Binary polymeric systems containing methylene blue: Continuous shear rheology

Junqueira MV[a], Borghi FB[a], Rosseto HC[a*], Toledo LAS[a], Pereira, RRA[a], Bruschi ML[a]

[a] Postgraduate Program in Pharmaceutical Sciences, Department of Pharmacy, Laboratory of R&D of Drug Delivery Systems, State University of Maringá, Paraná, Brazil.

Purpose: The present work aims to evaluate the effect of poloxamer (P407), Carbopol 934P (C934P) and methylene blue (MB) on the flow behaviour, by continuous shear rheology. **Method**: The formulations were prepared following a factorial design (2^3 with central point). Polymeric dispersions were prepared containing C934P (0.15; 0.20; 0.25%, w/w) in distilled water with following addition of P407 (15; 17.5; 20%, w/w), triethanolamine as neutralizing agent; 0.25; 0.50; 0.75% (w/w) of drug (MB) was added. Continuous shear rheograms were obtained using a rheometer (MARS II, Thermo-Haake) at 25 ºC and 37 ºC (n=5). The obtained results were analyzed using the Ostwald de Waele (Power Law) and Herschel-Bulkley equations. The polymeric concentration effects and the presence of MB on the flow properties were statistically evaluated using Experimental Design (DOE) from Statistica 8.0®. *Post-hoc* average comparison, for all ANOVA cases, was realized Tukey's honestly significant difference, $p<0.05$. **Results:** The formulations presented shear thinning flow behaviour; the yield stress was verified at 37 ºC for all the formulations, and at 25 ºC only for those containing 20% (w/w) of P407. The systems constituted by 15 and 17.5 % (w/w) of P407, may be classified as pseudoplastic fluids under 25 ºC, besides that, on higher temperature, as plastics. The systems with the highest P407 content, presented plastic behavior. Some systems displayed rheopexical characteristics, namely, the ones containing 15% (w/w) P407 at both temperatures and with 17.5% (w/w) P407 at 25 ºC. For the κ value (consistency index) at 25 ºC the equation obtained was $y = 41{,}925 + 82{,}632\,X_1 + 7{,}827\,X_2 + 3{,}634\,X_3 + 6{,}769\,X_1X_2 + 4{,}671\,X_1X_3 + 79{,}386\,X_2X_3 + 80{,}431\,X_1X_2X_3$ and at 37 ºC was $y = 150{,}555 + 245{,}139\,X_1 + 44{,}651\,X_2 + 20{,}799\,X_1X_2 - 47{,}058\,X_1X_3 - 7{,}099\,X_2X_3 - 19{,}517\,X_1X_2X_3$. As the P407 concentration increased, higher was the κ value and lower was the *n* value (flow index). In general, C934P and MB presented negative effect over both parameters. **Conclusion:** The systems 20/0.15 (P407/C934P) presented better results considering a topical administration, ease of spreadability and return to its original form when the shear is removed.

Financial support: CAPES, CNPq, Fundação Araucária, FINEP, UEM.