Novel MNPs-based isolation approach looking for 'the needle in the haystack'

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Magnetic nanoparticles (MNPs) have been widely exploited for the development of sensitive detection techniques. Due to their magnetic properties, this type of particles allows the isolation and concentration of the analyte, thus ensuring the detection of molecules even when present at low concentration. One of the problems related with the use of MNPs for the mentioned purpose is that once the magnetic field is applied both analyte-MNPs conjugates and free-MNPs are isolated. This can decrease the sensitivity of the detection method, since the presence of an excess of MNPs potentially interferes with the detection of the analyte. This limitation must be taken under consideration especially when the analyte is present at low concentration and if the quantification of the analyte is strictly related to the MNPs itself[1] (e.g. T2 relaxation time measurements). Several methods have been applied in order to overcome such limitation. In some cases, the MNPs are used only to isolate the analyte while the quantification occurs by a further recognition of the analyte-MNPs conjugates by a labelled-material[2],[3] (i.e. antibody, nanoparticles). Alternatively, the analyte-MNPs conjugates are physically entrapped while the free-MNPs are removed[4],[5]. Even though with these expedients some improvements have been achieved, each of them come along with other limitations such as the relatively high concentration of analyte required for fluorescence-based detection in the first case and false negative results given by the undesired MNP's aggregation in the second one.

We propose a novel method to improve the isolation of a selected analyte by using antibody-coated MNPs (Ab-MNPs). Once the analyte-Ab-MNPs conjugates is formed a second type of non-magnetic particle are employed, which interact only with the analyte-Ab-MNPs conjugates. The nanocomposite formed by the two types of particles is then selectively isolated allowing a precise quantification of the analyte even when present at low concentrations. The nanomaterials suitable for this detection techniques have been synthesised and characterised by dynamic light scattering (DLS), transmission electron microscopy (TEM) and the amount of biological material attached on their surface has been quantified by Bradford protein assay. Their behavior in the designed device has been extensively evaluated until the best conditions were selected (e.i. buffer, volume, concentrations, strength of the magnetic field). Thanks to the isolation-technique developed and the features of the selected nanomaterials the quantification of the analyte can be achieved using several analytical techniques (spectrophotometry, electrical measurements, Raman spectroscopy) which efficacy is currently under evaluation.

References

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