

Antibacterial Function of Chromium Nanoparticles Against *K. Pneumonia*, *E. coli* and *P. typhus*

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Short Report

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Abstract

The bioactive chromium nanoparticles were synthesized by calcination followed by thermal decomposition method. The antibacterial activity of chromium nanoparticles diffused in Dimethyl sulphoxide (DMSO). The antibacterial activity of chromium nanoparticles carried out against significant human pathogens (gram negative bacteria) viz, *K. pneumonia*, *E. coli* and *P. typhus* using agar diffusion cup plate method at 100 µg/ml concentration. The highest zone of inhibition was observed (12.0 mm) against *K. pneumonia* and lowest zone of inhibition (7.0 mm) *E. coli*. Thus, the outcomes of these studies suggest that synthesized chromium nanoparticles are of clinical importance.

Introduction

Nanoparticles of transition metal oxide represent wide range of materials that have been researched extensively due to their versatile electronic, medicinal, magnetic, catalytic and thermal properties. Chromium (Cr) metal is a heavy metal and widely used in pigment, electroplating, textile dyeing, paper and pulp industries [1]. Material developed at Nano range are applied in various fields i.e biomarkers, optical sensors, antimicrobial agent and drug delivery systems [2]. The nanotechnology studies have concentrated on the medicinal use of nanoparticles for the treatment and antimicrobial effect. Chromium and chromium oxide nanoparticle have gained wide recognition due to their importance in nanotechnology as well as medical field. Chromium nanoparticles have become the subject to immense research interest in the current years due to their broad application as antimicrobial agent, medical devices and water purification systems [3]. Nanoparticles shows a versatile property due their high surface to volume area as compared to bulk material. One of most important thing of nanotechnology plan is to identify efficient synthesis process of nanoparticles. Various method have been reported for the preparation for chromium nanoparticles such as hydrothermal [4–5], sol-gel [6], combustion [7], precipitation [8], gelation [9], microwave irradiation [10] micro-emulsion [11] method. Metallic nanoparticles have favourable application in biomedical sciences such as nano-diagnosis, drug delivery and biolabeling [12]. Previous work by many researchers reported that the chromium nanoparticles bring antimicrobial activity against pathogenic microorganism. For example, Ramesh et al. and Khatoon *et al.* reported Cr₂O₃ nanoparticles inhibit the growth of *Escherichia coli* [13–14] and *Pseudomonas aeruginosa*. El-Ajaily *et al.* [15] reported the antibacterial activity of Cr (VI) and Cr (III) complexes against *P. aeruginosa* bacteria. Singh *et al.* [16] reported viability of an environmentally relevant bacterium, *E. coli* exposed to varying concentrations of Cr₂O₃ nanoparticles was evaluated. Finally, it is very important to note that the antimicrobial activity of chemically synthesized chromium nanoparticles have not been studied for all three microorganisms. Therefore the purpose of this study were synthesis and characterization of chromium nanoparticles and their antibacterial function against *K. pneumonia*, *E. coli* and *P. typhus*.

Material And Methods

Throughout the present study analytical grade chemical Phenol, formaldehyde, chromium Chloride, and acetic acid (CDH Pvt. Ltd) and HCl (Fisher Scientific) were used. Chromium nanoparticle have been prepared by calcination method using phenol-formaldehyde resin as precursor. The studies of chromium nanoparticles characterized by Fourier Transform Infra-Red spectroscopy (FTIR), Nuclear Magnetic Resonance (NMR) spectroscopy, X-Ray Diffraction (XRD) analysis, Scanning Electron Microscopy (SEM). The detail method of synthesis and characterization of metallic nanoparticles has already been given in our earlier publication [17].

Antimicrobial Activity

Bioassay of chromium nanoparticles was investigated by employing agar diffusion cup plate method at 100 µg/mL against known bacterial strain viz. *K. pneumonia*, *E. coli* and *P. typhus* relying on commercial drug ciprofloxacin as control. 0.001 g of synthesized chromium nanoparticles was weighed and dissolve in 10 ml DMSO. 100 µg/mL concentration of chromium nanoparticles was prepared from stock and used for the analysis. Prepared luria agar medium was dispended into petri dishes and allowed for 1 hour to set. The plates were labelled and inoculated with 50µL of appropriate test organism. Wells of diameter 7 mm were bored in each plate using sterile cork borer, the wells were filled halfway with 100 µg/ml concentration of the synthesized metal nanoparticles solution. The plates were incubated at 37⁰C for 24 hours, after which the zone of inhibition was measured.

Proper safety measures were adopted by the researcher during the analysis to prevent any bio-hazard.

Result And Discussion

Antimicrobial activity of Cr NPs on *K. pneumonia*, *E. coli* and *P. typhus*

ZOI observed for chromium nanoparticles against three pathogens are show in the Table1 below:

Table 1
Zone of Inhibition (ZOI) for Cr NPs against *K. pneumonia*, *E. coli*, and *P. typhus*.

<i>Cr Nanoparticles</i>	<i>K. pneumoniae</i>	<i>E. coli</i>	<i>P. typhus</i>
ZOI (mm)	12..0	7.00	9.0

The ZOI observed for chromium nanoparticles showed (Fig. 1) that the transition metal nanocomposite is most active against *K. pneumonia*, evident in ZOI observed 12.0 mm. In contrast, a ZOI of 7.00 mm was observed for *E. coli*, thus indicating a poor activity of the metal nanoparticles against test organism. The afore reported observations on bioassay of chromium nanoparticles rationalized our conclusion that chromium nanoparticles are highly suitable for incorporation into drugs designed to mitigate diseases caused by *K. pneumonia*.

The higher Zone of Inhibition in case of *K. pneumonia* by the chromium oxide nanoparticles synthesized by sol-gel technique was reported earlier [18] and systematic antimicrobial activity of chromium nanoparticles against pathogenic bacteria also reported earlier (Uma *et al.* 2019 and Kanakalakshmi *et al.* 2017. [3, 19])

Conclusion

The bioactive chromium nanoparticles were synthesized by simple chemical precipitation followed by thermal decomposition method. The antibacterial activity of chromium nanoparticles compared with other microorganism using agar diffusion cup plate method. The highest zone of inhibition was observed against *K. pneumonia* (12.0 mm). The synthesized chromium nanoparticles were found to be better antibacterial agent. Furthermore, the extraordinary antibacterial activity of Cr NPs can be employed in their drug delivery, biomedical and pharmaceutical applications.

Abbreviations

Cr NPS

Chromium Nanoparticles; DMSO:Dimethyl Methyl Sulphoxide; ZOI:Zone of Inhibition; FTIR:Fourier Red Spectroscopy; NMR:Nuclear Magnetic Resonance; XRD:X-Ray Diffraction; SEM:Scanning Electron Microscopy;

Declarations

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Author contributions

GT conceived and designed the experiments; analysed and interpreted the data; wrote the paper, JC contributed reagents, materials, analysis tools or data, AJ analysed the data, D V and OM Performed the experiments.

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Availability of data and materials

Not applicable. "Please contact with author for data request"

Ethics approval and consent to participate

This article does not contain any studies with human participants or animals performed by any studies with human participants or animals performed by any of the authors. For this type of study, formal consent is not required.

Consent for publication

Not applicable

Competing interest

The authors declare no conflict of interest.

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Figures

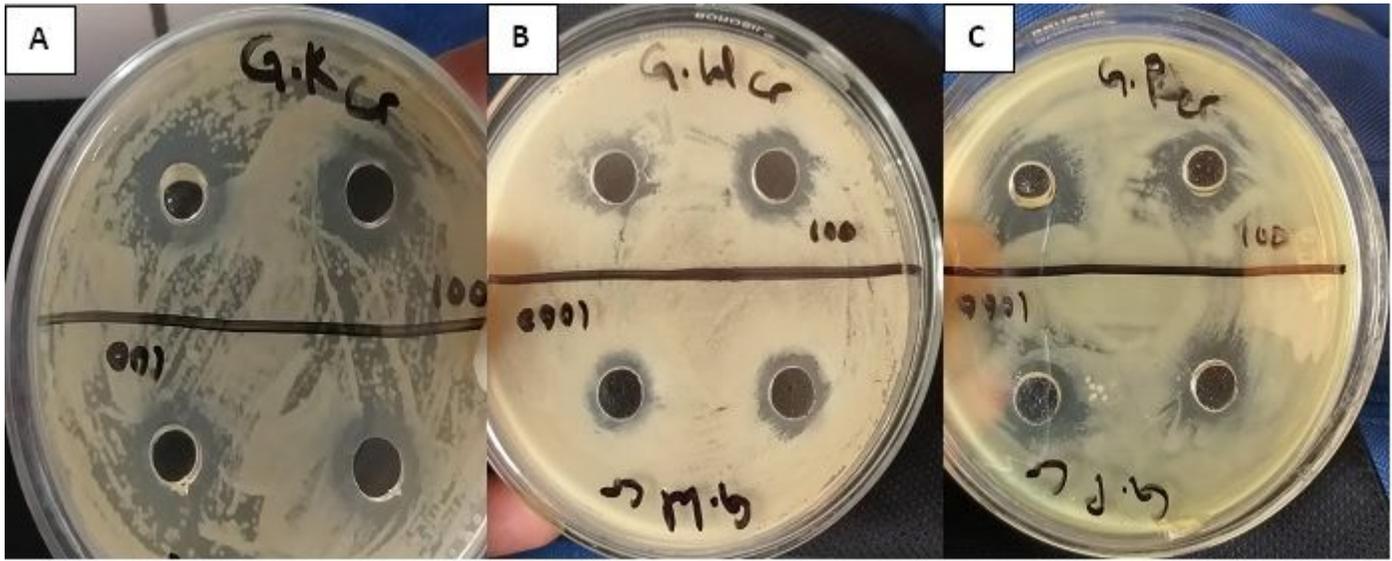


Figure 1

Zone of inhibition of chromium nano-composite against: (A) *K. pneumonia*, (B) *E. coli* and (C) *P. typhus*