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Spider plant:

An indigenous species with many uses

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Species and origins

Spider plant (*Cleome* or *Gynandropsis spp.*) also commonly known as spider flower plant, African spider flower or cats' whiskers, comprises 150-200 species of which 50 are indigenous to Africa (1). Edible and neglected species include *C. allamani*, *C. hirta* (Klotzsch) Oliv., *C. gynandra* L. Chiov, *C. monophylla* L., *C. rutidosperma* DC, and *C. viscosa* L. The crop belongs to the Capparaceae family and according to Jansen (2,3,4,5) and Mnzava and Ngwerume (6) *C. hirta (*Klotzsch*)* Oliv. and *C. viscosa* originate from Ethiopia, Somalia, and through Eastern and Central Africa. *C. monophylla* is widespread in tropical and subtropical Africa. The origins of *C. allamani*, *C. gynandra* (Fig. 1), and *C. rutidosperma* are unknown.

Spider plant is a C4 plant capable of withstanding high daytime temperatures, intense sunlight, and drought.

Breeding

The plant is monoecious and has three types of flowers:

a) flowers with anthers shedding pollen *before stigma are receptive* (protoandry). In this case, pollination can still occur on the same plant, but not on the same flowers.

b) flowers with anthers shedding pollen *when the stigma are receptive*. This situation favors self-pollination.

c) flowers with *stigmas receptive before pollen is shed* (protogyny). Depending on the type of flowers found on a particular genotype, selfing would then become a difficult task.

The crop has both purple and green stems. Difficulties reported in creating homogenous purple or green stem lines might be related to flower biology. In Venezuela, male sterile genotypes that could serve as female have been identified, but to date these have not been described in Africa.

Purple stem cultivars are reported to be more nutritious than those with green stems. They are also reported to be more resistant to insects, but more susceptible to diseases (1).

Who consumes spider plant?

Spider plant is consumed in most African and several South Asian countries. In Africa it is generally collected from the wild, although there is some limited cultivation of commercial leafy varieties in several countries in East and Southern Africa (7,8,9). Tender leaves, stems, pods, and flowers are consumed as vegetables by boiling in water or milk, alone or with other vegetables (e.g. tomato) and spices. To leach away the bitter taste, the initial cooking water is drained and fresh boiling water added. The small, aromatic leaves of *C. hirta* can be used as a spice (Fig. 2).

High in vitamins and micronutrients

Spider plant is nutritious. It is known to contain high levels of beta-carotene, vitamin C, and moderate levels of calcium, magnesium, and iron (Tables 1 and 2). Regarding vitamin A content, an analysis carried out in Tanzania showed that the in vitro accessibility of all-trans-ß-carotene in spider plant was the highest (26%) compared with cowpea, amaranth, sweet potato leaves, pumpkin, or combinations of these vegetables. The study also showed that when spider plant leaves were cooked with oil, in vitro accessibility increased to 53%. However, the total amount of all 9-cis ß-carotene did not significantly increase with the addition of oil (10). The analysis showed that spider plant could contribute 72% (without addition of cooking oil) to 477% (with addition of cooking oil) of the daily vitamin A requirement. The daily requirement for children is set at 400 µg RE with an assumption that 50% of all accessible ß-carotene will be converted to retinol in mucosa (10). The weight of a vegetable portion consumed varied from 52 to 157 g, with a median weight of 84 g used as the basis for calculations.

The plant contains high crude protein, lipids, and phenolic compounds (10, 11). The amino acid profile in spider plant is better than groundnut (13), as all amino acid contents are higher.

Protein consumption can be compromised by consuming food containing elevated levels of trypsin, which inhibits proteases activities. A study by Vanderjacgt et al. (13) showed that trypsin inhibitor activity in spider plant was low (0.45 and 0.32 µg/mg dry weight of plant respectively before and after boiling for 5 min) compared with the soybean reference (1.32 and 1.03 µg/mg dry weight of plant respectively before and after boiling for 5 min). For comparison, the same study showed 12 leafy vegetables including amaranth (*Amaranthus spinosus*) consumed in Niger had inhibitory activities higher than that of soybean, and that these enzymes were resistant to heat.

Vegetables can lose their vitamin C content after cooking, but Sreeramulu et al. (14) showed that spider plant best retains vitamin C compared with other vegetables. In fact, when 20 g of spider plant are cooked in 100 mL (very little) or 400 mL (excess) water, the losses were 5.3% and 18.3% respectively. By comparison, losses for amaranths *A. graecizans* were 86.2% and 46.4%, and *A. spinosus* 96.5% and 67.0%; for Ethiopian mustard (*Brassica juncea*), 51.4% and 86.1%; *Moringa* (*Moringa oleifera*) 85.4% and 98.5%; and bitter lettuce (*Launaea cornuta*) 93.5% and 94.5%. Understanding why spider plant retains most of its vitamin C after cooking would help indigenous vegetable breeders improve the nutritive value of this vegetable.

Free radicals are responsible for “oxidative stress” and often are implicated in the expression of several human diseases including diabetes, cancer, coronary heart diseases, neurodegenerative ailments, rheumatoid arthritis, etc. The human body has an antioxidant defense system that is believed to be strengthened by antioxidant-rich diets. Antioxidants include ß-carotene (pro-vitamin A caretonoids) and vitamin C, which are present in fruits and vegetables. Stangeland et al. (15) analyzed antioxidant activity in 35 Ugandan fruits and vegetables and found that spider plant had an antioxidant activity of 0.53 to 2.92 mmol/100 g and the derived food

Figure 1. Cleome gynandra
Illustration by Francisco Manuel Blanco

was a major contributor to the total dietary antioxidant capacity in the Ugandan diet.

High oil content in seed

Seed of spider plant has high levels of polyunsaturated oils that can reach up to 29.6% (12). The oil can be extracted by simple pressing and does not require refining. The seed cake can be used for animal feed, and the seed itself for feeding birds (6).

Spider plant as medicine

According to ethno-pharmacological surveys, spider plant has a number of medicinal uses. In Uganda, the plant is used to induce labor during childbirth (18). After giving birth, some women consume spider plant to increase lactation and blood formation. Spider plant remedies are used to alleviate migraine, vomiting, diphtheria, vertigo, headache, pneumonia, septic ears, and stomach ailments; the plant also is used as an eyewash and fed to boys after circumcision (1,7,17). Gessler et al. (19) analyzed 43 plants in Tanzania claimed to have medicinal properties and found that 37% of them had antimalarial activity and some had an IC_{50} as low as 10 µg/mL. For spider plant, the ethyl acetate extract was the most effective with an IC_{50} obtained with 14 µg/mL. In Rwanda, Boily and Van Puyvelde (20) showed that methanolic extracts of spider plant could inhibit *Candida albicans* and *Mycobacterium smegmatis* at 50 mg/mL. Another study carried out in Uganda (21) showed that *Staphylococcus aureus* and *Bacillus subtilis* were susceptible to inhibition to methanolic extracts.

Experimental rats suffering from arthritis were administered ethanolic spider plant leaf extracts at a dose of 150 mg/kg of body weight for 30 days. Analysis of enzymes involved in the expression of arthritis showed that the rats had recovered from the disease and their status was comparable to the healthy control rats (22). The control of the disease was related to substances present in the leaf extracts, including saponins, glycosides, lectins, steroids, flavonoids, tannins, triterpens, resins, phenolic compounds, and arthroquinones. However, the individual involvement of these compounds in the control of the disease needs to be investigated.

In another experiment administering spider plant leaf extracts to rats expressing severe arthritis, the analysis of lipid peroxidases, catalases, glutathione peroxidase (enzymes involved in the scavenging of free radicals) showed that these enzymatic activities had increased significantly in the diseased rats compared with the control diseased rats that were not fed the leaf extract treatment (23). On the other hand, the level of enzymes generating free radicals (glutathione and superoxide dismutase) was reduced significantly in the treated rats.

Free radicals also are cited as involved in the expression of plant diseases. Examining whether spider plant is effectively less susceptible to diseases than other plants (by using spider plant mutants that do not synthesize enzymes involved in the scavenging of free radicals) would be a useful model for plant pathologists.

Spider plant in crop protection

Spider plant has insecticidal and insect repellent properties. Spraying an aqueous extract of spider plant can considerably reduce aphid and thrip populations (1). Intercropping spider plant with cabbage also reduces diamondback moth as well as thrip attacks (1). Intercropping spider plant in rose-producing greenhouses at 8.3 plants/m^2 was reported to reduce red spider mite populations in Kenya (24). The plant also was shown to have anti-tick properties (25). Unpublished results obtained by AVRDC show that intercropping spider plant with tomato reduces thrips populations. Spider plant contains glucosinolates, including methylglucosinolate (26), cleomin, and glucocapparin (6, 27); their hydrolysis gives rise to methyl isothiocyanates, a strong antimicrobial compound (28, 29) that may contribute to insecticidal properties, along with phenolic compounds and an acid-volatile oil present in the glandular (which are involved in the characteristic mustard smell). Glucosinolates are responsible for the bitterness of the leaves. To date, no research has been published on the use of spider plant to control plant diseases; this may be a promising direction for future indigenous vegetable production research.

Table 1: Nutrient content of raw and cooked leaves and stems of spider plant

Food and Description	Nutrients per 100 g edible portion of spider plant											
	Food Energy	Moisture	Protein	Fat	Total Carbohydrates (incl. fiber)	Fiber	Ash	Calcium	Phosphorus	Iron	β-carotene equivalent	Ascorbic acid
Leaves, raw												
First set	34	86.6	4.8	0.4	5.2	1.2	3.0	288	111	6.0	--	13
Second set		83.3–89.6	3.0–5.8	0.3–0.4	--	1.0–1.5	2.0–5.2	246–331	36–155	--	--	--
Leaves and stems, cooked	41	86.6	4.2	1.0	6.3	1.3	1.9	135	94	3.4	--	--

Source: FAO Statistics (17)

Table 2: Nutrient composition of cooked spider plant leaves (dry weight basis) compared with nightshade and amaranth

	Vitamin C (mg/100 g)	Protein, crude		Fat (%)	Calcium (mg/100 mg)	Iron (mg/100 g)
		(%)	Fiber (%)			
Spider plant	89.6	1.5	0.8	0.3	40.5	0.8
Nightshade (*Solanum nigrum*)	234.5	1.0	0.8	0.2	66.8	2.5
Amaranth (*Amaranth spinosus*)	249.0	4.6	1.6	0.6	43.2	3.8
Amaranth (*A. hybridus*)	58.1	4.8	1.5	0.6	246.8	2.9

Source: Lymio et al. (11)

Figure 2. The small, aromatic leaves of *C. hirta* (Klotzsch) Oliv. (left, above) can be used as a spice.

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