# Shedding Light on Nutrition

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**Abstract:** Supplemental ultraviolet-B radiation (280-320 nm) can increase phenolic compounds in plants and help to preserve them during storage after harvest. The nutritional significance of these compounds and the use of UV-LEDs will be discussed. ©2009 Optical Society of America

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## 1. Introduction

Green, leafy vegetables make and store various polyphenolic compounds considered important for human nutrition [1]. These compounds may help to reduce oxidative stress [2] or they have more specific signaling functions [3]. Renewed interest in greenhouse cultivation to extend growing season, reduce transportation costs and generate high quality produce has revived recognition that typical greenhouse coverings reduce or eliminate the short wavelength portion of the solar spectrum resulting in decreased synthesis and accumulation of polyphenolics [4]. Most of our knowledge of UV-stimulation of plant polyphenolics derives from studies to assess potential increases in solar UV-B radiation (280-320 nm) as a result of stratospheric ozone destruction [5], but there is relatively little information on low-level irradiance, exposure and wavelength requirements. These studies were undertaken to evaluate the potential for UV-LEDs to improve produce nutritional quality.

## 2. Results and Discussion

Emission spectra of replicate UV LEDs (UVTOP, nominal wavelengths 300 and 370 nm, TO-39 package run at 16.7 and 11.6 mA, respectively; Sensor Electronic Technology, Columbia SC 29209, USA), are shown in Fig. 1. Spectra were recorded at 2 nm intervals and 2 nm half-bandwidth with a dual monochromator spectroradiometer (Model 754, Optronics Laboratories, Orlando FL 32811, USA) with LEDs positioned immediately above the quartz dome of the integrating sphere input optics. Measured peak wavelengths, half-peak bandwidths, and cut-on wavelengths (1% of peak) were, in order, 296 nm, 10 nm and 281 nm for the nominal 300 nm LED and 366 nm, 14 nm, and 349 nm for the nominal 370 nm LED. The LEDs have generally excellent characteristics for UV radiation sources for plant photobiology, although emission tails off gradually at longer wavelengths. Studies using LEDs emitting in the UV-B should therefore incorporate longer wavelengths controls, either as independent or simultaneous treatments.

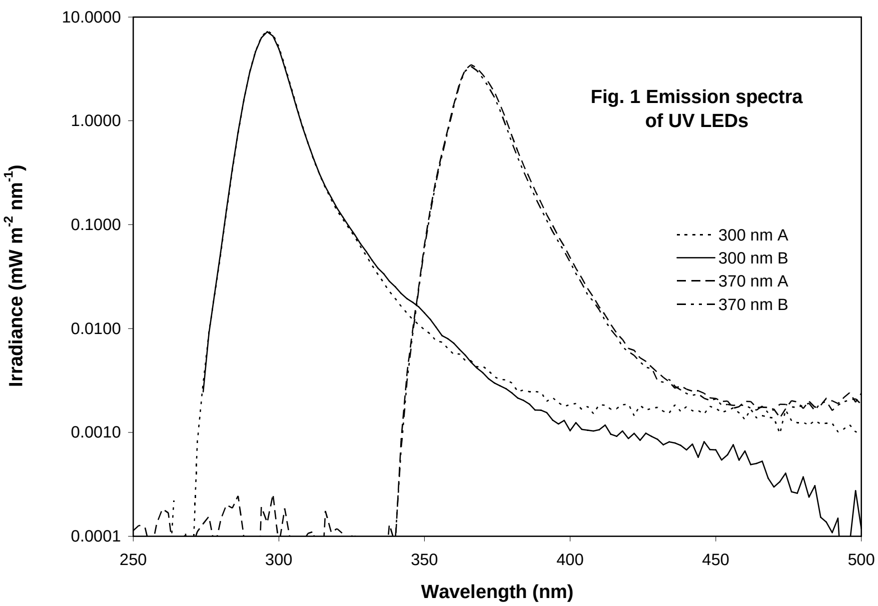


Fig. 1 Emission spectra of UV LEDs

To test if a UV-B emitting LED can induce accumulation of polyphenolic compounds, a representative red leaf lettuce plant (variety 'Red Sails') was transferred 20 days after seedling emergence from low UV growth conditions (simulated winter greenhouse) to a test chamber at 23 °C, 50% relative humidity and continuous light from low-pressure sodium and broad-spectrum blue fluorescent lamps (150 µmol $m^{-2}$ $s^{-1}$ photosynthetically-active radiation, 400-700 nm). In addition, a 300 nm UV LED was position approximately 1 cm above a partially developed leaf. LED output was not determined because it was below the limit of detection for a solar erythemal detector. After 43 h, the UV-exposed plant was removed and photographed with a control plant of identical age that remained under low UV growth conditions (Fig. 2).

The UV-treated plant presented dark coloration indicative of anthocyanin accumulation. Interestingly, pigmentation was strongest in young developing leaves that were not directly under the UV LED, but which probably were exposed to scattered UV-B. In contrast, the control plant remained lightly tinged with red pigment. HPLC analysis will confirm and quantify the presence of anthocyanin and related polyphenolics (e.g., quercetin, a flavonol, and chlorogenic acid, a phenolic acid ester) previously identified in red leaf lettuce and shown to increase in response to UV-B radiation from filtered fluorescent sunlamps [6].

Results indicate that even low levels of UV-B radiation rapidly induce significant accumulation of polyphenolics in leaf lettuce and that LEDs can be attractive sources for this purpose. Potential uses include basic photobiology (studies on irradiance and wavelength responses as well as interactions between UV-B and other photoreceptors) and practical applications (greenhouse supplements or postharvest manipulation of fruits or vegetables where UV exposure has been reported to enhance nutrient retention).

*Fig. 2. Red leaf lettuce with (right side) or without (left side) 43 h supplemental UV LED exposure (300 nm nominal peak wavelength).*

## 4. References

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