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Nifurtimox 3D-printed Tablets: In Vitro and In Vivo Anti-trypanosoma cruzi Research

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Introduction

Chagas disease, caused by Trypanosoma cruzi, remains one of the most significant parasitic diseases in Latin America, with an estimated 6 to 8 million individuals affected worldwide. The disease, which can lead to chronic cardiac and gastrointestinal complications, is primarily transmitted through the bite of infected triatomine bugs. The management of Chagas disease is challenging, as treatment options are limited and often associated with adverse side effects. Nifurtimox, an antiparasitic drug, has long been used to treat Chagas disease, but its poor solubility and side effects have led to the need for novel delivery systems to improve treatment outcomes. In recent years, 3D printing technology has emerged as a promising platform for creating personalized, controlled-release drug delivery systems. This paper explores the development of Nifurtimox 3D-printed tablets and their potential as an innovative treatment for Trypanosoma cruzi infections, focusing on in vitro and in vivo research findings.

Description

Chagas disease, caused by the protozoan parasite Trypanosoma cruzi, is a major public health issue in endemic regions, with the majority of cases concentrated in South and Central America. The disease presents in two phases: the acute phase, which may be asymptomatic or cause mild symptoms and the chronic phase, which can lead to severe cardiac and gastrointestinal complications, including heart failure and megacolon. The lack of effective diagnostic and therapeutic strategies, especially in the chronic phase, exacerbates the burden of Chagas disease. Current treatments for Chagas disease are limited to two main drugs. Benznidazole Nifurtimox. While both drugs have proven efficacy against the parasite, they are not free from limitations. Nifurtimox, in particular, has been used for decades to treat Chagas disease, but its clinical use is often hindered by side effects such as nausea, anorexia and neurological issues.

3D printing, also known as additive manufacturing, involves creating three-dimensional objects layer by layer from digital models. This technology has revolutionized many industries, including healthcare and pharmaceuticals, due to its ability to fabricate complex, customized structures with high precision. In the pharmaceutical industry, 3D printing has opened up new avenues for the design and production of drug delivery systems that are patient-specific, with tailored drug dosages, release profiles and even multiple drug combinations. Finally, 3D printing can facilitate the incorporation of poorly soluble drugs, such as Nifurtimox, into novel formulations that enhance their solubility and bioavailability. Several 3D printing techniques are used in the pharmaceutical industry, including Fused Deposition Modeling (FDM), Stereolithography (SLA) and Selective Laser Sintering (SLS). FDM is the most commonly employed method for printing pharmaceutical tablets due to its accessibility, affordability and ability to handle a wide range of materials, including thermoplastic polymers and drug-loaded filaments [1,2].

Conclusion

The development of Nifurtimox 3D-printed tablets represents a promising innovation in the treatment of Chagas disease, particularly for improving the solubility, bioavailability and controlled release of the drug. By harnessing the capabilities of 3D printing technology, researchers can design highly personalized drug delivery systems that address the challenges associated with traditional Nifurtimox formulations, including poor solubility and undesirable side effects. Through careful optimization of materials, printing parameters and tablet designs, these 3D-printed tablets can provide enhanced therapeutic efficacy while reducing the frequency of dosing and the potential for adverse reactions. In vitro studies of Nifurtimox 3D-printed tablets have shown the potential for improved drug release profiles and solubility, making the drug more accessible and effective in treating Trypanosoma cruzi infections. These advancements suggest that Nifurtimox 3D-printed tablets could play a crucial role in overcoming the limitations of current Chagas disease treatments, especially in patients who suffer from the chronic phase of the disease, where traditional therapies may fall short.

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