Synthesis and oxidation of (*E*)-1,2-diphenyl-2-(arylimino) ethanol derivatives

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Received: 18 July 2012/Accepted: 6 August 2012/Published online: 16 September 2012 © Springer Science+Business Media B.V. 2012

Abstract The compounds (E)-1,2-diphenyl-2-(phenylimino)ethanol, (E)-1,2-diphenyl-2-(p-tolylimino)ethanol, and (E)-2-((4-chlorophenyl)imino)-1,2-diphenyl-ethanol) were synthesized by reaction of a p-substituted aniline with benzoin then oxidized with chromium trioxide–triethylamine in chloroform to give (E)-1,2-diphenyl-2-(phenylimino)ethanone, (E)-1,2-diphenyl-2-(p-tolylimino)ethanone, and (E)-2-((4-chlorophenyl)imino)-1,2-diphenyl-2-(p-tolylimino)ethanone, and (E)-2-((4-chlorophenyl)imino)-1,2-diphenylethanone in very high yield. The products were characterized by IR and NMR spectral analysis.

Keywords Chromium trioxide $\cdot p,x$ -Substituted aniline \cdot Benzil \cdot Benzoin Schiff base

Introduction

A variety of oxidizing agents and conditions can be used to oxidize secondary alcohols to ketones [1–4]. Chromium trioxide–sulfuric acid in water, known as Jones reagent [5, 6], can be used to oxidize secondary alcohols to ketones in high yield without disturbing double or triple bonds which may be present, and without epimerizing an adjacent asymmetric center [5, 6]. Chromium trioxide–pyridine, known as Collins reagent, can be used to oxidize secondary alcohols, similar to Jones reagent, but this reagent is more specific for acid-sensitive alcohols. Corey [6–9] used Cr(VI)—oxidizing agents, for example pyridinium dichromate in dimethylformamide and pyridinium chlorochromate in dichloromethane. Both

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reagents are characterized by extraordinary ease of product isolation, since oxidizing agent removed by filtration and product obtained by evaporation.

The activity of these oxidizing compounds is strongly dependent on the nature of the heteroatomic ring and the position of attachment to the ring [11]. These compounds have been studied extensively because of their flexibility, selectivity, and sensitivity toward the central metal atom, and structural similarities with natural biological substances, and because of the presence of imine group (-N=CH-) which imparts biological activity [13–15]. In this work, chromium trioxide–triethylamine in chloroform was used for oxidation of (*E*)-1,2-diphenyl-2-(phenylimino)ethanol, (*E*)-1,2-diphenyl-2-(*p*-tolylimino)ethanol, and (*E*)-2-((4-chlorophenyl)imino)-1,2-diphenylethanol, because the secondary alcohol contains an azomethene double bond (C=N) which is very sensitive to hydrolysis in acidic and basic medium.

Experimental

All chemicals used were of reagent grade (supplied by Sigma-Aldrich) and used as supplied. Melting points were recorded on an Electrothermal Stuart apparatus and are uncorrected. IR spectra were recorded on a Euro OV Ectro FTIR 8400s infrared spectrophotometer and ¹H NMR spectra were recorded on a dpx400 instrument, with CDCl₃ as solvent.

Synthesis of (*E*)-1,2-diphenyl-2-(phenylimino)ethanone derivatives (I), (x = H, Me, Cl)

A mixture of equimolar amounts of benzoin and *p*,x-substituted aniline (x = H, Me, Cl) in a small amount of ethyl alcohol was heated at 120 °C for 1 h, then the reaction mixture was cooled. The residue obtained was crystallized from ethyl alcohol to give the 2-hydroxy-1,2-diphenyl-*N*-(*p*,x-substituted phenyl)-azomethene (I) (Table 1).



Compound I

Table 1 Physical and spectroscopic parameters of derivatives of compound I

Compound I	M.p. (°C)	Yield (%)	IR - v (cm ⁻¹)		¹ H NMR (δ , ppm)			
			OH	C=N	ОН	СН	Ph	Me
A(x = H)	124–6	76	3,400-3,375	1,680	-	-	_	-
B(x = Me)	118-120	79	3,380-3,360	1,665	4.6	6.0	7.2–7.9	2.2
C(x = Cl)	123-4	87	3,400-3,370	1,670	4.5	5.9	7.2-8.0	_

Compound II	M.p. (°C)	Yield (%)	IR- v (cm ⁻¹)		Crystallizing solvents	
			C=O	C=N		
A $(x = H)$	104–6	82	1,668	1,626	Ethyl alcohol	
B(x = Me)	110–2	87	1,662	1,618	Methyl alcohol	
C(x = Cl)	98–100	90	1,666	1,624	Methyl alcohol	

Table 2 Physical and spectroscopic parameters of derivatives of compound II

Oxidation of (*E*)-1,2-diphenyl-2-(phenylimino)ethanone derivatives (I), (x = H, Me, Cl)

With concentrated nitric acid

A mixture of compound I(1 g) in 4 ml concentrated nitric acid was heated on steam bath for 30 min. Then 20 ml water was added, the reaction mixture was cooled to room temperature, and the precipitate formed was collected, washed with water, and crystallized from ethanol to give benzil, m.p. 96. The melting point when mixed with authentic benzil was not depressed [7], and the IR spectrum of the product was identical with that of authentic benzil.



With chromium trioxide-triethylamine in chloroform

A solution of 60 mmol triethylamine and 30 mmol anhydrous chromium trioxide in 75 ml chloroform was swirled until a clear dark red solution was formed. The solution was cooled to room temperature, and 5 mmol **IA**, **IB**, or **IC** was added, with stirring, for 20 min. The clear solution was decanted. The residue was washed several times with chloroform and the chloroform was decanted. The combined chloroform solution was evaporated and the residue obtained was re-crystallized from a suitable solvent to give the 2-oxo-1,2-diphenyl-N(p,x-substituted phenyl)azomethene (**II**). Melting points, crystallizing solvents, and IR spectral data are given in Table 2.

Result and discussion

Condensation of the carbonyl groups of reducing sugars, for example aldoses and ketoses as α -hydroxy aldehydes and ketones, with the primary amino group of amino acids and proteins is known as the "Maillard reaction" [11]. It is a complicated

reaction, well described by Hodge [12, 13]. The initial step is addition–elimination reaction of the open chain aldoses and ketoses with the amine producing an unstable Schiff base (imine) which undergo enolization and molecular rearrangement to give 1-amino-1-deoxy-2-ketoses (Amadori product [13, 14]) and 2-amino-2-deoxy-1-aldoses (Heyns product [14]), respectively.



Benzoin as α -hydroxy ketone was condensed with *p*,x-substituted anilines (x = H, Me, Cl) as primary aromatic amines; the product was a stable benzoin Schiff base (imine) I, in contrast with the reducing sugar Schiff base.

IR spectral analysis of I revealed strong, broad OH-stretching bands in the range 3,400–3,360 cm⁻¹ and sharp, medium intensity (C=N)-stretching bands at 1,680, 1,665, and 1,670 cm⁻¹ for IA, IB, and IC, respectively. ¹H NMR spectral analysis revealed CH and OH protons signal at δ (ppm) 6 (1H, d) and 4.6 (1H, d) for IB and 5.9 (1H, d) and 4.5 (1H, d) for IC.

Oxidation of benzoin Schiff base (IA) with concentrated nitric acid gave benzil, which was characterized by its melting point (undepressed mixed point of oxidation product with authentic benzil), also identity of its IR-spectrum with that of authentic benzil [10]. Formation of benzil might be explained, that the benzoin Schiff base (imine) (IA) is more easily to hydrolysis in acidic media which was oxidize to benzil. Oxidation of the benzoin Schiff base (IA, IB, and IC) with chromium trioxide–triethylamine in chloroform gave the 2-oxo-1,2-diphenyl-N(p,x-substituted phenyl) azomethenes (IIA, IIB, and IIC) which were characterized by their melting points (undepressed when IIA, IIB, and IIC) were mixed with authentic samples prepared by another methods [15]). IR spectral analysis showed the disappearance of the strong, broad OH-stretching bands and the appearance of the strong, sharp (C=O)-stretching bands at 1,668, 1,662, and 1,666 cm⁻¹ and medium-intensity, sharp stretching bands of C=N groups at 1,626, 1,618, and 1,624 cm⁻¹, respectively. The IR spectra of IIA, IIB, and IIC were identical with those of authentic samples prepared by other methods [15], 16].

Conclusion

It is clear that use of chromium trioxide–triethylamine in chloroform as oxidizing agent for oxidation of benzoin Schiff base (IA, IB, and IC) did not disturb the azomethene double bond (C=N), which is highly sensitive to hydrolysis in acidic and basic media, and also gave very high yields with more rapid oxidation than by use of the Jones and Collins oxidizing agents.

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