

Vilsmeier reaction on some 6- and 7-methoxy-1- and 2-tetralones

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Abstract. Vilsmeier reaction on a few representative 6- and 7-methoxy-1- and 2-tetralones has been investigated. While 1-tetralones give the corresponding 1-chloro-2-formyl-3,4-dihydronaphthalenes, the 2-tetralones afford 1,3-bisformyl-2-chloronaphthalenes. Spectral characteristics of all the products obtained are given and a mechanistic proposal has been made to explain the observed chlorobisformylation.

Keywords. Vilsmeier reaction ; 1- and 2-tetralones ; chlorobisformylnaphthalenes ; synthesis and mechanism.

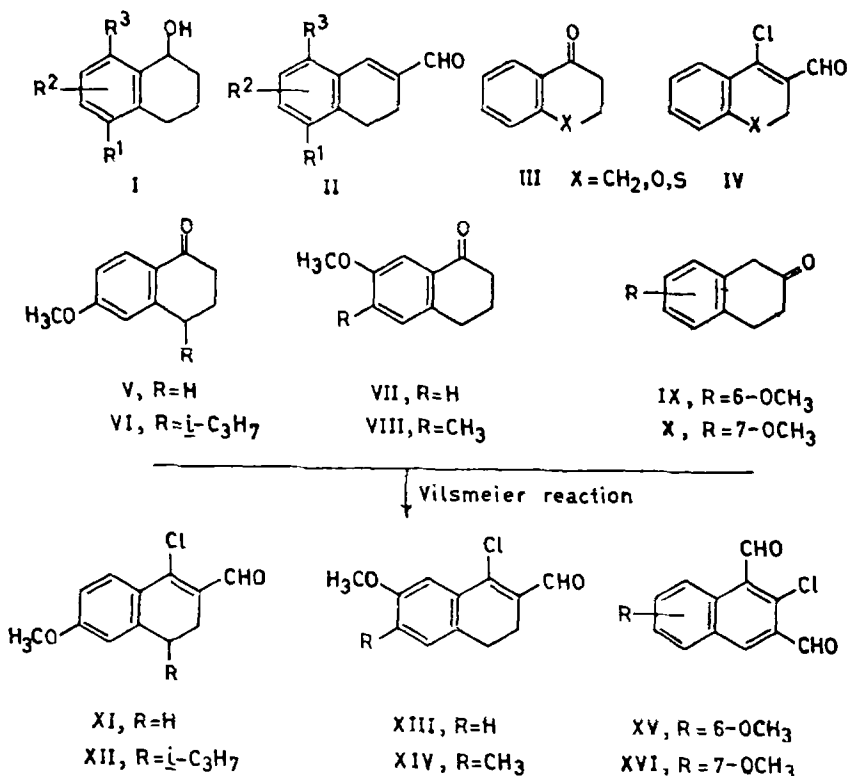
1. Introduction

Having observed the formation of 2-formyl-3,4-dihydronaphthalenes(II) from the Vilsmeier reaction (Jutz 1976) of certain 6-methoxy- and 7-methoxy-1-tetralols (I) (Anantha Reddy 1978; Anantha Reddy and Krishna Rao 1980) and having noted that 1-tetralone and 4-chromanone (III) afford on Vilsmeier reaction the corresponding chloroenals (IV) (Weissenfels *et al* 1966), we undertook a study of this reaction on a few representative 6-methoxy-1- (V and VI), 7-methoxy-1- (VII and VIII), 6-methoxy-2- (IX) and 7-methoxy-2-tetralones (X) (Anantha Reddy and Krishna Rao 1976). In this paper we present the results of these investigations.

2. Results and discussion

2.1. Vilsmeier reaction on 1-tetralones (V-VIII)

All the 1-tetralones (V-VIII) gave the corresponding 1-chloro-2-formyl-3,4-dihydronaphthalenes (XI-XIV) in 60-75% yield in line with the earlier findings (Weissenfels *et al* 1966). Of these the specific case of V giving XI on Vilsmeier reaction (Anantha Reddy and Krishna Rao 1976) has been recently corroborated (Ray *et al* 1979). 5-Aza-1-tetralones have also been subjected to similar reaction (Schröder *et al* 1979) to furnish anti-inflammatory agents analogous to 'nephrazen'.



2.2. Vilsmeier reaction on 2-tetralones (IX and X)

6-Methoxy-2-tetralone (IX) and 7-methoxy-2-tetralone (X) have now been subjected to Vilsmeier reaction for the first time. The unique feature with 2-tetralones, as distinguished from 1-tetralones appears to be chlorobisformylation of the ketone bearing ring. This is accompanied by aerial oxidation (dehydrogenation) to the naphthalene during work-up. Thus on treatment with dimethylformamide and phosphorus oxychloride the two tetralones (IX and X) furnish 1,3-bisformyl-2-chloro-6-methoxynaphthalene (XV) and 1,3-bisformyl-2-chloro-7-methoxynaphthalene (XVI) respectively in 62–65% yield. Physicochemical evidence in support of the Vilsmeier formylation products is presented in table 1.

2.3. Mechanism for the formation of chlorobisformyl naphthalenes (XV and XIV)

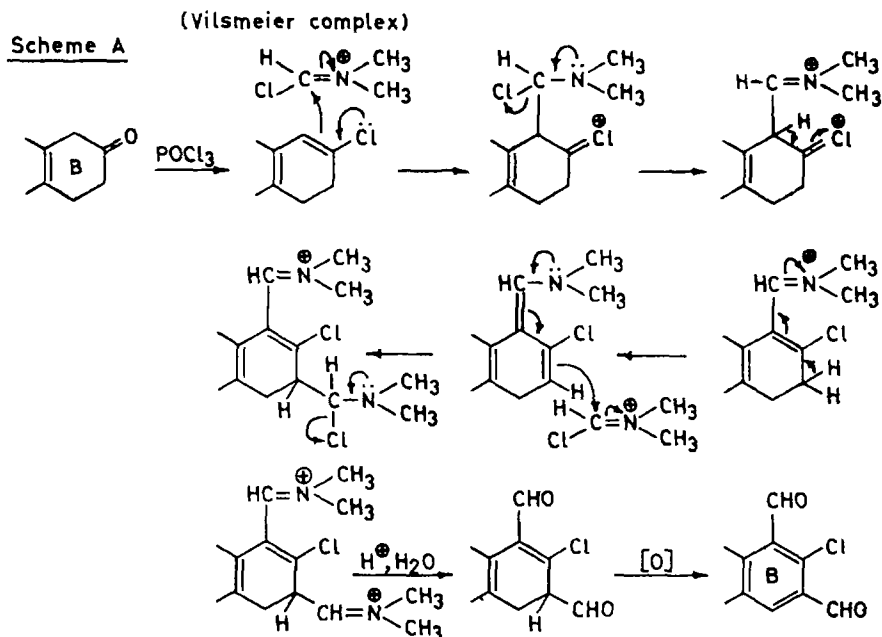
Scheme A portrays a mechanism for the formation of the chlorobisformyl naphthalenes in the Vilsmeier reaction of 2-tetralones.

3. Experimental

Bath temperatures (b.t.) and melting points are uncorrected. Before removal of solvent the organic extracts of reaction product/s were appropriately washed to neutrality, where necessary, and dried over anhydrous Na_2SO_4 . UV (λ_{max} in nm)-

Table 1. Physicochemical data of Vilsmeier reaction products (XI to XVI).

Tetralone	Vilsmeier reaction product	Elemental analysis	M.p. or B.t./torr.	UV (ethanol)		IR		¹ H-NMR (δ ppm)
				λ_{\max} (nm)	ν_{\max} (cm ⁻¹)	ν_{\max} (cm ⁻¹)		
V (Stork 1947; Thomas and Nathan 1948)	XI	Found : C, 64.55; H, 5.25 C ₁₅ H ₁₃ ClO ₃ (M ⁺ 248.5) requires C, 64.71; H, 4.95	71° (ethyl acetate)	250	1653 (C=O)		(60 MHz-CCl ₄) : 2.75 [4H, m, (CH ₂) ₄], 3.67 (3H, s, OCH ₃), 6.66 (1H, s, H ₆), 6.67 (1H, ABq, J = 8 and 2.5 Hz, H ₇), 7.70 (1H, d, J = 8 Hz, H ₈), 10.58 (1H, s, CHO)	
				330	705 (C-Cl)		(60 MHz-CCl ₄) : 0.8 (3H, d, J = 7.5 Hz, CHCH ₃), 0.9 (3H, d, J = 7.5 Hz, CHCH ₃), 3.87 (3H, s, OCH ₃), 6.67 (1H, bs, H ₆), 6.83 (1H, ABq, J = 8 and 2.5 Hz, H ₇), 7.8 (1H, d, J = 8 Hz, H ₈), 10.95 (1H, s, CHO)	
VI (Krishna Rao and Sukh Dev 1957)	XII	Found : C, 64.92; H, 5.31 C ₁₅ H ₁₃ ClO ₃ (M ⁺ 248.5) requires C, 64.71; H, 4.95	143-5°/2.5	230	1667 (C=O)		(60 MHz-CCl ₄) : 2.7 [4H, m, (CH ₂) ₄], 3.89 (3H, s, OCH ₃), 6.87 (1H, ABq), J = 8 and 3 Hz, H ₆), 7.25 (1H, bs, H ₆), 7.41 (1H, d, J = 3 Hz, H ₇), 11.1 (1H, s, CHO)	
				243	709 (C-Cl)		(60 MHz-CCl ₄) : 2.18 (3H, s, Ar-CH ₃), 2.6 [4H, m, (CH ₂) ₄], 3.85 (3H, s, OCH ₃), 6.89 (1H, s, H ₆), 7.18 (H, s, H ₆), 10.91 (1H, s, CHO)	
VII (Krishna Rao and Sukh Dev 1957)	XIII	Found : C, 62.81; H, 3.69 C ₁₅ H ₉ ClO ₃ (M ⁺ 248.5) requires C, 62.76; H, 3.62	56° (ethyl acetate)	247	1660 (C=O)		(100 MHz-CDCl ₃) : 3.97 (3H, s, OCH ₃), 7.26 (1H, d, J = 2.5 Hz, H ₃), 7.44 (1H, ABq, J = 8 and 2.5 Hz, H ₁), 8.51 (1H, s, H ₄), 8.95 (1H, d, J = 8 Hz, H ₆) 10.71 (1H, s, CHO), 10.92 (1H, s, CHO)	
				297				
VIII (Anantha Reddy 1978)	XIV	Found : C, 62.32; H, 3.69 C ₁₅ H ₉ ClO ₃ (M ⁺ 248.5) requires C, 62.76; H, 3.62	58° (hexane/ethyl acetate)	302	710 (C-Cl)		(100 MHz-CDCl ₃) : 4.04 (3H, s, OCH ₃), 7.34 (1H, ABq, J = 8 and 2.5 Hz, H ₆), 7.9 (1H, d, J = 8 Hz, H ₃), 8.6 (1H, s, Δ), 8.68 (1H, d, J = 2.5 Hz, H ₈), 10.66 (1H, s, CHO), 11.0 (1H, s, CHO).	
IX (Johnson <i>et al</i> 1957; <i>cf.</i> Taylor 1961)	XV	Found : C, 62.32; H, 3.69 C ₁₅ H ₉ ClO ₃ (M ⁺ 248.5) requires C, 62.76; H, 3.62	194° (ethyl acetate)	222	1690 (C=O)			
				245	696 (C-Cl)			
X (Prizhivalgovskaya <i>et al</i> 1965; <i>cf.</i> Taylor 1961)	XVI	Found : C, 62.32; H, 3.69 C ₁₅ H ₉ ClO ₃ (M ⁺ 248.5) requires C, 62.76; H, 3.62	181° (ethyl acetate)	226	1685 (C=O)			
				252	701 (C-Cl)			
				272				



IR (ν_{\max} in cm^{-1}) and PMR (chemical shifts and δ units from TMS) spectra were recorded on UNICAM SP 100, Perkin-Elmer model 137/Carl-Zeiss UR 10, and Varian HA 100/T 60 instruments. These observations apply to all the relevant experiments and the data of the products presented in table 1.

3.1. Typical Vilsmeier reaction on tetralones

To a cooled (0°) solution of the appropriate tetralone (10 mmol) in dry dimethylformamide (10 ml) was added phosphorus oxychloride (2.5 ml) dropwise during 15 min. The reaction mixture was heated at 100° for 3 hr and poured on to crushed ice (100 g). Saturated aqueous sodium acetate (30 ml) was added with stirring, followed by warming for 10 min to hydrolyse the iminium complex. The product was extracted with ether (100 ml \times 3). On removal of solvent the respective chloroformyl compounds obtained were purified by short-path distillation/crystallization. The data of the individual compounds is summarised in table 1.

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References

- Anantha Reddy P 1978 *Synthetic studies in terpenoids and Vilsmeier formylation on some hydronaphthalene systems* Ph.D. Thesis, Indian Institute of Science, Bangalore
 Anantha Reddy P and Krishna Rao G S 1976 Paper presented at *Chemists Convention*, Bangalore University, Abstract Org. p. 83

- Anantha Reddy P and Krishna Rao G S 1980 *Indian J. Chem.* (in Press)
- Johnson W S, Kemp A D, Pappo R, Ackerman J and Jones W F 1957 *J. Am. Chem. Soc.* **78** 6312
- Jutz C 1976 In *Iminium salts in organic chemistry* (eds.) Bohme H and Viehe H G (New York : John Wiley) pp. 225-342
- Krishna Rao G S and Sukh Dev 1957 *J. Indian Chem. Soc.* **34** 255
- Przhiyalgovskaya N M, Shner V F and Belov V N 1965 *Probl. orgon. Sinteza, Akar. Nauk SSSR, otá Obshch. i Tekhn. khim* 151 (Russ) ; *Chem. Abst.* **64** 11138 g
- Ray J K, Sharma S and Chatterjee B G 1979 *Synth. Commun.* **9** 727
- Schröder E, Lehmann M and Bottcher I 1979 *Eur. J. Med. Chem.—Chim. Ther.* **14** 499
- Stork G 1947 *J. Am. Chem. Soc.* **69** 576
- Taylor D A H 1961 *J. Chem. Soc.* p. 3319
- Thomas D G and Nathan A H 1948 *J. Am. Chem. Soc.* **70** 331
- Weissenfels M, Schurig H and Huchsam G 1966 *Z. Chim.* **6** 471 ; *Chem. Abst.* **66** 55177f