The Role of Water-Lipid Interfaces in the Oxidation of Lipids

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Lipid oxidation in many food systems is promoted by transition metals. The prooxidant activity of transition metals is primarily due to their ability to decompose lipid hydroperoxides into free radicals. This reaction is highly dependent on the physical and chemical properties of lipid-water interfaces since lipid hydroperoxides are surface active and metals must migrate to this interface in order to promote hydroperoxide decomposition. In oil-in-water emulsions, emulsion droplet interfacial properties such as charge and thickness impact lipid-metal interactions. Lipid-water interfaces also exist in bulk oils due to the ability of the minor components of oil to form physical structures in the presence of small amounts of water. These nanostructures which include reverse micelles and lamellar bilayers are known as association colloids. Techniques such as interfacial tension and small angle X-ray scattering have been used to show that the combination of phospholipids and water will result in the formation reverse micelles in bulk oils. The formation of the water-oil interface in association colloids will increase lipid oxidation rates as well as the prooxidant activity of transition metals. Lipid-water interfaces also impact the activity of antioxidants. Phospholipid in bulk oils can concentrate antioxidants such as tocopherol at the lipid-water interface, a process that inhibits lipid oxidation. In oil-in-water emulsions, emulsifiers can also impact the ability of antioxidants to concentrate at the oil-water interface. When emulsifier concentrations favor maximizing antioxidants concentrations at the water-oil interface, antioxidant activity is increased. The role of the oil-water interfaces in lipid oxidation mechanisms is very complex and we are only beginning to understand how the interface impacts lipid oxidation in simple model systems. It will be important to develop a more thorough understanding of how the physical and chemical properties of oil-water interfaces impact the activity of both prooxidants and antioxidants in complex food systems in order to develop new innovative technologies to control lipid oxidation.