

# 1. Introduction

## 1.1. Quinones

Quinones in their simplest form are classified as six-membered carbocyclic compounds containing two carbonyl residues, either separated by vinyl groups within a ring, *p*-quinones, or adjacent to one another, *o*-quinones. This structure is embedded in a variety of more complicated and carbocyclic compounds supported with varying numbers of rings (Weaver *et al.*, 2014).

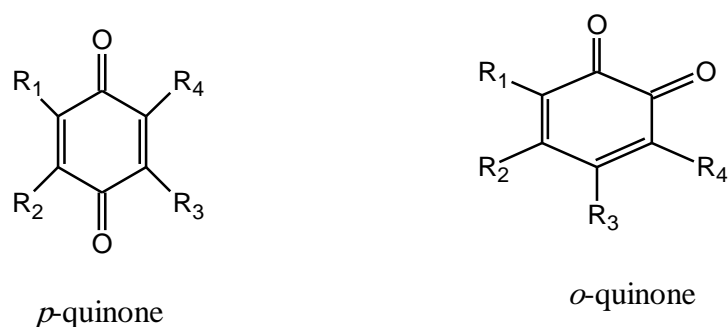


Fig.1.1.General classes of quinone substitution.

Quinones and heterocyclic quinones are large class of compounds with diverse biological activities. They are found to be very cheap and easily available having wide range of biological applications which includes electron transport and oxidative phosphorylation (Ravi *et al.*, 2014).

The Quinoline quinones have become a focus of interest in the search for better antimalarial drugs (Richard *et al.*,1954).Quinones constitute one of the well-known groups of naturally occurring organic compounds. One of the major attractions among researches towards quinones compounds is their color and biological activities (Radhakrishnan *et al.*, 2011). They are also constitute an important class of naturally occurring compounds that are found in plants, fungi, and bacteria, and that function primarily as components of electron transport chains involved in cellular respiration and photosynthesis. Human exposure to quinones can occur clinically, via the diet or via airborne pollutants (Terrence *et al.*, 1992).

Most of the quinones are of major industrial importance such as dyes, pigments and protection chemicals. Some quinones are related to more complicated aromatic systems which have been isolated from biological

sources. They are  $\alpha,\beta$ -unsaturated cyclic diketones with the oxygen atoms in simple or conjugate ring system, they are capable of forming 1,4-addition product(Saeed *etal.*, 2009).

Quinones are powerful intermediates for organic synthesis, because they possess both reactive carbonyl and olefinic bonds and occur frequently within structures of natural products (Nicolaou *etal.*, 2001).

The synthesis of quinones is important in organic chemistry because they are not only useful intermediates, but also many are pharmacologically active compounds (Tohma *etal.*, 2001).

Quinones are Micheal acceptors and represent a class of toxicological intermediates which can create a variety of hazardous effects i.e. acute cytotoxicity, immunotoxicity, and carcinogenesis (Judy *etal.*, 2000).

*p*-quinone compounds containing both electron withdrawing and donating substituents proved to be effective and give products in good yields(Victor *etal.*, 2010).They were known to possess antitumor activity, antimicrobial activity and antimalarial activity(Saeed *etal.*, 2009).

### **1.1.1. Physical properties of quinones:**

Quinones are colored (most are yellow) crystalline compounds with a penetrating odor. Quinones which have carbonyl in different rings. 2,6-napthaquinones, appear near  $1645\text{ cm}^{-1}$ . Some *p*- benzoquinones exhibit doublet carbonyl absorptions. The ultra-violet spectrum is often in establishing the presence and type of quinone as well as its substitution pattern .

### **1.1.2. Chemical properties of quinones:**

Quinones have two properties that are essential for understanding biological effects. First, quinones can undergo reversible oxidation reactions and second, most of them can undergo nucleophilic attack due to their electrophilic character. (El-Najjar *etal.*, 2011).

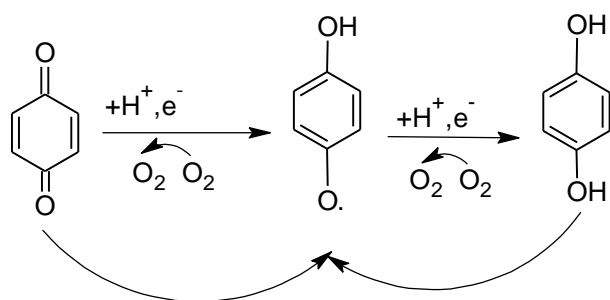
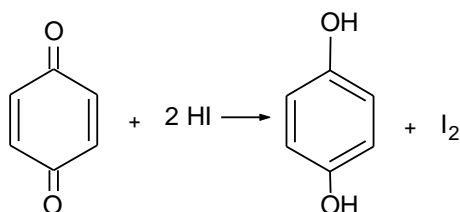


Fig.1.2. Illustration, using benzoquinone as an example, of one of two electron reduction yielding semiquinone and hydroquinone respectively.

Most quinones liberate iodine from acidified potassiumiodide solutions.



Quinones are also formed from oximes and semicarbazones.

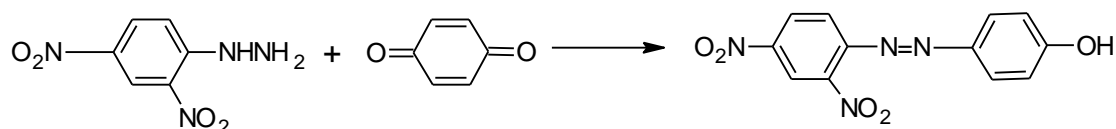


Fig.1.3. Quinones from oximes and semicarbazones

Quinones may be readily reduced to hydroquinones with a variety of reducing reagents, e.g., zinc and dilute hydrochloric acid or sodium dithionate (Morton,1965)

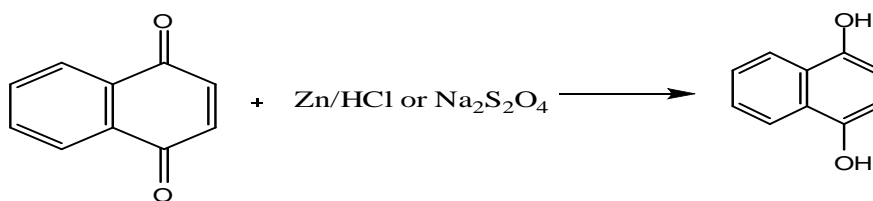


Fig.1.4. Reduction of quinones reaction

Like other aromatic diketones, *o*-quinones react with *o*-phenylenediamine to afford quinoxalines.

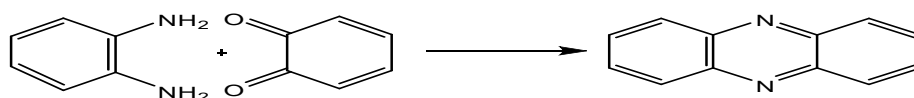


Fig.1.5. Reaction of *o*-quinones with *o*-phenylene-diamine

### 1.1.3. 1,4-Benzoquinones and their applications:

Quinones are large class of compounds endowed with rich and fascinating chemistry. 1,4- benzoquinone is the basic structure of quinonoid compounds.

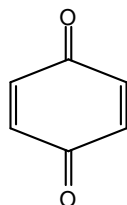


Fig.1.6.1,4-Benzoquinone structure.

A large number of chemical derivatives with 1,4-benzoquinone as the basic subunit exhibit prominent pharmacological applications such as antibiotic, antitumor, antimalarial, etc.

Wide applications of quinones can also be found in the field of synthetic organic chemistry. Coordination chemistry of quinones is also quite rich from the perspective of designing magnetic materials.

### 1.2. Chemical synthesis of *p*-quinones:

The most common quinone, benzoquinone was the first synthesized quinone in the late 1830's in the Liebig's laboratory as a result of oxidation of quinic acid with manganese dioxide and sulphuric acid. This reaction involves dehydration, decarboxylation and oxidation.

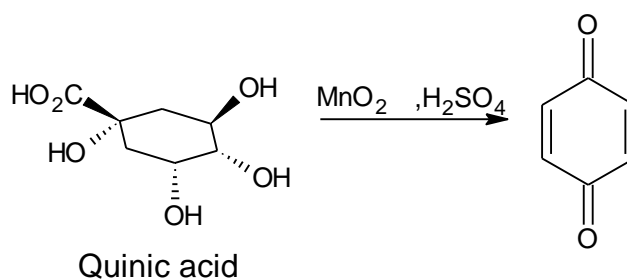


Fig.1.7.1 Synthesis of 1,4-benzoquinone.

The oxidation of aromatic hydrocarbons to the corresponding *para* or *ortho*-quinone represents for the most straight for a synthesis of quinodol compounds, the simple aromatic hydrocarbons i.e. benzene, naphthalene, and anthracene are all oxidized to the corresponding *p*-quinones.

Both chemical and electrochemical methods for the oxidation require the ionic or radical cationic intermediates. Consequently the reaction proceeds not readily in condensed polycyclic systems that permits intensive delocalization. The oxidation of aromatic hydrocarbon require harshly acidic reaction condition. (Thomas, *etal.* 1974).

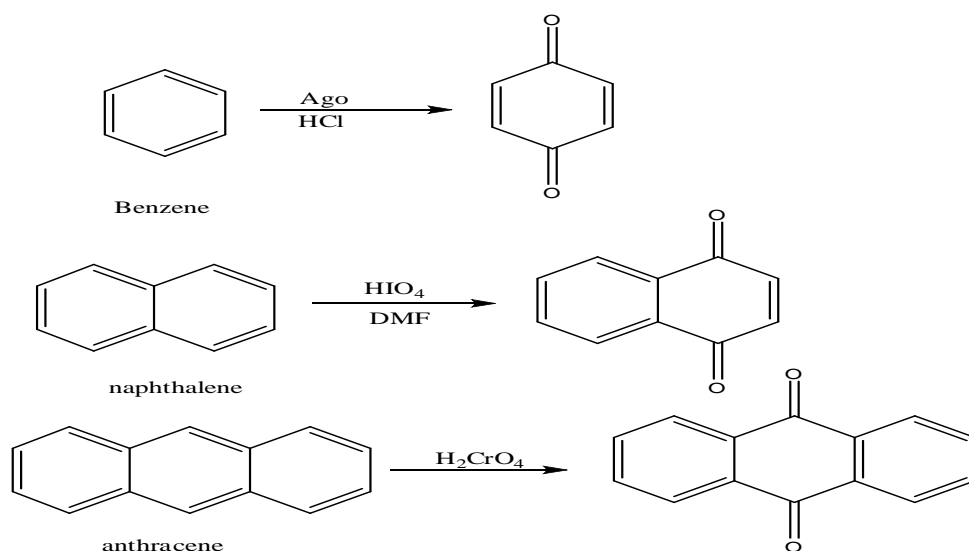


Fig.1.8. Preparation of *p*-quinone from aromatic hydrocarbon.

In general, quinones are been synthesized from phenols, 1,4-dihydroxybenzene or hydroquinones and dimethoxybenzene (Ignatious *etal.*,2011).