

Electron Spin Resonance Spectra of Products of Oxidation of Substituted 4-Piperidone Oximes by Lead Tetraacetate

P ANANTHAKRISHNA NADAR* & C DANIEL YESUDIAN

Chemistry Department, Anna University, Madras 600 025

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Several substituted 2,6-diphenyl-4-piperidone oximes with alkyl substituents at 3-, 5-positions and on the nitrogen have been prepared and oxidised by LTA. The ESR spectra of the radicals formed on oxidation reveal that only iminoxy and nitroxide radicals are formed. The major radical formed is the iminoxy radical when there are alkyl substituents at 3- and 5-positions. In the absence of alkyl substituents the main radical is the nitroxide radical. The study shows that the radical formed from 3,5-dimethyl-2,6-diphenyl-4-piperidone(VII) exists in a flattened chair form whereas that formed from its N-methyl derivative exists in twisted boat form.

Although the formation of several radicals in the lead tetraacetate oxidation of aldoximes and ketoximes has been noticed¹, only iminoxy and nitroxide radicals are found to have significant existence²⁻⁵. The iminoxy radicals have been characterised as σ -radicals with the unpaired electron contained in an orbital which is derived from a p -orbital on oxygen and the non-bonding sp^2 -orbital on nitrogen and which lies in the nodal plane of the molecular C-N π -bond. The characteristics of these radicals in monocyclic and polycyclic systems^{6,7} have been studied in detail by their ESR spectroscopy. The conformations of bicyclic oximes^{7,8} have been understood by a study of the ESR spectra of the radicals formed during their oxidation with LTA. No such study has yet been undertaken for heterocyclic oximes. This paper presents a detailed study of the radicals formed in the LTA oxidation of substituted 4-piperidone oximes with a view to understanding their conformations.

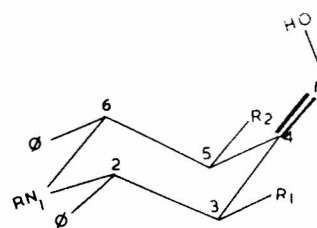
Materials and Methods

The oximes (I-VIII) were prepared from the corresponding 4-piperidone by a standard procedure⁹ and their melting points agreed with those reported in the literature. The purity of the oximes was tested by TLC.

The free radicals were generated by dropwise addition of a solution of LTA in methylene chloride to 5% (w/v) solutions of the oximes in the same solvent at 0°C and their ESR spectra recorded immediately. All spectra were recorded at 300K in a quartz aqueous cell on a Varian ESR spectrometer operating at X-band with 100 KHz field.

Results and Discussion

The oximes (I-VIII) are conformationally homo-

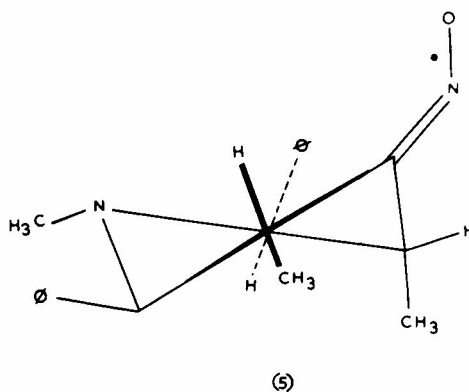
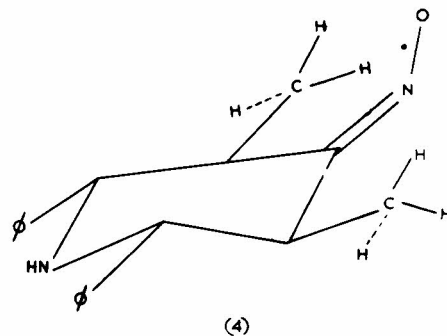
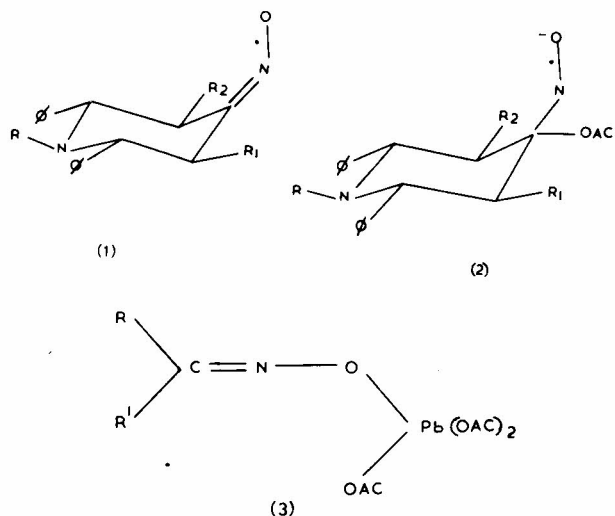


- I : R = R₁ = R₂ = H
 II : R = CH₃; R₁ = R₂ = H
 III : R = R₂ = H; R₁ = CH₃
 IV : R = R₁ = CH₃; R₂ = H
 V : R = R₂ = H; R₁ = *i*-Pr
 VI : R = CH₃; R₂ = H; R₁ = *i*-Pr
 VII : R = H; R₁ = R₂ = CH₃
 VIII : R = R₁ = R₂ = CH₃

Table 1—ESR Parameters of Iminoxy and Nitroxide Radicals

Radical of	a_N Iminoxy radical	a_N Nitroxide radical	a_H Proton hfs
I	30 G ^a	13.25 G ^b	—
II	— ^c	13.25 G ^b	—
III	29.25 G ^b	11.25 G ^a	—
IV	29.25 G ^b	11.25 G ^a	—
V	30.25 G ^b	13.0 G ^a	—
VI	30.25 G ^b	13.0 G ^a	—
VII	28.37 G ^b	13.0 G ^a	1.75 G
VIII	28.37 G ^b	13.0 G ^a	—

(a) rudimentary radical; (b) major radical; and (c) radical not observed



geneous *trans*-oximes. The ESR data of the radicals formed are given in Table 1.

It is seen that except for the oximes I and II, all other oximes produce iminoxy radicals (1) as the major species. They show only rudiments of nitroxide radicals (2). In the oxidation of oximes by LTA, a concerted mechanism involving the intermediate (3) has been suggested¹. The nitroxide radical (1) is believed to be formed from (3) by the internal attack of an acetate group on the methine carbon.

This attack is hindered by substituents at 3- and 5-positions and this explains rudimentary formation of 2. The formation of nitroxide radicals as the major species in the case of 2,6-diphenyl-4-piperidone oxime (I) and its N-methyl derivative(II) is due to the fact that during the formation of nitroxide radicals there is a transition in hybridization from a strained sp^2 ring carbon to a strain-free sp^3 hybridized carbon. This transition is facilitated by the absence of any group at 3- or 5-position in I and II.

Gilbert and Norman¹⁰ have suggested that for an effective interaction of the odd electron of the radical with any proton in its vicinity the system, $O-N=C-C-H$ should form part of a W-shaped framework and that the atoms lie close in a plane. Though the oximes (III) and (IV) have a methyl substituent at 3-position, there is no proton hyperfine shift (hfs) due to methyl substituent indicating that the odd electron is *anti* to methyl and far away and hence no hfs. In the case of the radical from 3,5-dimethyl-2,6-diphenyl-4-piperidone oxime(VII) there is proton hfs besides nitrogen hfs. Each of the iminoxy radical nitrogen triplet is found to further split up to give a quintet pattern of intensity 1:4:6:4:1 with two different proton hfs constants, $a_H = 2.00$ and 1.75G. This type of splitting pattern is expected only if the odd electron interacts with only two of the protons in each of the

methyl groups on either side of the iminoxy radical. This shows that methyl groups on either side of the radical have only restricted rotation. In order to relieve the strain arising from the non-bonded repulsion between one of the methyl groups and the iminoxy oxygen, the molecule may have undergone slight distortion (flattening) as shown in (4). In this distorted conformation the C-C-CH₃ bond angle at position-3 is different from that of C-C-CH₃ at position-5, thus rendering the methyl groups at 3- and 5-positions to split differently. This offers ready explanation for the two different proton hfs constants observed for (4). Further support for this distorted conformation is obtained from the PMR spectrum of VII in CDCl₃ which reveals that the two methyl groups at 3- and 5-positions are in two different environments with two different doublets with $J = 6.5$ and 7.0 Hz arising from coupling of the methyl groups with geminal protons. The $J_{2H_a,3H_a}$ value (8.0Hz) is different from $J_{5H_a,6H_a}$ value (6.5Hz). None of these value agrees with a value of 12 Hz observed for such coupling in perfect chair form. Further support for the flattened form (4) for VII is obtained from the appearance of two quintets arising from the splitting of the quartets of 3H_a by 2H_a and the splitting of the quartets of 5H_a by 6H_a. The octet expected in each overlaps to give a quintet pattern. Of the two quintets observed, one is symmetrical (1:4:6:4:1) and the other is non-symmetrical.

The iminoxy radical of 1,3,5-trimethyl-2,6-diphenyl-4-piperidone (VIII) shows the same a_N value

(28.37 G) as that of the radical from VII. But in the radical from VIII the hfs due to the methyl protons is absent. This indicates that the radical assumes a twisted boat form (5) wherein the W-shape coplanarity is absent.

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