Impact of light quality (white, red, blue light and UV-C irradiation) on changes in anthocyanin content and dynamics of PAL and POD activities in apical and basal spear sections of white asparagus after harvest

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Abstract

Postharvest quality decay of white asparagus spears is often due to red discoloration of spear tips, caused by enhanced epidermal anthocyanin synthesis and accumulation. Exposure to light of different wavelengths triggers distinct physiological processes in plants leading to changes in pigments (e.g. phenolic compounds) and their associated enzymes, among them e.g. phenylalanine ammonia-lyase [PAL, EC 4.3.1.5] and guaiacol peroxidase [POD, EC 1.11.1.7]). The presented work evaluated the impact of light quality (white, red, blue light and UV-C irradiation) on changes in anthocyanin contents and the dynamics of PAL and POD activities in different morphological spears sections (apical and basal) of harvested white 'Gijnlim' asparagus. After harvest, spears were exposed to weak white, red and blue light (30 µmol m^{-2} s^{-1}) for 3 h and to UV-C irradiation (254 nm, 1 kJ m^{-2}) for 8 min; untreated spears were used as controls. Untreated and light-treated spears were stored in darkness at 20 °C in water vapour saturated atmosphere for up to 4 d. On days 0, 2 and 4, six spears per treatment were selected, severed into basal and apical segments, and respiration rate, anthocyanin content, and PAL and POD activity determined. Light quality did not influence respiration, but section-specifically mediated changes of anthocyanin contents, and PAL and POD activities. White light triggered anthocyanin synthesis via an associated PAL increase, whereas red light and UV-C irradiation tendentiously resulted in an anthocyanin inhibition or even degradation, coinciding with changes in PAL activity, respectively. Blue light increased anthocyanin content in spear tips to the same extent as for controls. However, also other enzymes might play an important role in the light induced anthocyanin

synthesis. In basal segments, PAL and POD activities were higher than in apical segments; however, light treatments affected both enzyme activities differently. In the apical, PAL activity was enhanced by white light and UV-C. In contrast, in the basal segments the different wavelength ranges did not affect PAL except for UV-C also increasing PAL activity. The activity of POD increased in tip sections throughout storage and remained high irrespective of light treatments, except for UV-C, strongly stimulating POD activity. POD was also UV-C stimulated in basal segments, whereas white, blue and red light inhibited its activity for a limited time during storage. Differentiated responses in apical and basal segments indicated distinct physiological activity, signalling chains and availability of resources from primary metabolism. PAL may be a major factor controlling lignification in the basal segments of spears, irrespective of light quality, while POD activity is significantly triggered by mainly UV-C indicating its role as an antioxidant enzyme in the physiological active spear tips.