ZETA POTENTIAL AND ELECTROLYTE STABILITY OF FLUOROCARBON OXYGEN TRANSPORT EMULSIONS

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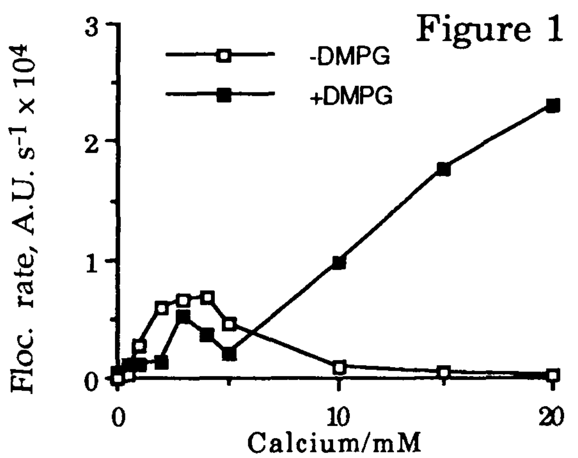
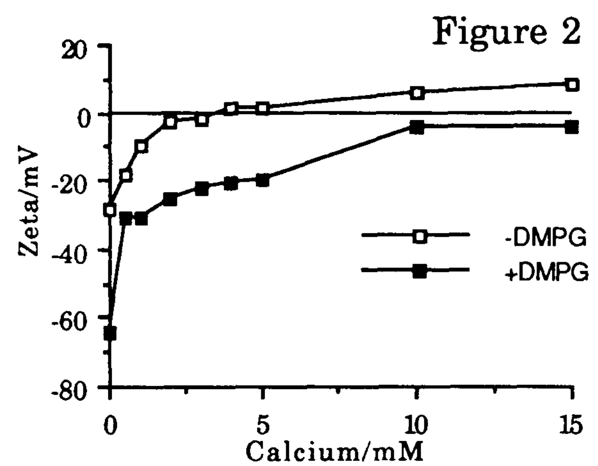
Perfluorocarbon (PFC) emulsions are currently among the most promising synthetic oxygen transport media for in vivo and clinical use. The perfluorocarbon is emulsified using an intravenously compatible surfactant. To date only two surfactants have been widely used, Pluronic F-68 and lecithin. Emulsions produced using Pluronics have demonstrated toxicity; while we believe that this is due to impurities in the polymer they are still regarded cautiously, and lecithins are gaining popularity for stabilization of PFC emulsions; a number of such products are currently under commercial development. Unfortunately lecithin-stabilized colloids are well-known for a broad range of surface interactions with cations, which cause instability in the presence of electrolytes such as those required in large volume parenterals. In addition, we have found the zeta potential of lecithin stabilized emulsions to be rather low, and their long-term stability to be correspondingly poor (Johnson et al. 1990).

We have examined the stability of perfluorodecalin emulsions to added electrolytes, both by measuring flocculation rates and zeta potentials. Emulsions (10% perfluorodecalin, 4% lecithin, 2% soya oil) were prepared as described by Johnson et al (1990). To raise their zeta potential, the acidic phospholipid dimyristoyl phosphatidylglycerol (DMPG) was added to the emulsions. Figure 1 shows the flocculation rates of the emulsions in solutions of calcium chloride, and Figure 2 the corresponding zeta potentials.





In the absence of added DMPG the emulsions flocculated at low calcium concentrations (CFC 1mM Ca^{2+}) and demonstrated restabilization by charge reversal. The zeta potential in the absence of calcium (-28 mV) was lower than that observed in fat emulsions (-45 mV), probably due to the poorer adsorption of the lecithin to the fluorocarbon surface. Addition of 1% DMPG caused the zeta potential in the absence of calcium to be increased to -64 mV, thus increasing the critical flocculation concentration to 5 mM Ca^{2+}. However, the zeta potential in this case could not be raised sufficiently for the systems to be restabilized by charge reversal, and so rapid flocculation was observed over a much broader range of electrolyte concentration than in the absence of added DMPG. It appears that adding charged lecithins to improve emulsion stability has its drawbacks; although the unmixed emulsion stability may be increased, the stability in the presence of electrolytes may not follow a similar trend.

Johnson O.L. et al (1990) Int. J. Pharm. 59: 131-5