.

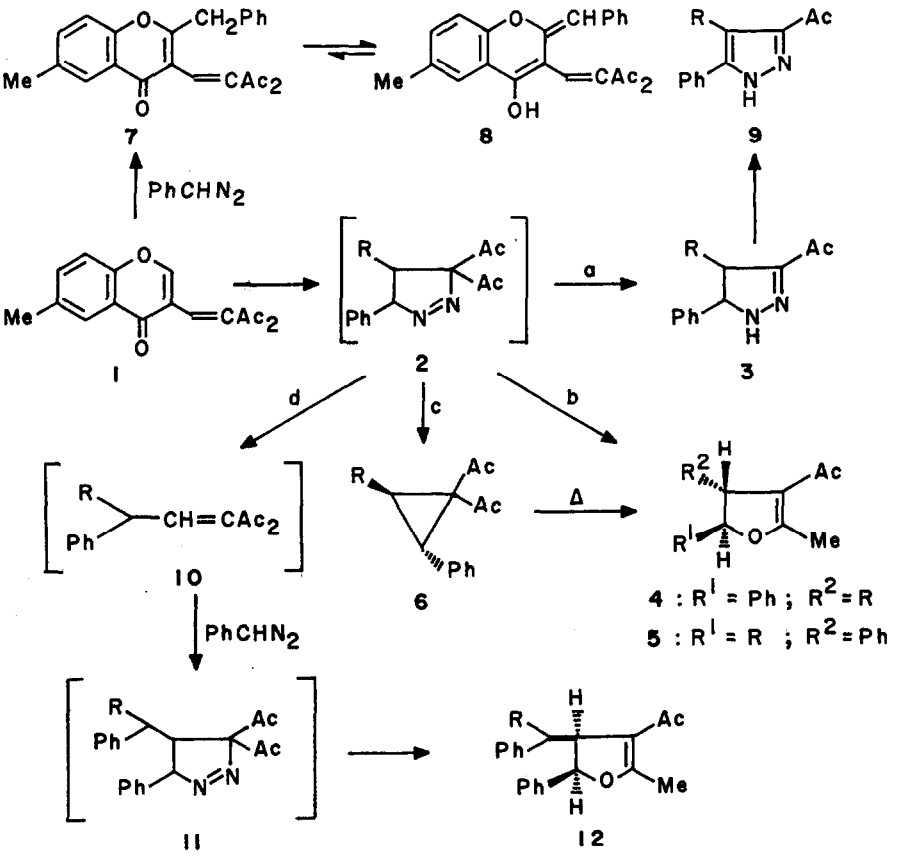
INTRODUCTION

Diazomethane adds to the exocyclic olefinic bond of the title benzopyran derivative **1**, the resultant 1-pyrazoline intermediate giving ultimately a 2-pyrazoline and a dihydrofuran linked to the 3-position of 1-benzopyran-4-one[2]. We were interested to investigate whether phenyldiazomethane, like diazomethane, would produce with the ethylene **1** the corresponding phenyl substituted products **3** and **4** via 1-pyrazoline **2**. The results of this investigation as described herein throw new light on the rarely studied reaction of phenyldiazomethane with a 1,1-diacylalkene.

RESULTS AND DISCUSSION

Phenyldiazomethane, prepared by treating *N*-nitroso-*N*-benzyl-*p*-toluenesulphonamide with sodium methoxide[3], was not purified by distillation and found to contain some amount of *N*-benzyl-*p*-toluenesulphonamide. The benzopyran substrate **1** was treated with an ethereal solution of excess phenyldiazomethane so prepared and the reaction mixture then chromatographed over silica, the eluant being ethyl acetate — light petroleum (1:6). Four products **8**, **6** highly admixed with *N*-benzyl-*p*-toluenesulphonamide, **12**, and **9** were obtained in order of elution, each of the products being further purified by column chromatography over silica and crystallisation from chloroform - light petroleum.

Unlike diazomethane, phenyldiazomethane can to some extent alkylate **1** at the pyran 2-position, the resultant 2-benzylated product **7** existing in the tautomeric form **8** at least in chloroform solution (*vide* Experimental). The other three products arise from the 1-pyrazoline intermediate **2** (non-isolable) derived by addition of phenyldiazomethane to the exocyclic alkenic bond of **1** [Scheme 1]. 3,3-Diacyl-1-pyrazoline **2** undergoes base catalysed monodeacylation[2,4] to **3**, diazoalkane[5] or **2** itself[6]



R = 6-Methyl-4-oxo-4*H*-1-benzopyran-3-yl

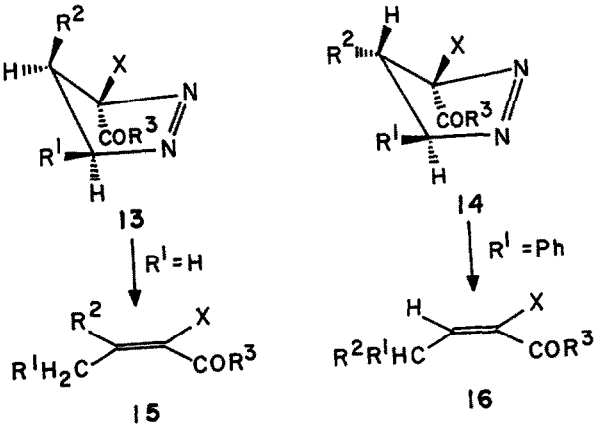
Scheme 1

functioning as the base (path a); unlike 5-unsubstituted 2-pyrazolines, 5-phenylpyrazoline **3** undergoes spontaneous heteroaromatisation to the pyrazole **9** by either air oxidation or disproportionation.

Direct conversion of **2** to **4** by a formal [1,5]sigmatropic shift of the carbonyl group accompanied by nitrogen extrusion[2,4,7] (path b) was not observed. The cyclopropane **6** arising from **2** by nitrogen extrusion (path c), however, gave on heating at 200° a dihydrofuran derivative. IR and PMR spectra fail to distinguish between the two isomeric dihydrofurans **4** and **5** likely obtainable by a [1,3]sigmatropic rearrangement of the acylcyclopropane **6**. In absence of any other data, the dihydrofuran isolated from thermal rearrangement of **6** is assigned the structure **4**. Two cyclopropyl protons of **6** appear as a multiplet centred around δ 3.76. By irradiating the pyran H-2 appearing at δ 7.80, this multiplet is reduced to an AB quartet with J ~ 3.8 Hz indicative of trans-stereochemistry of **6**[8]. The trans-disposition of the dihydrofuran H-2 and H-3 in **4** is indicated by their small coupling constant (J = 4 Hz)[9]. Here the thermal rearrangement of **6** to **4** (isolated yield 80%) with stereochemical retention is in accordance with the general characteristic (predominant retention of configuration at the migration centre) of an acylcyclopropane → dihydrofuran conversion[10].

3,3-Disubstituted 4-alkyl(or aryl)-1-pyrazoline preferably assumes the conformation as shown in **13** (R^1 = H; R^2 = alkyl or aryl; R^3 = OMe; X = Me) so that its pyrolysis involves the migration of H-4 (trans to the leaving nitrogen) to C-5 yielding the olefin **15**[11] (Scheme 2). Such hydrogen migration in the formation of the C-methylated product as **15** (R^1 = H; R^2 = 4-oxo-4*H*-1-benzopyran-3-yl; R^3 = OEt; X = CN or CO_2Et) from **15** (H in place of CH_2R^1; R^2, R^3 and X as before) and diazomethane[12] is also indicative of the conformer **13** being favoured over **14** for the corresponding 1-pyrazoline intermediate. The situation for the formation of 5-phenyl-1-pyrazoline **2** and its subsequent transformation to an olefin are dramatically changed. In this case phenyl group presumably always occupying the pseudo equatorial position, isomer **14** (R^1 = Ph; R^2 = 6-methyl-4-oxo-4*H*-1-benzopyran-3-yl; R^3 = Me; X = COMe) is less sterically strained than and consequently favoured over **13** (R^2–C–C–Ph dihedral angle in **13** and **14** being approximately 30° and 90°, respectively). Hence it is the R^2 group (benzopyran moiety) that being trans to C-5–N bond in **14** migrates to C-5 in concert with nitrogen extrusion to yield the olefin **16** (≡ **10** in Scheme 1 – path d) that reacts further with phenyldiazomethane and the resultant 1-pyrazoline **11** transforms to the dihydrofuran **12** by a sigmatropic rearrangement with nitrogen extrusion[2,4,7]. PMR spectrum of **12** showing furan H-2 peak at δ 6.64 as a doublet with J = 10 Hz is discernible with the cis-stereochemistry of its 2,3-disubstituted 2,3-dihydrofuran moiety[9]. A two proton multiplet around δ 4.72 is ascribed to the exocyclic benzylic H and furan H-3. Their precise position respectively at δ 4.90 and 4.60, and coupling constant as 12 Hz were determined by irradiating the furan H-2. Downfield shift of H-2 in the *cis*-dihydrofuran **12** vis-a-vis H-2 in the analogous *trans*-dihydrofuran **4** is in conformity with the general trend observed for the corresponding protons in the *cis*- and *trans*-isomeric pairs of several 3-alkyl-2-aryl-2,3-dihydrofurans[9,10]. The appearance of

the dihydrofuran H-3 at a relatively low field (δ 4.60) may be due to the deshielding effects exerted on this proton by the surrounding carbonyl, hetaryl and phenyl groups.



Scheme 2

CONCLUSION

Though migration of an alkyl or aryl group in the pyrolysis of 4,4-disubstituted 1-pyrazoline to olefin is amply demonstrated[6,13], that in the pyrolysis of a 4-monosubstituted 1-pyrazoline is not known to our knowledge. The conversion of 4-monosubstituted 5-phenyl-1-pyrazoline **2** to the olefin **10** is, therefore, the first example of facile competitive migration of a hetaryl group over hydrogen. Furthermore, the formation of 3-acyl-5-phenylpyrazole, 1,1-diacyl-2-phenylcyclopropane, and 4-acyl-3-benzyl-2-phenyl-2,3-dihydrofuran seems to be a general reaction of phenyldiazomethane with a 2-un(or mono)substituted 1,1-diacylethylene. Further studies are needed to prove the stereochemical fidelity or otherwise in the conversion of a 4,5-disubstituted 3-acyl-1-pyrazoline to the corresponding 2,3-disubstituted 2,3-dihydrofuran through a [1,5]sigmatropic rearrangement involving nitrogen extrusion.

EXPERIMENTAL

The reported melting points are uncorrected. The yields for isolated pure products are mentioned and optimisation of yield not attempted. IR spectra were recorded in $CHCl_3$ and PMR at 100 MHz in $CDCl_3$ with Me_4Si as internal standard. Light petroleum refers to the fraction with b.p. 40-60°.

Treatment of **1** *with phenyldiazomethane*

An ethereal solution of phenyldiazomethane, prepared from *N*-nitroso-*N*-benzyl-*p*-toluenesulphonamide (5.8 g, 20 mmol) was added to the title ethylene **1** (1.35 g, 5 mmol) dissolved in dichloromethane (50 ml). The reaction mixture was kept at room temperature for 24 h. The residue obtained after removal of the solvent (bath temp. 40°) was chromatographed over silica as described in the text to afford the products, the characterisation data of which are given below.

Trans-1,1-Diacetyl-3-(6-methyl-4-oxo-4H-1-benzopyran-3-yl)-2-phenylcyclopropane **(6)**

Yield 8%; m.p. 169° (Found : C, 76.4; H, 5.3. $C_{23}H_{20}O_4$ requires C, 76.7; H, 5.6%); IR : 1685 (acetyl CO), 1635 (pyrone CO), and 1615 (C=C) cm^{-1}; PMR : δ8.00 (1 H, d, J = 2 Hz, benzopyran H-5), 7.80 (1 H, d, J~1 Hz, benzopyran H-2), 7.60 - 7.24 (7 H, m, ArH), 3.76 [2 H, m, J (cyclopropyl H's)~3.8 Hz, J (benzylic coupling) ~ 1 Hz, cyclopropyl H], 2.46 (3 H, s, $ArCH_3$), 2.16 (3 H, s, $COCH_3$), and 2.00 (3 H, s, $COCH_3$).

1,1-Diacetyl-2-(2-benzylidene-4-hydroxy-6-methyl-2H-1-benzopyran-3-yl)ethylene **(8)**

Yield 15%; m.p. 182° (Found : C, 76.8; H, 5.6. $C_{23}H_{20}O_4$ requires C, 76.7; H, 5.6); PMR : δ 16.88 (1 H, s, exchangeable, OH), 8.00 (1 H, d, J = 2 Hz, benzopyran H-5), 7.68 [1 H, s, $CH{=}C(COMe)_2$], 7.62 - 7.20 (7 H, m, ArH), 6.80 (1 H, s, PhCH=), 2.42 (3 H, s, $ArCH_3$), and 2.24 (6 H, s, 2 $COCH_3$); MS : *m/z* 360(M^+), 318 (M - CH_2CO, base peak), 276 (318 - CH_2CO), 161 [M - $CH(COMe)_2$], and 135 [$HO(Me)C_6H_3CO$].

3-Acetyl-4-(6-methyl-4-oxo-4H-1-benzopyran-3-yl)-5-phenylpyrazole **(9)**

Yield 5%; m.p. > 250° (Found : C, 72.9; H, 4.3; N, 8.2. $C_{21}H_{16}N_2O_3$ requires C, 73.2; H, 4.7; N, 8.1%); PMR : δ 11.00 (1 H, bs, NH), 8.12 (1 H, d, J = 2 Hz, benzopyran H-5), 7.78 (1 H, s, pyran H-2), 7.60 - 7.32 (7 H, m, ArH), 2.46 (3 H, s, $ArCH_3$), and 2.42 (3 H, s, $COCH_3$).

Cis-2,3-Dihydro-2-phenyl-3-(6-methyl-4-oxo-4H-1-benzopyran-3-ylbenzyl)-4-acetyl-5-methylfuran **(12)**

Yield 12%; m.p. 208° (Found : C, 79.6; H, 5.5. $C_{30}H_{26}O_4$ requires C, 80.0; H, 5.8%); IR : 1660 (acetyl CO), 1630 (pyrone CO), and 1610 (C=C) cm^{-1}; PMR : δ7.90 (1 H, d, J = 2 Hz, benzopyran H-5), 7.80 (1 H, s, pyran H-2), 7.44 - 7.16 (12 H, m, ArH), 6.62 (1 H, d, J = 10 Hz, furan H-2), 4.90 (1 H, d, J = 12 Hz, exocyclic benzylic H), 4.60 (1 H, dd, J = 12, 10 Hz, furan H-3), 2.38 (3 H, s, $ArCH_3$), 2.16 (3 H, s, $COCH_3$), and 1.88 (3 H, s, furan Me-5); MS : *m/z* 450(M^+), 408 (M - CH_2CO), 366 (408 - CH_2CO), 338 (366 - CO), 249 (338 - C_6H_5CH + H), and 234 (338 - $C_6H_5CH{=}CH_2$).

Conversion of **6** *to trans-2,3-dihydro-2-phenyl-3-(6-methyl-4-oxo-4H-1-benzopyran-3-yl)-4-acetyl-5-methylfuran* (**4**)

The compound **6** (0.036 g, 0.1 mmol) taken in a 5 ml round bottomed flask was heated for 1 h in an oil bath at 200°. Chloroform solution of the product was heated with charcoal, filtered, and the filtrate on concentration afforded the dihydrofuran **4** (0.029 g, 80%), m.p. 162° (Found : C, 76.9; H, 5.3. $C_{23}H_{20}O_4$ requires C, 76.7; H, 5.6%); IR : 1655 (acetyl CO), 1635 (pyrone CO), and 1615 (C=C)cm^{-1}; PMR : δ 8.14 (1 H, d, J = 2 Hz, benzopyran H-5), 7.80 (1 H, s, pyran H-2), 7.71 - 7.44 (7 H, m, ArH), 5.46 (1 H, d, J = 4 Hz, furan H-2), 4.41 (1 H, d, J = 4 Hz, furan H-3), 2.57 (3 H, s, $ArCH_3$), 2.52 (3 H, s, $COCH_3$), and 2.14 (3 H, s, furan Me-5).

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