A Review: Metal Nanoparticle-Hydrogel Composites have Medical Potential

Yelcaw Weong*

School of Pharmacy, Taylor's University, Malaysia

Abstract

The combination of nanoparticles and hydrogels has proven to be an effective way for creating biomaterials with specific functions. It is becoming increasingly easier to create nanocomposite hydrogels that exhibit increased performance across a range of electrical, mechanical, and biological properties thanks to accessible engineering methodologies. Nanocomposite hydrogels were designed to address the shortcomings of hydrogels by integrating various types of nanoparticles or nanostructures into the hydrogel network. For a variety of biomedical applications, the development of multifunctional nanocomposite materials is of tremendous interest. Incorporating functional nanoparticles into hydrogels is a popular method for creating customised Nanocomposites. The use of metal nanoparticles (NPs) in hydrogels has become a new developing study field in tissue engineering and regenerative medicine. Tissue damage and degeneration were common outcomes of disease, injury, and trauma. The treatment usually involves the transplantation of tissue from the same patient or another individual for repair, replacement, or regeneration. The objective of the study to know the nanoparticle-hydrogel composites are currently used in biomedical applications.

Keywords

Nanoparticles, Hydrogel, Medical, Macromolecular

Correspondence to:

Yelcaw Weong
School of Pharmacy,
Taylor's University, Malaysia,
Email: weong.y34@ut.my

Citation: Weong Y (2022). A Review: Metal Nanoparticle-Hydrogel Composites have Medical Potential. EJBI. 18 (1): 7-8.

DOI: 10.24105/ejbi.2022.18.1.7-8

Received: 03-Jan-2022, Manuscript No. ejbi-22-53324;
Editor assigned: 04-Jan-2022, PreQC No. ejbi-22-53324(PQ);
Reviewed: 19-Jan-2022, QC No. ejbi-22-53324;
Revised: 23-Jan-2022, Manuscript No. ejbi-22-53324(R);
Published: 30-Jan-2022

1. Introduction

During the last few decades, the intersection between nanotechnology and other branches of science has gotten a lot of attention. There have been a variety of attempts to combining nanoscale technology with traditional procedures in order to create better materials. Nanocomposite hydrogels are a good illustration of how nanotechnology and biomaterial research may work together. Hydrogels are made up of interlinked natural/ synthetic polymer chains linked together by cross linkers to form a hydrophilic substance with a gel-like macromolecular structure. They can swell up to 99 percent water or biological fluids and can weigh several times their dry weight [1]. This highly hydrated three-dimensional (3D) porous network can simulate the native tissue milieu and is commonly used to store, release, or collect materials. Chemical gels and physical gels are the two forms of hydrogels based on the manufacturing method. Chemical gels are covalently cross-linked using a variety of processes, including polymerization in the presence of a cross-linker or cross-linking of an existing polymer using various means such as heating, ultrasound, UV or -irradiation, and so on. Physical gels are amorphous networks of hydrophilic polymers held together by noncovalent interactions including Van der Waals forces and hydrogen bonding, among other things. Physical gels dissolve in water and can be melted by applying heat, but chemical gels swell but do not dissolve in water. Important features, like as swelling, mechanical properties, diffusion rates, and chemical functionality, should be addressed while selecting materials for making a hydrogel. The cross-linking density, cross-link distance, macromolecular structures in the gel, and residual chemicals all influence these qualities [2].

Hydrogels have a low mechanical strength, which is a drawback when employed as tissue engineering scaffolds or in any application that requires strong mechanical strength, good compression tolerance, and elasticity (e.g. cartilage tissues). They are tough to handle and load in many sections of the body due to their limited mechanical qualities. Hydrogels' mechanical and chemical properties are being optimised for specific biological applications in recent years. Nanoparticles and nano-layers have a high surface-to-volume and aspect ratio, making them an excellent candidate for usage in a polymeric network. A nanocomposite hydrogel is created by physically and chemically connecting polymeric chains with distinct nano-scaled structures, resulting in a network with new unique features. After the nanoscale dispersion of fillers in the composite, novel characteristics and behaviours are found. Some qualities that already exist in unfilled matrices can be improved by such dispersion [3].

To make nanocomposite hydrogels, scientists employed nanomaterials with various bases. These nanomaterials include carbon nanotubes or CNTs, graphene, and nanodiamonds, as well as polymeric nanoparticles, inorganic/ceramic nanoparticles (hydroxyapatite, silicates, and calcium phosphate), and metal/ metaloxide nanoparticles (gold, silver, and ironoxides). Bioactive chemicals can be trapped inside the nanoscale core of hydrogels (nanogels). Because of their nano-dimensions, they are sensitive to micro environmental factors including temperature and pH [4].

Nano gels are made using a variety of processes depending on how they cross-link. In today‘s nanocomposite hydrogels, a number of important properties must be regulated, including stimuli response, biodegradation, and mechanical strength optimization. The type of nanoparticles placed within the hydrogel networks determines the type of stimulation utilised to change the properties of the hydrogel. Mechanically adaptable, pH/enzyme/ ion responsive, electrically stimulating, thermo responsive, and magnetic responsive elements are only some of the stimuli-responsive features that can be introduced into nanocomposite hydrogels. These are the directions in which nanocomposite hydrogel development will go in the future [5]. Multi-phase combination inside a nanocomposite hydrogel network to mimic the structure and characteristics of biological tissues is one trend to examine. Previous research has shown that multi-component hydrogels have better physical and chemical properties than two-component systems. To overcome the difficulties of tuning these systems for the essential applications, further trials are required.

2. Conclusion

Nanocomposite hydrogels are cutting-edge biomaterials that could be used in a variety of biological and pharmacological applications. Nanocomposite hydrogels outperform typical polymer hydrogels in terms of physical, chemical, mechanical, and electrical properties. Additionally, improved interactions between polymer chains and nanoparticles result in improved nanocomposite performance.

3. References

1. Gaharwar AK, Peppas NA, Khademhosseini A. Nanocomposite hydrogels for biomedical applications.Biotechnol Bioeng. 2014; 111:441-453.
2. Kumar S, Rani R, Dilbaghi N, Tankeshwar K, Kim KH. Carbon nanotubes: a novel material for multifaceted applications in human healthcare. Chem Soc Rev. 2017; 46:158-196.
3. Feng L, Zhang S, Liu Z. Graphene based gene transfection. Nanoscale. 2011; 3:1252-1257.
4. Zhang S. Emerging biological materials through molecular self-assembly. Biotechnology Advances. 2002; 20: 321-339.
5. Sunshine JC, Green JJ. Nanoengineering approaches to the design of artificial antigen-presenting cells. Nanomedicine. 2013 Jul;8(7):1173-89.