Breeding Tomatoes for Human Health and Nutrition

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Correlative evidence suggests that enhanced consumption of carotenoids may decrease the risk of certain cancers. The lack of knowledge concerning how carotenoid structure and concentration affect uptake and biological activity in the human body limits the use of tomato products as functional foods (foods designed to provide a specific and beneficial physiological effect on health). Numerous tools exist for genetic and phenotypic selection in order to develop tomato lines and varieties with altered carotenoid content. In order to develop genetic resources to test the physiological effects of dietary carotenoids in the food matrix, we used molecular-marker-assisted selection, Attenuated Total Reflectance Infrared (ATR-IR) spectroscopy, and classical selection to combine genes that affect both the biochemical synthesis of carotenoids and the structure of the chromoplast. As expected from past work, increased content of lycopene is often accompanied by a decrease in beta-carotene. When genes that affect chromoplast development (e.g., *dg* and *gf*) or genes that affect fruit ripening (*rin* and *alc*) are combined with genes that affect the conversion of cis-lycopene (*t* and t_v) to lycopene, zeta-carotene content is enhanced. Genetic resources developed from these studies have been used to verify the increased adsorption of cis-lycopene relative to trans-lycopene in human trials. Despite increased awareness and interest in dietary carotenoids, pigment composition is not yet directly valued in contract and pricing structures for tomato. In contrast, color and color uniformity are given value in contracts and in USDA product grades for processing tomatoes. Poor color uniformity is due to disorders that alter the ripening process resulting in internal white tissue and yellow or green sectors. Scanned images of tomato fruits were analyzed for internal fruit color with both the Tomato Analyzer Software (Brewer et al., Plant Physiology, 2006, 141**,** 15-25) and a colorimeter. We showed high correlations ($r_2 > 0.96$) and linearity of L*, a*, b* values obtained from scanned images and the colorimeter. The proportion of total phenotypic variance attributed to genotype for color and color uniformity measured from images was significantly improved relative to the colorimeter. Principle components analysis of color data from segregating populations revealed that color uniformity contributes high positive and negative loadings to PCA1, confirming the importance of color uniformity to variance in populations. In addition, fruit affected by color disorders have reduced lycopene and beta-carotene content. Varieties with improved color uniformity therefore have potential to return value to growers, processors and consumers.