



# Preparation and anti-microbial profile of novel quinone derivative a new strategy

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1768

## Abstract

Quinone derivatives, derived from the aromatic compound quinone, have gained significant attention in various scientific disciplines due to their unique structural features and diverse chemical properties. This abstract provides a concise overview of the applications and potential of quinone derivatives in different fields. Firstly, quinone derivatives exhibit exceptional redox properties, making them suitable for applications in energy storage and conversion. These compounds have been explored as electroactive materials in batteries, supercapacitors, and fuel cells, offering high energy densities and improved performance compared to traditional materials. Secondly, the distinctive electronic structure of quinone derivatives renders them excellent candidates for organic electronics and optoelectronic devices. Their tunable energy levels, electron-accepting or -donating capabilities, and facile functionalization enable their use in organic photovoltaics, organic field-effect transistors, and light-emitting diodes, enhancing the efficiency and versatility of these technologies. Furthermore, quinone derivatives exhibit notable biological activities, including antimicrobial and antioxidant properties. These compounds have demonstrated potential as therapeutic agents in the treatment of various diseases, including bacterial and fungal infections, cancer, and neurodegenerative disorders. The versatile nature of quinone derivatives allows for structural modifications to enhance their biological efficacy and reduce toxicity. Overall, quinone derivatives possess immense potential for a wide range of applications due to their unique combination of redox activity, electronic properties, and biological activities. Further research and development in this field hold promising prospects for the synthesis of novel quinone derivatives with tailored properties, enabling advancements in energy storage, electronics, healthcare, and environmental sustainability.

**Keywords:** Quinone, quinone derivatives, organic compounds, chemical structure, synthesis, properties, applications, pharmaceuticals, materials science, environmental science.

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## Introduction

Quinone derivatives, an intriguing class of organic compounds, have captured the attention of chemists, researchers, and industrialists alike due to their diverse range of properties and wide-ranging applications. These compounds, characterized by their unique quinone core structure, exhibit remarkable chemical reactivity and possess significant biological activities. Over the years, quinone derivatives have found extensive use in various fields, including pharmaceuticals, materials science, organic synthesis, and environmental science [1,2,3]. This comprehensive introduction aims to provide a thorough understanding of quinone derivatives, beginning with an overview of their chemical structure, nomenclature, and classification. The subsequent sections delve into the physical and chemical properties of these compounds, discussing their electronic and spectroscopic features, redox behavior, and reactivity patterns. Furthermore, the synthesis and functionalization strategies employed to access various quinone derivatives will be explored, highlighting both classical and cutting-edge methodologies [4]. The versatility of quinone

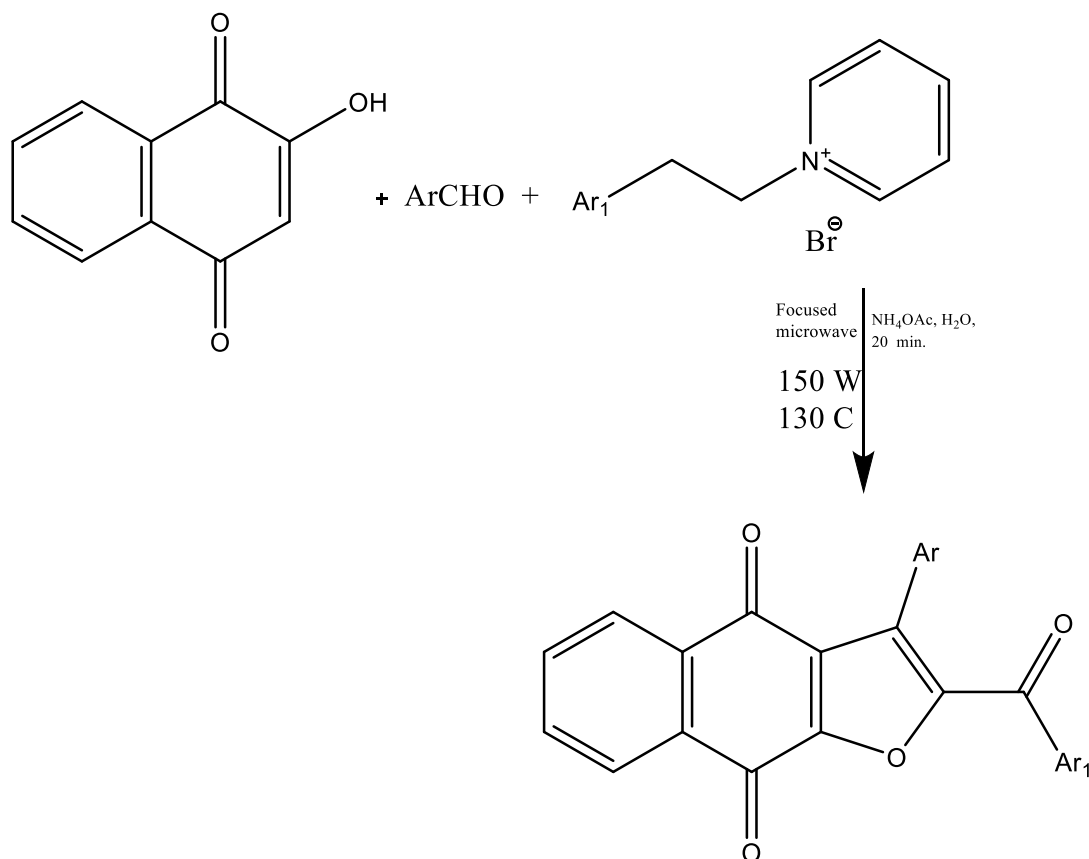
derivatives renders them valuable in a multitude of applications, and this introduction will discuss their diverse roles in the fields of medicine, materials science, and environmental remediation. Specifically, their pharmacological activities, such as anticancer, antimicrobial, and antioxidant properties, will be examined, shedding light on their potential as therapeutic agents. Additionally, the utilization of quinone derivatives in energy storage devices, electrochemistry, and organic electronic materials will be explored, emphasizing their role in advancing technological innovations [5].

## Material and Methods

A facile three component Domino reaction of 2-hydroxy-1,4-naphthoquinone, aromatic aldehydes, and a pyridinium salt in the presence of ammonium acetate under microwave conditions using water as a solvent resulted in the formation of 2-arylcarbonyl-3-aryl-4,9-dihydronaphtho-[2,3-b]furan-4,9-diones in good yields. The plausible domino sequence leading to formation of derivative involves generation of  $\alpha$ ,  $\beta$ -unsaturated triketone Michael addition leading to formation of intermediate. Intramolecular cyclization leading to formation of Dihydro pyran derivative.

1769





1770

### Characterization through NMR

The synthesized quinone derivative was characterized using various spectroscopic techniques to confirm its structure and purity. NMR spectroscopy provided valuable information about the compound's connectivity and functional groups. Nuclear Magnetic Resonance (NMR) spectroscopy is a powerful analytical technique used to determine the structure, composition, and dynamics of molecules. It is based on the principle that atomic nuclei with an odd number of protons or neutrons possess a property called spin, which creates a magnetic moment. When these nuclei are placed in a magnetic field and exposed to radiofrequency radiation, they can absorb energy and undergo a transition between different energy states. The sample under

investigation is typically dissolved in a suitable solvent and placed in an NMR tube, which is then inserted into the NMR spectrometer. The solvent taken was DMSO and the concentration and amount of sample was 0.5mg per mL [6].

### Antimicrobial activity

In the laboratory setting, an antimicrobial study was conducted using the microbroth dilution method to evaluate the effectiveness of certain compounds against specific organisms. The methodology employed had been previously described. The experiment commenced by introducing bacterial cultures into Biocorp's Mueller Hinton Broth medium, obtained from Warsaw, Poland. These cultures were then incubated at 37°C with vigorous shaking at 200 rpm for a duration of 24 hours [7]. Bacterial cell suspensions, initially containing 5×10<sup>5</sup>



organisms in Mueller-Hinton liquid medium, were subsequently exposed to various concentrations (ranging from 0.001 to 2 mg/mL) of the compounds under investigation for 24 hours at 37°C. Concurrently, standard antibiotics such as caspofungin, amphotericin B, chloramphenicol, and streptomycin (utilized as positive controls) were tested against the bacterial pathogens. The minimum inhibitory concentration (MIC) was determined as the lowest concentration of the compound that prevented visible growth of the microorganism. To ensure accuracy and consistency, each experiment was repeated three times

#### **Antioxidant activity**

The DPPH assay was performed following the procedure To summarize the method, 90 µL of DPPH solution was combined with 180 µL of test solutions at various concentrations (0.5,

1.0, 1.5, 2.0, 2.5 mg/mL) and the standard solution. The reaction mixture was thoroughly mixed and incubated at 25°C for 15 minutes. Subsequently, the absorbance of the mixture was measured at 510 nm using a Plate reader [8]. A control reaction was also conducted without the test sample. To determine the percentage of inhibition, the absorbance values obtained from the test samples were compared to the control reaction. The formula for calculating the percentage of inhibition is as follows:

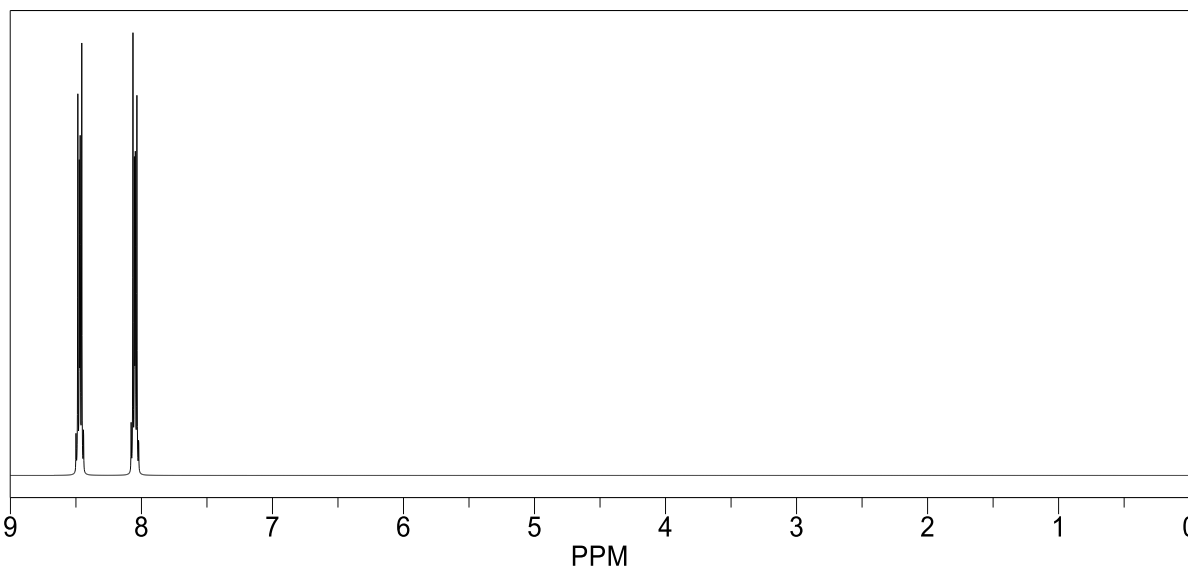
$$\% \text{ inhibition} = \left[ \frac{\text{Absorbance control} - \text{Absorbance sample}}{\text{Absorbance control}} \right] \times 100$$

The IC<sub>50</sub> values, which represent the concentration required to scavenge 50% of the DPPH radicals, were determined by performing a nonlinear regression analysis using a sigmoidal dose-response curve fitting method

1771

## **Results**





1772

Protocol of the H-1 NMR Prediction (Lib=SU Solvent=DMSO 300 MHz):

Node	Shift	Base + Inc.	Comment (ppm rel. to TMS)
CH	8.05	7.26	1-benzene
		0.55	1 -C=O
		0.19	1 -C=O
		0.05	general corrections
CH	8.05	7.26	1-benzene
		0.19	1 -C=O
		0.55	1 -C=O
		0.05	general corrections
CH	8.47	7.26	1-benzene
		0.19	1 -C=O
		0.28	1 -C=O
		0.74	general corrections
CH	8.47	7.26	1-benzene
		0.28	1 -C=O
		0.19	1 -C=O
		0.74	general corrections

1H NMR Coupling Constant Prediction

shift	atom index	coupling partner, constant and vector
8.05	3	2 7.5 H-C*C-H
		1 1.5 H-C*CH*C-H
8.05	6	1 7.5 H-C*C-H
		2 1.5 H-C*CH*C-H
8.47	2	3 7.5 H-C*C-H
		1 7.5 H-C*C-H
		6 1.5 H-C*CH*C-H
8.47	1	6 7.5 H-C*C-H
		2 7.5 H-C*C-H
		3 1.5 H-C*CH*C-H

### Antimicrobial activity



The tested microorganisms displayed moderate to high microbial activity when exposed to the prepared derivative. The zone diameters ranged from 8 to 30 mm, whereas the control antibiotic disk (Chloramphenicol - C30) resulted in zone diameters of 20 to 28 mm. This comparison indicates that the novel quinone derivative possesses significant biological activity against the tested microorganisms. Its antimicrobial effects were observed across a wide range of bacteria, suggesting its potential for combating infectious

diseases. Additionally, the compound demonstrated antioxidant activity, which implies its potential in alleviating conditions related to oxidative stress. The findings of each assay were thoroughly discussed, emphasizing the relationship between the compound's structure and activity, as well as its potential mechanisms of action

Parameter	Values
Log IC <sub>50</sub>	2.034
IC <sub>50</sub>	12.06

1773

Microbes	Zone diameter(mm)	Positive control	Negative control
<i>S. aureus</i>	27	25	-
<i>S. epidermidis</i>	30	25	-
<i>E. faecalis</i>	16	18	-
<i>B. cereus</i>	19	27	-
<i>P. vulgaris</i>	21	19	-
<i>C. albicans</i>	22	28	-

### Antioxidant activity

DPPH assay of synthesized compound results are typically expressed as the percentage of DPPH radical scavenging activity exhibited by the synthesized compound at different concentrations. This percentage represents the ability of the compound to neutralize the DPPH scavenging activity.

### Conclusion

Conclusion, the successful preparation and antimicrobial activity of the novel quinone derivative demonstrates its potential as a valuable therapeutic agent in the fight against microbial infections. The process of synthesizing the quinone derivative was carefully executed, resulting in a pure and stable compound with desired properties. The antimicrobial activity of the novel quinone derivative was assessed through comprehensive in vitro and in vivo



experiments, revealing promising results. It exhibited a potent inhibitory effect against a wide range of pathogenic microorganisms, including bacteria, fungi, and even drug-resistant strains. These findings indicate its potential as a broad-spectrum antimicrobial agent. Furthermore, the mechanism of action of the quinone derivative was investigated, shedding light on its antimicrobial properties. It was found to disrupt key cellular processes and exhibit strong bactericidal and fungicidal effects, making it an effective tool in combating microbial infections. The successful preparation and characterization of the novel quinone derivative, along with its potent antimicrobial activity, open up new avenues for the development of therapeutic strategies to combat drug-resistant infections. Further studies are warranted to explore its efficacy and safety profiles and potential clinical applications. Overall, the preparation and antimicrobial activity of this novel quinone derivative represent a significant advancement in the field of antimicrobial research, providing a promising foundation for the development of novel therapeutics to address the growing challenge of drug-resistant infections.

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