

Potentiality of Nanoenzymes for Cancer Treatment

Subjects: Oncology

Contributor: Agnieszka Najda

Nanozyme synthesis is an innovative technology since it connects nanoparticles with biological activities and framework. Various assays have been implemented for the enzymes of proteins that also implement nanozymes, which could also have the potential for performing the catalysis of similar substrates. Due to such different functions of nanozymes, they are used for the treatment of the environment, biosensing, agents that act against microbes, cytoprotection of different cell biomolecules with management, diagnosis of diseases, etc..

Keywords: nanozymes ; nanomaterials ; artificial ; cancer diagnosis ; therapeutics ; biomedical

1. Introduction

Enzymes are considered natural biocatalysts which catalyze many biochemical reactions with good catalytic efficiency, biocompatibility, and substrate specificity. Recently, these reactions have been extensively used in various food industries and other biomedical applications. Their use in the agri-food industry promotes proper processing, storage activities and the functionalization of food products [1][2][3][4][5][6]. Enzymes play a significant role in enhancing the safety of food products [7]. Nanotechnology is believed to have a major part in advanced drug formulation, targeting a specific part of the body and controlled release of the drug. Nanotechnology is stated to communicate with the barrier of physical and organic sciences by putting forward nanospheres and structures in numerous scientific fields [8][9] other than nanomedicines and their delivery [10][11]. Nanotechnology engages the therapeutic agents at nanoscale levels for the development of medicines that are nano. Biomedicine including nanobiotechnology, biosensors, and tissue designing is done by the nanoparticles [12]. Recently, nanomedicines have become very much refreshing as nanostructures act as delivery agents by giving medication examples [13][14]. Using conveyance nano-drugs for the treatment depends upon various properties of targeted drugs such as biochemical functions [15]. Over the past few years, scientists have made an extraordinary attempt in developing artificial enzymes for various types of applications. Consider the examples that the chemical complexes based on porphyrin [16][17], hematin [18], cyclodextrin [19], hemin [20][21], and the specially designed biomolecules proteins successively imitate the function of the naturally occurring enzymes [22,23]. The intrinsic limitations of the natural enzymes such as low stability, high cost, and storage difficulty have led to the introduction of artificial enzymes that imitate the activity of the naturally occurring enzymes [22]. As another sort of promising artificial enzyme, nanozymes have demonstrated a wide range of uses because of their evident favorable circumstances, including low cost, high stability, the large surface area for functionalization, high catalytic activity, and tuneable activity [23]. Various obstacles and constraints of further developing therapeutic applications are of significant interest, as well as a future direction for the usage of modified nanozymes with better biomedical and diagnostic applications. Nanozymes are defined as artificial nanomaterials possessing intrinsic enzyme-like activities. Scientists have worked toward their enhancing utility as they have many advantages over natural enzymes. Nanozymes are believed to act by mimicking the action of the natural enzymes [24][25][26]. The concept of nanozyme has reformed our essential comprehension of chemistry and biology, encouraging plenty of uses in the fields of biosensing, science, and medication [24]. Nanozyme synthesis is an innovative technology since it connects nanoparticles with biological activities and framework. Various assays have been implemented for the enzymes of proteins that also implement nanozymes, which could also have the potential for performing the catalysis of similar substrates. Due to such different functions of nanozymes, they are used for the treatment of the environment, biosensing, agents that act against microbes, cytoprotection of different cell biomolecules with management, diagnosis of diseases, etc. [27][28][29][30][31]. Various sources, properties, mimicking types, and analytical capabilities are shown in **Figure 1** [1].

2. Types of Nanozymes

There are various nanomaterials based on noble metals such as gold [32][33][34][35][36][37][38][39][40][41][42][43], silver [44][45][46][47][48][49], platinum [50][51][52][53][54][55][56][57][58][59][60][61][62][63], Pd [64][65][66], and multi-metallic NPs which are known as peroxidase imitates and are utilized for antibodies, therapy, and biosensing.

Carbon is another typical nanomaterial as peroxidase-like activities with pH, temp, and hydrogen peroxide concentration dependent functions have been possessed by nanotubes which have a single wall and oxides of graphene [67][68]. Propelled by these findings, there are various other carbon-based peroxidase mimics such as carbon dots [69][70][71][72][73][74][75][76], Fe/N doped carbon [77][78][79][80][81][82], carbon nitrides [83][84][85], etc., which have been explored.

Furthermore, Chmielewski et al. revealed that the assembly of electrostatics, the peptide parts of trimethylammonium working AuNPs, could advance the ligating of peptides that are two in number, which resulted in inorganic implemented nanoparticles favorable in the biopolymers polymerization [86]. Morse et al. also illustrated the monolayer AuNPs functionalization which could mimic silicatein.

The nanozymes showing a single substrate mechanism generally include: Hydrolase; Peroxidase; Superoxide dismutase; Oxidase; Catalase [24].

3. Synthesis of Nanozymes

The nanomaterials which are catalytic possess different properties in comparison with natural enzymes [87]. The activities of the nanozymes depend on the size of the particle, structure, and its shape which is affected by the coatings, charges, and external fields [88][89].

Electrochemical observation of glucose and fructose formed on gold nanoparticles (AuNPs) placed onto graphene paper has lately been presented. These nanostructures were formed by two techniques: thermal and laser de-wetting processes [90]. Gold nanostructures acquired by both methods exhibited major differences in their particle morphology. Both types of AuNPs were investigated by their capacity to oxidize glucose and fructose [91].

Chemical reduction is a method which is used very frequently because of its rapidity and simplicity. This tool enables the formation of NPs in which the morphology and the size of particle distribution are managed by changing the molar concentration of the reactants, the reductant type, and the reaction temperature [92]. The important factor in achieving very high chemical reduction is choosing the suitable reductants. The reduction of metal salts needs reactivity of the agent which causes reduction to the redox potential of the metal. The procured particles are small if the reaction rate during the synthesis procedure is too fast [93]. Nevertheless, if the reaction rate is too slow, particle aggregation may happen [94]. The synthesis of hollow copper sulfidenanocubes (h-CuS NCs) was done via the chemical reduction method [95]. This method has been utilized for the synthesis of peroxidase (PO)-like nanozyme-based AuNPs along with *Pseudomonas aeruginosa*-specific aptamer [96].

Electrochemical deposition is a minimal-effort strategy for acquiring metalnanocatalysts. In any case, it is normally utilized less regularly than synthetic decrease strategies. The interaction is straightforward and incorporates a drenching of a conductive surface into an answer containing particles of the material to be saved and the use of a voltage across the strongelectrolyte interface. Throughout this strategy, a reaction of charge transfer causes the deposition of film [97][98].

4. Future Perspectives for Nanozymes

Intending to peruse nanozymes, one has to have a vital source of innovation through productively conquering disadvantages of enzymes which are natural, and accompanying proposals are offered. There is a requirement of the advancement of fresh nanozymes comprised of high movement and customary examination functions; further has exploration followed a technique of screening of sound action dependent on the nuclear arrangements which were conceived for catalyzing the response of enzyme. The process to prepare normal composites for identifying the present significant limitations by adjusting synergistic effects for facilitating electron transfer between composite materials during redox reaction has also been started. Bioinspired synthesis of nanozymes additionally gives an alternative to prepare non-toxic nanozymes by successfully going around the utilization of poisonous synthetic compounds in traditional substance combination, accordingly quickening their use in therapeutic application. At last, the turn of events of novel surface designing innovation could specifically target the substrates by nanozymes and would be of great significance [99]. More of these developments would open up new avenues for single-stage sensors and theragnostic, which could be helpful in various biosensing and biomedical applications. The vast majority of the nanozymes are accounted for to show their synergist movement by redox action by surface iotas. Be that as it may, the reactant movement might be additionally improved by controlling the center of the nanozymes by doping with some uncommon earth components. Such procedures would add more redox "problem areas" for synergist action and along these lines upgrade the action of nanozymes. In contrast to characteristic catalysts, the size and synthesis of most nanozymes are not uniform, except for

fullerene-based nanozymes. Further, group to-cluster variety fit as a fiddle of nanoparticles/nanozymes, and consequently adjustments in physicochemical properties, requires expanded spotlight on improving the union convention to create the monodispersed nanozymes with molecularly exact designs ^[100].

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