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Organoclay based Nanocomposite enhanced by silver colloidal and natural fruit acid extract shows high antitumor efficiency against breast cancer

Ulviye Bunyatova
Baskent University, Turkey

Diverse naturally obtained polysaccharides provide a broad range of resources applicable in the field of traditional and alternative medicine and pharmaceuticals. Lately, Cellulose and its derivatives (ether and ester) are among the excipients frequently used in pharmaceutical compound are becoming the most wanted biopolymer for use toward therapeutic interventions. Cellulose is the most abundant biopolymer. It is present in the cell walls of a great diversity of organisms, from bacteria, prokaryotes, eukaryotes like fungi, amoebae, green algae, freshwater and cellulose algae, mosses, ferns, angiosperms, gymnosperms. Native cellulose made by biosynthesis in living organisms is composed only of glucose monomers. Cellulose derivatives are employed as excipients in pharmaceutical industrial products for oral, topical or parenteral administration. Their most relevant application, as observed in pharmaceutical industrial products, is to create matrix systems for solid oral dosage forms. Due to their aqueous swelling, the drug release is controlled by its diffusion through the hydrogel layers that are formed. For instance, the use of carboxymethyl cellulose (CMC) sodium salt as an excipient sustains the release in solid oral dosage forms. Additionally, the rapid development of nanotechnology has provided new opportunities in the field of alternative medicine. The current study is aimed at preparing a smart functionalized hydrofoil carboxymethyl cellulose (CMC) sodium salt-based nanocomposite using biomimetic synthesis pathway and evaluation its antitumor efficiency on 4T1 mouse mammary carcinoma cells line in vitro. Cancer is one of the most challenging illnesses, designated by the expansion of mutated cells that proliferate and spread to different organs uncontrollably. The traditional therapeutic strategies used in the treatment of cancer are surgery, chemotherapy, radiation, and targeted therapy. Breast cancer is the most common malignant tumor in women worldwide and is the primary cause of cancer-related death in women. Alternative treatment strategies are needed because the drugs used in cancer treatment cause side effects, low quality of life and high cost. Moreover, drugs used in generally often have poor water solubility. Hydrophobic agent decreased the biocompatibility and this needs to be handled in higher dosages to reach therapeutic efficiency. The studies on more biocompatible and cost-effective cancer treatments have speeded up research on the effects of nanoparticles on cancer. Biocompatible hydrogels with active nanoparticles have been a promising method in cancer treatment for the last decades. Presented in this study biocompatible hydrophilic polysaccharide-based nanocomposite offers opportunity to overcome some limitations of conventional anticancer drugs and chemotherapy. In this study the anti-carcinogenic and anti-metastatic effects carboxymethyl cellulose (CMC) sodium salt-based nanocomposite coated silver nanoparticles (AgNP) is investigated. Historically, silver metal has been used widely across the civilizations for different purposes. In ancient Indian medical system (Ayurveda) silver has been described as therapeutic agent for many diseases. Metallic silver has also been used for surgical prosthesis and splints, fungicides, and coinage. Soluble silver compounds, such as silver salts, have been used for treating mental illness, epilepsy, nicotine addiction, gastroenteritis. Nanomedicine concerns the use of precision-engineered nanomaterials to develop novel therapeutic and diagnostic modalities for human use There is an increasing use of silver as silver nanoparticles. Despite the fact that AgNPs are extensively applied in vitro studies using different cancer cell models (due to their intrinsic anticancer effect) they may show enhanced efficiency, particularly when also used synergistically with natural anticancer products used in their synthesis. For this purpose a cellulose Polysaccharide/organic clay/natural acid extract based nanocomposite encapsulated AgNPs have been syntheses using a new nonradiative light exposed method. This method allows AgNPs to be synthesized as highly effective anti-cancer agents at lower doses without disrupting their biocompatibility and without causing free radical formation. New formulated cellulose polysaccharide based nanocomposite (afterward mentioned as C@AgNP) was designed from carboxymethyl cellulose (CMC) sodium salt (matrix-90%(w/w)) / maleic acid (6%ww/w)/organic clay (3%)b and 1%(w/w) silver precursor. Malic Acid is an organic compound, a dicarboxylic acid that is the active ingredient in many sour and tart foods. Malic Acid is generated during fruit metabolism and occurs naturally in all fruits and many vegetables. Malic Acid is formed in metabolic cycles in the cells of plants and animals, including human. The use of clay minerals, especially in pharmacological applications is known from ancient times and they are regaining attention in recent years. In prehistory, clay minerals as antiseptic materials were used for the treatment of minor ailments including infections, pains, aches, and food poisoning. A nonradiative light source used in this study emits visible photons which energy strongly absorbed by the new formulated compounds and do not cause to any bonds damage in the polysaccharide nanocomposite network. Moreover it is known that visible light causes to the strengthening of the hydrogen bonds and the formation of new ones. C@AgNPs obtained by this environmentally friendly method have been evaluated using an MTT-based cell viability assay on a triple-negative breast cancer cell line. The toxicity of AgNPs towards 4T1 cancer cells was confirmed by the MTT test and the cell viability assay showed an IC50 value of 8.2 µg/mL (0.0082 mg/mL).

Conclusion: In summary, this study we obtained a novel cellulose polysaccharide based alternative hydrogel with high antitumor capacity toward 4T1 breast cancer. Moreover our study demonstrated that nonradiative harmless visible light approach as a alternative way to widely used non-eco-friendly syntheses methods is highly effective stimulating the biocompatible nanocomposite that shows strong antitumor activity. We suggest that newly formulated biocompatible C@AgNP may offer a new opportunity in plant based pharmacognosy antitumor strategies.

Biography

Ulviye Bunyatova is an Associate Professor at Biomedical Engineering Department at Baskent University, Turkey. She had an appointment as a Visiting Research Scholar at Electrical Department at Duke, NC, U.S. within the Edmund Pratt School of Engineering between 2019-2020 and State University at Buffalo/SUNY, N.Y. U.S. Her current specific interests and expertise include: Design and syntheses of novel visible light sensitive biopolymer /colloidal structure with an antimicrobial/antiviral properties and inhibitors for targeted cancer therapy; Innovative approaches in the development of advanced traditional and alternative medicine compounds on polysaccharide based smart materials. She has over 25 publications that have been cited over 150 times, and her publication h-index is 8. She has been serving as an editorial board member of several reputed journals.