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Antioxidant and tyrosinase inhibition properties of leaves and rhizomes of ginger species

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Abstract

Total phenolic content (TPC) and ascorbic acid equivalent antioxidant capacity (AEAC) of leaves of 26 ginger species belonging to nine genera and three tribes were screened. For 14 species, TPC and AEAC of rhizomes were also assessed. Ferrous ion-chelating (FIC) abilities of leaves and rhizomes of eight species were compared. Leaves of five species of *Etlingera* were analysed for tyrosinase inhibition activity. Of the 26 species, leaves of *Etlingera* species had the highest TPC and AEAC. Eleven of the 14 species had significantly higher TPC and/or AEAC in leaves than in rhizomes. Values of leaves of *Etlingera elatior* and *Etlingera maingayi* were seven to eight times higher than those of rhizomes. In terms of FIC ability, six of the eight species clearly showed higher values in leaves than in rhizomes. The most outstanding was the FIC value of *Alpinia galanga* leaves which was more than 20 times higher than that of rhizomes. Of the five species of *Etlingera*, leaves of *E. elatior* displayed the strongest tyrosinase inhibition activity, followed by leaves of *Etlingera fulgens* and *E. maingayi*. Values of their inhibition activity were significantly higher than or comparable to the positive control. Besides promising tyrosinase inhibition ability, leaves of these three *Etlingera* species also have high antioxidant activity and antibacterial properties.

Keywords: Zingiberaceae; Leaves; Rhizomes; Total phenolic content; Antioxidant activity; Tyrosinase inhibition activity

1. Introduction

Rhizomes of ginger plants (family Zingiberaceae) have been widely used as spices or condiments (Larsen, Ibrahim, Khaw, & Saw, 1999). Rhizomes are eaten raw or cooked as vegetables and used for flavouring food. Major commercially cultivated species are *Zingiber officinale*, *Curcuma longa*, and *Alpinia galanga*. As traditional medicine, rhizomes of ginger plants are consumed by women during ailment, illness and confinement. Rhizomes are also taken as carminatives for relieving flatulence.

Leaves of ginger plants have also been used for food flavouring and in traditional medicine. In Malaysia, leaves of *C. longa* are used to wrap fish before steaming or baking (Larsen et al., 1999). Leaves of *Kaempferia galanga* and *C. longa* are ingredients of curries. Some tribal natives in Malaysia flavour their wild meat and fish dishes with leaves of *Elettariopsis slahmong* (Lim, 2003). In Thailand, its leaves are eaten as salad. Despite their repulsive stinkbug odour, leaves of *E. slahmong* are considered a delicacy. Traditionally, leaves of *Elettariopsis latiflora* have been used to relieve flatulence, to improve appetite and as an antidote to poisons. In Okinawa, Japan, leaves of *Alpinia zerumbet* are sold as herbal tea, and are commonly used to flavour noodles and to wrap rice cakes. The hypotensive, diuretic, and anti-ulcerogenic properties of tea from *A. zerumbet* leaves have been reported (Mpalantinos, de Moura, Parente, & Kuster, 1998). Leaves of *Etlingera elatior*, mixed with other aromatic herbs, are used by *post-partum* women for bathing to remove body odour (Ibrahim & Setyowati, 1999). They are also used for cleaning wounds. Leaves of

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Kaempferia rotunda and *K. galanga* are eaten fresh or cooked as vegetables, and used as cosmetic powder and as food flavouring agents (Ibrahim, 1999). In Peninsular Malaysia, boiled leaves of *Hedychium* species are eaten for indigestion (Ibrahim, 2001). Leaves are sometimes eaten with betel nut to ease abdominal pain. In Thailand, boiled leaves of *Hedychium coronarium* are applied to relieve stiff and sore joints.

Past studies on the antioxidant properties of ginger species were confined to rhizomes (Habsah et al., 2000; Jitoe et al., 1992; Zaeoung, Plubrukarn, & Keawpradub, 2005). Rhizomes of gingers have been reported to have tyrosinase inhibition properties (Lee, Kim, Kim, Heo, & Kim, 1997). Skin-lightening cosmeceutical products were recently developed from rhizomes of gingers (Rozanida, Nurul Izza, Mohd Helme, & Zanariah, 2006). Although leaves of ginger species have been used for food flavouring and in traditional medicine, little research has been done on their antioxidant and tyrosinase inhibition properties.

In our present study, phenolic contents and radical-scavenging activities of leaves of 26 ginger species were screened. For 14 species, antioxidant properties of rhizomes were assessed. For eight species, metal ion-chelating abilities of leaves and rhizomes were also compared. Leaves of five species of *Etlingera* were analysed for tyrosinase inhibition activity. This study represents the most comprehensive study, where antioxidant properties of leaves and rhizomes of ginger species were systematically compared, and tyrosinase inhibition properties of leaves of *Etlingera* species were analysed.

2. Materials and methods

2.1. Plant materials

Locations where species were sampled for leaves and rhizomes are listed in Table 1. Voucher specimens of ginger plants studied were deposited in the herbaria of the Forest Research Institute Malaysia (FRIM) and Monash University Sunway Campus (MUSC), Malaysia.

2.2. Chemicals and instruments

Folin–Ciocalteu's phenol reagent (Fluka, 2N), gallic acid (Fluka, 98%), and anhydrous sodium carbonate (Fluka, 99%) were used for TPC analysis. 1,1-Diphenyl-2-picrylhydrazyl (Sigma, 90%) was used for DPPH radical-scavenging assay. Ferrozine (Acros Organics, 98%) and ferrous sulphate heptahydrate (HmbG chemicals) were used for FIC assay. L-DOPA (Sigma), mushroom tyrosinase (Sigma), and DMSO (Fisher Scientific) were used for assessing tyrosinase inhibition. Absorbance was measured with an Anthelie Advanced 5 Secoman UV–vis spectrophotometer for TPC and antioxidant activity, and with a BIOTEK PowerWave XS Microplate scanning spectrophotometer for tyrosinase inhibition activity.

Table 1
Locations of sampling leaves and rhizomes of ginger species

Species	Tribe	Location of sampling
Alpinia galanga	Alpineae	Bukit Maluri, Kepong, KL
A. malaccensis		FRIM, Kepong, Selangor
A. purpurata		SUC, Sunway, Selangor
A. zerumbet		Janda Baik, Pahang
A. zerumbet 'Variegata'		FRIM, Kepong, Selangor
Boesenbergia rotunda	Hedychieae	Sungai Buluh, Selangor
Curcuma aeruginosa	Hedychieae	Damansara Utama, Selangor
C. longa		FRIM, Kepong, Selangor
C. mangga		Damansara Utama, Selangor
C. zanthorrhiza		Damansara Utama, Selangor
Elettariopsis latiflora	Alpineae	FRIM, Kepong, Selangor
E. slahmong		FRIM, Kepong, Selangor
E. smithiae		Janda Baik, Pahang
Etlingera elatior	Alpineae	Janda Baik, Pahang
E. fulgens		Janda Baik, Pahang
E. littoralis		Genting Highlands, Pahang
E. maingayi		Janda Baik, Pahang
E. rubrostriata		Ulu Gombak, Selangor
Hedychium coronarium	Hedychieae	Lake Gardens, KL
Kaempferia galanga	Hedychieae	Damansara Utama, Selangor
K. pulchra		Sungai Buluh, Selangor
K. rotunda		Bukit Maluri, Kepong, KL
Scaphochlamys kunstleri	Hedychieae	FRIM, Kepong, Selangor
Zingiber officinale	Zingibereae	Bukit Maluri, Kepong, KL
Z. ottensii		Bukit Maluri, Kepong, KL
Z. spectabile		FRIM, Kepong, Selangor

Abbreviations: FRIM, Forest Research Institute Malaysia; SUC, Sunway University College; KL, Kuala Lumpur.

2.3. Extraction of plant samples

For antioxidant analysis, fresh leaves and rhizomes (1 g) were powdered with liquid nitrogen in a mortar and extracted using methanol (50 ml), with continuous swirling for 1 h at room temperature using an orbital shaker. Extracts were filtered under suction and stored at −20 °C for further use. For tyrosinase inhibition, fresh leaves (10 g) were extracted three times using methanol (100 ml). Methanol was removed by drying at 35 °C in a rotary evaporator prior to storage at −20 °C. Analysis of methanol extracts for antioxidant and tyrosinase inhibition properties was done in triplicate.

2.4. Total phenolic content

Total phenolic content (TPC) of extracts was determined using the Folin-Ciocalteu assay reported by Kähkönen et al. (1999). Samples (300 μl in triplicate) were introduced into test tubes, followed by 1.5 ml of Folin–Ciocalteu's reagent (10 times dilution) and 1.2 ml of sodium carbonate (7.5% w/v). The tubes were allowed to stand for 30 min before absorbance at 765 nm was measured. TPC was expressed as gallic acid equivalents (GAE) in mg per