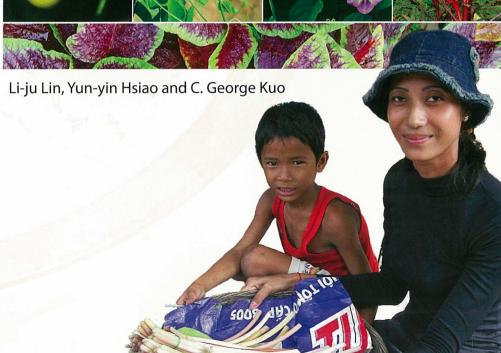


# Discovering Indigenous Treasures

Promising indigenous vegetables from around the world





### **Discovering Indigenous Treasures**

Promising indigenous vegetables from around the world



AVRDC – The World Vegetable Center is an international nonprofit institute committed to alleviating poverty and malnutrition through vegetable research and development. Our vegetable lines and technologies help small-scale farmers in the developing world boost yields, increase their incomes, and safely grow nutritious food for their families and communities.

#### Notice

Some of the indigenous vegetables introduced in this book may contain constituents that have medicinal applications; the reader should rely on qualified medical advice before using them for that purpose. Some people may have allergic reactions to indigenous vegetables. However, indigenous vegetables have been an integral part of diets around the world for centuries, and when properly prepared, are delicious and nutritious. The recipes in this book serve as guides for the proper preparation of indigenous vegetables.

AVRDC – The World Vegetable Center P.O. Box 42, Shanhua, Tainan 74199, Taiwan

Tel: +886-6-583-7801 Fax: +886-6-583-0009 E-mail: <u>info@worldveg.org</u> Web: <u>www.avrdc.org</u>

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#### **Foreword**

AVRDC – The World Vegetable Center is devoted to research into indigenous vegetables as part of an ongoing effort to diversify the range of vegetables available to the rural and urban poor in developing countries. The indigenous vegetable species and ecotypes domesticated and used in specific areas of the globe usually adapt to harsh environments. They could be introduced elsewhere for greater crop diversification and increased productivity, which would balance year-round nutrition, provide new market opportunities and enhance farm income. Moreover, they would help solve problems associated with global warming by reducing the demand on non-renewable energy and so lessen the ecological footprint of the food supply chain.

The World Vegetable Center's indigenous vegetable program involves the collection of genetic resources worldwide. It conserves and characterizes indigenous vegetables, analyzes their nutrient contents and selects those with the most promise. It also establishes appropriate production techniques and collates information to promote indigenous vegetables. The program is conducted through international partnerships.

A large number of indigenous vegetables have been evaluated at the Center's headquarters in Taiwan and its regional centers in Tanzania and Thailand. Many show promise of wider environmental suitability, low input requirement, adaptability to specific cropping systems, ease of seed or propagule production, easy harvesting and postharvest processing, and high nutritional and health values. Promising indigenous vegetables warrant further development for extended areas of production and consumption.

Based on research by our own and other scientists, this book illustrates the exciting world of indigenous vegetables and highlights the promising species now used by people in other parts of the globe. It provides attractive photos and textual descriptions of the botanical and horticultural features of each plant. It also shows their potential as new vegetables in appropriate agroecological systems to complement the production of beans, brassicas, bulb alliums, peppers and tomatoes to alleviate micronutrient malnutrition.

I hope this book will be of practical assistance to advance research and development into the greater use of promising indigenous vegetables.

J.D.H. Keatinge

Director General AVRDC – The World Vegetable Center

J.DH Kealing

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#### **About This Book**

Vegetables generally mean the edible portions of herbaceous, shrubby, or woody plants. Usually they have a savory taste and contain large amounts of water. Indigenous vegetables refer to those plants grown primarily in their centers of origin or diversity, or to those introduced species that adapt to the environment in a given area over a defined time. Some indigenous vegetables may be globally distributed, but most tend to occupy special niches. Indigenous vegetables may be semi-wild or domesticated.

Indigenous vegetables have been used for ages by local communities. However, many are underutilized because their value is not appreciated, particularly in regions where the plants are not native. This book attempts to narrow the knowledge gap. It is meant for consumers who would benefit from consuming diverse vegetables, farmers who consider growing new crops, researchers who seek to advance the frontiers of indigenous vegetables, and decision-makers who require information for setting research and development priorities.

The book begins with several sections on the basics that are treated in descriptions of individual indigenous vegetables. Both species and family names are used as the title heads of each entry. Common names are also given in Chinese (Cn), English (En), French (Fr), Japanese (Jp), Spanish (Sp), and Vietnamese (Vn). Each entry is explained by plant distribution, botanical features in text and photos, environmental factors, production methods, edible parts, and health values. The indigenous vegetable entries are arranged alphabetically by the genus and species names.

The photos show features such as the typical look of the plant, growth form, leaves, flowers, fruits, and seeds. Nevertheless, plants are individuals, and their overall shapes can be influenced and altered by their environment. For this reason a plant in your environment may not appear identical to the photos in this book. Some photos on cultivation methods and market sales are also included.

To encourage readers to fully appreciate the culinary and esthetic value of indigenous vegetables and integrate them into their lives, this book highlights attractive flower arrangements and appetizing recipes that can be made with selected species. In addition, a photo gallery shows some social marketing activities conducted at AVRDC – The World Vegetable Center headquarters in Taiwan. For readers seeking more specific details on certain indigenous vegetables, an extensive reference list is provided.

We hope this book contains the information you seek, and that you have as much enjoyment from using it as we had in preparing it.

# **Botanical Features**



As for other plants, indigenous vegetables can be identified by growth duration and form, root profile, leaf shape and size, inflorescence arrangement, flower structure, fruit formation, and seed structure. These features serve as the base of plant classification and are parts of species attributes.

#### Plant Classification and Names

Plants are classified according to their assumed relatedness. The **species** is the basic unit of classification based on the structure of flowers, fruits, and other organs. All species are classified hierarchically. Related species are grouped into a **genus**; related genera into a **family**; related families into an **order**; related orders into a **class**, e.g., flowering plants whose seed contains two seed-leaves (dicots) and flowering plants whose seed contains one seed-leaf (monocots); related classes into a **division**, e.g., ferns and flowering plants; and related divisions into a **kingdom**.

Common names form an important heritage for indigenous vegetables. However, some names may be used only in certain regions, some plants may have different names in different regions, and some different plants may share the same common names. To ensure international understanding of the same plant, the scientific name is extremely important. Each plant species receives a Latin name of two words, the first indicating the genus (capitalized) and the second indicating the species (lowercase), both written in italics.

#### Structure and Form

A plant has the genetic tendency to grow in a certain shape and to attain a certain mature height and spread.

- Herbs are soft and succulent, with little or no secondary tissue.
- Woody plants are those that develop secondary stem tissues.
- Vines are trailing or climbing plants that twine their stems or use tendrils around a support.
- Shrubs are low, woody plants with stems that are rigid and strong enough to sustain considerable erect growth with multiple branches of equal size from the ground.
- Trees are plants that are abundantly woody, typically have a single stem or trunk, and grow quite tall.

#### Lifecycle

Depending on species, a plant's life cycle that starts from seed germination to seed setting for the next generation may be completed in less than one year or over many years.

- Annuals complete their life cycle within a single growing season (usually less than one year).
- Biennials complete their life cycle within two growing seasons (usually more than one year). Normally during the first season, they develop vegetative growth and accumulate food reserves, and in the following season produce flowers and set seed.

• Perennials live through several growing seasons, and produce flower and set fruit each season. They usually shed their leaves (deciduous) at the end of season with little loss of woody branches.

From a horticultural perspective, a vegetable plant's life span is a function of climate and usage. Some vegetables are biennials or perennials, but cultivated as annuals for their edible parts.

#### Root

Roots normally grow in the soil and serve to anchor a plant and facilitate the uptake of water and mineral salts.

- Taproot is a primary root that grows from a plant vertically downward.
- Lateral roots extend horizontally from the taproot and may branch themselves.
- Storage roots are swollen (or tuberous) roots to store food and nutrition.
- Adventitious roots originate from stems or leaves.

#### Stem

The stem is the main structural axe of a vascular plant. It supports the entire plant and bears the buds, leaves, flowers, and fruits; it is a vital connection between leaves and roots. A stem is made up of **internodes** separated by **nodes** that are often thickened. A point between a leaf and the stem on the node is called the **axil** (adj. **axillary**). The **buds** on the axils grow into one or more leaves, inflorescence, flowers or branches. The stem growth may be **indeterminate** (i.e., the terminal end of a stem keeps growing) or **determinate** (i.e., the terminal bud forms a terminal flower and then dies out). The term **shoot** refers to new growth and includes not only stems but also other structures like branches, leaves, and flowers. The shoot can be hairless, nearly hairless, or hairy.

Stems are generally upright and above ground. However, there are stems that cling or wrap around other plants or structures, recline on the ground, or lay below ground. Underground stems include:

- **Rhizome** is a swollen main stem that grows horizontally and produces leafy stems and adventitious roots at the nodes.
- Tuber is a swollen end of a stem having many buds.

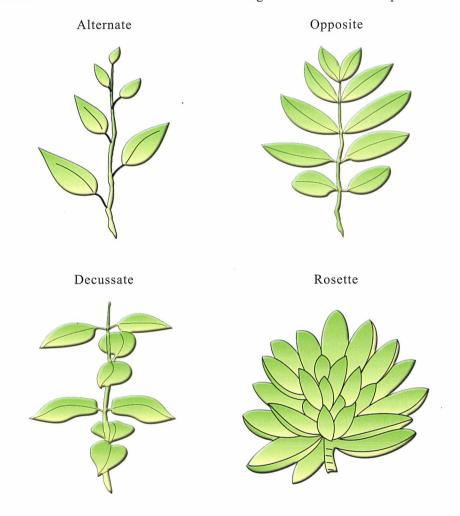
#### Leaf

A structurally complete leaf consists of an elongated fleshy stalk (petiole), a flattened blade (lamina), and a pair of leaf-like appendages at the base or on the petiole of a leaf (stipules). However, not every plant species produces leaves with all of the aforementioned structural components. In some species, a petiole may be absent (sessile), or paired stipules are absent or not obvious. Some have leaves whose base wholly or partly clasps the stem (sheath), while in others the blade may not be flattened. Some other species have secretory glands (adj. glandular) at the leaf base, on the leaf surface, or on other plant parts. The external characteristics of the leaf are important clues for identifying plant species.

#### Leafarrangement

The basic patterns of the leaf arrangement on the stem are as follows:

- Alternate: Each leaf occurs singly at each node; successive leaves are not directly above each other.
- Opposite: Two leaves per node, on opposite sides of the stem.
- Decussate: Opposite leaves at a right angle to the pair above and below.
- Rosette: A cluster of leaves in a circular arrangement at the base of a plant.



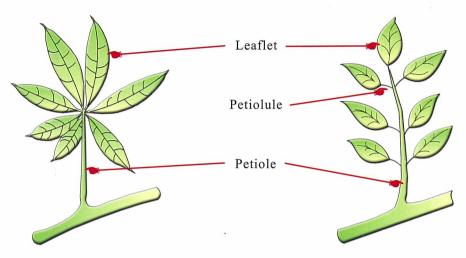
#### Leaf form

Two basic forms of leaves can be portrayed based on the way the blade is divided. A **simple leaf** has an undivided blade, whereas a **compound leaf** has a fully subdivided blade. Fully subdivided blades (**leaflets**) may be attached to a common petiole, in which case the leaflet's stalk is called a **petiolule**. Compound leaves have several unique patterns as follows:

- Foliolate compound leaves have a specified number of leaflets, e.g., trifoliolate with three leaflets.
- Palmate compound leaves have the leaflets radiating from the end of the petiole, like fingers off the palm of a hand.
- Pinnate compound leaves have leaflets on both sides of an elongated axis.

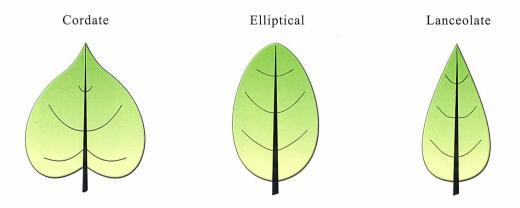
#### Palmate compound leaves

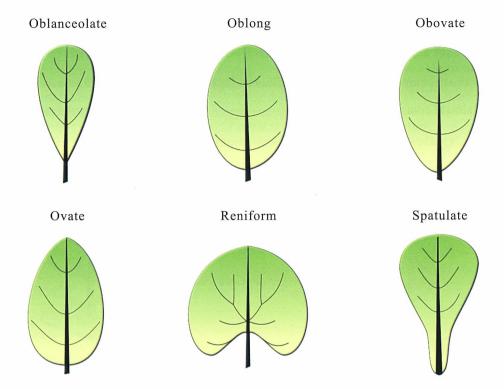
#### Pinnate compound leaves



#### Leafshape

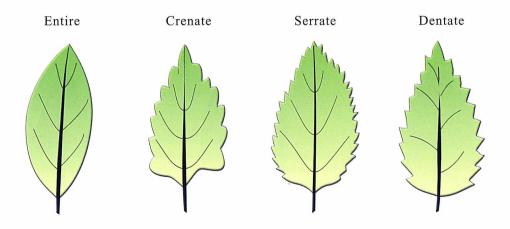
- Cordate: heart-shaped with the notch at the base.
- Elliptic or elliptical: the broadest point midway between the ends.
- Lanceolate: widening above the base and tapering to the apex.
- Oblanceolate: widest above the middle and tapering to the base.
- Oblong: much longer than wide with parallel sides.
- Obovate: of a plane with the outline of an egg attached at the narrow end.
- Ovate: of a plane with the outline of an egg attached at the broad end.
- Reniform: kidney-shaped.
- Spatulate: spoon-shaped.

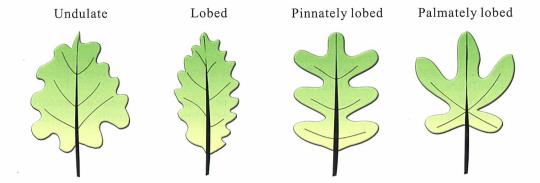




#### Leaf margins

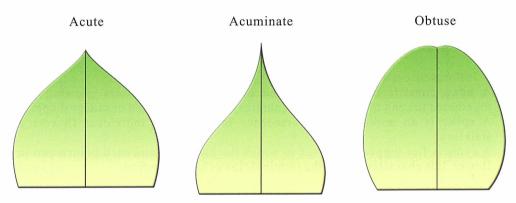
- Entire: a continuous margin, without teeth or divisions.
- Crenate: bluntly toothed margins.
- Serrate: with sharp teeth, oblique to the margin, pointing apically like a saw.
- Dentate: with sharp, spreading teeth perpendicular to the margin.
- Undulate: slightly wavy margins.
- Lobed: having deeply indented margins.
- Pinnately/pinnatifid lobed: lobes directed towards the midrib but not reaching it.
- Palmately lobed: lobes originate at or near the base of the leaf.





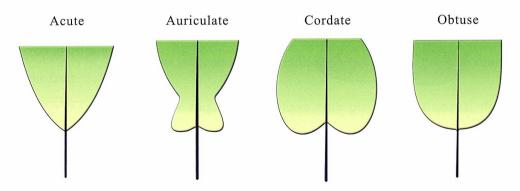
Tip of the leaf

- Acute: ending in a short narrow point.
  Acuminate: taper gradually to the apex.
  Obtuse: blunt or rounded at tip.



#### Base of the leaf

- Acute: coming to a short narrow point.
  Auriculate: with earlike lobes on either side of the petiole.
- Cordate: heart-shaped with the notch at the base.
- Obtuse: blunt or rounded at base.



#### Modification of the leaf

- Bract (adj. bracteate): a specialized leaf that is associated with an inflorescence or a flower. Usually bracts are green and resemble the other leaves, but some are brightly colored. Bracts in a whorl are collectively called an involucre, thus involucral bracts.
- Tendril: a specialized leaf, leaflet, petiole or stem branch with a threadlike shape that is used by climbing plants for attachment, generally by twining around whatever it touches.

#### Leaf-like structure of the fern

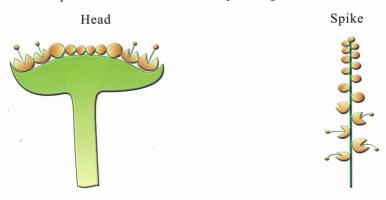
The leaf-like structure of a fern is called a **frond**, which consists of a supporting stalk (**stipe**) and a blade. On the underside of some mature blades occur spore-producing structures clustered in a **sorus** (pl. **sori**).

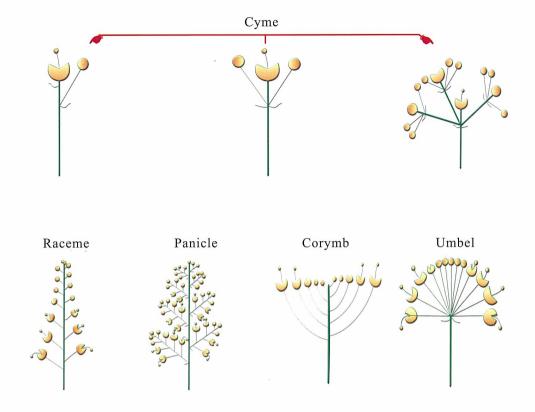
#### Inflorescence

In rare cases, a shoot has just a single (solitary) flower at its tip. But more often several or many flowers are grouped in clusters called **inflorescences**. The stalk holding the whole inflorescence is called a **peduncle**. The stalk of each single flower is called a **pedicel**.

Inflorescences are often arranged in a number of different ways:

- A head consists of many unstalked or short-stalked flowers growing close together at the end of a stem that is compressed into a flattened or saucer shape.
- A spike is an unbranched inflorescence in which the individual flowers are stalkless
- A cyme is flat-topped or convex in which the main axis and each branch end in a flower. It is characterized by the terminal flower blooming first.
- A raceme (adj. racemose) is an unbranched inflorescence consisting of stalked flowers.
- A panicle (adj. paniculate) is an inflorescence whose main branches are themselves branched.
- A corymb (adj. corymbiform) is a flat-topped, indeterminate inflorescence where pedicels are progressively shorter towards the center of the inflorescence.
- An umbel is a type of raceme with flower stalks of equal length that arise from the same point, with younger flowers in the center. Umbels are often compound, with several partial umbels on stalks of equal length.





#### Flower

A flower is the reproductive structure of angiosperms. It facilitates the union of male sperm with female ovum to produce seeds. The parts of a flower are arranged in whorls. The outer whorl, **perianth**, is sterile. The four major whorls of a flower are as follows:

- Calyx (pl. calyces) is the outer whorl of green sepals, which may be either free or fused together.
- Corolla is the whorl of petals, which are usually thin, soft, and colored.
- Stamen consists of pollen-bearing anthers supported by a filament. Pollen contains the male gametes.
- Pistil is made up of one or more carpels, which contain an ovule-bearing ovary at the base supporting an elongated region (the style). The style's sticky expanding tip, the stigma, is the receptor of pollen. The ovule contains female gametes and develops into seeds after pollination and fertilization. The mature ovary becomes the fruit.

For most plant species single flowers have both pistils and stamens; these flowers are referred to as **bisexual**. However, for some species flowers are **unisexual** with only male (stamen) or female (pistil) parts. If an individual plant is either female or male the species is referred to as **dioecious**. However, where separate male and female flowers occur on the same plant, the species is regarded as **monoecious**.

#### Fruit

Fruit develops from the ovary and accessory tissues that enclose the seeds. There are two basic types of fruit described in this book:

- **Simple** fruits derive from a simple or compound ovary with only one pistil. They can be fleshy or dry at maturity.
- Aggregate fruits derive from many pistils on a common receptacle.

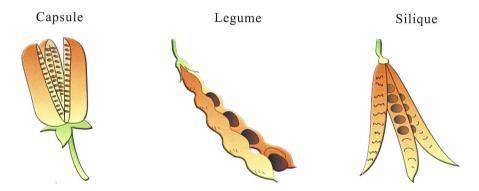
Simple fleshy fruits have two major types:

- Berry: the whole fruit wall, either fleshy or pulpy, with one or many seeds.
- Pepo: the berry with a hard outer wall (rind).

Simple dry fruits are either **dehiscent** (opening to discharge seeds) or **indehiscent** (not opening to discharge seeds) at maturity.

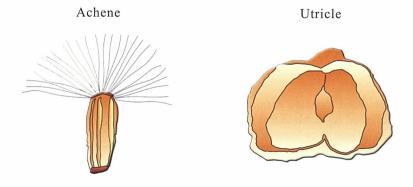
#### Dehiscent fruits

- Capsule is made up of two or more united carpels.
- Legume or pod is a several-seeded fruit that splits down both sides.
- Silique is a slender fruit that splits open along the edges leaving seeds attached to a central partition.



#### Indehiscent fruits

- Achene is a one-seeded fruit with the seed attached to the fruit at one point only.
- Utricle is a variant of achene; it is small, bladder-like, more or less inflated.



#### Seed

A seed is a small embryonic plant developed from an ovule and enclosed in the seed coat with some food reserves. In response to suitable environmental conditions, the dormant embryo resumes growth and emerges from the seed coat (germination). There are two patterns of seed germination:

- Epigeal: the cotyledons (seed leaves) appear above the ground.
- Hypogeal: the cotyledons remain below the ground.

A **propagule** is any plant material used for the purpose of crop production or propagation. In sexual reproduction, a propagule could be a true seed, a one-seeded indehiscent fruit such as in edible chrysanthemum and chayote, or a multiple-seeded fruit as in New Zealand spinach. In asexual reproduction, a propagule may be a stem cutting, leaf section, plant base, sucker (shoot sprouts from the plant base) or any other plant part.

#### Edible part

Parts used as vegetables may consist of the entire plant, stem, bulb, storage root, tuber, foliage, petiole, flower, fruit, or seed. Except the mature seed, most of the aforementioned edible parts are soft and tender. Leafy vegetables are by far the most common among indigenous vegetables. Nevertheless, there are multipurpose indigenous vegetabless characterized by more than one edible part. They are usually used in home gardens, but not in commercial production. Once established, perennials around the house can provide an abundance of leafy vegetables for a number of years.

# Environmental Factors



Environmental factors—light, temperature, water, and soil—greatly influence plant growth and geographic distribution. These factors determine the suitability of a crop for a particular location, cropping pattern, management practices, and levels of inputs needed. A crop performs best and is least costly to produce if it is grown under the most favorable environmental conditions. To maximize the production of any crop, it is important to understand how these environmental factors affect plant growth and development.

#### Light

Sunlight is essential for any crop. Dry matter production often increases in direct proportion with increasing amounts of light. The amount of sunlight received by plants in a particular region is affected by the intensity of the incoming light and the day length. The light intensity changes with elevation, latitude, and season, as well as other factors such as clouds, dust, smoke, or fog. The total amount of light received by a crop plant is also affected by cropping systems and crop density. Different plants differ in their light requirements:

- Full sun plants thrive in full sun but grow poorly in shade.
- Partial sun (or partial shade) plants will produce an edible crop when grown in a shady location. However, these plants need at least 50-80% of full sun.
- Full shade plants thrive in 30-50% of full sun but weaken in full sun. Shading sometimes is used to inhibit pigment development in crops in which the lack of color is an important quality factor.

Due to the tilt of the earth's axis and its travel around the sun, the day length (also called photoperiod) varies with season and latitude. Photoperiod controls flowering or the formation of storage organs in some species. Some plants flower when a specific day-length minimum has been passed:

- Short-day plants flower when day length decreases.
- Long-day plants flower when day length increases.
- Day-neutral plants are not affected by day length, and can flower under any light period.

#### **Temperature**

Temperature influences photosynthesis, water and nutrient absorption, transpiration, respiration, and enzyme activity. These factors govern germination, flowering, pollen viability, fruit set, rates of maturation and senescence, yield, quality, harvest duration, and shelf life. Different plants have different temperature requirements. However, for most crop species, optimum temperatures usually range around 25°C. Temperature requirements (usually based on night temperature) of plants are given below by the cardinal values and derived range for "effective growth" (growth range) and "optimum growth" (optimum range) that Krug (1991) has used for major vegetables.

- Hot: growth range 18-35°C; optimum range 25-27°C.
- Warm: growth range (10)12-35°C; optimum range 20-25°C.
- Cool-hot: growth range (5)7-30°C; optimum range 20-25°C.
- Cool-warm: growth range (5)7-25°C; optimum range 18-25°C.

Depending on the situation and the specific crop, ambient temperatures higher or lower than the effective growth range will reduce growth and delay development, and subsequently decrease yield and quality. The extremes may be considered killing frosts at about 0°C and death by heat and desiccation at about 40°C.

#### Water

Water is absolutely essential for any plant species. Plants can be grouped according to their natural habitats with respect to water supply:

- **Hydrophytes** are plants that are adapted to living in water or in soil saturated with water. The hydrophytes usually have large interconnected intercellular gas-filled spaces in their root and shoot tissues (aerenchyma) to facilitate air exchange.
- Mesophytes are the most common terrestrial plants that are adapted to neither a long wet nor a long dry environment. Depending on the extension of their root systems and other plant features, however, their water requirement varies.
- Xerophytes are plants that can endure relatively long periods of drought. The xerophytes usually have special features such as reduced permeability to decrease water loss, swollen tissues to conserve water, or deep and extensive root systems to acquire water.

#### Water requirement

Water is crucial for crop productivity and quality. However, crop water requirements differ according to plant and soil types. A plant's total sum of water requirement includes the water the crop uses by itself and also the losses due to evapotranspiration (which includes both plant transpiration and soil evaporation), water application, land preparation, and leaching during the crop growth period.

#### Drought

Drought is defined as a period without significant rainfall or soil moisture. Droughts may lead to plant water deficit (drought stress) and growth may be impacted. Drought stress usually occurs when soil water content is less than 50% of field capacity (i.e., when the soil is full of water, hence 100%). Drought stress symptoms include wilting, droopy, curling or rolling of leaves; or browning of shoot tips. Among the mesophytes, the effect of drought stress varies with the species, variety, degree and duration of drought stress, and the growth stage. The yield formation stage is most sensitive for most vegetables. Periods of even short drought stress during this period can reduce yield.

#### Flooding

Flooding occurs when water enters soil faster than it can drain away. Intense rainfall, river overflow, increased surface run-off, over-irrigation, and slow drainage through the soil profile all contribute to flooding, especially in lowland regions. Under waterlogged conditions all pores in the soil are filled with water, depriving the soil of oxygen. As a result, plant roots cannot obtain oxygen for respiration to maintain their activities for nutrient and water uptake. Weakened plants are susceptible to soil-borne diseases. Oxygen deficiency in the soil due to waterlogging also causes death of root hairs, and increases formation of compounds toxic to plant growth. All of these lead to retarded growth or the death of the plant.

The extent of flooding damage depends upon the species or variety, stage of plant development, duration of flooding, water level in the soil, soil texture, temperature, and type of microorganisms present. High temperatures usually accelerate the damaging effects. Most mesophytes and xerophytes are sensitive to flooding. However, some species are able to tolerate flooding because of their abilities to increase porosity of the shoot base, or to replace damaged roots.

#### Soil

Soil is a natural medium that provides anchorage for the plant and supplies water and mineral nutrients for normal growth. Soil consists of mineral matter, organic matter, air, and water. The proportion of these four constituents and the types of mineral and organic material determines soil properties such as soil type, soil pH, and fertility.

#### Soil type

Soil is made up in part of mineral particles grouped as sand (0.05 to 2 mm), silt (0.002 to 0.05 mm), and clay (<0.002 mm). The ratio of these determines soil types, such as **clay, clayey loam, loam, sandy loam**, and **sand**. Loam is composed of sand, silt, and clay in relatively even amounts, and exerts a greater influence on soil properties than does sand, silt, or clay.

Soil type determines the soil's capacity to store water and nutrients, aeration, drainage, and ease of field operations. Sandy soils are easily tilled, well-drained and aerated but usually have low fertility and water-holding capacity. Clayey soils, on the other hand, are more fertile and have high water retention but are poorly drained and aerated.

#### Soil pH

Soil pH is a measure of the soil's acidity or alkalinity, and it affects the plant indirectly by influencing the availability of nutrients and the activity of microorganisms. Nutrients are most available at pH levels between 6.5 and 7.5. Nutrients in the soil may be chemically tied up or bound to soil particles and unavailable to plants if the pH is outside this range. Individual plants have pH preferences and grow best if planted in soils that satisfy their pH requirements.

#### Soil fertility

Soil fertility is the inherent capacity of soil to provide plant nutrients in adequate amounts and in proper balance for the growth of specific plants. A fertile soil is usually rich in nitrogen, phosphorus, and potassium, and contains sufficient trace elements and soil organic matter that improves soil structure and soil moisture retention.

#### Soil salinity

Soil salinity refers to the presence of excess salts in soil water, which often results from irrigated agriculture. After the plants take up the water, the dissolved salts from irrigated water start to accumulate in the soil. Soil salinity is usually measured as electrical conductivity (EC) of soil solution, and expressed in decisiemens per meter (dS/m). Excess salts generally affect plant growth by increasing osmotic tension in the soil, making it more difficult for the plants to take up water. Excessive uptake of salts from the soil by plants also may have a direct toxic effect on the plants. Soil salinity is most pronounced in arid areas.

Not all plants respond to salinity in a similar manner; some crops can produce acceptable yields at much higher soil salinity than others. This is because some crops are better able to make the osmotic adjustments, enabling them to extract more water from a saline soil. For example, turnip and carrot are among the most sensitive vegetables and can tolerate soil salinities of only about 1 dS/m before yield declines. Zucchini, on the other hand, can tolerate soil salinity of up to 4.7 dS/m before yield reduces. The ability of a crop to adjust to salinity is extremely useful. In areas where a build-up of soil salinity cannot be controlled, an alternative crop can be selected that is both more tolerant of the expected soil salinity and able to produce economic yields.

#### Plant-Plant Interaction

Apart from the preceding discussion on abiotic factors, plant growth is also determined by biotic factors (living organisms), such as soil microorganisms, pollinating insects, pathogens, insect pests, other plants, etc. Plants in a community may compete with other plants for space, water, light, and nutrients.

Some plants do not root in soil, but grow upon another living plant for physical support. They are called **epiphytic plants**, and they usually do not derive nutrition from their hosts. Epiphytic plants use photosynthesis for energy and obtain moisture from the air or from dampness on the surface of their hosts. Roots may develop primarily for attachment.

After a new plant has been introduced to a new location, there is a chance that the non-indigenous species will reproduce, start spreading throughout the new habitat, and eventually out-compete existing crop species or native plant species. This causes a negative impact on the existing cropping system or ecosystem. Some indigenous vegetables have certain traits that contribute to invasiveness. The traits that the growers should pay attention to are: 1) fast growth rate; 2) stress tolerance; 3) sturdy root or rhizome system; 4) seed shattering and small seeds; 5) easy to propagate vegetatively; and 6) dispersed easily by animals.

Another type of interaction between plants is called **allelopathy**. In this case, some plants release compounds by means of root exudation, leaching, volatilization or decomposition of plant residues in the soil, and directly inhibit the growth of others. Some weeds show allelopathic traits and prevent desired crops from growing. On the other hand, allelopathic substances, if present in crop varieties, may reduce the need for weed management.

## **Production Methods**



Crop production takes place in a physical environment that is not controllable. Many aspects of production systems and cultural practices, however, can be adapted to amend the environment more favorably for crop production. Profitable production comes about through the integration and balance of all controllable practices and environmental factors.

#### **Crop Selection**

To optimize productivity and maximize profitability, it is important to select species and varieties suited to the particular combination of soil and climate in a given area. Selection is primarily based on yield potential under this particular combination. Usually it is the adaptation to abiotic and biotic stresses in a given area that establishes the crop options from which growers make economic choices.

Diverse indigenous vegetables are adapted to different environmental stresses. Therefore, indigenous vegetables as a group have a comparative advantage to diversify crop production systems over space and time. Diversified production systems can recycle nutrients, improve system stability and resilience, and reduce incidences of diseases and pests. Consequently, system productivity will not be held captive to the yield variations and economic risks of any single vegetable. This in turn contributes to micronutrient security, improved health, and reduced poverty.

#### **Production Systems**

Based on the plant species and availability of land space, technologies and inputs, vegetable production usually employs one or more of the following systems:

#### Collection of wild plants

Some indigenous vegetables are collected from the wild to supplement household diets. This practice is important in marginal areas of developing countries.

#### Home gardening

Small-scale production at home or in the community can supplement the food budget or household income. Through proper planning and design, home gardens combine different vegetables with various growth patterns and durations to best use the natural and applied resources. Indigenous vegetables in developing countries usually are produced using this method.

#### Large-scale cultivation

Crops are grown in stands (population) on a farm as **monocrops** or **multiple crops** for marketing. The former is a system where a single crop is produced year after year. The latter involves the growing of two or more crops in one of the following modes:

- Sequential cropping or crop rotation: the second crop is planted after the first crop has been completely harvested.
- Relay cropping: the second crop is planted prior to the harvest of the first crop.
- Intercropping: two or more crops overlap in time and space during their growth.
- Companion cropping: the planting of an annual crop with a perennial crop so that their growth overlaps only for the time the annual crop is present.

#### Protected cultivation

Structures are installed to modify the aerial environment, root environment, or both. These structures allow control over the growing environment, reduce environmental risks and disease and pest problems, extend the growing season, permit plant growth during periods of the year not commonly used to grow open-field crops, and increase or stabilize crop yields and quality. The structures range from simple to sophisticated as noted below:

- Organic or plastic mulch to control soil moisture or temperature, or suppress weed growth.
- Plastic row covers or tunnels to prevent crop damage by excess rain, pests, sunlight and sometimes frost in cooler areas.
- Rain shelters or shading to avoid crop damage by excess rain or sunlight.
- Hydroponics (soilless) culture to check soil-borne diseases.
- Plastic or glass houses to prevent crop damage by adverse climate, diseases, and pests.

#### Planting Materials

There are two types of propagation, sexual and asexual, to multiply the numbers of a species, perpetuate a species, or maintain the vigor of a plant. Sexual propagation involves the union of the pollen with the egg to produce a seed. (Ferns sexually propagate from spores that develop in sori.) Since genetic recombination has occurred, a plant grown from seed may have different traits from its parents. Asexual propagation involves taking a piece of a parent plant and regenerating it into a new plant, which is genetically identical to its parent.

Plants which re-seed themselves or from which the farmer can gather viable seed as planting material are more desirable than those which will grow but not reproduce. This is a good indicator of a plant's adaptability to its environment and it is a way to avoid transmission of certain diseases. Through seeds, one can maintain genetic diversity and select for broad genetic combinations that are better adapted to a particular environmental condition. On the other hand, asexual propagation may be the only way to perpetuate some species or varieties. It also bypasses the juvenile phase of perennials. Techniques for asexual propagation include:

- Cutting that involves removing a piece of leaf, stem or root from the parent plant.
- **Division** that entails breaking up of plants with more than one rooted crown.
- Storage organs such as bulbs, rhizomes, and tubers.
- Ratooning that involves the sprouting shoot from the plant base of the previous crop.

The success of crop production mainly depends on the quality of either sexual or asexual planting materials. In this regard, quality materials are true-to-type (for seeds), uniform, disease-free, and viable.

#### Crop Establishment

Crops may be established by transplanting seedlings or direct sowing of pregerminated or ungerminated seeds in situ where they are to mature. The choice depends on seed size, climatic conditions, and available resources. The methods of direct sowing include:

- Broadcast: sprinkle seeds over the planting area and cover with soil.
- Drill: poke a hole in the soil, sow seeds, and then cover with soil.
- Furrow: dig a shallow furrow in the soil, drop seeds in a line, and cover with soil.

Transplanting of seedlings is relatively expensive and requires some nursery skills. However, it is more widely used for commercial production because it reduces seed requirements, avoids extreme aerial and soil conditions, maximizes the extent of multiple cropping, eases disease and pest control, and promotes early and uniform harvest. Healthy and stocky seedlings with four to six true leaves are usually used for transplanting. The two main methods of raising seedlings are:

- Seedbed: grown in the soil in a seedbed, lifted out and planted into the field. Damage to the roots at lifting can lead to irregular establishment.
- Tray or plug: grown in trays or plugs of composted soil or artificial media, usually under protected conditions. Because the root system of each plant grows separately, the root system is less prone to damage during transplanting.

#### **Crop Management**

#### Fertilization

Fertilization supplements the nutrients from natural sources and helps achieve the yield target. The optimum fertilization depends on the species, growing conditions, original nutrient sources, soil properties, and the part of the plant to be harvested. As for common vegetables, nitrogen, phosphorus, and potassium are three basic elements for indigenous vegetables. In general, vegetables require more nitrogen for the growth of their leaves, more phosphorus for flowers, fruits and seeds, and more potassium for storage roots and tubers.

Whether the soil is sand or clay, the application of organic matter such as compost and green manure will reduce soil compaction, increase soil aeration, and promote the beneficial activity of soil organisms. In addition, organic matter holds more water and nutrients than would be found in any soil without amendments. The result is vigorous crop growth that can better resist abiotic and biotic stresses. Organic matter in the amount of 10-30 t/ha is usually applied in commercial production systems.

#### Irrigation

Irrigation supplements probable rainfall so that the seasonal water needs of the crop are satisfied. The amount of irrigation required for crop production depends on the particular season's useful rainfall and other climatic conditions, the soil's waterholding capacity, expected yield, and the crop's water needs as related to its rooting depth and leaf structure. Useful rainfall is that portion of the rain stored in the root

zone (rainfall minus surface runoff, minus deep percolation). Basically, irrigation is used to maintain 50-80% of the available soil water (field capacity) in the root zone.

In general, crops grown in the dry season, crops with high yield expectations, leafy vegetables, and long-season crops require more water. By balancing soil moisture content with crop water needs, irrigation requirements of indigenous vegetables are arbitrarily categorized into **frequent**, **moderate**, and **meager** types in the depiction of individual species.

The stages of seed germination, transplant establishment, and yield formation (i.e., leaf development for leafy vegetables, fruit development for fruit vegetables) usually need an adequate water supply. Thus, as much water as possible should be held in reserve for irrigation during these critical stages.

#### Other cultural practices

Beside fertilization and irrigation, the following cultural practices are often used with indigenous vegetables:

- Trellising or staking boosts growth of indeterminate or vine vegetables and keeps the leaves and fruits free from soil-borne diseases. It also makes harvesting easier. Twining is done soon after the plants are established. There are many options for trellising, including A-frames, bamboo or wood stakes, wire frames, cages, fences, branches, and other plants as in companion cropping.
- Covering of the edible parts during their formation process keeps out sunlight, and helps to keep the edible parts tender and preserve delicate flavors. The materials used for covering include paper wrap, rice straw, plastic covers, and tall plants.
- Crop rotation avoids the build up of pathogens and pests, balances the fertility demands of various crops to avoid excessive depletion of soil nutrients, and improves soil structure. Crops of different botanical families are used in this practice.

In general, indigenous vegetables are well-adapted to specific environments, and have few problems with diseases and pests. If outbreaks do occur, the control measures are similar to common vegetables of the related genera or same families.

#### Harvesting

One of the most important phases of vegetable production involves knowing when the edible parts reach the right stage of flavor, size, weight, nutrition, color, or firmness for harvesting. The quality of produce cannot be improved after harvest, only maintained, so it is important to gather the crops at the proper stage when they are at their peak. Produce picked too soon is too tender, and lacks substance and flavor. Picked too late, it is likely to be tough, fibrous, or mushy, and also lacking in taste. The time for harvesting varies with the climate, the particular location, and the vegetables involved. The figures of "planting to the first harvest" in the depiction of individual indigenous vegetables are given in general terms.

There are two methods for harvesting the produce:

- Once-over harvesting is the harvest of all the edible parts or of all plants at once. The way to harvest is to cut or snap off the edible part, cut the whole plant at the ground level, or to uproot the whole plant. This method allows the grower to set aside land and time for crop rotation, saves labor, and secures uniformity of the produce. In commercial production systems, mechanical means are often used with this method. Nevertheless, manual harvests can still be cost effective for smaller operations, and provide significant environmental benefits over mechanical harvesting.
- Repeated harvesting involves several rounds of picking. The way to harvest is to cut or snap off edible parts when they reach maturity. This is a common method for indeterminate and vine vegetables, and perennials. Many leafy vegetables can be either repeated or once-over harvested.

#### Yield

The yield is the fresh weight of the particular part of the crop for which the crop is grown. Marketable yield is the particular part that meets the consumer's quality requirement. Yield often is expressed on a unit area basis. The yield indicated in the depiction of individual indigenous vegetables is the attainable yield in farmers' fields with good management practices and without nutrient limitations. However, yield can vary substantially in farmers' fields despite sufficient nutrient supply and good practices because of small variations in soil moisture or fertility from field to field, and differences in climatic conditions from season to season.

The yield is a product of several yield components. Beside the plant number per unit area, other yield components include leaf number per plant and average leaf size for leafy vegetables; fruit number per plant and fruit size for fruit vegetables; or pod number per plant, seed number per pod, and average seed size for seed vegetables. These components affect each other. The fruit number per plant decreases as the plant number per unit area increases, within certain limits. In a similar manner, the more fruit number per plant, the smaller the fruit size. As a plant population increases within a unit area, a point is reached at which each plant begins to compete for nutrients, sunlight, and water. Because of this, the yield per unit area usually increases with increasing population until a certain point beyond which further population increase results in stagnated yield. Thus, the optimum population is one that produces the greatest net return to the grower.

In the case of commercial production, the greatest yield does not necessarily give the greatest profit. Produce prices often do not keep pace with the increasing cost of inputs. Thus, inputs must be measured carefully so that the yield for each unit is worth more than the cost of the input.

#### Postharvest Handling

Postharvest handling is the final stage in producing high quality fresh vegetables. Being able to maintain a level of freshness from the field to the dinner table presents many challenges. Fresh produce actively respirates and contains a large amount of water, ranging between 80 to 95%. Because of this, fresh produce deteriorates quickly if no preventive measures are taken.

Some basic principles to minimize postharvest losses are listed below:

- Use species/varieties with a long shelf life.
- Harvest the produce at the appropriate stage of maturity.
- Avoid harvesting during rainy periods.
- Prevent mechanical injuries (abrasion, bruising, scratching) during harvest.
- Harvest in the early morning and keep the produce shaded in the field.
- Cool the produce as soon as possible after harvest.
- Pack and refrigerate produce that requires periods of storage and transportation.
- In home gardens, harvest small quantities at intervals and use up quickly.

# Health Values



Vegetables are generally low in energy and protein, but are rich in micronutrients (vitamins and minerals), dietary fiber and other beneficial phytochemicals. Micronutrients, present in minute quantities, are essential for physiological functions, enzyme systems, and biosynthesis of many compounds. Limited consumption of vegetables could lead to micronutrient deficiencies and cause serious health problems.

#### **Vitamins**

Vitamins are organic compounds that have diverse biochemical functions in the body. Most of them must be ingested from the diet. There are two types of vitamins. Fatsoluble vitamins (A, D, E, and K) are stored in the liver and fat cells. Water-soluble vitamins (B-group and C) have to be taken daily. Specific functions of certain vitamins that can be procured from vegetables are briefly described below:

#### Vitamin A

Vitamin A is essential for the visual pigments, immune system functions, and skin and mucous membrane health. The major form of vitamin A is retinol. Precursors to vitamin A are the carotenes from fruit and vegetables. Among all carotenes,  $\beta$ -carotene has the highest vitamin A activity. Vitamin A deficiency causes severe visual impairment and is a significant contributor to severe infections and death.

#### Vitamin E

Vitamin E, consisting of tocopherols, has a role in cell membrane integrity, antiinflammatory action and immune response. Deficiency in vitamin E can lead to anemia. It is a highly effective antioxidant and is known to reduce the risk of several degenerative diseases.

#### $Vitamin B_{\gamma}(riboflavin)$

As coenzymes, vitamin B<sub>2</sub> plays a central role in releasing energy from food. The signs of vitamin B<sub>2</sub> deficiency include cracked skin and blurred vision.

#### Vitamin B<sub>9</sub> (folic acid or folate)

Folic acid helps in the formation of red blood cells and making of DNA and RNA. Folate deficiency causes anemia during pregnancy and is a risk factor for coronary heart disease and stroke.

#### Vitamin C (ascorbic acid)

Vitamin C is essential for the formation of collagen (a protein to make skin), scar tissue, tendons, ligaments, and blood vessels. Early signs of vitamin C deficiency include splitting hair, dry skin and bleeding gums. Vitamin C also promotes the absorption of iron from the diet.

#### **Dietary Minerals**

Mineral nutrients are required to build tissues and regulate body processes. They function in nerve impulse transmission, muscle contraction, bone structure, and blood clotting. They can be introduced into the body through a balanced diet. Vegetables are an excellent source of mineral nutrients. The following two elements are of public health importance in developing countries.

#### Calcium

Calcium is essential for building strong bones and teeth, as well as maintaining bone strength and density. Calcium also plays a role in muscle contraction, blood clotting, and maintenance of cell membranes. Inadequate dietary calcium has been associated with a number of chronic medical disorders.

#### Iron

Iron is vital for the formation of hemoglobin (oxygen-carrying protein) in red blood cells and myoglobin (oxygen-storing protein) in muscle cells. The iron in hemoglobin combines with oxygen and transports it through the blood to the body's tissues and organs. The main cause of anemia is iron deficiency.

#### **Contents of Micronutrients**

Diverse species of indigenous vegetables vary as much in composition and content of micronutrients as they do in forms and flavors. Some have only minimum micronutrients, while others have a great deal. Micronutrients content also varies between varieties within the same species, and, to some extent, is influenced by external factors such as soil fertility and moisture, temperature, light intensity and duration, stage of harvesting, etc. Thus, the proximate ranges of micronutrient contents are grouped into extremely high, high, medium, and low (Table 1) in the depiction of individual indigenous vegetables using the dietary reference intake (DRI), a system of nutrition recommendations, as benchmarks.

Table 1. Content ranges in 100 g edible portion and dietary reference intake (DRI) of selected micronutrients.

	DRI	Extremely high	High	Medium	Low
β-carotene	3.6 mg	>4.8 mg	4.7-3.5 mg	3.4-1.2 mg	1.1-0 mg
Vitamin E	10 mg	>10.0 mg	9.9-5.0 mg	4.9-1.0 mg	0.9-0 mg
Vitamin B <sub>2</sub>	1,200 μg	>720 μg	719-360 μg	359-180 μg	179-0 μg
Vitamin B <sub>9</sub>	400 μg	>200µg	199-80 µg	79-40 μg	39-0 μg
Vitamin C	80 mg	>60 mg	59-45 mg	44-15 mg	14-0 mg
Calcium	1,200 mg	>520 mg	519-260 mg	259-130 mg	129-0 mg
Iron	8 mg	>7.2 mg	7.1-3.6 mg	3.5-1.8 mg	1.7-0 mg

#### Dietary Fiber

Dietary fiber is a complex mixture of plant materials that are resistant to breakdown by the human digestive system. There are two kinds of dietary fiber: insoluble fiber exists mainly in the plant cell wall, and soluble fiber exists inside the plant cell. Insoluble fiber provides bulk for stool formation and speeds up its passage through the colon. It also helps to satisfy appetite by creating a full feeling. Soluble fiber helps decrease blood cholesterol levels. Vegetables are good sources of dietary fiber. Studies indicate that a high intake of vegetable fiber appears to be more effective than cereal fiber in lowering the risk of colon cancer.

#### Other Biologically Active Phytochemicals

Apart from vitamins and dietary minerals, vegetables contain phytochemicals that are biologically active and can be beneficial. There is abundant evidence from medical studies indicating that the intake of certain vegetables can significantly reduce the risk of some degenerative or infectious diseases due to the following phytochemicals:

#### Antioxidants

Antioxidants are a group of substances that reduce the rate of oxidation of other substances by neutralizing free radicals (unstable molecules made by the process of oxidation during normal metabolism), or protect cells from the damage caused by free radicals. Therefore, they have important effects on health by preventing the oxidation of several celluar components and reducing blood clotting. Antioxidants include: some vitamins (vitamin C, vitamin E, and  $\beta$ -carotene); some trace elements; and some non-nutrients such as phenolic compounds (e.g., flavonoids, phenolic acids, etc.). Thus, it is beneficial to procure a variety of antioxidants from vegetables that have somewhat different oxidation potentials and mechanisms of action.

#### Betalains

Betalains are a group of water-soluble violet or red-violet (betacyanins) and yellow (betaxanthins) pigments that replace anthocyanins in a restricted number of plant families. Chemically, betalains contain a colored portion and a sugar, and have antioxidant properties.

#### Betanin (betacyanin)

#### Flavonoids

Flavonoids are water-soluble phenolic substances widely distributed in vegetables, and are responsible for pigmentation. They include diverse substances but all have a common chemical structure based on the phenolic compounds: flavans (with two six-carbon rings joined by a three-carbon chain) combined with a sugar (glycoside). Flavonoids may be further divided into several subclasses, including flavones, flavonols (hydroxy derivatives of flavones), etc. Besides adding color and flavor to the diet, many flavonoids have antioxidative properties. Antioxidative flavonoids present in indigenous vegetables include quercitin, kaempferol, anthocyanin, luteolin, stilbenoid, galangin, etc.

#### Glucosinolates

Glucosinolates are a large group of pungent, water-soluble, sulfur-containing glucosides found in brassica vegetables. After physical damage to the plant tissue, glucosinolates are broken down by the endogenous enzyme myrosinase, releasing glucose and a complex variety of biologically active products such as thiocyanate, isothiocynate, nitrile, etc. They serve as defense for the plant, and have been shown to be protective against cancers, especially those of the gastrointestinal tract and lung.

#### Isoprenoid compounds

Isoprenoid compounds are a diverse group of compounds with a common structural five-carbon isoprene unit. They are called isoprenoids, terpenoids, or terpenes. The terpenoids can be classified according to the number of isoprene units, in which these units are usually joined in a head-to-tail fasion:

#### Isoprene unit

$$\begin{array}{c|c} & & CH_3 \\ \hline \\ & \\ \end{array}$$
 (head) —— H\_2C —— C —— CH —— CH\_2 —— (tail)

Sesquiterpenoids (e.g., sesquiterpene) contain three isoprene units, diterpenoids (e.g., limonene) four, and triterpenoids six. All phytosterols (e.g., sitosterol) are triterpenoids; some of them have anti-inflammatory properties. Carotenoids (e.g. carotene, lycopene, zeaxanthin) are made from eight isoprene units. Carotene, limonene, lycopene, sitosterol, sesquiterpene, and many other isoprenoid compouds are antioxidants. Epidemiological studies show that the consumption of foods containing phytosterols and other isoprenoid compounds reduces the risk of colon, prostate, ovary, stomach and breast cancers.

Mucilage

Mucilage is one of soluble fibers consisting of polysaccharides and polyglucuronic acids. It forms a gel-like material in water. Mucilage can sooth the digestive tract and absorb toxins from the bowel. In addition, it protects friendly bacteria in the digestive tract. By slowing down sugar absorption from the digestive tract into the body, mucilage helps prevent the cravings that come from low blood sugar. Galactomannans, one type of mucilage consisting of mannose and galactose units, exist predominantly in legumes and are used in foods as stabilizers.

#### Phenolic compounds

Phenolic compounds arise from the shikimitic acid pathway and subsequent reactions, and have an aromatic ring that contains various attached substituent groups. Among those with antioxidative activities are allanthoidol, caffeic acid, chicoric acid, chlorogenic acid, gallic acid, gallotannins, monocaffeyltartaric acid, and phenylpropanoids. A group of compounds closely related to phenolic compounds and also derived from the shikimitic acid pathway are the coumarins. Some of the coumarins also have antioxidative activities.

#### Natural Toxicants and Antinutrients

Vegetables are beneficial to people. But some vegetables may contain small amounts of natural toxicants that can be harmful to the body if they are consumed in large quantities without proper preparation. These toxicants are part of a plant's defense mechanisms against pests. Vegetables also may contain substances that interfere with the body's use of other nutrients. Some toxicants and antinutrients that occur in a few indigenous vegetables are summarized below:

#### Alkaloids

Alkaloids are compounds with nitrogen in a complex molecular ring structure. There are thousands of alkaloids in plants. Most alkaloids have an extremely bitter taste and many have undesirable effects in carbohydrate metabolism. Some have pharmacological effects that are useful to humans.

#### Metal chelators

Metal chelators include **oxalic acid** (or **oxalate**, COOHCOOH) and **phytic acid** (or **phytate**). Oxalic acid is a calcium-binding substance, and phytic acid has the ability to bind calcium, magnesium, zinc, copper and iron to form insoluble complexes that can not be readily absorbed from the intestine. Both contribute to mineral deficiencies. Furthermore, oxalic acid causes stone formation in the urinary tract. People should use high oxalate vegetables with caution. Vegetables high in oxalate should be soaked in water first to leach out the substance, and cooked thoroughly before being consumed.

#### Protease inhibitors

Protease inhibitors exist in many plants, but are particularly common in legumes. **Trypsin inhibitor** hinders the action of enzymes involved in the digestion of proteins such as trypsin and chemotrypsin. However, most are destroyed by heat during cooking.

#### Saponins

Saponins are a group of glycosides with a bitter taste and detergent properties. When consumed in large quantities, saponins can cause skin rashes in some people.

#### Tannins

Tannins are polyphenols responsible in part for the astringent flavor of some indigenous vegetables. When consumed in large quantities, tannins can have a negative effect on digestibility.

# Promising Indigenous Vegetables



# Okra

#### Abelmoschus esculentus

Malvaceae

#### **Common Names**

Okra, lady's finger (En); gombo, gumbo (Fr); quingombó, guingombó (Sp); 黄秋葵 (Cn)

#### Plant Distribution

Southeast and South Asia, tropical Africa, Brazil

#### **Botanical Features**

Annual herb, hairless to bristly-hairy; stem erect up to 1.5 m or more, stout, branched, woody toward the base; leaves alternate, long-petioled, 6-35 cm wide, palmately five-lobed to compound or scarcely lobed; inflorescence of solitary, large, stout-pediceled flowers in the upper leaf axils, involucral bracts 8-12, linear, up to 2.5 cm long, falling early; flowers up to 7.5 cm wide, radially symmetric, broadly bell- or funnel-shaped; corollas white to yellow, purple or red at the base; capsules many-seeded, 5-angled, 6-25 cm long, cylindric or finger-shaped, beaked, bristly then nearly hairless, green to purple when young, brownish when mature; seeds globular, 3-6 mm across, blackish; epigeal germination.

Different leaf types



















Light requirement: full sun; photoperiod: short-day; temperature requirement: hot; preferred soil type: sandy to clayey; optimum soil pH: 6.0-7.0; tolerance: heat; sensitivity: cold, flooding.

Flower with purple petal base

Red ridged pods



Different pod types







System: home gardening, intercropping, monocropping; planting material: seeds, sometimes ratooning; planting method: soak the seeds overnight before sowing, dibble the soaked seeds; irrigation: moderate; priority fertilizer: organic matter, high potassium; crop management: free standing; planting to 1<sup>st</sup> harvest: 70-80 days after sowing; harvesting: repeated removal of developing fruit 6-8 days old at 2-3 day intervals; yield: 5-20 t/ha.

Field production



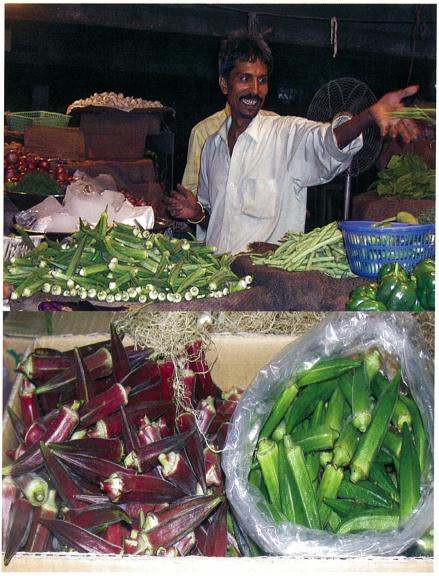
Young fruit is often boiled as ingredient in soups and sauces, consumed blanched, sautéed, stir-fried, raw or pickled, or stuffed with other ingredients; young leaves sometimes eaten cooked.

#### **Health Values**

Beta-carotene: low in fruit and leaves; vitamin E: low in fruit; riboflavin: low in fruit, extremely high in leaves; folic acid: high in fruit; ascorbic acid: medium in fruit, extremely high in leaves; calcium: low in fruit, extremely high in leaves; iron: low in fruit and leaves; protein: 2.1% in fruit, 4.4% in leaves. Young fruit and leaves are rich in mucilage, and young fruit has high antioxidative activities.

Okra varieties in the market







# Baobab

#### Adansonia digitata

#### Bombacaceae

#### **Common Names**

Baobab, monkey-bread tree, dead-rat tree, cream-of-tartar tree (En); calebassier du Sénégal, arbre de mille ans, pain de singe (Fr); baobab, árbol botella (Sp); 猢猻木 (Cn)

#### Plant Distribution

Tropical Africa, Indian Ocean islands, Arabian Peninsula

#### **Botanical Features**

Deciduous tree to 20-25 m; trunk stout to 10 m in diameter, branches short, leafy at the ends; leaves palmately compound; petiole up to 16 cm long; leaflets 5-7, oblong, to 15 cm, acuminate, entire, sessile or shortly stalked; flowers on long peduncles to 20 cm in diameter, white; fruit woody, indehiscent capsules, globular to egg-shaped or cylindrical, 10-30 cm, many-seeded; seeds  $1.5 \times 1.0 \text{ cm}$ , smooth, dark brown to black, with thick seed coat; hypogeal germination.



Light requirement: full sun; photoperiod: day-neutral; temperature requirement: hot; preferred soil type: sandy; tolerance: acid and calcareous soils, drought, heat, flooding; sensitivity: frost.

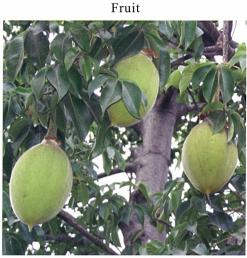


Leaves



System: container planting, sapling nursery, individual tree; planting material: seed pretreated with boiling water for 6 minutes or sulfuric acid for 8 hours, stem cutting; planting method: direct with seed, transplanting with cutting; irrigation: moderate; crop management: free standing, trimming to encourage leaf production; planting to 1<sup>st</sup> harvest: 50-70 days for leaves; harvesting: repeated removal of leaves on 50-cm saplings.





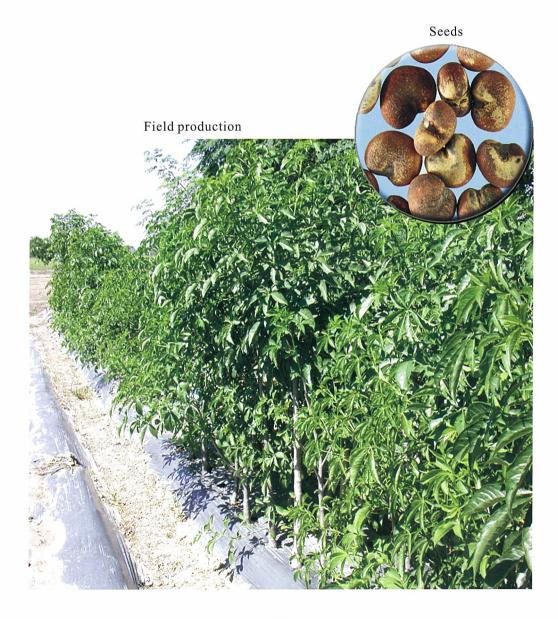
Tender shoots



Young leaves and tender shoots are eaten raw, boiled or stir-fried, or dried and powdered to thicken soup and sauce. Flowers are also eaten raw, and seeds raw or roasted to thicken soup, or fermented.

#### Health Values

Beta-carotene: medium; vitamin E: medium; riboflavin: medium; folic acid: medium; ascorbic acid: extremely high; calcium: high; iron: medium; protein: 3.6%. Leaves contain mucilage, and older leaves develop tannins.





### **Amaranth**

#### Amaranthus spp.

#### **Amaranthaceae**

#### **Common Names**

Amaranth, Chinese spinach, spiny pigweed, Joseph's-coat (En); amarante, épinard malabar, épinard piquant (Fr); amarantos, moco de pavo, blero (Sp); 莧菜 (Cn)

#### **Related Species**

A. tricolor, A. dubius, A. blitum, A. gangeticus, A. spinosus, A. viridis

#### Plant Distribution

All tropical and subtropical regions

#### **Botanical Features**

Annual herb up to 130 cm tall; stems erect, branched, angular, hairless to sparsely hairy, soft, juicy; leaves alternate, elliptic or ovate, 5-10 cm, soft-textured, golden yellow to dark green, some with red markings; inflorescence axillary, cluster up to 2.5 cm wide and 20 cm long; flowers sessile, minute and inconspicuous, unisexual, male and female intermixed; fruit one-seeded utricles; seeds 0.5-1.5 mm diameter, shining black or brown, faintly netted; epigeal germination.

#### Different leaf shapes and colors

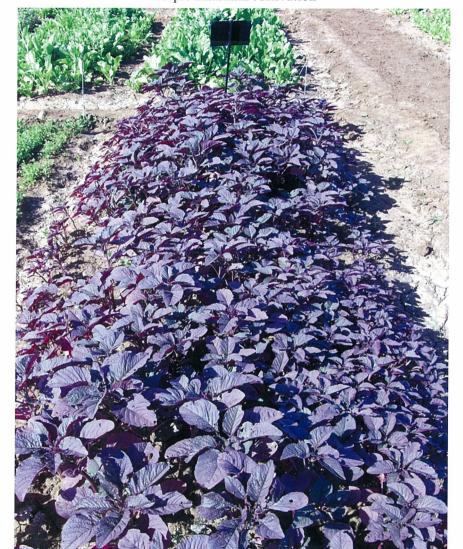


Light requirement: full sun, partial sun; photoperiod: short-day, day-neutral; temperature requirement: hot; preferred soil type: sandy loam; optimum soil pH: 5.5-7.5; tolerance: high aluminum soils, drought, heat; sensitivity: flooding.





System: gathering wild, home gardening, intercropping, monocropping; planting material: seeds; planting method: directly broadcast, covered with soil, transplanting; irrigation: frequent; priority fertilizer: nitrogen, organic matter, potassium; crop management: free standing; planting to 1<sup>st</sup> harvest: 20-40 days; harvesting: once-over (uproot or cut off at ground surface) or repeated (cut 50% of foliage and tender stem every 1-2 weeks at 15-20 cm above ground surface until flowering) for leaf production; for seed, cut inflorescence before shattering; yield: 25-50 t/ha (leaf).



Purple amaranth cultivation

Leaf and tender stem are eaten fresh, boiled, steamed, stir-fried, as soup, stewed, pureed; seed popped, ground to thicken stews or used as flour.

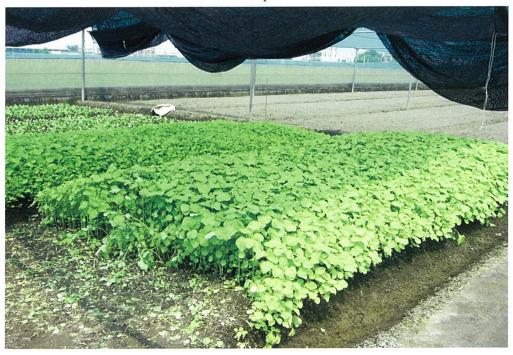
#### **Health Values**

Beta-carotene: medium in leaves; vitamin E: medium in shoots; riboflavin: medium in leaves and seeds; folic acid: high in leaves; ascorbic acid: high in leaves, low in seeds; calcium: high in leaves and seeds; iron: high in leaves and seeds; protein: 2-4% in shoots. Leaves contain also betacyanin (amaranthine) and oxalic acid (ca. 0.5%). Seeds are rich in beta-sitosterol and other phytosterols.



Bundled amaranth in the market





# Ashitaba

#### Angelica keiskei

**Apiaceae** 

**Common Names** 

Ashitaba (Jp); 明日葉 (Cn)

#### Plant Distribution

East Asia

#### **Botanical Features**

Biennial or perennial herbaceous to 1.5 m, aromatic; stem hollow, round, 2.5-5.0 cm in diameter, yellowish green, purplish red; leaves pinnate; leaflets serrate, often 3-parted; petioles long with sheathing; inflorescences terminal, compound umbels, involucred; flowers white, bisexual, insect pollinated, self-fertile; fruits compressed, ovate, ridged.





Flowers



Light requirement: full sun, partial sun; temperature requirement: cool-hot; preferred soil type: well-drained, moist sandy/clayey loam; tolerance: frost, salinity; sensitivity: heat.

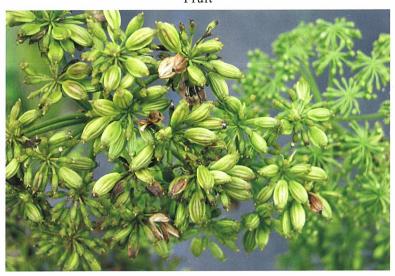
Inflorescence





System: monocropping; planting material: seeds; planting method: germination under shade, transplanting of seedling with 3-4 true leaves; irrigation: frequent; priority fertilizer: organic matter; crop management: free standing, shading in summer; planting to 1<sup>st</sup> harvest: 50-60 days; harvesting: repeated cutting of leaves with enlarged stalks starting from lower leaves until flowering; yield: 40-50 t/ha.





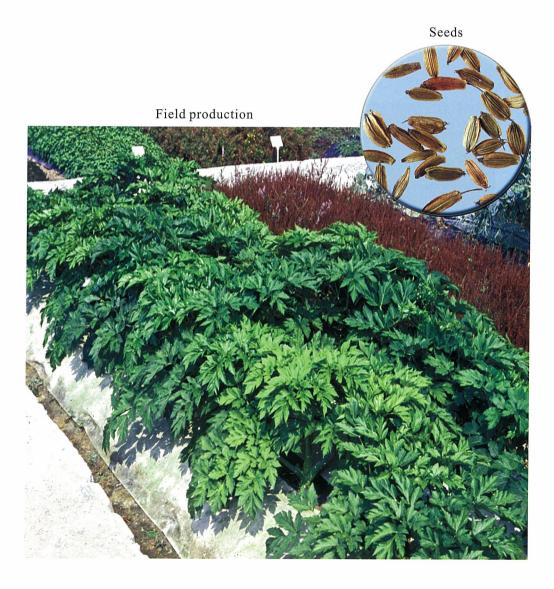
Edible leaves and stalks



Leaves and stalks are eaten raw, boiled, or deep-fried, or dried and ground for juice, dessert or other value-added products; roots cooked or pickled.

#### Health Values

Beta-carotene: medium to high; vitamin E: low; riboflavin: medium; folic acid: extremely high; ascorbic acid: medium; calcium: medium; iron: medium; protein: 2.2%. Edible parts contain also vitamin  $B_{12}$  (normally not found in terrestrial plants; function in the formation of red blood cells and nerves), coumarin (archangelicin), and flavones (chalcones that show antibacterial, antifungal, antitumor and anti-inflammatory properties).



# Madeira-vine

#### Anredera cordifolia

Basellaceae

#### **Common Names**

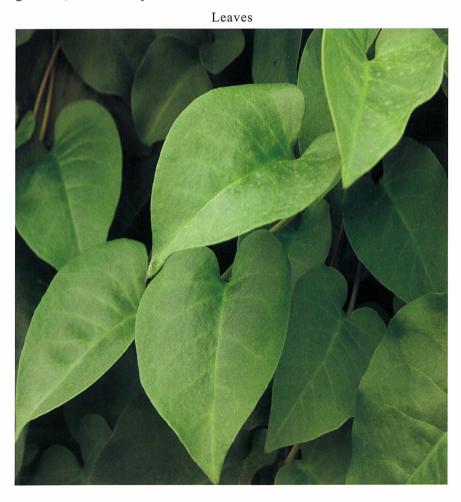
Madeira-vine, heartleaf madeiravine (En); vigne de madère (Fr); enredadera del mosquito, para de madeira (Sp); 藤三七, 川七 (Cn)

#### Plant Distribution

Tropical Americas, the Caribbean, East Asia

#### **Botanical Features**

Herbaceous vine up to 6 m tall; stems much-branched, slender, often reddish; root tuberous; leaves alternate, ovate or lanceolate, 3-10 cm, succulent, shining, obtuse to long acuminate, often with aerial wart-like tubers in their axils; inflorescence racemose, to 30 cm long; flowers fragrant, white, whitish green; scarcely formed fruits globular, enclosed in perianth.



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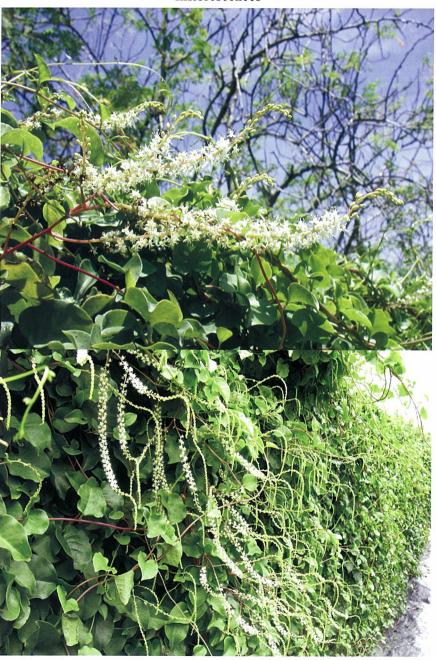
Light requirement: full sun, partial sun; temperature requirement: warm; preferred soil type: sand, loam, clay; tolerance: drought; sensitivity: frost, flooding; may be invasive.

Aerial tubers



System: home gardening, monocropping; planting material: aerial tubers, stem cuttings, divided roots; planting method: direct; irrigation: moderate; priority fertilizer: organic matter; crop management: training to twine up stakes; planting to 1<sup>st</sup> harvest: 45 days, peak around 75 days; harvesting: repeated (weekly cutting of leaves and tender stems); yield: 7-10 t/ha.





Leaves and tender stems are eaten raw, boiled, stir-fried with sesame oil and ginger, or in soups.

#### **Health Values**

Beta-carotene: high; vitamin E: medium; riboflavin: low; folic acid: low; ascorbic acid: high; calcium: medium; iron: low; protein: 1.2%. Leaves contain mucilage.







Field production





# White mugwort

#### Artemisia lactiflora

**Asteraceae** 

#### **Common Names**

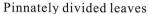
White mugwort, wormwood, ghostplant, angle dish, pearl dish (En); artémise (Fr); ajenjo blanco (Sp); 角菜, 珍珠菜 (Cn)

#### Plant Distribution

East and Southeast Asia

#### **Botanical Features**

Perennial aromatic herb, erect, up to 1.2-1.8 m, stems grooved, hairless, highly branched, clump-forming; lower leaves up to 20 cm long, pinnated into ovate-lanceolate, toothed or lobed segments to 8 cm long, upper leaves shorter, lower surface paler; heads about 15 mm across, cone-shaped, many, in loose panicles to 50 cm; flowers bisexual, white; fruit (achenes) 1-1.5 mm, angled, one-seeded; seeds 1 mm, oblong, yellowish-brown, shiny.





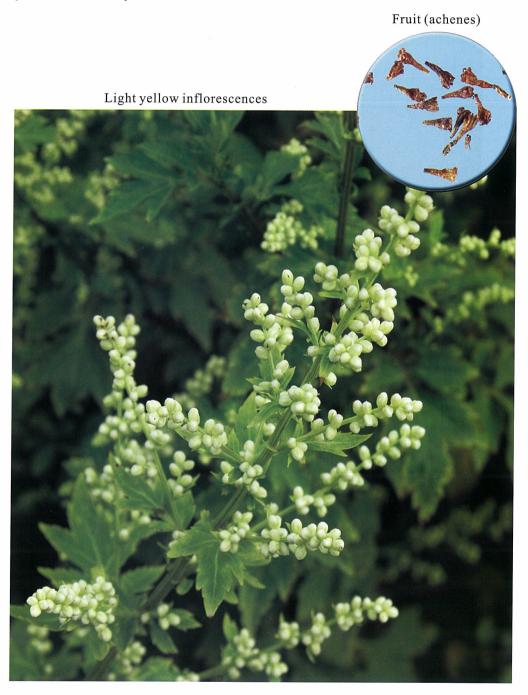
Light requirement: full sun, partial sun; photoperiod: short-day; temperature requirement: warm; preferred soil type: sandy loam; optimum soil pH: 5.5-7.0; tolerance: cold, heat; sensitivity: drought, heat, flooding.

Creamy white inflorescences





System: gathering wild, home gardening; planting material: 12-cm stem cuttings with nodes, divided roots, seeds; planting method: transplanting; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: free standing; planting to 1<sup>st</sup> harvest: 25-40 days; harvesting: repeated cutting of side shoots with 3-5 leaves; yield: 75-120 t/ha/year.



Leaves and tender stems are eaten boiled or stir-fried, or in soups.

#### **Health Values**

Beta-carotene: extremely high; riboflavin: medium; ascorbic acid: medium; calcium: low; iron: medium; protein: 3.6%. Leaves contain also sesquiterpene lactones (bitter absinthin and anabsinthin that stimulate digestive function, antimalarial artemisinin), monoterpene (narcotic thujone), and cytotoxic diacetylenic spiroketal enol ethers that have cancer-preventing effects.



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# Bird's nest fern

#### Asplenium australasicum

#### **Aspleniaceae**

#### **Common Names**

Bird's nest fern, crow's nest fern (En); asplénie cétérach, cétérach officinal (Fr); 南洋山蘇花, 南洋巢蕨 (Cn)

#### **Related Species**

A. nidus, A. antiguum

#### Plant Distribution

East and Southeast Asia

#### **Botanical Features**

Large epiphyte, elliptical fronds simple, 5-20 x 60-80 cm, radiated in rosette to 3 m in diameter and 0.5 m in height; lamina yellow-green, leathery texture, apex obtuse or acute; midrib strongly keeled below, hairless; veins free, intramarginal vein present; sori underside of fronds, in 2 parallel rows 4 mm from midrib, 40-60 mm long; roots massive.



Leaf-like fronds

Light requirement: partial sun, full shade; temperature requirement: cool-warm; preferred soil type: loam, clay; optimum soil pH: 6.3-7.3; tolerance: humid, shading; sensitivity: full sun.

Underside of fronds with sori

Sori in 2 parallel rows







System: intercropping with trees, monocropping under shade; planting material: 2-3 cm leaf cuttings, ratooning, spores released from sori; planting method: two-time transplanting to different pot sizes before transplanting to the field; irrigation: frequent with good drainage; priority fertilizer: nitrogen, organic matter; crop management: free standing, maintain two whorls of vigorous, outer leaves (about 10-15 leaves); planting to 1<sup>st</sup> harvest: 6-12 months from cutting, 1-2 years from spores; harvesting: repeated removal of new leaves of the inner whorl that reach 15-20 cm, or repeated cutting the top 1/3 of new leaves that reach 30 cm; yield: 120 kg/ha, harvest once every two weeks (summer), 240 kg/ha, harvest weekly (winter); 5 t/ha in one year.



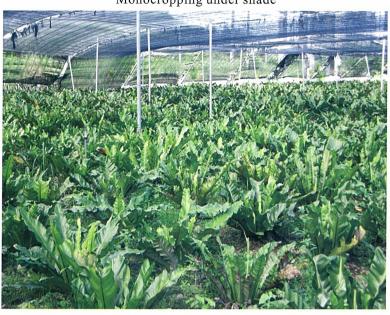
Intercropping with betel nut under black shade net

Tender leaves are eaten stir-fried, boiled, or steamed.

#### **Health Values**

Ascorbic acid: extremely high; calcium: low; iron: low; protein: 2.8%. Leaves contain kaempferol glucosides.

Monocropping under shade



Packing for marketing



Edible fronds



### **Tropical violet**

### Asystasia gangetica

### Acanthaceae

### **Common Names**

Tropical violet, tropical primrose (En); herbe le rail, mange-tout (Fr); caracola (Sp); 赤道櫻草 (Cn)

### **Plant Distribution**

South Asia, tropical America, sub-Saharan Africa, Oceania

### **Botanical Features**

Perennial herb; stems prostrating, sprawling, branches curing upward to 70-100 cm in height and 60 cm in width; leaves simple; dark green; blades ovate at 5 x 7 cm; inflorescences racemose, terminal, 5-12 cm; flowers violet, white or light yellow, bisexual, funnel-shaped, 2.5-4.0 cm long; fruit (capsules) club-shaped, 2-3 cm long, hairy and glandular, usually 4-seeded; seeds dispersed from explosive capsules; seeds egg-shaped, flattened, 4-5 mm long, gray to brown.





Light requirement: full sun, partial sun; photoperiod: short-day; temperature requirement: hot; preferred soil type: loam; optimum soil pH: 4.0-5.0; tolerance: flooding, humidity; sensitivity: cold; may be invasive.

Inflorescences
Flowers (purple)

Flowers (white)

Immature capsules





### **Production Methods**

System: home gardening, monocropping; planting material: seeds, cuttings taken after flowering; planting method: direct; irrigation: moderate; priority fertilizer: nitrogen, organic matter; crop management: free standing, staking; planting to 1<sup>st</sup> harvest: 60-70 days; harvesting: repeated removal of 10-15 cm young shoots; yield: 100 t/ha for continuous harvests for 55 weeks.





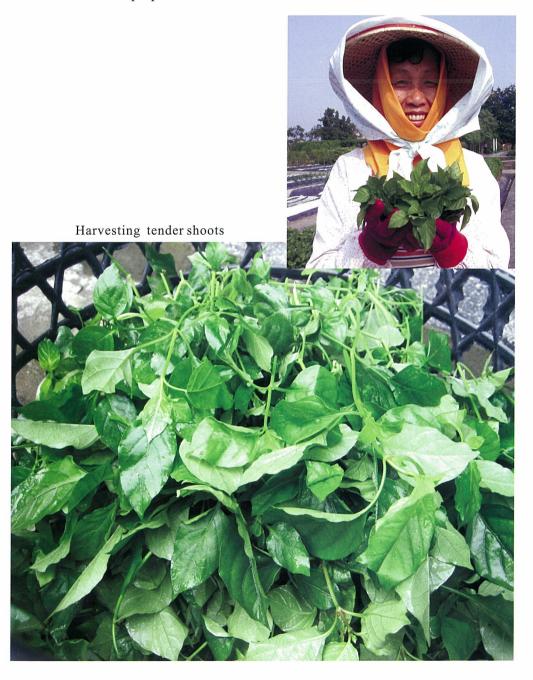
Field production



Tender leaves and stems are eaten boiled or stir-fried.

### **Health Values**

Beta-carotene: extremely high in leaves; vitamin E: high; riboflavin: medium; folic acid: low; ascorbic acid: high; calcium: medium; iron: high; protein: 3.7%. Leaves have anti-asthmatic properties.





### Malabarspinach

### Basella spp.

### Basellaceae

### **Common Names**

Malabar spinach, Ceylon spinach, vine spinach (En); baselle, brède de Malabar (Fr); espinaca blanca, espinaca de Malabar (Sp); 落葵 (Cn)

### **Related Species**

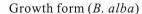
B. alba, B. rubra

### **Plant Distribution**

Pantropical, naturalized in neotropics

### **Botanical Features**

Annual or perennial herb; stem twining, slender, smooth, green or purplish, to 8 m long, leaves alternate, simple, succulent; stipules absent; petiole to 9 cm long; blade ovate to heart-shaped, 2.5-15 x 2-12.5 cm, usually cordate at base, acute or acuminate at apex, dark green or purplish, succulent; inflorescence axillary, spiked to 30 cm long, hanging, with long peduncle; flowers bisexual, regular, sessile, 2.5-6 mm long, white, pink or purple; fruit near-globular, 4-10 mm in diameter, purplish black, containing purple to violet juice, 1-seeded; seed globular, 3 mm in diameter, dark brown to black; epigeal germination.





Light requirement: full sun, partial sun; photoperiod: short-day; temperature requirement: hot; preferred soil type: humus-rich sandy loam; optimum soil pH: 6.0-7.0; tolerance: heat, high rainfall, flooding, brief drought; sensitivity: frost, salinity.

Growth form (*B. rubra*)



Flowers (B. alba)



Flowers (B. rubra)





### **Production Methods**

System: home gardening, container planting, monocropping; planting material: seeds, 20-cm cuttings; planting method: direct, transplanting; irrigation: moderate; priority fertilizer: nitrogen, organic matter; crop management: staking, creeping; planting to 1<sup>st</sup> harvest: 30-45 days; harvesting: once-over, repeated (weekly removal of 6-12 cm of leaves and tender stems); yield: 20-80 t/ha.

Berries (B. rubra)



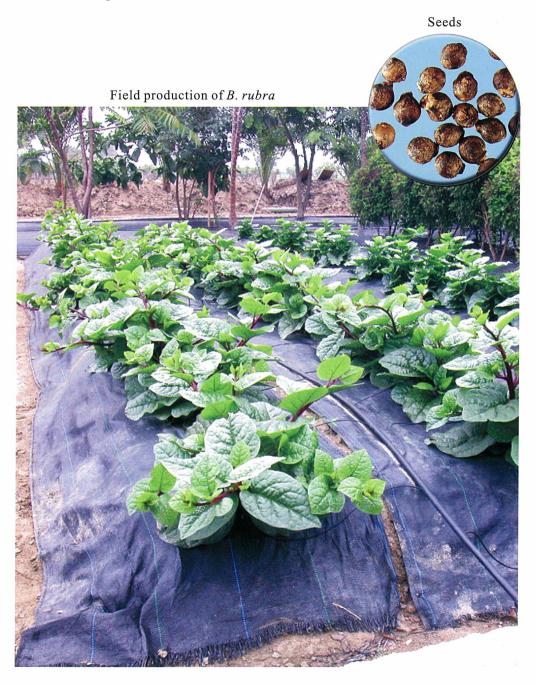
Young shoots in the market



Leaves and tender stems are eaten as salad, boiled, stewed or stir-fried, or in soups.

### **Health Values**

Beta-carotene: high; vitamin E: medium; riboflavin: medium; folic acid: high; ascorbic acid: extremely high; calcium: medium; iron: medium; protein: 3.5%. Leaves contain mucilage.





### Chard

### Beta vulgaris var. cicla

### Chenopodiaceae

#### **Common Names**

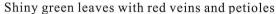
Chard, Swiss chard, silverbeet, spinach beet, leaf beet (En); bette, poirée, blette (Fr); acelga (Sp); 菾菜 (Cn)

### Plant Distribution

Worldwide

### **Botanical Features**

Annual or biennial herb, robust, erect; leaves in the basal rosette with long petioles arise from the base of the plant, on stems alternate and shortly stalked, often ovate and cordate, 20-40 cm or more in length and 15-25 cm in width, margins wavy, leaf tissue puckered between veins, nearly hairless, dark shiny green to red; petiole and midrib swollen; inflorescence a long, paniculate, branched spike up to 1.5 m long; flowers sessile, bisexual, usually 2-5 together, greenish or reddish, subtended by minute bracts; fruit (utricles) developing mostly from aggregates of 2 or more flowers joining together at base with swollen perianth bases, 3-7 mm across; seed kidney-shaped, brown, 1.5-3 mm across.





Light requirement: full sun, partial sun; photoperiod: long-day; temperature requirement: warm; preferred soil type: well-drained sandy loam to clayey loam; optimum soil pH: 6.5-8.0; tolerance: frost; sensitivity: heat, flooding, shading.



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### **Production Methods**

System: home gardening, monocropping; planting material: entire fruit (containing 2-5 seeds); planting method: direct seed followed by thinning, sometimes transplanting; irrigation: frequent; priority fertilizer: organic matter, nitrogen; crop management: free standing; planting to 1<sup>st</sup> harvest: 35-40 days for outer leaves; harvesting: onceover at 50-60 days after sowing, repeated cutting of outer leaves with a sharp knife about 5 cm above the ground every 8-10 days; yield: 30-60 t/ha.





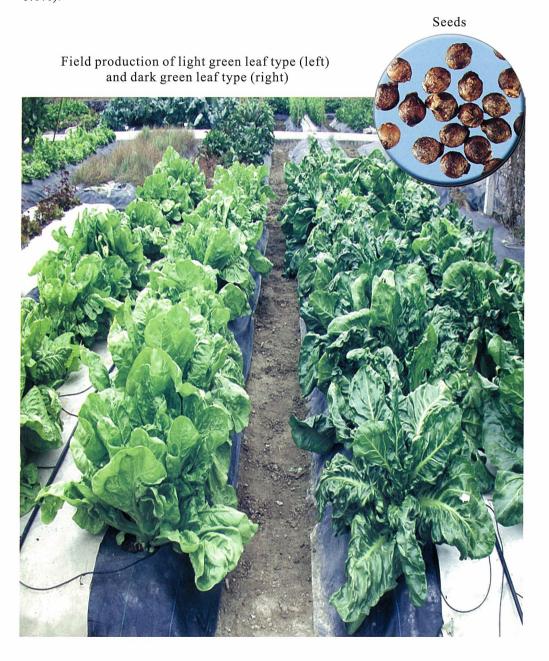
Fruit (utricles)



Leaves and petioles are consumed boiled, steamed, or sautéed. Often boiled and soaked in water after boiling to remove the strong flavor and acrid taste.

### **Health Values**

Beta-carotene: medium; vitamin E: low; riboflavin: low; folic acid: low; ascorbic acid: medium; calcium: low; iron: medium; protein: 2.0%. Young leaves and stems contain antioxidative syringic acid (phenolic acid), kaempferol, and oxalic acid (ca. 0.6%).





### Blackjack

### Bidens pilosa

Asteraceae

### **Common Names**

Blackjack, Spanish needles (En); sornet, bident hérissé, herbe aiguille (Fr); bidente piloso, mozote, margarita silvestre (Sp); 咸豐草 (Cn)

### **Related Species and Varieties**

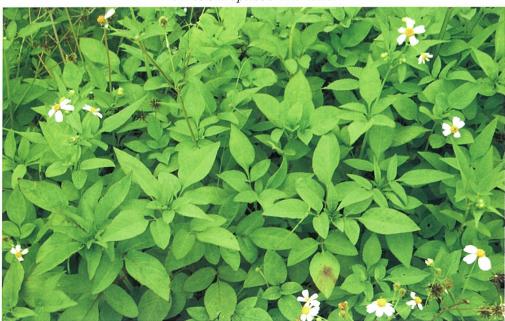
B. bipinnata, B. pilosa var. minor, B. pilosa var. radiata

### Plant Distribution

All tropical and subtropical areas

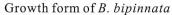
#### **Botanical Features**

Annual, erect herb up to 100 cm tall, with slender, stiff and 4-angled stems and spreading branches; leaves decussately opposite, pinnately 3-5-foliolate, up to 15(-20) cm long, sometimes lower leaves simple, without stipules; leaflets with short petiolules, blade ovate to ovate-lanceolate, margins usually serrate or crenate-serrate, terminal leaflet larger than lateral leaflets; inflorescence axillary or terminal head 6-12 mm in diameter, solitary or arranged in lax cymes; outer involucral bracts 7-10, spatulate, 3-4 mm long, bent sharply downward at the period of blooming, inner ones ovate-lanceolate; ray flowers absent or 4-8, with strap-like corolla limb 7-15 mm long, sterile, white to yellow or pinkish; disk flowers tubular, bisexual, with 3.5-5 mm long, yellow; fruit linear achene 4-13 mm long, 4-6-ribbed, with 2-3(-5) barbed bristles of 2-4 mm long directed downward; epigeal germination.



Leaves of B. pilosa var. radiata

Light requirement: full sun, partial sun; photoperiod: short-day; temperature requirement: hot; preferred soil type: loam; optimum soil pH: 4.5-8.5; tolerance: salinity; sensitivity: flooding; invasive.





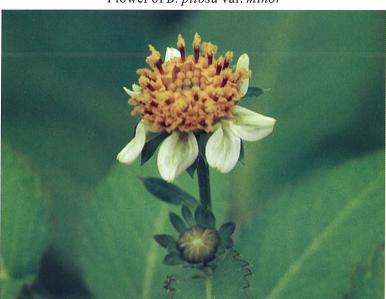
Growth form of B. pilosa var. radiata





### **Production Methods**

System: gathering wild, home gardening, intercropping with cereals or pulses; planting material: seeds; planting method: soaked before sowing; irrigation: moderate; priority fertilizer: nitrogen, organic matter; crop management: free standing; planting to 1<sup>st</sup> harvest: 30-40 days; harvesting: before seed setting, plants reach 15-30 cm high, once-over (uproot or cut at the ground level), repeated six times if possible; yield: 15 t/ha.



Flower of B. pilosa var. minor

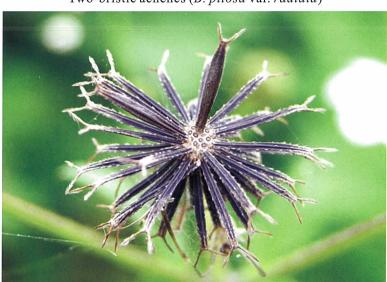




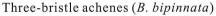
Tender shoots are eaten boiled or stir-fried, or powdered and added to sauce.

### **Health Values**

Beta-carotene: high; vitamin E: medium; ascorbic acid: high; calcium: low; iron: low; protein: 3.0%. Leaves contain also anti-inflammatory, antioxidant and antigastrointestinal bacterial coumarins, flavonols and stilbenoids (flavonoids), phytosterols, polyacetylenes, and triterpenes, as well as saponins.



Two-bristle achenes (B. pilosa var. radiata)





## Ethiopian kale

### Brassica carinata

### Brassicaceae

#### Common Names

Ethiopian kale, Ethiopian mustard, Abyssinian mustard, African kale (En); chou éthiopien, moutarde d'Abyssinie (Fr); mostaza etíope (Sp); 非洲芥藍 (Cn)

### Plant Distribution

East and North Africa

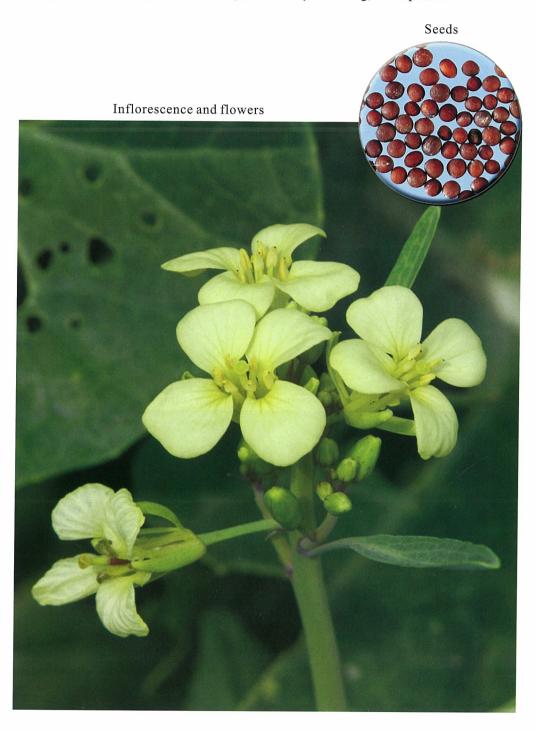
### **Botanical Features**

Erect, annual or biennial or perennial herb to 150 cm tall, branched, hairless to hairy at stem and petiole bases; taproot strong; leaves alternate, simple, lower ones with 1 pair of small side lobes, short petiole; blade obovate, up to 20 x 10 cm, lower ones minutely toothed but upper ones entire; inflorescence umbel-like raceme to 50 cm long; flowers bisexual, regular, pale to bright yellow; fruit (siliques) 2.5-6 x 2-3.5 mm, constricted between seeds, dehiscent to 20 seeds; seeds globular, 1-2 mm in diameter, finely netted, pale to dark brown; epigeal germination.



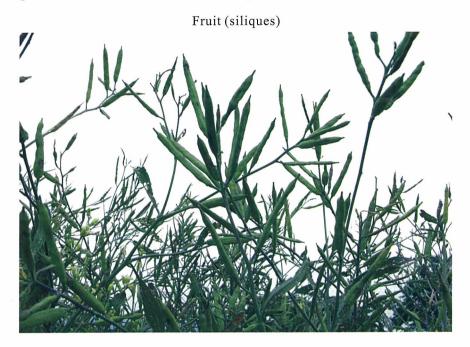
Flowering and fruiting

Light requirement: full sun; photoperiod: long-day; temperature requirement: coolwarm; preferred soil type: sand, loam, clay; optimum soil pH: 5.5-8.0; tolerance: drought, heat, salinity, cold, humidity; sensitivity: flooding; allelopathic.

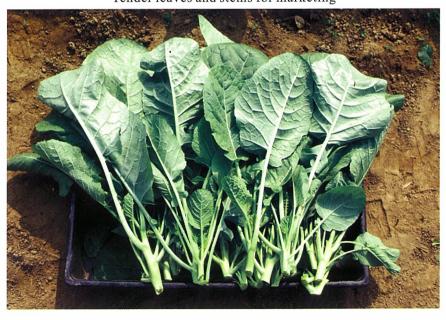


### Production Methods System: home garden

System: home gardening, intercropping; planting material: seeds; planting method: direct sowing in rows, broadcast, transplanting of seedlings at 4-leaf stage; irrigation: moderate; priority fertilizer: nitrogen, organic matter; crop management: free standing; planting to 1<sup>st</sup> harvest: 30-40 days; harvesting: once-over (uproot), repeated cutting of leaves to 50% at 2-week intervals; yield: 10-50 t/ha.



Tender leaves and stems for marketing

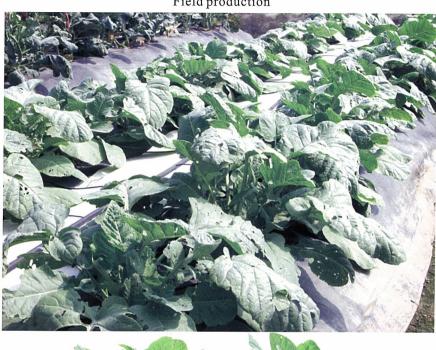


Leaves and tender stems are eaten in salad, boiled or pickled.

### **Health Values**

Beta-carotene: low to medium; vitamin E: medium; folic acid: high; ascorbic acid: extremely high; calcium: medium; iron: low; protein: 2.8%. Leaves are rich in glucosinolates.

Field production







### Celosia

### Celosia argentea

### **Amaranthaceae**

### **Common Names**

Celosia, Lagos spinach, quail grass, plumed cockscomb, silver cock's comb (En); célosie, célosie argentée, crête de coq (Fr); borlón, cresta de gallo (Sp); 青葙 (Cn)

### **Plant Distribution**

Worldwide

### **Botanical Features**

Annual herb up to 1.5 m tall; stem ridged, hairless, branched; leaves alternate, simple, linear to lanceolate-oblong, 15-20 x 6-9 cm; inflorescence dense, droopily spiked, to 20 cm long; flowers narrowly elliptical-oblong, 6-10 mm long, bisexual, silvery to pink; fruit egg-shaped to globular, 3-4 mm long, few-seeded; seeds shiny black, 1-1.5 mm long.

Seedlings for transplanting



Light requirement: full sun, partial sun; photoperiod: day-neutral; temperature requirement: hot; preferred soil type: sandy loam; optimum soil pH: 6.0-6.5; tolerance: heat, cold, drought, salinity; sensitivity: flooding.

Flower



### **Production Methods**

System: gathering wild, home gardening; planting material: seeds, cuttings; planting method: direct, transplanting of seedlings at 10-15 cm in height on raised bed; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: free standing; planting to 1<sup>st</sup> harvest: 30-50 days; harvesting: once-over (uproot), repeated 2-3 times at 1-2 week intervals; yield: 50 t/ha.

Production of green-leaf type



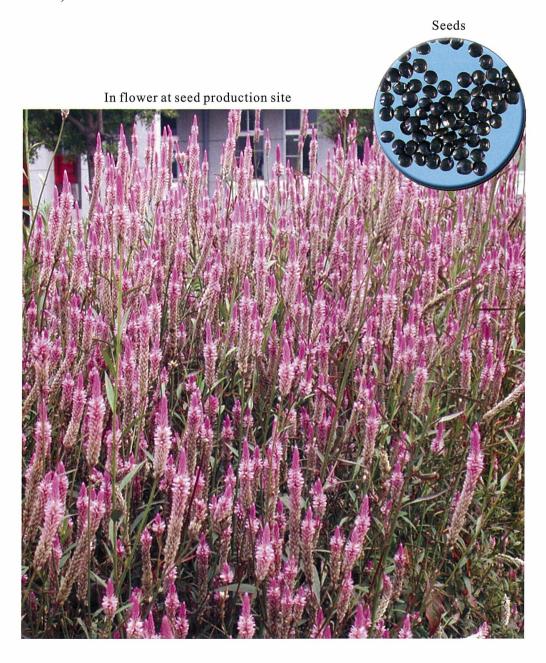
Production of purple-leaf type



Leaves, tender stems, and young flower spikes are eaten boiled, or cooked in sauce or stew with other ingredients. Other uses: as ornamental plants, windbreaks, soap, etc.

### Health Values

Beta-carotene: extremely high in leaves; vitamin E: medium; folic acid: high; ascorbic acid: medium; calcium: medium; iron: medium; protein: 4.7%. Leaves contain also amaranthine (betacyanin), oxalic acid (ca. 0.2%) and phytic acid (ca. 0.12%).





### **Endive**

### Cichorium endivia

**Asteraceae** 

### **Common Names**

Endive, escarole (En); chicon, chicorée endive, scarole (Fr); escarola, escarol crespa (Sp); 苦苣, 菊苣 (Cn)

### Plant Distribution

Europe, North America, Central Asia, tropical Africa

### **Botanical Features**

Annual or biennial herb, erect up to 170 cm; taproot containing bitter milky juice; leaves many in a basal rosette, alternate or simple, sessile, oblong, lobed or greatly cut and curled; stem progressively reduced upwards, slightly hairy or hairless, stem-clasping up the stem; inflorescence head, 1-6 together, sessile with bracts; flowers 15-20 per head, violet blue, sometimes white; fruit (achenes) reverse egg-shaped to cylindrical, attached at the narrow end, 2-3 x 1-1.5 mm, brown, with 1-3 rows of small, persistent membranous scales; seed 1 per achene.





Light requirement: full sun, partial sun; photoperiod: long-day; temperature requirement: cool-hot; preferred soil type: sandy loam; optimum soil pH: 6.5-7.8; tolerance: mild frost; sensitivity: heat, flooding.

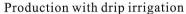
Seeds (also fruit or

achenes) Flowers



### **Production Methods**

System: intercropping with other leafy vegetables, monocropping; planting material: seeds; planting method: sow in seed beds of deeply tilled soil, direct sowing, transplant to raised beds when seedlings have 4-6 leaves; irrigation: moderate; priority fertilizer: nitrogen, phosphorus; crop management: free standing, light shading to produce tender leaves; planting to 1<sup>st</sup> harvest: 60-90 days; harvesting: cut the head from the root, remove diseased or damaged leaves; yield: 20 t/ha.



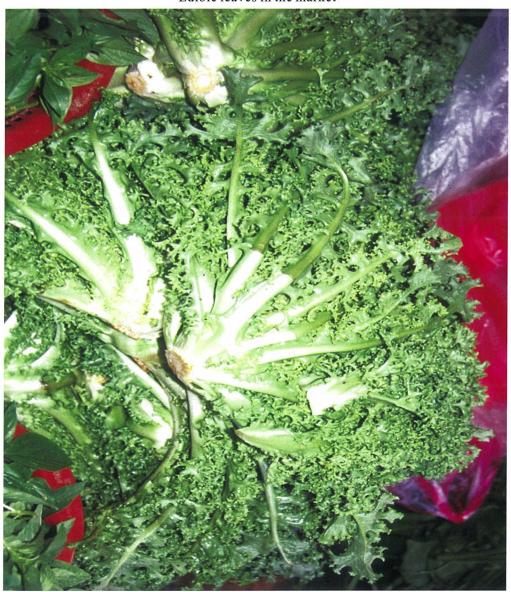


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Rosette or curled leaves are eaten raw in salad, boiled, steamed, sautéed, or cooked in soups, stews and mixed vegetable dishes. Blue flowers are used raw as salad, served as a garnish, or pickled in vinegar and oil.

### Health Values

Beta-carotene: medium; vitamin E: medium; riboflavin: low; folic acid: medium; ascorbic acid: low; calcium: low; iron: low; protein: 1.4%. Leaves contain also chlorogenic acid and chicoric acid.



Edible leaves in the market

### **Spider plant**

### Cleome gynandra

### Capparaceae

### **Common Names**

Spider plant, cat's whiskers, spider flower, spiderwisp (En); feuilles caya, mozambé (Fr); volatin, masambey, jasmín de río (Sp); 西洋白花菜 (Cn)

### Plant Distribution

Naturalized throughout the tropics

#### **Botanical Features**

Erect annual herb up to 1.5 m tall, strongly branched; long taproot; stems densely glandular; leaves alternate, palmately compound; petiole 2-10 cm long, glandular; leaflets 3-7, sessile, obovate to elliptical or lanceolate, 2-10 x 1-4 cm, toothed, hairy; inflorescence up to 30 cm long; flowers bisexual with bracts, white or tinged with purple; pedicel 1.5-2.5 cm long; sepals 4, free, ovate to lanceolate, up to 8 mm long; petals 4, elliptical to obovate, up to 1.5 cm long, clawed; cylindrical capsules up to 12 cm x 1 cm, stalked and beaked, usually green or yellow, dehiscing from below with 2 valves, many-seeded; seeds near globular, 1-1.5 mm in diameter, gray to black, irregularly ribbed; seedling with oblong cotyledons; first leaves 3-foliolate.





Light requirement: full sun; photoperiod: day-neutral; temperature requirement: hot; preferred soil type: sandy to clayey loam; optimum soil pH: 5.5-7.0; tolerance: drought, heat; sensitivity: flooding.

White flowers

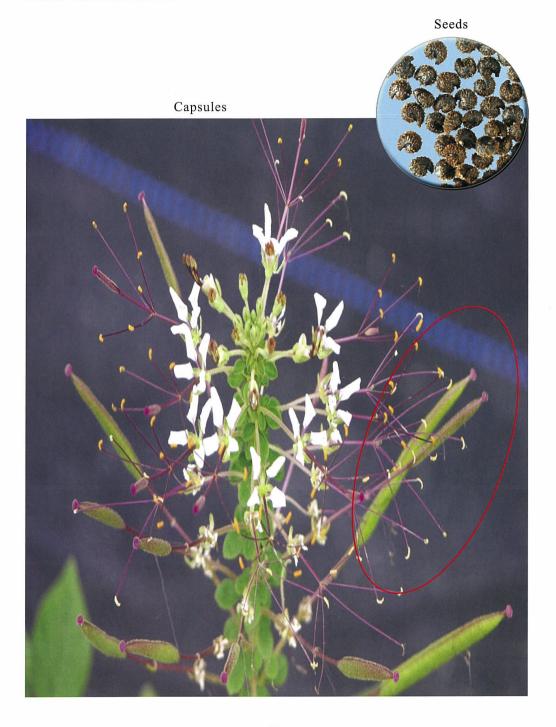


Purple-pink flowers



### **Production Methods**

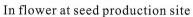
System: gathering wild, home gardening; planting material: seeds; planting method: direct; irrigation: moderate; priority fertilizer: nitrogen; crop management: free standing; planting to 1<sup>st</sup> harvest: 25-30 days; harvesting: weekly cutting of 25-cm long shoots with tender leaves.



Sharp, mustard-flavored tender leaves and shoots are eaten boiled or in stews.

### **Health Values**

Beta-carotene: high; vitamin E: low; folic acid: high; ascorbic acid: extremely high; calcium: high; iron: medium; protein: 4.0%. Leaves possess antioxidative and anti-inflammatory properties, and contain oxalic acid (ca. 0.01%).





Field production



# Ivy gourd Coccinia grandis

### Cucurbitaceae

### Common Names

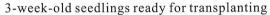
Ivy gourd, scarlet-fruited gourd (En); tindola, courge écarlate (Fr); pepino cimarrón (Sp); 紅瓜 (Cn)

### Plant Distribution

Tropical Asia, East Africa, Oceania

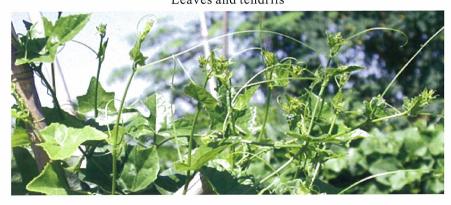
### **Botanical Features**

Perennial; stem climbing or prostrate, up to 20 m long with simple tendrils, green and longitudinally ribbed when young, becoming woody at the base when old; roots tuberous; leaves alternate, simple, petiole 1-5 cm long; blade broadly triangular-ovate, 3-12 x 3-15 cm, shallowly to deeply palmately 3-5-lobed; dioecious; flowers axillary, unisexual; male flowers solitary or paired, pedicel 1-7 cm long; female flowers solitary, pedicel up to 2.5 cm long; fruit egg-shaped or oblong, 3-7 x 1-3.5 cm, fleshy, green with white stripes when young, turning scarlet at maturity, many-seeded; seeds asymmetrically pear-shaped in outline, compressed, 6 x 3 mm, margin rather thick and grooved.





Leaves and tendrils



Light requirement: full sun; photoperiod: day-neutral; temperature requirement: hot; preferred soil type: sandy loam; tolerance: heat; sensitivity: cold; may be invasive.

Female flower with 3-stigma lobes



Female flower with 4-stigma lobes



Fruit



Male flowers



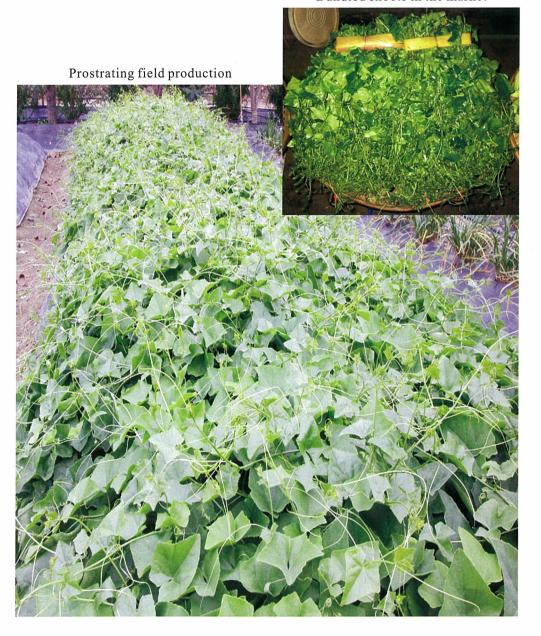
Seeds



# Production Methods System: intercropping

System: intercropping, monocropping; planting material: 10-15 cm cuttings, seeds; planting method: cuttings placed upright or at an angle, direct sowing for shoot production; irrigation: frequent during dry spell; priority fertilizer: organic matter, nitrogen, phosphorus; crop management: a ratio of 1:10 male to female plants for fruit production, prostrating, training, staking; planting to 1<sup>st</sup> harvest: 15-20 days for shoots, 150 days for fruit; harvesting: repeated cutting of tender shoots at 15-20 cm twice weekly; yield: 35-45 t/ha of shoots from 50 weeks of harvesting, 10 t/ha of fruit.

Bundled shoots in the market

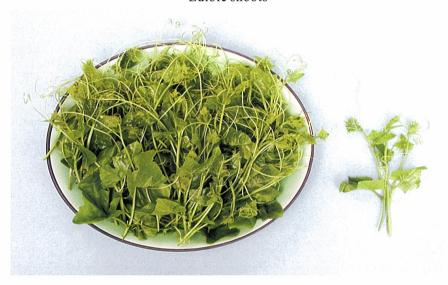


Green fruit is used in soups and curries; ripe fruit used raw or stewed with other vegetables; tender leaves/shoots are eaten blanched, boiled or stir-fried, or in soups.

### **Health Values**

Beta-carotene: high in shoots, low in green fruit, medium in mature fruit; vitamin E: medium in shoots; riboflavin: high in shoots, low in fruit; folic acid: high in shoots; ascorbic acid: extremely high in shoots, low in fruit; calcium: low in shoots and fruit; iron: medium in shoots and ripe fruit, low in green fruit; protein: 3.5-4.0% in shoots, 4.9% in fruit. Leaves contain ingredients that act like insulin.





Field production with stakes and shade net



### Jute mallow

#### **Corchorus olitorius**

**Tiliaceae** 

#### Common Names

Jute mallow, nalta jute (En); corète potagère, jute potager (Fr); gute malevaceo, yute (Sp); 長蒴黄麻 (Cn)

#### Plant Distribution

South Asia, East Asia, tropical Africa, Middle East, Brazil, the Caribbean

#### **Botanical Features**

Erect annual herb, 2-4 m tall, strongly branched; stems reddish or greenish, fibrous and tough; leaves alternate, simple; stipules narrowly triangular with long point; petiole 0.5-7 cm long; blade narrowly ovate or elliptical, 4-15 x 2-5 cm, serrate or crenate, shiny dark green, 3-7 veined from the base; inflorescence 1-4-flowered axillary clustered together with bracts; flowers bisexual, regular, shortly stalked, obovate, 5-7 mm long, yellow; fruit cylindrical, 2-5 cm long, ribbed, dehiscing by 5 valves, many-seeded; seeds angular, 1-3 mm long, dark gray; epigeal germination.





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Light requirement: full sun; photoperiod: short-day; temperature requirement: hot; preferred soil type: sand, loam; optimum soil pH: 4.5-8.2; tolerance: heat, high rainfall, flooding, brief drought; sensitivity: cold.

Flower



Young fruit



#### **Production Methods**

System: intercropping, monocropping; planting material: seeds; planting method: direct, transplanting; irrigation: moderate; priority fertilizer: nitrogen, organic matter; crop management: raised bed in rain season, furrow bottom in dry season, free standing; planting to 1st harvest: 30-40 days; harvesting: once-over (uproot or cut at ground level), repeated (weekly cutting of 20-30 cm of tender stems and removal of tip and leaves for 2-5 months); yield: 3-10 t/ha.



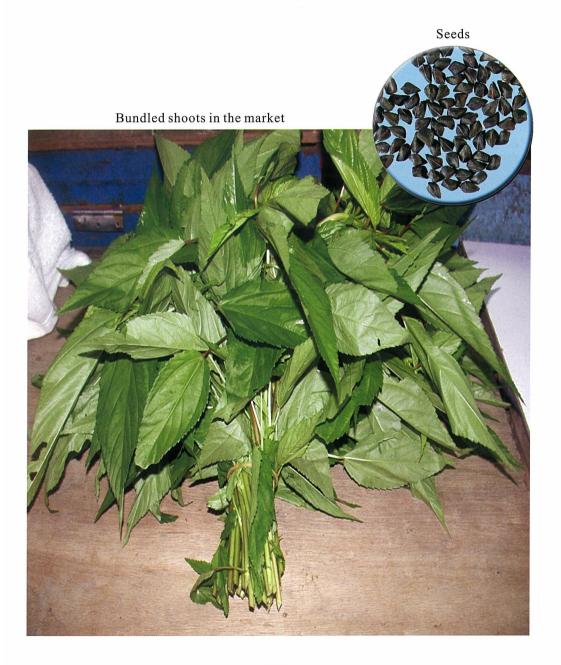
Field production and harvesting

#### **Edible Parts**

Leaves and tender stems are eaten boiled, stew, stir-fried, or in soup. Sticky leaf mass is used as vegetarian spread.

#### **Health Values**

Beta-carotene: extremely high; vitamin E: medium; riboflavin: high; folic acid: extremely high; ascorbic acid: extremely high; calcium: medium to high; iron: high to extremely high; protein: 4.5%. Leaves contain mucilage and several phenolic compounds.





### Honewort

#### Cryptotaenia japonica

**Apiaceae** 

#### **Common Names**

Honewort, Japanese honewort, Japanese parsley (En); persil japonais (Fr); mitsuba (Jp); perejil japonés (Sp); 鴨兒芹, 山芹菜 (Cn)

#### Plant Distribution

East Asia, Asian Russia

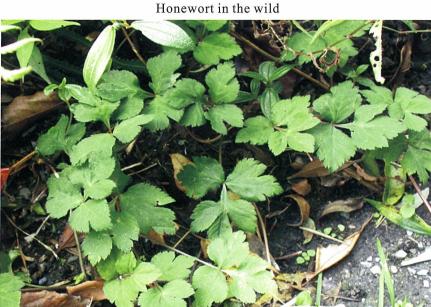
#### **Botanical Features**

Perennial herb, 20-100 cm, aromatic; roots thick; leaves clasping base, 3 toothed leaflets; leaflets oblong-lanceolate to obovate; slender petioles, 10-15 cm long, 2-4 mm thick; flowers white; fruit 4-6 x 1-1.5 mm.

#### Edible leaves



Light requirement: partial sun; photoperiod: day-neutral; temperature requirement: cool-warm; preferred soil type: well-drained and humus-rich loam or sandy loam; optimum soil pH: 5.5-6.7; tolerance: frost, partial shade; sensitivity: drought, heat, full sun.









#### **Production Methods**

System: monocropping, greenhouse, hydroponics; planting material: seeds; planting method: direct sowing, transplanting when seedlings have 4-5 leaves; irrigation: frequent; priority fertilizer: organic matter, nitrogen, potassium; crop management: free standing, blanching; planting to 1<sup>st</sup> harvest: 30-60 days; harvesting: once-over, repeated harvesting as needed; yield: 10-20 t/ha.



Field production

#### **Edible Parts**

Tender leaves and shoots are consumed fresh as salad or garnish, stir-fried, deep-fried, or cooked in soups.

#### **Health Values**

Beta-carotene: medium in tender shoots; vitamin E: low; riboflavin: medium; folic acid: medium; ascorbic acid: medium; calcium: low; iron: extremely high; protein: 1.5-3.4%.





### **Pumpkin**

#### Cucurbita moschata

#### Cucurbitaceae

#### Common Names

Pumpkin, winter squash, crookneck squash (En); courge musquée, giraumon (Fr); auyama, calabaza, calabaza moscada, tamalayote, zapallito coreano (Sp); 南瓜 (Cn)

#### Plant Distribution

Central and South America, sub-Saharan Africa

#### **Botanical Features**

Annual vine with branched tendrils; stems obtusely angular, running and branched, hairy, often rooting at nodes, climbing laterally; leaves alternate, simple, grooved petioles 10-20 cm long, blade broad-ovate to shallowly palmately lobed, 20-35 cm in diameter, margins toothed, softly hairy, often with whitish marks; flowers solitary, unisexual, regular, 5-merous, large, 10-20 cm in diameter, lemon yellow to deep orange; calyx lobes often very large and leafy, corolla lobes wide-spreading, crinkly, mostly acute; male flowers with long pedicel up to 15 cm and 3 stamens; female flowers with pedicel up to 3.5 cm and inferior 1-celled ovary; fruit (pepos) large, globular to egg-shaped or cylindrical, up to 10 kg, with a wide range of colors, often covered with green spots and gray stripes; fruit flesh yellow to orange, many-seeded; peduncles enlarged at apex; seeds reverse egg-shaped, attached at the narrow end, flattened, 1-2 x 0.5-1 cm, usually white or tawny, sometimes dark-colored, surface smooth to somewhat rough, margin prominent; epigeal germination.





Light requirement: full sun; photoperiod: short-day; temperature requirement: coolwarm; optimum soil pH: 5.0-8.0; tolerance: brief drought; sensitivity: heat, humidity.

Growth form



Male flower



Female flower





#### **Production Methods**

System: intercropping, monocropping; planting material: seeds; planting method: transplanting of nursery seedlings; irrigation: moderate; priority fertilizer: organic matter; crop management: creeping on ground.

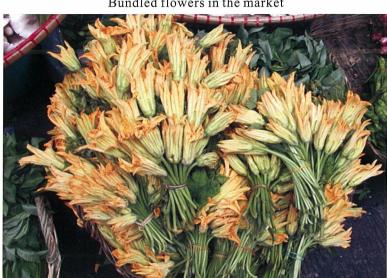


#### **Edible Parts**

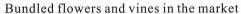
Flowers, leaves, and young stems are blanched, boiled, or stir-fried, or added to soups and stews. Fruit is baked, fried, boiled, mashed, or dried.

#### Health Values

Beta-carotene: medium in shoots; vitamin E: medium in shoots and fruit; riboflavin: medium in shoots, low in fruit; ascorbic acid: high in shoots, medium in fruit; calcium: medium in shoots, low in fruit; iron: low in shoots and fruit; protein: 4.0%.



Bundled flowers in the market





### Cluster bean

#### Cyamopsis tetragonoloba

**Fabaceae** 

#### **Common Names**

Cluster bean, guar, guar bean (En); cyamopse à quatre ailes (Fr); goma de guar (Sp); 穗豆, 印度扁豆 (Cn)

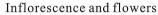
#### Plant Distribution

South Asia

#### **Botanical Features**

Erect annual herb 1-2 m high, hairs parallel to the surface; leaves alternate, trifoliate; leaflets ovate, 5-10 cm long, distantly serrate, terminal leaflet largest; racemes 10 cm long; bracts slender, longer than flowers; flowers rose-colored; pods 4-12 cm long, pointed, 5-15 seeds; seeds 3-5 x 3-4 mm, white, gray or black.







Light requirement: full sun; photoperiod: short-day, day-neutral; temperature requirement: warm; preferred soil type: alluvial, sandy loam; optimum soil pH: 5.3-8.3; tolerance: drought, salinity; sensitivity: frost.

#### **Production Methods**

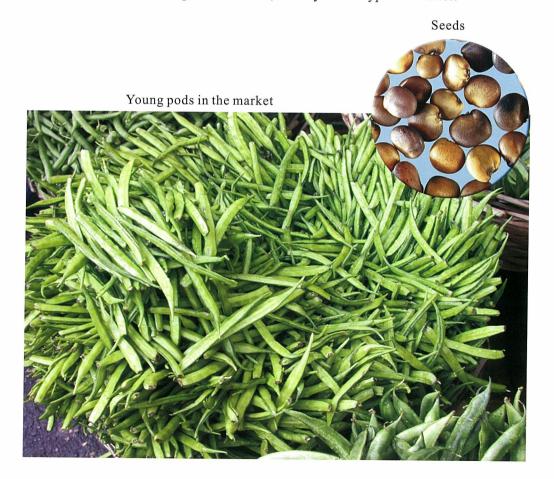
System: intercropping, monocropping; planting material: seeds; planting method: direct broadcast; irrigation: moderate; priority fertilizer: phosphorus, organic matter; crop management: free standing, staking; planting to 1<sup>st</sup> harvest: 50-80 days for leaves and green pods, 90-150 days for seeds; harvesting: repeated; yield: 5-8 t/ha (green pod), 200-2,000 kg/ha (seed).

#### **Edible Parts**

Leaves are used boiled or stir-fried; green pods used boiled, stir-fried, or dried for storage; dry seeds processed for gum as thickener.

#### **Health Values**

Beta-carotene: low in green pods; vitamin E: low in green pods; folic acid: high in green pods; ascorbic acid: high in green pods; calcium: extremely high in leaves, low in green pods; iron: medium in green pods; protein: 2.5-3.0% in leaves and green pods. Leaves contain also galactomannan, and dry seeds trypsin inhibitor.





## Vegetable fern

### Diplazium esculentum

#### Dryopteridaceae

#### **Common Names**

Vegetable fern (En); fougère végétale (Fr); kuwareshida (Jp); fern vegetal (Sp); 過構菜蕨,過貓 (Cn)

#### Plant Distribution

East, Southeast and South Asia, Oceania

#### **Botanical Features**

Rhizomes erect, trunk like; stipes stout, blackish at base; fronds 60 x 90 cm, triangular, young fronds 1-pinnate, older fronds 2-pinnate, veins netted; sori kidney-shaped on along side of veinlets.

One-pinnate fronds



Light requirement: partial sun; temperature requirement: hot; preferred soil type: slightly acidic soil; tolerance: humidity, heat, shading; sensitivity: cold.

Two-pinnate fronds



Young-curled fronds



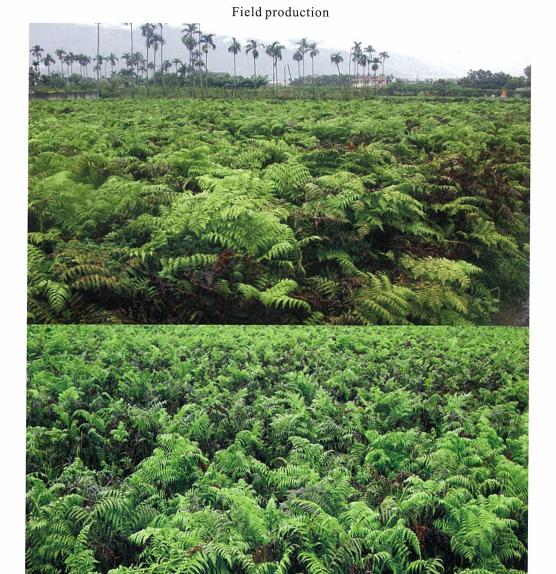
Tender fronds ready for harvesting





#### **Production Methods**

System: gathering wild on streambanks, companion cropping with trees or under shade, monocropping; planting material: offshoots; planting method: transplanting; irrigation: moderate; priority fertilizer: organic matter; crop management: light shading; planting to 1<sup>st</sup> harvest: 90 days; harvesting: repeated cutting of unextended young fronds 15 cm in length; yield: 20 t/ha/year.



#### **Edible Parts**

Tender fronds are blanched, boiled, or stir-fried.

#### **Health Values**

Beta-carotene: low; vitamin E: medium; riboflavin: low; ascorbic acid: low; calcium: low; iron: low; protein: 3.2%. Both fresh and boiled leaves have antioxidative activities higher than alpha-tocopherol.

Harvesting tender fronds



Bundled fronds in the market





### Spiny coriander

#### Eryngium foetidum

**Apiaceae** 

#### Common Names

Spiny coriander, false coriander, Mexican coriander, spiritweed (En); chardon étoile, panicaut fétide, coulante (Fr); culantro, chadron benee, alcapate (Sp); ngò gai (Vn); 刺芹, 刺芫荽 (Cn)

#### **Plant Distribution**

Tropical Americas, Southeast Asia

#### **Botanical Features**

Annual or biennial herb 15-45 cm high; leaves form a rosette, blades lanceolate to oblanceolate, up to 30 x 5 cm, crenate to serrate with small spines; inflorescence heads numerous, cylindric, about  $10 \times 5$  mm, involucral bracts lanceolate, exceeding the heads, commonly 2-3 cm long; petals white or greenish; fruit greenish, near globular, about  $1.5 \times 10^{-2}$  mm in diameter.

Leaves



Inflorescences



Flowers



Light requirement: partial sun; photoperiod: long-day; temperature requirement: hot; preferred soil type: well-drained sandy loam; optimum soil pH: 5.5-6.5; tolerance: heat, drought, shading; sensitivity: frost, full sun.

Harvesting young leaves







#### **Production Methods**

System: home gardening, monocropping under shade; planting material: seeds; planting method: transplanting; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: free standing, regularly pruning of flower stalks to maintain vegetative growth and maximize yields; planting to 1<sup>st</sup> harvest: 60 days; harvesting: once-over (cutting the entire rosette at soil level), repeated (leave topmost 3 leaves intact and harvest 10-15 leaves in 5-10 harvests at 1-2-week intervals, before flowering intervenes); yield: 40 t/ha.

Production under black shade net in high groundwater area



Production under black shade net



#### **Edible Parts**

Aromatic leaves with strong coriander-like scent are used fresh or dried in soup, noodle dishes, and curries, or mixed with other vegetables to make spicy sauces and salsa.

#### **Health Values**

Beta-carotene: high; riboflavin: high; ascorbic acid: medium; calcium: low; iron: medium; protein: 3.3%. Leaves contain also phytosterols, and aliphatic aldehydes (essential oil).





Bundled plants in the market





## Edible chrysanthemum

#### Glebionis coronarium

Asteraceae

#### **Common Names**

Edible chrysanthemum, garland chrysanthemum, crown daisy (En); chrysanthème des jardins (Fr); antimonio, mirabeles, moya (Sp); 歐茼蒿 (Cn)

#### **Related Types**

Small leaflet type, large-leaved type, and stalked type

#### Plant Distribution

East, Southeast, South, and West Asia; Southern Europe; Northern Africa

#### **Botanical Features**

Annual herb, stout, branched, scented, 20-60 cm in vegetative stage, 90-120 cm in reproductive stage; leaves alternate, 2-pinnately parted into sharply toothed segments or smooth, auriculate at base, hairless; inflorescence heads 3 cm across, involucral bracts; marginal flowers yellowish white, only female; central flowers numerous, bisexual, yellow; fruit (achenes) angled, 2-3 mm long, a collection of achenes with a tuft of hairy calyces form a soft spherical structure.





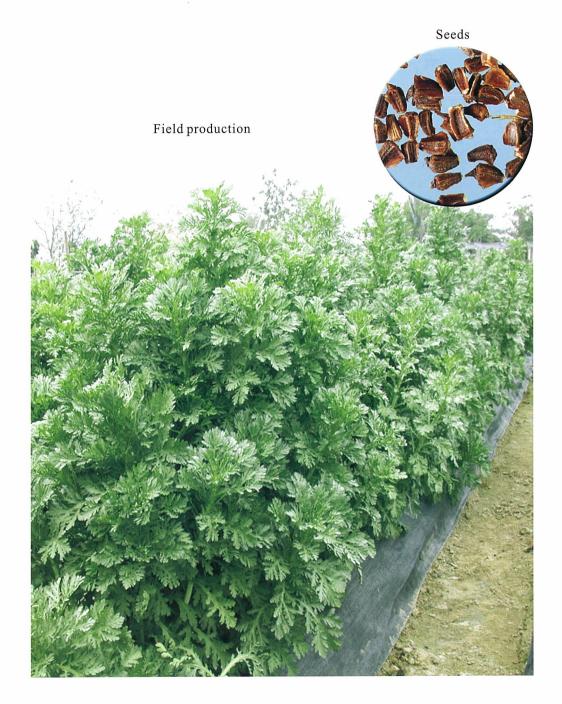
Light requirement: full sun; photoperiod: short-day, day-neutral; temperature requirement: cool-warm; preferred soil type: clayey loam, sandy loam; optimum soil pH: 5.5-6.8; tolerance: light frost; sensitivity: heat.





#### **Production Methods**

System: intercropping, monocropping, protected production; planting material: seeds; planting method: direct broadcast; irrigation: frequent; priority fertilizer: nitrogen; crop management: free standing; planting to 1<sup>st</sup> harvest: 30-40 days; harvesting: once-over (uproot), repeated over 1-3 months.



#### **Edible Parts**

Aromatic leaves and flower heads are eaten blanched, steamed, stir-fried or deep-fried (like tempura), or in soups (like sukiyaki). Other uses: as a sand-binder.

#### **Health Values**

Beta-carotene: high in leaves; vitamin E: high; riboflavin: low; folic acid: medium; ascorbic acid: medium; calcium: low; iron: low; protein: 2.7%.

Bundled shoots in the market





### Velvet plant

### Gynura bicolor

**Asteraceae** 

#### **Common Names**

Velvet plant, redflower ragleaf, fireweed (En); ebolo (Fr); ginura (Sp);紅鳳菜 紫背天葵 (Cn)

#### **Related Species**

G. crepidioides, G. formosana

#### Plant Distribution

Southeast Asia, South Pacific, tropical Africa

#### **Botanical Features**

Annual or perennial herb, up to 100 cm tall; stems erect, soft, ribbed, succulent, branched, hairless, red, purple, green; leaves arranged in rosette, simple to shallowly lobed; petiole 0.3-3 cm long; blade obovate, spatulate, elliptical or ovate, 15 cm long, lower leaves purple and upper leaves green; leaf surface dark green or purplish, underside purple; inflorescences in cylindrical heads 13-16 x 5-6 mm, loosely racemosely or paniculately grouped, many-flowered; flowers bisexual, corolla tubular, yellow or orange with reddish brown top; fruit (achenes) ribbed 3-4 mm long, hairy, dark purplish; epigeal germination.

Leaves of G. bicolor



Growth form of G. crepidioides



Growth form of G. formosana



Light requirement: full sun, partial sun; photoperiod: short-day; temperature requirement: cool-hot; preferred soil type: sandy loam, clayey loam; tolerance: drought, heat; sensitivity: flooding.

Inflorescences of G. crepidioides



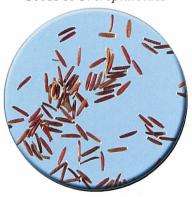
Flowers of G. bicolor



Seeds of G. bicolor



Seeds of G. crepidioides



Seeds of G. formosana



#### **Production Methods**

System: full sun, partial sun; planting material: seeds, cuttings; planting method: direct sowing or planting; irrigation: frequent; priority fertilizer: organic matter, balanced fertlizer; crop management: weeding during seedling stage; planting to 1<sup>st</sup> harvest: 35-40 days; harvesting: once-over (uproot), repeated cutting of leaves of 20-25 cm plant at 8-10 cm above ground surface at 1-2 week intervals for 40-50 days; yield: 4-7 t/ha.

Field production of G. bicolor



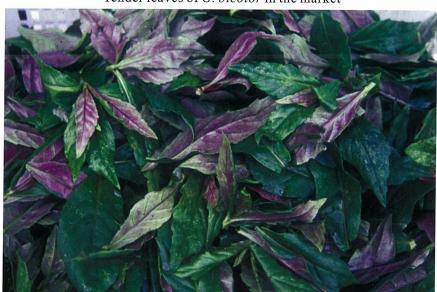
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#### **Edible Parts**

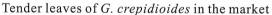
Succulent, tender leaves and shoots are eaten boiled or stir-fried, or added to stews and soups.

#### Health Values

Beta-carotene: medium in tender leaves; vitamin E: low; riboflavin: low; ascorbic acid: low; calcium: medium; iron: extremely high; protein: 1.5-2.0%. Leaves are rich in mucilage and flavonoids.



Tender leaves of G. bicolor in the market





### Roselle

#### Hibiscus sabdariffa

Malvaceae

#### Common Names

Roselle, Jamaica sorrel, red sorrel (En); oseille de Guinée, karkadé, bissap, groseille pays (Fr); rosa de Jamaica, sereni (Sp); 洛神葵 (Cn)

#### Plant Distribution

South and Southeast Asia, tropical Africa

#### **Botanical Features**

Annual herb up to 3.0 m tall, branched; stems most hairless, some spiny, reddish; leaves dark green to red, alternate, hairless, long-petiolate, palmately divided into 3-7 lobes, with serrate margins; flowers solitary in leaf axils, bisexual, regular, pedicel up to 2 cm long; calyces large, fleshy, 8-12 segments united at base, pale yellow or pale pink with dark red-purple centre; fruit egg-shaped, up to 2.5 cm long, enclosed by calyx, many-seeded; seeds kidney-shaped, up to 7 mm long, dark brown; epigeal germination.

Leaves



Flower



Calyx



Seeds



Light requirement: full sun, partial sun; photoperiod: short-day; temperature requirement: hot; preferred soil type: deep, fertile, well-drained loam; optimum soil pH: 5.5-7.5; tolerance: drought; sensitivity: flooding.

#### **Production Methods**

System: home gardening, monocropping; planting material: seeds, cuttings; planting method: direct broadcasting or dibbling (planting in shallow holes); irrigation: meager; priority fertilizer: organic matter; crop management: free standing; planting to 1<sup>st</sup> harvest: 45-60 days for leaves, 80-160 days for calyces; harvesting: repeated picking of leaves 2-3 times during vegetative growth, repeated picking of calyces during flowering period; yield: 10 t/ha for leaves, 8 t/ha for calyces.

#### **Edible Parts**

Young shoots and leaves are eaten in salad, curries, or stir-fried with meats; fleshy calyces are eaten in salad, soup, stir-fried, or finely cut in sauces; dried calyces are used to make a refreshing drink.

#### Health Values

Beta-carotene: medium in shoots; vitamin E: medium in shoots; riboflavin: high in shoots; ascorbic acid: medium in shoots; calcium: medium in shoots; iron: medium in shoots; protein: 3.3%. Flowers and leaves contain also anthocyanins and other antioxidants.



Field production

# Saururus

#### Houttuynia cordata

#### Saururaceae

#### Common Names

Saururus, chameleon (En); houttuynie (Fr); dokudami (Jp); houttuynia (Sp); giấp cá (Vn); 蕺菜, 魚腥草 (Cn)

#### Plant Distribution

East, Southeast, and South Asia

#### **Botanical Features**

Perennial herb, 20-60 cm high; rhizomes creeping; leaves alternate, ovate 5-7 cm long, cordate, 5-vein from base, gland-dotted; spike 1-2 cm long, involucral bracts 4, white, to 1 cm long, each flower subtended by a small bract; fruit spike up to 2.5 cm long.



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Light requirement: full sun, partial sun; temperature requirement: hot; preferred soil type: fertile moist soil; tolerance: flooding; may be invasive in moist soil.

#### **Production Methods**

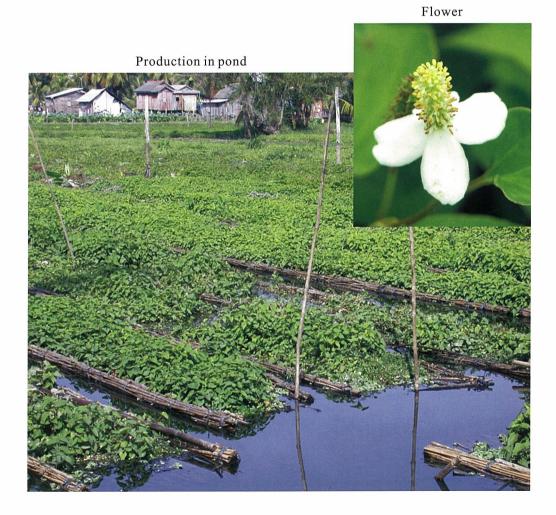
System: gathering wild from water pond, home gardening in moist soil; planting material: rhizomes with 2-3 buds, seeds; planting method: transplanting; irrigation: frequent; crop management: free standing; planting to 1<sup>st</sup> harvest: 60-90 days; harvesting: repeated; yield: 15-30 t/ha.

#### **Edible Parts**

Astringent aromatic shoots, leaves and rhizomes are used as fresh herbal garnish in salad, soup, fish stew, etc.

#### **Health Values**

Beta-carotene: medium; vitamin E: medium; folic acid: low; ascorbic acid: high; calcium: low; iron: high; protein: 2.4-3.2%. Leaves contain also antioxidative polyphenols, and volatile oils that are responsible for the plant's characteristic flavor.



## Kangkong

#### Ipomoea aquatica

#### Convolvulaceae

#### **Common Names**

Kangkong, water convolvulus, water spinach, swamp morning glory (En); liseron d'eau, patate aquatique (Fr); espinaca acuáica (Sp); 蕹菜, 空心菜 (Cn)

#### Related Types

Narrow-leaf type: white flower, green stem, best suited for wet cultivation Broad-leaf type: pink flower, white stem, best suited for upland cultivation

#### Plant Distribution

East and Southeast Asia

#### **Botanical Features**

Annual herb; stems trailing, smooth, hollow with milky sap, up to 3 m long, rooting at nodes; leaves alternate; petioles hairless, 5-25 cm long; blade ovate or triangular to lanceolate or linear, 2.5-20 x 0.5-10 cm, entire or toothed; flowers at leaf axils, bisexual, showy, funnel form, 4-8 cm, white or pink-lilac; fruit oval or spherical, woody at maturity, 1 cm diameter, 2-4 seeded; seeds angular to rounded, 4 mm long, hairy, pale to dark brown; epigeal germination.

Ovate leaves

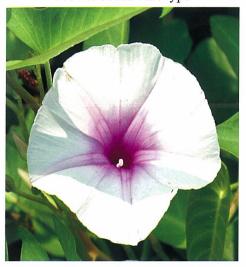


Linear leaves



Light requirement: full sun; photoperiod: short-day; temperature requirement: hot; preferred soil type: loam, clay; optimum soil pH: 5.3-6.0; tolerance: heat, flooding; sensitivity: cold.

Flower of red vine type



Flower of green vine type





#### **Production Methods**

System: intercropping, monocropping; planting material: seeds, cuttings; planting method: direct seed broadcast or sow in rows, planting of cutting in wet or paddy field; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: free standing (upland cultivation), creeping (wet cultivation); planting to 1<sup>st</sup> harvest: 21-45 days (upland cultivation), 30-60 days (wet cultivation); harvesting: once-over (uproot or cutting of upland cultivation at ground level), repeated cutting of young shoots at 5-10 cm above ground level every 4-6 weeks; yield: 7-30 t/ha (upland cultivation).

#### Production in pond



Production in paddy field



Production in river



Tender shoots or leaves are used fresh as salad, or steamed, boiled, or stir-fried.

#### **Health Values**

Beta-carotene: medium; vitamin E: medium; riboflavin: low; folic acid: medium; ascorbic acid: medium to high; calcium: medium; iron: medium; protein: 2.5%. Leaves contain also flavonoids.

Production in upland



Bundled shoots with green vines in the market



Bundled shoots with red vines in the market



## **Sweet potato**

#### Ipomoea batatas

#### Convolvulaceae

#### **Common Names**

Sweet potato (En); patata douce (Fr); batata, boniato, camote (Sp); 甘薯, 蕃薯, 地瓜葉 (Cn)

#### Plant Distribution

Pantropics

#### **Botanical Features**

Annual or perennial herb with milky exudate in all parts; stems (vines) trailing, 1-5 m long, green to purple, rooting at nodes; leaves variable, ovate entire to deeply lobed, heart-shaped, 5-15 x 5-15 cm, green to yellow to purple; tuberous roots develop from adventitious roots, shape and color of skin (white, orange, brown to purple) and flesh (white, orange, brown to purple) variable; flowers axillary, funnel shaped, purple; fruit (capsules) 5-10 mm across; seeds angular, 3 mm long, with hard seed coat; epigeal germination.

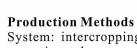
Different leaf types and colors



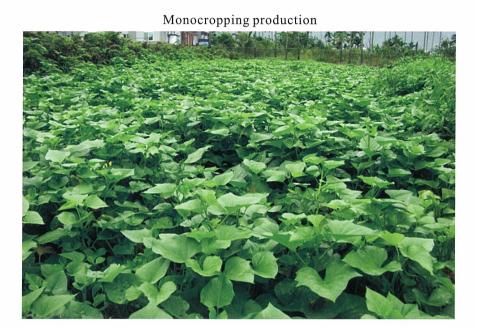
Light requirement: full sun; photoperiod: short-day, day-neutral; temperature requirement: hot; preferred soil type: sandy loam; optimum soil pH: 6.1-7.7; tolerance: drought; sensitivity: frost, flooding.

Flowers

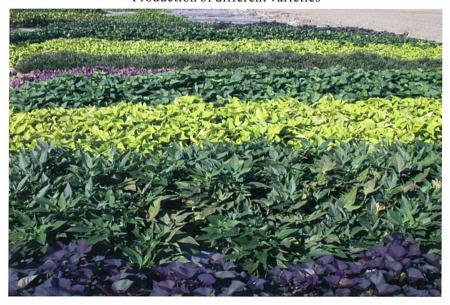




System: intercropping, monocropping; planting material: 20-30 cm vine cuttings, sprouting tuberous roots, root pieces; planting method: direct planting; irrigation: moderate; priority fertilizer: nitrogen for leaf, potassium for tuberous root; crop management: creeping on ground; planting to 1<sup>st</sup> harvest: 40-50 days for shoots; harvesting: repeated cutting of young shoots every 7-15 days in hot-warm season, 20-30 days in cool season; yield: 5-6 t/ha for shoots.



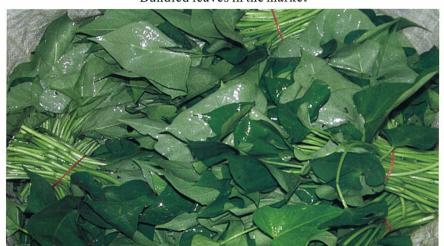
Production of different varieties



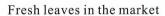
Tender leaves and shoot tips are eaten boiled or stir-fried; tuberous root used boiled, baked, or deep-fried.

#### **Health Values**

Beta-carotene: medium in leaves, medium to extremely high in tuberous roots; vitamin E: high in shoots; riboflavin: medium in leaves; ascorbic acid: high in leaves, medium in tuberous roots; calcium: low in leaves and tuberous roots; iron: high in leaves, low in tuberous roots; protein: 3.2% in leaves, 1.0% in tuberous roots. Leaves and tender shoots contain antioxidative phenolic compounds and flavonoids, and have antiproliferative properties.



Bundled leaves in the market





## Indian lettuce

#### Lactuca indica

Asteraceae

#### **Common Names**

Indian lettuce, milkweed, wild lettuce (En); lechuga de la India (Sp); 山萵苣 (Cn)

#### Plant Distribution

South, East, and Southeast Asia

#### **Botanical Features**

Perennial herb, erect; leaves in a basal rosette before flowering, up to 20 cm high, alternate, sessile, undivided oblong-lanceolate to deeply pinnatifid oblong, 5-35 x 1-10 cm; inflorescences terminal, corymbiform, 50-100 cm long, many branched, with numerous small flower heads, involucral bracts partly ovate (outer ones), partly oblong-linear-lanceolate (inner ones); flowers with strap-shaped corolla limb, bright yellow; flat elliptical fruit (achenes); seeds, black, 3-4 x 2 mm.





Light requirement: full sun; photoperiod: short-day, day-neutral; temperature requirement: warm; preferred soil type: sandy loam; optimum soil pH: 5.0-8.0; tolerance: heat and moist; sensitivity: flooding.



#### **Production Methods**

System: home gardening, gathering from wild; planting material: seeds, root cuttings; planting method: sow seed on seed-bed before transplanting; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: free standing; planting to 1<sup>st</sup> harvest: 60 days; harvesting: repeated cutting of leaves 20 cm long.





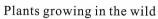
Fruit (achenes)



Leaves and tender stems with slight bitterness are used fresh as salad, boiled, steamed or stir-fried, or in soup.

#### **Health Values**

Beta-carotene: high; riboflavin: medium; ascorbic acid: medium; calcium: medium; iron: high; protein: 2.2%. Leaves contain also six antioxidative phenolic compounds.





Bundled leaves in the market



## **Velvetleaf**

#### Limnocharis flava

#### Limnocharitaceae

#### **Common Names**

Velvetleaf, sawah-flower rush, sawah lettuce, yellow bur-head (En); cebolla de chucho, hoja de buitre (Sp); 黃花藺 (Cn)

#### Plant Distribution

Southeast Asia, Central and South America

#### **Botanical Features**

Perennial, erect, aquatic herb, 20-50 cm tall, strongly tillering; leaves rosette, hairless; petioles 5-70 cm long, thick with many air chambers, sheathing at the base; blades lanceolate to broadly elliptic or ovate, 5-30 x 4-25 cm, velvety-green; umbels with 3-15 flowers, peduncles up to 90 cm long, erect when flowering, down-curved when fruiting, yellow flowers in the axils of membranous bracts; pedicels 2-7 cm long; fruit compound, 1.5-2.0 cm across; seeds 1.0-1.5 mm long.





Light requirement: full sun; photoperiod: day-neutral; temperature requirement: hot; tolerance: flooding; may be invasive in wetlands.

Inflorescence

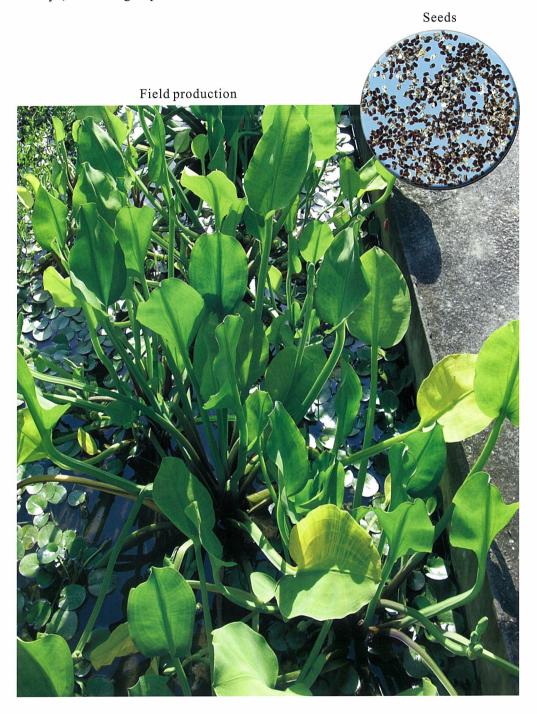


Open flower



#### **Production Methods**

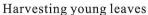
System: water pond, hydroponics; planting material: cuttings, seeds; planting method: layering, transplanting; irrigation: grow in ponds or paddy fields; priority fertilizer: organic matter; crop management: free standing; planting to 1<sup>st</sup> harvest: 60-90 days; harvesting: repeated.



Young leaves with petioles and young inflorescences are eaten.

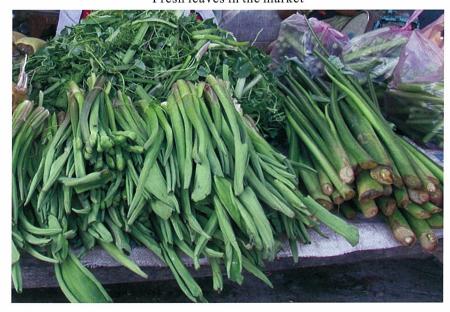
#### **Health Values**

Beta-carotene: low in shoots; vitamin E: low in stems, high in leaves; folic acid: low in shoots; ascorbic acid: medium in stems, extremely high in leaves; calcium: medium in stems, high in leaves; iron: low in shoots; protein: 0.7% in stems, 1.9% in leaves.





Fresh leaves in the market



# Swamp leaf

### Scrophulariaceae

#### Common Names

Swamp leaf, ambulia, finger grass, rice paddy herb (En); herbe à paddy (Fr); hierba del arrozal (Sp); 大葉石龍尾, 大葉田香 (Cn)

#### Plant Distribution

Southeast and East Asia, South Pacific

#### **Botanical Features**

Perennial herb in marshy areas, often aromatic when bruised; main stems creeping, branches erect reaching 30-60 cm; leaves opposite, aerial only, oblong-ovate or ovate, 2-9 x 1-5 cm, margins toothed, upper surface rough; flowers 1 cm long, purplish, cluster in the axils of the leaves or terminate on the leafy branches; fruit (capsules) egg-shaped, 5-6 mm long, 3 mm across.





Flower



Light requirement: partial sun; temperature requirement: warm; tolerance: flooding; sensitivity: heat.

#### **Production Methods**

System: gathering wild (from freshwater pools, stagnant backwaters, swampy places, ditches, along canal banks, rice fields), home gardening on moist soil; planting material: seeds, stem cuttings; planting method: transplanting; irrigation: supply water when dry; priority fertilizer: organic matter; crop management: free standing.

#### **Edible Parts**

Aromatic leaves are eaten raw with other vegetables as salads, or used to flavor cooked dishes.

#### **Health Values**

Beta-carotene: low; vitamin E: medium; folic acid: low; ascorbic acid: medium; calcium: medium; iron: extremely high; protein: 2.0%. Edible parts contain also limonene and 5,7-dihydroxy-8,3',5'-trimethoxyflavone (a flavonoid).



Field production

## Chinese boxthorn

### Lycium chinense

#### Solanaceae

#### **Common Names**

Chinese boxthorn, Chinese wolfberry, Chinese matrimony vine (En); lyciet de Chine (Fr); palo de gallina (Sp); 枸杞, 葉用枸杞 (Cn)

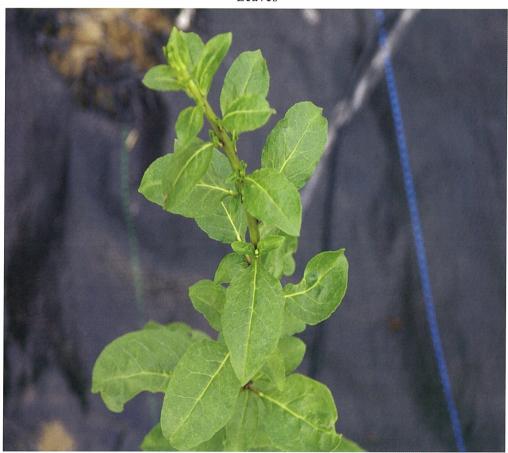
#### Plant Distribution

East, Southeast, and South Asia

#### **Botanical Features**

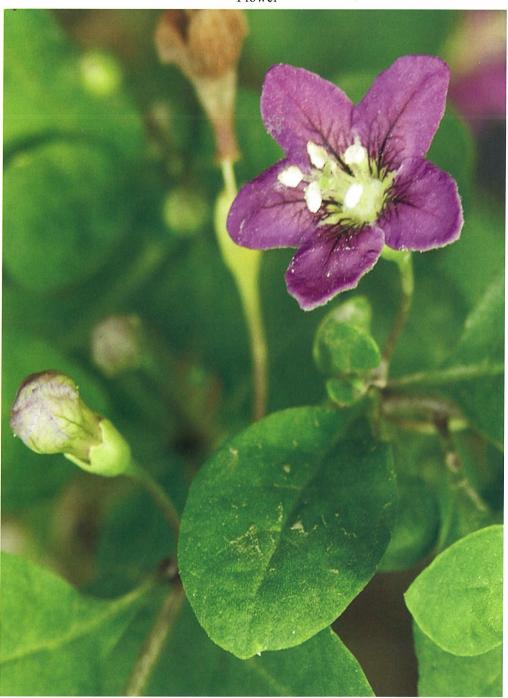
Erect perennial, deciduous; stems thick, 0.5-1(-2) m tall; branches long arching or prostrate, with thorns; leaves alternate, ovate or ovate-lanceolate, up to 7 cm long, in tight clusters; leaf blades thick and grayish; flowers usually 2-8 at a node, 1 cm long, funnel-form, corolla purplish; fruit (berries) scarlet or orange, egg-shaped or oblong, up to 2 cm long; seeds numerous, yellow, 2.5-3 mm.





Light requirement: full sun; temperature requirement: warm; preferred soil type: fertile sandy loam; tolerance: shade; sensitivity: flooding.

Flower





#### **Production Methods**

System: home gardening, monocropping; planting material: cuttings, sometimes seeds; planting method: transplanting; irrigation: frequent; priority fertilizer: organic matter, nitrogen; crop management: free standing, side dressing at peak harvest; planting to 1<sup>st</sup> harvest: 50-60 days; harvesting: weekly for leaves, biweekly for fruit; yield: 2-4 t/ha for leaves.

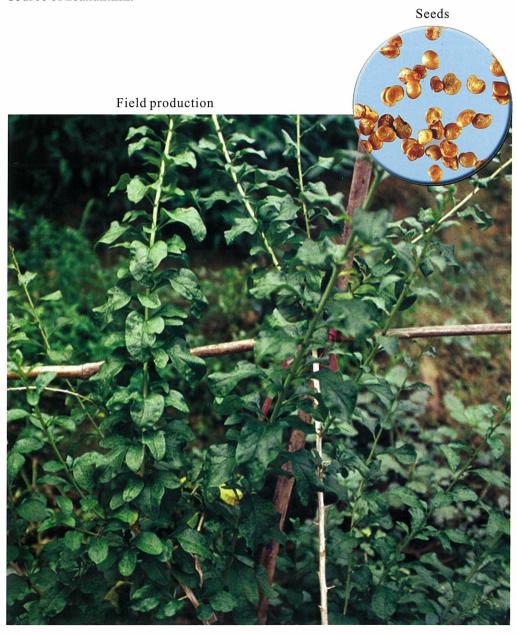
#### Mature berries



Young leaves are used fresh in salad, stir-fried with other food items, or in soup; berries used fresh or cooked with other food items, or dried to make into a beverage.

#### **Health Values**

Beta-carotene: extremely high in leaves; vitamin E: high in leaves; riboflavin: low in fruit; folic acid: medium in leaves; ascorbic acid: medium in leaves; calcium: medium in leaves and fruit; iron: high in leaves, medium in fruit; protein: 3.0-6.0% in leaves. The berry improves eyesight and enhances immune system function, and is a rich source of zeaxanthin.





## **Cluster mallow**

#### Malva verticillata

Malvaceae

#### Common Names

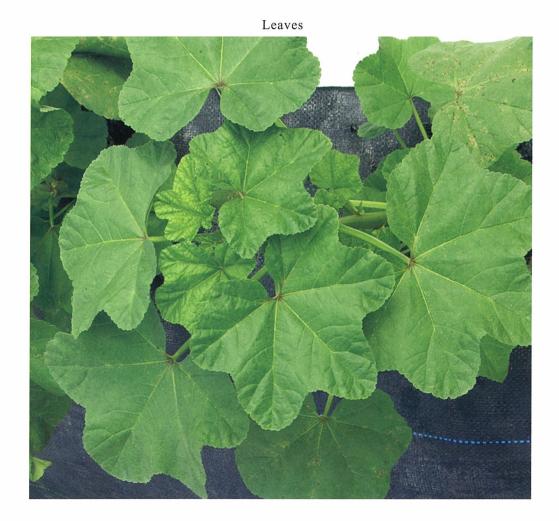
Cluster mallow, whorled mallow, curled mallow (En); mauve crépue, mauve verticillée (Fr); malva crespa (Sp); 冬寒菜 (Cn)

#### **Plant Distribution**

East Asia, cultivated elsewhere in temperate regions

#### **Botanical Features**

Annual or biennial herb; stems erect, up to 150 cm long, white or purple; leaves alternate, rounded, 5- or 7-lobed, with radiate veins; flowers in dense axillary clusters, white or purplish, about 1 cm long; disk-shape fruit (capsules) contain a single beakless black seed.



Light requirement: full or partial sun; temperature requirement: cool-warm; preferred soil type: sandy, loamy, clayey; sensitivity: heat, flooding.

White flower





#### **Production Methods**

System: monocropping; planting material: seeds, cuttings; planting method: direct planting, transplanting; irrigation: moderate; priority fertilizer: organic matter; crop management: free standing; harvesting: repeated until flowering.

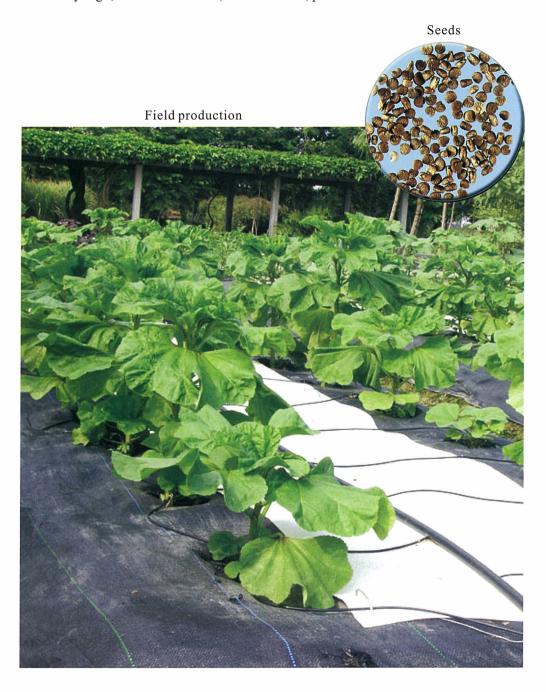
Pale purple flower



Seedlings, tender leaves, and shoots are eaten boiled, stir-fried, pickled, roasted with soy sauce, or added to soups.

#### **Health Values**

Beta-carotene: high in edible parts; vitamin E: medium; folic acid: low; ascorbic acid: extremely high; calcium: medium; iron: medium; protein: 4.6%.





## Spiny bitter gourd

#### Momordica cochinchinensis

#### Cucurbitaceae

#### **Common Names**

Spiny bitter gourd, cochinchin gourd, sweet gourd (En); margose à piquants (Fr); pepino amargo espinoso, pepinillo del diablo, cundeamor (Sp); gấc (Vn); 木鱉子 (Cn)

#### Plant Distribution

East, South, and Southeast Asia, Australia

#### **Botanical Features**

Perennial vine, dioecious; stems robust, multiple, angular; leaves alternate, palmately veined, deeply 5-lobed, serrate, 5-10 cm petiole glandular; flowers axillary, solitary, 8 cm across, yellow; male flowers with 5-30 mm peduncle bearing sessile bract; female flowers with smaller bract; fruit round or oblong, 5-10 x 10-15 cm, rind hard, covered in small spines, green but red or dark orange upon ripening, fleshy middle part of fruit wall dark red with six cartilaginous carpels containing 10-20 seeds; seeds compressed, sculptured, 2.5 x 2 x 0.5 cm, dark brown.

Leaves



Male flowers



Female flowers





Light requirement: full or partial sun; temperature requirement: cool-warm; preferred soil type: sandy, loamy, clayey; sensitivity: heat, flooding.





Fully ripe fruit

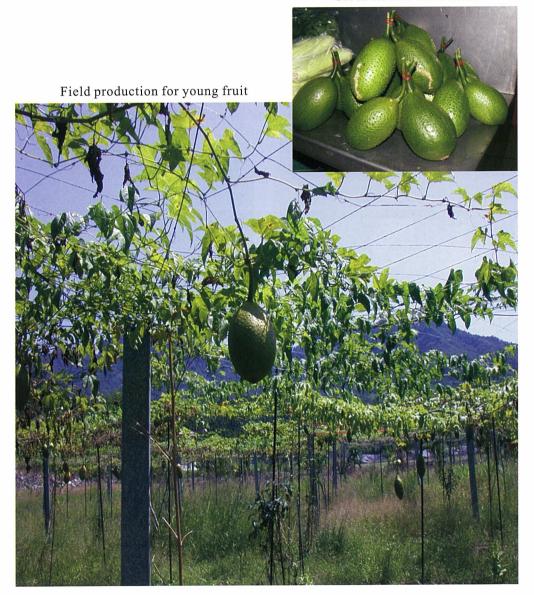




#### **Production Methods**

System: gathering wild, home gardening; planting material: preferably with tuberous roots to maintain proper female/male ratio, seeds; planting method: transplanting; irrigation: moderate; priority fertilizer: complete fertilizers; crop management: fencing, staking or latticing when veins reach 1 m, use auxin-type growth regulators on female plants to produce parthenocarpic fruit when there are no male plants; planting to 1<sup>st</sup> harvest: anytime 15 days after planting for tender shoots,10-15 days after blooming of female flowers for young fruit with soft spines; harvesting: repeated (fruit harvested at green or mature stages) in three months; yield: 30-60 gourds/plant in one season, 1-3 kg each.

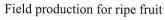
#### Green fruit in the market

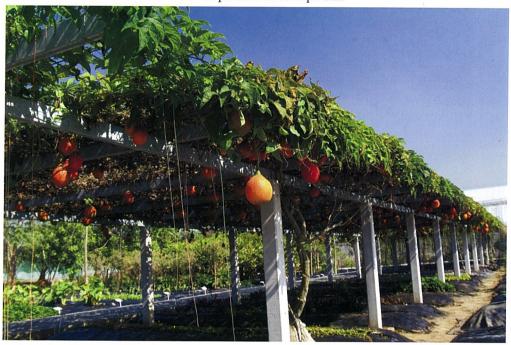


Young leaves and flowers are eaten boiled or stir-fried; young fruit is boiled or used in soup after peeling rind; mature fruit cooked along with seeds to flavor and add red color to rice dishes for festive occasions.

#### **Health Values**

Beta-carotene: low in shoots, extremely high in mature fruit; vitamin E: medium in shoots, high in fruit; folic acid: high in shoots; ascorbic acid: extremely high in shoots and green fruit; calcium: low in shoots and green fruit; iron: low in shoots and green fruit; protein: 3.0% in shoots, 0.9% in green fruit. Fleshy coverings of seeds are rich in lycopene.

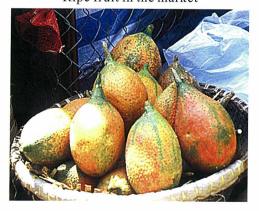




Bundled leaves in the market



Ripe fruit in the market



# Oval-leaf pondweed Monochoria vaginalis

#### Pontederiaceae

#### Common Names

Oval-leaf pondweed, pickerel weed (En); pontédérie (Fr); monochoria (Sp); 學菜, 鴨舌草 (Cn)

#### Plant Distribution

East, South, and Southeast Asia, Oceania

#### **Botanical Features**

Annual hydrophytic herb; stems creeping or ascending; leaves radically or spirally arranged, entire, extremely variable from linear to broadly-ovate, with sharply acuminate apex and cordate base, 2-20 x 0.2-10 cm, with many veins connected by cross-veins, petioles up to 50 cm long; inflorescences with 2-20 flowers, peduncles 2-10 cm long, bracts obovate, apex with bristle-like structure; flowers blue, 1 cm long, pedicels less than 1 cm; capsules oblong, 8 mm long, with numerous seeds; seeds egg-shaped with ribs.

Leaves



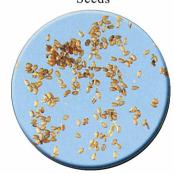
Light requirement: full sun; photoperiod: short-day; temperature requirement: hot; preferred soil type: clay; optimum soil pH: 5.0-6.5; tolerance: flooding; sensitivity: drought; may be invasive.

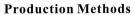


Capsules

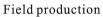


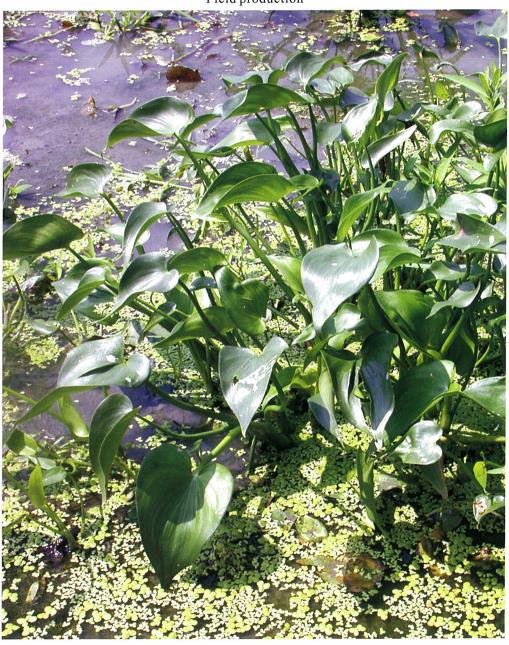
Seeds





System: gathering wild (from freshwater pools, stagnant backwaters, swampy places, ditches, along canal banks, rice fields), planting in swamps; planting material: lateral shoots, seeds; planting method: planting in rows, direct broadcast; irrigation: frequent; crop management: supply water when dry; planting to 1<sup>st</sup> harvest: 30 days; harvesting: once-over uprooting of whole plants with roots, immediately pack in plastic bags to avoid wilting.





Leaves with petioles are eaten boiled; inflorescences are used fresh as salad.

#### **Health Values**

Beta-carotene: low to medium in shoots; vitamin E: low in stems, high in leaves; folic acid: low in stems, medium in leaves; ascorbic acid: low in stems, extremely high in leaves; calcium: low in stems, medium in leaves; iron: low in stems, high in leaves; protein: 1.0% in stems, 4.0% in leaves.



## **Indian mulberry**

#### Morinda citrifolia

Rubiaceae

#### **Common Names**

Indian mulberry, noni, canary wood (En); fromager, bois douleur, murier indien (Fr); mora de la India (Sp); 海巴戟, 檄樹 (Cn)

#### **Plant Distribution**

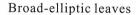
South Asia, South Pacific, East Asia, Australia, the Caribbean

#### **Botanical Features**

Small, hairless tree, 3-6 m tall; leaves narrow-oblong to broad-elliptic to 25 cm long, entire, glossy, with prominent curving lateral veins, stipules large, early falling; flowers white; aggregate fleshy fruit near globular or egg-shaped, 4-7 cm in size, fleshy, at first green, turning light yellow or white when ripe, pungent odor, numerous seeds.



Narrow-oblong leaves





Light requirement: full sun, partial sun; photoperiod: day-neutral, flowers and fruit produce throughout most of the year; temperature requirement: hot; preferred soil type: well-drained loamy sand; optimum soil pH: 5.0-6.5; tolerance: drought, flooding, salinity, wind; sensitivity: cold.

Flowers





#### **Production Methods**

System: home gardening, intercropping; planting material: seeds, 20-40 cm stem cuttings; planting method: sow scarified seeds on potting media, transplant seedlings when 10 weeks old; irrigation: meager; priority fertilizer: balanced fertilizer, organic matter; crop management: weed control; planting to 1<sup>st</sup> harvest: 2 years for fruit; harvesting: repeated removal of fruit; yield: 80 t/ha of fruit from monocropping.





Ripe fruit



Young leaves and terminal buds are cooked to supplement other dishes; mature leaves used to wrap around fish and then eaten with the cooked fish; unripe fruit cooked with curries; ripe fruit consumed raw with salt; dried leaves or fruit used to make infusions and teas.

#### **Health Values**

Beta-carotene: medium in leaves; vitamin E: high in leaves; ascorbic acid: high in leaves; calcium: high in leaves; iron: medium in leaves; protein: 3.5% in leaves. Leaves and fruit contain xeronine (an alkaloid that repairs the damaged cells), scopoletin (a coumarin that regulates blood pressure), anthraquinones, americanin A (a potent antioxidant of neolignan), phenolic compounds, etc.





## **Drumstick**

#### Moringa oleifera

### Moringaceae

#### **Common Names**

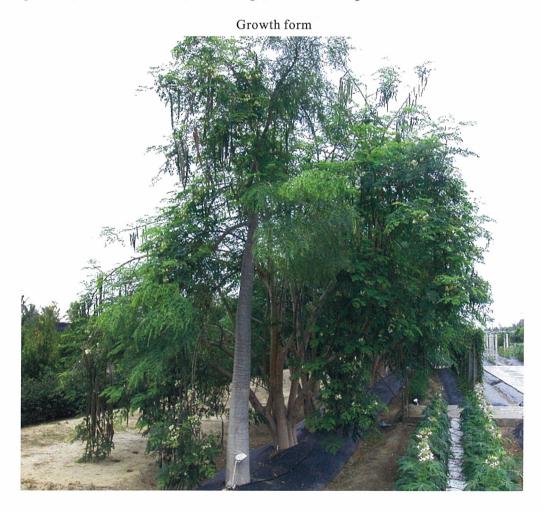
Drumstick, horseradish tree (En); mouroungue, ben ailée, moringa ailée (Fr); maranga, paraíso (Sp); 辣木 (Cn)

#### **Plant Distribution**

South and Southeast Asia, tropical Africa

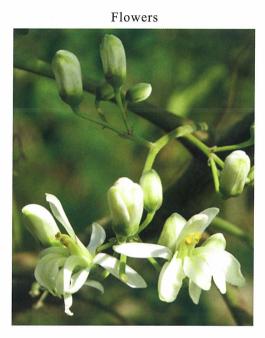
#### **Botanical Features**

Deciduous perennial tree 5-15 m tall; bark corky, up to 45 cm in diameter, gray or pale buff; leaves alternate, 2- or 3-pinnate, 10-50 cm long; leaflets round to oval, 1-2 cm diameter; inflorescences 8-30 cm long; flowers bisexual, 7-14 mm long, white to pale yellow; fruit 3-valved, 10-50 cm long, brown when ripe, many-seeded; seeds globular, 1-1.5 cm diameter, 3 thin wings, 0.5-2.5 cm long.

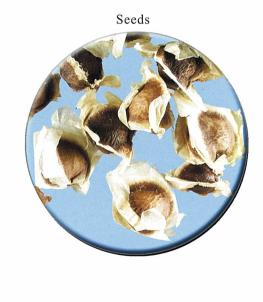


Light requirement: full sun; photoperiod: short-day, day-neutral, long-day; temperature requirement: hot; preferred soil type: well-drained sand and loam; optimum soil pH: 5.5-7.0; tolerance: drought, heat; sensitivity: flooding.

Leaves



Mature pods

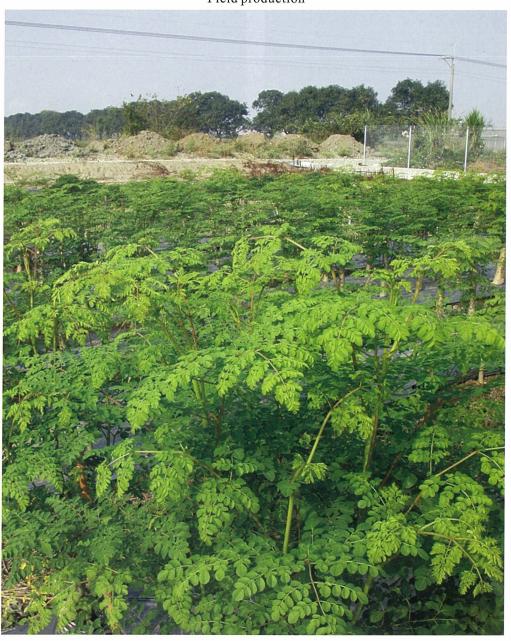




#### **Production Methods**

System: sole trees, hedge in home gardens, companion cropping; planting material: seeds, cuttings; planting method: direct planting of either seeds or cuttings; irrigation: meager; priority fertilizer: grows well in infertile soil; crop management: free standing, regular pruning to keep the plant height at around 1 m; planting to 1<sup>st</sup> harvest: 55-70 days for shoots; harvesting: repeated removal of young shoots biweekly; yield: 20 t/ha for shoots.

Field production



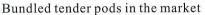
Tender leaves, shoot tips, flowers and young pods are cooked in soup or sauce, or stirfried; leaves are sometimes dried and stored for later use.

#### **Health Values**

Beta-carotene: high in leaves, low in fruit; vitamin E: high in leaves; riboflavin: high in leaves; folic acid: high in leaves; ascorbic acid: extremely high in leaves and fruit; calcium: medium in leaves, low in fruit; iron: high in leaves and fruit; protein: 4.0% in leaves, 3% in fruit. Edible portions provide an array of beta-sitosterol, caffeoylquinic acid (phenolic compound), glucosinolates, kaempferol, quercetin, zeatin, etc., and are employed in indigenous medicine for the treatment of different ailments.



Edible young shoots







## Watercress

#### Nasturtium officinale

**Brassicaceae** 

#### **Common Names**

Watercress (En); cresson d'eau, cresson de fontaine (Fr); berro (Sp); 豆瓣菜, 西洋菜 (Cn)

#### Plant Distribution

East, Southeast, and West Asia, Indian Ocean islands, Europe, Northeast Africa

#### **Botanical Features**

Perennial, aquatic herb; hairless stems creeping or floating, to 1 m long, hollow, juicy, much branched, rooting freely at nodes; leaves alternate, juvenile leaves ovate or cordate and entire, adult leaves pinnate, 10 cm long; leaflets 2-9 pairs, sessile, nearly circular to elliptical or obovate, essential entire, somewhat fleshy; inflorescences racemose, 10 cm long; flowers bisexual, white, yellow anthers; siliques 2-3 x 5-12 mm, many seeds in 2 rows; seeds spherical, dark red-brown, netted; epigeal germination.





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Light requirement: full sun; photoperiod: day-neutral, long-day; temperature requirement: cool-warm; preferred soil type: loam; optimum soil pH: 6.5-7.5; tolerance: cold, flooding; sensitivity: heat.

Leaves



Flowers

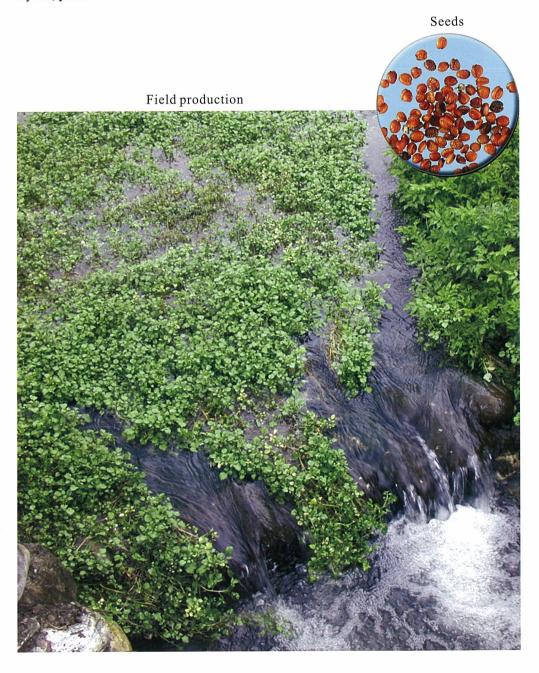


Fruit (siliques)



#### **Production Methods**

System: cultivated as an annual or biennal in slowly flowing water stream on both a large scale and a garden scale, hydroponics; planting material: 10-20 cm stem cuttings, seeds; planting method: transplanting on moist sand; irrigation: continuous running water, frequent irrigation when the water source dries up; priority fertilizer: phosphorus, nitrogen; crop management: floating in clean, flowing water; planting to 1<sup>st</sup> harvest: 20-40 days; harvesting: repeated cutting of tender shoots every 3 weeks for a year; yield: 10-20 t/ha.

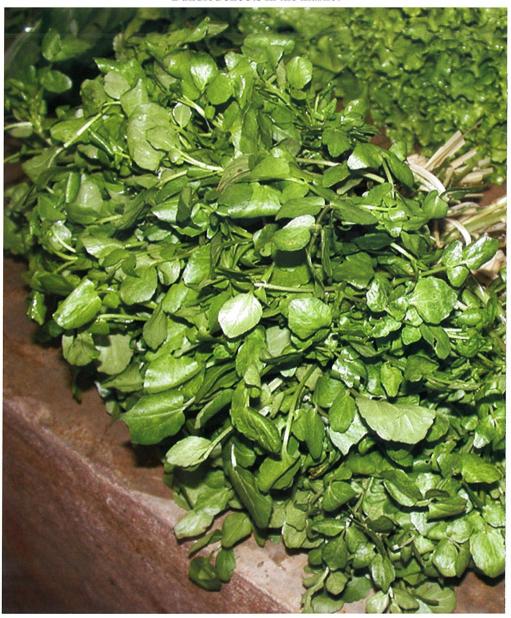


Pungent tender shoots or leaves are eaten in soup, salad, or as a garnish and condiment.

#### **Health Values**

Beta-carotene: medium; vitamin E: low; riboflavin: low; folic acid: high; ascorbic acid: extremely high; calcium: medium; iron: medium; protein: 2.1%. Leaves contain also phenethyl isothiocyanate (glucosinolate).







## Water mimosa

### Neptunia oleracea

**Fabaceae** 

#### **Common Names**

Water mimosa (En); neptunie potagère (Fr); carurú de agua, juqueri manso (Sp); 芽菜, 水合歡 (Cn)

#### **Plant Distribution**

Southeast Asia

#### **Botanical Features**

Perennial or annual, aquatic herb; stems prostrate up to 1.5 m long, forming spongy-fibrous swollen internodes and producing fibrous adventitious roots at the nodes; leaves alternate, 2-pinnate; petioles angled, 2-7 cm long; leaflets 8-20 pairs, oblong, 5-20 x 1.5-3.5 mm, hairless; yellow flowers, with 30-50 spikes, sessile in solitary, axillary heads; peduncles 5-30 mm long; fruit (pods) with 4-8 seeds, oblong and flat, 2-3 x 1 cm; seeds 4-5 x 2.5-3.5 mm, brown.





Light requirement: full sun, partial sun; temperature requirement: hot; tolerance: flooding; sensitivity: drought, saline water, shade.

Flowers



Leaves



Seeds





#### **Production Methods**

System: gathering wild (from paddy fields, canals), gardening in ponds; planting material: stem cuttings; planting method: transplanting; priority fertilizer: nitrogen during low water level; crop management: staking in canals, grow with duckweed; planting to 1<sup>st</sup> harvest: 30 days; harvesting: repeated at intervals of 5-7 days for 4-6 months.

Commercial production



Removing fibrous shoots and bundling for marketing



Young shoots are consumed raw, cooked, or stir-fried.

#### **Health Values**

Riboflavin: low in young shoots; ascorbic acid: low; calcium: high; iron: high; protein: 6.4%.

Bundled spongy shoots in the market



Bundled shoots in the market



## **Anemone**

#### Nymphoides hydrophylla

#### Menyanthaceae

#### **Common Names**

Anemone, water skin lotus, crested floatingheart (En); faux-nénuphar, petit nénuphar (Fr); camalotillo variegado, ninfoides, gencianas acuáticas (Sp); 龍骨瓣莕菜, 野蓮 (Cn)

#### Plant Distribution

East and Southeast Asia

#### **Botanical Features**

Hydrophytic perennial herb; stems 10-30 cm, rooting from nodes; leaves floating, simple, cordate, 1-6 x 1-5 cm, submembranous, hairless on both surfaces; petioles 4-10 cm, slender, with ascending water can reach up to 130-150 cm as false stems; leaf blade; flowers in dense, axillary umbels, pedicelled, flowering nodes with a cluster of short, spur-like roots; flowers 5-merous, white; fruit (capsules) globular, 3 mm across, 6-10-seeded; seeds brown, globular, 1 mm across.

#### Growth form



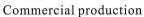
Leaves



Flowers



Light requirement: full sun, partial sun; photoperiod: long-day; temperature requirement: warm; preferred soil type: clay; tolerance: heat, flooding; sensitivity: cold, drought.





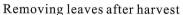
Harvesting





#### **Production Methods**

System: in pond with clean water, duckweed or tilapia, hydroponics; planting material: cuttings from flowering stem with roots; planting method: flat the pond soil, after planting maintain water at 3-5 cm deep; irrigation: frequent; priority fertilizer: organic matter at the initial stage; crop management: add clean creek or ground water biweekly until the water surface reaches 100 cm; planting to 1st harvest: 60-75 days (mean day temp above 30°C), 90-100 days (mean day temp below 20°C); harvesting: once-over uprooting of 100-150 cm false stems for one month; yield: 2-5 t/ha.





Washing



Leaves and false stems are eaten boiled or stir-fried.

#### **Health Values**

Beta-carotene: medium in edible parts; vitamin E: low; ascorbic acid: low; calcium: low; iron: low; protein: 0.7%.

Length of harvested false stems



Packed false stems in the market



Edible false stems





## Water dropwort

#### Oenanthe javanica

**Apiaceae** 

#### **Common Names**

Water dropwort, Chinese celery, Japanese parsley, Java waterdropwort (En); persil Vietnamien (Fr); Filipéndula de agua (Sp); 水芹 (Cn)

#### Plant Distribution

East, South, and Southeast Asia, Australia

#### **Botanical Features**

Perennial herb, up to 50-100 cm high; stems slender, smooth, erect, often sprouting and rooting at the lower nodes to form new plants; roots fibrous and tuberous; leaves alternate, several times divided pinnate with hollow petioles sheathed for half their length; leaflets oval, serrate, sometimes entire margins; flowers white, in compound umbels at the top of seed stalk, involucre small or absent; seed stalks well branched; one-seeded fruit oblong, with corky ribs.

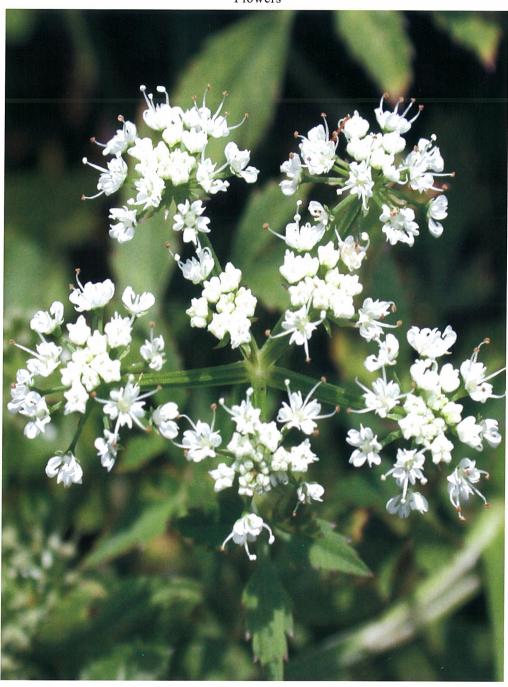




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Light requirement: full sun; photoperiod: long-day, day-neutral, short-day; temperature requirement: cool-warm; preferred soil type: clay, loam, sand; optimum soil pH: 5.5-6.5; tolerance: cold, humid, flooding; sensitivity: heat, shading.

Flowers





System: gathering wild from marsh or along stream, home gardening in wetland or moist soil, hydroponics; planting material: stem cuttings, root divisions, seeds with erratic germination; planting method: transplanting; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: free standing, light shading for leaves; planting to 1<sup>st</sup> harvest: 20-30 days; harvesting: repeated; yield: 50 t/ha.





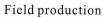
Edible leaves



Tender stems and leaf stalks are used fresh as salad, to garnish steamed rice and other dishes, or boiled and chopped as greens.

#### **Health Values**

Beta-carotene: high; vitamin E: extremely high; riboflavin: medium; ascorbic acid: high; calcium: medium; iron: high; protein: 1.1%. Chlorophyll-rich leaves have antigenotoxic and antioxidative properties.







## Perilla

#### Perilla frutescens

Lamiaceae

#### **Common Names**

Perilla, beefsteak plant (En); périlla (Fr); shiso (Jp); perilla (Sp); 紫蘇 (Cn)

#### Plant Distribution

East, South, and Southeast Asia

#### **Botanical Features**

Annual herb, erect, up to 90 cm tall; stems branched, densely hairy, square in cross section; leaves opposite, broadly ovate, up to 12 cm long, more or less acuminate, toothed, long-hairy, especially on veins, green or purple on both sides or purple on underside, long petioled; flowers whorl-like on axillary or apical racemes, pale purple, white; fruit spherical with slightly flattened ends, grayish brown, 1.5 mm in diameter; seeds brown, 2 mm across.

Purple leaf type



Green leaf type



Inflorescence and flowers



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Light requirement: full sun, partial sun; photoperiod: short-day; temperature requirement: cool-hot; preferred soil type: loam, sandy loam; optimum soil pH: 6.0-6.5; tolerance: drought; sensitivity: heat, frost.

#### **Production Methods**

System: home gardening, monocropping; planting material: seeds; planting method: transplanting; irrigation: moderate; priority fertilizer: balanced fertilizer; crop management: free standing; planting to 1<sup>st</sup> harvest: 30 days; harvesting: cutting of leaves every 3-4 days; yield: 200 kg/ha.

#### **Edible Parts**

Young leaves are eaten raw with rice or stir-fried in sesame oil as a side dish, mixed in salad, stir-fried, deep-fried, pickled, or used as a wrapping or garnish for meat, fish, tofu, soup, deep-fried (tempura), etc.

#### **Health Values**

Beta-carotene: extremely high; vitamin E: medium; riboflavin: medium; folic acid: high; ascorbic acid: high; calcium: medium; iron: medium; protein: 3.5%. Leaves contain antioxidative phenolic compounds and sitosterol, and luteolin that has anti-inflammatory and antibacterial activities.



# Vietnamese coriander

#### Polygonaceae

#### **Common Names**

Vietnamese coriander, Vietnamese cilantro, Cambodian mint (En); coriandre du Vietnam, persicaire du Vietnam, renouée odorante (Fr); culatro de Vietnam (Sp); rau răm (Vn); 香蓼 (Cn)

#### Plant Distribution

Southeast Asia

#### **Botanical Features**

Perennial herb, 60-90 cm tall; stems green with tinges of red, segmented; leaves alternate, simple, entire, lanceolate, upper side dark green with red-green crescent marks, underside burgundy red, stipular sheaths well developed; flowers tiny, pink; fruit (achenes) small.

#### Leaves



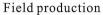
Light requirement: full sun, partial sun; temperature requirement: warm; preferred soil type: well-drained moist sandy loam; tolerance: partial shade, flooding; sensitivity: frost, heat; may be invasive.

Flowers



#### **Production Methods**

System: gathering wild, home gardening, container planting; planting material: stem cuttings; planting method: transplanting; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: creeping, cut back to the ground when leaves become tough to produce more fresh young leaves; planting to 1<sup>st</sup> harvest: 50 days; harvesting: repeated cutting of tender shoots; yield: 5 t/ha.





Strongly flavored seedlings, leaves and stems are eaten fresh in salads in moderation, or chopped to garnish soup and other dishes.

#### **Health Values**

Beta-carotene: extremely high; vitamin E: high; folic acid: medium; ascorbic acid: extremely high; calcium: extremely high; iron: high; protein: 5.8%. Edible parts contain long-chain aldehydes and sesquiterpenes, possess antimutagenic and anti-inflammatory activities, and have antioxidative activities that contribute to gastroprotective effect.





## **Purslane**

#### Portulaca oleracea

#### **Portulacaceae**

#### **Common Names**

Purslane, garden purslane, pigweed, pusley (En); pourpier, pourpier potager (Fr); verdolaga, buglosa, porcelana, hierba grasa (Sp); 馬齒莧 (Cn)

#### Plant Distribution

Throughout tropical regions

#### **Botanical Features**

Succulent, branched, erect or prostrate annual herb, forming mats; stems up to 50 cm long, thick and soft, hairless, green to reddish or brownish; leaves alternate, opposite or in whorls, spatulate to obovate, 0.5-3.3 x 0.2-1.5 cm, puckered, thick, soft and smooth, green with purplish green underside; inflorescences sessile, clustered at the apex of stems, up to 8-flowered; flowers bisexual, regular, bright yellow, white and pink; fruit (capsules) cone-shaped, 4-7 mm, many-seeded; seeds 0.6-1.0 mm, black, kidney-shaped; epigeal germination.





Light requirement: full sun; photoperiod: short-day, day-neutral, long-day; temperature requirement: hot; preferred soil type: sand, sandy loam; optimum soil pH: 5.5-7.0; tolerance: drought, salinity, flooding; sensitivity: frost.

Leaves



#### **Production Methods**

System: gathering wild, home gardening; planting material: seeds, 10-cm vine cuttings; planting method: direct broadcast and cover lightly with compost; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: creeping on ground; planting to 1<sup>st</sup> harvest: 20-30 days; harvesting: once-over (uproot), repeated cuttings at 2-3 week intervals; yield: 20 t/ha.

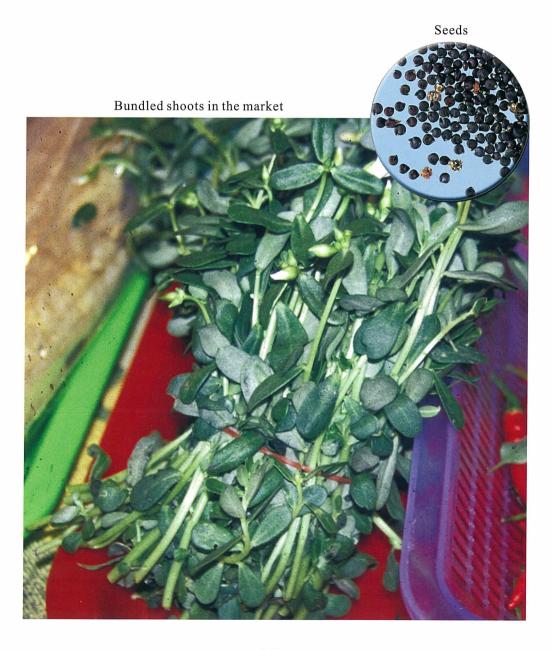
Different flower colors



Tender shoots with pleasant acidic flavor are used fresh in salad, blanched, pickled, or sun-dried.

#### **Health Values**

Beta-carotene: medium; vitamin E: low; riboflavin: low; folic acid: low; ascorbic acid: medium; calcium: low; iron: high; protein: 1.3%. Edible portions contain coumarins, flavonoids, and oxalic acid (ca.1%). Purslane contains omega-3 fatty acids that are available to the human diet mainly through animal sources such as fish; it may have a protective effect against cardiovascular disease.



## Radish

#### Raphanus sativus

#### **Brassicaceae**

#### **Common Names**

Radish, Chinese radish, Japanese radish, mooli (En); radis, petit rave, navet chinois (Fr); daikon (Jp); rábano, rabanillo, rabanito (Sp); 蘿蔔, 葉用蘿蔔 (Cn)

#### **Plant Distribution**

East and Southeast Asia

#### **Botanical Features**

Erect, annual herb up to 100 cm tall; roots much swollen, variable in size, form, weight and color; leaves alternate, hairless to sparingly bristly hairs, lower leaves in a radical rosette; stipules absent; petiole 3-5.5 cm long; blade oblong to pinnatifid, yoked in 3-5 pairs with a round or ovate terminal lobe, 5-30 cm long; higher leaves much smaller, shortly petioled, lanceolate-spatulate, more or less dentate; inflorescences terminal, erect, long, many-flowered raceme; flowers bisexual, 4-merous, 1.5 cm across, fragrant, white to lilac; fruit (siliques) cylindrical, up to 10-50 x 1.5 cm, divided into 2-12 one-seeded compartments, with a long, seedless beak; seeds egg-shaped to globular, 3 mm across, yellowish.





Light requirement: full sun, partial sun; photoperiod: long-day; temperature requirement: cool-warm; preferred soil type: well-drained sandy loam to clayey loam; optimum soil pH: 5.8-7.0; tolerance: brief drought; sensitivity: continuous cropping, heat.



Inflorescence and flowers



#### **Production Methods**

System: monocropping; planting material: seeds; planting method: direct broadcast; irrigation: frequent; priority fertilizer: organic matter, nitrogen; crop management: free standing; planting to 1<sup>st</sup> harvest: 20-30 days for leaves; harvesting: once-over; yield: 12-25 t/ha of leaves.

Developing fruit (siliques)



Mature pods



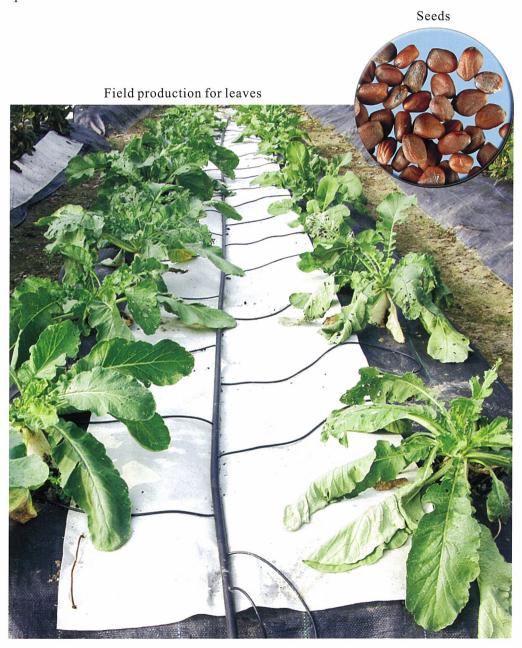
Bundled leaves in the market



Apart from common use of fleshy root, seedlings, leaves or young pods (siliques) are eaten raw in salad, boiled or stir-fried.

#### **Health Values**

Beta-carotene: high in leaves; vitamin E: medium; riboflavin: medium; folic acid: high; ascorbic acid: extremely high; calcium: medium; iron: medium; protein: 2-4%. Leaves also show antioxidative activities comparable with alpha-tocopherol and quercetin.





## Garden sorrel

#### Rumex acetosa

#### Polygonaceae

#### **Common Names**

Garden sorrel, broad-leaf sorrel, sour dock (En); oseille commune, grande oseille (Fr); acedera, acedilla, vinagrera (Sp); 酸模 (Cn)

#### Plant Distribution

Europe

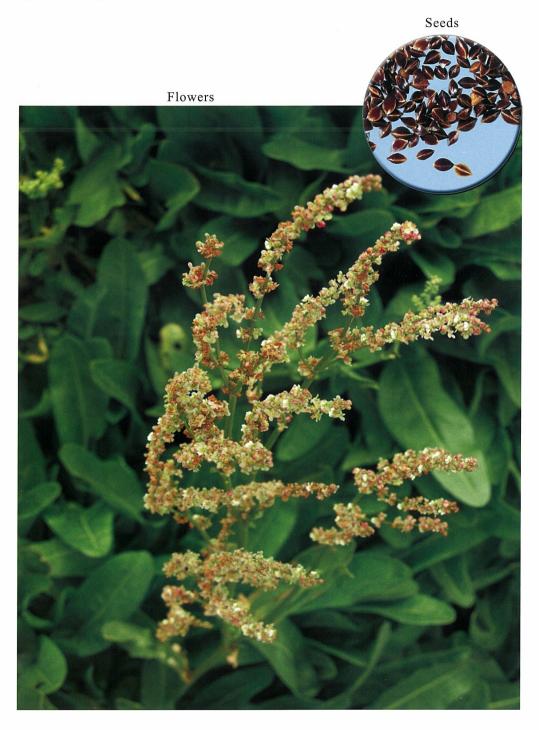
#### **Botanical Features**

Perennial herb, up to 60 cm tall; stems slender, juicy; roots run deeply into the ground; leaves oblong or oblong-elliptic; lower ones 7-15 cm in length, slightly arrow-shaped at the base, with long petioles; upper ones sessile, crimson; spikes leafless, 15 cm long; flowers unisexual, reddish-green to purplish in whorls; seeds brown, shining.





Light requirement: full sun, partial sun; photoperiod: long-day; temperature requirement: warm; preferred soil type: well-drained fertile and moist sandy loam; optimum soil pH: 5.0-7.0; tolerance: shade, acid soil; sensitivity: frost, heat.



System: gathering wild, home gardens; planting material: seeds, rootstocks with buds; planting method: seedlings establishment in the shade before transplanting; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: free standing; planting to 1<sup>st</sup> harvest: 60 days; harvesting: repeated pinching or cutting off leaves with a knife until flowering.

Field production



Leaves, known for their acidity, are eaten raw in salad, added to soup, or cooked to season lamb, beef, omelettes, and sauces.

#### **Health Values**

Beta-carotene: medium in leaves; vitamin E: low; folic acid: low; ascorbic acid: high; calcium: medium; iron: low; protein: 1.5%. Leaves contain also oxalic acid (ca. 0.3%) and tannins.

Edible leaves



## Sweet leaf bush

#### Sauropus androgynus

#### Euphorbiaceae

#### Common Names

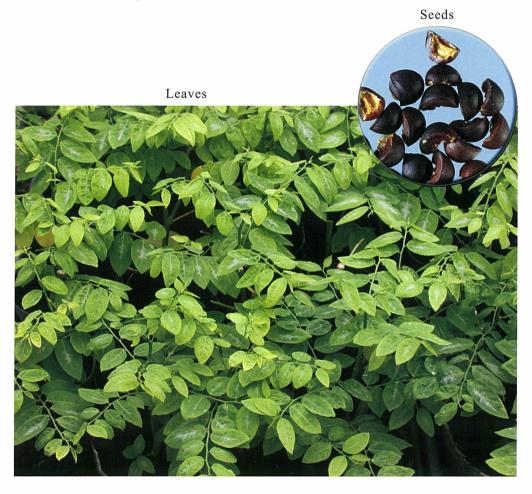
Sweet leaf bush, star gooseberry (En); sauropus (Fr); katuk (Sp); 守宮木 (Cn)

#### Plant Distribution

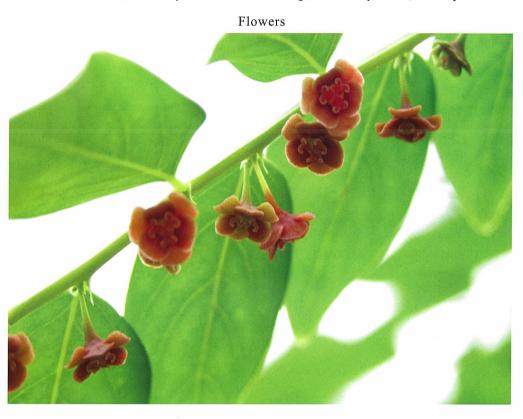
East, Southeast, and South Asia

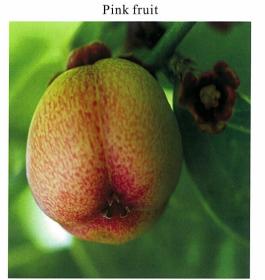
#### **Botanical Features**

Perennial monoecious shrub, up to 3.5 m tall; leaves alternate, oblong to nearly circular, 2-7.5 x 1-3 cm, glaucous, entire; inflorescences in dense axillary, clustered together, first producing 1 to few female, afterwards several male flowers; flowers corolla absent, calyx persistent, dark red or with dark red dots on a yellowish background; fruit (capsules) globular to slightly 6-angular, up to 1.5 cm across, white or slightly flushed with pink or purplish, dehiscing to release 3 seeds; seeds triangular in transverse section, black.



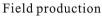
Light requirement: full sun; photoperiod: short-day, day-neutral, long-day; temperature requirement: hot; preferred soil type: clayey loam; optimum soil pH: 6.0-7.0; tolerance: heat, humidity, occasional flooding; sensitivity: frost, salinity.







System: as hedge in home gardens, container planting for saplings; planting material: stem cuttings, seeds with erratic germination; planting method: 20-40 cm cuttings directly planted in the field or rooted in the nursery; irrigation: moderate; priority fertilizer: organic matter, nitrogen; crop management: pruning after establishment to stimulate new shoots and maintain height; planting to 1st harvest: 55-70 days; harvesting: repeated cutting of leaves and young shoots at monthly intervals over several years; yield: 30 kg/day.





Tender leaves, shoot tips, flowers, and immature fruit are eaten boiled, steamed, stir-fried, or in soups. Tender leaves can be added to sandwiches, meat, rice and curries, scrambled eggs, etc. as a garnish.

#### **Health Values**

Beta-carotene: extremely high; vitamin E: extremely high; riboflavin: low; folic acid: high; ascorbic acid: extremely high; calcium: medium; iron: high; protein: 4.8-7.6%. Leaves contain lutein and gallic acid, and exhibit antioxidative activities.

Edible shoots



## Chayote Sechium edule

#### Cucurbitaceae

#### **Common Names**

Chayote, vegetable pear, choyote (En); chou-chou, chouchoutte, christophine, mirliton(Fr); chocho, pipinela, tallote, cidrayota, gayota(Sp); 隼人瓜, 佛手瓜, 龍鬚菜(Cn)

#### **Plant Distribution**

Central America, South and Southeast Asia, tropical Africa

#### **Botanical Features**

Monoecious, perennial herb, sprawling or climbing with large, 2-5-branched tendrils; roots large, tuberous; stems up to 15 m long, grooved; leaves arranged spirally, simple; stipules absent; petiole 3-25 cm long; blade broadly ovate-circular in outline, 7-25 cm in diameter, 3-7-angular or lobed, base deeply cordate, margins obtusely toothed, 5-7-veined from the base; flowers unisexual; male and female flowers 1-2 cm diameter, green to cream, male in axillary racemes, female solitary in axil of same leaf; fruit fleshy, variable in shape but commonly pear-shaped, 7-20 x 10-12 cm, somewhat ribbed, smooth or shortly spiny, dark green to almost white, pulp white or greenish-white, 1-seeded; seeds egg-shaped to elliptic in outline, compressed, 2.5-5 cm long, white.



Light requirement: full sun, partial sun; photoperiod: long-day, day-neutral; temperature requirement: hot; preferred soil type: sandy/clayey loam; optimum soil pH: 5.5-7.5; tolerance: heat; sensitivity: drought, frost.

Male flowers



Female flower



Young fruit

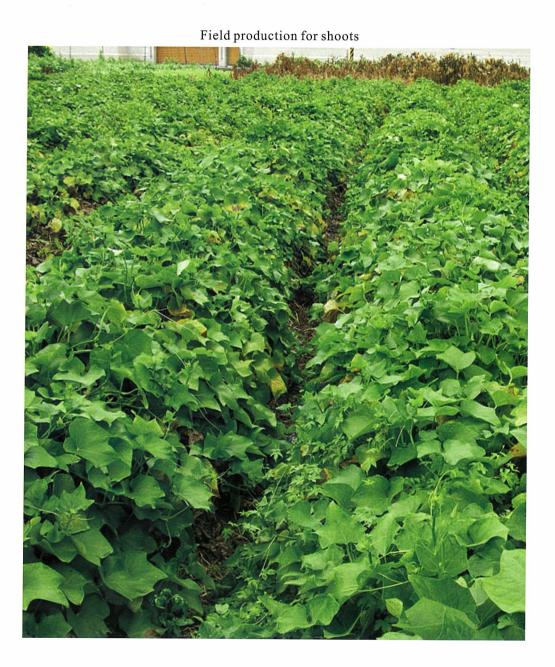


Seeded fruit





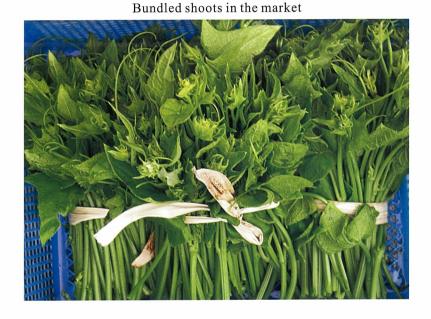
System: home gardening, monocropping; planting material: whole fruit, seeds, cuttings; planting method: large end of fruit pointed down at angle on seeding bed, transplanting one month after; irrigation: frequent; priority fertilizer: organic matter; crop management: staking, training; planting to 1<sup>st</sup> harvest: 50 days for shoots, 75-90 days for fruit; harvesting: every 3 days in summer and 10 days in winter for shoots, 2-4 times per week for fruit; yield: 200-300 kg/ha, harvest every six days (summer), 600 kg/ha, harvest every five days (winter) for shoots, 100 kg of fruit/plant, 20-30 t/ha for fruit.

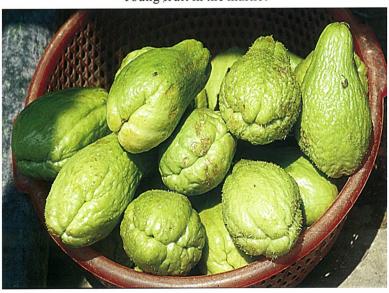


Tender shoots, leaves and tendrils are eaten boiled or stir-fried; immature fruit is eaten raw, steamed, stir-fried, boiled, baked, pickled, or curried.

#### **Health Values**

Beta-carotene: low in shoots and fruit; vitamin E: low in fruit; riboflavin: medium in shoots; folic acid: medium in fruit; ascorbic acid: medium in shoots and fruit; calcium: low in shoots and fruit; iron: medium in shoots, low in fruit; protein: 4.0% in shoots, 0.5% in fruit. Leaves contain also flavonoids.





Young fruit in the market

## Coffee senna

#### Senna occidentalis

**Fabaceae** 

#### **Common Names**

Coffee senna, antbush, septicweed (En); bentamare, café batard, casse-puante (Fr); bricho, brusca, frijolillo, guanine, hedionda (Sp); 望江南, 石決明 (Cn)

#### Plant Distribution

Throughout the tropics and warm temperate regions

#### **Botanical Features**

Erect annual herb up to 2 m tall; leaves leathery compounded; leaflets 4-6 pairs, 2-10 x 2-4 cm, stipules, gland near base; inflorescences racemose; flowers in axils, yellow; pods dark brown, curve slightly upward, 0.1 x 8-12 cm, 20-30 seeds; seeds dull brown, flattened on both ends, 4-5 mm long.





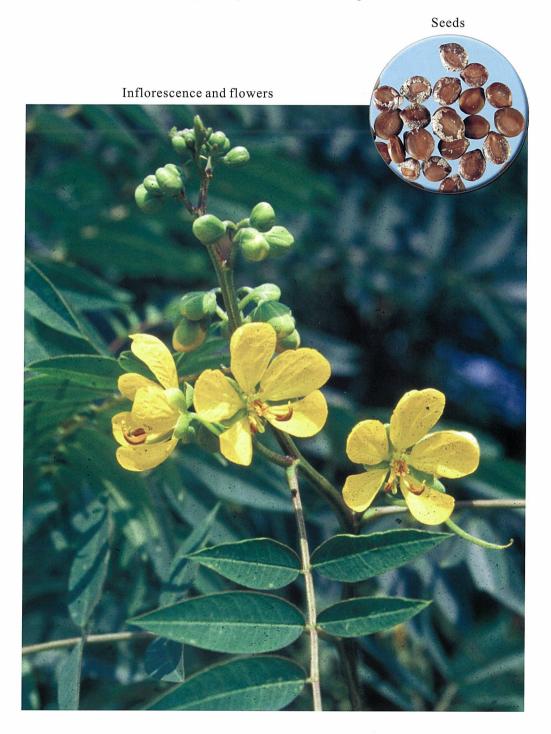
Light requirement: full sun; photoperiod: short-day; temperature requirement: hot; preferred soil type: clayey loam; optimum soil pH: 5.0-7.0.







System: home gardening; planting material: seeds after breaking or scratching the seed coat; planting method: transplanting; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: free standing.



Tender leaves, flowers, and green pods are eaten boiled or steamed.

#### **Health Values**

Beta-carotene: high in leaves; vitamin E: medium; riboflavin: high; ascorbic acid: extremely high; calcium: medium; iron: medium; protein: 5.2%. Leaves contain also aromatic, yellow anthraquinones that tend to have laxative effects.





## Sesbania

#### Sesbania grandiflora

**Fabaceae** 

#### **Common Names**

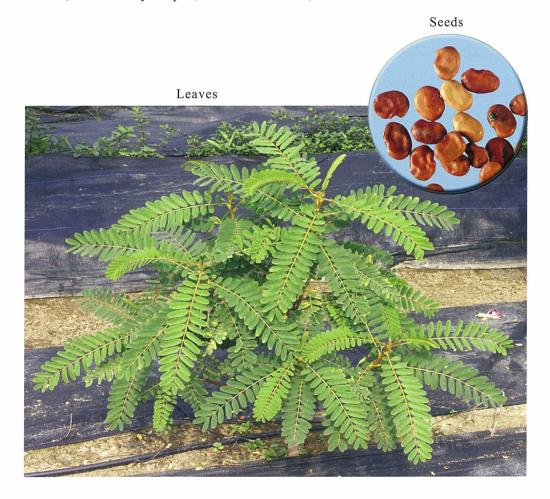
Sesbania, scarlet wisteria, vegetable hummingbird (En); colbri vegetal, fagotier, papillon, pois valette, pois vallier (Fr); baculo, gallito, pico de flamenco, zapaton blanco (Sp); so đũa (Vn); 大花田菁, 木田菁(Cn)

#### Plant Distribution

South and Southeast Asia, Australia, tropical Africa

#### **Botanical Features**

Short-lived, quick-growing, softwood tree, up to 3 m tall; stems 25 cm across, straight, cylindrical, sparsely branched; leaves pinnate, up to 30 cm long; leaflets oblong, 10-30 pairs, up to 5 cm long; racemes 2.5 cm long; flowers 2-4 together, up to 8 cm long, white to red; pods slender, flat, 20-50 cm long, broad sutures, 15-50 seeded; seeds kidney-shaped, 6.5 x 5 x 2.5-3 mm, dark brown.



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Light requirement: full sun; photoperiod: short-day; temperature requirement: hot; preferred soil type: loam, clay; optimum soil pH: 6.6-8.5; tolerance: acid soil, drought, flooding; sensitivity: frost, wind.





Red flowers





System: companion cropping with other annual crops, intercropping with other trees, container planting for saplings; planting material: seeds, cuttings; planting method: seeds after breaking or scratching the seed coat; irrigation: meager; priority fertilizer: none; crop management: regular pruning when trees reach 1.5 m; planting to 1<sup>st</sup> harvest: 9 months (flower buds); harvesting: repeated cutting of both leaves and flower buds, for flower buds every 2 days; yield: 50 t/ha for leaves, 65 t/ha for flower buds.



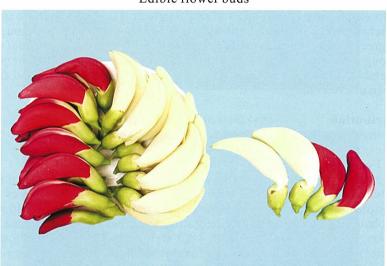
Field production



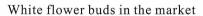
Flowers with pistils removed (to reduce bitterness) are eaten raw in salads, boiled, deep-fried, or used in curries, soups, and stews. Young leaves and shoots are eaten in salad, stews, or as potherbs. Young pods are eaten boiled and sautéed.

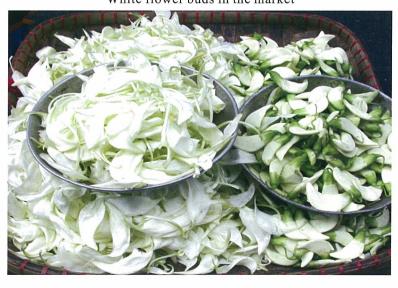
#### **Health Values**

Beta-carotene: extremely high in leaves, low in flower buds; vitamin E: high in leaves, low in flower buds; riboflavin: low in leaves and flower buds; folic acid: low in flower buds; ascorbic acid: extremely high in leaves, high in flower buds; calcium: extremely high in leaves, low in flower buds; iron: high in leaves, low in flower buds; protein: 8.0% in leaves, 1.5% in flower buds. Leaves have anxiolytic and anticonvulsive activities.



Edible flower buds





# African eggplant Solanum aethiopicum

#### Solanaceae

#### Common Names

African eggplant, scarlet eggplant, bitter tomato (En); aubergine africaine, aubergine écarlate, tomate amère, djakattou (Fr); nakati etíope, berenjena escarlata (Sp); 非洲紅茄 (Cn)

#### **Related Species**

Closely related species is S. macrocarpon. Based on their usage, S. aethiopicum is classified in three groups. The Gilo group has edible fruit of many shapes (depressed spherical to elliptic in outline) and sizes (2-8 cm across). The Shum group is a short much-branched plant with small hairless leaves and shoots that are plucked frequently as a leafy green. However, the small (1.5 cm across) very bitter fruit is not eaten. The Kumba group has a stout main stem with large hairless leaves that can be picked as a green vegetable, and later produces very large (5-10 cm across) grooved fruit that is picked green or even red.

#### Plant Distribution

Sub-Saharan Africa, South America

#### **Botanical Features**

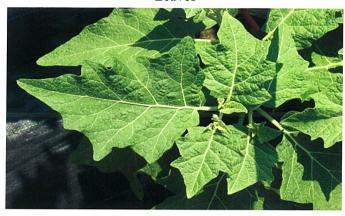
Perennial or annual deciduous shrub with or without prickles, up to 2 m tall; stems much-branched; roots extending both vertically and laterally; leaves alternate, simple, petiole up to 11 cm long, ovate-elliptic with an acute apex, 12-30 x 4-21 cm, entire or lobate-dentate, pinnately veined; inflorescences lateral racemose cymes, up to 12 flowers; flowers bisexual, regular, 4-10-merous; pedicel 2-15 mm long, yellow; fruit (berries) globular to depressed globular, elliptic in outline, egg-shaped or spindle-shaped, 1-6 cm long, smooth to grooved, red or orange, many-seeded; seeds lense-shaped to kidney-shaped, flattened, 2-5 mm across, pale brown or yellow; epigeal germination.





Light requirement: full sun; photoperiod: day-neutral; temperature requirement: hot; preferred soil type: sandy loam; optimum soil pH: 5.5-6.8; tolerance: drought; sensitivity: frost.





Flowers on purple stem type

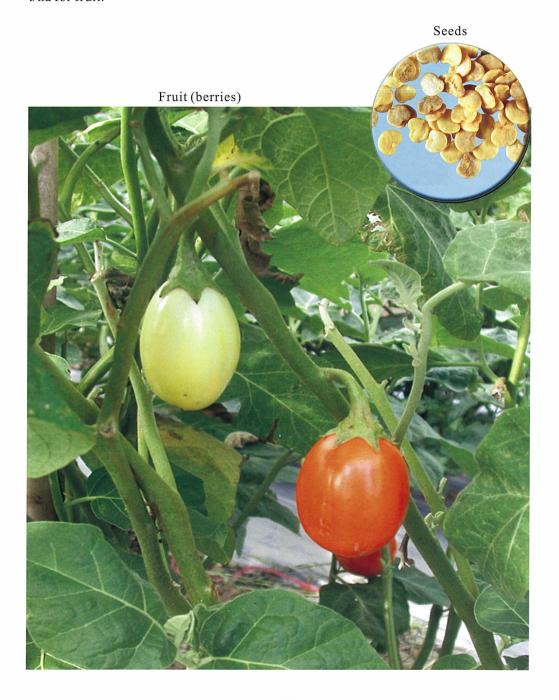


Flowers on green stem type





System: monocropping; planting material: seeds; planting method: direct sowing; irrigation: frequent during fruiting stage; priority fertilizer: organic matter, complete fertilizers; crop management: staking; planting to 1<sup>st</sup> harvest: 45-60 days for leaves, 100-120 days for fruit; harvesting: repeated picking of leaves about 10 cm above the ground, repeated cutting before fruit skin becomes tough; yield: 40 t/ha for leaves, 25 t/ha for fruit.



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Orange-red fruit is eaten boiled, steamed, pickled, or in stews with other vegetables or meats. Young leaves are cut and used in soups.

#### **Health Values**

Beta-carotene: extremely high in leaves, low in fruit; vitamin E: low in fruit; riboflavin: low in leaves and fruit; folic acid: low in fruit; ascorbic acid: high in leaves, low in fruit; calcium: extremely high in leaves, low in fruit; iron: high in leaves, low in fruit; protein: 4.8% in leaves, 1.0% in fruit. Leaves contain also alkaloids, which possess anti-inflammatory and immunosuppressive properties, and oxalic acid. The bitter taste in leaves is attributed to furostanol glycosides (saponins).



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## African nightshade

#### Solanum scabrum

Solanaceae

#### **Common Names**

African nightshade, black nightshade, garden huckleberry (En); morelle de Guinée, brède martin, crève-chien, morelle noire (Fr); hierba mora, llague, pintamora, tomatitos (Sp); 木龍葵 (Cn)

#### **Related Species**

S. nigrum, S. aethiopicum Shum group

#### Plant Distribution

East, South and Southeast Asia, tropical Africa, South Pacific, North America, the Caribbean

#### **Botanical Features**

Prostrate or erect annual herb, up to 1 m tall, leaves ovate to ovate-lanceolate, mostly 8-15 cm long, entire or angularly lobed, undulate, glossy above; petiole up to 3 cm long; inflorescences axillary, shorter than leaves, several-flowered; flowers white or yellowish, 0.7 cm across; berries purple black, 0.6 cm across, juicy, many-seeded; seeds flat, 1.5 x 1 mm.





Light requirement: full sun, partial sun; photoperiod: day-neutral; temperature requirement: hot; preferred soil type: sandy loams to friable clay; optimum soil pH: 6.0-6.5; sensitivity: drought, frost.

Flowers





System: home gardening, monocropping; planting material: seeds, less common 20-30 cm cuttings; planting method: direct sowing in field or nursery, transplanting 4-6 weeks later; irrigation: frequent after transplanting and fruiting stage; priority fertilizer: organic matter, nitrogen; crop management: side dressing at fruiting stage; planting to 1<sup>st</sup> harvest: 40-60 days; harvesting: repeated cutting of leaves and shoots 15 cm from the ground at 7-14 day intervals; yield: 10-30 t/ha.





Mature fruit (berries)



Young shoots and leaves are blanched, boiled or stir-fried, cooked with other vegetables or added to soups. Berries are bitter in taste and usually not eaten.

#### **Health Values**

Beta-carotene: extremely high in leaves; vitamin E: medium; folic acid: medium to high; ascorbic acid: high to extremely high; calcium: medium; iron: medium; protein: 2.0-4.0%. Leaves contain also some alkaloids.



## Chickenspike

### Sphenoclea zeylanica

#### **Sphenocleaceae**

#### **Common Names**

Chickenspike, gooseweed, wedgewort (En); herbes aux oies (Fr); desconocido (Sp); 尖瓣花(Cn)

#### Plant Distribution

Tropical Africa, Southeast Asia

#### **Botanical Features**

Annual marsh herb; stems, erect with aerenchymatous tissue at the base, much branched up to 80 cm tall; leaves, simple, spiral, elliptic-lanceolate, entire; petioles up to 3 cm long; inflorescences terminal, dense spike, green, cylindrical, up to 7.5 cm long, narrowed at apex; peduncle up to 8 cm long; flowers densely crowded, rhomboid or hexagonal by compression, sessile, wedge-shaped below, attached longitudinally to the main inflorescence stalk by a linear base, white; fruit (capsules) flattened globular, 4-5 mm across; seeds yellowish-brown, 0.5 mm long.





Light requirement: full sun; temperature requirement: hot; preferred soil type: clay; tolerance: heavy rain; sensitivity: wind; may be invasive in wetland.

Leaves





System: gardening in ponds, hydroponics; planting material: seeds; planting method: direct sowing or transplanting to paddy; irrigation: wet soil; priority fertilizer: nitrogen; crop management: free standing, side dressing weekly during peak growth; planting to 1<sup>st</sup> harvest: 30 days; harvesting: once-over uprooting of plants at 20-25 cm height.



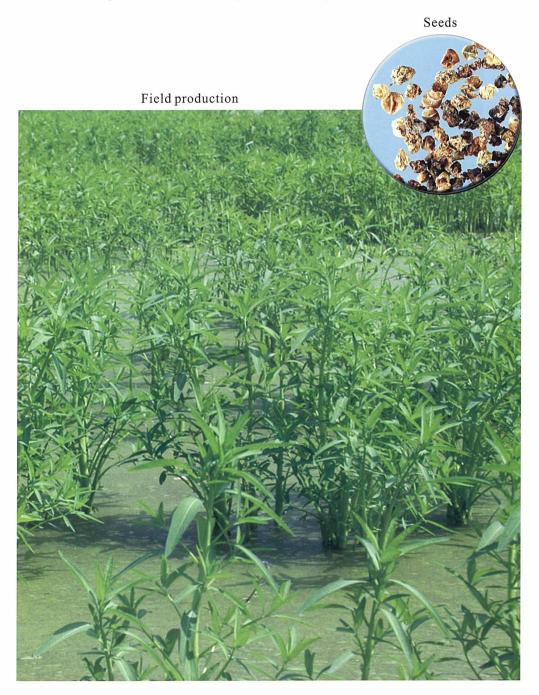


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Leaves and tender shoots are eaten steamed, boiled, or mixed with grated coconut.

#### **Health Values**

Beta-carotene: extremely high in edible parts; ascorbic acid: extremely high; calcium: low; iron: low; protein: 2.7%. Edible portions contain some phytic acid.





## **Dandelion**

#### Taraxacum officinale

**Asteraceae** 

#### **Common Names**

Dandelion, dandelion greens (En); dente de lion, pissenlit vulgaire (Fr); achicoria amarga, amargón, diente de león (Sp); 蒲公英 (Cn)

#### Related species

T. formosana

#### Plant Distribution

Widespread in temperate Asia, Europe, and North America

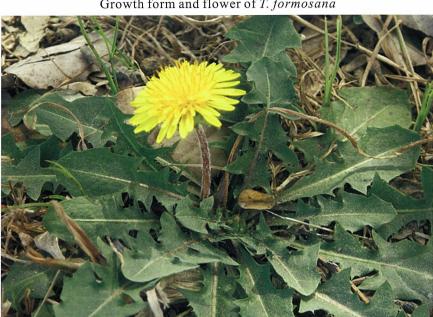
#### **Botanical Features**

Biennial or perennial herb, containing white milky juice; stems short and narrow; leaves oblong, spatulate or oblanceolate, 5-40 x 1-10 cm, nearly entire to pinnately lobed, stalkless, midrib hollow and winged at the base; inflorescence heads 4.5 cm across, on scapes to 30 cm high, outer involucral bracts bent sharply downward; flowers deep yellow; fruit (achenes) beaked, gray-brown to olive-brown; epigeal germination.





Light requirement: full sun; photoperiod: long-day; temperature requirement: warm; preferred soil type: loam, sand; optimum soil pH: 5.5-6.5; tolerance: frost, dry to wet; sensitivity: heat, high rainfall; invasive.



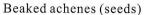
Growth form and flower of *T. formosana* 







System: gathering wild, home gardens; planting material: seeds, cuttings; planting method: direct sowing or planting; irrigation: moderate; priority fertilizer: nitrogen, organic matter; crop management: tying or shading for pale leaves; harvesting: 30-40 days; yield: 5 t/ha.





Edible young leaves

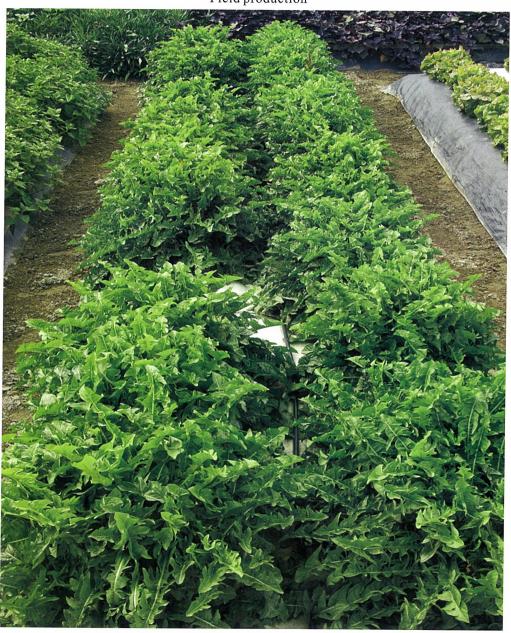


Young leaves are eaten in salad, boiled, steamed, sautéed, added to soups, etc.

#### **Health Values**

Beta-carotene: high in young leaves; vitamin E: medium; riboflavin: medium; folic acid: low; ascorbic acid: medium; calcium: medium; iron: medium; protein: 2.1%. Leaves contain also chicoric acid, luteolin, monocaffeyltartaric acid, and phenylpropanoids.

Field production





## Fragrant telosma

#### Telosma cordata

#### **Asclepiadaceae**

#### Common Names

Fragrant telosma, Tonkin creeper, Pakalana vine (En); parfum nocturne (Fr); fragancia nocturna (Sp); hoa thiên lý (Vn); 夜香花, 香花菜 (Cn)

#### Plant Distribution

Southeast, East and South Asia, Europe, North and South America

#### **Botanical Features**

Woody vine, 3-6 m tall; stems yellowish green, hairy to nearly hairless; leaves opposite, blade ovate, 4-12 x 3-10 cm, base deeply cordate, with petioles 2-5 cm long; cymes with 15-30 flowers and 0.5-1.5 cm peduncles; flowers very fragrant that yield perfumed oil; sepals oblong-lanceolate; corolla yellowish green, tube 6-10 x 4-6 mm; pods 10-15 cm long; seeds broadly ovate, ca 1 x 1 cm, flat, apex slanting, margin membranous.





Light requirement: full sun, partial sun; photoperiod: long-day; temperature requirement: warm; preferred soil type: well-drained sandy loam; optimum soil pH: 6.1-7.5; tolerance: drought, infertile soil; sensitivity: flooding, cold.

Inflorescence (early stage)



Inflorescence (ready for harvesting)



### **Production Methods**

System: as hedge in home gardens; planting material: cuttings; planting method: direct planting of cuttings; irrigation: moderate; priority fertilizer: potassium, organic matter; crop management: staking, trellis; planting to 1<sup>st</sup> harvest: 150-180 days; harvesting: daily pinching of inflorescences with 50% of flower buds ready to open; yield: 15-25 t/ha.

Open flower



Field production



### **Edible Parts**

Flower buds are consumed stir-fried or boiled.

### **Health Values**

Beta-carotene: low in flower buds; vitamin E: medium; folic acid: medium; ascorbic acid: high; calcium: low; iron: low; protein: 3.1%. Geraniol, beta-ionone, dihydro-beta-ionol, and cis- and trans-theaspirane are the ingredients for the characteristic scent of the flower. They are used in cooking and medicinally to treat conjunctivitis (pinkeye).

Packing for marketing



# New Zealand spinach

### Tetragonia tetragonioides

**Aizoaceae** 

### **Common Names**

New Zealand spinach, warrigal cabbage (En); tétragone cornue, épinard de Nouvelle-Zélande, épinard d'été (Fr); Nieuw zeelandse spinazie (Sp); 番杏 (Cn)

### **Plant Distribution**

Australia, New Zealand, South America, Southeast and East Asia

### **Botanical Features**

Annual herb, covered with minute, shining, white papillae; stems soft, prostrating, sprawling, curing upward at the ends to 60 cm high; leaves spirally arranged, succulent, ovate to triangular, entire to undulate, petioled; flowers 1-2 together sessile, 0.5 cm across, yellowish; fruit 1 cm long, 2-4 horns, 4-10 seeded; seeds kidney-shaped.





### **Environmental Factors**

Light requirement: full sun; photoperiod: long-day, day-neutral; temperature requirement: warm; preferred soil type: loamy sand; optimum soil pH: 6.5-7.0; tolerance: drought, heat; sensitivity: frost.

Flower

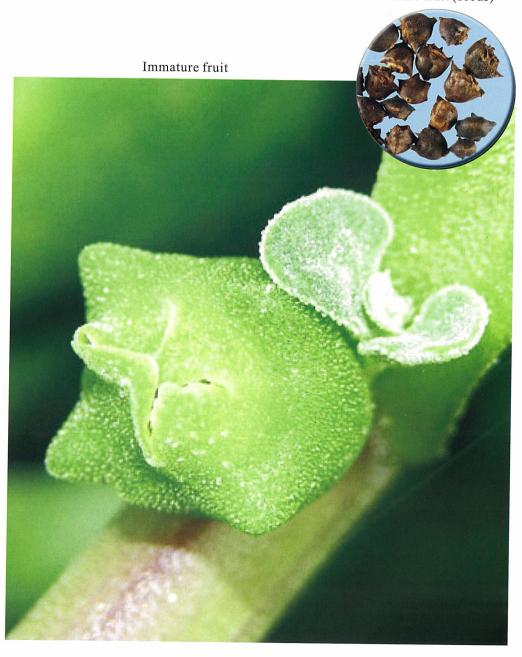




### **Production Methods**

System: home gardening; planting material: seeds, fruit, cuttings; planting method: soak seeds or fruit before planting in nursery, transplanting when seedlings have 6-7 leaves; irrigation: meager; priority fertilizer: organic matter, nitrogen; crop management: light shade for good-tasting leaves; planting to 1<sup>st</sup> harvest: 45-60 days; harvesting: repeated removal of young shoots and leaves at 1-2 week intervals; yield: 30 t/ha.

Mature fruit (seeds)

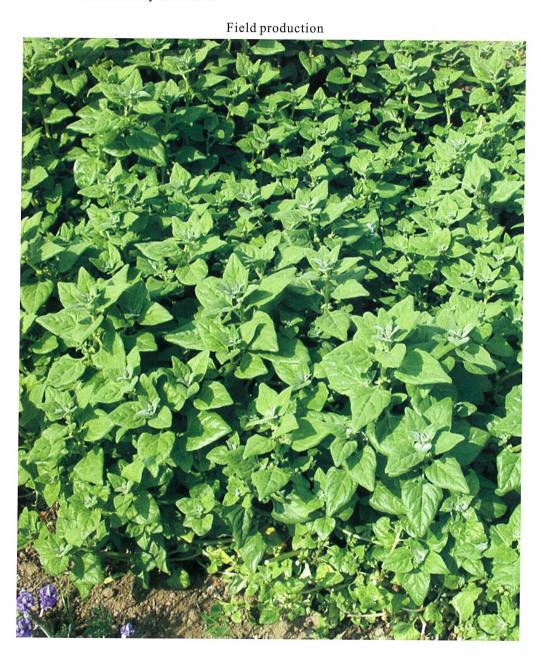


### **Edible Parts**

Young succulent leaves and tender shoots are eaten raw, steamed, boiled, stir-fried, served with mushrooms, etc.

### Health Values

Beta-carotene: medium in tender shoots; vitamin E: medium; riboflavin: low; folic acid: low; ascorbic acid: medium; calcium: low; iron: low; protein: 1.5%. Edible portions contain also phenylpropanoids and oxalic acid, and have anti-ulcerogenic and anti-inflammatory activities.





# Chinese toon

### Toona sinensis

Meliaceae

### **Common Names**

Chinese toon, Chinese cedar, red toon (En); cédréla (Fr); cedro de China (Sp); 香椿 (Cn)

### Related Types

Chinese toon is divided into 2 types: the green type with upright plants, bark green gray, and young shoots less aromatic; and the purple type, with branches stretching out, bark gray brown, and young shoots strongly aromatic.

### Plant Distribution

East, South, and Southeast Asia

### **Botanical Features**

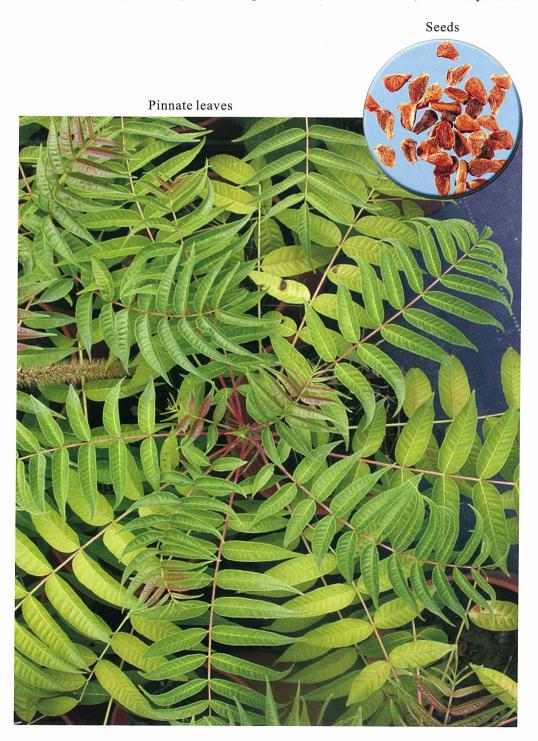
Perennial deciduous tree, up to 8 m tall, bark shaggy; stems up to 30 cm in diameter; pinnate leaves alternate, up to 20-40 cm long; leaflets 10-20, oblong or oblong-lanceolate, serrate or entire, hairy beneath; inflorescences in panicles 20-30 cm long at the end of branches; flowers white, needle-shaped; fruit (capsules) 3 cm long; seeds flat, winged in upper part.



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### **Environmental Factors**

Light requirement: full sun; temperature requirement: cool-warm; preferred soil type: well-drained sandy loam; optimum soil pH: 5.5-8.0; tolerance: cold; sensitivity: frost.





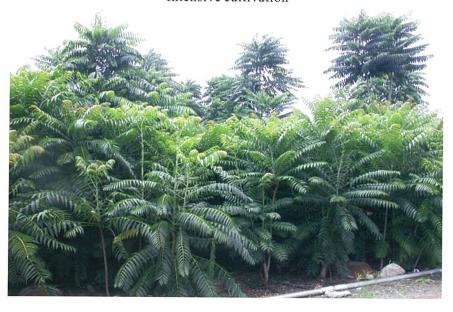
### **Production Methods**

System: tree nursery, home gardens, high-density cultivation in greenhouse; planting material: seeds, 5-cm root cuttings; planting method: sow soaked seeds or plant cuttings into pots, later transplanting to the field; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: branches shortened to maintain shrub shape and to concentrate sprouting buds, blanching nurseries; planting to 1st harvest: 1 year; harvesting: repeated cutting of young 20-cm shoots; yield: 0.5 kg/plant/year or 5 t/plant/year.

### Intercropping with basil



Intensive cultivation

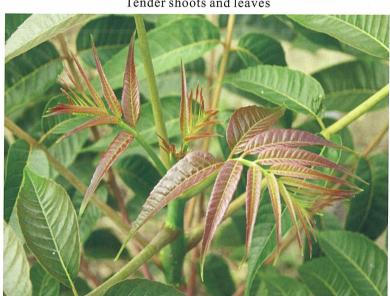


### **Edible Parts**

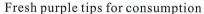
Fragrant tender shoots and young leaves are eaten in salad, stir-fried with egg, pickled, or roasted and dried as tea.

### Health Values

Beta-carotene: medium to high in tender shoots; vitamin E: extremely high; riboflavin: low; folic acid: low; ascorbic acid: high to extremely high; calcium: high; iron: high; protein: 6.3-9.8%. Leaves and shoots contain also gallic acid, gallotannins, and flavonoids.



Tender shoots and leaves





# Sweet bitterleaf Vernonia hymenolepis

**Asteraceae** 

### **Common Names**

Sweet bitterleaf, bitterleaf (En); vernonie douce, vernonie, ndole (Fr); vernonia (Sp); 鱗斑鳩菊 (Cn)

### Plant Distribution

Sub-Saharan Africa

### **Botanical Features**

Perennial shrub up to 2 m tall; young branches with dense soft hairs; leaves alternate, simple, sessile; blade elliptical to lanceolate, 5.5 x 9.5 cm, wedge-shaped to long-attenuate and sometimes auriculate at base, acuminate at apex, margin minutely to coarsely toothed, hairy below, pinnately veined; inflorescence umbel-like cymes; involucre egg-shaped to hemispherical, 1.5-4 cm long, bracts 2-6-seriate, up to 3.5 cm long, with green or white appendages; flowers bisexual, tubular, 1-2 cm long, whitish to purple, glandular, with short, erect lobes; ribbed achenes 3-6.5 mm long, hairless to slightly hairy, dark brown, crowned by long, fine bristles that easily fall off; epigeal germination.





### **Environmental Factors**

Light requirement: full sun; photoperiod: short-day; temperature requirement: warm; soils: sandy, loamy, clayey; sensitivity: drought; allelopathic.



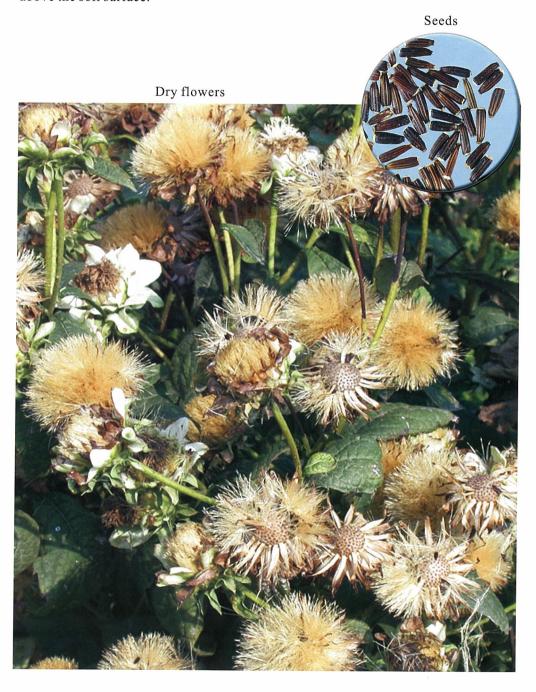


Flowers



### **Production Methods**

System: home gardening, intercropping, monocropping; planting material: seeds, stem cuttings with four buds; planting method: direct on raised beds, transplanting, ratoon; irrigation: frequent; priority fertilizer: nitrogen, organic matter; crop management: free standing, mulching occasionally; planting to 1<sup>st</sup> harvest: 30-55 days; harvesting: repeated cutting of young shoots or gathering leaves at 5-10 cm above the soil surface.

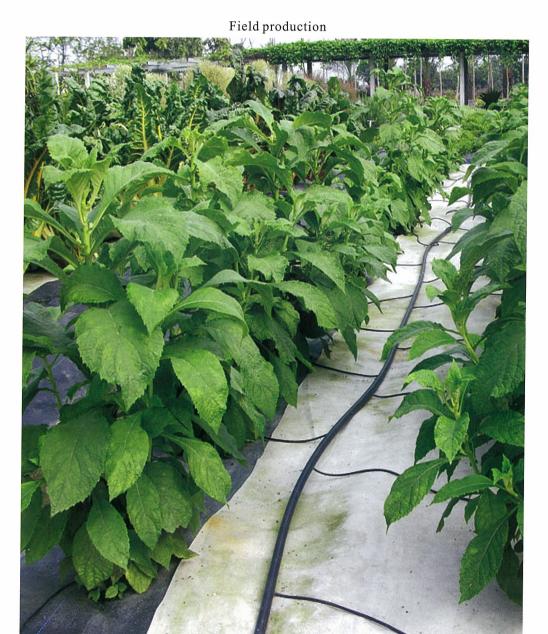


### **Edible Parts**

Tender leafy shoots are eaten boiled or in soup, or finely cut and dried to garnish other dishes.

### **Health Values**

Beta-carotene: high in leaves; vitamin E: medium; folic acid: medium; ascorbic acid: high; calcium: medium; iron: high; protein: 3.8%. Leaves contain sesquiterpene lactones and steroid glucosides that show antiparasitic and platelet anti-aggregating properties.



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# Cowpea

### Vigna unguiculata

**Fabaceae** 

### **Common Names**

Cowpea, blackeyed pea, yardlong bean, asparagus bean (En); niébé, haricot à l'œil noir, pois yeux noirs, haricot dolique, dolique asperge (Fr); frijol de costa, caupies, rabiza (Sp); 豇豆, 葉用豇豆 (Cn)

### Plant Distribution

Sub-Saharan Africa, East, South, and Southeast Asia

### **Botanical Features**

Herbaceous annual; angular stems erect or climbing, up to 4 m long; trifoliate leaves alternate with stipules at the base; leaflets ovate to lanceolate, 6-16 x 4-12 cm; inflorescences racemose with peduncles, up to 35 cm long; bisexual flowers 2-3 cm in diameter, white, yellow, or purple; pods pendant, linear-cylindrical, 10-120 cm long, 10-30 seeds; seeds 5-12 mm, brown to white, solid, speckled; epigeal germination.





### **Environmental Factors**

Light requirement: full sun; photoperiod: short-day, day-neutral; temperature requirement: hot; preferred soil type: well-drained sandy/clayey loam, clay; optimum soil pH: 5.5-7.5; tolerance: drought; sensitivity: frost, salinity, flooding.

Flower



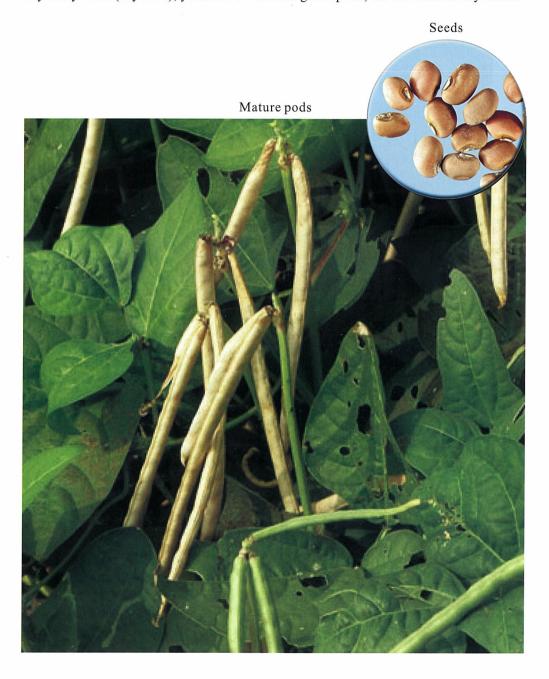
Young pods





### **Production Methods**

System: intercropping, relay cropping, monocropping; planting material: seeds; planting method: direct on well-manured raised bed; irrigation: frequent; priority fertilizer: phosphorus; crop management: free standing, staking; planting to 1<sup>st</sup> harvest: 30 days for leaves, 40-50 days for immature pods, 55-70 days for dry seeds; harvesting: repeated cutting 10 cm above ground (leaves), repeated picking when the outline of the seeds visible (green pod), once-over when at least two-thirds of pods dry and yellow (dry seed); yield: 15-30 t/ha for green pods, 0.5-3.0 t/ha for dry seeds.

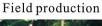


### **Edible Parts**

Leaves are used boiled or stir-fried; green pods used fresh, steamed, stir-fried or sautéed; dry seeds used in soups, stews, purees, ground into flour, or fermented.

### **Health Valuess**

Beta-carotene: extremely high in leaves, medium in green pods, low in dry seeds; vitamin E: high in leaves; riboflavin: medium in leaves and dry seeds, low in green pods; folic acid: high in leaves, medium in green pods, extremely high in dry seeds; ascorbic acid: medium in leaves and green pods, low in dry seeds; calcium: high in leaves, low in green pods and dry seeds; iron: low in leaves and green pods, extremely high in dry seeds; protein: 3-4% in leaves and green pods, 24% in dry seeds. Seed protein is relatively rich in lysine, but poor in S-containing amino acids.







# Japanese prickly ash

### Zanthoxylum ailanthoides

Rutaceae

### **Common Names**

Japanese prickly ash (En); cayratia japonica (Fr); ceniza espinosa japonesa (Sp); 食茱萸, 紅刺蔥 (Cn)

### Plant Distribution

East Asia

### **Botanical Features**

Deciduous tree up to 18 m tall with alternative branches; pinnate leaves 30 cm long; leaflets, 11-27, opposite, ovate to lanceolate, 7-18 x 2-6 cm, grayish green or reddish brown when young, oil glands numerous and visible; whole plant covered with sharp and strong thorns; inflorescences terminal, many-flowered; flowers dioecious in cymes to 12 cm, yellowish white; berries pale gray to brownish gray, 4.5 mm across, single seeded, seeds 4 mm across.



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### **Environmental Factors**

Light requirement: full sun, partial sun; photoperiod: long-day; temperature requirement: warm; preferred soil type: sandy, loamy, clayey; optimum soil pH: 5.5-8.5; sensitivity: frost, flooding.





Oil glands and sharp thorns

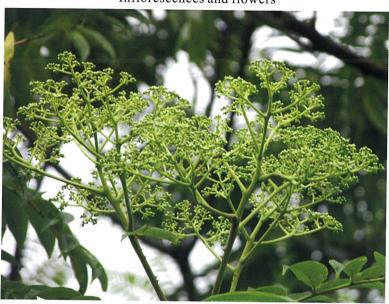




### **Production Methods**

System: tree orchard, container planting for saplings; planting material: seeds, scratching the seed coat or 2-3 months of pretreating with moist cold, seeds soaking for 1-2 days before sowing, 20-cm long stems or stem cuttings, suckers; planting method: direct, transplanting when seedlings are 15 cm tall; irrigation: frequent at seedling stage; crop management: free standing, repeated pruning (harvesting) to maintain at 60-100 cm high; harvesting: repeated.

Inflorescences and flowers



Dry fruit

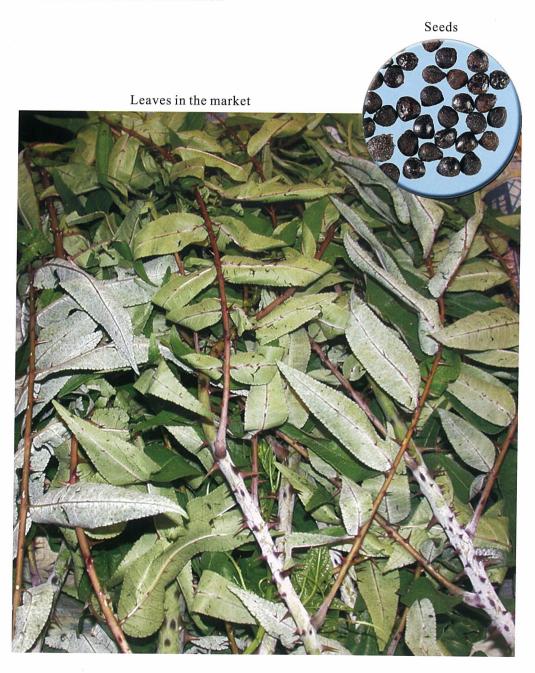


### **Edible Parts**

Young leaves are chopped and eaten raw or cooked to garnish other dishes, or coated in flour and deep-fried. Berries are dried and powdered to garnish other dishes.

### **Health Values**

Beta-carotene: extremely high in young leaves; vitamin E: high; riboflavin: low; folic acid: medium; ascorbic acid: extremely high; calcium: high; iron: medium; protein: 4.9%. Leaves contain ailanthoidol.



# Nature's Palette



Cultivating beauty is universal to all cultures and beneficial to physical and mental health. Indigenous plants add beauty to our lives in many ways, as foliage, flowers, or food. When indigenous vegetables become part of our meals and surroundings, we connect with nature's palette in a healthy and holistic way.

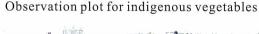
### Indigenous Vegetables Add Color

Pigments, including some vitamins and phytochemicals, have important roles in plant functions. Major plant pigments include: 1) green chlorophylls to trap solar energy for photosynthesis; 2) yellow, orange, or red carotenoids to protect chlorophylls from photo-oxidation, to attract animals and insects to flowers, or to accumulate in storage organs and other plant parts; 3) flavonoids, including red or blue anthocyanins and white or pale yellow quercitin and kaempferol, to attract animal pollinators and seed dispersers; and 4) betalains, including red-violet betacyanin and yellow betaxanthin, to attract animals. These pigments account for the different colors of vegetables, and make foliage, flowers, and fruit appealing to human eyes.

Indigenous vegetables come in a rainbow of colors: deep orange (day lily, spiny bitter gourd, African eggplant), green (kangkong, jute mallow, nightshade, and many other leafy species), purple (perilla, lablab bean, velvet plant), red and pink (amaranth, spiny bitter gourd, Chinese toon, kangkong, Malabar spinach, okra, African eggplant), silvery gray (white mugwort, garden ruta), variegated (sweet potato leaves), yellow-green (sweet potato leaves, fragrant telosma), and white (sesbania, African eggplant). Food plates prepared with nature's palette make our meals appealing to the eye and the palate. In addition, we benefit from the micronutrients, phytochemicals, and fibers each vegetable color group offers.

### Indigenous Vegetables as Ornamental Materials

Colorful foliage, charming flowers, and unique shapes of different plant organs add variety throughout the seasons. A vegetable garden can be a creative as well as a productive endeavor; combining vegetables with flowers in a well-planned design enhances the landscape. AVRDC's indigenous vegetable observation plot has an elegant geometric pattern based on squares and circles.





Indigenous vegetables add interest to floral arrangements. Many plant parts can be used in floral displays, including: 1) strong branches such as drumstick for support; 2) foliage such as bird's nest fern, mother of pearl plant (*Graptopetalum paraguayense*), etc.; 3) flowers such as celosia, day lily (*Hemerocallis fulva*), aloe (*Aloe* spp.), pinnacled fame-flower (*Talinum paniculatum*), etc.; and 4) fruits such as snake gourd (*Trichosanthes anguina*), African eggplant, African nightshade, bitter gourd (*Momordica charantia*), spiny bitter gourd, etc. Whether they are crafted in modern, exotic, or simple styles, floral arrangements with indigenous vegetables create a feeling of rusticity, abundance, and vitality. Below are some representative masterpieces that have been displayed at AVRDC – The World Vegetable Center headquarters.

### Ode of life

The rugged branches of drumstick are used as the main frame. Reaching out in all directions, they signify the unyielding will to strive. As the backdrop, pinnacled fame-flowers are arranged in a radiating pattern, showing support. Up front, an assortment of flowers and fruit from indigenous vegetables twine around the drumstick branches.



### Soaring high

The upright bamboo and aloe flower stalks symbolize progress. Materials inclduing bird's nest fern, plumed celosia flower, and the cup-shaped seed head of lotus are the foundation of this display.





### Story of the flowers

The statuesque fame-flowers sway gently in the breeze. Below them, the horizontal curves of large-flowered sesbania's green pods are adorned by chili pepper and embellished by the leaves and fruits of rosemary, mother of pearl plant, cherry tomato and ashitaba.



### Grand vision of color

Curved green sponge gourd fruit is used as the main theme. White garlic bulbs in the center are set in contrast to the hues and fragrances of leaves and fruit from indigenous vegetable species such as eggplant, spiny bitter gourd, bitter gourd, tomato, and Indian mulberry. The slender bamboo sticks are made into a fence, adding a garden touch.



### Floral eloquence

Water lilies add color to the green foliage of bird's nest fern, and dangling materials of tomato, African scarlet eggplant, roselle, sesbania, rosemary and yellow-fruit nightshade. The piece nicely graces the speaker's podium.

### Ethereal beauty

Small-size leaves and fruits of indigenous vegetables such as celosia, white mugwort, African eggplant, hairy nightshade, water nightshade, rosemary, roselle, yellow-fruit nightshade, lablab bean, endive, and sesbania present a delicate, fragile beauty through the elaborate variation in height and depth of the materials.





### Indigenous Vegetables as Culinary Materials

Many of the compounds that make vegetables colorful are also important for human health. Indigenous vegetables as a group offer the greatest possible variety in appearance, color, flavor, quality, texture, and health values, and should assume a significant place in diets of people all around the world.

### **Preparation**

Before cooking, most indigenous vegetables are peeled or trimmed to remove the tough skin, outer leaves, or lignin tissue. However, care should be taken not to remove too much, as micronutrients and other health-related compounds tend to be located near the skin or the outer leaves of most vegetables.

### Cooking

Vegetables are cooked to: 1) soften dietary fiber, cellulose, and other plant parts to make plants digestible; 2) enhance taste; 3) destroy harmful microorganisms; 4) facilitate the availability of beneficial phytochemicals to the body; 5) make a single serving of vegetables in bulk possible; and 6) dispel or denature any harmful toxicants. Nevertheless, heat leads to changes in color, flavor and texture, and destroys vitamins, enzymes, and antioxidants. Thus, it is best to cook vegetables in the shortest time possible.

Vegetables can be prepared or cooked in several ways. The method chosen will affect the flavor and consistency of the vegetable. In general, denser vegetables with less water content require longer cooking times. Slicing or chopping vegetables into pieces can reduce cooking time. For strongly flavored vegetables, it is advisable to cook them in an open vessel, so that the flavor may be decreased by evaporation. Vegetables mild in flavor, however, are improved by being cooked in a closed vessel to retain their flavor.

Practically all vegetables, cooked or green, should be served with oil to enhance flavor and the intake of fat-soluble vitamins and phytochemicals. Seasoning with a small amount of salt helps to harden the tissues and draw out the flavor of vegetables. Here are the cooking methods used for indigenous vegetables:

- Blanch: drop vegetables into a large pot of boiling water, remove after a brief interval, then dip into ice-cold water to halt the cooking process.
- **Boil:** immerse vegetables in boiling water or stock until tender. Use the shortest boiling time necessary to preserve micronutrients and phytochemicals.
- Cold-toss: mix together vegetable ingredients away from a heat source; most common with salads.
- Pickle: preserve and flavor vegetables in a solution of brine (water nearly saturated with salt) or vinegar.
- Puree: finely mash vegetables with a blender or a sieve (usually after cooking) to give a smooth, fine pulp. Puree is often used as a garnish, served as a side dish, or added as a thickener to sauces or soups.
- Sauté: cook vegetables with a small amount of oil in a shallow pan over high heat for a relatively short period of time.
- Simmer: cook vegetables gently in water at a temperature just below that of boiling, or low enough that tiny bubbles just begin to break the surface.
- Steam: cook vegetables in a steaming basket over boiling water. This can be a stainless steel or bamboo basket set over a pan on the stove. It is a desirable method of cooking many vegetables because it retains many water-soluble micronutrients.
- Stir-fry: constantly and briskly toss chopped pieces of the vegetables in a large, heated pan with a small amount of oil over a short period of time. This method results in less loss of micronutrients and phytochemicals.

### Appetizing and Healthy Recipes

Indigenous vegetables are so versatile they can be served as appetizers, side dishes, the main course, or even as dessert. The following 23 recipes are examples showing how indigenous vegetables can add interest, color, and vital nutrients to the diet.

# **Swamp Tune Sauce**

Serves three

Preparation time: 30 minutes Cooking time: 20 minutes

### Ingredients

Tender swamp leaf (Limnophila rugosa) shoots, 10 g Red and yellow sweet pepper strips, 10 g each Tomato, 1 about 200 g Water bamboo (Zizania latifolia), 3 (each about 135 g) Mirin (a Japanese seasoning), 1 teaspoon Pickled cucumber sauce, 2/3 tablespoon Salad oil, 1/4 teaspoon Salt, 1/4 teaspoon Yellow mustard paste, 2/3 tablespoon

### Preparation

- 1. Rinse swamp leaf shoots and sweet pepper strips, dry on paper towel. Chop into tiny pieces.
- 2. Mix chopped vegetables with yellow mustard paste and pickled cucumber sauce, make them into paste, and set aside.
- 3. Rinse and dry tomato. Cut in half, remove the inside flesh and seed, and pour in the swamp leaf paste for serving as dip.
- 4. Remove outer leaf sheaths of water bamboo, rinse and cut into 10-cm pieces, boil with salt and salad oil, and remove.
- 5. Eat water bamboo with the swamp leaf dip.

### **Variations**

Swamp leaf can be replaced with spiny coriander or Vietnamese coriander. Water bamboo can be replaced with asparagus, bamboo shoot, cauliflower, broccoli, onion, lettuce, or mushroom.



# Colorful Salad

Serves three

Preparation time: 30 minutes Cooking time: 15 minutes

### Ingredients

Swamp leaf (Limnophila rugosa) shoots, 10 g Head lettuce, 50 g Tomato, 1 about 200 g Dried bean curd sheet, 6 pieces Red and yellow sweet pepper strips, 30 g each White and purple onion shreds, 30 g each Fresh chili pepper shreds, 5 g Salad oil, 1/4 teaspoon Salt, 1/4 teaspoon Sugar, 1/4 teaspoon Vinegar, 1/4 teaspoon

### Preparation

- 1. Rinse and dry swamp leaf shoots, head lettuce, and tomato. Cut tomato in half and remove the seeds.
- 2. Cut all vegetables and the bean curd sheet into small strips.
- 3. Mix and toss all the ingredients with the sugar, vinegar, salad oil, and salt before serving.

### **Variations**

Swamp leaf shoots can be replaced or mixed with spiny coriander leaves or Vietnamese coriander shoots.



# Pas de Deux Salad

Serves four

Preparation time: 40 minutes Cooking time: 30 minutes

### **Ingredients**

Water dropwort (Oenanthe javanica) shoots with tough petioles removed, 2 portions of 50 g each

Onion, 2 stems of green onion and 1 bulb onion of 80-100 g

Cherry tomato, 8-10

Pepper, red and yellow sweet, 80-100 g each; chili, 3 of small size

Garlic cloves, 2

Cassava starch, 2 tablespoons

Perch fillet, 200 g

Canned tuna, about 110 g

Lemon juice, 1 teaspoon

Salad oil, 2 tablespoons

Salt, 1/4 teaspoon for central portion, 1/8 teaspoon for outer portion

### Preparation

- 1. Cut perch into finger-size strips, place strips into a container, sprinkle evenly with salt, set aside.
- 2. Chop green onion and garlic into tiny pieces and cut chili pepper into thin strips.
- 3. Coat fish strips with cassava starch; fry over medium heat until golden brown; remove from pan, drain off the oil; and set aside.
- 4. Stir-fry green onion, garlic and chili pepper with salad oil; when fragrant, add water dropwort and then fish; continue stir-frying until evenly mixed; remove and place in the center of a serving plate.
- 5. Cut onion and sweet peppers with seeds removed into thin strips.
- 6. Place vegetable strips into a container, sprinkle with salt, and toss well with water dropwort.
- 7. Drain oil from tuna; combine with water dropwort mixture; add lemon juice; and mix well.
- 8. Place the mixture in the outer portion of a serving plate.

### Variations

Water dropwort shoots can be replaced with blanched young leaves of velvetleaf or young shoots of tropical violet and honewort.



# **Idyllic Cheese Rolls**

Makes 35 rolls

Preparation time: 40 minutes Cooking time: 25 minutes

### **Ingredients**

Tropical violet (Asystasia gangetica) shoots, 300 g Onion, 2 of about 250 g each Dried radish shreds, 200 g Cheese puff pastry (14 cm x 14 cm), 10 Minced meat (beef, chicken, mutton, or pork), 150 g Black pepper powder, 1/2 teaspoon Salt, 1/2 teaspoon Sesame oil, 1 teaspoon Soy sauce, 1 tablespoon

### Preparation

- 1. Rinse and dry tropical violet shoots and onion. Chop into small pieces, set aside.
- 2. To make the filling, heat the pan with sesame oil, stir-fry minced meat, onion, dried radish, and tropical violet before adding seasonings.
- 3. Cut cheese puff pastry into four equal pieces, place a little of the filling on top of each pastry piece, fold opposite corners to form rolls, and tie with small strips of pastry (about 1 cm wide).
- 4. Bake cheese rolls at 180°C for 10 minutes, and serve.

### Variations

Tropical violet shoots can be replaced with jute mallow leaves, ivy gourd shoots, chard leaves, etc.



### **Pastoral Salad**

Serves six

Preparation time: 25 minutes Cooking time: 40 minutes

### **Ingredients**

Tender velvetleaf (Limnocharis flava) leaves, 50 g Chopped tomato (seeds removed), 50 g Chopped onion, 40 g Egg, 3 Black pepper powder, 1 teaspoon Mayonnaise, 2 tablespoons Pickled cucumber paste, 1 1/3 tablespoons Salt, 1 teaspoon Yellow mustard paste, 1 tablespoon

### Preparation

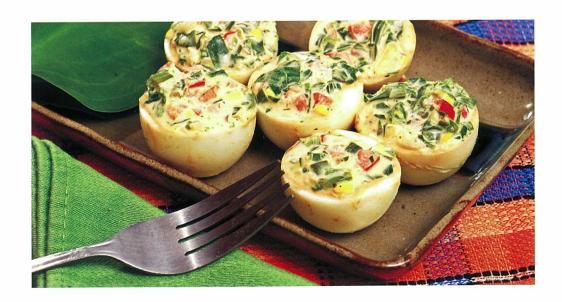
1. Boil eggs until cooked. Remove shells and cut into halves. Remove yolks; place in a bowl. Put the whites on a plate and set aside.

2. Rinse and dry velvetleaf leaves, and cut into small pieces. Combine with egg yolks, tomato, onion, and all seasoning ingredients, stir clockwise until well combined.

3. Fill the egg white halves with the mixture, and serve on a plate.

### **Variations**

Velvetleaf leaves can be replaced with blanched and finely chopped ivy gourd shoots and oval-leaf pondweed leaves, or finely chopped water dropwort shoots and Vietnamese coriander shoots. Egg whites can be replaced with toast (with crust removed).



# Party Finger Tuna Sandwiches

Makes 12 sandwiches Preparation time: 30 minutes Cooking time: 20 minutes

### **Ingredients**

Fragrant telosma (*Telosma cordata*) inflorescences, 100 g Onion, large about 250 g Canned tuna, about 110 g Half loaf of thinly-sliced sandwich bread Mayonnaise, 70 g Ground black pepper, 1/2 teaspoon

### Preparation

- 1. Cut fragrant telosma flower buds from the inflorescence, rinse and dry. Quickly fry in the heated pan with black pepper, then set aside to cool.
- 2. Chop the onion into 5-mm pieces, dip the pieces into ice-cold water for 5-10 minutes, remove and dry. Set aside.
- 3. Drain the oil from the tuna.
- 4. Place the tuna in a bowl. Add the mayonnaise and mix.
- 5. Add the fragrant telosma flower buds and chopped onion. Mix well.
- 6. Spread the mix on bread slices, and cut the bread diagonally into four pieces before serving.

#### **Variations**

Fragrant telosma flower buds can be replaced with blanched and finely chopped ivy gourd shoots.



## Salmon Rolls

Serves six

Preparation time: 30 minutes Cooking time: 40 minutes

### **Ingredients**

Roselle (*Hibiscus sabdariffa*) young shoots, 150 g Onion strips, half cup Sweet pepper strips, half cup Head lettuce, whole or half about 250-300 g Grapefruit, about 250-300 g Smoked salmon strips, 6 pieces

### Dressing

Ground black pepper, 1 teaspoon Mustard powder, 1 tablespoon Olive oil, 3 tablespoons Orange juice, 1 tablespoon Red vinegar, 2 tablespoons Salt, 1/4 teaspoon Sugar, 2 tablespoons

### Preparation

- 1. Rinse tender roselle shoots in salt water, and dry.
- 2. Rinse and dry lettuce leaves. Cut into 2 cm x 2 cm pieces.
- 3. Remove grapefruit flesh.
- 4. Wrap roselle young shoots, sweet pepper strips, and onion strips with smoked salmon strips.
- 5. Mix all dressing ingredients. Combine lettuce and grapefruit flesh; pour half of dressing over top and toss, then place on a plate.
- 6. Place salmon rolls on top of lettuce and pour the remaining dressing over the salmon rolls.
- 7. Chill and serve.

### **Variations**

Roselle shoots can be replaced with other sour-flavored indigenous vegetables such as blanched garden sorrel or purslane.



## **Bacon Rolls**

Makes 20 rolls

Preparation time: 20 minutes Cooking time: 30 minutes

#### **Ingredients**

Young okra (Abelmoschus esculentus) pods, 20, about 12 g each Bacon, 10 slices

#### Preparation

- 1. Rinse okra pods before blanching in boiling water. Cool and cut to the width of the bacon slices.
- 2. Cut the bacon slices in half crosswise.
- 3. Wrap each bacon piece around an okra pod, and fix with toothpicks.
- 4. Place bacon rolls in pan. Cook over medium heat until bacon browns or until most of the grease is cooked off. (If desired, spoon off excess drippings halfway through cooking time.)
- 5. Place cooked bacon rolls on paper towels to drain off excess grease. Remove toothpicks and serve warm.

#### **Variations**

Okra can be replaced with sesbania flower buds with their pistils and styles removed.



# **Burmese Leaf Soup**

Serves two

Preparation time: 30 minutes Cooking time: 30 minutes

#### Ingredients

Ivy gourd (Coccinia grandis) shoots, 150 g Onion, 1 about 200 g Pumpkin, 1 about 300 g Bacon, 4 slices Butter, 10 g Flour, 2 tablespoons Ground black pepper, 1 teaspoon Salt, 1 teaspoon Soup stock (meat, seafood or vegetable), 1 cup Whipping cream, 1 cup

#### Preparation

- 1. Rinse and dry ivy gourd shoots, cut into 3-cm pieces, and set aside.
- 2. Rinse pumpkin and steam in a pot until half cooked. Slice a portion off the top and carefully remove the inside flesh, keeping the outer rind intact.
- 3. Blend ivy gourd shoot pieces and pumpkin flesh in a blender.
- 4. Rinse and dry onion, and cut both onion and bacon into 2-5 mm pieces.
- 5. Fry onion pieces in pot first, add bacon pieces and continue frying until bacon just begins to crisp. Pour in soup stock, add ivy gourd and pumpkin, and stir evenly until the mixture boils.
- 6. Add salt and black pepper to soup. Thicken the soup with whipping cream and flour. Cook gently until flour loses its raw taste.
- 7. Pour the soup into the half-cooked pumpkin and serve hot.

#### **Variations**

Ivy gourd shoots can be replaced with pumpkin shoots, tropical violet shoots, chayote shoots, or bird's nest fern fronds.



# African Sticky Soup (Ewedu)

Serves three

Preparation time: 30 minutes Cooking time: 30 minutes

#### Ingredients

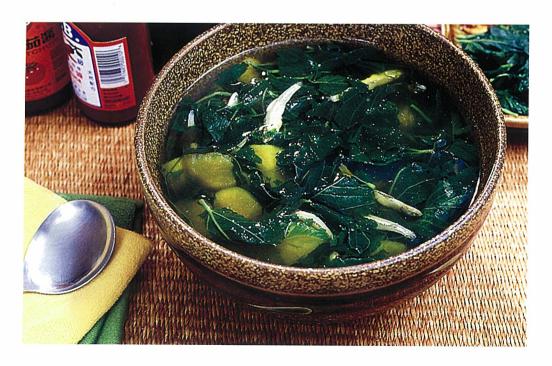
Jute mallow (Corchorus olitorius) leaves, 200 g Sweet potato, 200 g Dried small fish or shrimp, 15 g Salt, 1 teaspoon Water, 2 cups

#### Preparation

- 1. Wash sweet potato, peel the skin, and cut into cubes.
- 2. Boil water in pot, add sweet potato cubes, and cook until soft.
- 3. Add small dried fish or shrimp to soup; continue to boil.
- 4. Rinse jute mallow leaves well, then rub the leaves until foamy and sticky.
- 5. Add jute mallow to soup, season with salt, and cook until the soup thickens.

#### **Variations**

Jute mallow leaves can be replaced with other mucilaginous indigenous vegetables such as okra, or with non-mucilaginous plants such as amaranth, cowpea, tropical violet, etc. In the latter case, some corn starch or potato starch is first mixed with water, then poured into the soup, and the soup is stirred until it thickens.



## **Mixed Sardines and Peanuts**

Serves four

Preparation time: 20 minutes Cooking time: 10 minutes

#### Ingredients

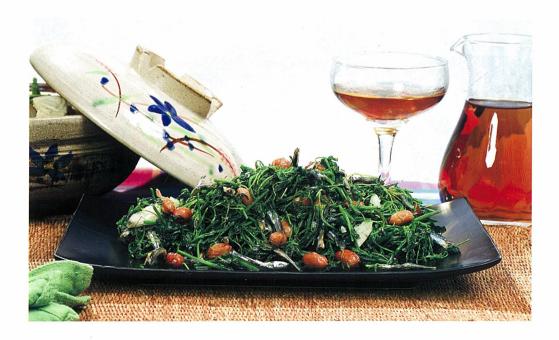
Tender ivy gourd (Coccinia grandis) shoots, 200 g Garlic cloves, 5 Shelled and dried peanut, 20 g Dried or salted small sardines or shrimps, 30 g Ground black pepper, 1/4 teaspoon Salad oil, 1 tablespoon Salt, 1/4 teaspoon

#### Preparation

- 1. Rinse and dry ivy gourd shoots. Cut into 3-cm pieces, and set aside.
- 2. Crush garlic cloves and set aside.
- 3. Heat salad oil in a frying pan or skillet; stir-fry crushed garlic cloves, peanuts, and sardines or shrimps.
- 4. Add salt and black pepper powder while stirring.
- 5. Increase heat. Add chopped ivy gourd shoots, stir-fry for 15-20 seconds, and immediately pour all the mixed ingredients onto a serving plate. Serve hot.

#### **Variations**

Ivy gourd shoots can be replaced with other leafy indigenous vegetables such as pumpkin shoots, chayote shoots, kangkong shoots, bird's nest fern fronds, etc.



# **Grandmother's Plain Stir-Fry**

Serves four

Preparation time: 20 minutes Cooking time: 10 minutes

#### Ingredients

Tender tropical violet (Asystasia gangetica) shoots, 200 g Cassava starch, 1 teaspoon Shredded ginger, 1 teaspoon Meat strips (beef, chicken, mutton, or pork), 50 g Salt, 1 teaspoon Sesame oil, 1/2 tablespoon Soy sauce, 1 tablespoon Sugar, 1/4 teaspoon

#### Preparation

- 1. Rinse tropical violet and blanch, set aside.
- 2. Mix meat strips with starch, sugar, and soy sauce in a bowl, set aside.
- 3. Gently heat a pan or wok. Add sesame oil; stir-fry ginger over low heat until fragrant, then add and stir-fry marinated meat strips with high heat.
- 4. Add tropical violet, stir-fry until cooked, and add salt at the end.

#### **Variations**

Shredded chili pepper could be added for a spicier flavor. Shredded ginger can be replaced with minced garlic. Tropical violet shoots can be stir-fried alone with 1 tablespoon of water before seasoning with salt. Tropical violet shoots can be replaced with other indigenous vegetables such as shoots of ivy gourd, pumpkin, chayote, drumstick, kangkong or sweet potato leaves, or leaves of Chinese boxthorn, Ethiopian kale, etc.



# **Amphibious Porridge**

Serves four

Preparation time: 15 minutes Cooking time: 15 minutes

#### **Ingredients**

Tropical violet (Asystasia gangetica) shoots, 100 g Rice, 1 cup Fish fillet (codfish, perch, or milk fish), or salted sardines, 100 g Salt, 2 teaspoons Water, 1.5 liter

#### Preparation

- 1. Rinse and dry tropical violet shoots. Cut into 3-cm pieces, set aside.
- 2. Rinse rice, pour into water, bring to a boil and then cook over low heat with constant stirring until rice is mushy and thick.
- 3. Cut fish into 1 cm x 1 cm pieces, set aside.
- 4. Add tropical violet to rice and continue cooking.
- 5. Add fish to rice porridge, maintain at a gentle boil, and season with salt. Serve when fish is cooked.

#### **Variations**

Tropical violet shoots can be replaced with amaranth leaves, jute mallow leaves, chard leaves, nightshade leaves, etc. Fish can be replaced with other seafood. Rice can be replaced with other starchy foods such as sweet potato, yam, plantain, or cassava that is pounded first, as in West African fufu.



## African Vegetable Loaf

Serves six

Preparation time: 40 minutes Cooking time: 30 minutes

#### **Ingredients**

Tender baobab (Adansonia digitata) leaves, 100 g Carrot, 100 g Onion, 200 g Cassava or potato starch, 1 tablespoon Minced meat (beef, chicken, fish, mutton, or pork), 200 g Ground black pepper, 1/2 teaspoon Garlic cloves, 5 Salad oil, 1 tablespoon Salt, 1/2 teaspoon

#### Preparation

- 1. Wash and dry baobab leaves, carrot, onion and garlic. Cut baobab leaves and onion into 1 cm pieces, carrot into thin threads, and garlic in fine pieces; set the cut pieces aside.
- 2. In a large bowl, combine the cut vegetables with the minced meat, the cassava starch, black pepper, and salt; mix thoroughly.
- 3. Add salad oil to a frying pan or skillet over medium heat.
- 4. Add the vegetable mixture and saute or fry gently until cooked.

#### **Variations**

Baobab leaves could be replaced with other leafy indigenous vegetables.



# **Saag (Indian Creamed Greens)**

Serves four

Preparation time: 30 minutes Cooking time: 10 minutes

#### **Ingredients**

Tender chard (*Beta vulgaris*) leaves, 200 g Cherry tomato, 60 g Onion, 75 g Potato, 1 about 150 g Butter, 2 tablespoons Milk, 200 ml Chopped green chili pepper, 5 g Curry powder, 50 g Finely chopped garlic and young ginger, 10 g each Ground black pepper, 1 tablespoon Toasted cumin seeds, 1/2 teaspoon Salt, 1 teaspoon Water, 100 ml

#### Preparation

- 1. Rinse and dry chard leaves, onion and cherry tomato; chop into fine pieces; squeeze any excess water out of the chopped chard; set the cut pieces aside.
- 2. Wash potato and boil it in water. Remove the peel, then mash the potato with a fork; set the mashed potato aside.
- 3. In a pot over low heat, cook chard with mashed potato and milk, stirring continuously.
- 4. Heat frying pan, add butter, and fry chopped garlic, young ginger, green chili pepper, and curry powder until fragrant, then add chopped onion, tomato and cumin seeds. Continue frying until fragrant, then pour all into the pot with the potato mixture, and stir well.
- 5. Simmer with constant stirring until the mixture becomes thick, then season with salt and black pepper.
- 6. Serve with bread for dipping.

#### **Variations**

Chard leaves could be replaced with other leafy indigenous vegetables. Amount of spices used depends on personal preference.



## **Coconut Milk Casino**

Serves four

Preparation time: 30 minutes Cooking time: 10 minutes

#### Ingredients

Tender African nightshade (Solanum scabrum) leaves, 220 g Chopped green chili pepper, 5 g Diced onion and red sweet pepper, 50 g each (about 1 cm x 1cm) Finely chopped garlic and young ginger, 10 g each Diced beef, chicken, mutton, or pork, 110 g (about 1 cm x 1cm) Coconut milk, 50 ml Milk, 150 ml Salad oil, 1 tablespoon Salt, 1 teaspoon

#### Seasoning

A: for marinating the meat Chili pepper powder, 1 1/3 tablespoons Curry powder, 2 tablespoons Ground black pepper, 1 1/3 tablespoons Salt, 1 teaspoon

B: for the cooking
Chili pepper powder, 1 1/3 tablespoons
Curry powder, 2 tablespoons
Toasted cumin seeds, 1/2 teaspoon

#### Preparation

- 1. Rinse and dry African nightshade leaves. Chop into small pieces.
- 2. Mix diced meat with seasoning A in a bowl, set aside for 20 minutes.
- 3. Heat frying pan, add salad oil, and fry chopped garlic, young ginger and green chili pepper until fragrant, then add seasoning B, marinated meat, diced onion and sweet pepper. Continue frying until meat loses its raw look, then add milk and coconut milk and cook gently for 2 minutes.
- 4. Add African nightshade, stir the mixture thoroughly, bring to a boil, and season with salt. Serve hot.

#### **Variations**

African nightshade leaves can be replaced with other leafy indigenous vegetables. Amount of spices depends on personal preference.



## Japanese Domburi

Serves two

Preparation time: 30 minutes Cooking time: 10 minutes

#### **Ingredients**

Baobab (Adansonia digitata) leaves, 100 g Tomato, 1 about 200 g Onion, large about 250 g Minced meat (beef, chicken, mutton, or pork), 100 g Steamed rice, 2 cups Garlic cloves, 2 Salad oil, 1 tablespoon Salt, 1/4 teaspoon

#### Preparation

- 1. Rinse and dry baobab leaves, tomato and onion. Cut into 1-cm pieces, and set aside.
- 2. Crush garlic cloves and set aside.
- 3. Heat the pan, add salad oil. Stir-fry garlic, and when fragrant, add minced meat and stir-fry.
- 4. While stir-frying minced meat over high heat, add chopped tomato and onion first, and then baobab leaves. Season with salt.
- 5. Stir-fry the ingredients well and serve on top of the steamed rice.

#### **Variations**

Baobab leaves can be replaced with mucilaginous okra or jute mallow. They also can be replaced with non-mucilaginous leafy indigenous vegetables. In this case, some corn starch or potato starch is first mixed with water, then stir-fried with the vegetables before turning off the heat.



### **Flavored Rice**

Serves two

Preparation time: 20 minutes Cooking time: 40 minutes

#### **Ingredients**

Spiny coriander (Eryngium foetidum) leaves, 30 g Rice, 1 cup
Pre-cooked oat flakes, 1/2 cup
Dried small fish, 30 g
Chopped ginger, 5 g
Chopped fresh chili pepper, 5 g
Furikake (a Japanese seasoning), 1 tablespoon
Salad oil, 1 tablespoon
Salt, 1/4 teaspoon
Water, 1 1/2 cups

#### Preparation

- 1. Rinse and dry spiny coriander leaves, chop into 2-mm pieces, and quickly stir-fry in heated pan.
- 2. Divide cooked spiny coriander into halves. Set aside one portion, and mix the other with the furikake for later use.
- 3. Rinse rice and soak for 15 minutes.
- 4. Rinse dried small fish and dry on a paper towel. Chop into tiny pieces.
- 5. Heat a frying pan, add salad oil and fry chopped small fish with chili pepper and ginger for a few seconds.
- 6. Mix together soaked rice, oat flakes, and fried small fish pieces. Cook in a rice cooker until rice is cooked.
- 7. Add the spiny coriander/furikake mixture into the cooked rice while still warm.
- 8. Wet hands in water and rub them with some salt; place the rice on hands, and form the rice into a ball or a triangle by pressing lightly with both palms. Top the rice ball with spiny coriander pieces.

#### **Variations**

Spiny coriander leaves can be replaced with perilla or Chinese toon. The cooked rice can be served directly as pilaf, without forming into balls.



## Chinese Bao-Tzu

Makes 15 buns

Preparation time: 60 minutes Cooking time: 20 minutes

#### Ingredients

Dandelion (Taraxacum officinale) leaves, 150 g for the dough and 300 g for the filling

Dough: All-purpose flour, 300 g; baking soda, 5 g; yeast powder, 8 g; egg, 1; salad oil, 10 g; salt, 5 g; sugar, 20 g

Filling: bamboo shoot diced, 3 tablespoons; chopped green onion, 2 tablespoons; shiitake mushroom dice, 2 tablespoons; minced beef, chicken, mutton, or pork, 300 g; brown sugar, 3 tablespoons

Seasoning: combine ground black pepper, 2 teaspoons; oyster sauce, 1 tablespoon; rice wine, 1 tablespoon; salt, 1/2 teaspoon; sesame oil, 1 tablespoon; sugar, 1 tablespoon

#### Preparation

- 1. Blanch rinsed dandelion leaves, cut into 3-cm pieces and blend with 1/4 cup of water as juice.
- 2. Pour the flour into a container, add other dough ingredients, and use the juice to make dough.
- 3. Knead the dough, cover with a wet cloth and let it rise for 40 minutes.
- 4. Blanch rinsed dandelion leaves for filling in brown sugar water, drain and cut into small pieces. Place in a bowl with minced meat, other stuffing ingredients, and the seasoning mixture; stir thoroughly.
- 5. Knead the raised dough. Pull off pieces about 40 g each and roll into smooth balls. Flatten each ball with hands, then roll it out into a thin, flat round shape. Insert about 1.5 tablespoons of filling, and wrap the dough around it to make a bun.
- 6. Place the buns in a steamer, let rest for 15-20 minutes. Steam buns over boiling water for 15-20 minutes and serve hot.

#### Variations

Dandelion can be replaced with ivy gourd shoots, or with the leaves of endive, drumstick, chard, nightshades, cowpea, tropical violet, or sweet potato.



# **Boiled Dumplings**

Makes 40 dumplings

Preparation time: 60 minutes Cooking time: 10 minutes

#### **Ingredients**

Dough: Bread flour, 2 1/2 cups; salt, 1/4 teaspoon; water, 1 cup

Filling: Ivy gourd (Coccinia grandis) shoots, 100 g; chopped cabbage, 300 g; chopped green onion, 2 tablespoons; minced beef, chicken, mutton, or pork, 300 g; salt, 1 teaspoon

Seasoning: Ginger juice, 1 teaspoon; ground black pepper, 1/2 teaspoon; salt, 1/2 teaspoon; sesame oil, 1 teaspoon; soy sauce, 1 tablespoon

#### Preparation

- 1. Make dough by slowly mixing flour, salt and water; let rise for 15-20 minutes under wet cloth.
- 2. Chop rinsed ivy gourd shoots, set aside. Sprinkle cabage with salt; leave for 5-10 minutes before squeezing out the water; set aside.
- 3. Mix minced meat, ivy gourd, cabbage, green onion and all seasoning ingredients in a clockwise direction for about 10 minutes.
- 4. Knead the dough again and divide into 40 balls, and roll out as flat, round wrappers.
- 5. Place 1/2 tablespoon of filling in the wrapper, fold it over and pinch at the end to make dumplings.
- 6. Drop dumplings in boiling water, stir carefully to prevent sticking together, cook until all the dumplings are floating, use a mesh strainer to lift the dumplings, and serve hot with a dipping sauce.
- 7. The dipping sauce is a mixture of soy sauce, sesame oil, vinegar, chili pepper, ginger, and garlic.

#### Variations

Ivy gourd can be replaced with shoots of water dropwort, tropical violet, cluster mallow, white mugwort, etc. The dumplings also can be fried in oil with a little water.



## Taiwanese Koe

Makes 10 pieces

Preparation time: 60 minutes Cooking time: 15 minutes

#### **Ingredients**

Jute mallow (Corchorus olitorius) leaves, 100 g each for the crust and the filling Glutinous rice flour, 350 g, for the crust Rinsed banana leaf disks in oval shape (10 cm x 15 cm), 10, for the base Dried radish shreds, 100 g Dried small shrimp, 10 pieces Minced meat (beef, chicken, mutton, or pork), 200 g Shallot cloves, 5

Seasoning: black pepper powder, 1/4 teaspoon; salt, 1 tablespoon; soy sauce, 1 tablespoon; sugar, 1 teaspoon

#### Preparation

- 1. Cut rinsed jute mallow leaves for filling; cut shallot and soaked radish shreds into tiny pieces.
- 2. Grease the surface of banana leaf disks with 1 tablespoon of salad oil.
- 3. Fry dried shrimp, minced meat and radish in 1 tablespoon of salad oil; add jute mallow and continue frying, add all seasoning ingredients, and stir well. Cool and set aside for use as filling.
- 4. Blend rinsed jute mallow leaves for crust with 200 ml of water in a blender to make juice.
- 5. Slowly add the juice into rice flour, and mix well with 1 teaspoon of sugar to make dough.
- 6. Knead the dough into 10 balls, flatten, place about 1 tablespoon of filling in the center, round up and then flatten again and place on top of banana leaf disks. Brush each dumpling with salad oil.
- 7. Steam the dumplings for 10-15 minutes and serve hot.

#### **Variations**

Jute mallow can be replaced with leaves of dandelion, endive, drumstick, amaranth, chard, nightshade, tropical violet, ivy gourd, etc. Banana leaves can be replaced with leaves of shell ginger (*Alpinia speciosa*), white ginger-lily (*Hedychium coronarium*), or beach hibiscus (*Hibiscus tiliaceus*).



## Rice Ball Bean Soup

Makes 30 rice balls

Preparation time: 60 minutes Cooking time: 15 minutes

#### Ingredients

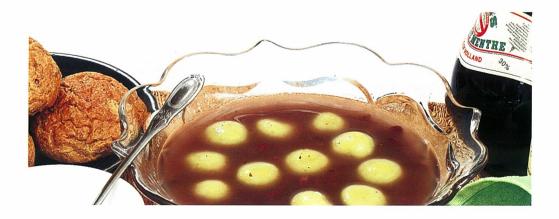
Tender drumstick (Moringa oleifera) leaves, 75 g Sticky rice flour, 300 g De-hulled mungbean (Vigna radiata), 90 g Adzuki bean (Vigna angularis), 100 g (soaked in cold water overnight) Sugar, 200 g (20 g for mungbean, 180 g for adzuki bean) Water, 400 ml

#### Preparation

- 1. Rinse drumstick leaves and blend with 100-ml water in a blender. Filter the juice through a fine net bag and mix well with sticky rice flour.
- 2. Knead the dough to form 15 g balls, and flatten each ball to make a crust.
- 3. Cook de-hulled mungbean with 100-ml water in an electric cooker (about 20 minutes) or simmer in a pot until beans are fully tender (about two hours). Add 20 g of sugar, stir thoroughly to make bean paste, divide into 3 g portions.
- 4. Wrap the sticky rice ball crusts around each ball of the bean paste filling to make sticky rice balls. Set aside.
- 5 Cook adzuki bean with 100-ml water in an electrical cooker (about 20 minutes) or simmer in a pot until beans are fully softened (about two hours). Add 180 g of sugar and 100-ml water to the cooked beans, bring to a boil, and simmer until beans become mushy.
- 6. Bring water to boil in another pot. Add the sticky rice balls, cook until they float, then slowly add adzuki bean soup. Boil and stir well for one minute; serve hot as a perfect winter dessert.

#### Variations

Drumstick shoots can be replaced with dandelion leaves, chard leaves, nightshade leaves, cowpea leaves, tropical violet shoots, ivy gourd shoots, etc.



## **Healthy Jelly**

Makes 20-25 jellies

Preparation time: 30 minutes Cooking time: 20 minutes

#### Ingredients

Ashitaba (Angelica keiskei) leaves, 70 g Apple, half (about 200 g) Agar powder or plain pectin, 1 1/2 teaspoons Sugar, 70 g Water, 600 ml

#### Preparation

- 1. Rinse ashitaba leaves, cut into small pieces, and blend with water in a blender until smooth.
- 2. Add sugar to the ashitaba puree.
- 3. In a pot, bring the mixture to a full rolling boil over high heat, stirring constantly with a long-handled wooden spoon. Pour in the agar all at once and stir. Return mixture to a full rolling boil; boil hard for 1 minute, stirring constantly.
- 4. Rinse apple, peel and cut into 1-cm pieces, set aside.
- 5. Pour the ashitaba mixture into jelly molds, place 3-4 pieces of apple in each mold, and let the jelly cool.
- 6. Chill jellies. Serve cold jellies with cream poured over the top.

#### **Variations**

Ashitaba leaves can be replaced with sesbania flower buds with their pistils and styles removed.



# Social Marketing

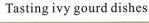


AVRDC - The World Vegetable Center employs various strategies to emphasize the vital importance of conserving and using indigenous vegetables, and to promote their value to everyone, everywhere. The following photos, taken at AVRDC headquarters in Taiwan, show a few of the many initiatives directed at increasing public awareness and appreciation of indigenous vegetables.

### **Promotion of Ivy Gourd and Tropical Violet**

Examining field-grown ivy gourd







Explaining field-grown tropical violet



Feedback from the public



Tropical violet seedlings to take home







### Learning about Indigenous Vegetables

Farmers attending a lecture on the value of indigenous vegetables



Scientists note the biodiversity of indigenous vegetables



The Center's Director General, Thomas A. Lumpkin, with Paraguayan President, Nicanor Duarte Frutos, 23 May 2004

Center scientists with Gambian President Yahya Jammeh, and Taiwan President,



Chen Shui-bian, 9 October 2005



Explaining the nutritional value of indigenous vegetables



The diplomatic corps in Taiwan appreciating indigenous vegetables



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