



Diagnosing malaria by the magneto-optic detection of nano-scale haemozoin, the parasites waste product

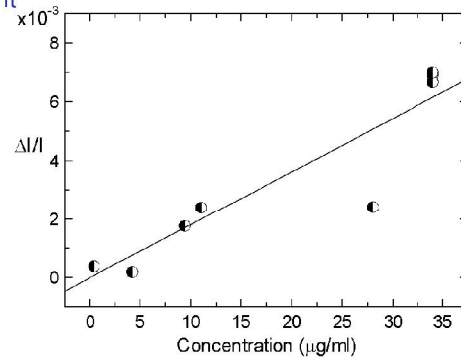
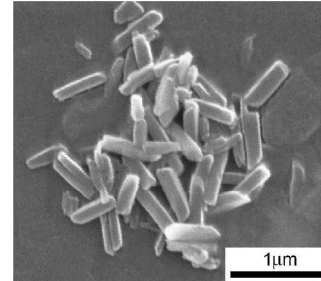
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Malaria is a very serious global health problem. Each year some 300 to 500 million cases of infection by the parasite plasmodium falciparum result in more than 2 million fatalities. Even in Europe the number of cases and fatalities increases year on year reflecting the increasing preference of Europeans to holiday in malarial prevalent areas coupled with a reluctance to take anti-malarial prophylaxes.

During infection the parasite invades red blood cells and digests the protein (globin) part of the oxygen carrying haemoglobin molecule. It must then dispose of the waste haem component of the molecule which is toxic. To protect itself it converts this into **insoluble haemozoin** always, as shown, in the form of highly regular, rod shaped crystals approximately 800nm long and 100 or so nanometres in cross section.

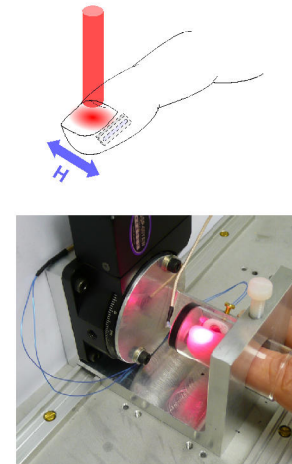
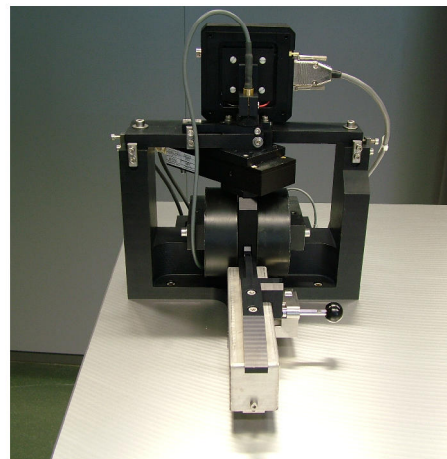
The presence of haemozoin in blood is therefore positively indicative of malarial infection and its concentration correlates with severity of infection. Detection of these nano-crystals of haemozoin via the Cotton-Mouton magneto-optic effect forms the basis of a new malarial diagnostic technique. It may be applied invasively by taking a fingerprick blood sample or non-invasively by interrogating through the fingernail.

Detection Mechanism: In a blood sample or living tissue the long axes of the haemozoin crystals are randomly orientated throughout three dimensions and so the suspension expresses no preferred direction of optical absorption on interrogation using linearly polarised radiation. However, on application of a magnetic field the paramagnetic crystals become weak bar magnets experiencing a torque seeking to orientate them along the applied field direction. When fully aligned with the field the dispersion of haemozoin crystals behaves like a weak dichroic polarizer similar to Polaroid®.



The fractional change in transmittance $\Delta I/I$ associated with magnetically induced dichroism arising from rotation of haemozoin crystals within the cell vacuoles of live parasitized cells grown and sampled from non-synchronous culture.

Patient Characteristics	Result Rapid Diagnostic Test for malaria	Final clinical diagnosis based on extensive diagnostic procedures	MOT diagnosis	MOT Fractional Change
Nigerian child with fever	Positive	<i>P. falciparum</i> infection	Positive	8.2E-5
Nigerian child with fever	Positive	<i>P. falciparum</i> infection	Positive	4.7E-5
Nigerian child with fever	Positive	<i>P. falciparum</i> infection	Positive	7.8E-5
Nigerian child with fever	Positive	<i>P. falciparum</i> infection	Positive	9.5E-5
Nigerian child with fever	Positive	<i>P. falciparum</i> infection	Positive	5.8E-5
Dutch returned traveller	Positive	<i>P. Ovale</i> infection	Positive	4.4E-5
Dutch returned traveller	Positive	<i>P. falciparum</i> infection	Positive	5.9E-3
Tanzanian adult; asymptomatic for malaria	Negative	Sickle cell anaemia	Negative	-
Tanzanian adult; asymptomatic for malaria	Negative	Beta-Thalassaemia	Negative	-
Tanzanian adult; asymptomatic for malaria	Negative	Rheumatic-associated disease	Negative	-
Dutch returned traveller with fever	Negative	Undifferentiated fever	Negative	-
Dutch returned traveller with fever	inconclusive	Undifferentiated fever	Negative	-
Dutch returned traveller with fever	Negative	Visceral leishmaniasis	Negative	-



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