Electronic Supplementary Material (ESI) for Nanoscale Advances.

Supplementary Information for:

Dual-functionalised shellac nanocarriers give a super-boost of the antimicrobial action of berberine

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(Nanoscale Advances 2018)

Comparison of the different nanocarriers for berberine

Table S1. Characteristics of the formulation of BRB within nanocarriers.

Nanocarrier used to load BRB	Average particle size (nm)	Average zeta potential (mV)	E.E. %	Loading drug %	Ref.
Liposomes	2200-3500	-	79	30	1
SLNs using lipid materials: glycerol tripalmitate: soybean phospholipid	77	8	58	4	2
SLNs using glyceryl monostearate	81	-29	70	3	3
Polylactide glycolic acid	268	-	65	-	4
O-hexadecyl-dextran	238	-	24	-	5
PEG–lipid–PLGA NPs/BBR–SPC	150± 5	−27 ± 1	89	-	6

As can be seen in Table S1, berberine (BRB) has been loaded within nanocarriers of other materials in other studies but not all of their *in vitro* characteristics were determined and compared, and most of these BRB nanocarriers have negative surface charge which decrease the attraction between them and the cell membrane. In this study, the aim was to construct a nanocarrier consisting of different subsequently added components and systematically study the carrier antimicrobial efficiency by characterising the size, zeta potential, encapsulation efficiency, drug release, and drug content as well as the cytotoxicity of each component on different microorganisms. This has not been done systematically elsewhere. Shellac NPs which contain carboxylic groups as well as hydrophobic part were used to be loaded with BRB. These NPs were stabilised by Poloxamer 407 micelles by conducting steric repulsion between the particles, which can also play a synergistic effect as antibacterial, as it has been used as topical/ dermal formulation.[7] Besides, these nanocarriers were coated with water-insoluble cationic surfactant (ODTAB) to inverse the carrier particle surface charge from negative to positive and this can promote the adhesion with the cell membrane with balancing the stability at the same time. The positive charge of the nanocarrier allows it to deliver and boost action of the encapsulated antibacterial agents at any type of microorganisms and at low amount near or inside the cell vicinity. All these characteristics allow the nanocarrier to amplify the efficiency of encapsulated BRB one order of magnitude more than the free BRB at the same concentration.

TEM images and size distribution of shellac NPs stabilised by P407

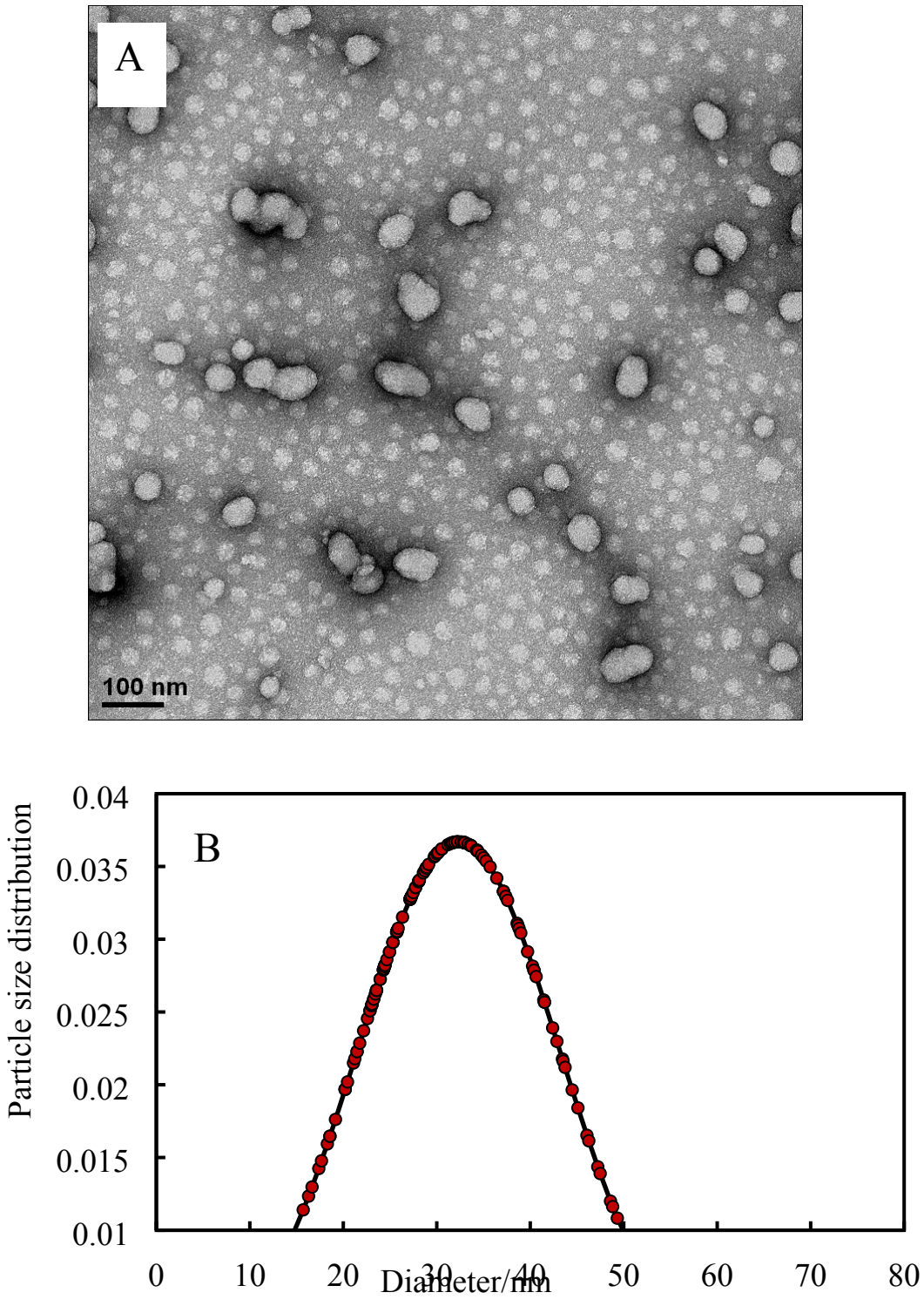

Figure S2. (A): The TEM image of shellac NPs, for a solution consisting of 0.25 wt. % shellac with 0.2 wt. % P 407 in Milli-Q water and negatively stained with 1% uranyl acetate. (B) The shellac NPs size distribution measured from series of TEM images like (A).

Fig. S2-A shows the TEM image of the shellac NPs suspension after drying up, and it reveals a spherical shape of the NPs with size of 33±10.87 nm as can be seen in Fig. S2-B. This supports the result obtained by using the zeta sizer equipment that shellac NPs have sizes below 50 nm.

Stability of the Shellac NPs

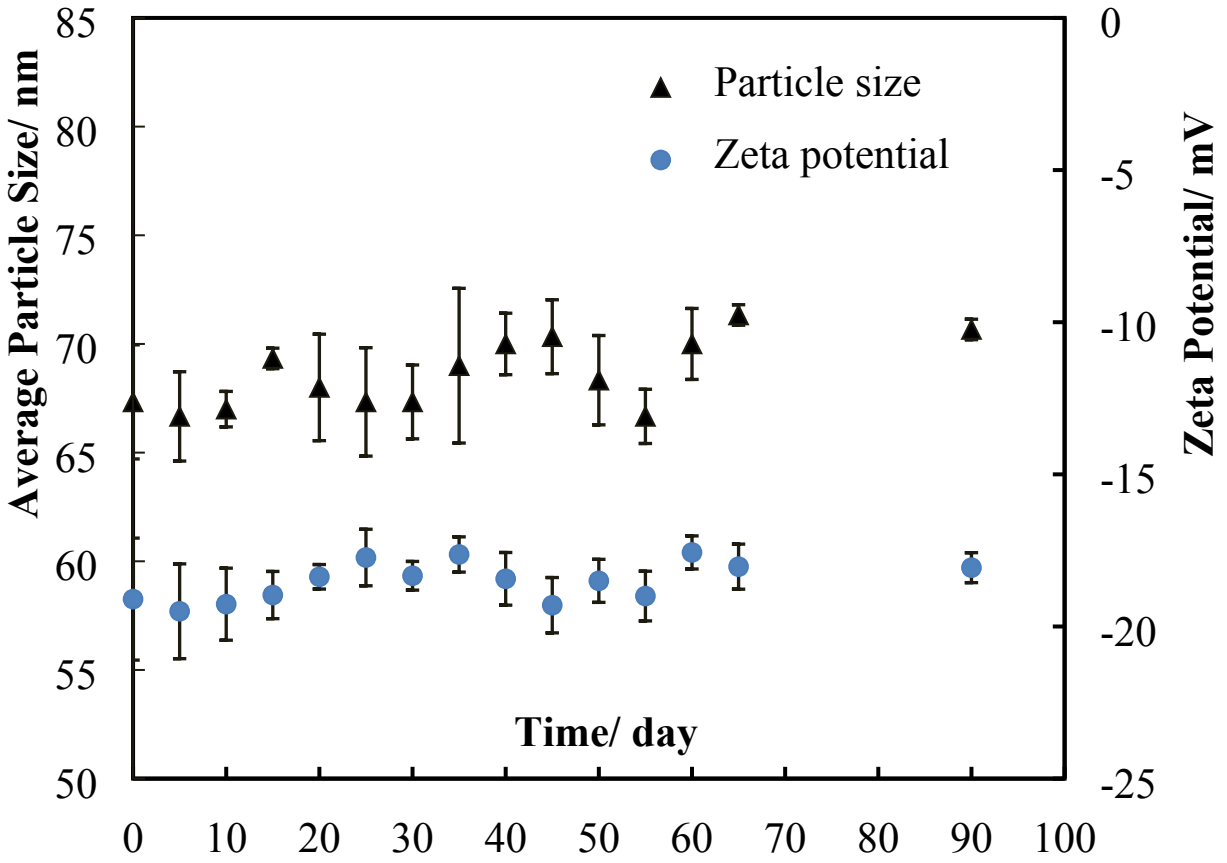

Figure S3. The average particle hydrodynamic diameter and the zeta-potential of shellac NPs at different time using DLS technique. The data are averaged from 3 samples.

In order to investigate shellac NPs storage condition, the size distribution and zeta potential of the nanoparticles were measured as a function of time, up to 90 days in Mili-Q water. Figure S3 (ESI) shows the particle size and zeta-potential of shellac NPs and as it can be seen that shellac NPs are stable within period last more than three months with hydrodynamic diameter of around 68 nm and surface charge of -18 ± 5 mV. This shows that the shellac NPs can be stored for a long time without aggregation and used to encapsulate actives with long shelf life."

References

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