Folk Medicine, Pharmacological and Biological Activities

Amaranthus cruentus and *Amaranthus hybridus* have a high nutritional value (e.g. Aletor and Adeiogum, 1995; Cai and Corke, 1999; Guerra-Matias and Areas, 2005; Fasuyi, 2006, 2007; Odhav *et al*., 2007). The consumption of *Amaranthus cruentus* products is advised for patients with celiac disease and therefore, also for diabetic persons (Guerra-matias and Areas, 2005). *Amaranthus hybridus* is one of the antimalarial herbal remedies in Kenya (Nguta *et al*., 2010) These two species are reputed to promote health and a long shelf life (Nana *et al*., 2012).

Amaranthus hybridus has been used tradionally for the treatment of liver infections and Knee pain and for its laxative, diuretic and circatrisation properties (Ibrahim *et al*., 2011; Nana *et al*., 2012); the products are used particulary for stomachaches, diarrhea and dysentery. *Amaranthus hybridus* leaves are used as a vegetable (Dhellot *et al*., 2006), and sauces prepared from the plant are recommended for convalescent patients. The seeds of both *Amaranthus cruentus* (Cheng *et al*., 2010a) and *Amaranthus hypochondriacus* (Cheng *et al*., 2010b) have been reported to produce fermented beverages rich in nutrients and can be used for preventing hypertension, hyperlipemia, cardiovascular and cerebrovascular diseases, diabetes, obesity and digestive system diseases. A beverage has been also prepared from *Amaranthus paniculatus* (Sokolenko *et al*., 2012).

Amaranthus paniculatus has been reported valuable as an antiscorbutic. The tender leaf is also eaten as a vegetable in Iran and Iraq. The plant is cultivated in many warm countries for

its grain and supplies the staple food of hill tribes over a large area in the Indian Peninsula. In Central Africa the plant has been used for making red ink. The plant may be poisonous when frosted or wilted although it has been stated that it is eaten by livestock. In India the plant has been found to benefit piles and stangury and is also used as a diuretic. It is applied locally to scrofulous sores. A leaf infusion is used for chest complaints in Philippines (Watt and Breyer-Brandwijk, 1962).

Amaranthus cruentus is used in Nigeria as expellant, for relief of respiratory diseases and tapeworm (Mensah *et al*., 2008).

No significant difference in biological value was found between *Amaranthus cruentus*, *Amaranthus gangeticus* and *Amaranthus mangostanus* when fed to rats at 10% level of protein intake (Narang and Puri, 1961)

Mbiapo and Moundipa (1993) studied the effects of the leafy vegetable *Amaranthus hybridus* diet on the drug-metabolizing enzymes after aflatoxin B_1 treatment in male rats for 30 days. The results obtained confirmed the ability of *Amaranthus hybridus* to induce hepatic liver drug-metabolizing enzymes by improving nutritional value of the diet. The trypsin-chemotrypsin inhibitor (AmI), isolated from the seeds of *Amaranthus hybridus* var. *erythrostachys* inhibited the anchorage-independent growth of MCF-7 breast cancer cells, suggesting that AmI may have anticarcinogenic activity (Tamir *et al*., 1996).

The aqueous leaves extract of *Amaranthus hybridus* produced a minimal antianemic effect, reflected by a significant increase ($P < 0.05$) in haemoglobin concentration in phenylhydrazine-induced anemia in rabbits (Ogbe *et al*., 2010). The ethanol and aqueous root extracts of *Amaranthus hybridus* possess significant and dose dependent central and peripheral antinociceptive activity justifying its traditional use in treating conditions associated with painful conditions (Singh and Sheoran, 2011).

Rivillas-Acevedo and Soriano-Garcia (2007) confirmed the antifungal activity of a protean extract from *Amaranthus hypochondriacus* against such pathogenic fungi as *Alternaria alternata*, *Fusarium solani*, *Candida albicans*, *Fusarium oxysporum*, *Trichoderma* sp. and *Aspergillus ochraceus*. The antibacterial activity of *Amaranthus hybridus* has been reported (Wagate *et al*., 2010). Glutelin extracts (from *Amaranthus hypochondriacus*) digested with trypsin, showed the induction of apoptosis against HeLa cells. Prediction of other bioactive peptides in amaranth globulins and glutelins were mainly antihypertensive (Silva-Sanchez *et al*., 2008). The antihypertensive activity of *Amaranthus hypochondriacus* seed peptides was reported (Fritz *et al*., 2011). The plant has been suggested by the latter authors to exert a protective effect in serum and liver of rats intoxicated with ethanol.

Experiments with isolated rat heart showed that pectin isolated from *Amaranthus cruentus* caused coronary spasm without changing contractile tone (Desalen *et al*., 1997). The antioxidant activity of *Amaranthus cruentus* grain and by-products (flour, popping and cereal) has been reported (Paśko *et al*., 2007). Administration of amaranth seeds to rats did not inhibit the increase of triglyceride induced by fructose. There was an increase in glucose concentration of between 3% and 14%. Uric acid concentrations also increased in all groups (30-37%), while changes in creatinine levels were varied. Fructose addition to fodder also brought about a significant decrease in alkaline phosphatase activity (9-20%) (Paśko *et al*., 2011). A composition of an extract selected from group of plants (including *Amaranthus cruentus*) is described as an anti-inflammatory blend targeting NFkB (Kaur *et al*., 2011).

The antioxidant activity of *Amaranthus cruentus* (Pasko *et al*., 2009; Escudero *et al*., 2011; Kunyanga *et al*., 2012), *Amaranthus hybridus* (Chipurura *et al*., 2011; Gbate *et al*., 2012) and *Amaranthus hypochondriacus* (Lucero Lopez *et al*., 2011), has been reported. Veechi and Anon (2009) provided proof of the antihypertensive value of *Amaranthus hypochondriacus*. The bile acid binding activity of products obtained from *Amaranthus*

cruentus was reported (Tiengo *et al*., 2011).

An antiallergic agent is prepared from seed of *Amaranthus hypochondriacus* by using the seed directly or after extraction or enzymic treatment. The agent can be prepared into pharmaceuticals, cosmetics, health foods and health beverages, and the content of seed of *Amaranthus hypochondriacus* is 0.5-50%. It has effect in promoting generation of interleukin-12 or interferon GAMMA, inhibiting generation of interleukin-4 or interleukin-5, and inhibiting IgE antibody production, and can be used for alleviating, inhibiting or preventing inflammation and allergy caused by allergic reaction (Uenogawa *et al*., 2003).

Amaranthus paniculatus was found to improve learning in mice after radiation stress (Bhatia, 2003). The antioxidant activity of raw and blanched *Amaranthus paniculatus* and *Amaranthus viridis* has been proved (Amin *et al*., 2005).

Common pigweed, *Amaranthus hybridus*, is a favorite host of the beet armyworms (BAW), *Spodoptera exigua* and *Spodoptera eridania*. Chemicals extracted from pigweed with water, ethanol and methylene chloride deterred oviposition by the BAW larvae, thus confirming that deterrence was due to plant allelochemicals (Mitchell and Heath, 1985).