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File: ■ Horseradish Tree (*Moringa oleifera*, Moringaceae)
■ Safety and Efficacy

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RE: Review of the Safety and Efficacy of Horseradish Tree Preparations

Stohs SJ, Hartman MJ. Review of the safety and efficacy of *Moringa oleifera*. *Phytother Res*. June 2015;29(6):796-804.

The horseradish tree (*Moringa oleifera*, Moringaceae), also known as the drumstick tree or ben oil tree, is native to India and now commercially grown in many tropical and sub-tropical regions of the world. The highly nutritious leaves and immature seed pods of the tree are often consumed as food. The seeds, leaves, oil, sap, bark, roots, and flowers are also used for medicinal purposes. This review evaluates the safety, efficacy, and bioactive constituents of the horseradish tree.

Toxicity Studies
The aqueous leaf extract was found to be generally not toxic or genotoxic in rats at an oral dose of 1000 mg/kg body weight, equivalent to 30 times the 400-mg dose commonly consumed by humans. Methanol leaf extracts consumed by mice caused a dose-dependent increase in body weight, which was opposite to the effect found with aqueous leaf extracts, the preferred method of extraction. Leaf supplementation in the rat diet, at 15-20% body weight, did not have any toxic effects on the liver and blood or lipid profiles of rats. A hexane extract of the leaves (17 to 1700 mg/kg body weight) resulted in the increased production of sperm. No significant toxic effects were found for aqueous or methanol extracts of seeds (below 2000 mg/kg and 3000 mg/kg, respectively). Although intraperitoneal injections of methanol extracts of the roots indicated some hepatotoxicity and kidney damage, these effects could not be equated to oral intake of aqueous leaf extracts.

Human Trials
Several human trials have indicated that whole leaf powders may treat hyperglycemia and dyslipidemia, especially in people with type 2 diabetes (T2D). A single dose of 50 g of leaf powder given to patients with T2D reduced glucose levels by 21%, with no alterations in insulin secretion. Other longer-term studies with patients with T2D evaluated doses ranging from 4.6 g for 50 days to 8 g for 40 days. These studies showed a reduction in blood glucose and improved lipid profiles as a result of the intervention. In postmenopausal women, 7 g of leaf powder for three months improved

markers of antioxidant activity and reduced glucose levels. No leaf extracts were evaluated in human trials.

Animal and In Vitro Studies
In addition to the anti-hyperglycemic and anti-dyslipidemic effects observed in both animal and human trials, leaf powder and extracts (mostly from leaves) have exhibited other biological effects. Leaf extracts demonstrated antioxidant effects that included inhibition of lipid peroxidation and oxidative damage to DNA, as well as free radical scavenging activity in vitro. Diabetic and normal mice treated with aqueous leaf extracts had a significant increase in endogenous antioxidant activity. Anti-tumor effects and reduced reactive oxygen species were observed in lung cancer cell lines treated with the leaf extracts.

Several studies have also shown that liver damage was prevented in mice treated with aqueous leaf extracts, which may be partially due to antioxidant effects. Leaf extracts also protected against diabetes-induced retinal dysfunction, chromium-induced testicular cancer, kidney toxicity, and ulcerogenic effects of aspirin, as well as exhibited cardioprotective and neuroprotective effects. Some of these effects are also attributed to antioxidant activity. Extracts from the leaves have also exhibited immunomodulatory effects in mice. Both leaf and root extracts injected intraperitoneally in rats exhibited analgesic effects. Aqueous leaf extracts were also effective at wound healing in rats. Leaf extracts protected against radiation-induced damage to bone marrow and the liver. Seed, pod, and leaf extracts were found to have anti-hypertensive effects. Leaf extracts were also shown to be a cognitive enhancer in dementia-induced rats and have anticonvulsant effects in mice.

Bioactive Compounds
The hypotensive effects of ethanol seed extracts were attributed to thiocarbamate, isothiocyanate glycosides, and hydroxybenzoate. Niaziridin, an enhancer for nutrient absorption and antibiotic bioactivity, was found in the leaves and to a greater extent in the pods. The indole alkaloid N,α-L-rhamnopyranosyl vincosamide, found in the leaves, has been shown to have cardioprotective effects in rats. Isothiocyanates (compounds similar to those found in broccoli [*Brassica oleracea* var. *italica*, Brassicaceae] and other cruciferous vegetables) isolated from the leaves have exhibited anti-inflammatory effects. In terms of nutritional content, the dried leaves were reported to have 77 mg/100 g of vitamin E and 18.5 mg/100 g of ascorbic acid, as well as 30.3% protein, 19.89% fiber, 1.8% lignin, 4% cellulose, 3.2% tannins, and 2% polyphenols. Numerous minerals were also identified. Although no guidelines exist for standardization of horseradish tree extracts, bioactive components are often based on the relative polyphenol and glucosinolate content.

Although human trials have mostly focused on the effects of horseradish tree whole leaf powders for the treatment of hyperglycemia and dyslipidemia, animal studies suggest numerous other health benefits are associated with horseradish tree leaf, as well as seed, pod, flower, and root preparations. Future trials should confirm these effects. Moreover, standardization guidelines should be developed based on the plant components used and the bioactivity of interest.

—Laura M. Bystrom, PhD

The American Botanical Council has chosen not to include the original article.