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Surface imprinting of complex matrices for plasmonic screening of global polyphenols and proteins interaction

Polyphenols have been highlighted as a group of promising therapeutic or protective agents against a broad range of diseases such as Alzheimer's, Parkinson's or cancer[1-2]. Even though polyphenols role is not fully understood, their mechanism of action has been associated with their ability to bind proteins. The uptake of polyphenols either by digestion or therapeutic delivery result in the binding with complex protein environment giving a complex set of global interactions likely determining their effect.

In order to study and characterize the specific and global interactions between polyphenols and complex protein matrices we developed a reusable plasmonic sensor combined with molecular imprinting polymers (MIP). MIPs are an attractive biomolecular recognition element due to their inherent stability and short time preparation.

Therefore, MIP has the role to capture and stabilize a natural matrix of human saliva proteins close to the surface of gold nanodisks, simulating oral cavity environment. The ultrathin MIP layers (~4nm) of both single (α-amylase) and multiple protein matrix (saliva) were surface imprinted on 100 nm diameter and 20 nm height gold nanodisks followed by localized surface plasmon resonance (LSPR) spectral response.

The two smart materials produced were then used for protein rebinding and subsequent polyphenol interactions.

The interactions were carried out with specific polyphenols such as pentagalloyl glucose (PGG), procyanidin (B3), and (+)-catechin, giving insight into the molecular diversity of polyphenol retention and activity in the oral cavity.

Overall, we observed a significant variation in the binding strength of polyphenols to the complex mixture of saliva proteins compared to binding to a single specific protein (α-amylase). Demonstrating that for studying the global effects of different polyphenol binding on proteins, a complex saliva protein mixture has the potential to give a better response than sensors based on single or a few proteins.

References

[1] Ehrnhoefer, D. E.; Bieschke, J.; Boeddrich, A.; Herbst, M.; Masino, L.; Lurz, R.; Engemann, S.; Pastore, A.; Wanker, E. E., Nature Structural & Molecular Biology, 15 (2008) 558.

[2] Albini, A.; Tosetti, F.; Li, V. W.; Noonan, D. M.; Li, W. W., Nature Reviews Clinical Oncology, 9 (2012) 498

Figures

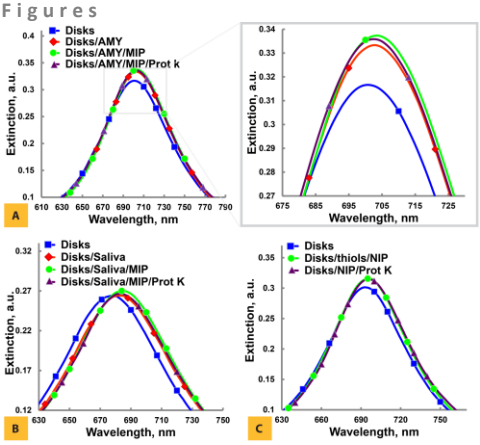

Figure 1: LSPR spectral response for the molecular imprinting process (A) AMY imprinting, (B) saliva imprinting, and (C) nonimprinted control. Blue line corresponds to bare Au nanodisks (square), red line to AMY 10 μM or saliva adsorption (inverted square), green line to polymer polymerization (circles), and purple line to protein removal (triangle).

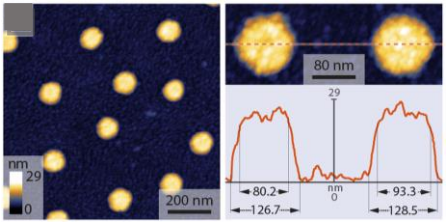

Figure 2: AFM images in liquid of amylase imprinted on Au nanodisks substrate.