Specialty Crops for Pacific Island Agroforestry (http://agroforestry.net/scps)

Farm and Forestry
Production and Marketing Profile for

Kava

(*Piper methysticum*)

By Scot C. Nelson

PAR

USES AND PRODUCTS

A traditional beverage made from the roots and stump of the kava plant continues to be the most important kava product. This medicinal, psychoactive, and ceremonial drink is an aqueous suspension of phytochemicals called kavalactones and other components. Aerial portions of the plant should never be used in beverage preparations; consumption of photosynthetic tissues may pose a human health hazard.

Kava beverages may be produced from freshly harvested roots and stumps or from dried roots and stump powders. The traditional methods of preparing the pulp for extraction from fresh material include chewing, rock pounding, and abrading with pieces of rough coral. A robust mortar and pestle or mechanical grating (using grinders or hammer mills) are generally used to reduce dried material to a powder for extraction. Fresh drinking water, a bowl, a strainer and a cup complete the items needed for preparing the kava beverage. The kavalactones may be extracted from kava plants using organic solvents or carbon dioxide, purified and used directly or in formulations with other components. Other value-added beverages are made where kava-based fluids, powders, or extracted kavalactones are mixed with fruit juices or other liquids.

NAMES

Preferred scientific name

Piper methysticum Forst. f., meaning "intoxicating pepper."

Family

Piperaceae (Pepper family)

Common names

Kava has been adopted as the English common name for *Piper methysticum*. In Polynesian languages kava or its equivalent means bitter, sour, sharp, or pungent. It can also refer to acidity and acridity of food or drink. Some vernacular names for kava in the Pacific include

Fiji: *yaqona*
Hawai'i: *'awa*, *'ava*
Kolepom (New Guinea): *wati*
Kosrae: *seka*
Marquesas: *kava-kava*
Niue: *kavainu*
Papua New Guinea: at least 37 names, including *ka*, and in the Western Province *sika*, *saka*
Pohnpei: *sakau*
Polynesia: *kava* (variant is *kawa*).
Samoa: *'ava 'ava*
Tahiti: *'ava, 'ava 'ava, evava*
Vanuatu: at least 30 local names including *maloku*, *malohu*, *gea* (Bank Islands), *gi* (Torres Island)

Brief botanical description

Kava is a shrub with greenish to dark purplish stems 1.2–3.6 m (4–12 ft) tall. The distinctive, lenticel-bearing stems are swollen at the nodes and have alternate, heart-shaped leaves approximately 13–20 cm (5–8 in) long and of similar width. Blades have 11–13 veins originating at the base and 2.5 cm (1 in) long petioles. Flowers are borne on narrow spikes. The plant is dioecious (male and female on different plants). Kava plants can flower within a month or two after planting, and continually thereafter until harvest. Flowers are sterile and viable seeds do not form.

DISTRIBUTION

Native range

On the location of kava's origin, Lebot et al. (1997) states "the presence and number of *Piper* species indicates that the area of kava origin is somewhere in Melanesia: in New Guinea, the Solomon Islands, or Vanuatu." It is possible that all kava cultivars trace back to a single, ancestral plant in northern Vanuatu, a set of islands which is a center of phenotypic and chemotypic diversity for the species.

Heart-shaped leaves.

Lenticel-bearing stem.

Kava was introduced to most high islands in the Pacific by societies who used the plant for centuries. Since western contact, kava has spread throughout the subtropics and tropics worldwide. However, the Pacific islands—Vanuatu, Fiji, Papua New Guinea, Samoa, Tonga, Pohnpei, and Hawai'i—still produce most of the crop.

ENVIRONMENTAL PREFERENCES AND TOLERANCES

Climate

Kava grows best in humid subtropical to tropical climates where soil friability and drainage are adequate and there is protection from high winds. The land and/or growth media available, the topography, and the growing zone determine the production system used to grow the plants. Kava thrives in shaded, tropical agroforestry settings near streams or at the edge of forests or clearings.

Kava grows best at lower elevations with high rainfall. The elevation range for kava depends upon the latitude. Elevations with temperatures suitable for kava growth are highest at the equator and decrease as one moves north toward the Tropic of Cancer or south toward the Tropic of Capricorn. Heavy cloud cover and high rainfall also may restrict the maximum elevation for successful kava production.

Drought tolerance of kava depends on elevation, growth medium, and cultivation system. Young plants are drought intolerant and should be shaded with palm fronds, shade cloth, or other material and mulched until the roots and foliage are well established.

Elevation, rainfall, and temperature

Elevation range	**lower:** just above sea level, away from high winds, beaches and salt water spray **upper:** 457 m (1,500 ft) on windward sides and 762 m (2,500 ft) on leeward sides of islands
Mean annual rainfall	**lower:** 190–216 cm (70–85 in) **upper:** 4,570 mm (180+ in) Rainfall required is influenced by elevation, temperature, and soil type.
Rainfall pattern	Kava thrives where rainfall is distributed uniformly throughout the year.
Dry season duration (consecutive months with <40 mm [1.6 in] rainfall)	Older (>1 yr old) and well established plants can survive periods of drought or low rainfall lasting one month.
Mean annual temperature	20–25°C (68–77°F)
Mean maximum temperature of hottest month	35°C (95°F)
Mean minimum temperature of coldest month	15°C (60°F)
Minimum temperature tolerated	15–18°C (60–65°F)

Kava growing with banana and other overstory trees in Pohnpei.

Agroforestry system with kava, banana, papaya, and coconut in American Samoa.

Soils

Kava grows best in deep, friable, well drained, well aerated, and fertile soils or media that are rich in organic matter, with pH of 5.5–6.5. Highest kava yields occur on silica-clay soils. Ideal planting locations are beside streams, at the edge of forests or on slopes in rainy locations, under moderate shade and protected from wind.

Five production systems are used in Hawai'i and the Pacific region, based on soil type or planting system: 1) deep soil, 2) rocky soil, 3) forest planting, 4) lava soil, and 5) basket or planter-style cultivation. Growth media range from various soils to volcanic cinders. Where planted in flat terrains or in open areas, soils are usually hilled or mounded first to ensure adequate drainage around roots. Well prepared, cured compost is a useful addition to soils or growth media as it provides nutrition and fosters adequate drainage and aeration.

Kava does not require high levels of commercial nitrogen fertilizers. Where rainfall or irrigation may be somewhat lacking, soils or growth media should be shaded by overstory plants such as trees to conserve soil moisture during dry periods.

GROWTH AND DEVELOPMENT

New kava plants are always propagated vegetatively from freshly cut stems or from stem sections, as viable seeds do not form. Stem sections consisting of one or more nodes may be planted directly into moist soils, or allowed to root first in a moistened medium or misted area within a shaded nursery before planting. Sufficient roots form on the moist, severed stems within several weeks after planting or misting.

Some cultivars are ready for harvest after about 2 years. However, a 3–4 year crop cycle allows the medicinal and psychoactive kavalactone content of roots, stump, and basal stem tissues to reach their maximum levels. The Hawaiian cultivars 'Papa Kea' and 'Honokane Iki' are in the 2-year maturing group. Other cultivars mature after 3 or 4 years. After 3 years there is less water in the roots, and the drink derived has stronger effects and plants are higher yielding.

Individual kava plants can grow for two decades or more without any loss of phytochemical essence or value, and the yield of older individual plants can be quite high. New stems form regularly on plants, and older plants may have dozens of stems, as the base of the plant expands radially. The lifetime of individual stems is approximately 2 years or more, depending on environmental conditions and disease and pest attack (e.g., insects, rodents).

Ethnobotanically, kava cultivars have both general and specialized uses. Cultivars may be restricted to medicinal applications or to consumption by a specific chiefly rank or during a specific ceremonial role that is determined by the properties of the cultivar or the character of the event. In the social realm, kava use varies from very formal ceremonies to casual gatherings. The most formal and ritualized ceremonies are for very important occasions such as welcoming or coronation of royalty, for heads of state, or to welcome highly honored guests. Life's significant events such as birth, marriage, and death are often accompanied by kava use or ceremony. Regular meetings of village leaders, chiefs, or nobles and visiting chiefs and dignitaries also have appropriate kava ceremonies. Common social events or gatherings and business meetings often start with a cup or two of kava.

AGROFORESTRY

Understory planting is a traditional method for cultivating kava, such as beneath or at the edge of the canopies of large trees or by or within forests. In the natural shade of a forest, kava usually has access to moisture and well drained, fertile soil, and low pest populations.

Left: A sprouting kava stem node embedded in moist sphagnum moss in a nursery in Hawai'i. A variety of light-textured, well drained, and well aerated growth media are suitable for the vegetative propagation of this plant. Right: Tongan farmer standing under a kava plant he grew for family use.

Left: A decades-old kava plant that was planted by Hawaiians near a stream on the island of Hawai'i. Middle: Freshly harvested kava plants in Pohnpei, Federated States of Micronesia, just before their processing into a fresh beverage. Right: Squeezing pounded kava tissues and water through *Hibiscus* stem fibers in Pohnpei for use as a fresh beverage.

Kava stems or rooted cuttings may be planted in any area within an agroforestry setting that has free soil for the roots to explore. Abundant rainfall may be necessary if plants are extremely isolated. Dry season irrigation could also be provided by water catchment tanks or ponds.

PROPAGATION AND PLANTING

The main requirement for cultivation of new kava plants is to use freshly harvested stems exposed to a moist but well drained, pathogen-free environment. Although commercial rooting preparations such as hormones may enhance root production, their use is not necessary.

Kava propagates readily from mature, freshly harvested entire stems or 1–4 node sections of stems. Stem sections should be severed very close to a node to minimize rotting. Stem sections having two or more nodes may survive and withstand rot better than sections of only a single stem node. Place the stem sections into a planting bed horizontally with the new leaf buds uncovered and facing the sunlight. Whole kava stems may also be planted directly or allowed to develop some roots and new shoots and then cut into smaller plantlets.

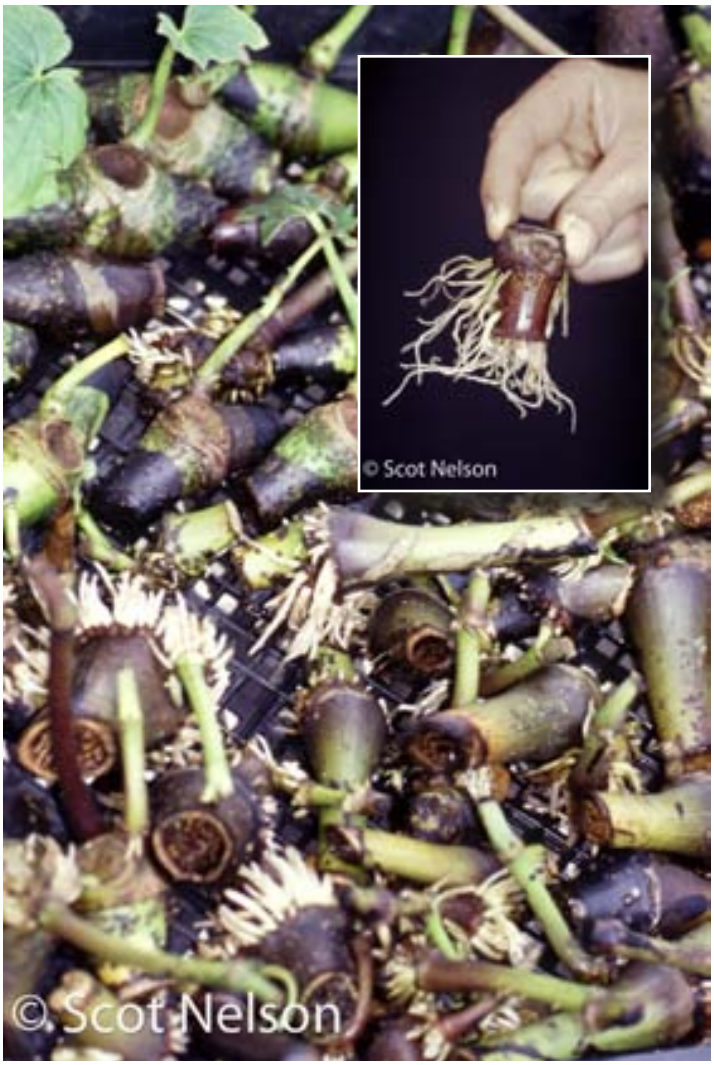
Loose, well drained, but moisture-retaining growth media are best for starting new kava plants. Rich top soil, sand, compost, or other media (potting soils) are appropriate for nursery production. Mixtures of media also work well, such as 10 parts soil, one part timber shavings, and one part coral beach sand. Avoid poorly aerated and poorly drained, heavy clay soils. Low oxygen levels caused by poorly aerated and inadequately drained soils foster rots of kava stem sections and roots.

Water daily and do not allow the growth medium to dry out. Provide at least 30–50% shade for young plants for several months, and thereafter increase sunlight gradually over time to harden the plants for outplanting. After about 3–5 months and when plants are about 30 cm (12 in) tall, they may be outplanted.

In another cultivation method, plant stems are harvested and detached from the base of a plant when its roots and stump are harvested for kava processing. The stems are trimmed of their lower leaves and placed in a nearby stream to soak (or they are outplanted immediately), and then outplanted in the following days to selected locations in a forest by inserting the lower end of the stem into a hole in the ground that is at least 20–30 cm (8–12 in) deep.

Where there is no ready supply of irrigation water, transplant kava at the beginning of the rainy season to ensure adequate moisture for plant survival and vigorous growth during the first critical months. Mulching and wind protection for young plants reduces the probability of undue stress from tissue damage, drought, and aerially dispersed viruliferous aphids.

Left: Kava thrives in a shaded environment where irrigation water may be scarce or expensive to apply. Here, a young crop of kava is grown under the shade of trees in Hawai'i. After about a year of growth, the trees are pruned back to allow more sunlight to reach the well established kava plants, and the stems of the pruned trees chipped into mulch and made into compost and placed around the kava plants for weed management and to retain soil moisture. Right: Kava understory in Tongatapu, Tonga.



Left: Bare rooting of kava stem sections in moist air is possible under a shaded misting system, which eliminates the need for a solid rooting medium. Right: Kava plant production in sphagnum moss at a small farm in Hawai'i. In the background the rooted plants are placed into rows of mounded volcanic cinder for their cultivation.

Freshly harvested, mature stems (1–2 years old) may be planted directly into soils, by inserting it at a 5–45 degree angle from horizontal and burying several nodes. Stem nodes rooted in nursery media are also outplanted.

CULTIVATION

Known varieties

Piper methysticum is a variable species with about 118 known cultivars in the Pacific region. Each island group where the plant is grown usually has one or more unique cultivars. Hawai'i has at least 13 unique cultivars.

Detached and trimmed kava stems with their basal ends immersed in a stream in an upland agroforest on the island of Pohnpei in the Federated States of Micronesia. The plant from which these stems derived was harvested beforehand and utilized for fresh beverage for consumption at a local kava market. These stems were subsequently used as planting material to start new plants in the forest. The basal ends of each of these stems may be inserted into the soil to start a new plant. Either complete stems or small stem pieces containing at least one node may be used effectively to propagate kava vegetatively. This planting method has been used in Pohnpei for thousands of years.

Local variation among kava plants emerged over the centuries by selection of the spontaneous mutants that arise naturally from existing plants. Cultivar identity is based on plant morphology (stems, leaves) and the qualities or effects of the consumed beverage derived from roots and stumps. Traditional and commercial cultivars are the same.

Names for the existing Hawaiian cultivars are 'Hanakapiai', 'Hiwa', 'Honokane Iki', 'Kumukua', 'Mahakea', 'Mapulehu', 'Mo'i', 'Nene', 'Opihikao', 'Panaewa', 'Papa 'Ele'ele', 'Papa 'Ele'ele Pu'upu'u', and 'Papa Kea'. All of these have traditional and commercial uses. Vanuatu has much more variation in kava plant morphology and a greater number of cultivars, where there are at least 80 distinct cultivars.

The modern vernacular names of the cultivars commonly refer to place names where a cultivar is abundant. The old Hawaiian names that can be traced directly to specific cultivars refer to unique or characteristic aspects of plant morphology.

Numbers of traditional cultivars by island state

Location	# of cultivars
Fiji	5
Hawai'i	at least 13
Marquesas	21
New Guinea (Kolepom)	5
Papua New Guinea	at least 4
Pohnpei	2
Samoa	9
Tahiti	2
Vanuatu	at least 80
Wallis and Futuna	3
Western New Guinea	at least 2

Basic crop management

Crop management practices for kava depend greatly upon the general cultivation practices of a given region. In some Pacific island states where kava grows in traditional agroforestry settings, there is very little crop management after planting. The plot may be fenced, if needed. Weeds are controlled during early phases of growth and compost or mulch added periodically as fertilizers. After kava plants have become well established, overstory plants are pruned back to increase light infiltration which enhances kava plant growth and maturity. There may be some clearing of plants within forests in some areas for more intensive cultivation of kava. These larger clearings require more attention to invasive weed control and to prevention of soil erosion. Where kava is grown in baskets or planters, there is little need for weed control.

About a year after outplanting kava to shaded areas, overstory trees may be pruned back or removed to allow more

Characteristic aspects of plant morphology

Characteristic	Possible variations	Example cultivar names from Hawai‘i
general plant appearance	erect, normal, prostrate	‘Papa’ = set close together, thick together
stem coloring	shades of green, purple, black	‘Hiwa’ = totally black
internode configuration and shape	uniform, mottled, speckled, striated and speckled; short and thick, long and thin, long and thick	‘Pu‘u pu‘u’ = full of protuberances, pimply
leaf coloring	shades of green or purple	
lamina edges	undulate, raised, drooping, regular	
leaf hairs	present or not	

Planting kava adjacent to a stream is a common traditional cultivation practice in the Pacific islands. The practice protects kava plants during periods of drought and provides a ready source of clean irrigation water. This plant was started by inserting a severed stem into the soil and rocks on the banks of the stream. The kava roots grew out into the flowing water. Flood damage is possible for plants growing near streams in steeply sloped landscapes or forests. Planting kava at least 1.2 m (4 ft) higher in elevation than stream level or at least 6 m (20 ft) back from stream banks can protect plants from flooding injury.

Kava growing in an elevated rock planter at a high-rainfall location in Hawai‘i. This practice may be modified in a number of ways, including the materials used and size of the planter. This technique eliminates the need for digging up the plant at harvest, but renders the plant more susceptible to drought because the roots are not as protected from exposure to air as they would be in non-elevated plantings in the ground.

Kava growing in basket planters made of wire mesh and polypropylene fabric in Hawai'i.

sunlight and the prunings chipped and used as mulch for water conservation and weed control, or composted.

Where kava is cultivated as a monocrop on islands such as in Hawai'i, crops are often managed as any other high-value, monocropped system and having a greater need for plant nurseries, soil fertility management, weed control, windbreaks, and effective pest and disease management practices.

Commercial production of kava as a monocrop in deep soils requires soil cultivation practices and the hilling or mounding of soil for planting. Crop sanitation practices and pruning may be required to manage certain diseases such as fungal leaf and stem spot (*Phoma* sp.) and kava dieback (*Cucumber Mosaic Virus*, CMV). Pre-plant nematicides may be necessary to manage root-knot nematodes (*Meloidogyne* spp.)

The main advantages of growing kava as a polycrop or in forests are the reduced need for crop management, especially for irrigation, weeding, and insects and disease control. The main disadvantages of growing kava as a polycrop or in an agroforest are reduced kava yields per unit area and slower plant growth and development.

PESTS AND DISEASES

Susceptibility to pests/pathogens

Kava is susceptible to a wide range of insect pests and plant pathogens. The diseases that affect kava most severely which may lead to severe plant debility or plant death include kava dieback (a virus disease caused by CMV), root rot (caused by the pseudofungus *Pythium splendens*), shot hole (a leaf and stem spot caused by the fungus *Phoma* sp.), root knot (caused by the root-knot nematodes, *Meloidogyne* spp.), and node rot of vegetatively propagated cuttings (caused by the fungus *Fusarium* sp.). Important insect pests that threaten kava crops include spider mites and aphid vectors of CMV such as the melon aphid, *Aphis gossypii*. There also exist a number of minor pests which do not usually cause major damage kava crops, but can produce conspicuous or obvious damage or symptoms. Kava is not salt-tolerant and the roots can be easily burned by commercial fertilizers, resulting in root rot and wilting and desiccation of foliage and even plant death.

Sustainable methods for preventing and treating problem pests and diseases

Sustainable methods for treating problem pests and diseases of kava include avoidance of dense monocropping systems and instead growing kava as a polycrop or in agroforests. Avoid exposing young plants to root-knot nematode infested soils. Use crop rotation and avoid cultivation of successive crops of kava in the same locations. Scout fields regularly for symptoms of severe diseases and practice good field sanitation to rogue out the most severely affected plant or parts of plants. For example, remove stems of plants that display symptoms of CMV infection or remove severely diseased plants altogether. Pick up leaves that have defoliated due to Phoma shot hole disease, and prune back and destroy severely diseased stems to interrupt the disease cycle and reduce levels of pathogen inoculum. Control weeds or plants that may become infected with CMV and infested

The stump and roots of kava may become infected by root-knot nematodes (*Meloidogyne* spp.), creating swollen, galled tissues that decay and turn black before harvest. The disease imparts an unpleasant, sour taste when roots are processed into beverages. It is very important to avoid planting kava stems or plants into media or soil that contains root-knot nematodes.

with its aphid vectors. Apply composts early in the cropping cycle to combat nematodes. Do not over-fertilize.

DISADVANTAGES

Consumption of the green, photosynthetic portions of the plant (leaves, stems) may not be healthy for everyone. The use of kava was or is banned in some European locations owing to a controversy about potential damage to human health. The controversy received much media attention, which halted a large portion of the kava export commodity market for Pacific island farmers in the early 2000s.

Freshly prepared kava beverages, such as those served in a kava bar, have a short shelf life and are problematic to pasteurize due to the root chemistry and reaction to heating. Application of pasteurization heat is problematic because components of the prepared kava liquid can separate, congeal, and precipitate.

A reversible skin condition known as kava dermopathy (characterized by scaly skin eruptions) can affect kava drinkers who consume large amounts regularly. Social and family problems may result from overuse of this plant. Infrequently tended plots may suffer from animal damage (e.g., pig) or plants may be lost to thievery.

Potential for invasiveness

Kava is not an invasive plant. It produces no viable seeds and can only propagate by vegetative means.

Foliar mosaic, leaf crinkling and yellow veins in leaves are just a few of the possible symptoms of kava dieback disease, caused by the plant-pathogenic virus, *Cucumber Mosaic Virus*. The disease is vectored by aphid species and also spread by infected stem cuttings used to make new plants. The disease can be fatal to young plants. Other symptoms include stem and plant dieback and blackened veins within leaves and stems. This is the most important and yield-reducing plant disease of kava in the Pacific. Symptomatic stems should be removed as soon as symptoms become evident, or heavily diseased plants rogued from fields. Remove infected stems by breaking them by hand at about three nodes from the base of the stem. Avoid cutting infected stems with tools to avoid transmitting the virus to other plants via infected plant sap. Planting kava in an agroforestry setting usually reduces the probability of CMV infection and epidemics of kava dieback.

Typical leaf spot and shot hole symptoms caused by a *Phoma* sp. (a plant-pathogenic fungus) on kava in Hawai'i. The disease may be very difficult to control in rainy locations and for kava grown within densely planted monocropping systems.

COMMERCIAL PRODUCTION

Scale of commercial production

Kava is a multi-million dollar industry worldwide. The Pacific islands are the main producers and exporters of kava. Hawai'i imports some kava from islands such as Fiji and Tonga. Most Pacific island nations do not import kava because they grow enough for their own consumption.

In the 1990s there were more than 10,000 ha (24,700 ac) of kava in cultivation throughout the Pacific islands, mostly in agroforestry or polycropping systems.

Estimated hectares devoted to kava cultivation (1990s)

Island state	Area
Fiji	3,000–4,000 ha (7,413–9,884 ac)
Tonga	800 ha (1,976 ac)
Pohnpei	300 ha (742 ac)
Vanuatu	6,000 ha (14,826 ac)
Hawai'i	less than 40 ha (100 ac)

Postharvest handling and processing for commercial use

Kava farmers, buyers, and processors distinguish among kava plant parts: the lateral roots and rootlets, the underground portion of the stem and stump, and the first three nodes and internodes. The value and effect of the kavalactones is highest in the roots and lowest in the nodes and internodes.

Traditionally, roots and stumps are dug out of the ground, chopped into manageable pieces, washed in fresh, clean water, and pounded or ground into a pulp using locally available tools or with equipment such as a hammer mill. For fresh consumption, the pulp is massaged continually with fresh water to extract the oily kavalactones, then filtered or sieved into a brownish aqueous suspension for drinking within a few hours after processing. Refrigeration can preserve the fresh kava beverage for 2–3 days.

For shipping or storage, the pulp may be dried into a powder or frozen. Alternately, the freshly harvested materials may be washed and shipped directly under refrigeration or freezing or dried as root or stump segments or chunks for further processing at destination locations.

Frozen pulp is treated as fresh pulp after thawing and may be processed into freshly made beverages as described above or processed into dried powder. The powders are mixed with water at room temperature and massaged to extract the kavalactones, as with fresh pulp.

The psychoactive and relaxing kavalactones may be chemically extracted from fresh or dried kava tissues and encapsulated or mixed into flavored beverages. Kavalactones are the

Top: Dried kava bagged for sale at a market in Fiji. Bottom: Vanuatu and Hawaiian kava sold in small packets at a farmers' market in Hilo, Hawai'i.

active ingredients of kava and produce a pronounced sedative effect. There are six kavalactone types that occur in different proportions in kava cultivars. The amounts and proportions of them impart distinctive psychoactive effects to the beverages derived from the cultivars. The kavalactones and their identifying numbers are desmethoxyyangonin (1), dihydroxykavain (2), yangonin (3), kavain (4), dihydromethysticin (5) and methysticin (6).

The word "chemotype" is used to describe a kava cultivar, and is based on the predominance of the six major kavalactones in the cultivar. For example, a cultivar with chemotype "643251" is richest in methysticin (6) and least rich in desmethoxyyangonin (1) by weight.

Methods of processing

Methods for processing kava that can be done to add value at a community or local farm level without highly technical, industrial processes include dehydration, freezing, infusion, and powdering.

Dehydration. Dehydration of kava roots brings the moisture content to acceptable levels (about 12.5% or lower) to retard spoilage from molds and bacteria. Materials are

Left: Metal racks used for drying kava roots in a propane-based drying chamber. Right: Dried lateral roots of kava from Hawai'i. Root tissues contain the highest percentage of the active ingredients, kavalactones.

washed clean before processing. Roots may be dried whole or chopped; stumps are chopped into smaller pieces before dehydration. Materials are dried in solar dehydration sheds or in propane gas-powered or electric drying chambers.

Freezing. Frozen materials are first washed thoroughly, chopped, and usually processed into pulp using a hammer mill. The pulped materials are placed into plastic freezer bags and frozen. The frozen materials may be kept in that state indefinitely without loss of potency.

Infusions. Infusions are solutions obtained by steeping or soaking a substance (usually in water). This is the traditional method for making freshly prepared kava beverages for sale at markets and kava bars. Fresh roots and stumps are washed in fresh water, chopped, pounded, and kneaded with water to extract the kavalactones, and then squeezed through natural or artificial fibers to produce a beverage that is relatively free of plant sediment.

Powdering. Dried material may be ground into a powder using a hammer mill or a hand-powered grain mill. Powders with small particle sizes are more desirable because they more readily produce a quality beverage and have more facile extraction of kavalactones.

Processing techniques

Solvent extraction (consisting of dry matter acquisition, crushing, powdering, solvent maceration, filtration, elimination of solid residues, evaporation and recovery of solvent, resin extraction, and placement of resin on a base to create 30% kavalactones powder). Solvent extraction is the process of exposing dried kava materials to a solvent such as alcohol in order to extract the kavalactones. The powdered materials may be macerated in the presence of the solvent and then filtered to eliminate solid residues. The solvent is then evaporated, resins are extracted, and kavalactone resins deposited on a base to create a 30% kavalactone powder. The powder may be used to make beverages or encapsulated within gelatin capsules.

Spray drying (consisting of fresh root acquisition, crushing, filtration, fresh juice, pump at high pressure, spray drying, and creation of a water-soluble powder). Spray drying involves creating a fresh juice from kava materials that are crushed and filtered. The juice is pumped at high pressure through fine spray nozzles to create a water-soluble powder for use in various products such as beverages.

Carbon dioxide extraction. In 2006 (Gow *et al*), a method was patented to extract kavalactones using liquid carbon dioxide and reverse phase high performance liquid chromatography (HPLC) to produce superior extract-based products. The patent states that "By controlling the extraction parameters and stopping the extraction before all of the kavalactones have been extracted or allowing the extracted kavalactones to be preferentially precipitated in one or more collection environments, a processed kava product can be produced that has a kavalactone distribution profile that can differ substantially from that of the source material. As a result, roots from a less desirable kava cultivar can be used to produce a processed kava product which has a kavalactone distribution profile that is similar to that of a highly desired cultivar. The kava paste can be further processed to produce a dry flowable powder suitable for use in, e.g., a tableting formula."

Quality standards

To ensure no adverse health effects from consuming kava, no green (photosynthetic) portions of kava plants (stems and leaves) should be consumed or included in bulk shipments of harvested materials. Only non-green stumps, lower stem sections and roots should be processed and consumed.

Harvested materials should be washed with clean, pathogen-free water to remove soil or growth medium. Product should be dried to approximately 12% moisture or less to prevent fungal or mold growth in transit or storage.

Product storage requirements

Dried kava powder or chunks can be stored in airtight containers for years without significant loss of potency or flavor. Fresh, unfrozen materials are normally consumed on the day of harvest or shortly thereafter if refrigerated. Fresh kava beverage (the aqueous suspension) must be refrigerated if not consumed within a few hours. Shelf life of processed roots and stump as a beverage is a maximum of only 2–3 days if not pasteurized. Shelf life of pasteurized beverages is from weeks to months, depending on the processing method and preservatives.

Recommended labeling and packaging

Labeling of bulk or finished products may include name of cultivars(s) used, physiological specifications or characteristics, chemical characteristics, date processed, processing technique, country or island of origin and product expiration date, any associated hygienic protocols or regulations satisfied, and if the product was grown and produced organically.

Bulk products shipped at the commodity level usually are not intensively labeled, but should include a statement regarding the exclusion of green kava parts and non-kava plant species.

Possible items for product labelling

Physiological specifications of kava	
Description	botanical name and brief description of product
Physical properties	simple tests designed to detect quality (appearance, aroma)
Flavor	description
Filth	soil, bacteria
Moisture content	approx. 12% or less
Ash	an indicator test for quality characteristics such as cleanliness (not to exceed 5.36%).
Kavalactones	percentage, the most important characteristic of kava
Physical characteristics	
Color	light brown or grey
Aroma	characteristic of the plant, free from other associated aromas
Flavor	description
Filth	not to exceed 0.63% weight to weight ratio on dry weight basis. Between 0.63% and 0.7% is second grade. More than 0.7% is designated for re-washing and re-drying.
Moisture	Not to exceed 12.54% when dried to a constant weight at 105°C (221°F). Kava between 12.53% and 12.88% is second graded, and over 12.88%, it is re-dried.

SMALL SCALE PRODUCTION

Kava is both grown and used extensively throughout the Pacific islands by households. In some locations, kava is harvested and used daily by families, primarily men. Growing this crop on a family farm can eliminate the need to purchase it or import it from elsewhere. Kava is well suited as a commercial crop for home gardens, urban lots and smaller farms (less than 0.5 ha [1.2 ac]). The plant may be cultivated as it is done on larger farms and harvested and sold fresh to local kava bars, or it may processed, dried or frozen for sale in farmer's markets. Kava can be processed as dried, frozen, or fresh material for sale to local kava bars, on the Internet, or in farmer's markets. The dried portions of the plant are popular on Internet markets and can be readily sold from home gardens or small farms in that manner.

Left: Coffee, a commercial crop, interplanted with kava for home use in Kona, Hawai'i. Right: A backyard kava planting among native hapu'u (*Cibotium menziesii*) ferns. Pahoa, Hawai'i.

Drying

Steps for drying kava include

- Wash material thoroughly, then cut roots and stump sections into small pieces
- Dry in direct sunlight (or in clear plastic-covered drying chamber) on a raised platform, or use a hot-air drying method during rainy seasons or in moist locations. The material should be dried to about 12% moisture or less.
- Place dried material in a moisture-proof container to prevent re-hydration and mold development. Store the dried material at less than 50°C (122°F). The recovery of dry kava from fresh material is approximately 25% by weight.

Kavalactone content in marketable parts of kava plant

Plant part	Percent kavalactones
Basal stem (the bottom three nodes, as long as they are not green or photosynthetic)	3–5%
Chips of the rootstock	3–8%
Roots	8–16%
Peeling (or root bark) of the rootstock	7–15%
Residues	variable

Nutrition

Kava contributes to the health of the community by relieving anxiety, promoting relaxation and sleep, and by fostering friendly communication among users.

YIELDS

Kava yields depend primarily on cultivar, plant age, growing conditions, and the presence of plant diseases. The fresh weight of the roots and stump of a healthy plant can vary from 9 to 27 kg (20–60 lb) or more for plants of 2–5 years of age.

Left: Washing freshly harvested kava with a power sprayer. Right: Table for air drying.

Nutritional content (percentage of dry matter), after Lebot and Cabalion (1986)

Proteins (amino acids)		Sugars	
Aspartic acid	0.28	Saccharose	0.50
Threonine	0.08	Maltose	0.10
Serine	0.11	Fructose	1.75
Glutamic acid	0.26	Glucose	0.85
Glycine	0.11	Total sugars	3.20
Phenylalanine	0.07		
Histidine	0.05	Minerals	
Lysine	0.10	Potassium	2.237
Arginine	0.08	Calcium	0.372
Alanine	0.16	Magnesium	0.179
Valine	0.11	Sodium	0.111
Methionine	0.02	Aluminum	0.150
Isoleucine	0.07	Iron	0.106
Leucine	0.14	Silica	0.090
Tyrosine	0.06	Total minerals	3.245
Others	1.87		
Total proteins	3.57		

For monocrops, spacing of 1.8 × 1.8 m (6 × 6 ft) or 2.4 × 2.4 m (8 × 8 ft) seems to be optimum for the kava plant. However, some farmers plant as close as 0.6 m (2 ft) apart or as far as 3.7 m (12 ft) apart. Closer plant spacing is more conducive to the development of plant disease epidemics and attacks from populations of insect pests. Rows of plants are separated by 1.8–3.6 m (6–12 ft). In agroforestry settings, plants are placed randomly or where space allows and usually not at regular spacing intervals.

MARKETS

Local markets

Local markets for kava include kava bars or markets (for consumption of freshly produced beverage), roadside vendors of freshly produced beverage, grocery stores for bottled beverage, and farmer's markets for fresh beverage and dried products.

Young kava plants may be sold at local nurseries or garden stores. Powders and encapsulated kava can be found in most health food stores and in some herbal remedy markets or health-related industries such as massage clinics.

Export market

Kava may be exported to any country or location where its use is legal or not banned, such as anywhere in the Pacific, to Asia, Australia, North America, Central and South America, etc. The largest export market is currently the United States.

For bulk shipments of kava, new, securely fastened, woven polypropylene bags, usually 16–22.7 kg (35–50 lb) dry weight, are commonly used in the Pacific for export. Each bag is labeled with the name of the exporter and the importer.

Specialty markets

The primary specialty market for kava is organic markets and health and nutrition markets. However, the location and method of cultivation in some Pacific island locations qualifies it for other specialty markets such as rainforest, bird friendly, and fair trade.

Branding possibilities include the names of unique or potent cultivars and novel processing methods for bottled beverages. Another possibility is to distinguish cultivars by their kavalactone profiles, and educate retailers and customers about the various benefits of certain profiles. The potential for Internet sales and marketing to tourists is very high.

Handmade kava-flavored chocolate sold at a local market. Kealakekua, Hawai'i.

EXAMPLE SUCCESSES

Pu'uala Farm and Ranch, Hawai'i Island

This farm grows kava organically in an understory, polycropping setting. The farm has been in business since the late 1990s. The farm is located in a relatively dry, windy coastal lowland environment on the Hāmākua coast of Hawai'i island near Honoka'a. Kava requires irrigation in this location, which is one of the biggest challenges. A plant disease problem that is managed well at this farm is kava dieback. Overstory trees are pruned periodically to allow more sunlight to enter the kava crop canopy. The farm business is vertically integrated: kava is grown and harvested at the farm and then processed promptly for fresh market consumption at a kava bar owned by the farmer at a tourist destination in Kailua-Kona, Hawai'i. Harvested materials have also been processed for fresh and dried products for export and for Internet sales.

Kava plants growing between rows of nitrogen-fixing trees (*Leucaena* sp.) at Puʻuala Farm and Ranch, Hāmākua, Hawaiʻi.

Puʻu O Hoku Farm and Ranch, Molokaʻi

This large farm grows kava in monocropped strips on the eastern tip of the island of Molokaʻi and has been in business for about 10 years. The farm exports dried and fresh kava materials mainly for consumption off-island. The main plant disease problems here and at many farms are the leaf spot and stem disease caused by the fungus *Phoma* and kava dieback.

Puʻu O Hoku Farm and Ranch, Molokaʻi.

Ālia Point ʻAwa Nursery, Hilo, Hawaiʻi

During the late 1980s through 2004, Ālia Point ʻAwa Nursery sold thousands of kava plants for farm, ornamental, and backyard planting. The nursery sold at the farmers markets and through retail outlets as well as direct on-site retail sales. Displays and brochures on how to plant, harvest, and home process were used to increase sales with good success. These included information about a hand-cranked corn mill to make kava beverages and commercial choppers to make commercial beverage products. Displays also included health benefits of kava drinks, cultural uses, and options for kava plants as ornamentals in landscaping.

Plants for retail sale at Ālia Point ʻAwa Nursery in Hilo, Hawaiʻi.

ECONOMIC ANALYSIS

Expenses of production

Expenses of production vary with location, cultivation method, and extent of processing. Kava is a cash crop for the Pacific islands of Vanuatu, Fiji, Futuna, Samoa, Tonga, Pohnpei, and Hawaiʻi.

For agroforestry operations, the principal cost is the land and labor for families involved in growing, harvesting, and processing the plant. Very few other inputs are used or required. There are usually no commercial fertilizers or pest control products used. There is some weeding and perhaps irrigation required for plants less than a year old.

For monocropping operations in Hawaiʻi, plants are usually prepared from stem cuttings of one to two nodes in length. These young plants are either produced by farmers from existing plants from stems purchased from other farmers, or as established plants in pots from nurseries.

Farm operations include:

- Harvesting of stems for plant production, processing stems into stem sections

- Nursery production of plantlets (materials and construction of the nursery, irrigation supplies and construction, growth media, rooting trays, growth pots, rooting hormones, pest control products and application equipment, fertilizers)
- Field preparation (soil sampling, tillage, mounding or hilling, field or plot layout, irrigation installation, soil amendments, windbreaks or shade trees)
- Outplanting (digging holes, transporting plants from nursery, planting the plants, irrigating the plants)
- Weed control (ongoing)
- Insect pest and disease control (ongoing)
- Scouting fields for problems.

Labor inputs for kava cultivation (assume 4-year cropping cycle) (source: Lebot 1997)

	Work days/ha (1,000 plants/ha)			
Activity	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Bush clearance	50			
Fencing upkeep	25			
Hilling up and shading	28			
Nursery work	10			
Cutting and planting	28			
Weeding	25	25	25	
Mulching and pruning	10	15	15	
Harvesting				28
Total	176	40	40	28

Expected income per plant

Expected income per plant depends on a number of factors, including yield per plant, intended market and level of processing. The value or cost of the products increases with more processing and for retail consumers.

Kava powders range in price, depending on the market source and amount purchased. Currently, the retail price is $66/kg ($30/lb) or more for dried kava powder. Prices depend on the quantity purchased, the cultivar, where it was grown, and the particle size of the powder. A kava plant having a fresh harvest weight of 14.5 kg (32 lb) can produce approximately 3.6 kg (8 lb) of powder valued at $240, given a retail price of $66/kg ($30/lb). Fresh kava drinks (approximately 300 ml (10 oz) or more cost several dollars apiece in Hawai'i kava bars.

FURTHER RESEARCH

Preclinical research published in 2008 in a scientific journal, Cancer Prevention Research, suggested strongly that kava has significant preventive and therapeutic potential against bladder carcinoma and against the major tobacco-related lung cancer diseases. Also, there is convincing epidemiological evidence that populations of kava drinkers have unusually low incidences of cancer diseases, despite high incidences of smoking tobacco products. Additional preclinical and clinical studies will determine the ultimate role of kava as a possible herbal remedy for some cancers, and may help to dispel the negative perceptions that arose in many Western countries as kava was banned by them in 2002 after reports of severe hepatoxicity associated with its ingestion. The liver damage associated with these reports was later found to be linked to inclusion of green (photosynthetic), non-root portions of kava plants within kava products.

Where planted as a monocrop in deep soil without shade, kava can develop grassy weed overgrowth that poses a large management problem for farmers.

Potential for crop improvement

Kava can possibly be improved by finding or producing superior cultivars that produce higher quantities of kavalactones.

Some kava cultivars (e.g., Papua New Guinean 'Isa') possess some significant resistance to important plant diseases, and if markets can be found for these cultivars they would be more amenable to monocropping than are the more disease-susceptible cultivars. Kava breeding by traditional means is currently not possible due to its lack of ability to sexually reproduce within current kava plant populations.

Genetic resources

There are more than 100 kava cultivars in the Pacific region, and therefore the genetic resources are relatively high for this species. In Hawai'i, there are collections at Amy B.H. Greenwell Ethnobotanical Garden, Waimea Falls Park, and Lyon Arboretum.

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OTHER RESOURCES

Public assistance

The University of Hawaiʻi at Mānoa, College of Tropical Agriculture and Human Resources

The College of Micronesia, Federated States of Micronesia (Pohnpei)

Internet

The University of Hawaiʻi at Mānoa has published a number of informative Cooperative Extension articles on important kava diseases, including a kava pest and disease image gallery online. These publications describe disease and insect pest symptoms and signs and also management strategies. Readers may also consult with the author on any pest and disease problem for kava.

Kava Pest and Disease Image Gallery: http://www.ctahr.hawaii.edu/kava (Scot Nelson)

Specialty Crops for Pacific Island Agroforestry (http://agroforestry.net/scps)

Farm and Forestry Production and Marketing profile for Kava (*Piper methysticum*)

Author: Scot C. Nelson, PhD, University of Hawai'i at Mānoa, Cooperative Extension Service, 3050 Maile Way, Gilmore 402, Honolulu, HI 96822; Tel: 808-956-2000; Email: snelson@hawaii.edu; Web: http://www.ctahr.hawaii.edu

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