INPLASY PROTOCOL

To cite: Luque-Jacobo et al. Biogenic Synthesis Of Copper Nanoparticles: A Systematic Review Of Their Features And Main Applications. Inplasy protocol 202350109. doi: 10.37766/inplasy2023.5.0109

Received: 29 May 2023

Published: 29 May 2023

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Support: **Fondo Nacional de Desarrollo Científico, Tecnológico y de Innovación Tecnológica (Contrato 108-2021 - Esquema E041-2021-02).**

Review Stage at time of this submission: **Completed but not published.**

Conflicts of interest:
None declared.

Biogenic Synthesis Of Copper Nanoparticles: A Systematic Review Of Their Features And Main Applications

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Review question / Objective: **The objective of this systematic review is to assess research articles published over the past decade regarding the antioxidant, antitumor, antimicrobial, dye removal, and catalytic activities of biogenically synthesized copper nanoparticles, using a scientific methodology of big data analytics. We aim to assist the scientific community in comprehending and locating helpful information for future research or application development.**
Condition being studied: **The condition being studied in the provided information is the biogenic synthesis of copper nanoparticles. Biogenic synthesis refers to the production or formation of nanoparticles using biological sources, such as plant extracts. Copper nanoparticles have gained significant attention in various fields due to their unique properties and potential applications. A systematic review of their features and main applications, such as antioxidant, antibacterial, antitumoral, and catalytic effects.**

INPLASY registration number: This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 29 May 2023 and was last updated on 29 May 2023 (registration number INPLASY202350109).

INTRODUCTION

Review question / Objective: **The objective of this systematic review is to assess research articles published over the past decade regarding the antioxidant, antitumor, antimicrobial, dye removal, and catalytic activities of biogenically synthesized copper nanoparticles, using a scientific methodology of big data analytics. We aim to assist the scientific community in comprehending and locating helpful information for future research or application development.**

Rationale: **The rationale behind conducting a systematic review of the biogenic synthesis of copper nanoparticles, their**

features, and their main applications is to gather and analyze existing scientific literature in a structured and comprehensive manner. A systematic review provides an evidence-based approach to synthesising available information.

Condition being studied: The condition being studied in the provided information is the biogenic synthesis of copper nanoparticles. Biogenic synthesis refers to the production or formation of nanoparticles using biological sources, such as plant extracts. Copper nanoparticles have gained significant attention in various fields due to their unique properties and potential applications. A systematic review of their features and main applications, such as antioxidant, antibacterial, antitumoral, and catalytic effects.

METHODS

Search strategy: We analyzed research on CuNPs ' biogenic or green synthesis and their primary applications. We formulate the problem based on the premise that there is no systematic review of the principal applications of biogenically synthesized CuNPs.
A bibliographic search was conducted from 2012 to date, using the PubMed, Web of Science (WOS) Core Collection, and SCOPUS databases (September 2014 to January 2023). The results were deduplicated and uploaded to EndNote (Clarivate Analytics) and Rayyan Software. The Preferred Reporting Items for Systematic Reviews and Me-ta-analyses (PRISMA) recommendations were followed. We carried a screening set for biogenic or green synthesis of CuNPs in databases mentioned before, using the keywords in the title and abstract: (nanoparticle*) AND (biogenic) OR (green AND synthesis) AND (copper) OR (cu) OR (cu2o) OR (cuo)).

Participant or population: We systematically reviewed research articles published in English, excluding non-English publications, case reports, books, letters, and patents. We analyzed re-search on CuNPs ' biogenic or green synthesis and their primary applications.

Intervention: Summarizing the existing knowledge and understanding of the biogenic synthesis of copper nanoparticles.

Comparator: Not applicable.

Study designs to be included: Research and experimental studies.

Eligibility criteria: A bibliographic search was conducted from 2012 to date, using the PubMed, Web of Science (WOS) Core Collection, and SCOPUS databases (September 2014 to January 2023). The authors selected the studies and reviewed the titles and abstracts of all published articles using the Rayyan software, based on the selected criteria and keywords. To compile research articles on biogenic synthesis, patents, clinical trials, reviews, du-plicates, and in vivo tests-related studies and articles were excluded. The authors carried out the review process and management by extracting authors' and content's raw data in accordance with a standard procedure.After the initial database data collection, we screened and categorized the major applications using four screening sets. The first set contained antitumor terms, the second set contained antioxidant terms, the third set contained antibacterial terms, and the fourth set contained catalytic effect and dye removal terms.The quality and risk of bias were evaluated based on the Cochrane Handbook for Systematic Interventions recommendations. Independently, the authors evaluated the possibility of bias during the review process. At any stage of the reviewing process, disagreements among the authors were discussed and resolved.The A Measurement Tool to assess Systematic Reviews (AMSTAR) was used to assess and evaluate the validity, quality, and reliability of the systematic review, as the content of each article was evaluated by following a set of criteria.

Information sources: The PubMed, Web of Science (WOS) Core Collection, and SCOPUS databases were used.

Main outcome(s): The biogenic synthesis of copper nanoparticles is a promising method for producing functional and stable nanoparticles with numerous potential applications. Biogenic synthesis has several advantages over conventional chemical synthesis methods, including low toxicity, cost-effectiveness, and mild reaction conditions. In addition, these nanoparticles have antioxidant, antibacterial, and antitumor properties, making them useful for healthcare and medical applications.
Due to their large surface area and unique surface properties, copper nanoparticles synthesized biologically have demonstrated catalytic potential in numerous chemical reactions. As efficient catalysts, they can improve reaction rates and selectivity, and their production can support ecofriendly and sustainable chemical industry processes.
Due to their antioxidant and antitumor properties, the biogenic synthesis of copper nanoparticles has shown great promise in medicine as antimicrobial agents and for cancer treatment and prevention.
Overall, the biogenic synthesis of copper nanoparticles is a promising and innovative technique that offers numerous advantages over conventional chemical synthesis techniques. Their potential applications, which include antibacterial, antitumor, antioxidant, and catalytic properties, make them an exciting study area. Further development of biogenic synthesis techniques could produce copper nanoparticles that are even more functional, stable, and applicable to a wider variety of fields.

Data management: Data were managed and analyzed using Rayyan Software and VOSviewer server software (Version 1.6.15; https://www.vosviewer.com).

Quality assessment / Risk of bias analysis: The systematic review was carried out following the guidelines of the Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA) and The A Measurement Tool to assess Systematic Reviews (AMSTAR) to assess and evaluate the validity, quality, and reliability of the systematic reviews screened.

Strategy of data synthesis: The search for the terms associated in the literature with the biogenic or green synthesis of CuNPs was performed using the keywords mentioned in the search strategy part, in the title and abstract. These results were then analyzed in a co-occurrence network map of terms in the VOSviewer software (version 1.6.18).

Subgroup analysis: The subgrouped data extracted were:
-The biological source, such as plant extracts (plants of the plant).
-Synthesis parameters, such as physicochemical parameters and characteristics (Salt sources and concentrations, size, and shapes of biogenic CuNPs.).
-Application analysis, according to the effect of the biogenic CuNPs, specific data was analyzed and collected, such as antioxidant activity, cancer cell lines, susceptible microorganism and compound synthesis, degradation and/or removal.

Sensitivity analysis: The research topics for the selected studies had to be from the past decade and about different applications of biogenically synthesized CuNPs, including antioxidant, antitumor, antimicrobial, dye-scavenging, and catalytic activities; helping to understand and organized the available information with robustness and reliability.

Language restriction: English.

Country(ies) involved: Peru and Brazil.

Keywords: Copper nanoparticles; biogenic synthesis; systematic review; antibacterial; antioxidant; antitumoral; catalytic and removal activity.

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