1.0 INTRODUCTION

Free radicals (e.g., super oxide, nitric oxide and hydroxyl radicals) and other reactive species (e.g., hydrogen peroxide, peroxynitrite and hypochlorous acid) are constantly being formed in the body as by products of energy metabolism during immune reactions. Free radicals are highly reactive chemicals that indiscriminately attack and destroy tissues causing aging, inflammation, allergies, disease, and disrupt organ and enzyme function. Free radicals play a dual function as both hazardous and beneficial compounds in human body. Immune system is the main body system that utilizes free radicals to fight infection, in which the radicals are generated by phagocytic cells to kill invading pathogens (Droge, 2002b).

Oxidative stress is a condition that arises when cells cannot adequately destroy the free radicals. The body is constantly exposed to free radicals from the environment as a result of air pollution, electromagnetic fields and toxins in the food, including pesticides, food additives and processing derivatives. In addition, chronic stress adds to the free radical load in the body.

Oxygen, an essential element for life, can create damaging by-products during normal cellular metabolism. Antioxidants counteract these cellular by-products, called free radicals, and bind with them before they can cause damage. Antioxidants in the right amounts and combinations have been shown to prevent free radical damage. Antioxidants are emerging as prophylactic and therapeutic agents, which among others, scavenge free radicals such as reactive oxygen species and prevent the damage caused by them (Venkat Ratnam *et al*., 2006).

Synthetic antioxidants such as butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) have limited use in foods, as they are suspected to be carcinogenic (Namiki, 1990). As a result, the importance of exploiting natural antioxidants from by-products obtained during food processing has increased tremendously in recent years. Natural antioxidants are considered to be attractive due to their low cost and availability in large quantity as raw material (Kong *et al*., 2010). Therefore, the search for non-toxic high potential natural antioxidants is of increasing interest. Numerous works have been carried out on antioxidant activities from different plant sources (Cai *et al*., 2004; Okonogi *et al*., 2007).

Natural antioxidants from fruits and vegetables provide a measure of protection that slows the process of oxidative damage (Bruckdorfer, 1996; Hsu, 2006; Pietta, 2000). Recent studies have shown that many flavonoids and related polyphenols contribute significantly to the total antioxidant activity of many fruits and vegetables (Bozin *et al*., 2008; Singh *et al*., 2008). Natural antioxidants such as flavonoids, phenolics, tannins, curcumin and terpenoids are found in various plants (Fritz *et al*., 2003; Jayaprakasha *et al.,* 2002; Prakash *et al.,* 2007). They can reduce the access of oxidants and other deleterious molecules due to their ability to scavenge oxygen-nitrogen-derived free radicals by donating hydrogen atom or an electron, chelating metal catalysts, activating antioxidant enzymes, and inhibiting oxidases (Ames *et al*., 1993; Ardestani & Yazdanparast, 2007; Patricia *et al*., 2005; Robak & Gryglewski, 1988). Based on accumulative evidence, in recent decades, tremendous interest has considerably increased in finding natural substances (i.e., antioxidants) present in foods or medicinal plants to replace synthetic antioxidants, which are being restricted due to their side effects. On the other hand, polyphenols, used as natural antioxidants, are gaining importance, due to their health benefits for humans, decreasing the risk of cardiovascular and degenerative diseases by reduction of oxidative stress and counteraction of macromolecular oxidation (Bingham *et al.*, 2003; Silva *et al.*, 2004). Natural antioxidants are also in high demand for application as nutraceuticals/functional food/bio-pharmaceuticals because of consumer preferences.

The World Health Organisation and Food and Agricultural Organisation (2003) recommended the daily consumption of at least 400 g of fruit and vegetables for the prevention of heart disease, cancer, type II diabetes and obesity. The protective effects of vegetables and fruit may be contributed by their antioxidant content (Lako *et al.*, 2007; Naczk & Shahidi, 2006). These antioxidants may help to relieve oxidative stress, i.e. preventing free radicals from damaging biomolecules such as proteins, DNA, and lipids (Shahidi & Naczk, 2004). Through additive and synergistic effects, the complex mixture of phytochemicals in vegetables and fruit may provide better protection than a single phytochemical (Liu, 2003), one of the reasons why diet rich in fruits and vegetables from different colour group is recommended (Heber, 2001). These highlight the importance of comprehensive antioxidants measurement in fruits and vegetables.

Generally, Malaysians consume vegetables that are relatively abundant sources of antioxidant components with strong potential antioxidant activities (Amin *et al.*, 2004, 2006; Amin & Lee, 2005). In this study, six selected local vegetables namely *Allium tuberosum, Apium graveolens* (L.), *Ipomoea batatas* (L.), *Murraya koenigii* (L.), *Psophocarpus tetragonolobus,* and *Sauropus androgynus* were tested for antioxidant activities.

1.1 *Allium tuberosum*

Allium tuberosum or garlic chives which are also known as Chinese chives, Chinese leek, “ku chai” is a relatively new vegetable in the English-speaking world but well-known in Asian cuisine, where the flavor of garlic chives is more like garlic than chives, though much milder. Garlic chives are much used in Chinese herbal medicines to treat fatigue, control excessive bleeding, and as an antidote for ingested poisons. The leaves and bulbs are applied to insect bites, cuts, and wounds, while the seeds are used to treat kidney, liver, and digestive system problems. Till now no study has been carried out to compare the beneficial effect of these two species of garlic against hyperlipidemia hence this study was under taken to discover the relative potency of these agents with respect to their anti-hyperlipidemic effect and curative potential against atherosclerosis (Chevallier, 1996).

1.2 *Apium graveolens* (L.)

Apium graveolens (L.) is a plant species in the family Apiaceae commonly known as celery (var. *dulce*) or celeriac (var. *rapaceum*) depending on whether the petioles or roots are eaten. *Apium graveolens* is used worldwide as a vegetable, either for the crisp petiole (leaf stalk) or the fleshy taproot. In temperate countries, celery is also grown for its seeds. The use of celery seed in pills for relieving pain was described by Aulus Cornelius Celsus ca. 30 AD. The seeds are also used to treat arthritis and urinary tract infections. Essential oils from celery have a sedative and anticonvulsant effect, and are used in the treatment of hypertension (Chevallier, 1996).

1.3 *Ipomoea batatas* (L.)

Ipomoea batatas (L.), or the sweet potato leaves is from a dicotyledonous plant which belongs to the family Convolvulaceae. Amongst the approximately 50 genera and more than 1000 species of this family, only *I. batatas* is a crop plant whose large, starchy, sweet tasting tuberous roots are an important root vegetable (Purseglove, 1991; Woolfe, 1992). The young leaves and shoots are sometimes eaten as greens. In total, they contain 15 different compounds that could help prevent heart disease, diabetes, infection and some types of cancer (Edmond & Ammerman, 1971).

1.4 *Murraya koenigii* (L.)

Murraya koenigii (L.), or the curry leaves is from a tropical to sub-tropical tree in the family Rutaceae, which is native to India. It produces the leaves known as curry leaves or sweet neem leaves. The leaves are highly valued as seasoning in South Indian and Sri Lankan cooking. Apart from cooking, the curry leaves has a number of medicinal uses. In India, the curry leaf is used to prevent conditions such as nausea and stomach upsets. It is also used in treating skin irritations and poisonous bites. Its oil is invaluable as repellants and to cure skin disorders common to the tropics. The leaves of *Murraya koenigii* are also used as an herb in Ayurvedic medicine (Arulselvan & Subramanian, 2007).

1.5 *Psophocarpus tetragonolobus*

Psophocarpus tetragonolobus or the winged bean also known as the Goa bean (kacang botol in Malaysia) is a tropical legume plant native to Papua New Guinea. It grows abundantly in hot, humid equatorial countries, with high rainfall. The plant is one of the best nitrogen fixers with nodulation accomplished by the soil bacterium Rhizobium. Because of its ability to fix nitrogen from the atmosphere, the plant requires very little or no fertilizers. This bean has been called the "one species supermarket" because practically all of the plant is edible. The beans are used as a vegetable, but the other parts (leaves, flowers, and tuberous roots) are also edible. Each of these parts of the winged bean provides a source of vitamin A, vitamin C, calcium, iron, and other vitamins (Venketeswaran *et al*., 1990).

1.6 *Sauropus androgynus*

Sauropus androgynus, also known as katuk, star gooseberry, or sweet leaf, is a shrub grown in some tropical regions as a leaf vegetable. Among the Chinese it is called “mani cai”, and among the Malays it is called “cekur manis” or “sayur manis”. It is one of the most popular leaf vegetables in South Asia and Southeast Asia and is notable for high yields and palatability. The shoot tips have been sold as tropical asparagus. It is among only a few floras containing vitamin K (Kao *et al*., 1999).

1.7 Objectives

The **objectives of the study** are to evaluate the crude petroleum benzene, chloroform, methanol and water extracts of *Allium tuberosum, Apium graveolens* (L.)*, Ipomoea batatas* (L.)*, Murraya koenigii* (L.)*, Psophocarpus tetragonolobus,* and *Sauropus androgynus* for:

- radical scavenging activities using DPPH Radical Scavenging Assay
- reducing ability using the Reducing Power Assay
- metal chelating ability using the metal chelating assay
- ability to enhance H_20_2 reduction using the haemolysate catalytic assay
- the level of lipid hydroperoxide using the lipid hydroperoxide assay
- phytochemical contents using thin layer chromatography