

Synthesis of phenolics and flavonoids in ginger (*Zingiber officinale* Roscoe) and their effects on photosynthesis rate

Abstract

The relationship between phenolics and flavonoids synthesis/accumulation and photosynthesis rate was investigated for two Malaysian ginger (*Zingiber officinale*) varieties grown under four levels of glasshouse light intensity, namely 310, 460, 630 and 790 $\mu\text{mol m}^{-2}\text{s}^{-1}$. High performance liquid chromatography (HPLC) was employed to identify and quantify the polyphenolic components. The results of HPLC analysis indicated that synthesis and partitioning of quercetin, rutin, catechin, epicatechin and naringenin were high in plants grown under 310 $\mu\text{mol m}^{-2}\text{s}^{-1}$. The average value of flavonoids synthesis in leaves for both varieties increased (Halia Bentong 26.1%; Halia Bara 19.5%) when light intensity decreased. Photosynthetic rate and plant biomass increased in both varieties with increasing light intensity. More specifically, a high photosynthesis rate (12.25 $\mu\text{mol CO}_2\text{ m}^{-2}\text{s}^{-1}$ in Halia Bara) and plant biomass (79.47 g in Halia Bentong) were observed at 790 $\mu\text{mol m}^{-2}\text{s}^{-1}$. Furthermore, plants with the lowest rate of photosynthesis had highest flavonoids content. Previous studies have shown that quercetin inhibits and salicylic acid induces the electron transport rate in photosynthesis photosystems. In the current study, quercetin was an abundant flavonoid in both ginger varieties. Moreover, higher concentration of quercetin (1.12 mg/g dry weight) was found in Halia Bara leaves grown under 310 $\mu\text{mol m}^{-2}\text{s}^{-1}$ with a low photosynthesis rate. Furthermore, a high content of salicylic acid (0.673 mg/g dry weight) was detected in Halia Bara leaves exposed under 790 $\mu\text{mol m}^{-2}\text{s}^{-1}$ with a high photosynthesis rate. No salicylic acid was detected in gingers grown under 310 $\mu\text{mol m}^{-2}\text{s}^{-1}$. Ginger is a semi-shade loving plant that does not require high light intensity for photosynthesis. Different photosynthesis rates at different light intensities may be related to the absence or presence of some flavonoid and phenolic compounds.

Keyword: Flavonoids; Halia bara; Halia bentong; Photosynthesis; Salicylic acid