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Rheological characterization of thermoresponsive semi-solids for vaginal HIV vaccine delivery

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Purpose. To manufacture and characterize, through oscillatory rheology, thermoresponsive rheologically structured vehicles (RSV's) capable of enhanced retention times within the vagina for the purposes of HIV vaccine delivery.

Methods. Pluronics F127, F108 and F68 were investigated and RSV's were prepared by dissolving sorbic acid (0.1% w/w) and mucoadhesive component (Gantrez SBF97 or Noveon AA1, 3% w/w) in the required amount of H₂O and NaOH. Pluronic (10% w/w) was added via mixing in an ice-bath followed by hydroxyethylcellulose (5%) and subsequently poly(vinylpyrrolidone) (4% w/w). Oscillatory temperature sweeps between 10-38°C were performed within the linear viscoelastic region of the formulations on an AR2000 rheometer (T.A. Instruments, Surrey, England) with a 2cm diameter parallel plate geometry and a plate gap of 1000µm at 1Hz.

Results. Table 1 illustrates storage modulus (G'), a measure of the elastic component of the samples, at 10°C, 25°C, and 37°C.

Table 1 Values of G' (mean±SD, n=5) at a range of temperatures for various formulations

Formulation	G' at 10°C	G' at 25°C	G' at 37°C
F127+Gantrez	1139±82	14970±85	14345±21
F68+Gantrez	8951±723	7949±900	3194±860
F108+Gantrez	544±472	957±1109	9135±2526
F127+Noveon	5590±895	17423±2866	15157±2438
F68+Noveon	6846±557	6307±512	5654±451
F108+Noveon	5078±256	5684±291	8795±456

During storage, formulation F108+Gantrez was found to separate out leading to large deviations upon rheological evaluation with the onset of gelation occurring at 25°C. Similarly, its Noveon counterpart underwent gelation at 25°C while maintaining physical stability. Formulations containing pluronic F127 and either Gantrez or Noveon demonstrated an increase in G' upon reaching 25°C however due to melting of the pluronic, a slight decrease was then experienced before reaching 37°C. These systems underwent gelation at 15 and 16°C respectively. Conversely, pluronic F68 formulations showed a decrease in G' with increasing temperature with a more marked decrease being experienced in the case of the Gantrez formulation.

Conclusions. The thermo-gelation of the RSV's is therefore dependent upon the type of pluronic and mucoadhesive component included, with formulations containing pluronic F127 appearing to be most suitable for the delivery of vaginal vaccines.