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The Properties of Nano Cellulose based Nano Composite Materials

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INTRODUCTION

Nanocellulose, a substance made of plant fibres, is gaining popularity due to its cutting-edge qualities and potential for commercialization across a variety of industries, notably in the biopolymer and biomedical sectors. Malaysia has a lot of potential to turn unused biomass into valuable goods because it is a major producer of oil palm. Utilizing environmentally friendly processes, Oil Palm Empty Fruit Bunch (OPEFB) nanocellulose extraction and purification is an effective technique to reduce waste and keep production costs down. Nano cellulose's strong strength and mechanical qualities make it perfect for additive manufacturing (3D printing), which has the ability to create specialised and intricate goods. Depending on the application and input material, 3D printing divides various procedures into categories. The majority of ink ingredients come in powder, liquid, and solid forms. Polylactic acid (PLA), Acrylonitrile Butadiene Styrene (ABS), polyurethane (PU), and polyethylene glycol (PEG), which undergo resource depletion and are less favourable for sustainability and the environment, were previously used to make a lot of inks. OPEFB's nanocellulose, which is used in printing ink, degrades more quickly and may transform underused biomass into useful and sustainable materials. It's a fantastic opportunity to start with nanocellulose as the need for biopolymer printing ink rises. With its excellent biocompatibility for applications involving living things, biopolymer ink, made from natural materials, resolves certain earlier ink problems.

Numerous researches have investigated cellulose derivatives, such as regenerated nanocellulose, cellulose nanofibrils, cellulose nanocrystalline, and cellulose nanofibrils, as biomaterial ink. However, there hasn't been much research done on the utilisation of nanocellulose derivatives as the biomaterial ink for the absorption and release of Bovine Serum Albumin (BSA) protein solution using 3D printing. In conjunction with 3D printing, the Cellulose Nanofibrils (CNF) biomaterial ink made from OPEFB is employed to absorb and release BSA. The potential for further biological applications involving live cells in the near future will be clearly explained by the ability for protein absorption and release. Additionally, the 3D-printed hydrogel with a customised design exhibits good features for form integrity because to CNF qualities.

DESCRIPTION

Hydrogel's structure, which resembles that of the extracellular matrix nearly exactly, is ideal for the trapping and proliferation of live cells in biomaterials. In contrast to two-dimensional (2D) cultures, three-dimensional *in vitro* models offer a challenging potential for advancement in Tissue Engineering (TE) and regenerative medicine because they offer a different approach that more closely represents the true complexity of tissues *in vivo*. Due to the controlled spatial deposition of bioinks, a mixture of a biomaterial (often hydrogel) and biological components, new and sophisticated technologies, such as 3D bioprinting (BioP), enable the creation of artificial 3D cellular microenvironments (such as cells). These bioinks need to be printable, have the proper physico-chemical characteristics (such as stiffness and viscosity), and be biocompatible.

Therefore, it is crucial to have a suitable hydrogel design and characterization in order to fulfil the criteria for 3D BioP and cell growth. A critical stage in the creation of a bioink is the evaluation of printability and form fidelity, in particular. The production and stacking of hydrogel filaments throughout the layer-by-layer printing process has to be examined since they are the fundamental components of BioP. Shape fidelity has to be evaluated in increasingly complicated creations, including planar or multilayer structures, after reliable control over filament deposition is accomplished. Hydrogel cross-linking is carried out during or right after BioP to guarantee the struc-

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tural integrity of the printed build. Depending on the exposure period and cross-linker concentration, the cross-linking process has a significant impact on the characteristics of the bioink.

Cells move and multiply *in vitro* to produce the biological-tissue model once the 3D build has been made. For this aspect, it's crucial to ensure that the substrate is biocompatible and to replicate the native network with the proper stiffness and porosity to influence cell activity. It is difficult to combine printability and cell viability. However, this need can be satisfied by creating individualised inks that allow the fiberous proteins, glycoproteins, glycosaminoglycans, and proteoglycans-components of the extracellular matrix (ECM) to be appropriately cross-linked and mixed to "tune on demand" the mechanical and biological properties of the finished construct.

CONCLUSION

The significance of the ECM in controlling cell destiny is widely documented in the literature; tissue stiffness, for example, differs across different organs and between normal and pathological states, as does the biochemistry of the ECM. Furthermore, cross-linking techniques are frequently employed to regulate the final 3D scaffold's stiffness and structural organisation. The most popular BioP hydrogels, such as sodium alginate or methacrylated-gelatin, however, call for ionic or UV-based crosslinking techniques that include the addition of potentially cytotoxic chemicals or reagents with side effects. The Diels-Alder cycloaddition is a significant chemo selective reaction that may be used for a variety of biological applications and happens under moderate experimental settings that are ideal for the co-presence of cells.