Physiological and biochemical responses of Chinese cabbage (Brassica rapa var. Chinensis) to different light treatments

ABSTRACT

Artificial agriculture is promoted as an economically viable technology for developing plants under controlled conditions whereby light, water, and fertilizer intake are regulated in a controlled manner to produce maximum productivity with minimal resources. Artificial light has been used to produce high-quality vegetables because it can regulate plant growth and phytochemical production through light intensity, photoperiod, and spectrum modulation. This study aimed to compare the physiological and biochemical responses of Chinese cabbage (Brassica rapa var. chinensis) grown under artificial light with varying light intensities (75 and 150 μmol m− 2 s− 1), photoperiods (12:12 and 6:6:6:6 h), and wavelengths (blue, red, and magenta) to plants grown in a glasshouse under natural light. The novelty of this study lies in the manipulation of artificial LED lighting to achieve high-quality plant growth and phytochemical composition in B. rapa model vegetables for potential optimal productivity. The analysis revealed that B. rapa grown under artificial lights produced more consistent biomass yield and had a higher chlorophyll content than B. rapa grown under natural light (control). Plants grown under artificial lights have also been shown to produce biochemical compositions derived primarily from fatty acids, whereas plants grown under natural light have a biochemical composition derived primarily from alkanes. Twenty compounds were found to be statistically different between light treatments out of a total of 31 compounds detected, indicating that they were synthesized in response to specific light conditions. Exposure to the full artificial light spectrum (white) resulted in the absence of compounds such as dodecane and 2,6,10-trimethyltridecane, which were present in B. rapa grown in natural light, whereas exposure to the blue spectrum specifically induced the production of tetracosane. Eicosane, neophytadiene, l-(+)-ascorbic acid 2,6-dihexadecanoate, and (Z,Z,Z)-9,12,15-octadecatrienoic acid were all prevalent compounds produced in B. rapa regardless of light conditions, and their absence may thus affect plant development and survival. The results show that cultivation under artificial light produced consistent biomass, high chlorophyll content, and phytochemical content comparable to natural light conditions (control). These findings shed

light on how artificial light could improve the production efficiency and organoleptic qualities of Chinese cabbage.