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Surface Decoration of Selenium Nanoparticles by Proteins from the Culinary-Medicinal Shiitake Mushroom, *Lentinus edodes* (Agaricomycetes), for Enhanced Fibrinolytic Activity

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ABSTRACT: *Lentinus edodes* (shiitake mushroom) has exhibited fibrinolytic activity. We synthesized and characterized selenium nanoparticles (SeNPs) using protein precipitated from the mushroom. We also investigated the fibrinolytic activity of the SeNPs. The proteins from a crude extract of *L. edodes* were recovered through the use of aqueous 2-phase separation, and these we used as the capping agent in SeNP biosynthesis. We characterized the SeNPs using UV-visible spectrophotometry, field emission scanning electron microscopy (FESEM), energy dispersive X-ray (EDX), transmission electron microscopy (TEM), particle size distribution analysis, and Fourier transform infrared spectroscopy (FT-IR). The fibrinolytic capability of the SeNPs was tested through an *in vitro* fibrin plate assay. The UV-visible spectra showed maximal absorbance at 220 nm. FESEM images showed that the SeNPs were dispersed and did not clump. The TEM images revealed a spherical shape and average size of the SeNPs. The particle size distribution analysis confirmed the mean size of the SeNPs at 64.53 nm. A strong signal for the presence of selenium was observed in the EDX analysis. The FT-IR spectrum revealed the involvement of protein functional groups in the reduction of selenite. Overall, the SeNPs capped with protein from shiitake mushroom were effective as an *in vitro* fibrinolytic agent.

KEY WORDS: fibrinolytic activity, *Lentinus edodes*, medicinal mushrooms, nanoparticles, selenium, shiitake

ABBREVIATIONS: ATPS, aqueous 2-phase separation; **EDX**, energy-dispersive X-ray; **FESEM**, field emission scanning electron microscopy; **FTIR**, Fourier transform infrared spectroscopy; **SeNP**, selenium nanoparticle; **SeNPs-C**, control selenium nanoparticles; **SeNPs-PPP**, selenium nanoparticles synthesized with partially purified protein from *L. edodes*

I. INTRODUCTION

Edible mushrooms have recently become attractive as functional foods and sources of biologically active metabolites.[1–3] Many such compounds are beneficial; they show antitumor, antiviral, antibacterial, antihypertension, immunostimulatory, antioxidative, and anticoagulation activities.[4] Also, fibrinolytic proteases have been purified from edible or medicinal mushrooms and characterized; such mushrooms include *Fomitella fraxinea, Pleurotus ostreatus, P. eryngii, Armillaria mellea*, *Ganoderma lucidum*, *Flammulina velutipes*, and *Tricholoma saponaceum*.[5–11] Most of the enzymes obtained are either metalloproteases or serine proteases.

Fibrinolytic proteases from mushrooms can degrade blood clots, but the delivery of therapeutic proteins remains a huge challenge.[12–14] The therapeutic potential and clinical application of therapeutic proteins are hampered by obstacles such as poor solubility, poor *in vitro* stability (shelf life), poor bioavailability, short *in vivo* stability (half-life), and the lack of large-scale production.[15]