Pulmonary surfactant membranes of hibernating ground squirrels possess increased fluidity but are capable of maintaining an ordered membrane structure at low temperatures

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Pulmonary surfactant, a mixture of lipids and proteins, regulates the surface tension at the air-liquid interface of the lung. Reduced body temperature during hibernation is accompanied in 13-lined ground squirrels (*Ictidomys tridecemlineatus*) by an increase in fluid monounsaturated phosphatidylcholine (PC) species (e.g. PC 16:0/16:1, PC 16:0/18:1) and phosphatidylglycerol (PG) species (*e.g.* PG 16:0/18:1, PG 18:0/18:2), but fewer disaturated PC and PG species (Possmayer *et al.*, 2010). Previously we speculated that altered surfactant lipid composition during metabolic depression states such as torpor or hibernation will reduce the phase transition temperature (T_m) of the mixture, enabling pulmonary surfactant to remain fluid over a broader range of temperatures and thereby maintaining respiratory function (Lang *et al.*, 2005). Here we analyze thermodynamic properties and behavior of surfactant from hibernating and summer-active 13-lined ground squirrels in relation to natural porcine surfactant, using differential scanning calorimetry and LAURDAN fluorescence spectroscopy. In addition we conducted epifluorescence studies to visualize changes in phase coexistence of surfactant films of hibernating and summer-active animals. Surfactant membranes of hibernators showed gel-to-fluid transitions at lower T_m with reduced enthalpy relative to membranes from summer-active squirrels. Both exhibited lower enthalpy than porcine surfactant. LAURDAN fluorescence and epifluoresence suggested possible structural re-arrangements of surfactant membrane lipids and films, respectively, in hibernators. These exhibited a similarly dehydrated and condensed highly packed ordered phase as for summer active squirrels, despite differences in composition and T_m. In conclusion, pulmonary surfactant composition changes in hibernating squirrels to increase overall fluidity, but to maintain an ordered membrane structure at low temperature.

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