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# Effects of different drying methods on the antioxidant properties of leaves and tea of ginger species

E.W.C. Chan, Y.Y. Lim\*, S.K. Wong, K.K. Lim, S.P. Tan, F.S. Lianto, M.Y. Yong

School of Science, Monash University Sunway Campus, Bandar Sunway, 46150 Petaling Jaya, Selangor, Malaysia

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#### ABSTRACT

Effects of five different drying methods on the antioxidant properties (AOP) of leaves of *Alpinia zerumbet*, *Etlingera elatior*, *Curcuma longa*, and *Kaempferia galanga* were assessed. All methods of thermal drying (microwave-, oven-, and sun-drying) resulted in drastic declines in total phenolic content (TPC), ascorbic acid equivalent antioxidant capacity (AEAC), and ferric-reducing power (FRP), with minimal effects on ferrous ion-chelating ability and lipid peroxidation inhibition activity. Of the non-thermal drying methods, significant losses were observed in air-dried leaves. Freeze-drying resulted in significant gains in TPC, AEAC, and FRP for *A. zerumbet* and *E. elatior* leaves. After one week storage, AOP of freeze-dried *E. elatior* leaves remained significantly higher than those of fresh control leaves. Freeze-dried tea of *A. zerumbet* was superior to the commercial tea for all AOP studied.

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### 1. Introduction

Past studies on the antioxidant properties (AOP) of ginger species (Zingiberaceae) were confined to rhizomes. Although their leaves have been used for food flavouring and in traditional medicine (Larsen, Ibrahim, Khaw, & Saw, 1999), very little research has been done on their total phenolic content (TPC) and antioxidant activity (AOA).

Alpinia zerumbet, also known as Shell Ginger, is an ornamental plant with attractive fragrant flowers. In Japan, leaves of *A. zerumbet* (Getto) are sold as herbal tea, and are used to flavour noodles and wrap rice cakes. Its tea has hypotensive, diuretic, and antiulcerogenic properties (Mpalantinos, de Moura, Parente, & Kuster, 1998). Decoction of leaves has been used during bathing to alleviate fevers. From the leaves of *A. zerumbet*, flavonoids, kava pyrones, and phenolic acids have been isolated (Elzaawely, Xuan, & Tawata, 2007; Mpalantinos et al., 1998). Leaves of *A. zerumbet* had the highest TPC and AOA among five species of *Alpinia* studied (Chan et al., 2008). Leaves had higher inhibition of β-carotene oxidation and radical–scavenging activity than rhizomes (Elzaawely et al., 2007).

Etlingera elatior or Torch Ginger is widely cultivated throughout the tropics. Young inflorescences are commonly used as the ingredients of spicy dishes (Larsen et al., 1999). Post-partum women use *E. elatior* leaves together with other aromatic herbs for bathing to remove body odour. They are also used for cleaning wounds. Flavonoids in leaves of *E. elatior* have been identified as kaempferol 3-glucuronide, quercetin 3-glucoside, and

quercetin 3-rhamnoside (Williams & Harborne, 1977). Screening of leaves of 26 ginger species belonging to nine genera showed that species of *Etlingera* had the highest phenolic content and radicalscavenging activity (Chan et al., 2008). Leaves of *E. elatior* had the most outstanding AOP among five *Etlingera* species studied (Chan, Lim, & Omar, 2007).

Curcuma longa is a widely cultivated ginger plant with pungent rhizomes that produce turmeric, a popular spice for curries, food flavouring, and colouring. Curcumin, the active component of turmeric, is known to have a wide array of bioactivity including antioxidant, anti-inflammatory, anti-cancer, and cardio-protective properties. The aromatic leaves of *C. longa* are used for flavouring steamed and baked fish (Larsen et al., 1999). Phenolic content and radical–scavenging activity were significantly higher in rhizomes than in leaves of *C. longa*, but metal ion-chelating ability was higher in leaves (Chan et al., 2008).

Kaempferia galanga is a small, cultivated ginger plant with broadly ovate and pale green leaves. Its leaves and rhizomes are used in traditional medicine, perfumery, and food flavouring. Rhizomes of *K. galanga* are used as expectorants and carminatives. They are also used as ingredient for preparing 'Jamu', a local health tonic consumed by the Malays. Its mild spicy leaves are ingredients for savoury dishes. Its leaves and rhizomes are eaten fresh or cooked as a vegetable, and used in cosmetic powder and as a food flavouring agent. Phenolic content, radical–scavenging activity, and metal ion-chelating ability were significantly higher in leaves than in rhizomes of *K. galanga* (Chan et al., 2008).

In our present study, TPC and AOA of leaves of *A. zerumbet*, *E. elatior*, *C. longa*, and *K. galanga* as affected by three thermal drying methods (microwave-, oven-, and sun-drying) and two

<sup>\*</sup> Corresponding author. Tel.: +60 3 55146103; fax: +60 3 55146364. E-mail address: Lim.Yau.Yan@sci.monash.edu.my (Y.Y. Lim).