The Tribological Properties of Methyl Cellulose as a Model Oviductal Fluid

KEYWORD
Biotribology

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INTRODUCTION
As a medical issue, infertility affects approximately 186 million women from all parts of the world, consequences are varied and can include societal repercussions and personal suffering [1]. The viscosity of the oviductal fluid may provide important information regarding the success rate of the spermatozoa reaching the oocyte and subsequent fertilisation. As the sperm needs to traverse against the oviductal flow gradient, also known as rheotaxis, a higher viscosity of the oviductal mucus presents an obstacle for the sperm. It also decreases the frequency and wavelength of the sperm flagellar wave. The transport of an oocyte from the ovaries along the fallopian tubes can be described as a tribological process, as traction forces experienced by cells are crucial to various biological processes such as wound healing, angiogensis and metastasis. To understand the influence of the physical properties of the mucus on the tribology of the system, there is a need to formulate a model fluid that closely replicates the oviduct mucus. A Methyl Cellulose (MC) based model mucus was developed, which has previously been reported as an ideal in-vitro sperm motility fluid [2]. Understanding the behaviour of the mucus under various dynamic conditions, allows a correlation on the effect of MC concentration on the tribology of the system.

METHODS
Physical properties including the density, viscosity, surface tension and the contact angle were evaluated. Further to which, a mini-traction machine (MTM) was employed to obtain a fully automated traction mapping of different concentrations of the model mucus. The experimental conditions consisted of a 19.05mm PDMS ball (E= 0.7GPa, ν=0.5) loaded onto a 46mm diameter silicone elastomer disc (E= 6.9MPa, ν=0.5) (figure 1a), which were independently driven in order to simulate the interactions between the mucus, fallopian tube wall and the oocyte, the temperature was set to 37˚C to simulate the body temperature. Stribeck curves were formed for all samples by measuring traction from 0-100mm/s with a scaled-up 2N normal force.

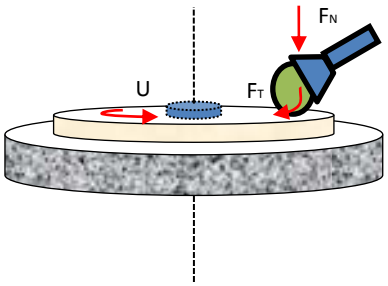

Figure 1: Schematic of the Mini-Traction Machine (MTM)

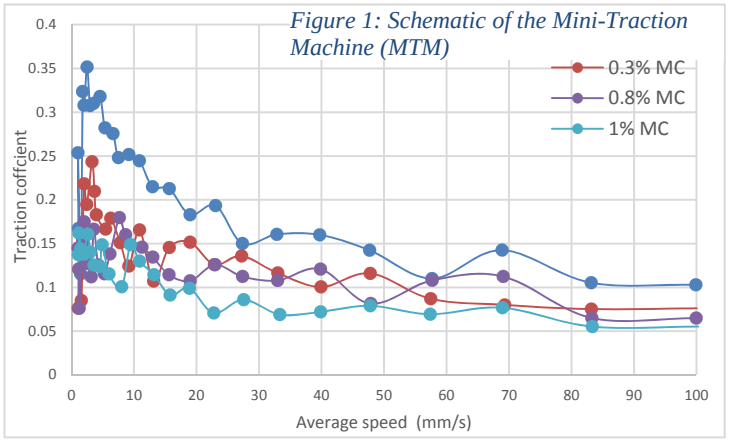

Figure 2: Coefficient of traction versus speed of 0.1-1% Methyl Cellulose

CONCLUSIONS
As the viscosity of the model mucus is increased with higher concentrations of MC, a reduction of the traction coefficient is observed (figure 1b). This is a favourable condition for oocyte transport, however may negatively affect sperm rheotaxis. These results suggest that a balance in the physical and tribological properties of the mucus is essential to provide the favourable conditons for successful fertilisation.

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