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Screening of antioxidant activity and antioxidant compounds of some edible plants of Thailand

Anchana Chanwitheesuk, Aphiwat Teerawutgulrag, Nuansri Rakariyatham *

Department of Chemistry, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand

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Abstract

A large number of plants, which have been used as food and herbs in Thailand, were investigated for their antioxidant activity by using a β-carotene bleaching method. The contents of plant chemicals, such as vitamin C, vitamin E, carotenoids, tannin, and total phenolics, were also determined. The results showed that the highest antioxidant activity was found in the plant *Gymnema inodorum*, followed by *Piper sarmentosum* and *Mentha arvensis*, respectively. *G. inodorum* also contained the highest amount of vitamin E, and *M. arvensis* contained the highest amount of total xanthophylls. Correlations between the chemical content of each plant and the antioxidant index were observed. The results suggest that chemicals such as vitamin C, vitamin E, carotenoids, and phenolic compounds are the contributors to the antioxidant activity in the plants.

Keywords: Antioxidant activity; Antioxidant compounds; Edible plants

1. Introduction

The oxidative deterioration of lipid-containing food is responsible for the rancid odours and flavours during processing and storage, consequently decreasing the nutritional quality and safety of foods due to the formation of secondary, potentially toxic compounds (Zainol, Abd-Hamid, Yusof, & Muse, 2003). Moreover, in humans, lipid oxidation is also thought to induce physiological obstruction, causing aging of the cells and carcinogenesis (Lampart-Szczapa, Korczak, Nogala-Kalucka, & Zawirska-Wojtasiak, 2003). A large number of experimental studies indicate that lipid oxidation products, called free radicals, can harm healthy cells, create harmful molecules, and contribute to the degenerative processes related to aging and diseases, e.g. cancer, cardiovascular disease, and neurodegenerative disorders, such as Alzheimer's disease (Croft, 1999; Lemberkovics, Czinner, Szentmihályi, Balázs, & Szöke, 2002; Sami, 1995; Shon, Kim, & Sung, 2003). The antioxidants are now known to play an important role in protection against disorders caused by oxidant damage. The term "antioxidants" refers to compounds that can delay or inhibit the oxidation of lipids or other molecules by inhibiting the initiation or propagation of oxidative chain reaction (Velioglu, Mazza, Gao, & Oomah, 1998), and which can thus prevent or repair damage done to the body's cells by oxygen. They act in one or more of the following ways: reducing agents, free radical scavengers, potential complexers of pro-oxidant metals, and quenchers of singlet oxygen (Hudson, 1990).

Recently, there has been a considerable interest in finding natural antioxidants from plant materials to replace synthetic ones. Natural antioxidant substances are presumed to be safe since they occur in plant foods, and

* Corresponding author. Tel.: +66 53 943341-45x342; fax: +66 53 892277.
E-mail address: nuansril@yahoo.com (N. Rakariyatham).

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are seen as more desirable than their synthetic counterparts. Data from both scientific reports and laboratory studies show that plants contain a large variety of substances called ''plant chemicals'' or ''phytochemicals'' that possess antioxidant activity (Pratt, 1992). Natural antioxidants occur in all higher plants, and in all parts of the plant (wood, bark, stems, pods, leaves, fruit, roots, flowers, pollen, and seeds). Typical compounds that exhibit antioxidant activity include vitamins, carotenoids, and phenolic compounds. Therefore, recommendations have been made to increase the daily intake of fruit and vegetables, which are rich in these nutrients that lower the risk of chronic health problems associated with the diseases mentioned above (Klipstein-Grobusch et al., 2000; Moeller, Jacques, & Blumberg, 2000; Morris et al., 1998; Slattery et al., 2000).

The antioxidant compounds of higher plants have been demonstrated, in vitro experiments, to protect against oxidation damage by inhibiting or quenching free radicals and reactive oxygen species. The roles of these compounds as potential antioxidants can be inferred by their similarity to synthetic antioxidants, of related structures (Larson, 1988). Vitamin C has been proposed, for a long time, as a biological antioxidant. It was found to act as a chain-breaking scavenger for peroxy radicals and also to act as a synergist with vitamin E, since vitamin C can donate a hydrogen atom to the vitamin E-derived phenolate radical, thus regenerating its activity. Vitamin E is one of the best quenchers for singlet oxygen, and can act as a chain-breaking antioxidant. Furthermore, singlet oxygen is very powerfully quenched by carotenoids, especially β-carotene. In the case of phenolic compounds, the ability of the phenolics to act as antioxidants depends on the redox properties of their phenolic hydroxyl groups, that allow them to act as reducing agents, hydrogen-donating antioxidants, oxygen quenchers (Rice-Evans & Miller, 1996).

In the present study, we collected 43 edible plant species from eight families that are widely consumed in Thailand, and analyzed antioxidant activities of methanolic extracts prepared from these plants. The contents of six antioxidant compounds, including vitamin C, vitamin E, total carotenes, total xanthophylls, tannins, and total phenolics, were also investigated in the plants.

2. Materials and methods

2.1. Plant material

The plant species used were purchased from a local market in Chiang Mai, Thailand, during June–October 2000. They were identified botanically at the Biology Department of Chiang Mai University. The scientific names of the plants which were used in the study are given in Table 1. The plants were cleaned and cut into small pieces before being dried in a hot air-blowing oven at 50 °C. All samples, after drying, had water contents below 10%. They were ground to a fine powder in a mechanical blender and kept at room temperature prior to extraction. The dried plants were used for the analysis of antioxidant activity, vitamin C, vitamin E, carotenoids, tannins and phenolic compounds.

2.2. Determination of antioxidant activity

A dried plant was soaked overnight in methanol at room temperature in a flask. Each flask contained 0.5 g sample in 10 ml of methanol. The extract was filtered through Whatman No. 42 filter paper, and the residue was washed with hot methanol. The insoluble residue was discarded. The filtrate was evaporated in a water bath at 40 °C to a final volume 1 ml. Antioxidant activity was determined by measuring the coupled oxidation of carotene and linoleic acid, as described by Hammerschmidt and Pratt (1978). One ml of β-carotene solution in chloroform (1 mg/10 ml) was pipetted into a flask, which contained linoleic acid and Tween 40. After removal of the chloroform on a water bath at 50 °C, 50 ml of distilled water (which was bubbled by an air pump for 1 h) were added to the flask with vigorous swirling. Five ml aliquots of this emulsion were placed in test tubes which contained 0.2 ml of the extracts. Samples were read against a blank containing the emulsion minus the carotene. A reading at 470 nm was taken immediately ($t = 0$) and then at 15-min intervals for 105 min. The bleaching rate of β-carotene was determined by the difference in the spectral absorbance reading between the initial and last reading of bleaching that remained essentially linear divided by time. The antioxidant index was the ratio of the bleaching rate of control (system with no added test compound) to the bleaching rate when a test compound was in the system.

2.3. Determination of vitamin C content

The content of vitamin C in the plants was determined by the spectrophotometric procedure of Bajaj and Kaur (1981). A known mass of dried plant material (0.5 g) was extracted overnight with 10 ml of oxalic acid–EDTA solution at room temperature. The extract was filtered through a filter paper. A 2.5 ml aliquot was then transferred into a 25-ml volumetric flask. Then, the other reagents (2.5 ml of oxalic acid-EDTA solution, 0.5 ml of metaphosphoric acid-acetic acid solution, 0.1 ml of sulfuric acid solution, and 2 ml of ammonium molybdate reagent) were added. After that, the solvent was adjusted to a volume of 25 ml with distilled water. The molybdenum blue complex, which was formed by the reduction of ammonium molybdate with ascorbic acid (vitamin C), was