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Sustained-release Drug Delivery: Advancements and Application

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Introduction

This study explores enhanced oral bioavailability for irbesartan using lipid nanocarriers, optimizing formulations for better drug absorption and sustained release. The in-vitro and in-vivo evaluations confirmed the potential of these carriers to improve therapeutic efficacy by prolonging drug presence in the body[1].

Here's a look at a long-acting sustained-release formulation of liraglutide, designed to manage type 2 diabetes more effectively. This innovation aims to reduce the frequency of drug administration, improving patient adherence and maintaining stable glucose control over extended periods[2].

This article discusses the utility of sustained release antifungal agents delivered via implants to combat challenging ocular fungal infections. What this really means is a more direct and prolonged delivery of medication to the eye, offering better treatment outcomes and reducing the need for frequent drops[3].

Let's break down the development of injectable, self-healing, and thermoresponsive hydrogels designed for the localized and sustained release of curcumin in treating osteoarthritis. This system offers precise drug delivery, potentially minimizing systemic side effects and improving therapeutic efficacy at the joint[4].

This work focuses on fabricating and evaluating sustained-release flurbiprofen microparticles, utilizing zein and sodium alginate. The goal here is to prolong the anti-inflammatory effect of flurbiprofen, making it more effective and reducing dosing frequency for patients[5].

The paper investigates targeting cancer cells with therapeutic agents released in a sustained manner from biodegradable polymeric nanoparticles. This method allows for a more consistent drug concentration at the tumor site, potentially leading to increased efficacy and reduced systemic toxicity[6].

This review covers recent advances in ocular sustained-release drug delivery systems, specifically for diseases affecting the posterior segment of the eye. What this means for patients is the potential for less frequent eye injections and more consistent drug levels, which can significantly improve treatment compliance and outcomes[7].

Here's an overview of 3D printed oral sustained-release dosage forms. This technology offers incredible flexibility in designing complex drug release profiles, custom-tailoring medication delivery to individual patient needs and optimizing therapeutic effects over time[8].

This article delves into sustained-release formulations for vaccine delivery, highlighting both progress and ongoing challenges. The idea is to enhance vaccine efficacy and potentially reduce the number of doses needed by extending antigen presentation, leading to stronger and longer-lasting immune responses[9].

In situ forming polymeric systems for sustained drug delivery are the focus here, looking at recent advances and future directions. These systems solidify or gel upon injection, creating a drug reservoir that releases medication over an extended period, which is great for localized and long-term treatments[10].

Description

Sustained-release drug delivery systems are transforming how medication is administered, offering solutions to improve patient adherence and therapeutic outcomes. For example, research explores enhanced oral bioavailability for irbesartan using lipid nanocarriers, optimizing formulations for better drug absorption and sustained release. This approach prolongs the drug's presence in the body, which has been confirmed through both in-vitro and in-vivo evaluations [1]. Similarly, a long-acting sustained-release formulation of liraglutide is designed to manage type 2 diabetes more effectively. This innovation reduces the frequency of drug administration, thereby improving patient adherence and maintaining stable glucose control over extended periods [2].

Localized and targeted drug delivery represents a significant advancement. Sustained-release antifungal agents delivered via implants combat challenging ocular fungal infections. What this really means is a more direct and prolonged delivery of medication to the eye, offering better treatment outcomes and reducing the need for frequent drops [3]. In another area, injectable, self-healing, and thermoresponsive hydrogels are being developed for the localized and sustained release of curcumin in treating osteoarthritis. This system offers precise drug delivery, potentially minimizing systemic side effects and improving therapeutic efficacy right at the joint [4]. This approach to localized treatment is crucial for conditions where systemic exposure needs to be minimized.

Innovation extends to the fabrication of drug carriers. For instance, sustained-release flurbiprofen microparticles are being fabricated and evaluated, utilizing zein and sodium alginate. The goal here is to prolong the anti-inflammatory effect of flurbiprofen, making it more effective and reducing dosing frequency for patients [5]. Another important development involves targeting cancer cells with therapeutic agents released in a sustained manner from biodegradable polymeric nanoparticles. This method allows for a more consistent drug concentration at the tumor site, potentially leading to increased efficacy and reduced systemic toxicity [6].

Ocular health is a major beneficiary of these advancements. Recent advances in ocular sustained-release drug delivery systems, specifically for diseases affecting the posterior segment of the eye, are promising. What this means for patients is the potential for less frequent eye injections and more consistent drug levels, which can significantly improve treatment compliance and outcomes [7]. Beyond traditional methods, the field is seeing the emergence of in situ forming polymeric systems for sustained drug delivery. These systems solidify or gel upon injection, creating a drug reservoir that releases medication over an extended period, which is great for localized and long-term treatments [10].

New manufacturing technologies are also reshaping drug delivery. Here's an overview of 3D printed oral sustained-release dosage forms. This technology offers incredible flexibility in designing complex drug release profiles, custom-tailoring medication delivery to individual patient needs and optimizing therapeutic effects over time [8]. Additionally, sustained-release formulations for vaccine delivery are being explored, highlighting both progress and ongoing challenges. The idea is to enhance vaccine efficacy and potentially reduce the number of doses needed by extending antigen presentation, leading to stronger and longer-lasting immune responses [9]. These diverse innovations showcase the dynamic evolution of sustained-release technologies across various medical fields.

Conclusion

The development of sustained-release drug delivery systems is a significant focus in pharmaceutical innovation. Researchers are exploring various methods to enhance drug absorption, prolong therapeutic effects, and improve patient outcomes. One key area involves optimizing drug bioavailability. For instance, enhanced oral bioavailability for irbesartan has been achieved using lipid nanocarriers, which improve absorption and provide sustained release, prolonging the drug's presence in the body. Similarly, long-acting sustained-release formulations of liraglutide are being developed for type 2 diabetes management, aiming to reduce administration frequency and maintain stable glucose control over extended periods. Localized and targeted drug delivery is another critical aspect. Sustained-release antifungal agents delivered via implants combat challenging ocular fungal infections by offering direct, prolonged medication to the eye, reducing the need for frequent drops. Injectable, self-healing, and thermoresponsive hydrogels are designed for localized, sustained release of curcumin in osteoarthritis treatment, minimizing systemic side effects while improving efficacy at the joint. Targeting cancer cells with therapeutic agents using biodegradable polymeric nanoparticles also allows for consistent drug concentration at tumor sites, leading to increased efficacy and reduced systemic toxicity. Ocular diseases, especially those affecting the posterior segment, benefit from recent advances in sustained-release drug delivery systems, potentially reducing the frequency of eye injections and ensuring consistent drug levels. Additionally, in situ forming polymeric systems are being developed for sustained drug delivery; these systems solidify upon injection to create a long-term drug reservoir, ideal for localized and extended treatments. Innovative fabrication methods are also emerging. The creation and evaluation of sustained-release flurbiprofen microparticles, utilizing materials like zein and sodium alginate, aim to prolong its anti-inflammatory effects and reduce dosing frequency. Furthermore, 3D printing technology is revolutionizing oral sustained-release dosage forms, offering unprecedented flexibility in designing complex release profiles tailored to individual patient needs. Even vaccine delivery is seeing advancements with sustained-release formulations, aiming to enhance efficacy and reduce the number of doses by extending antigen presentation for stronger, longer-lasting immune responses. These diverse approaches collectively underscore the broad impact and ongoing progress in sustained-release technologies.

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Conflict of Interest

None.

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