Gold nanoparticles green synthesis: the effect of natural compounds

Caterina Medeot[1,2,*], Ahmed Alsadig [3], Francesco D'Amico[2], Albano Cossaro [1,4], Hendrik Vondracek[2,5], Giovanni Birarda[2], Paola Posocco[1], Pietro Parisse [2,4], Loredana Casalis[2] and Serena Bonin[1]

[1] University of Trieste

[2] Elettra Sincrotrone Trieste S.C.p.A

[3] Institute of Radiopharmaceutical Cancer Research, Helmholtz Zentrum Dresden-Rossendorf

[4] Istituto Officina dei Materiali – National Research Council (CNR-IOM), Area Science Park, Trieste

[5]Diamond Light Source Ltd, Harwell Science and Innovation Campus, Didcot, Oxfordshire, UK

caterina.medeot@phd.units.it

Background:

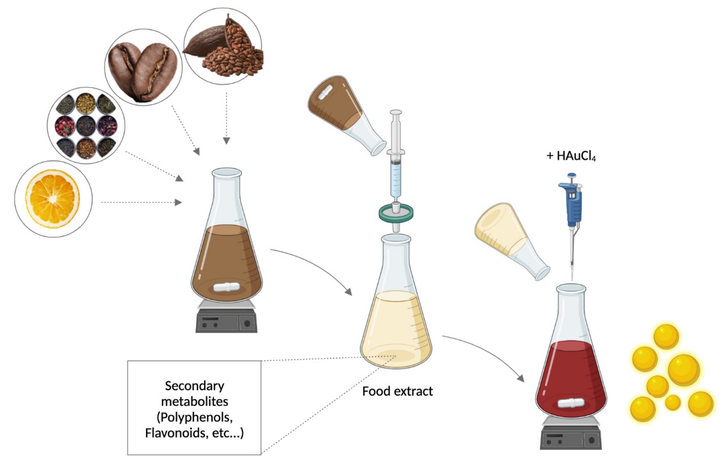
Among nanomaterials, gold nanoparticles (AuNPs) have gained enormous scientific interest owing to their unique properties. Despite the feasibility of standard wet chemistry, limitations are found in the impossibility to separate as-made AuNPs from reaction mixture, including toxic chemicals. Therefore, there is the rising demand of developing environmental-friendly routes to synthetize AuNPs. Current studies lack of standardize synthesis procedures, and the nature of the reducing reaction is still unclear.

Aim:

Compare AuNPs synthesis procedures obtained from different natural extracts (lemon juice, coffee Arabica powder, tea leaves, and cocoa powder) through careful spectroscopic (UV-Visible, Raman, ATR-FTIR and XPS spectroscopy) and morphological analysis (TEM, and AFM) were performed.

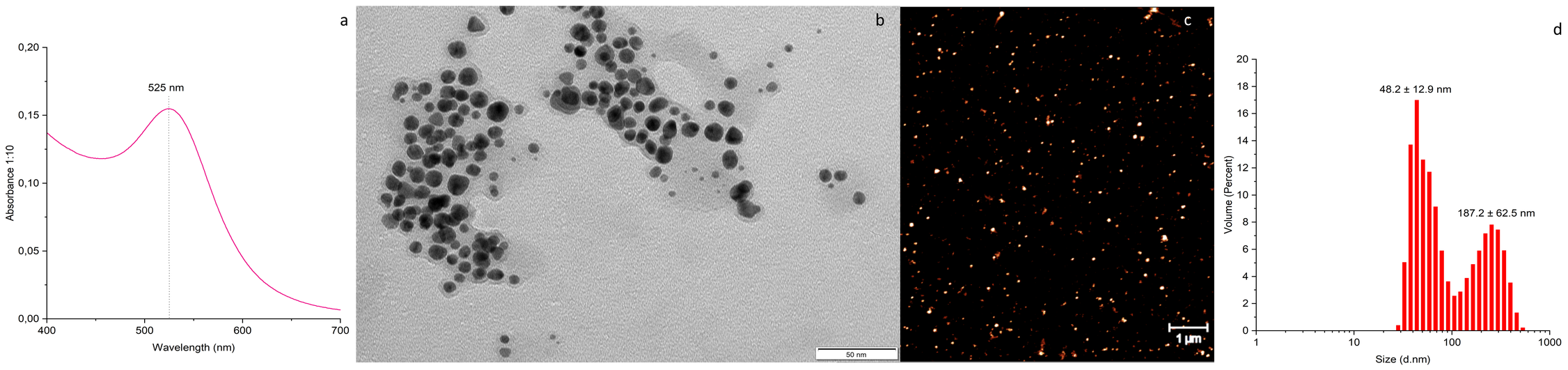
Materials and Methods:

The selected four different natural extracts, retrieved al local market, were prepared in milli-Q water and stirred for 15 minutes. Then, were purified by filtering with 0.45 µm syringe filter. Successful synthesis of spherical AuNPs was obtained only from cocoa powder.

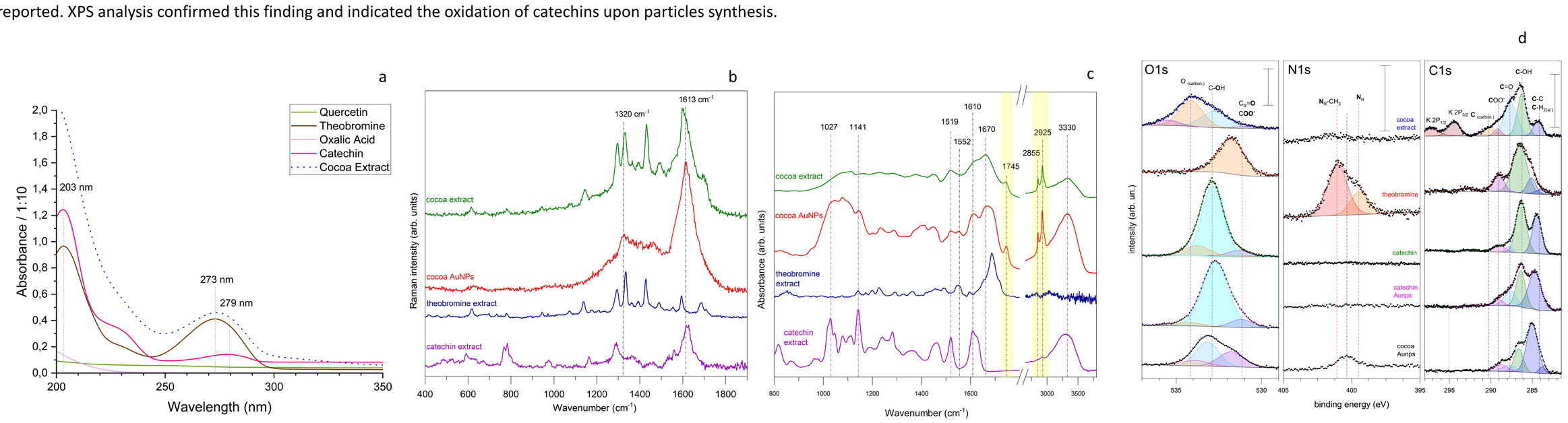


Results:

AuNPs synthesis and morphology was verified by UV-Visible Spectroscopy (a); TEM (b); AFM (c) microscopies, reporting an average diameter of 11 nm from TEM data and of 15 nm from AFM data. The hydrodynamic diameter was obtained using DLS (d), which indicated a bimodal distribution, index of aggregates presence.

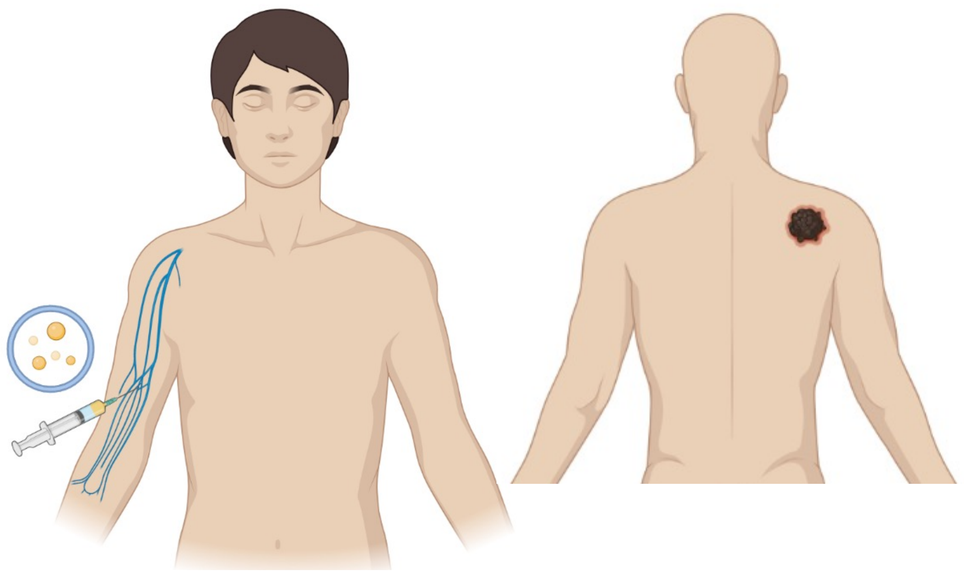


A comprehensive chemical characterization by means of UV-Visible (a), Raman (b), ATR-FTIR (c) and XPS (d) spectroscopies was performed, to better understand the role of each molecular component of the cocoa extract, namely theobromine, catechins, oxalic acid, fatty acids, and proteins, in the AuNPs synthesis. From vibrational spectroscopies, catechins were found to be the main stabilizer of the NPs. The presence of fatty acids was also reported. XPS analysis confirmed this finding and indicated the oxidation of catechins upon particles synthesis.



Conclusion and future outlook:

We successfully performed the synthesis of AuNPs from a green protocol based on cocoa extract. Through a detailed chemical analysis wee identified catechins as the main component of the extract involved in the particles synthesis as effective reducing/stabilizing agent. As a next step, we are attempting to functionalize our green AuNPs with drugs as MEK or BRAF inhibitors towards melanoma cellular pathways. They can be also associated with liposomes/exosomes in favour of melanoma cell uptake.



References:

[1] R. Chouwdhury *et Al.*, "Chocolate" Gold Nanoparticles - One Pot Synthesis and Biocompatibility, Nanomaterial, 2018;

[2] F.T. Soares *et Al.*, Cocoa By-Products: Characterization of Bioactive Compounds and Beneficial Health Effects, Molecules, 2022;

[3] L. Pohjala *et Al.*, Aggregating Behaviour of Phenolic Compounds – A Source of False Bioassay Results?, Molecules, 2012;

[4] M. Grassia *et Al.*, Polyphenols, methylxanthines, fatty acids and minerals in cocoa beans and cocoa products, Food Measure, 2019;

[5] P. Janeiro *et Al.*, Catechin Electrochemical Oxidation Mechanisms, Analytica Chimica Acta, 2004.