

The Role of Alkali Metal Cations in the Stabilization of Guanine Quadruplexes: Why K^+ is the best

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The alkali metal cation affinity of guanine quadruplexes has been studied with dispersion-corrected density functional theory (DFT-D). Our computational investigations have been done in aqueous solution which cover the supramolecular situation of guanine bases assembling into stacked quartets as well as the biological conditions in which telomeric quadruplexes are formed. In both cases, an alkali metal cation is needed to assist the self-assembly. Our computations are able to reproduce the experimental order of affinity of the guanine quadruplexes for the cations Li^+ , Na^+ , K^+ , Rb^+ , Cs^+ . The strongest binding is computed between the potassium cation and the quadruplex as it occurs in nature. The desolvation of the alkali metal cation and the size of this cation are thought to be responsible for the order of affinity. Up till now, the relative importance of these two factors is still unclear and debated. By determining the quantum chemical 'size' of the cation with the deformation of the quadruplex, needed to accommodate the cation, and with the energy decomposition analysis (EDA), we reveal that the desolvation and the size of the alkali metal cation are both almost equally responsible for the order of affinity.