

Antimicrobial activity and cellulose acetate membrane characterization with tangerine peel extract (*Citrus reticulata*) for bio packing

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ABSTRACT

Biopacking material was obtained by incorporating tangerine peel extract (*Citrus reticulata*) in cellulose acetate (CA) film. The acetate film with tangerine extract was shown to have a homogeneous material characteristic by FTIR and DSC analysis, being reinforced in MEV and MFA, and showed absence of pores in the film with extract. These characteristics justify the reduced water absorption and release of the CA membrane extract. Low water absorption is important for the film to act as a barrier with external environment and the release of the extract was sufficient to prevent the growth of the strains investigated on the sample surface. The introduction of the extract also reduced the tensile strength and deformation of the film. This study showed the good potential of biomass for active bio packing that can gradually replace non-renewable packaging and take advantage of agricultural waste.

Keywords: Bio packing; tangerine peel; *Citrus reticulata*; antimicrobial activity

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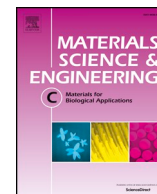
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Polymer-based wafers containing *in situ* synthesized gold nanoparticles as a potential wound-dressing material

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ABSTRACT

Polymer-based wafers containing gold nanoparticles (AuNP) were prepared using κ-carrageenan (κC), locust bean gum (LBG) and polyvinyl alcohol (PVA) at ratios of 42/22/13% w/w and 35/15/17% w/w. The synthesized AuNPs were evaluated for their particle size and morphology. The produced wafers containing AuNPs were investigated for their physicochemical, morphological, mechanical, and swelling properties. In addition, bacterial barrier activity and *in vitro* cytotoxicity were also evaluated in this study. The AuNPs obtained were spherical in shape (~ 10–15 nm in diameter) and exhibited a single bell-shaped UV–vis absorption band centered ~ 540 nm. FT–IR spectra of the wafers containing AuNPs exhibited a shift of ν(O=S=O) absorption band toward a lower wavenumber and a shift of ν(O–H) absorption band toward a higher wavenumber due to the coordination of O–H groups to AuNPs and their interaction with O=S=O groups of κC, respectively. SEM images confirmed the porous structure of the produced wafers, being the surface area, mechanical properties, and swelling behavior directly affected by changing both the initial amount of [Au³⁺] and the composition of the wafers. Lastly, the produced wafers showed non-toxicity to NIH–3T3 fibroblast cells, and they also serve as a bacterial barrier. These findings endorsed the claim that the produced wafers containing AuNPs could be a promising material for wound dressing applications.

1. Introduction

The wound healing process is usually characterized by four highly integrated and overlapping phases, including hemostasis (right after the injury), inflammation (1–3 days), proliferation (4–21 days), and tissue remodeling (21 days–1 year) [1,2]. Chronic wounds are generally characterized by a failure in these orderly set of stages that frequently stall the healing process during the beginning stages [3]. Normally, chronic wounds exhibit excessive exudate production in the wound bed that reduces growth factors and increases bacterial infection, thus hindering the wound healing in the inflammatory phase [4–6]. So far, a number of wound dressings are being designed to handle this issue, including hydrogels [7–10], cryogels [11], rubbers, membranes [13],

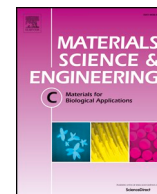
and lyophilized wafers [14–16]. Nevertheless, hydrogel, rubber and membrane dressings struggle to effectively heal chronic wounds because of their inability to absorb high amount of exudates [17]. Therefore, the use of lyophilized wafers (hereafter referred to as wafers) could be more appropriate to mitigate the excessive amount of exudate in chronic wounds. Because of their highly porous nature, they can absorb large amounts of exudate, in addition to maintaining a moist environment in the wound bed [14]. Moreover, their inherently porous nature permits a gaseous exchange between wound bed and environment that prevents fluid accumulation under the dressing, and ultimately inhibits bacterial infections and skin maceration [18].

Wafers are prepared by freeze-drying gels usually obtained from natural and naturally derived polymers, including sodium

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Treatment with isolated gold nanoparticles reverses brain damage caused by obesity

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ABSTRACT

In this study, we performed two experiments. In the first experiment, the objective was to link gold nanoparticles (GNPs) with sodium diclofenac and/or soy lecithin and to determine their concentration in tissues and their toxicity using hepatic and renal analyzes in mice to evaluate their safety as therapeutic agents in the subsequent treatment of obesity. In the second experiment, we evaluated the effect of GNPs on inflammatory and biochemical parameters in obese mice. In the first experiment, we synthesized and characterized 18 nm GNPs that were administered intraperitoneally in isolation or in association with sodium diclofenac and/or soy lecithin in mice once daily for 1 or 14 days. Twenty-four hours after the single or final administration, the animals were euthanized, following which the tissues were removed for evaluating the concentration of GNPs, and serum samples were collected for hepatic and renal analysis. Hepatic damage was evaluated based on the levels of alanine aminotransferase (ALT), whereas renal damage was evaluated based on creatinine levels. A higher concentration of GNPs was detected in the tissues upon administration for 14 days, and there were no signs of hepatic or renal damage. In the second experiment, the mice were used as animal models of obesity and were fed a high-fat diet (obese group) and control diet (control group). After eight weeks of high-fat diet administration, the mice were treated with saline or with GNPs (average size of 18 nm) at a concentration of 70 mg/L (70 mg/kg) once a day, for 14 days, for 10 weeks. Body weight and food intake were measured frequently. After the experiment ended, the animals were euthanized, serum samples were collected for glucose and lipid profile analysis, the mesenteric fat content was weighed, and the brains were removed for inflammatory and biochemical analysis. In obese mice, although GNP administration did not reduce body and mesenteric fat weight, it reduced food intake. The glucose levels were reversed upon administration of GNPs, whereas the lipid profile was not altered in any of the groups. GNPs exerted a beneficial effect on inflammation and oxidative stress parameters, without reverting mitochondrial dysfunction. Our results indicate that the intraperitoneal administration of GNPs for 14 days results in a significant GNP concentration in adipose tissues, which could be an interesting finding for the treatment of inflammation associated with obesity. Based on the efficacy of GNPs in reducing dietary intake, inflammation, and oxidative stress, they can be considered potential alternative agents for the treatment of obesity.

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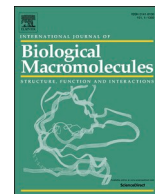
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Bio-packaging based on cellulose acetate from banana pseudostem and containing *Butia catarinensis* extracts

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ABSTRACT

Banana (*Musa acuminata*) pseudostem cellulose was extracted and acetylated (CA) to prepare membranes with potential use as bio-packages. The CA membrane was embedded by Butia seed (CA-BS) or Butia pulp (CA-BP) extracts obtained from *Butia catarinensis* (Butia). The produced CA, CA-BS, and CA-BP membranes were evaluated for their physical-chemical, mechanical, thermal, and antibacterial properties. The process for obtaining the cellulose yielded a material with about 92.17% cellulose (DS = 2.85). The purity, cellulose degree acetylation, and the incorporation of Butia extracts into the membranes were confirmed by FTIR. The CA-BS and CA-BP membranes showed a smaller contact angle and higher swelling ratio than the CA membrane. Furthermore, Butia seed or pulp extracts reduced the elastic modulus and deformation at break compared to the CA membrane. The DSC analysis suggested the compatibility between sections and the CA matrix, whereas the TGA analysis confirmed the thermal stability of the membranes. Moreover, less than 1% of the Butia seed and pulp extracts were put into a food simulant media from the membrane. Finally, the CA-BS and CA-BP membranes could inhibit the growth of *Staphylococcus aureus* and *Escherichia coli* on their surface, confirming the potential use of these membranes as bio-packaging for food preservation.

1. Introduction

Banana plantations are a source of large amounts of organic residues, 220 tons of residual material per plantation hectare [32,38]. These residues, composed mainly of the pseudostem and the leaves that were cut, among its possible uses, one can highlight as adsorbent materials [5,11,14], biofuels [44,50] and composites/biopolymers [10,12,13,84].

In addition, they are rich in cellulose and can serve as a promising alternative to plastics for use in food packaging [32,38,47]. Bio-packages, known as packaging derived from natural polymers, represent approximately 1% of the packaging consumed in Europe ([64,77] However, it is estimated that by 2023, the consumption of bio-packages should be up to 9.45 million tons [1,9]. The sustainability, the abundance of raw materials, low cost, and mechanical properties are some of the reasons that justify the interest in this type of packaging.

Commonly, bio-packages based on chitosan, starch, cellulose, and their derivatives have been produced and used primarily in the food area [19,56,69]. Among cellulose derivatives, cellulose acetate (CA) has received particular attention in the development of bio-packages due to its non-toxicity, good water vapor permeability [69], excellent optical properties, and high resistance to heat [17] and chemical agents [56,72].

Unlike standard packages - which have a passive action concerning food, acting basically as a physical barrier - bio-packages which material was embedded with plant extracts can slow down, reduce or even inhibit the growth of pathogenic microorganisms. In this case, bio-packages can serve as carriers of those plant extracts, ensuring their control and maintaining their release for more extended periods [69,86]. This type of bio-packing could, for instance, reduce the number of synthetic additives added directly to food [24,25,53].

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A polysaccharide-based hydrogel as a green platform for enhancing transdermal delivery

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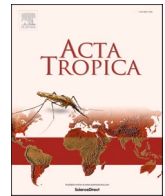
ABSTRACT

The potential role of using carrageenan/locust bean gum (coded as κ C: LBG) hydrogel to enhance transdermal delivery of hydrophilic actives was investigated in this study. To this purpose, κ C: LBG hydrogel embedded with arbutin (coded as κ C:LBG:AR) was investigated for their viscosity, physical-chemical, thermal and morphological properties, in vitro cytotoxicity, and release profile, and the in vivo performance was compared to arbutin cream. The κ C:LBG:AR hydrogel showed viscosity values higher than those found in κ C:LBG. Overall, both hydrogels demonstrated smooth surfaces and are cytocompatible in vitro. DSC showed that κ C:LBG:AR hydrogel enhanced transdermal delivery through the skin by changing the structural organization of the lipid bilayer. The κ C:LBG:AR hydrogel showed a significant increase in skin hydration and reduction in the melanin index as compared with commercial cream. These findings suggest that κ C:LBG hydrogel possesses great potential to be used as a green platform for enhancing transdermal delivery.

1. Introduction

Transdermal delivery is one of the most sought-after routes to treating many types of skin disease and cosmetic disorders and offers several advantages over other routes including the avoidance of the hepatic first-pass metabolism, enhanced patient compliance, and sustained or controlled drug release (Singh et al., 2019). Melasma is one of the most common cosmetic disorders and has many adverse effects on the quality of life because its treatment is often lifelong and sometimes unsatisfactory (Crocco et al., 2015; Zhong et al., 2015). The topical use of tyrosinase inhibitors is recognized as the best therapy for treating melasma because tyrosinase is a rate-limiting enzyme found within melanocytes (Maeda and Fukuda, 1996; Sarkar et al., 2013; Sugimoto et al., 2004). However, most of the prescribed tyrosinase inhibitors that include hydroquinone, kojic acid, azelaic acid, vitamin C, and α -arbutin are hydrophilic in nature (Ogbechie-Godec and Elbuluk, 2017). Therefore, the delivery of these molecules across the skin barrier is highly challenging due to the stratum corneum, the outermost layer of the skin, that serves as a brick-and-mortar system consisting of layers of dead keratinocytes surrounded by a lipid matrix (Jiang et al., 2018). This feature imposes a significant barrier to the transdermal delivery of hydrophilic molecules with a molecular weight greater than 500 Da (Aung et al., 2020; Bos and Meinardi, 2000).

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Polymer-based nanostructures loaded with piperine as a platform to improve the larvicidal activity against *Aedes aegypti*

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ABSTRACT

Piperine is an alkaloid extracted from the seed of *Piper* spp., which has demonstrated a larvicidal effect against *Ae. aegypti*. The incorporation of piperine into nanostructured systems can increase the effectiveness of this natural product in the control of *Ae. aegypti* larvae. In this study, we evaluated the effectiveness of piperine loaded or not into two nanostructured systems (named NS-A and NS-B) prepared by the nanoprecipitation method. The *Ae. aegypti* larvae were exposed to different concentrations of piperine loaded or not (2 to 16 ppm) and the mortality was investigated after 24, 48, and 72 hours. The nanostructures prepared were spherical in shape with narrow size distribution and great encapsulation efficiency. The lethal concentration 50 (LC₅₀) for non-loaded piperine were 13.015 ppm (24 hours), 8.098 ppm (48 hours), and 7.248 ppm (72 hours). The LC₅₀ values found for NS-A were 35.378 ppm (24 hours), 12.091 ppm (48 hours), and 8.011 ppm (72 hours), whereas the values found for NS-B were 21.267 ppm (24 hours), 12.091 ppm (48 hours), and 8.011 ppm (72 hours). Collectively, these findings suggested that non-loaded piperine caused higher larval mortality in the first hours of exposure while the nanostructured systems promoted the slow release of piperine and thereby increased the larvicidal activity over time. Therefore, loading piperine into nanostructured systems might be an effective tool to improve the larval control of vector *Ae. aegypti*.

1. Introduction

Arboviruses are diseases caused by viruses transmitted by several species of arthropods, whose participation in the cycle also includes the replication of viral particles (Lopes et al., 2014). These diseases have a great impact on public health because they are among the main causes of human morbidity and mortality and have worldwide distribution (Lopes et al., 2014; Martelli et al., 2015; Powell, 2018). Among the main vectors involved in the transmission of human arboviruses is *Aedes aegypti* (Diptera: Culicidae), which participates in the cycle of diseases

such as dengue, urban yellow fever, chikungunya, and Zika fever (Powell, 2018). Its capacity for environmental adaptation is due to its oviposition characteristics and resistance to egg desiccation, which challenges the control of this species (Kweka et al., 2018). Vector population control has been the main strategy adopted for the prevention of related human diseases (Hermann et al., 2015; Powell, 2018). Different methods have been proposed, such as chemical, environmental, biological, genetic, personal, and mechanical control (Baldacchino et al., 2015). Chemical control is the most used and consists of the application of products of synthetic origin called larvicides or pesticides (Benelli

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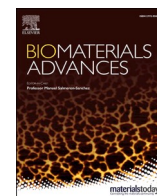
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Iota-carrageenan/xyloglucan/serine powders loaded with tranexamic acid for simultaneously hemostatic, antibacterial, and antioxidant performance

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ABSTRACT

This study sought to prepare powder hemostats based on *iota*-carrageenan (iC), xyloglucan (XYL), L-serine (SER), and tranexamic acid (TA). The powder form was chosen because it enables the hemostat to be used in wounds of any shape and depth. The powder hemostats showed irregular shapes and specific surface areas ranging from 34 to 46 m²/g. Increasing TA amount decreases the specific surface area, bulk density, water and blood absorption, and the antibacterial activities of the powder hemostats, but not the water retention ability. Conversely, *in vitro* biodegradation was positively impacted by increasing the TA content in the powder hemostats. In both the *in vitro* and *in vivo* tests, powder hemostats showed reduced bleeding time, significant adhesion of red blood cells, great hemocompatibility, moderate antioxidant activity, and high biocompatibility. These findings shed new light on designing powder hemostats with intrinsic antibacterial and antioxidant activity and excellent hemostatic performance.

1. Introduction

Severe injuries are commonly accompanied by uncontrollable bleeding episodes and are the leading cause of death among people aged 5 to 44 worldwide [1]. Mitigating blood loss is, therefore, of utmost importance and should serve as the impetus for creating effective hemostatic agents [2]. Currently, there are five main categories of hemostatic agents available: physical (bone wax and ostene), absorbable (gelatin, oxidized cellulose, and collagen), biologically active (topical thrombin, fibrin sealant, and platelet gel), synthetic (cyanoacrylate, polyethylene glycol, and glutaraldehyde) and hemostatic dressings (chitosan and mineral zeolite) [3–5]. Undoubtedly, many of these hemostatic agents are valuable for hemorrhage control; however, most of them come in forms that are not flexible enough to conform nicely to irregular wounds and thereby fail to achieve rapid blood coagulation [6,7]. To overcome this shortcoming, powder hemostatic agents have been suggested as a promising alternative to improve the hemostatic performance owing to the large surface area that enables it to conform

easily to irregular-shaped wounds [8].

QuikClot® (zeolite-based hemostatic powder), Surgicel® (oxidized regenerated cellulose-based hemostatic powder), and Celox® (chitosan-based hemostatic powder) are some examples of powder hemostatic agents that have shown superior hemostatic performance [9,10]. However, concerns have been raised regarding their side effects on hemostasis since previous studies have reported that QuikClot® can cause thermal injury resulting in necrosis of tissue, and Celox® needs to be dissolved in acid solvents, thereby limiting its clinical use [11–14]. Surgicel® has negatively impacted tissue healing due to the inflammation caused by the product itself [15]. Hence, there is highly urgent to develop a hemostat that combines safety and effectiveness over a broader range of bleeding conditions.

The combination of more than one hemostatic agent may be a strategy to ensure safe, rapid, and effective hemostasis. For instance, tranexamic acid (TA) is a biologically active hemostat that competitively inhibits the activation of plasminogen to plasmin, thereby preventing degradation of the fibrin clot [16,17]. Accordingly, tranexamic acid-

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Polycaprolactone triol-based polyurethane film conjugated ibuprofen to sustained release: Synthesis, physicochemical, cytotoxic, and release studies

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ABSTRACT

Polyurethanes are among the most ubiquitous materials in the biomedical and pharmaceutical areas. Thus, in this study, polycaprolactone-triol-based polyurethane conjugated ibuprofen (coded as PU-ibu) was synthesized by a two-step condensation method and characterized according to composition, morphological, thermal, and mechanical. In addition to wettability, hemocompatibility, cytotoxicity, and *in vitro* release. In addition to wettability, hemocompatibility, cytotoxicity, and *in vitro* release. The synthesized PU film had a smoother surface and superior mechanical properties compared to PU-ibu film.

Moreover, PU was capable of swelling in PBS while PU-ibu film exhibited a surprising “de-swelling” behavior. Additionally, PU-ibu film not only had adequate wettability, excellent hemocompatibility, and sustained delivery capability but also greatly enhanced the proliferation of fibroblast cells. Therefore, the PU-ibu film provides a potential novel system for sustained drug delivery.

1. Introduction

Polyurethanes are among the most ubiquitous materials in the biomedical field whose use includes but is not limited to heart valves, intra-aortic balloons, guided bone regeneration, breast implants, and drug delivery systems. One factor that explains this widespread use is the presence of amide bonds in its structure (–NH–COO–). They are related to the amide bonds found in the chemical structure of the proteins. Besides, polyurethane properties can be tailored and tuned to achieve specific features important for biomedical devices, especially in drug delivery systems [1–3].

Given the variety of polyurethane chemical structures and the potential for functional modification, polyurethanes are suitable as biotherapeutics and controlled devices for low molecular weight medicines. Examples that stand out include drug-covalently bound polyurethanes

(including ibuprofen), drug-dispersed polyurethanes, and polyurethanes used to deliver oligonucleotides and proteins [4,5]. Although several studies are investigating polyurethanes in drug delivery systems, few studies report using polycaprolactone-based polyurethanes in drug delivery systems [6–9]. Most of the studies have been focusing their attention on the development of polycaprolactone-based polyurethanes to be used in guided bone regeneration [10,11], tissue repair [12,13], and tissue engineering [14,15].

Polycaprolactone (PCL) is undoubtedly one of the most used soft segments in biodegradable polyurethane [15]. Among the PCL family, polycaprolactone-triol (PCL-T) has inherent characteristics that confer additional advantages over the other members, including a lower melting point (~30 °C). Polycaprolactone-triol (PCL-T) also has a higher wettability, a faster degradation rate, and three free-side hydroxyl groups. Additionally, like the other members of the PCL family, PCL-T is

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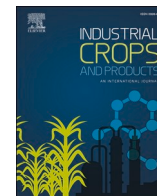
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Using sugars as both reducing and cryoprotectants of freeze-dried silver nanoparticles for improving long-term stability

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ABSTRACT

This study has proposed using maltose and lactose as reducing and cryoprotectant agents to improve silver nanoparticles' long-term stability (AgNPs). For the reducing performance, UV-vis spectroscopy revealed that both sugars could be used as reducing and eventually as capping agents of the as-synthesized AgNPs. For cryoprotective performance, the UV-vis spectroscopy and dynamic light scattering (DLS) showed that both sugars could prevent maltose-reduced (coded as AgNP-M) and lactose-reduced (coded as AgNP-L) AgNPs from irreversible aggregation under freezing and freeze-drying. For long-term stability, UV-vis spectroscopy, DLS, and transmission electron microscopy (TEM) data revealed that aged freeze-dried AgNP-M and AgNP-L were generally more stable than their non-freeze-dried counterparts under accelerated storage conditions. Likewise, the antibacterial and cytotoxic activities of aged freeze-dried AgNP-M and AgNP-L were close to those observed in their as-synthesized counterparts. Otherwise, aged non-freeze-dried AgNP-L demonstrated reduced antibacterial and cytotoxic activities, while such behavior was not present in the aged non-freeze-dried AgNP-M. These findings proved that maltose and lactose could emerge as a green alternative to synthesize AgNPs and simultaneously cryoprotect them during freezing and freeze-drying to achieve long-term stability.

1. Introduction

Over the past few decades, nanosized silver particles (AgNPs), whose structure exhibits novel and distinct physical-chemical and biological properties, have proved to be a promising material finding application in nanomedicine, biosensing, and catalysis (Batista et al., 2022; He et al., 2022; Rai et al., 2015; Satyanarayana et al., 2019). There is well-supported scientific evidence that the biological properties of AgNPs, including antimicrobial activity and cytotoxicity, are mainly related to their size, shape, and surface chemical nature (Batista et al., 2018; Béteky et al., 2021; Zhang et al., 2022). Accordingly, several synthesis routes such as physical (Mpala et al., 2023), chemical (Velgosova et al., 2022), mechanochemical (Goga et al., 2021), and biochemical (Velgosova and Veselovský, 2019) were proposed to control the size and shape better. Nevertheless, one of the biggest challenges

facing AgNPs is maintaining their long-term stability. Most studies on this topic have stated that the presence of inert inorganic substrate, charged segments, and large molecules on the AgNPs surface might improve their long-term stability (Amendola et al., 2021; Liu et al., 2018; Velgosová and Mražíková, 2017). It is worth noting that most studies focused on analyzing the AgNP's stability from a short-term perspective or under freeze storage conditions. This scenario enforces the need for further investigation concerning the development of new strategies as a means to form long-term stable AgNPs.

Given that AgNP's stability is strongly affected by the physical state in which they are stored (Stevenson et al., 2012), one possible strategy to minimize the physical and chemical transformations would be to keep them in a dry state. Freeze-drying is a typical industrial process that removes water from colloidal systems, including liposomes, gold nanoparticles, and polymeric nanoparticles (Trenkenschuh and Friess, 2021).

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