Serum Carotenoids Correlate to Overall Antioxidant Status

The Pharmanex® BioPhotonic Scanner measures carotenoids in human skin. Developed by doctors and physicists at a top U.S. research university, the BioPhotonic Scanner is the world's first measuring tool for carotenoid antioxidant levels using Raman technology. Studies have shown that this measurement, or the Skin Carotenoid Score (or SCS) can be used to infer the status of other nutrients in the body.

To better understand this issue, it is beneficial to look closely at carotenoids. Carotenoid molecules are not regenerated like other antioxidants, and are degraded in the process of neutralizing free radicals or reactive oxygen species. A typical carotenoid molecule like lycopene or ß-carotene is able to sustain more than 20 free radical hits by lipid radicals before it becomes completely destroyed (Tsuchiya, 1994). Lycopene and ß-carotene are just two examples of antioxidants among hundreds of antioxidants that make up the *antioxidant network*.

Carotenoids act sacrificially to protect other members of the antioxidant network (such as vitamins E and C) from having to sustain free radical hits; in this way carotenoids will support the entire antioxidant network consequently reducing the danger from oxidative stress (Packer, 1994; Packer and Coleman, 1999). Conversely, high levels of oxidative stress (e.g., with smoking) adversely affect the antioxidant network, and the resulting increased free radical activity leads to a depletion or reduction in tissue carotenoids (Smidt and Shieh, 2003; Gollnick and Siebenwirth, 2002, Dietrich, 2003; Lee, 1998).

A study conducted by Svilaas *et al*. established carotenoids as a reliable indicator of other dietary antioxidants. Svilaas and his colleagues assessed antioxidant intake from diets of more than 2,670 adults, and evaluated blood serum antioxidants of 61 individuals for seven consecutive days. Svilaas *et al*. found the ability of carotenoids to predict serum levels of other antioxidants was stronger than the predictive ability of alpha, beta, delta, and gamma-tocopherols as well as glutathione (Svilaas, 2004).

Carotenoids are not only convenient biomarkers because they are accurate predictors of overall antioxidant status, but also they are Raman active and can be detected without the concerns of blood samples (Bernstein, 1998, 2002; Gellermann 2002a; Zhao, 2003, Ermakov, 2004b). Furthermore, carotenoids are delivered to tissues by the same mechanism as other fat-soluble antioxidants. This shared LDL delivery mode is the proposed mechanism to explain the correlation between tissue carotenoids and other fat-soluble antioxidants in multiple studies (Lasheras et al., 2002; Steinberg & Chait, 1998).

Serum Carotenoids Correlate to Skin Carotenoids

Skin carotenoids analyzed by HPLC were shown to correlate significantly to serum carotenoid levels (Peng, 1995). The significant correlation between skin biopsy-levels of carotenoids and serum carotenoid levels eliminates the need for routine skin removal. Another study showed a highly significant correlation between serum total carotenoids and skin carotenoids as assessed by Raman Spectroscopy ($r = 0.78$, $p < 0.001$) (Smidt, 2004). These data bridge the findings of Svilaas, and Peng, to validate Raman Spectroscopy as a method to assess skin carotenoid status as an indication of broad-spectrum antioxidant status, without the inconvenience of skin and blood samples.