

## **Elevated carbon dioxide increases contents of flavonoids and phenolic compounds, and antioxidant activities in Malaysian young ginger (*Zingiber officinale* Roscoe.) varieties.**

### **Abstract**

*Zingiber officinale* Roscoe. (Family Zingiberaceae) is well known in Asia. The plant is widely cultivated in village gardens in the tropics for its medicinal properties and as a marketable spice in Malaysia. Ginger varieties are rich in physiologically active phenolics and flavonoids with a range of pharmacological activities. Experiments were conducted to determine the feasibility of increasing levels of flavonoids (quercetin, rutin, catechin, epicatechin, kaempferol, naringenin, fisetin and morin) and phenolic acid (gallic acid, vanillic acid, ferulic acid, tannic acid, cinnamic acid and salicylic acid), and antioxidant activities in different parts of Malaysian young ginger varieties (Halia Bentong and Halia Bara) with CO<sub>2</sub> enrichment in a controlled environment system. Both varieties showed an increase in phenolic compounds and flavonoids in response to CO<sub>2</sub> enrichment from 400 to 800  $\mu\text{mol mol}^{-1}$  CO<sub>2</sub>. These increases were greater in rhizomes compared to leaves. High performance liquid chromatography (HPLC) results showed that quercetin and gallic acid were the most abundant flavonoid and phenolic acid in Malaysian young ginger varieties. Under elevated CO<sub>2</sub> conditions, kaempferol and fisetin were among the flavonoid compounds, and gallic acid and vanillic acid were among the phenolic compounds whose levels increased in both varieties. As CO<sub>2</sub> concentration was increased from 400 to 800  $\mu\text{mol mol}^{-1}$ , free radical scavenging power (DPPH) increased about 30% in Halia Bentong and 21.4% in Halia Bara; and the rhizomes exhibited more enhanced free radical scavenging power, with 44.9% in Halia Bentong and 46.2% in Halia Bara. Leaves of both varieties also displayed good levels of flavonoid compounds and antioxidant activities. These results indicate that the yield and pharmaceutical quality of Malaysian young ginger varieties can be enhanced by controlled environment production and CO<sub>2</sub> enrichment

**Keyword:** CO<sub>2</sub> enrichment; Flavonoids; Free radical scavenging (DPPH) power; Phenolic acids.