Specific ion effects on lysozyme adsorption on ordered mesoporous silica

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Ordered mesoporous materials (OMMs) are becoming of high interest in important fields such as nanomedicine, biodsorption, and biocatalysis. They have unique features, namely high surface area, high pore volume, and a narrow pore size distribution. This last feature is particularly useful for the adsorption of proteins since their dimension often matches the OMMs pore size. Previous works have shown how to tune the amount of adsorbed protein by changing pH or ionic strength of the adsorbing solution [1]. Actually, there is no awareness of what is the effect of different salts used to fix ionic strength. Such effects, Hofmeister phenomena, reflecting both co- and counterion specificity, are universal [2].

In the present work the adsorption of lysozyme on a functionalized mesoporous silica sample (SBA-15-NH$_2$) as a function of added salts was investigated. It was ascertained that, below the isoelectric point (pI=11), the amount of adsorbed protein follows an inverse Hofmeister series for anions (sodium salts): SCN$^-$ > ClO$_4^-$ > Br$^-$ > NO$_3^-$ > Cl$^-$ > SO$_4^{2-}$ whereas for cations (chloride salts) the sequence was: Na$^+$ > Li$^+$ > K$^+$ > Cs$^+$. A similar trend for anions was observed for the cloud points [3], as well as in the effective charge [4] of lysozyme solutions. The comparison of our data with those of other works allows to ascribe the observed phenomena to the interaction among ions and proteins (and silica) surface, according to the concept of ‘matching water affinities’ [5], and newest developments of dispersion forces theory [2]. Finally, these findings demonstrate the importance of specific ion effects occurring at solid/liquid interface between ordered mesoporous silica and proteins.