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3D Interactions in Under Water Acoustic Simulationseffect of Green Synthesized Metal Nanoparticles on Gene Expression in an In-Vitro Model of Non-alcoholic Steatohepatitis

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Abstract : Metabolic dysfunction-associated liver disease (MASLD) is a chronic condition characterized by excessive fat accumulation in the liver, distinct from conditions caused by alcohol, viral hepatitis, or medications. MASLD is often linked with metabolic syndrome, including obesity, diabetes, hyperlipidemia, and hypertriglyceridemia. This disease can progress to metabolic dysfunction-associated steatohepatitis (MASH), marked by liver inflammation and scarring, potentially leading to cirrhosis. However, only 43-44% of patients with steatosis develop MASH, and 7-30% of those with MASH progress to cirrhosis. The exact mechanisms underlying MASLD and its progression remain unclear, and there are currently no specific therapeutic strategies for MASLD/MASH. While anti-obesity and anti-diabetic medications can reduce progression, they do not fully treat or reverse the disease. As an alternative, green-synthesized metal nanoparticles (MNPs) are emerging as potential treatments for liver diseases due to their anti-diabetic, anti-inflammatory, and anti-obesity properties with minimal side effects. MNPs like gold nanoparticles (AuNPs) and silver nanoparticles (AgNPs) have been shown to improve metabolic processes by lowering blood glucose, body fat, and inflammation. The study aimed to explore the effects of green-synthesized MNPs on gene expression in an in vitro model of MASH using C3A/HepG2 liver cells. The MASH model was created by exposing these cells to free fatty acids (FFAs) followed by lipopolysaccharide (LPS) to induce inflammation. Cell viability was assessed with the Water-Soluble Tetrazolium (WST)-1 assay, and lipid accumulation was measured using the Oil Red O (ORO) assay. Additionally, mitochondrial membrane potential was assessed by the tetramethyl rhodamine, methyl ester (TMRE) assay, and inflammation was measured with an Enzyme-Linked Immunosorbent Assay (ELISA). The study synthesized AuNPs from Carpobrotus edulis fruit (CeF) and avocado seed (AvoSE) and AgNPs from Salvia africana-lutea (SAL) using optimized conditions. The MNPs were characterized by UV-Vis spectrophotometry and Dynamic Light Scattering (DLS). The nanoparticles were tested at various concentrations for their impact on the C3A/HepG2-induced MASH model. Among the MNPs tested, AvoSE-AuNPs showed the most promise. They reduced cell proliferation and intracellular lipid content more effectively than CeFE-AuNPs and SAL-AgNPs. Molecular analysis using real-time polymerase chain reaction revealed that AvoSE-AuNPs could potentially reverse MASH effects by reducing the expression of key pro-inflammatory and metabolic genes, including tumor necrosis factor-alpha (TNF-α), Fas cell surface death receptor (FAS), Peroxisome proliferator-activated receptor (PPAR)-α, PPAR-γ, and Sterol regulatory element-binding protein (SREBPF)-1. Further research is needed to confirm the molecular mechanisms behind the effects of these MNPs and to identify the specific phytochemicals responsible for their synthesis and bioactivities.

Keywords : gold nanoparticles, green nanotechnology, metal nanoparticles, obesity
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