Tannins as Metal Ion Chelators

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Phenolics can affect the biological availability or activity of metal ions by chelating the metal (McDonald, M.; Mila, I.; Scalbert, A. ***J. Agric. Food Chem.*** 1996, 44, 599). Chelation requires appropriate patterns of substitution and a pH above the pKa of the phenolic group. Bacterial siderophores with multiple phenolic groups and very high affinities for essential metals such as iron have been characterized (Harris, W.R.; Carrano, C.J.; Cooper, S.R.; Sofen, S.R.; Avdeef, A.E.; McArdle, J.V.; Raymond, K.N. ***J. Am. Chem. Soc.*** 1979, 101, 6097). The similarity between siderophore ortho-dihydroxy substitution pattern and the substitution patterns on condensed and hydrolyzable tannins suggests that tannins may also have very high affinities for metals.

Phenolic-metal ion complexes are often colored, and it has been suggested that characteristic colors can be used to identify specific arrangements of phenolic groups (Mole, S.; Waterman, P.G., ***Oecologia*** 1987, 72, 137-147). However, these methods have not been adequately tested and are not recommended.

It is widely believed that tannin-chelated metal ions are not bioavailable. For example, consumption of large quantities of tea or other tannin-rich foods is sometimes associated with deficiency diseases such as anemia (Baynes, R.D. and Bothwell, T.H. ***Ann Rev. Nutr.*** 1990 10, 133). In many ecosystems, the slow decomposition of tannin-rich leaves has been attributed in part to the low levels of biologically available metal ions (Vituosek, P.M.; Turner, D.R.; Parton, W.J. and Sanford, R.L. ***Ecology*** 1994, 75, 418). The populations of microfauna essential to leaf decomposition and soil formation are unable to grow when metals are unavailable. Metal ion chelation can alter the redox potential of the metal, or prevent its participation in redox reactions. Thus metal ion chelators can be inhibitors or enhancers of Fenton-driven oxidative reactions.