CHARACTERIZATION OF THE MALARIA PARASITE OPTICAL FEATURES FOR DEVELOPMENT OF A NON-INVASIVE DIAGNOSTIC DEVICE

Vitória Baptista[1,2,3], Carla Calçada[1,2], Miguel Teixeira[1,2], Pedro Ferreira[1,2], Graça Minas[3], Susana O. Catarino[3*], Maria Isabel Veiga[1,2*]

1- Life and Health Sciences Research Institute (ICVS), School of Medicine, University of Minho, Campus Gualtar, 4710-057 Braga, Portugal
2- ICVS/3B's - PT Government Associate Laboratory, Braga/Guimarães, Portugal
3- Microelectromechanical Systems Research Unit (CMEMS-UMinho), University of Minho, Guimarães, Portugal
*- shared authorship

Early and accurate malaria diagnosis is critical for the disease control and elimination [1]. Microscopy and/or immuno-rapid tests remain the standard diagnosis [2, 3], nevertheless it requires a skin puncture for blood sampling and not sensitive enough for reliable detect low-density parasitemias, urging the need to develop more sensitive and non-invasive tools.
Symptoms of the disease starts when parasites infect the red blood cell (RBC), suffering biochemical and morphological changes [4]. Parasite survival is dependent on hemozoin (Hz) formation as a by-product of heme detoxification process of the parasite upon haemoglobin (Hb) degradation and therefore a good unique feature to identify parasites presence in patients'.
Taking advantage of the fact that the Hz and Hb molar extinction coefficients differ significantly, especially at certain wavelengths [4, 5], and their proportion is inversely related upon parasite maturation inside the RBC, each stage of malaria is characterized by specific absorbance and reflectance spectra, according to the Hb/Hz concentrations on the iRBC.
It is intended the development of a portable, non-invasive, chip-sized device based on Hb/Hz reflectance spectra measurements, able to detect variations in the RBC related to the presence of malaria. The optical characterization of the reflectance spectra will follow different steps:

1) Extraction and purification of natural *Plasmodium falciparum* Hz, at different parasiteamias, to study the minimum detectable Hz from the reflectance spectra.
2) Preparation and characterization of aqueous phantoms representative of human tissues (healthy and malaria-infected).
3) Samples optical characterization (reflection and absorbance) with a top-bench setup available at CMEMS-UMinho, for extraction of the Hb and Hz molar extinction coefficients and selection of the relevant spectral bands for malaria detection.

The unnecessary need to collect blood is the biggest advantage of this optical method, diagnosing malaria directly in patient's skin, aiming higher sensitivity than current methods.

[1] Malaria World Report, *World Health Organization* (2018)
[2] H.W. Hou, et al., *Lab on a Chip*, **10**(19), 2605 (2010)
[3] N.W. Lucchi, et al. *PLoS One*, **11**(3), e0151437 (2016)
[4] R.K. Saha, S. Karmakar, M. Roy, *PloS one*, **7**(12), e51774 (2012)
[5] I. Silva, R. Lima, G. Minas, S.O. Catarino, Proc. AOP2017 - III International Conference on Applications in Optics and Photonics, Faro, Portugal (2017), DOI: 10.1117/12.2270995
[6] S. Pimenta, et al., *Biomedical optics express*, **6**(8), 3084 (2015)

Work supported by project NORTE-01-0145-FEDER-028178, funded by NORTE 2020 Portugal Regional Operational Programme, under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund and by Fundação para a Ciência e Tecnologia (FCT), IP.