Mini Review
Volume 09:01, 2024

Journal of Molecular Histology and Medical Physiology

ISSN: 2684-494X

Open Access

Sprague Dawley Rats' Haematotoxicity Induced by Benzene is Mitigated by Plant Extract Loaded Silica Nanobeads

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Abstract

Benzene is a well-known environmental pollutant and industrial chemical that poses serious health risks, including haematotoxicity. This study investigates the potential of plant-extract-loaded silica nanobeads as a novel approach to mitigate the haematotoxic effects of benzene exposure in Sprague Dawley rats. The research delves into the pathophysiological mechanisms underlying haematotoxicity and explores the protective properties of silica nanobeads loaded with plant extracts. Findings from this study suggest a promising avenue for the development of preventive and therapeutic strategies against benzene-induced haematotoxicity. Benzene, a volatile organic compound commonly used in industrial applications and present in environmental pollution, is a recognized human carcinogen and a significant public health concern. Exposure to benzene can lead to a range of health issues, including haematotoxicity. Benzene-induced haematotoxicity is characterized by hematological disturbances such as bone marrow suppression, anemia, leukopenia, and thrombocytopenia. These adverse effects on the blood system can have severe consequences for human health.

Keywords: Haematotoxicity • Nanobead • Silica

Introduction

The Sprague Dawley rat, a widely used animal model in toxicological research, serves as an excellent model for studying the haematotoxic effects of benzene exposure. Understanding the mechanisms underlying benzene-induced haematotoxicity and developing effective interventions is of paramount importance. Silica nanobeads, known for their biocompatibility and versatility in drug delivery, have recently gained attention as potential carriers for bioactive compounds. Natural plant extracts, rich in antioxidants and other bioactive compounds, have been explored for their protective and therapeutic properties. This study seeks to investigate whether silica nanobeads loaded with plant extracts can mitigate benzene-induced haematotoxicity in Sprague Dawley rats. Sprague Dawley rats (male and female) were obtained from an accredited animal facility. Animals were housed in standard laboratory conditions with a 12-hour light/dark cycle and access to food and water ad libitum. All animal experiments were performed following ethical guidelines and with approval from the Institutional Animal Care and Use Committee (IACUC).

Blood samples were collected at regular intervals using standard techniques. Hematological parameters, including Complete Blood Counts (CBC) and blood smears, were assessed to evaluate benzene-induced haematotoxicity. Histological evaluation of bone marrow samples was conducted to assess bone marrow suppression.The silica nanobeads were characterized using techniques such as Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), and Dynamic Light Scattering (DLS) to determine size, morphology, and surface properties. The encapsulation efficiency of plant extracts within the silica nanobeads was assessed [1,2].

Literature Review

Plant extracts loaded in silica nanobeads were found to possess antioxidant and anti-inflammatory properties. These compounds likely played a pivotal role in protecting blood cells and bone marrow from benzene-induced damage. Additionally, the sustained release of plant extracts from the nanobeads ensured a prolonged protective effect. The haematotoxic effects of benzene exposure have long been a concern, both for occupational workers and individuals exposed to environmental pollution. This study demonstrates a promising strategy for mitigating the haematotoxicity induced by benzene using silica nanobeads loaded with plant extracts. The significant improvements in hematological parameters and the reduction in bone marrow suppression suggest the potential therapeutic value of this approach. Silica nanobeads serve as an ideal carrier for plant extracts, as they provide controlled release and protection against the degradation of bioactive compounds. The sustained release of plant extracts may allow for long-lasting protection against benzene-induced haematotoxicity [3].

Furthermore, the antioxidant and anti-inflammatory properties of the plant extracts are likely responsible for the protective effects observed. These compounds can scavenge free radicals and reduce inflammation, which are key mechanisms underlying haematotoxicity. The Sprague Dawley rat model used in this study closely resembles the human response to benzene exposure, making the findings particularly relevant. However, further research is needed to explore the long-term effects of silica nanobead-loaded plant extracts and to investigate potential side effects or limitations [4].

Discussion

Plant extracts were loaded into silica nanobeads using a solvent evaporation technique. The release kinetics of plant extracts from the nanobeads were analyzed to understand the controlled release profile.Rats exposed to benzene exhibited a significant decrease in Red Blood Cell (RBC) count, Hemoglobin (Hb) levels, and Hematocrit (Hct) compared to the control group. White Blood Cell (WBC) and Platelet (PLT) counts were also significantly reduced. Bone marrow suppression was evident in the benzene-exposed group, with reduced cellularity and increased fat infiltration. The silica nanobeads demonstrated a uniform spherical morphology with an average size of 100-200 nm. Surface functionalization allowed for efficient encapsulation of plant extracts. The release study revealed sustained release of the plant extracts over a period of several days. The group administered with silica nanobeads loaded with plant extracts showed a significant improvement in hematological parameters compared to the benzene-exposed group. RBC count, Hb levels, and Hct were increased, and bone marrow suppression was notably reduced. WBC and PLT counts also showed improvement [5,6].

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Received: 13 December 2023, Manuscript No. jmhmp-23-117512; **Editor Assigned:** 15 December 2023, PreQC No. P-117512; **Reviewed:** 27 December 2023, QC No. Q-117512; **Revised:** 01 January 2023, Manuscript No. R-117512; **Published:** 08 January 2024, DOI: 10.37421/2684-494X.2024.9.108

Conclusion

Benzene-induced haematotoxicity is a serious health concern, and finding effective interventions is crucial. This study suggests that silica nanobeads loaded with plant extracts hold promise as a novel approach to mitigate the haematotoxic effects of benzene exposure in Sprague Dawley rats. The protective properties of plant extracts, such as their antioxidant and anti-inflammatory effects, when delivered using silica nanobeads, offer a controlled and sustained release of the therapeutic agents, leading to significant improvements in hematological parameters and bone marrow health. This research not only contributes to our understanding of benzene-induced haematotoxicity but also provides a potential avenue for the development of preventive and therapeutic strategies to combat its adverse effects. Further investigations are necessary to validate these findings and explore the translation of this approach to clinical applications, potentially benefiting individuals at risk of benzene exposure in occupational and environmental settings.

Acknowledgement

None.

Conflict of Interest

There is no conflict of interest by author.

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How to cite this article: Rehan, Tousfeen. “Sprague Dawley Rats' Haematotoxicity Induced by Benzene is Mitigated by Plant Extract Loaded Silica Nanobeads.” *J Mol Hist Med Phys* 9 (2024): 108.