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Investigation and modeling effective parameters influencing the size of BSA protein nanoparticles as colloidal carrier

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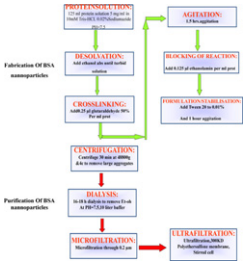
HIGHLIGHTS

- Simple coacervation method was used for production of BSA nanoparticle.
- Effects of several process parameters on the size of NP were investigated.
- AFM and SEM technique have been used to provide surface and morphological information
- Mathematical method was implemented to model the experimental data.

GRAPHICAL ABSTRACT



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ABSTRACT

Bovine Serum Albumin (BSA) nanoparticles (NPs) with different sizes were prepared using a self-assembly simple coacervation method and cross-linking with glutaraldehyde. Protein NPs were purified with 48,800 × *g* centrifuge followed by dialysis, microfiltration and ultrafiltration. The produced protein NPs were subjected to physical and morphological as well as biochemical characterization tests. Image analysis studies by scanning electron microscopy and atomic force microscopy proved semi-spherically shape of the particles whereas size distribution was measured by photon correlation spectroscopy. The influences of several process parameters such as pH, initial BSA concentration, agitation speed, glutaraldehyde concentration and organic solvent addition rate on the size of protein NPs at different temperature (24 °C, 14 °C, 4 °C) were investigated to achieve a suitable size of NP. Furthermore, mathematical method was implemented to model the experimental data. The mechanistic for preparing protein NPs as well as their characterizations were discussed.

1. Introduction

During the 1980s and 1990s, several drug delivery systems such as nanoparticles (NPs), liposome and denderimer were developed to improve the efficiency of drugs and minimize side effects [1,2]. Drug delivery carrier should be non-toxic and it does not accumulate in tissues [3,4]. Important advantages associated with NPs are the ease of their preparation from well-known biodegradable polymers and high stability in biological fluids during storage [5].

NPs as drugs-carrier were developed in the early 1980s [6,7] but over the past few decades, there has been considerable interest in developing biodegradable NPs as effective drug delivery devices [8]. NPs generally vary in size from 10 to 1000 nm [9]. Several drugs such as Dexamethasone [10], Doxorubicin [11], Dalargin [12], Isradipine [13] and Haloperidol [14] were loaded on biodegradable polymers. The drugs is dissolved, entrapped, encapsulated or attached to a NPs matrix and depending on the preparation method, nanospheres or nanocapsules can be obtained [15–17]. Fig. 1 shows the schematic of nanocapsulated and nanosphere particles loaded with drugs.

The body distribution of colloidal drug delivery systems is mainly influenced by two physicochemical properties; particle size and surface characteristics [18]. Liposomes have been used as

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