

Prostanoids: LXXVI.* Synthesis and Specific Features of Reductive Dechlorination with the System Zn-NH₄Cl-MeOH of Some 3-N-, O-, S-, Cl-, and Alkyl-substituted 2-Chloro-4,4-ethylenedioxy-cyclopent-2-en-1-ones** Ozonolysis of 3-Caren-5-one

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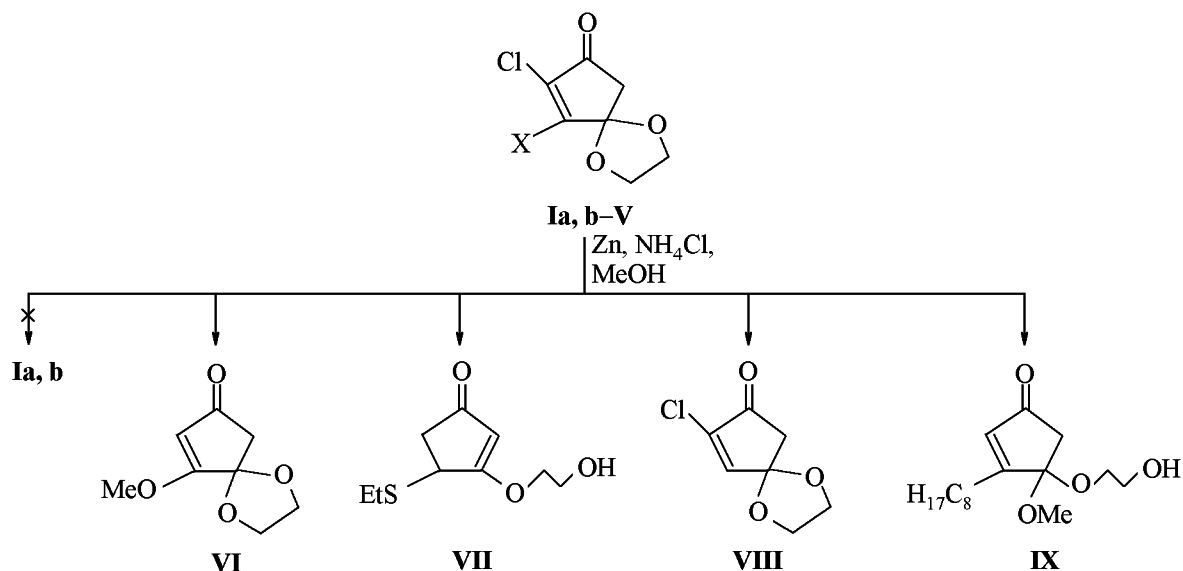
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Abstract—Reaction of a number of 3-N-, O-, S-, Cl-, and alkyl-substituted 2-chloro-4,4-ethylenedioxy-cyclopent-2-en-1-ones with Zn in NH₄Cl-MeOH medium were investigated. The expected or partially transformed dehydrochlorination products were isolated. An exclusive chemical stability of 3N-containing cyclopentenones was disclosed. This phenomenon was understood as originating from stabilizing n-d-p-interaction of electrons belonging to heteroatoms in the planar C¹(O)-C²(Cl)-C³(N) fragment contained in the molecules of the compounds.

Investigating the reaction of related compounds, *N,N*-dialkylamides **I** [2], ether **II** [3], thioether **III**, chloride **IV** [4], and ketone **V** [5], with a mild reducing system Zn-NH₄Cl-MeOH we established that notwithstanding the similarity of their chemical nature compounds **I-V** in this reaction behaved quite

different. The enaminochloroketones **Ia, b** did not suffer any changes even at long heating in the system Zn-NH₄Cl-MeOH (60°C, 10 h) whereas ether **II** and thioether **III** under similar conditions rapidly (1 h) and cleanly were converted into new cyclopentenones **VI** and **VII** respectively.



X = NR₂ (**I**), OMe (**II**), SEt (**III**), Cl (**IV**), C₈H₁₇ (**V**); R = Me (**a**), Et (**b**).

* Communication LXXV see [1].

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Dichlorocyclopentenone **IV** is highly reactive and under common conditions quickly affords a mixture of several compounds. Under careful control (1 equiv of Zn, 20°C, TLC) in more than 60% yield at incomplete conversion of the initial compound we succeeded in isolation of monodechlorination product **VIII**. The reductive dechlorination of 3-alkyl-substituted cyclopentenone **V** as also of compound **IV** is better performed at 20°C. Here alongside C²-dechlorination occurs simultaneous opening of the dioxolane cycle to yield an mixed ketal **IX**.

The above examples may be regarded as a certain chemical correlation of the degree of "inertness" of a fragment in vicinal hetero-substituted α,β -unsaturated ketones **I-V** based on the difference in participation of the secondary orbital interactions *n,d,p*-electrons of the heteroatoms in the planar fragment C¹(O)-C²(Cl)-C³(X) of a cyclopentenone (X-ray analysis data for a related structure see [6]). The experimental results show that the best stabilization of the conjugated system in ketones **I-V** occurs in enaminketones **Ia, b**, the worst one at X = Cl, alkyl (compounds **IV, V**). In compounds with X = O, S (**II, III**) the stabilization degree is of intermediate level. Some of new cyclopentenones described in this article we use in the synthesis of analogs of "sea prostanoids" and "9-LO-prostanoids" [1, 7].

EXPERIMENTAL

IR spectra were recorded on UR-20 instrument from thin film. ¹H and ¹³C NMR spectra were registered on spectrometer Bruker AM-300 in CDCl₃, internal reference TMS. Cyclopentenones **III** and **IIb** used in the study were prepared by treating dichlorocyclopentenone **IV** with EtSH and Et₂NH respectively according to procedure [4].

3-Dimethylamino-2-chloro-4,4-ethylenedioxy-cyclopent-2-en-1-one (Ia). IR spectrum (ν , cm⁻¹): 1600, 1705, 3120. ¹H NMR spectrum (δ , ppm): 2.47 s (2H, C⁵H₂), 3.20 s (6H, 2CH₃), 3.94–4.50 m (4H, 2CH₂O). ¹³C NMR spectrum (δ_C , ppm): 41.52 (CH₃), 45.76 (C⁵), 64.02 (2CH₂O), 104.78 (C²), 109.16 (C⁴), 159.65 (C³), 189.57 (C=O).

3-Diethylamino-2-chloro-4,4-ethylenedioxy-cyclopent-2-en-1-one (Ib). IR spectrum (ν , cm⁻¹): 1595, 1700. ¹H NMR spectrum (δ , ppm): 1.15 t (6H, 2CH₃, *J* 7.0 Hz), 2.46 s (2H, C⁵H₂), 3.50 q (4H, 2CH₂, *J* 7.0 Hz), 3.94–4.08 m (4H, 2CH₂O). ¹³C NMR spectrum (δ_C , ppm): 14.19 (2CH₃), 44.95 (CH₂), 45.76 (C⁵), 63.70 (2CH₂O), 103.52 (C²), 109.31 (C⁴), 158.61 (C³), 189.60 (C=O).

2-Chloro-4,4-ethylenedioxy-3-ethylthiocyclopent-2-en-1-one (III). mp 77–78°C, yield 63%. IR spectrum (ν , cm⁻¹): 1570, 1720. ¹H NMR spectrum (δ , ppm): 1.33 t (3H, CH₃, *J* 7.1 Hz), 2.70 s (2H, C⁵H₂), 3.40 m (2H, SCH₂), 4.00–4.20 m (4H, 2CH₂O). ¹³C NMR spectrum (δ_C , ppm): 14.97 (CH₃), 25.16 (SCH₂), 65.77 (2CH₂O), 110.51 (C⁴), 130.99 (C²), 164.73 (C³), 191.94 (C=O).

General procedure of hydrodechlorination. To a solution of 2 mmol of ketone in 20 ml of MeOH was added 2 g of Zn and 0.5 g of NH₄Cl, and a mixture was stirred at reflux for 1 h. The reaction mixture was cooled and evaporated. The residue was dissolved in 10 ml of H₂O, the reaction products were extracted into dichloromethane (30 ml), the combined extracts were dried with MgSO₄, filtered, and evaporated. The products were purified on SiO₂ (eluent pentane–ethyl acetate, 1:1).

3-Methoxy-4,4-ethylenedioxy-cyclopent-2-en-1-one (VI). Oily substance, yield 76%. IR spectrum (ν , cm⁻¹): 1690, 1720. ¹H NMR spectrum (δ , ppm): 2.67 s (2H, C⁵H₂), 3.95–4.20 m (4H, 2CH₂O), 3.33 s (3H, OMe), 7.27 s (1H, HC=). ¹³C NMR spectrum (δ_C , ppm): 44.83 (C⁵), 59.63 (OMe), 66.18 (2CH₂O), 107.45 (C⁴), 128.11 (C⁷), 173.27 (C⁶), 192.58 (C=O).

3-(2-Hydroxyethyloxy)-4-ethylthiocyclopent-2-en-1-one (VII). Oily substance, yield 63%. IR spectrum (ν , cm⁻¹): 1660, 1720, 3120, 3400. ¹H NMR spectrum (δ , ppm): 1.22 t (3H, CH₃, *J* 7.3 Hz), 2.38 d.d (1H, C⁵H, *J* 2.3, 18.5 Hz), 2.62 q (2H, CH₂, *J* 7.3 Hz), 2.921 d.d (1H, C⁵H, *J* 7.4, 18.5 Hz), 3.35–3.65 br.m (1H, OH), 3.85–4.17 m (5H, 2CH₂O, C⁴H). ¹³C NMR spectrum (δ_C , ppm): 14.46 (CH₃), 42.06 (C⁵), 43.02 (C⁴), 60.14 (C²), 73.69 (C¹), 105.45 (C²), 188.55 (C³), 202.87 (C=O).

2-Chloro-4,4-ethylenedioxy-cyclopent-2-en-1-one (VIII). Oily substance, yield 76%. IR spectrum (ν , cm⁻¹): 1600, 1740. ¹H NMR spectrum (δ , ppm): 2.73 s (2H, C⁵H₂), 4.01 s (4H, 2CH₂O), 3.33 s (3H, OMe), 7.15 s (1H, HC=). ¹³C NMR spectrum (δ_C , ppm): 45.17 (C⁵), 65.37 (2CH₂O), 108.73 (C⁴), 138.10 (C²), 149.98 (C³), 195.78 (C=O).

4-(2-Hydroxyethyloxy)-4-methoxy-3-octyl-cyclopent-2-en-1-one (IX). Oily substance, yield 43%. IR spectrum (ν , cm⁻¹): 1640, 1730, 3030, 3600. ¹H NMR spectrum (δ , ppm): 0.80 t (3H, CH₃, *J* 7 Hz), 1.1–1.6 m (10H, 5CH₂), 2.25–2.45 m (2H, C¹H), 2.57 s (2H, C⁵H), 2.65–2.80 br.m (1H, OH), 3.23 s (3H, OMe), 3.45–3.75 m (4H, 2CH₂O), 5.95 s (1H, HC=). ¹³C NMR spectrum (δ , ppm):

13.99 (C^{8'}), 22.54 (C^{7'}), 26.79 (C^{1'}), 27.42 (C^{2'}), 29.09 (C^{5'}), 29.24 (C^{4'}), 29.35 (C^{3'}), 31.72 (C^{6'}), 43.33 (C⁵), 51.25 (OMe), 61.67 (CH₂O), 65.54 (CH₂O), 107.04 (C⁴), 130.76 (C³), 177.0 (C²), 202.55 (C¹).

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