

## Effect of CO<sub>2</sub> enrichment on synthesis of some primary and secondary metabolites in Ginger (*Zingiber officinale* Roscoe).

### Abstract

The effect of two different CO<sub>2</sub> concentrations (400 and 800  $\mu\text{mol mol}^{-1}$ ) on the photosynthesis rate, primary and secondary metabolite syntheses and the antioxidant activities of the leaves, stems and rhizomes of two *Zingiber officinale* varieties (Halia Bentong and Halia Bara) were assessed in an effort to compare and validate the medicinal potential of the subterranean part of the young ginger. High photosynthesis rate (10.05  $\mu\text{mol CO}_2 \text{ m}^{-2}\text{s}^{-1}$  in Halia Bara) and plant biomass (83.4 g in Halia Bentong) were observed at 800  $\mu\text{mol mol}^{-1}$  CO<sub>2</sub>. Stomatal conductance decreased and water use efficiency increased with elevated CO<sub>2</sub> concentration. Total flavonoids (TF), total phenolics (TP), total soluble carbohydrates (TSC), starch and plant biomass increased significantly ( $P \leq 0.05$ ) in all parts of the ginger varieties under elevated CO<sub>2</sub> (800  $\mu\text{mol mol}^{-1}$ ). The order of the TF and TP increment in the parts of the plant was rhizomes > stems > leaves. More specifically, Halia Bara had a greater increase of TF (2.05 mg/g dry weight) and TP (14.31 mg/g dry weight) compared to Halia Bentong (TF: 1.42 mg/g dry weight; TP: 9.11 mg/g dry weight) in average over the whole plant. Furthermore, plants with the highest rate of photosynthesis had the highest TSC and phenolics content. Significant differences between treatments and species were observed for TF and TP production. Correlation coefficient showed that TSC and TP content are positively correlated in both varieties. The antioxidant activity, as determined by the ferric reducing/antioxidant potential (FRAP) activity, increased in young ginger grown under elevated CO<sub>2</sub>. The FRAP values for the leaves, rhizomes and stems extracts of both varieties grown under two different CO<sub>2</sub> concentrations (400 and 800  $\mu\text{mol mol}^{-1}$ ) were significantly lower than those of vitamin C (3107.28  $\mu\text{mol Fe (II)/g}$ ) and  $\alpha$ -tocopherol (953  $\mu\text{mol Fe (II)/g}$ ), but higher than that of BHT (74.31  $\mu\text{mol Fe (II)/g}$ ). These results indicate that the plant biomass, primary and secondary metabolite synthesis, and following that, antioxidant activities of Malaysian young ginger varieties can be enhanced through controlled environment (CE) and CO<sub>2</sub> enrichment.

Keyword: CO<sub>2</sub> enrichment; TSC; TF; TP; FRAP assay; Halia Bara.