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Use of magnetic nanoparticles for the extraction of DNA

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Functionalized magnetic nanoparticles have been widely utilized in biomagnetic separation and purification of DNA. Purified, high quality DNA has a wide variety of downstream applications such as PCR, restriction digestion, transfection and sequencing. Conventional DNA purification methods suffer from several drawbacks. They are often complex, time-consuming and involve the use of solvents and toxic chemicals such as phenol and ethidium bromide ultimately leading to low overall yield and high cost. In this study, a simple DNA purification process was developed which involves the use of iron oxide nanoparticles (IONP) functionalized with hydroxyapatite (HAp). The process is effective, low cost and has potential for commercialization. Hydroxyapatite [$Ca_{10}(PO_4)_6(OH)_2$] which is biocompatible and non-toxic, has a higher affinity for DNA, and its conjugation with iron oxide nanoparticles makes it an ideal candidate for rapid isolation of high quality DNA.

For this application samples with HAp/IONP molar ratios of 0.3, 1.2 and 2.3 were synthesized and were characterized with Fourier transformed infrared spectroscopy (FTIR). The spectra of the coated particles exhibit characteristic absorption bands of the functional groups of hydroxyapatite, indicating successful functionalization of the iron oxide nanoparticles. Subsequently, the coated samples were used in extraction of known amounts of DNA. A low ionic strength phosphate buffer was used for selective retention of double stranded DNA molecules on hydroxyapatite coated nanoparticles and the magnetic particles with its trapped DNA were immobilized by application of an external magnet. Elution of DNA was accomplished using high ionic strength phosphate buffer. The quality and the yield of DNA were then determined by agarose gel electrophoresis. These coated samples exhibit an average DNA binding capacity of 1.2 µg/mg (DNA/ IONPs) and high quality DNA was obtained. This magnetic bead DNA extraction procedure required less than 30 minutes compared to several hours taken by conventional protocols. The developed procedure eliminates the need for organic solvents, toxic chemicals or sophisticated equipment. Together with these advantages, further improvements and automation of this simple bio magnetic separation procedure may play an important role in the near future, and may be a potentially viable alternative to commercially available high cost DNA extraction materials and kits.

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