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In vitro anticancer activity of silver nanoparticles phyto-fabricated by *Hylocereus undatus* peel extracts on human liver carcinoma (HepG2) cell lines

S. Shyamalagowri [a], P. Charles [b], J. Manjunathan [c], M. Kamaraj [d], R. Anitha [a], A. Pugazhendhi [e f]

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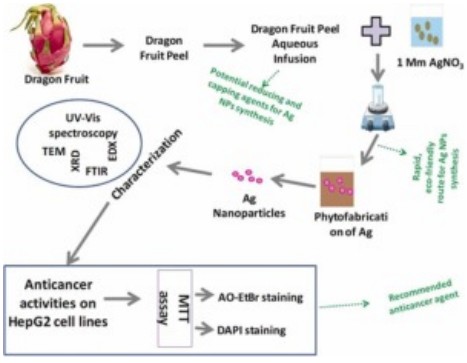
Abstract

Every year, millions of people die from cancer, and most anticancer medications have a low specificity of action and significant toxicity, resulting in severe side effects. As a result, the discovery of effective anticancer drugs is a top priority. Hence, the focal point of this research is to synthesize the dragon fruit peel aqueous extract fabricated silver nanoparticles (DFPAE-AgNPs) in a facile and green chemistry approach as a new-fangled anticancer agent. The selected primary phytochemicals are qualitatively screened for their presence in dragon fruit peel aqueous extract utilized for the fabrication of AgNPs. The analytical results revealed that DFPAE-AgNPs were crystalline, spherical in shape in the size range of 10–50 nm, and composed of 73.90% weight of a silver element. The IC_{50} value of the DFPAE-AgNPs is evaluated as 37.98±0.21 μg mL^{-1} with a HepG2 cell line. Acridine orange- ethidium bromide (AO-EtBr) staining and nuclear acid staining assays demonstrated the dose-dependent (10–50 μg mL^{-1}) apoptotic increase phenomenon of the DFPAE-AgNPs in the HepG2 cell line at 24 h. The current study suggested DFPAE as a vital, reliable, and active phytoconstituents for the fabrication of AgNPs with anticancer potentials in a rapid and eco-friendly way. Further meticulous investigation on the DFPAE-AgNPs behavioral nature is recommended to make use of these as alternatives to synthetic drugs in wider anticancer applications.

Graphical Abstract



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Introduction

Cancer continues as one of the world's frightening diseases and its represent by the unusual growth of cells and tissues which causes a high rate of disease-related mortality. The most profound treatment techniques include chemotherapeutic drugs, radiation, and surgery are often killing the healthy cells along with tumor cells and causing a health hazard to humans [1]. Hepatocellular carcinoma (HCC) is one of the widespread primary liver cancer accounts for ~70% of cases [2]. It is been expected that the number of patients and death linked with HCC to be continued in the near future. Although there have been a variety of approaches for treating cancer disease in recent years, most of them are expensive and have limitations, such as an inability to discern between cancer and normal cells to eliminate them in the human body [3], [4]. Therefore researchers and scientists are still facing the challenges to explore feasible mechanisms and successful remedies for liver cancer [5]. The targeted drug delivery and imaging using nanomaterials are promising moves in nanomedicine for anticancer research and treatment. Hence, the anticancer efficacy of various nanomaterials is under investigation of in vitro level to pilot scale experimentation [6].

The silver nanoparticles (AgNPs) are noble metal NPs and receiving greater focus on nanotechnology research due to their unique properties such as higher optoelectronic property, high surface area, and biocompatibility [7]. The AgNPs are preferred in anticancer agents due its more biocompatible over conventional therapies, thus they can be employed for site-specific delivery and drug encapsulation to increase the drug efficacy and reduces the undesired toxic effects of large-sized particles [8]. Literature shows that several synthetic routes (in particular physical or chemical routes) for the synthesis of NPs, which in general require expensive equipment with high energy utilization and/or use of toxic solvents. Hence, the fabrication of nanoscaled materials especially metal NPs moves towards the green chemistry approach to attain benefits such as waste reduction, eco-friendly, cost-effective, facile, etc. [9], [10]. In specific, the phyto-fabrication (phytochemical mediated synthesis) of NPs are received much attention in recent years over other biological methods due to it contains more biologically active compounds and/or secondary metabolites acting as reducing and capping agents [11]. Phyto-fabricated Ag-NPs are usually derived from the attrition of metallic salts from positive oxidation to zero in an aqueous medium by the use of phytomolecules [9], [12]. Various plants and plant-based materials are employed for the development of AgNPs [13], [14], and their anticancer activity is assessed on various cell lines including HepG2 [5], [15]. However, the report on dragon fruit peel mediated synthesis of Ag-NPs in a facile one spot method and its anticancer evaluation is rare.

Hylocereus undatus (Dragon fruit) is a tropical fruit of cactus species (Cactaceae) which has red peel with green fins. It contains rich antioxidants (vitamins and minerals that help prevent cancer, cardiovascular, diabetics, gastrointestinal, respiratory, and urinary disease), and low calory dietary fibers [16]. The dragon fruit skin is a thin rind usually covered in scales and contains fleshy pulp in the center. The major chemical compositions of dragon fruit peel are pectin, phyllocactin, betanin, triterpenoids, betacycanin, and steroids [17]. Food industries with the target of manufacturing dragon fruit juice are generating a large accumulation of fruit waste. The use of non-edible components of the fruit is under investigation, and it could be advantageous to assess their potential as a low-cost source of value-added products [18]. The exploitation of dragon fruit peel (DFP) for the development of AgNPs with potential biological activities is an evolving faction that entails a vital waste reduction and reconnoiters on useful avenues. Consequently, this method could be cost-effective and eco-friendly by using DFP waste-mediated extracts for the rapid formation of Ag NPs in the bulk with anticancer potentials. Hence, the present study is intended to phyto-fabricate AgNPs using dragon fruit peel and access their in vitro chemoprotective activity on HepG2 cell lines.

Section snippets

Materials

The dragon fruit peels were collected from the local fruit juice shops in Ooty, Tamil Nadu, India upon their immediate disposal. The fruit is authenticated as *Hylocereus undatus* (Haw.) Britton & Rose, Syn: '*Selenicereus undatus* (Haw) D.R. Hunt' at Botanical Survey of India, Coimbatore, Tamil Nadu, India. All chemicals required for synthesis, nutritional and

phytochemical analysis, and chemoprotective activity were analytical grades procured from Merck, India, and the solution prepared using…

Phytochemical analysis of DFPAE

Since the phyto-fabrication involves DFPAE, the preliminary phytochemical screening is performed to find out the phytoconstituents available in the extract. Qualitative analysis of the present study (Table 1) reveals the strong presence of phenols, flavonoids, tannins, and saponins and the moderate presence of anthocyanin and carbohydrates. The acids, cardiac glycosides, quinines, and terpenoids are present in the trace amount, whereas, alkaloids, coumarins, glycosides, protein, and steroids…

Conclusion

In this study, an aqueous extract of dragon fruit peel was exploited as a reducing and capping agent to phyto-fabricate the AgNPs in a facile one-pot method without utilizing and generating the harmful chemicals. This strategy has some benefits such as developing an anticancer agent with low cost and time. The phyto-fabricated DFPAE-AgNPs are found to be a crystalline nature, spherical shape with a size range of 10–50 nm. The cytotoxicity and cell apoptotic of DFPAE-AgNPs in HepG2 cells are…

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.…

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> ...Now scientists are exploring its new properties and it's used in various biomedical applications. AgNPs are biocompatible and have an antimicrobial activity (Fig. 4 and Table 3) which allows us to use them for various purposes from bone implants to wound healing (Shyamalagowri et al., 2022; You et al., 2017). Shortcomings are being studied and scientists are engaged in optimizing the method of harvesting its maximum potential....

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