Layer-by-Layer Biopolymer Nanocapsulesfor Biologically Active Compounds

Tatsiana G. Shutava, e-mail: shutova@ichnm.basnet.by
Olga A. Masalova, Alyaksandr N.Kraskouski, Vladimir E.Agabekov
Institute of Chemistry of New Materials, National Academy of Sciences of Belarus

New polysaccharide-based nanocapsules are of great interest as vehicles suitable for encapsulation of bioactive substances. Encasing molecules in an anocarrier enhances chemical stability and dispersibility of the substance in biological fluids, controls release of the active ingredient, enhances its bioavailability and changes tissue distribution. The nanocore/shell containers are the foundation for targeted delivery systems with enhanced blood circulation and low systemic toxicity.

Non-emulsion syntheses of stable gel nanoparticles of calcium alginate and calcium pectinate with diameters in the range of 100-250 nm and narrow size distribution were recently proposed; the range is hardly reachable by reverse emulsion-gelation technique [1,2].The use of diluted polysaccharide solutions, permanent ultrasound treatment, certain pH and ionic strength values applied during the syntheses supports the nanosize of the particles. Utilization of stabilizers (Tween 80, polyethylene glycols (PEG)) during the syntheses further decreases the hydrodynamic diameter of nanoparticles with a factor of 1.3-3.0 and prolongs their colloidal stability up to 30 days. The stabilizers are partially remains adsorbed on the nanoparticle surface after syntheses preventing sticking in concentrated colloids. By weight, the obtained gel nanoparticles consist of more than 80 % of water and less than 20% of solid material; the values vary with polymer and synthesis conditions. Admixing bovine serum albumin (BSA) to a polysaccharide solution prior the nanoparticles synthesis allows to obtain protein/polysaccharide nanoparticles containing up to 0.58 mg per 1 mg of polysaccharide [2]; thus cores with tunable hydrophobicity were created for further modification with layer-by-layer (LbL) polyelectrolyte shell. The outer surface of the negatively charged polysaccharide nanoparticles was modified by a layer of chitosan.

Similarly, 150-200 nm soft gelatin cores were prepared and coated with multiple layers of medium molecular weight biopolyelectrolytes (dextran sulfate, poly-L-lysine, poly-L-arginine, carboxymethylcellulose, gelatin, protamine) [3].

The obtained nanocapsules consisting of a soft gel-like interior surrounded by a multilayer polyelectrolyte shellswere used for encapsulation of polyphenols((-)-epigallocatechingallate, tannic acid, the aflavin) and 2-aminoarylpyrimidine derivatives (Imatinib and its analogs) with previously proven anticancer activity. The bioactive substances were encased in the developed nanocapsules in a high concentration.

The non-washing LbL assembly technique was proposed for coating soft, gel or otherwise unstable cores with diameters in the nanometer range [4]. The nanoparticle aggregation during the LbL assembly was avoided by using constant ultrasound treatment and PEG-modified polyelectrolytes. It also allows for further increasing colloidal stability of nanocapsules dispersions in salt solutions and attaining modest protein-resistant properties.

References

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