

Synthesis of superparamagnetic iron oxide nanoparticles for DNA purification

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Nowadays DNA purification is still time consuming and sophisticated procedure. Commonly used centrifuge- and column-based protocols require specialised equipment, often use toxic reagents, and are not economically scalable or practical to use in a high-throughput manner. Although it has been known for some time that magnetic beads can provide an elegant answer to these issues. [1]

In order to do this, superparamagnetic iron-oxide nanoparticles were prepared by a combined combustion-sonochemical method in which iron(II)-acetate was used as iron precursor. These iron-containing nanoparticles were first dispersed in polyethylene-glycol (PEG 400) using high-efficient ultrasonic technique. Sonochemical treatment initiated the precipitation of iron hydroxide particles, then the PEG based colloids were burnt to create the iron oxide nanoparticles.

DNA binding capacity of these nanoparticles produced were tested for biological applications such as DNA purification. In this experiments, purified pBAD type vector DNA was used which is a high copy number vector. The plasmid purification from *Escherichia coli* host was performed by a general plasmid purification protocol which combines the conventional alkaline-SDS lysis and a HiBind® technology. In tests of the binding of DNA to the nanoparticles, DNA was detected in the elution fraction, which means that DNA bound reversibly to these nanoparticles. After further improvements, application of such magnetic nanoparticles can provide a method for fast and simple DNA purification from complex samples.

The magnetic nanoparticles were examined by X-ray powder diffractometry (XRD) and high-resolution electron microscopy (HRTEM). In XRD experiment three phases were observed: ferrimagnetic magnetite (Fe_3O_4), antiferromagnetic hematite ($\alpha\text{-Fe}_2\text{O}_3$), and ferrimagnetic maghemite ($\gamma\text{-Fe}_2\text{O}_3$). The maghemite phase became the largest in the produced samples (61.8%). Samples were also characterized by Fourier transform infrared spectroscopy (FTIR) and zeta potential measurements, in order to identify functional groups of the surfaces and to examine the surface charge of the nanoparticles. Hydroxyl groups and carbon were identified on the surface of tested nanoparticles. Presence of OH groups on the surface of the magnetic nanoparticles resulted in negative zeta potential due to the deprotonation of hydroxyl groups. This phenomenon gives good dispersibility properties to magnetic nanoparticles in aqueous phase. Between the hydroxyl groups of the nanoparticles and DNA hydrogen bond interaction can be formed, thus magnetic iron oxide based nanoparticles are good candidate for DNA purification applications.

[1] Oberacker P, Stepper P, Bond DM, Höhn S, Focken J, Meyer V, et al. Bio-On-Magnetic-Beads (BOMB): Open platform for high-throughput nucleic acid extraction and manipulation. *PLoS Biol* **2019**, 17(1): e3000107.