FACTSHEET no: 1

# Feasibility study on increasing the consumption of nutritionally-rich leafy vegetables by indigenous communities in Samoa, Solomon Islands and Northern Australia

## *Introduction*

### *Epidemic of diet-related metabolic diseases*

Since the 1940s the consumption of high-energy, low-nutrient foods, including white flour, sugar, polished rice, turkey tails and mutton rib flaps by Pacific Islanders and indigenous Australians, combined with reduced exercise, has resulted in alarming rates of obesity, heart disease, diabetes and certain cancers. These conditions were not present when traditional diets and lifestyles predominated.

### *Value of leafy vegetables*

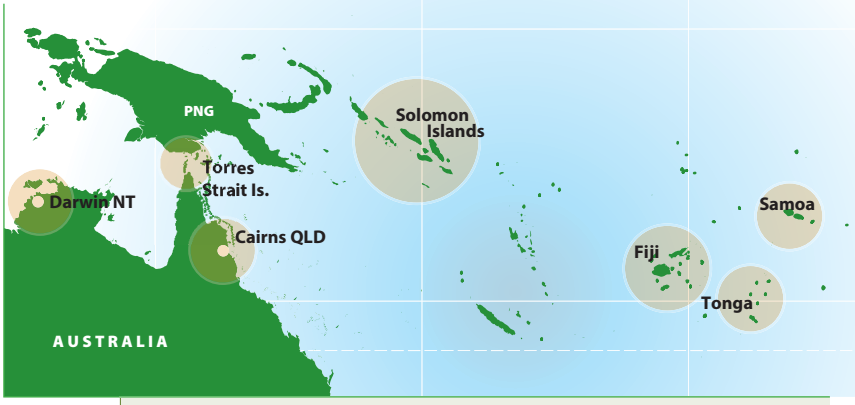
Many different types of leafy vegetables are grown and eaten in the Pacific region. When available, local vegetables are usually inexpensive and thus affordable to most people in both urban and rural areas; despite this, they can be overlooked, being sometimes regarded as "low status foods". However, research has shown most leafy vegetables are valuable foods: they are nutritious and rich in protein, minerals, vitamins (e.g. A, B, C, K), beneficial phyto (plant) chemicals and fibre (for example, aibika/bele, drumstick tree, Ceylon spinach, kangkong).

Most leafy vegetables can be easily grown in home gardens, providing leaves daily for meals. Some crops usually grown for their corms/tubers/storage roots, for example, taro, sweetpotato and cassava, also have nutritious edible leaves. The leaves usually have higher concentrations of vitamins, minerals, fibre and other beneficial compounds than the roots, which are higher in carbohydrate/energy. Some leafy vegetables are found growing in the wild, sometimes as weeds or wayside plants, for example black-berried nightshade and cobbler's pegs.

Iron is an example of an important mineral nutrient found in leafy vegetables. Lack of iron can cause iron-deficiency anaemia, common in women, inducing fatigue and weakness, and in children, affecting growth, energy levels and learning ability. Aibika/bele, sweetleaf/boneo, taro leaf and kangkong are all good sources of iron.

A variety of foods, including various leafy greens, should be consumed to achieve optimum body and brain growth, development and maintenance, and general good health. It is recommended to eat around one and a half cupfuls or three handfuls (around 150 millilitres or grams) of leafy vegetables each day. Leaves, which reduce the glycaemic load when eaten with high-energy foods like bread and white rice, are an ideal weight loss food.

Leaves contain many plant chemicals, such as flavonoids, anthocyanins, polyphenols and and carotenoids, which are beneficial to humans as antioxidants and anti-inflammatory agents in reducing the risk of diabetes, heart disease and cancers; for example, glucosinolates in drumstick leaves and anthocyanins in purple sweetpotato leaves. Certain carotenoids, notably beta- and alpha-carotene, are converted to vitamin A when eaten, especially if consumed with some oil (e.g. coconut cream). Others, notably lutein (which is often abundant in leafy vegetables) and zeaxanthin are important for eye health, including reducing the risk of cataracts.




• *Project location map in the Pacific Islands & Australia*

Although this project focuses on the food/nutritional value of leafy green vegetables, traditionally many are used for specific medical applications, for example, aibika and sweetleaf for bone repair and osteoporosis, Ceylon spinach as an anti-inflammatory and drumstick as an antibacterial agent. In addition, leaves of sweetleaf, aibika and ete (*Polyscias*) are used to increase milk production in nursing mothers.

Furthermore, growing food to improve nutrition, such as leafy greens, sweetpotato, taro and cassava, also makes economic sense and can help to address the trade deficits associated with the high consumption of imported foods in the Pacific. In addition, increased food crop diversity enhances the resilience of food systems to climate change, and thus strengthens food security.

### *How to eat these vegetables*

Some green leaves can be eaten uncooked, for example kangkong, Ceylon spinach, drumstick, chilli, which preserves most vitamins. The optimum cooking methods include steaming, boiling in a little water, baking, stir fry in a little oil (ideally virgin coconut oil or coconut cream) for as short a time as possible to reduce nutrient loss. If making a soup, the leftover cooking water which contains some minerals and vitamins can be used; the exception being cassava or sweetleaf leaves.

Example of ingredients for tasty leaf soup: 3 handfuls of Ete/ Ofenga leaves (or bele, Ceylon spinach, amaranth, drumstick, etc, leaves), 1 cup thinly sliced fish/meat, ½ teaspoon cassava flour, 1 teaspoon soy sauce, ½ teaspoon sugar, 1 tablespoon oil (ideally coconut), 1 onion (or several spring onions or a chilli), chopped, 2 teaspoons sliced ginger, 6 cups water, salt, pepper.

## *The Project*

### *Aims of the project*

- To identify leafy vegetables with the potential to improve human nutrition, and thus health
- To develop a strategy to raise awareness of the health benefits of leafy vegetables, to encourage increased production and consumption.

### *Project personnel*

Graham Lyons (University of Adelaide, South Australia, Project Leader), Roger Goebel (Etty Bay Exotics, Mourilyan, Queensland, Horticultural Consultant), Mary Taylor (Powys, UK, Pacific Crop Germplasm/Agricultural Development Consultant), Adimaimalaga Tafunai, Stephen Hazelman, Pule Elia Toleafoa, Fuatino Aquinas Afato, Kalais Jade Stanley (Women in Business Development, Samoa), Tolo Iosefa, (University of the South Pacific, Samoa), Pita Tikai (World Vegetable Centre, Honiara, Solomon Islands), Rosemary Kafa (Ministry of Health and Medical Services, Honiara, Solomon Islands), Luseane Taufa (Ministry of Agriculture, Food, Fisheries and Forests, Nuku'alofa, Tonga), Natalie Orero (Queensland Health, Thursday Island), George Ernst (Technical and Further Education, Thursday Island), Tania Paul (Charles Darwin University, Darwin).

### *Implementation*

There has been some excellent research conducted, and information provided, on leafy vegetables in the Pacific (see Bibliography below). This 12 month project adds to this previous work in providing further information on levels of minerals, protein and carotenoids in a range of leafy vegetables collected in Samoa, Solomon Islands, Tonga, Torres Strait Islands and Queensland, growing on different soils. Nutritional analysis was carried out on species which were growing together on the same soil and across different sites. In addition to this introductory factsheet, 11 factsheets have been produced: one describes an exciting horticultural demonstration initiative on Thursday Island in the Torres Strait, and the other 10 feature the most nutritious leafy vegetables identified during this project…and they all taste good as well! Although not featured on factsheets, other leafy greens gave good results for the various nutrients, including sweetpotato leaves, cassava leaves, edible/sweet fern, watercress and various fig/ "sandpaper cabbage" leaves. Information on these will appear in the final report.

• *Pele dish, Tonga*

Leaf mineral and carotenoid data are presented in each factsheet in the form of a table which includes the featured leafy vegetable sampled at a particular representative site, compared with another leafy vegetable growing at the same site, and also compared with English cabbage (using average values of samples purchased at markets in the South Pacific.

The project continues both with the analysis of certain polyphenols in some samples and also in determining the most effective ways to promote production and consumption of leafy vegetables in the Pacific Islands and Northern Australia.

### *Bibliography*

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### *Acknowledgement*

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**Australian Government**

**Australian Centre for International Agricultural Research**

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COMPILED BY **R. GOEBEL, M. TAYLOR** & **G. LYONS**

# TAROLEAF

FACTSHEET no: 2

• *True Taro leaves*

• *Tannia leaves*

• *Taro plants*

**Botanical name:** *Colocasia esculenta; Xanthosoma sagittifolium* (Araceae)

**Location specific common names:** *C. esculenta*: true taro, talo, dalo, dasheen

*X. sagittifolium*: tannia, taro palagi, Singapore taro, malanga, cocoyam, eddoe

**Plant characteristics:** All taros are edible aroids, with large, broad leaves on stems growing from a corm or enlarged starchy stem with numerous roots. The main difference between *X. sagittifolium* and *C. esculenta* is in the leaf shape; *Xanthosoma* spp have sagittate (arrow-shaped leaves) whereas the leaves of *Colocasia* spp are peltate (rounded/shield shaped). Most taros are known as a starchy vegetable but in many countries leaves, stems, and runners are important and nutritious foods. Plants range from 1 to 3 m in height. The sap from these plants can irritate the skin.

**Uses:** The younger full leaves are best to eat. They are often used as edible wraps for food parcels but must be well cooked (preferably boiled) to reduce the itchiness caused by calcium oxalate crystals in the leaf tissue. For example in Tonga the leaves of *C esculenta* are used to produce *lupulu* (corned beef wrapped in taro leaf then baked), and in Samoa for *palusami* which is onion and coconut cream (sometimes with meat/fish included) wrapped in taro leaf and baked. Shredded leaves can be added to other ingredients and cooked by steaming, boiling, frying or baking.

**Availability:** Leaves of both taros are available all year in most tropical locations.

**Propagation methods:** New plants can be produced from tops of the main corm, suckers or in some cases, runners. Tissue cultured plants are recommended for introducing new varieties into a country or in some cases, between different islands and areas within a country, to ensure disease free mother plant material and to prevent the spread of diseases.

**How to grow:** Both aroids are not difficult to grow providing the soil is rich in organic matter; however *C. esculenta* is more demanding of water than *X. sagittifolium*. Both species can be grown in full sun but preferably with some afternoon shade. Ideally the plants should be well-mulched, keeping the soil moist and the area around the plants free of grass and other weeds.

**Threats:** *C. esculenta* is more susceptible to pests and diseases than *X. sagittifolium*. Taro leaf blight, a fungal disease, is a serious problem in some countries, for example, Samoa and therefore resistant varieties must be grown. Leaf eating insects like the hornworm (hawk moth) and armyworm caterpillars can also cause significant leaf damage, if not controlled. Selecting healthy planting material and providing good growing conditions can reduce the occurrence and impact of these pests.

**Harvesting:** Suitable leaves (younger) can be harvested daily. They should be neatly picked, kept cool and moist and rolled into small bundles. Harvesting in the cooler

• *Mature Taro plants in cultivation*

• *Harvested taro leaves in Suva market*

• *Mature Tannia plants in agroforestry plot*

part of the day prevents wilting. Unless being grown solely for leaves, plants should grow 2-3 new leaves after harvesting; this allows the plant to maintain its vigour and produce a reasonable corm.

**Post harvest and storage:** Leaves should be used fresh after washing carefully with water of drinking quality or clean seawater. They can be loosely bundled, wrapped in damp paper and kept in a cool location. If covered with a clean plastic bag, and kept cool, they should store for a day or two.

**Project findings/nutritional value:** Samples of taro leaves for analysis were collected from north Queensland, Torres Strait Islands, Tonga, Solomon Islands and Samoa. Around 100 grams of fresh leaf (about 3 handfuls) per person for a meal serving will provide useful nutrition. Taro leaves are good sources of the carotenoids, lutein and beta-carotene, protein and certain minerals

***Carotenoids:*** Lutein is important for eye health (e.g. reducing risk of cataracts), and beta-carotene (pro-vitamin A) is important for vision, immunity and bone health.

***Protein:*** This is important in forming muscle, cell membranes, enzymes, blood components antibodies, DNA and RNA. The nitrogen analysis here indicates a protein content of around 18%.

***Iron:*** Important for healthy blood and energy.

***Zinc:*** Important for immunity, growth, carbohydrate metabolism, and DNA and protein formation. Humans have around 600 different Zn-containing enzymes/ proteins.

***Potassium:*** Controls body water balance through its interactions with sodium and chloride ions, and is involved in electrical stimulation of nerves and muscles. Its deficiency can cause muscle weakness, cramps and irregular heartbeat.

This table compares selected mineral nutrients and carotenoids in leaves of taro (*C. esculenta*), ete (*Polyscias spp.*) and "sandpaper cabbage" (*Ficus spp.*) grown together on a low pH soil at Nunura Village, Marau, Guadalcanal, Solomon Islands in 2012 and English cabbage (average of samples bought from Honiara market, Solomon Islands and Nukualofa market, Tonga in 2012) (concentration in mg/kg dry weight, except N: % dry weight).

| | Fe | Cu | Zn | Ca | Mg | K | P | N % | lutein | alpha carotene | beta carotene |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Taro | 75 | 11 | 27 | 12900 | 3500 | 42000 | 3100 | 4.1 | 364 | 10 | 148 |
| Ete | 61 | 19 | 33 | 16300 | 10400 | 41000 | 2400 | 4.8 | 233 | 29 | 66 |
| Ficus | 27 | 5 | 16 | 22000 | 3500 | 17600 | 1250 | 2.1 | 300 | 32 | 80 |
| Cabbage | 40 | 2 | 20 | 5700 | 1450 | 29000 | 3750 | 2.8 | 5 | 0 | 2 |

Fe: iron; Cu: copper; Zn: zinc; Ca: calcium; Mg: magnesium; K: potassium; P: phosphorus; N: nitrogen.

Analyses conducted by Waite Analytical Services and the Mares Laboratory, University of Adelaide, South Australia

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# AIBIKA

FACTSHEET no: 3

• *Aibika plant at the Ministry of Health Nutrition Unit garden, Apia, Samoa*

• *Mature plants showing 3 distinct leaf shapes*

**Botanical name:** *Abelmoschus manihot* (Malvaceae)

**Location specific common names:** bele, pele, Pacific cabbage, slippery cabbage, edible hibiscus, neka

**Plant characteristics:** Under reasonable growing conditions aibika is a fast growing bush, similar in appearance to cassava but without any storage roots or tubers. Closely planted and trimmed, the plants can be grown as a hedge. The relatively large leaves can vary from round to bird foot shaped. Some varieties are hardier than others and some produce softer, less fibrous leaves.

**Uses:** Aibika leaves and short succulent tips are usually cooked but can be eaten fresh. Slightly older leaves are best steamed, boiled, fried or baked. It is a suitable first food for infants when boiled and mashed with root vegetables. If boiling aibika a little water should be used, as some minerals, especially potassium, magnesium, zinc, iron and calcium are lost in the water; any water should be consumed as soup. Aibika (and most other cooked leaves) is ideally served with coconut cream, which increases the uptake of beta-carotene and conversion to vitamin A. Traditionally aibika has medicinal uses such as treating sore throats, stomach aches, diarrhoea, increasing milk production, and preventing bone loss.

**Availability:** This plant can be grown all year in most tropical locations but growth often slows with cooler, shorter days and drier conditions.

**Propagation methods:** This plants can be grown from seeds or cuttings; seed-derived plants are usually slower to establish and may vary from the parent plant. Cuttings of mature wood, from 200 to 600 mm long, are the most suitable for propagation, and should be planted with at least one third under the soil surface. Cuttings can be stored or transported for a few days provided they are kept in the shade, and in a little water, which should be regularly changed to reduce the possibility of stem rots.

**How to grow:** Aibika is not difficult to grow providing the soil is rich in organic matter and water is readily available. Plants can grow in full sun preferably with some shade in the afternoon. Mulching the plants is recommended to keep the soil moist and free of grass and other weeds. To reduce bark rots the mulch must not be in contact with the immediate base of the plant. Regular pruning will encourage growth.

**Threats:** Pests and diseases, other than leaf eating insects and post harvest leaf rots, do not usually affect the growth of aibika. Leaf eating insects like *Nisotra* beetles, grasshoppers and some caterpillars can cause problems in drier weather, especially on plants growing in full sun. Selecting healthy planting material and providing good growing conditions will reduce the occurrence and impact of these pests.

**Harvesting:** Depending on the amount of aibika being grown and the growing conditions, harvesting can be carried out daily. Selected leaves and even the growing tips back to the newest full leaf should be picked, ideally in the cooler hours of the day to prevent wilting.

**Post harvest and storage:** The leaves and tips should be washed carefully with water of drinking quality or clean seawater. They can be loosely bundled in damp paper, and if kept cool, should store for a day. If placed in an airtight container in a cool room or refrigerator, they can store for two or three days.

**Project findings/nutritional value:** Samples of aibika for analysis were collected from the Torres Strait Islands, Tonga, Samoa and Solomon Islands. Around

• *Leaves with Nisotra beetle damage*

• *Potted cutting established and ready to plant*

• *Harvested leaves suitable for cooking*

100 grams of fresh leaf (about 3 handfuls) per person for a meal serving will provide useful nutrition. We found this to be the best leafy vegetable analysed, for all-round nutrition: carotenoids, protein and various minerals. There was some variation in nutrient levels between varieties grown on the same soil.

***Carotenoids:*** Aibika had the highest levels of lutein, which is important for eye health (e.g. reducing risk of cataracts) in all of our samples, and was also high in beta-carotene (pro-vitamin A), important for vision, immunity and bone health.

***Protein:*** This is important in forming muscle, cell membranes, enzymes, blood components (including haemoglobin, albumin, transferrin), antibodies, DNA and RNA. The nitrogen analysis here indicates a protein content of around 22%.

***Magnesium:*** This mineral is important in bone formation, energy production, and nerve and muscle function.

***Zinc:*** Important for immunity, growth, carbohydrate metabolism, and DNA and protein formation. Humans have around 600 different Zn-containing enzymes/ proteins.

***Manganese:*** Enzymes containing manganese are important in the metabolism of carbohydrates, protein and fats, and in enhancing immunity.

***Calcium:*** The most important mineral for the growth and maintenance of bones and teeth. Calcium is also important for cellular physiology.

***Sulphur:*** Needed for production of the hormone insulin, which controls blood sugar level. Sulphur is also needed for the protein keratin, important for bone, cartilage and tendons.

***Iron:*** Important for healthy blood and energy.

***Potassium:*** Controls body water balance through its interactions with sodium and chloride ions, and is involved in electrical stimulation of nerves and muscles. Deficiency can cause muscle weakness, cramps and irregular heartbeat.

This table compares selected mineral nutrients and carotenoids in leaves of aibika (average of three different types according to leaf shape), okra and "sandpaper cabbage" (*Ficus spp.*) grown together at Burns Creek, Honiara, Solomon Islands in 2012 and english cabbage (average of samples bought from Honiara market, Solomon Islands and Nukualofa market, Tonga in 2012) (concentration in mg/kg dry weight, except N: % dry weight).

| | Fe | Mn | Zn | Ca | Mg | K | S | N % | lutein | alpha carotene | beta carotene |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Aibika | 73 | 77 | 44 | 23600 | 7100 | 32000 | 4500 | 4.9 | 1006 | 31 | 315 |
| Okra | 70 | 18 | 25 | 30000 | 4400 | 26000 | 3600 | 4.3 | 693 | 4 | 315 |
| Ficus | 72 | 25 | 31 | 18800 | 3900 | 28000 | 2300 | 3.1 | 554 | 159 | 57 |
| Cabbage | 40 | 23 | 20 | 5700 | 1450 | 29000 | 3750 | 2.8 | 5 | 0 | 2 |

Fe: iron; Mn: manganese; Zn: zinc; Ca: calcium; Mg: magnesium; K: potassium; S: sulphur; N: nitrogen.
Analyses conducted by Waite Analytical Services and the Mares Laboratory, University of Adelaide, South Australia

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# ETE & OFENGA

FACTSHEET no: 4

• *Mature Ete shrubs on Tawa'ahi Island, Solomon Islands*

• *Ofenga leaves, Solomon Islands*

**Botanical names:**
Ete: *Polyscias verticillata, P. scutellaria, P. macgillivrayi, P. fruticosa* (Araliaceae)

Ofenga: *Pseuderanthemum whartonianum* (Acanthaceae)

**Location specific common names:** *Ete:* Aralia, bebero, geke, paa, bebenu, kobikobi, momotu
*Ofenga:* Pure, burape, wasina, aidua, sungu

**Plant characteristics:** Ete is a tall shrub, growing 3 - 6 m high and 2 - 3 m wide, often planted as a hedge. Leaves vary in shape from large, round and shiny to narrow and fernlike.

Ofenga is a tall shrub, growing up to 6m high, similar in appearance to the large-leaved varieties of Ete, but the leaves are less shiny, have prominent veins and are oval-shaped, narrowing to a point at both ends. The flowers of ofenga are purple and white.

**Uses:** The young leaves of both ete and ofenga have the best taste and can be eaten fresh, but mature leaves are usually cooked in stews and soups, ideally with coconut cream to increase carotenoid availability and conversion to vitamin A.

Medicinally ete has been traditionally used to increase milk production in nursing women. It also has anti-inflammatory effects. Ofenga is used (particularly in Vietnam) to treat high blood pressure, diarrhoea, wounds, diabetes and tumours.

**Availability:** These plants can be grown all year in the tropics. Ete is widespread in the Pacific, common in coastal areas, especially on high pH coralline soils. Ofenga is common in Solomon Islands (particularly Malaita) and Vanuatu, near the coast and in rainforest.

**Propagation methods:** Both are usually grown from stem cuttings around 40 cm long, but can also be grown from seed. The area around the cuttings should be mulched to help keep soil moist and the area free from weeds

**How to grow:** Ete in particular prefers high pH soils, i.e. 7.6-8.6, and will grow well on coralline soils with low available iron and phosphorus, while other crops such as cassava grow poorly and appear chlorotic when grown on these soils. Ofenga commonly grows in coastal and forest locations. Both ete and ofenga can be grown as a hedge.

**Threats:** Pink wax scale (*Ceroplastes rubens*) and passion vine mealybug (*Planococcus pacificus*) can cause problems. Healthy planting material and good growing conditions can help reduce the occurrence and impact of these pests.

**Harvesting:** Young and older leaves can be harvested on a daily basis, ideally in the cooler part of the day to prevent wilting. Leaves for food can be collected at the same time as a hedge is trimmed, which helps to keep the hedge tidy.

**Post harvest and storage:** As for most leaves, ete and ofenga should be washed with clean water and stored in a cool, shady place. Ideally, leaves should be eaten within a day of picking, but the large-leafed forms of ete, which are quite fibrous, can remain fresh for up to 3 days.

• *Cutting of Ete ready for planting*

• *Another form of Ete*

• *Ete leaves, Marau, Solomon Islands*

**Project findings/nutritional value:** Samples were collected in Solomon Islands (Guadalcanal and Santa Ysabel). Ete was among the best of the leaf samples for accumulation of zinc (even higher than leaves of cassava, a renowned zinc accumulator), and was also high in calcium and magnesium compared to most leafy vegetables.

Ofenga was one of our highest samples for magnesium and was also high in calcium and carotenoids, especially lutein.

***Zinc:*** Important for immunity, growth, carbohydrate metabolism, and DNA and protein formation. Humans have around 600 different Zn-containing enzymes/proteins.

***Calcium:*** The most important mineral for the growth and maintenance of bones and teeth. Calcium is also important for cellular physiology.

***Magnesium:*** This mineral is important in bone formation, energy production, and nerve and muscle function.

This table compares selected mineral nutrients and carotenoids in leaves of ete (average of three varieties) and cassava (average of two varieties) grown together on high pH soil on Tawa'ahi Island, Marau, with ofenga (average of three samples collected at Burns Creek, Honiara and Legalawa Village, Marau) on Guadalcanal, Solomon Islands in 2012 and english cabbage (average of samples bought from Honiara market, Solomon Islands and Nukualofa market, Tonga in 2012) (concentration in mg/kg dry weight, except N: % dry weight).

| | Fe | B | Cu | Zn | Ca | Mg | K | N % | lutein | alpha carotene | beta carotene |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ete | 31 | 45 | 7 | 92 | 27000 | 6800 | 18000 | 2.6 | 250 | 30 | 74 |
| Cassava | 35 | 85 | 7 | 67 | 20100 | 6200 | 11400 | 3.6 | 310 | 1 | 175 |
| Ofenga | 55 | 31 | 13 | 43 | 25400 | 18400 | 34000 | 3.4 | 557 | 67 | 167 |
| Cabbage | 40 | 12 | 2 | 20 | 5700 | 1450 | 29000 | 2.8 | 5 | 0 | 2 |

Fe: iron; B: boron; Cu: copper; Zn: zinc; Ca: calcium; Mg: magnesium; K: potassium; N: nitrogen
Analyses conducted by Waite Analytical Services and the Mares Laboratory, University of Adelaide, South Australia

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# SWEETLEAF

FACTSHEET no: 5

• *Buds and flower bracts on a branch*

• *Harvested tips*

**Botanical name:** *Sauropus androgynus* (Euphorbiaceae)

**Location specific common names:** Sweetleaf, boneo, katuk, star gooseberry.

**Plant characteristics:** Sweetleaf is a perennial shrub, with small red flowers, usually growing to 2 m. Regular pruning is needed to prevent the plant becoming top-heavy and collapsing.

**Uses:** Young tips, young leaves, flowers and fruit can be eaten raw, and the leaves are well known for palatability. Raw leaves combine well with tomato, cucumber, onions, etc. Older leaves are best cooked (steamed, boiled or baked) and are a tasty, nutritious addition to stews and soups. Fruits can be used to make jam. Medicinally sweetleaf is traditionally considered to be effective in reducing undesirable blood fats, gastrointestinal disorders, obesity, osteoporosis, heart disease and cancer. In common with several other leaves, sweetleaf apparently stimulates lactation.

**Availability:** Sweetleaf is common in the Pacific and Northern Australia.

**Propagation methods:** Sweetleaf can be grown from seed and planted out at a height of 30 cm preferably at the start of the wet season. However, hardwood cuttings, around 30 cm in length, produce stronger plants. Cuttings can be struck in pots in a simple shade house at any time of the year.

**How to grow:** Sweetleaf grows on a wide range of soils and is known for high yield. It prefers well drained soils with high levels of organic matter. Like aibika (bele, pele) it can be grown as a hedge. Regular pruning encourages new growth and keeps the plants compact.

**Threats:** Plants may suffer from leaf eating insects like grasshoppers, especially under dry conditions. Spraying is not usually needed as the problem insects can be easily removed.

**Harvesting:** Sweetleaf usually grows fast and young leaves can be picked after four months. Leaves should be harvested in the cooler part of the day to prevent wilting. Year-round production is expected if plants are growing vigorously. Plants are best kept trimmed to 1 - 2 m for leaf production and harvesting.

**Post harvest and storage:** Leaves or tips can be picked as needed. Loosely bundled cut branches, wrapped in moist paper and placed in a cool location, can be stored for a day or two.

**Project findings/nutritional value:** Samples were collected from Solomon Islands and the Torres Strait Islands. Sweetleaf ranks with ete (*Polyscias* spp., bebero, momotu) as the best zinc accumulators that we analysed, and is a very good nutritional all-rounder, usually high in iron, manganese, calcium, magnesium, sulphur, protein and carotenoids. It is also high in vitamins B and C.

***Zinc:*** Important for immunity, growth, carbohydrate metabolism, and DNA and protein formation. Humans have around 600 different Zn-containing enzymes/ proteins.

***Iron:*** Important for healthy blood and energy.

***Manganese:*** Enzymes containing manganese are important in the metabolism of carbohydrates, protein and fats, and in enhancing immunity.

• *Tips and leaves ready for harvesting*

• *Mature plant on Thursday Island, Torres Strait Islands, Australia*

• *Mature plants in a hedge row*

***Magnesium:*** This mineral is important in bone formation, energy production, and nerve and muscle function.

***Calcium:*** The most important mineral for the growth and maintenance of bones and teeth. Calcium is important for cellular physiology.

***Sulphur:*** Sulphur is needed for production of the hormone insulin, which controls blood sugar level. Sulphur is also needed for the protein keratin, important for bone, cartilage and tendons.

***Protein:*** This is important in forming muscle, cell membranes, enzymes, blood components antibodies, DNA and RNA. The nitrogen analysis here indicates a protein content of around 19%.

***Carotenoids:*** Lutein is important for eye health (e.g. reducing risk of cataracts) and beta-carotene (pro-vitamin A) is important for vision, immunity and bone health.

This table compares selected mineral nutrients and carotenoids in leaves of sweetleaf and sweetpotato (average of two varieties) grown together at Porokokore Village, Marau, Guadalcanal, Solomon Islands in 2012 and English cabbage (average of samples bought from Honiara market, Solomon Islands and Nukualofa market, Tonga in 2012) (concentration in mg/kg dry weight, except N: % dry weight).

| | Fe | Mn | Zn | Ca | Mg | K | S | N % | lutein | alpha carotene | beta carotene |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sweetleaf | 71 | 2300 | 174 | 18900 | 12600 | 13800 | 5400 | 4.4 | 653 | 30 | 272 |
| Sw.potato leaf | 56 | 146 | 34 | 3700 | 3700 | 28000 | 3000 | 4.2 | 534 | 3 | 173 |
| Cabbage | 40 | 23 | 20 | 5700 | 1450 | 29000 | 3750 | 2.8 | 5 | 0 | 2 |

Fe: iron; Mn: manganese; Zn: zinc; Ca: calcium; Mg: magnesium; K: potassium; S: sulphur; N: nitrogen

Analyses conducted by Waite Analytical Services and the Mares Laboratory, University of Adelaide, South Australia

In the 1990s there were several cases of lung disease in Taiwan associated with excessive consumption of uncooked sweetleaf juice. The alkaloid papaverine may have been responsible; it occurs at higher levels in older leaves and is reduced by cooking. However, sweetleaf has been consumed throughout SE Asia and the Pacific for a long time without causing toxicity. Nevertheless, as with all foods, sweetleaf should be consumed in moderation.

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COMPILED BY **R. GOEBEL, M. TAYLOR** & **G. LYONS**

# KANGKONG

FACTSHEET no: 6

• *Mature plants of Kangkong*

• *Leaves with leaf miner damage*

**Botanical name:** *Ipomoea aquatica, Ipomoea reptans* (Convolvulaceae)
**Location specific common names:** water spinach or swamp cabbage

**Plant characteristics:** Under reasonable growing conditions kangkong is a fast growing, vine-like plant that spreads along the ground or water surface, and is reluctant to climb. It is a close relative to sweetpotato but is grown for its succulent growing tips and not roots or tubers.

There are two recognized types, the upland type, *Ipomoea reptans* is more common throughout the Pacific and adapted to moist soils compared to the lowland or aquatic kangkong (*Ipomoea aquatica*) which is adapted to flooded conditions.

**Uses:** Kangkong is best prepared fresh/uncooked. After thorough washing, short succulent tips can be eaten in salads or liquidized for adding to a drink. Slightly older leaves are best steamed, boiled, fried or baked; the stems, cut into sections, can be used in stir fry.

**Availability:** This plant can be cultivated in most tropical locations. It is grown in most Pacific islands and in tropical and sub-tropical Australia.

**Propagation methods:** New plants can be produced from cuttings or seed. Plants grown from seed are usually slower to establish; the quality is also less reliable compared to plants derived from cuttings. The seeds should be soaked for one day before sowing. Cuttings from 200 to 600 mm long preferably taken a day or two after harvesting the tip, are the most suitable for propagation. Care with watering is needed until the cuttings are well established. Cuttings can be stored or transported for a few days provided they are kept in the shade, and in a little water, which must be changed regularly to reduce the possibility of stem rots.

**How to grow:** Kangkong is not difficult to grow providing the soil is rich in organic matter and water is readily available. It can grow in full sun preferably with some afternoon shade. The main roots require soil to grow but the plant will easily spread over water. Soils of poorer fertility and insufficient water will produce slower growing plants with thinner stems and smaller leaves with a stronger, bitter flavour. Cuttings of three or more nodes should be planted with at least one node under the surface. The area around the plant should be kept moist and free of grass and other weeds.

**Threats:** Pests and diseases do not usually cause problems. Leaf eating insects such as grasshoppers and some caterpillars are occasional pests that may become a problem in drier weather. Leaf miner and mealybug can cause reduced growth and malformed leaves. Healthy planting material and good growing conditions can help reduce the occurrence and impact of these pests.

**Harvesting:** Depending on the amount of kangkong being grown and the growing conditions, harvesting can be carried out daily. The tips, usually back to the 3rd newest full leaf, should be neatly picked, ideally in the cooler part of the day to prevent wilting. The cut tips can be stood upright in a bucket or container with some clean water. Where a tip has been harvested that runner should produce one or more new tips suitable for harvesting in a few days.

• *Kangkong runner suitable for replanting*

• *Potted cutting ready to transplant*

• *Harvested tips suitable for eating, about 300 mm long, 10 mm thick at the base and with 3 to 5 full leaves*

**Post harvest and storage:** Tips should be washed carefully with water of drinking quality or clean seawater. They can be bundled with their stems trimmed and stood upright in a small amount of clean fresh water. They should store for a day or two if covered and kept in a cool location.

**Project findings/nutritional value:** Samples of kangkong for analysis were collected from north Queensland, Tonga and Samoa. Around 100 grams of fresh vegetable (about 3 handfuls) per person for a meal serving will provide useful nutrition. Kangkong is strong in:

***Carotenoids:*** Lutein (important for eye health) and beta-carotene (pro-vitamin A, important for vision, immunity, bone growth).

***Iron:*** Important for healthy blood and energy.

***Manganese:*** Enzymes containing manganese are important in the metabolism of carbohydrates, protein and fats, and in enhancing immunity.

***Copper:*** Component of enzymes, involved in iron metabolism, therefore supports production of healthy blood and generation of energy.

***Protein:*** This is important in forming muscle, cell membranes, enzymes, blood components (antibodies, DNA and RNA. The nitrogen analysis here indicates a protein content of around 19%.

This table compares selected mineral nutrients and carotenoids in leaves of Kangkong and Sweetpotato grown near each other at Lotofaga, Upolu, Samoa in 2012 and English cabbage (average of samples bought from Honiara market, Solomon Islands and Nukualofa market, Tonga in 2012) (concentration in mg/kg dry weight, except N: % dry weight).

| | Fe | Mn | Cu | Zn | Ca | Mg | S | N % | lutein | alpha carotene | beta carotene |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Kangkong | 75 | 93 | 16 | 17 | 5500 | 3500 | 2900 | 4.3 | 373 | 0 | 226 |
| Sw.potato leaf | 69 | 53 | 15 | 27 | 5500 | 4800 | 2800 | 3.6 | 336 | 6 | 225 |
| Cabbage | 40 | 23 | 2 | 20 | 5700 | 1450 | 5900 | 2.8 | 5 | 0 | 2 |

Fe: iron; Mn: manganese; Cu: copper; Zn: zinc; Ca: calcium; Mg: magnesium; S: sulphur; N: nitrogen
Analyses conducted by Waite Analytical Services and the Mares Laboratory, University of Adelaide, South Australia

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# PUMPKIN & CHOKO TIPS

FACTSHEET no: 7

• *Pumpkin tip for harvest*

• *Choko tips ready to eat*

**Botanical name:** **Pumpkin** *Cucurbita spp.* (Cucurbitaceae)

**Choko** *Sechium edule* (Cucurbitaceae)

**Location specific common names for pumpkin:** squash, gramma

**Location specific common names for choko:** chayote

**Plant characteristics:** There are numerous pumpkin types. The true pumpkin, *Cucurbita moschata,* is best for most tropical conditions and provides tender, sweet tips. Under good growing conditions pumpkin and choko are fast growing vine-like plants that spread along the ground and are able to climb. Choko vines need trellis support.

**Uses:** The tender growing tips of choko can be used fresh in salads or lightly steamed. Pumpkin tips are covered in fine hairs that can be peeled from the thicker end. Older tips are best cooked by steaming, boiling, frying or baking.

**Availability:** Most pumpkin types grow best in the cooler months in tropical areas but gramma types are often grown year round. Once established, choko vines can produce all year if well watered.

**Propagation methods:** Pumpkin plants can be grown from seed which has been purchased as packaged seed, self-saved or taken from shop fruit. Choko is grown from sprouted fruit planted in the soil with the sprout above the surface. The sprouted fruit should be protected from sun and weeds.

**How to grow:** Pumpkins and choko are not difficult to grow providing the soil is rich in organic matter and water is readily available. Plants will spread over poorer soils, which can encourage fruiting. They can be grown all year in most tropical locations, including those with full sun. Soils of poorer fertility and insufficient water will produce slower-growing plants with thinner stems, and smaller leaves with a stronger, bitter flavour. The area around the plants should be kept moist and free of grass and other weeds.

**Threats:** Some pests and diseases can be limiting factors in growing pumpkins and chokos. Leaf diseases like downy and powdery mildew can cause problems at various times of the year. Root nematodes can limit plant growth. Providing good growing conditions, wide plant spacing and rotating crops can reduce the occurrence and extent of these problems.

**Harvesting:** Under good growing conditions, harvesting can be carried out daily. Up to 200 mm of the tips can be picked, ideally in the cooler part of the day to prevent wilting. The tips can be stood upright in a bucket or container with some clean water. Where a tip has been harvested that runner should produce one or more new tips suitable for picking in a week.

**Post harvest and storage:** Tips should be washed carefully with water of drinking quality or clean seawater. They can be loosely bundled with their stems trimmed and stood upright in a small amount of clean fresh water, and if covered with a clean plastic bag, and kept cool, they should store for a day. If placed in an airtight container in a cool room or refrigerator, they can last two or three days.

• *Choko plant growing along a support fence*


• *A. Choko fruit*
• *B. Pumpkin fruit*

• *Pumpkin plants under cultivation in northern Australia*

**Project findings/nutritional value:** Samples of pumpkin and choko tips were collected for analysis from north Queensland, Torres Strait Islands, Samoa, Tonga and Solomon Islands. Around 100 grams of fresh vegetable (about 3 handfuls) per person for a meal serving will provide useful nutrition. Pumpkin and choko tips were particularly rich in protein and phosphorus, and also good sources of zinc and copper.

***Protein:*** This is important in forming muscle, cell membranes, enzymes, blood components, antibodies, DNA and RNA. The nitrogen analyses of our samples indicated a protein range of 18 - 30 %. The higher samples had more protein than many legumes.

***Phosphorus:*** Component of genetic material (DNA and RNA) and various fats and proteins; important role in energy production.

***Zinc:*** Important for immunity, growth, carbohydrate metabolism, and DNA and protein formation. Humans have around 600 different Zn-containing enzymes/ proteins.

***Copper:*** Component of enzymes, involved in iron metabolism, therefore supports production of healthy blood and generation of energy.

This table compares selected mineral nutrients and carotenoids[1] in young leaves of pumpkin, choko and kangkong grown together near Cairns, Queensland, Australia in 2012 and English cabbage (average of samples bought from Honiara market, Solomon Islands and Nukualofa market, Tonga in 2012) (concentration in mg/kg dry weight, except N: % dry weight).

| | Cu | Zn | Ca | Mg | K | P | N % | lutein | alpha carotene | beta carotene |
|---|---|---|---|---|---|---|---|---|---|---|
| Pumpkin | 17 | 72 | 8800 | 5500 | 44000 | 9500 | 5.1 | 288 | 0 | 117 |
| Choko | 17 | 90 | 5700 | 3100 | 44000 | 10100 | 5.9 | 249 | 5 | 84 |
| Kangkong | 10 | 33 | 5400 | 3200 | 43000 | 5300 | 4.0 | 263 | 0 | 169 |
| Cabbage | 23 | 20 | 5700 | 1450 | 29000 | 3750 | 2.8 | 5 | 0 | 2 |

Cu: copper; Zn: zinc; Ca: calcium; Mg: magnesium; K: potassium; N: nitrogen.
Analyses conducted by Waite Analytical Services and the Mares Laboratory, University of Adelaide, South Australia

*[1]Carotenoid levels in pumpkin leaf samples in Cairns were similar to those in Leulumoega-uta (Upolu, Samoa) and Thursday Island (Torres Strait Islands, Queensland, Australia) (average 291, 5, 105 mg/kg for lutein, a-carotene and b-carotene, respectively) but lower than those in Burns Creek and Aruligo (Guadalcanal, Solomon Islands) (average 887, 17, 272 mg/kg for lutein, a-carotene and b-carotene, respectively), illustrating the effect that soil and microclimatic variation can have on carotenoid content in leaves.*

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# DRUMSTICK TREE

FACTSHEET no: 8

• *Leaf of the drumstick tree*

**Botanical name:** *Moringa oleifera* (Moringaceae)

**Location specific common names:** moringa, horseradish tree, mulangay

**Plant characteristics:** This plant grows into a medium sized tree, 4 to 6 m tall. It can be kept to a useful size by regular pruning, and can be trained to grow as a hedge. The name *drumstick* comes from the distinctive long tapered seedpods that hang from the branches.

**Uses:** Leaves are best prepared soon after picking. The tender small leaflets of the youngest leaves can be eaten in salads after washing. Slightly older leaflets can be steamed, boiled, fried or baked. Leaves can be frozen for later use. The following is a simple recipe which provides a very tasty and nutritious dish: rinse 6 handfuls of leaves (just fully developed). Strip the leaflets from the wiry stalks, (these do not soften with cooking), and add to 1 litre of fish soup base, flavoured with 2 finely shredded lime leaves or lemon grass, add salt, pepper and chilli to taste. Bring to simmer for 1 minute. This will serve 4 people.

The drumstick tree is also used for livestock fodder, living fences, fertilizer/green manure, purifying water (using seeds). Traditionally drumstick tree has been used medicinally as an antibacterial, antiviral, anti-diabetes agent, and has been shown to lower harmful blood fats and high blood pressure.

**Availability:** Drumstick trees are common in Fiji and Kiribati, but can be scarce in other Pacific islands and in northern Australia.

**Propagation methods:** Plants can be produced from cuttings or seed; seed-derived plants are usually slower to establish but develop a strong root system. Cuttings of mature wood, 200 to 600 mm long, planted with at least one-third of the cutting in the soil, are most suitable for propagation.

**How to grow:** Drumstick trees are not difficult to grow. Once established, the tree is drought tolerant, can survive on shallow soil of poor fertility, will grow in full sun and is wind tolerant. The canopy of cutting-grown plants can be pruned to increase wind tolerance. If growing conditions are poor, growth will be slower, and leaves smaller with a stronger flavour. For the first two years mulching is recommended, keeping the soil around the tree moist and free of grass and other weeds.

**Threats:** Pests and diseases are not usually a problem however root rot can occur if the tree is grown in waterlogged soils.

**Harvesting:** The leaves should be neatly picked, usually back to the third newest full leaf and ideally in the cooler hours of the day to prevent wilting.

**Post harvest and storage:** Full leaves (leaflets plus wiry stalks) should be washed carefully with water of drinking quality or clean seawater. If bundle wrapped in moist paper and kept in a cool location they should

• *Mature plant in northern Australia*

• *Potted seedling ready to transplant*

• *Drumstick leaves*

store for a day. Leaves can last for up to a week, if placed in an airtight container in a cool room or refrigerator. If the leaves dry they will drop their leaflets and lose their value as a food.

**Project findings/nutritional value:** Samples were collected from the Torres Strait Islands, Solomon Islands and Samoa. Around 100 grams of fresh vegetable (about 3 handfuls) per person for a meal serving will provide useful nutrition. The leaves are renowned for their high levels of minerals, vitamins, protein, carotenoids and other phytochemicals, including the anticancer compounds glucosinolates and isothiocyanates. Samples were collected from the Torres Strait Islands, Solomon Islands and Samoa.

***Carotenoids:*** A Solomons drumstick tree sample was the highest of all of our leaf samples for beta-carotene (pro-vitamin A), and was also high in lutein, which is important for eye health.

***Sulphur:*** This mineral is needed for production of the hormone insulin, which controls blood sugar level. Sulphur is also needed for the protein keratin, important for bone, cartilage and tendons. Drumstick tree leaves are usually 3-4 times higher in sulphur than leaves of other plants growing on the same soil.

***Selenium:*** Important in antioxidant enzymes, for thyroid and brain function and for its antiviral and anticancer effects. Drumstick tree leaves are usually around 10 times higher in selenium than those of other plants growing nearby.

This table compares selected mineral nutrients and carotenoids in leaves of Drumstick tree and Aibika grown together at Burns Creek, Honiara, Solomon Islands in 2012 and English cabbage (average of samples bought from Honiara market, Solomon Islands and Nukualofa market, Tonga in 2012) (concentration in mg/kg dry weight, except N: % dry weight). Aibika data: average of 3 varieties.

| | Cu | Zn | Ca | Mg | S | N % | Se | lutein | alpha carotene | beta carotene |
|---|---|---|---|---|---|---|---|---|---|---|
| Drumstick | 7 | 31 | 20000 | 3700 | 12300 | 5.1 | 2.0 | 773 | 0 | 427 |
| Aibika | 8 | 44 | 23600 | 7100 | 4500 | 4.9 | 0.17 | 1006 | 31 | 358 |
| Cabbage | 2 | 20 | 5700 | 1450 | 5900 | 2.8 | na | 5 | 0 | 2 |

Cu: copper; Zn: zinc; Ca: calcium; Mg: magnesium; S: sulphur; N: nitrogen; Se: selenium;
na: not analysed
Analyses conducted by Waite Analytical Services and the Mares Laboratory, University of Adelaide, South Australia

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# CEYLON SPINACH

FACTSHEET no: 9

• *Harvested Spinach leaves*

• *Green form of Ceylon Spinach*

**Botanical name:** *Basella alba* (Basellaceae).

**Location specific common names:** Malabar greens, Indian spinach, vine spinach

**Plant characteristics:** Ceylon spinach is a fast growing, vine like plant with fleshy leaves that will climb over other plants and structures. It grows vigorously in reasonably fertile soils with regular watering and is suitable for container growing. Vines grow to around 3 m long. There are two recognized varieties: variety *B. alba* with green leaves and light green stems and variety *B. rubra* with green leaves, dark red/purple stems and red flowers. Both have purple berries.

**Uses:** The leaves and young tips are best prepared fresh. After thorough washing short succulent tips can be used fresh in salads or liquidized for adding to vegetable drinks. Older leaves require a little steaming or can be added to dishes like soups, curries and stews. Medicinally Ceylon spinach has been traditionally used as an anti-inflammatory, antifungal, anticancer agent; to lower high blood pressure, and to treat dysentery.

**Availability:** This plant can be grown all year in most tropical locations and seasonally in sub tropical areas.

**Propagation methods:** New plants are produced from cuttings or seed. Plants often self-seed and the seedlings easily transplant. Preferably cuttings (200 to 600 mm long) should be taken after harvesting the tip; care with watering is needed until the cuttings are established. Cuttings can be stored or transported for a few days provided they are kept in the shade, and in a little water, which must be changed regularly to reduce the possibility of stem rots.

**How to grow:** This plant is well suited to growing in large pots. A pot of 20 litres capacity or larger should be used, filled with a well drained loam and compost mix. About 4 seeds or a rooted cutting can be placed in the pot along with a strong climbing structure, such as bamboo stems. Ceylon spinach will grow well if water is readily available. It can grow in full sun but a little shade is preferable. It usually behaves as an annual with a lifespan in the tropics of around 6 months. Soils of poorer fertility and insufficient water will produce slower growing, smaller leaved plants with thinner stems, and which flower earlier.

**Threats:** Pests and diseases are not usually a limiting factor in growing Ceylon spinach. Leaf eating insects like grasshoppers and some caterpillars are occasional pests that may become a problem in drier conditions. Selecting healthy planting material and providing good growing conditions can reduce the occurrence and impact of these pests.

**Harvesting:** Harvesting can start around 5 weeks after planting; regular harvesting is recommended to encourage plant growth. The tips, usually back to the third newest full leaf, and fresh looking older leaves should be neatly picked, ideally in the cooler part of the day to prevent wilting. The cut tips and leaves can be loosely packed in moist paper. Where a tip has been harvested, that runner should produce one or more new tips suitable for picking in a week or two.

**Post harvest and storage:** Leaves should be washed carefully with water of drinking quality or clean seawater; they can be bundled with their stems

• *Flowers and fruit with seed*

• *Mature plant of Alba (green stem) type at Violets and Lace Nursery, North Queensland*

• *Mature plant of Rubra (red stem) type in Samoa*

trimmed and stood upright in a small amount of clean fresh water. If kept cool and covered with a clean plastic bag, they should store for a day or two. If placed in an airtight container in a cool room or refrigerator, they can last for up to a week.

**Project findings/nutritional value:** Samples of Ceylon spinach for analysis were collected from north Queensland, Tonga, Samoa and Solomon Islands Around 100 grams of fresh vegetable (about 3 handfuls) per person for a meal serving will provide useful nutrition. It is strong in:

***Magnesium:*** This mineral is important in bone formation, energy transfer in cells, and nerve and muscle function.

***Calcium:*** The most important mineral for the growth and maintenance of bones and teeth. Calcium is also important for cellular physiology.

***Zinc:*** Important for immunity, growth, carbohydrate metabolism, and DNA and protein formation. Humans have around 600 different Zn-containing enzymes/ proteins.

This table compares selected mineral nutrients and carotenoids in leaves of Ceylon spinach and ivy gourd (*Coccinia grandis*) grown together at Leififfi, Upolu, Samoa in 2012 and English cabbage (average of samples bought from Honiara market, Solomon Islands and Nukualofa market, Tonga in 2012) (concentration in mg/kg dry weight, except N: % dry weight).

| | Mn | Cu | Zn | Ca | Mg | K | S | N % | lutein | alpha carotene | beta carotene |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ceylon spinach | 70 | 8 | 41 | 26000 | 15500 | 22000 | 3300 | 4.1 | na | na | na |
| Ivy gourd | 81 | 7 | 30 | 97000 | 11300 | 16200 | 10000 | 3.6 | 556 | 17 | 256 |
| Cabbage | 40 | 23 | 20 | 5700 | 1450 | 29000 | 3750 | 2.8 | 5 | 0 | 2 |

Mn: manganese; Cu: copper; Zn: zinc; Ca: calcium; Mg: magnesium; K: potassium; S: sulphur; N: nitrogen.
na: not analyzed.
The Ca level for ivy gourd leaves of 97000 mg/kg is easily the highest recorded in this project.
Analyses conducted by Waite Analytical Services and the Mares Laboratory, University of Adelaide, South Australia

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# CHILLI LEAF

FACTSHEET no: 10

• *Tips ready for harvest*

• *Mature plant of Tabasco/Birdseye chilli*

**Botanical name:** Capsicum spp. (Solanaceae)

**Location specific common names:** *C. frutescens* (Birdseye and Tabasco)

*C. annuum* (Sweet peppers or capsicum) chili, chile

**Plant characteristics:** Chilli plants are small bushes that usually grow for a year or more in warm locations. They are suitable for container growing. Many recognized species and varieties exist, ranging from sweet capsicums with no heat to the fieriest hot-fruited forms. Birds are not affected by the heat component (capsaicin) in chilli, therefore birds are effective seed dispersal agents, thus volunteer plants are often found in unusual places.

**Uses:** The leaves and very young tips can be used fresh or in cooked dishes. Leaves have a mild distinctive flavour that is not hot to taste.

**Availability:** This plant can be grown all year in most tropical and sub tropical areas.

**Propagation methods:** New plants are produced from seed. Plants often self-seed and with a little care, the seedlings easily transplant.

**How to grow:** Chilli plants can be easily grown in large pots. A pot of 20 litres capacity or larger should be used, filled with a well drained loam and compost mix, in which four seeds or young plants can be placed. Chilli plants like more alkaline soils than most tropical plants so coral sand in the mix will promote growth. They are deep rooted but require occasional watering during drier conditions. Chilli plants will grow in full sun but a little shade produces larger, tender leaves.

Leaves should not be harvested too often as plant vigour may be affected, and fast growing younger plants produce the best leaves. For a continuous supply of leaves two or three staggered plantings of ten or more plants will be required each year. Leaf production is reduced when the plants fruit.

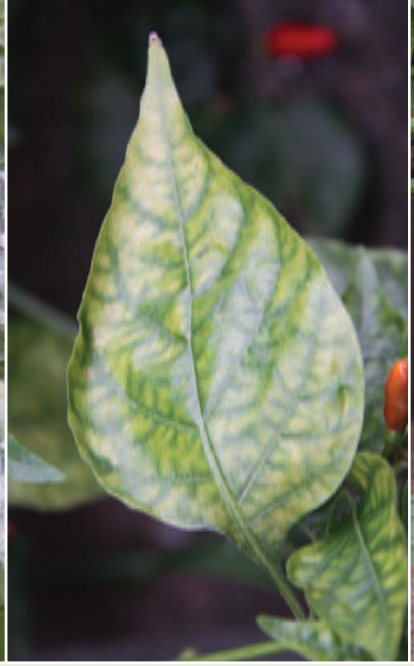
**Threats:** Pests like scales and spiralling whitefly will reduce plant vigour, resulting in smaller leaves or even death of the plant. Scales can be controlled by reducing ant populations with well mulched, moist soils. Spiralling whitefly can be reduced by mulching the soil with light coloured materials such as shredded paper and spraying the undersides of leaves with jets of water.

**Harvesting:** Leaves and tips can be neatly picked, ideally in the cooler hours of the day to prevent wilting. Harvesting too many leaves at one time will reduce plant vigour.

**Post harvest and storage:** Leaves should be washed carefully with water of drinking quality or clean seawater. If loosely bundled in moist paper and kept in a cool location, leaves should keep fresh for a day or two. If placed in an airtight container in a refrigerator, they can last for up to a week. Chilli leaves are firm and therefore can be frozen.

**Project findings/nutritional value:** Samples of chilli leaves for analysis were collected from Solomon Islands, Samoa and the Torres Strait Islands. 50 to 100 grams of fresh leaf (1.5-3 handfuls) per person for a meal serving will provide useful nutrition.

• *Leaves with spiralling white flies*



• *Nutritional deficiency symptoms on chilli leaf*

• *Mature plant of tropical sweet capsicum*

We found chilli leaf to be a consistently rich source of potassium and copper, as well as being relatively high in most other minerals and carotenoids: for example, at a Burns Creek, Honiara (Solomon Islands) site, chilli leaf was found to contain 829, 32 and 340 mg/kg dry weight of lutein, alpha-carotene and beta-carotene, respectively, all excellent levels.

***Carotenoids:*** Lutein is important for eye health (e.g. reducing risk of cataracts) and beta-carotene (pro-vitamin A) is important for vision, immunity and bone health.

***Potassium:*** Controls body water balance through its interactions with sodium and chloride ions, and is involved in electrical stimulation of nerves and muscles. Deficiency can cause muscle weakness, cramps and irregular heartbeat.

***Copper:*** Component of enzymes, involved in iron metabolism, therefore supports production of healthy blood and generation of energy.

This table compares selected mineral nutrients in leaves of Chilli and "sandpaper cabbage" (*Ficus spp.*) grown together at Aruligo, Guadalcanal, Solomon Islands in 2012 and English cabbage (average of samples bought from Honiara market, Solomon Islands and Nukualofa market, Tonga in 2012) (concentration in mg/kg dry weight, except N: % dry weight).

| | Mn | B | Cu | Zn | Ca | Mg | K | P | S | N % |
|---|---|---|---|---|---|---|---|---|---|---|
| Chilli | 32 | 72 | 26 | 22 | 19900 | 4600 | 50000 | 4900 | 3800 | 3.2 |
| Ficus | 26 | 54 | 8 | 18 | 25000 | 3200 | 22000 | 2100 | 2100 | 3.1 |
| Cabbage | 23 | 12 | 2 | 20 | 5700 | 1450 | 29000 | 3750 | 3750 | 2.8 |

Mn: manganese; B: boron; Cu: copper; Zn: zinc; Ca: calcium; Mg: magnesium; P: phosphorus; S: sulphur; N: nitrogen. Analyses conducted by Waite Analytical Services and the Mares Laboratory, University of Adelaide, South Australia

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The factsheets are intended to provide information on some of the most nutritious leafy green vegetables suitable for growing in tropical areas.

COMPILED BY **R. GOEBEL, M. TAYLOR** & **G. LYONS**

# AMARANTH

FACTSHEET no: 11

• *Potted cutting ready to transplant*

• *Amaranth (Moca) in Suva Market, Fiji*

**Botanical name:** *Amaranthus spp.* (Amaranthaceae)
**Location specific common names:** moca, tubua, aupa, bhaji, bayam

**Plant characteristics:** Amaranth is a small to medium-sized annual bushy plant with a distinct taproot, diamond shaped leaves and feather-like seed heads. Numerous species exist, many selected and grown for grain, leaves or for their ornamental value, although some are classed as weeds. *A. tricolor* is a popular species for leaf production**.** Amaranth grows vigorously in reasonably deep, fertile soils with occasional watering.

**Uses:** Young leaves of most species are edible but some produce large tender leaves and are grown specifically for leaf consumption. Leaves are best prepared lightly steamed; older leaves require longer steaming or they can be added to moist dishes like soups, curries and stews. Uncooked Amaranth leaves should not be consumed as the oxalate content reduces the bioavailability of iron, zinc, calcium and magnesium; cooking reduces the oxalate level. Tender stem tips are better peeled before cooking.

**Availability:** Amaranth can be grown year-round in most tropical and subtropical locations.

**Propagation methods:** New plants are produced from seed or cuttings. Seeds are very small; plants often self seed. Plants often self-seed and young seedlings transplant readily.

**How to grow:** Amaranth is well suited to growing in large pots or garden beds with a well-drained loam and compost mix. It will grow in full sun but afternoon shade encourages good leaf production. Soils of poorer fertility and insufficient water produce slower growing, smaller leaved plants with thinner stems and earlier flowering

**Threats:** Pests and diseases do not usually affect this plant, however, leaf eating insects such as grasshoppers are occasional pests and may become a problem at any time.

**Harvesting:** Plant growth is promoted by regular harvesting. The tips, usually back to the fifth newest full leaf and fresh looking older leaves can be picked and loosely packed in moist paper. Harvesting in the cooler hours of the day prevents drying/wilting. Once a tip has been harvested the plant will continue to grow and produce one or more new tips suitable for picking in a few weeks.

**Post harvest and storage:** Leaves should be washed carefully with water of drinking quality or clean seawater and best used as they are picked. They can be bundled with their stems trimmed and stood upright in a small amount of clean fresh water. If covered with a clean plastic bag and kept cool, they should store for a day or two. Leaves are firm and can be stored frozen.

**Project findings/nutritional value:** Samples were collected in Samoa. Amaranth is a nutritious all-rounder, being a good source of protein, carotenoids and most minerals, particularly zinc, calcium and magnesium. Around 100 grams of fresh vegetable (about 3 handfuls) per person for a meal serving will provide useful nutrition.

***Protein:*** This is important in forming muscle, cell membranes, enzymes, blood components, antibodies, DNA and RNA. The nitrogen analyses of our samples

• *Leaf eating insects like caterpillars are often the biggest problem*

• *Seed heads with characteristic feather like shape*

• *Potted cutting ready to transplant*

indicated a protein level of around 23%.

***Carotenoids:*** Lutein is important for eye health (e.g. reducing risk of cataracts), and beta-carotene (pro-vitamin A) is important for vision, immunity and bone health.

***Zinc:*** Important for immunity, growth, carbohydrate metabolism, and DNA and protein formation. Humans have around 600 different Zn-containing enzymes/ proteins.

***Magnesium:*** This mineral is important in bone formation, energy production, and nerve and muscle function.

***Calcium:*** The most important mineral for the growth and maintenance of bones and teeth. Calcium is also important for cellular physiology.


• *Mature plants growing in beds*

This table compares selected mineral nutrients and carotenoids in leaves of amaranth and sweetpotato grown together at Lotofaga, Upolu, Samoa in 2012 and English cabbage (average of samples bought from Honiara market, Solomon Islands and Nukualofa market, Tonga in 2012) (concentration in mg/kg dry weight, except N: % dry weight).

| | Mn | Zn | Ca | Mg | K | P | S | N % | lutein | alpha carotene | beta carotene |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Amaranth | 58 | 64 | 15500 | 18800 | 45000 | 6400 | 4400 | 5.3 | 462 | 8 | 350 |
| Sweetpotato | 75 | 23 | 5500 | 4600 | 15900 | 3600 | 3200 | 4.6 | 457 | 10 | 317 |
| Cabbage | 23 | 20 | 5700 | 1450 | 29000 | 3750 | 3750 | 2.8 | 5 | 0 | 2 |

Mn: manganese; Zn: zinc; Ca: calcium; Mg: magnesium; K: potassium; P: phosphorus; S: sulphur; N: nitrogen.
Analyses conducted by Waite Analytical Services and the Mares Laboratory, University of Adelaide, South Australia

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FACTSHEET no: 12

# Improving nutrition with the Thursday Island Donut Gardens

• *Student topping up a garden*

Thursday Island in the Torres Strait is a difficult place to establish a garden.

Local educator and horticulturalist George Ernst has developed a garden system that has produced fruit, vegetables and spices, and which can also be adapted to grow ornamental and medicinal plants.

The name "donut" refers to the round mound of mulch and compost that reduces weed growth, retains moisture and breaks down to provide plant foods. The distinct shape and relatively small size, between 3 to 4 metres across, also defines these gardens.

Each garden has a central fruit tree like a grafted lemon or mango tree and three or four other plants like pineapple, chilli, pawpaw or pumpkin. The key to deciding which plants to cultivate in the garden is that the same management needed for the fruit tree will also support the growth of the other plants which will produce a crop in a shorter time than the fruit tree.

This effort is a team event. The plants cost money and the garden beds require regular maintenance. George has some financial support from the local Technical and Further Education (TAFE) college, the local council and ACIAR, but the major effort is provided by dedicated and enthusiastic locals including grade 11 and 12 students.

The use of mulch, largely in the form of chipped fallen and pruned tree branches supplied by the council, is important. To ensure a constant supply of nutrient, chicken manure and small amounts of inorganic fertilizer are incorporated as well. This garden system can be adapted to reticulated water or stand alone irrigation. Shade and windbreaks can be constructed for particular plants.

Within the first 18 months, 48 garden beds have been planted. The project aims to improve the environment and provide a range of healthy foods. The beds are located on public land and each site is chosen carefully to enhance the appearance of its surroundings and at the same time, not interfere with pedestrian and vehicle access, powerlines and underground services. Each bed is accessible to the public and includes painted pegs that provide information such as the name of the fruit tree, who planted it and when. Additional information such as at the stage of maturity when the crop can be picked, may also be displayed.

Most of the garden inputs can be sourced locally and apart from labour, upkeep costs are minimal.

• *Wongi tree with chilli and pumpkin plants*


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