

Influence of Proton Donors Addition on Reaction Intermediaries in the Reduction of Aminoquinone Derivatives in Acetonitrile. Traveling from Hydrogen-Bonding to Proton Transfer Pathways.

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The aminoquinones are broadly used compounds in therapeutics due to a great variety of their pharmacological properties. Such properties are mainly related to the quinone system reduction mechanisms. Thus, it is necessary to understand, as far as possible, the factors that control the reaction pathways of the various species appearing in the quinone-hydroquinone systems. It is known that both hydrogen-bonding and protonation are fundamental factors that control potentials and mechanisms in the reduction of quinones. However, to describe different pathways of the Q/QH₂ system reduction square schemes were principally used, which only involve proton and electron transfers. Thus, the possibility to form hydrogen bonding instead of direct protonation within this scheme has been little considered. So, the objective of our work is to demonstrate the influence of both hydrogen-bonding mediated interaction and direct protonation on reduction mechanisms of different types of aminoquinones (figure 1). For that purpose, an electrochemical study in acetonitrile solutions was carried out in this work. The effect of modifying the quinone system reduction mechanisms was systematically studied either by modifying the quinone basicity through structural changes (figure 1), or varying the acidity level of the medium through the addition of increasing quantities of additives with different hydrogen-ion concentrations (ethanol, phenol, benzoic acid and perchloric acid).

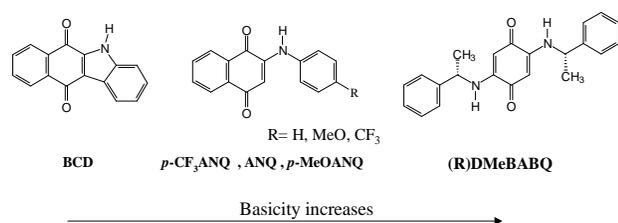


Figure 1. Structures and keys of aminoquinones, showing the degree of molecule basicity.

In acid additive free acetonitrile it was found that all aminoquinones present the behaviour typical of quinones¹, consisting of two reversible waves of reduction, Q/Q^{•-} (wave Ic) and Q^{•-}/Q²⁻ (wave IIc)(figura 2a), that indicates the absence of acid in the proton of -NH- group².

The addition of ethanol (EtOH) at concentrations 100 times higher than quinone concentration in solution (1mM), gives rise to a positive displacement of both reduction waves (without loss of reversibility), indicating the presence of interaction via hydrogen bonding of Q^{•-} and Q²⁻ with ethanol. The constants of hydrogen-bonding formation as well as the number of EtOH molecules,

involved in the bonding, directly depend on the basicity of the considered quinone.

In the presence of phenol (PhOH), it was found that the interaction between Q^{•-} and Q²⁻ with the PhOH is actually a competition between hydrogen bonding and protonation, which depends on the quinone basicity.

With the addition of benzoic acid (HBz), stronger than PhOH, it was also possible to observe the interaction through hydrogen bonding between Q and HBz, which was identified by the presence of the wave IVc at less negative potentials than that corresponding to the wave Ic (figura 2b). It was observed that the higher is the quinone basicity, the more important is the displacement of the wave IVc.

On the other hand, the addition of perchloric acid (HClO₄), at 2.7 < C_{HClO₄} < 260 mM, allowed us to observe the reduction of mono and deprotonated quinones, which were identified by the presence of the peaks VIc and VIIc respectively (figures 2c and 2d).

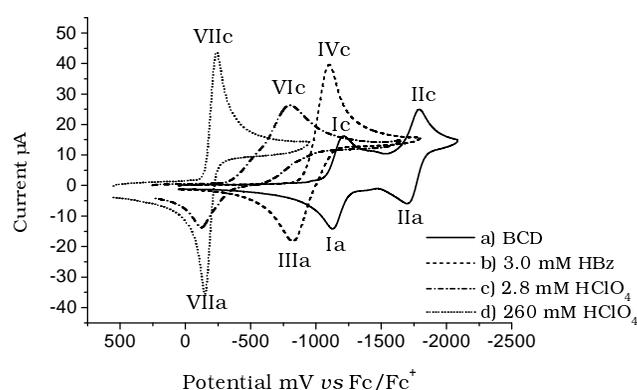


Figure 2. Typical cyclic voltammograms of 1mM BCD in 0.1 M Et₄NBF₄/acetonitrile at different concentrations of HBz and HClO₄. Working electrode: glassy carbon (7 mm²). Scan rate = 100 mV/s.

In conclusion, through this work the successive interaction between the acid additive and different species in solution might be observed, also allowing the traveling through different pathways of reduction that can be experienced by the quinone system. It demonstrates that the nature of interaction between the acid additive and different quinone species may be due to formation of hydrogen bonding or direct protonation. It depends on both basicity of electrogenerated intermediaries and proton availability in the acid additive. The extreme cases of hydrogen bonding formation with EtOH and protonation with HClO₄ made possible to elucidate the competition between these two types of interactions presented with PhOH and HBz.

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