Association for Hawaiian ‘Awa

Hawaiian ‘Awa

Views of an Ethnobotanical Treasure

Edited by Ed Johnston and Helen Rogers

Ē ka ‘ohu kolo ē, ho‘oua ‘ia mai i ulu ka ‘awa.
(O creeping mist, make it rain so that the ‘awa will grow.)

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Association for Hawaiian ʻAwa
Hilo, HI

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The quotation on front cover is from Mary Kawena Pukui and Samuel H. Elbert's *Hawaiian Dictionary*, revised and enlarged edition, 1986, p. 361.

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This book is dedicated to Mr. Genesis Lee Loy,
ʻawa grower of Panaʻewa,
kupuna and director of the Association for Hawaiian ʻAwa
since its founding in 1998.

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Acknowledgments

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About the Association for Hawaiian ʻAwa

The Association for Hawaiian ʻAwa (AHA) is a charitable organization established for "research, education, and preservation of the cultural and medicinal values associated with the ʻawa plant." Formed in 1998 with a federal grant from the Rural Economic Transitional Assistance-Hawaiʻi program, AHA received additional support at its inception from the Sacharuna Foundation.

AHA's original board of directors was comprised of Jerry Konanui, Jeri Ooka, Ed Johnston, Genesis Lee Loy, Joel McCleary, and Noelani Whittington.

By sponsoring a number of publications, workshops and conferences, AHA has shown people around the islands how to grow the plant, recognize the different Hawaiian varieties, and prepare the drink.

AHA has generally focused on ʻawa as a traditional drink consumed at the end of the workday to relax and have a deep, restful night's sleep. This was one of the numerous uses of ʻawa in old Hawaiʻi, and its importance and relevance to the populace cannot be overemphasized. We believe that, with thoughtful and responsible use, ʻawa can play a significant beneficial role in Hawaiʻi today.

AHA's Current Board of Directors	
Jerry Konanui	President
Jeri Ooka	Vice President
Ed Johnston	Project Coordinator
Genesis Lee Loy	Kupuna
Jorge Nijensohn	Director

Chapter 1

Introduction

Ed Johnston and Helen Rogers

The Plant

The plant called *'awa* in the Hawaiian language is known throughout the world as *kava*.[1] It has become prominent in alternative medicine for its ability to reduce anxiety, soothe sore muscles, and induce relaxation, calm, and sleep, without being addictive or impairing the user's judgment.

The botanical name is *Piper methysticum,* meaning "intoxicating pepper." According to James A. Duke (2000, 135), "Phytochemicals called kavalactones provide kava's stress-beating, muscle-relaxing influence. Each produces a somewhat different physiologic effect in the body and all of them working together are better than any one of them acting alone."

'Awa's origin has been called "one of the classic enigmas of Oceanic ethnobotany" (Lebot, Merlin, and Lindstrom 1992, 10). It is found throughout the migratory routes of Pacific Islanders, who prized the drink made from the rootstock.[2] The Hawaiian Islands were the final stop in 'awa's long voyage from Melanesia through Polynesia (see figure 1.2).

Y.N. Singh (1992, 13) has noted that the "kava custom . . . so widespread throughout Oceania . . . might be considered the one item in their material culture that linked together most of the peoples of Oceania." Over the centuries, the various Pacific regions developed unique cultivars[3] of this plant, each with its own distinguishing features and chemical profile.

According to Lebot, Merlin, and Lindstrom (1992, 53), "it is possible that all kava cultivars trace back to a single ancestral plant somewhere in northern Vanuatu that has been repeatedly cloned, developed, and dispersed by stem cuttings over perhaps three millennia."

This ancestral plant probably was *Piper methysticum* var. *wichmannii* (often referred to as *Piper wichmannii*), whose roots also contain the psychoactive chemicals. However, in this wild relative of 'awa, the less desirable kavalactones predominate. Its roots would make a much inferior drink.

P. methysticum lost the ability to produce seed during the course of its long developmental history. Thus, improved varieties could not arise from sexual reproduction, and native cultivators propagated it exclusively through stem cuttings. Nevertheless, through millennia of vegetative propagation, unique cultivars emerged.

Pacific Islanders produced varieties of 'awa by selecting the somatic mutations sometimes arising as offshoots of the parent. "Somatic mutation" is the process whereby the genetic make-up of part of the plant changes. A single stem in a plant might look different from the others, leading a farmer to propagate from that stem, thus creating a plant with a different appearance.

Likewise, changes in the chemistry of the roots that alter the drink's effects could prompt the native planter to retain a new variety (Lebot, Merlin, and Lindstrom 1992, 39). If the drink was not to their liking, they stopped cultivating the plant. This selection process has produced numerous cultivars throughout the Pacific, each with the potential to act somewhat differently on the body and mind.

Fig. 1.1. Drawing by Sydney Parkinson, 1769. 'Awa: *Piper methysticum* var. *methysticum*

[1] The names are used interchangeably in this book, though 'awa is favored, especially in discussions of the plant in the Hawaiian context.

[2] For a picture of the rootstock, see figure 8.13 on page 77.

[3] Short for "cultivated variety," a cultivar is a plant variety found only under cultivation. Within a species, there may be a number of named cultivars individually recognized by distinctive characteristics (Robinson 2001, 34).

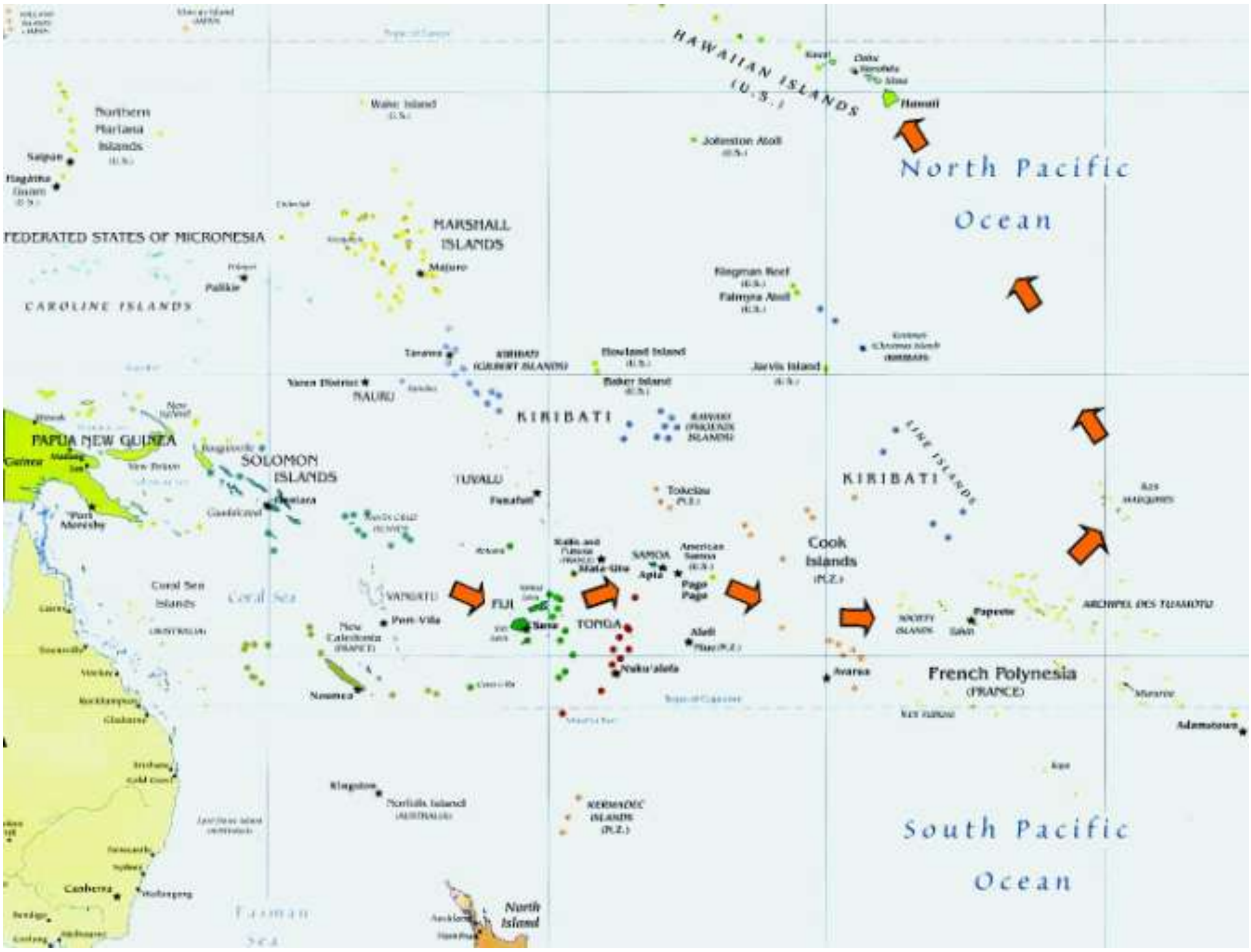


Fig. 1.2. ʽAwa's progress through the Pacific to Hawaiʽi.
Based on map entitled *Oceania* by the U.S. Central Intelligence Agency (2001) and Lebot, Merlin, and Lindstrom (1992, 52).

ʽAwa Comes to Hawaiʽi

As Pacific Islanders migrated throughout the vast ocean of scattered islands, they brought with them their most important plants. This is the way ʻawa came to Hawaiʻi, at the outer reaches of Polynesia, with the early settlers. The cuttings, brought as “canoe plants” probably from the Marquesas, became the cultivars we grow and consume in Hawaiʻi today.

ʻAwa had many uses in old Hawaiʻi. Margaret Titcomb summarized them in her article, "Kava in Hawaii":

> The awa custom is of interest in Hawaii because it was a sacred drink of importance in many phases of Hawaiian life. Outside of water and drinking coconut, no other drink was known. Its effect is to relax mind and body and it was used by farmer and fisherman for this purpose. Medical *kahunas* (learned men) had many uses for it. It was customary for chiefs to drink it before meals, for commoners also if obtainable. It was essential on occasions of hospitality and feasting, and as the drink of pleasure of the chiefs. The manner of its use indicated rank, though not to the extent displayed in western Polynesia. It was a fit and necessary offering to the gods and the gods shared with man the desire for its potent effect (Titcomb 1948, 106).

Chapter 2 of this book, Kepā Maly's paper entitled "ʻAwa: Cultural-Historical Perspectives in Hawaiʻi," discusses many of the uses of ʻawa in Hawaiʻi.

Hawaiʻi's unique climate and environmental conditions caused the plant to mutate to suit the new surroundings. In addition, Hawaiian planters worked with nature to develop new plant cultivars:

> In the matter of shrewd observation of varieties and careful, conscious selection of mutants in the creation of subvarieties of their plants, the Hawaiians were true experimental horticulturists. New varieties are still consciously created by selecting sports from bud or slip mutation. A variant sport … is termed a *keiki* (child) (Handy and Handy 1991, 21).

The mutations that pleased the horticulturists were kept and propagated for Hawaiian gardens, while undesirable ones were discarded. In this way, ʻawa cultivars developed as an expression of Hawaiian culture and became a part of the rich cultural legacy of Hawaiʻi's people.

In 1999, *Economic Botany* published the first research paper specifically about the ʻawa cultivars of Hawaiʻi. DNA was studied in 22 plants, and 44 plants were analyzed for major kavalactones and morphological traits. The article concluded that thirteen distinct cultivars unique to Hawaiʻi are now known and that our ʻawa cultivars are likely to be somatic mutations from a single variety introduced by Polynesian voyagers to Hawaiʻi (Lebot et al. 1999, 407).

The thirteen cultivars remaining to us in Hawaiʻi reflect the intentions of the people who selected and preserved them in cultivation. It is not surprising then that Hawaiʻi's cultivars are highest in those kavalactones most "valued for their especially pleasant effects" (Lebot et al. 1999, 415).

These Hawaiian cultivars are described and shown in photographs in chapter 5. Information on seven non-Hawaiian cultivars also grown here is given in chapter 6.

We have fewer ʻawa cultivars now, growing in our farms and gardens, than the ancient Hawaiians had. In the days before the missionaries held sway in Hawaiʻi, ʻawa was central to daily life. There may have been 35 different cultivars, possibly more (Winter 2004, 80). It is entirely possible that some of the lost ʻawa cultivars of old Hawaiʻi still remain, just out of view, growing in isolated valleys or perhaps in someone's backyard.

Horticultural knowledge can help us protect and sustain the varieties we still have. To this end, the Association for Hawaiian ʻAwaʻs *ʻAwa Production Guidebook*, first published in 1999, has been updated and incorporated into this book as chapter 8. Following it is a chapter by Scot Nelson on pest and disease management for ʻawa plants.

Misconceptions about ʻAwa

Health Food of the Gods or Dangerous Drug?
ʻAwa was often mistrusted by newcomers to the Pacific. Captain James King, who sailed under Captain Cook, was understandably concerned about it:

> The Excess with which the Chief[s] drink the Kava, destroys their Strength & makes them sad objects of Debauchery, they far outdo in the use of this pernicious root all the other Indians we have vist'd; the more Scaly their bodies are, the more honourable it is with them. . . . Many before they are forty are miserable Objects, their whole frame trembles, their Eyes are so sore & redned, that they seem in Constant pain; yet I believe in a short time by disusing this liquor the soreness of the Eyes goes away; at least we made some of our friends refrain & they recovered amazingly (Cook [1784] 1967, 3:617).

Captain Cook noted that "though these islanders have this liquor always fresh prepared … I have seen them drink it seven times before noon" (Cook 1784, 3:142).

It is true that very excessive consumption can cause the skin condition called "kava dermopathy." It disappears quickly once the patient stops taking ʻawa (Norton 1994, 94). In fact, Hawaiians used to deliberately induce kava dermopathy as a skin peel and cure for skin conditions. After the drinker stopped using so much ʻawa, the scales came off, leaving smooth, new skin instead (Titcomb 1948, 125-126).

ʻAwa had many medicinal purposes, notably to treat insomnia, muscle aches, and excessive weight (Krauss 1993, 102; Kamakau [1869] 1976, 43). In general, native Hawaiians saw ʻawa as a healthy drink and important medicine—a plant that helps people—and an offering essential for winning the favor of the gods.

ʻAwa use continued despite the antipathy it aroused in the missionaries, who recognized its importance to the old Hawaiian religion and feared its intoxicating effects. A few years after missionaries arrived in the early 1820s, Queen Kaʻahumanu declared that "the planting of ʻawa is prohibited. Neither chiefs nor commoners are to drink ʻawa" (Kamakau [1868] 1961, 299). However, missionary John S. Emerson was soon complaining that "laws against rum, awa, idolatry, kakauing (tattooing), gambling & the like have been laid aside . . ." (Emerson 1840, quoted in Sahlins 1992, 1:158).

Laws were enacted later in the 19th century to restrict ʻawa to medicinal uses and to require expensive licenses to cultivate or sell it (Brown 2003, 102). Nevertheless, the use of ʻawa continued. Indeed, Isabella Bird remarked that

> No law on the islands is so grossly violated. It is easy to *give* it, and easy to grow it, or dig it up in the woods, so that, in spite of the legal restrictions, it is used to an enormous extent (Bird [1875] 1964, 178).

There were prosecutions, however, and the laws must have made ʻawa consumption more difficult in some localities.

Mark Twain saw ʻawa being sold in the market when he came through Hawaiʻi in 1866: "It is said that but for the use of this root the destruction of the people in former times by certain imported diseases would have been far greater than it was . . . but all are not willing to allow to the awa the virtues claimed for it" (Twain [1871] 1993, 452).

A Mormon mission president on Oʻahu caused a rift in his church in 1874 when he attempted to stop some of his congregation from cultivating, selling, or drinking it. When the crops were ordered destroyed, "this pronouncement almost caused a riot in the chapel" (Britsch 1989, 85-86).

Such was ʻawa's reputation that even people born in the islands, with no first-hand evidence against ʻawa, believed it should be banned. In 1903, the Rev. Oliver P. Emerson wrote of chewing the root himself and of his surprise that a certain Hawaiian man, whom he knew to be full of strength and stamina, drank ʻawa in the evenings to soothe sore muscles and sleep — with no ill effects. Nevertheless, Emerson (140) concluded that "alcohol, opium and awa are allies, bringing their victims to the same woeful end."

The name of the plant is also the name of the drink made from it. Unfortunately, today the name "kava" is also given to commercially available pills and extracts. These often contain only some of the chemical constituents of the ʻawa rootstock and may be adulterated with other material.

Recently, very rare cases of liver failure have been linked to the pills and extracts, which is surprising since numerous clinical trials of ʻawa revealed few side effects. Several countries have banned ʻawa altogether, though it is still lawful to sell and use it in the United States. At present, the prohibitions against ʻawa in Europe are being reviewed and may be repealed. ʻAwa's chemistry and safety are covered in chapters 3 and 4 of this book.

People considering ʻawa for themselves must weigh the risks associated with ʻawa against its benefits. There are warnings to be aware of (Singh 2004, 133). Pregnant and lactating women and depressed people should not drink ʻawa. Drinkers are cautioned against operating machinery or driving. ʻAwa should not be used with alcohol or other central nervous system depressants, and there is potential for interaction with other drugs. (Consequently, people facing surgery or anesthesia should ask their doctors when to begin abstaining from ʻawa.) Parkinson's disease patients should definitely avoid ʻawa. The U.S. Food and Drug Administration has advised people with existing liver disease or taking medications affecting the liver to consult their doctors before using ʻawa (U.S. Food and Drug Administration 2002). [The supplement to this book provides information about more recent studies on potential health effects of ʻawa.-Editors.]

ʻAwa Confused with Alcohol

Misconceptions about ʻawa originate most commonly outside the Pacific Island peoples who know it well. Westerners often thought of ʻawa as a pernicious vice, at least as harmful as alcohol can be. Indeed, as late as 1997, a standard reference book from a respected university press declared ʻawa to actually ***be*** a fermented, alcoholic drink (Vaughan and Geissler 1997, 146).

In reality, ʻawa's effects are relatively mild and quite unlike alcohol's. In the words of an anonymous Hawaiian from 1871:

> [I]t is not right to arrest those under the influence of ʻawa; for when one looks at a person who is intoxicated with rum one can plainly see that he is drunk, but with ʻawa it is not possible to tell whether one is drunk or not. And too, one who is

> drunk with ʻawa does not make trouble like the one who is drunk with rum, who talks out loud. He may have received his glassful from another person but it is he who fights and shouts aloud before others. On the other hand, when a man is drunk with ʻawa, his body relaxes, his mind also relaxes, and he does nothing to interfere with the peace of others so that it becomes necessary to forbid and blame him (Anonymous, 1871, quoted in Brown 2003, 103).

It has been far from easy for societies around the world to accommodate alcohol. Down through the ages, excessive drinking and the resulting social problems have been widely deplored. From the innermost heart of the Western literary canon, Shakespeare himself has one of his characters admit, "I could well wish courtesy would invent some other custom of entertainment" (*Othello* 2.3.26). Hawaiians had that alternative in ʻawa, which was "the drink of pleasure," at least for the aliʻi.

As alcohol became more important in Hawaiian life, ʻawa lost influence in many arenas. Alcohol even began to replace ʻawa in offerings to Pele (Pukui n.d. quoted in Winter 2004, 39). At present, it's not uncommon for the popular press to state that the traditional offering to Pele is brandy, gin, or whiskey, with no mention of ʻawa at all. The fact is, in the words of Margaret Titcomb, "all the gods demanded ʻawa, lesser gods, male and female, personal, family gods and hero gods" (1948, 157). Pele, in particular, is associated with ʻawa (Kanahele and Wise 1989, 43-64; Titcomb 148, 129). The widespread belief that alcohol is her traditional offering is a major indication that ʻawa's eclipse by alcohol in Hawaiʻi is very nearly complete.

Although the use of ʻawa is increasing around the state, Kāwika Winter notes that alcohol customs have supplanted ʼawa customs. Social drinking in bars is now the way ʻawa is used instead of the many practices respecting ʻawa that Hawaiians formerly maintained (Winter 2004, 117).

False ʻAwa: *Piper auritum*

A number of plants are sometimes mistaken for ʻawa, including *Piper auritum*, sometimes called "false ʻawa" (Ram 1999a, 8). These species are in the *Piper* genus, but they do not have kavalactones and, thus, do not provide ʻawa's psychoactive effects.

Nurseries have even sold *P. auritum* under the name ʻawa. Luckily, several important characteristics enable us to tell the plants apart. The leaf of *P. auritum* has a more elongated shape than ʻawa leaves do, and *P. auritum*'s leaf features a midrib through the center, with veins branching out along it. ʻAwa leaves, on the other hand, have nine to thirteen veins radiating out from the point where the leaf meets the stem.

Fig. 1.3. Comparison of the leaves of *Piper auritum* (left) and *Piper methysticum* (right)

The smell of the crushed leaves is also quite different. The safrole in the leaves of *P. auritum* makes them smell like sassafras or root beer.

Often, *Piper* species that look like ʻawa are actually invasive species, capable of choking out desirable plants. If your land has an ʻawa look-alike instead of ʻawa, you should consider uprooting and discarding it. The many photographs in chapter 5, showing ʻawa's overall appearance, swollen stem nodes, and distinctive leaves, will help growers avoid the counterfeits.

There is More to ʻAwa than Just Kavalactones

Chapters 3 and 4 discuss kavalactones, the chemical components that cause ʻawa's psychoactivity. These chapters also describe other chemicals in ʻawa with physiological effects. In fact, researchers are studying the possibility that certain compounds in ʻawa called flavokawains[4] may help prevent cancer (Zi and Simoneau 2005, 3479; Folmer et al., forthcoming). [The supplement to this book provides information about more recent studies on potential health effects of ʻawa.-Editors.]

[4] Also spelled flavokawin, flavokavin, or flavokavain.

Chapter 7, which explains how to prepare the ʻawa drink from fresh and dried roots, also lists the sugars, amino acids, and minerals found in ʻawa.

The above-ground parts of the plant (stems and leaves) contain an alkaloid that may be damaging to the liver. This is why it's advisable to avoid consuming anything but the rootstock (the stump and roots growing from it). Chapter 4 gives more information.

Conclusion

The heart of this book is its presentation of the thirteen Hawaiian cultivars still in existence. These are all that have been found growing throughout the islands in farms, gardens, forests, and gulches—that we know of. Each is the result of careful observation, centuries of use, and a wealth of experience in growing this remarkable plant. The Hawaiian people can take pride in naming them among the treasures of their culture.

Chapter 2

'Awa: Cultural-Historical Perspectives in Hawai'i

Kepā Maly

Introduction

By way of this small collection of native Hawaiian traditional and historical accounts, I wish to provide readers with a general overview of the cultural context of ʻawa[1] (*Piper methysticum*) in Hawaiʻi. The narratives include documentation from two primary sources — (a) the writings of nineteenth and early twentieth century Hawaiian historians, and (2) oral history interviews with kūpuna (elders) born between c. 1912 to 1930. This collection of historical accounts is by no means exhaustive, nor does it include references to all cultural materials published on ʻawa in Hawaiʻi. Instead, and perhaps of greatest interest, you will be introduced to several little known historical accounts about ʻawa, that were recorded by native writers in Hawaiian language newspapers.

It is significant to note here that, in Hawaiʻi, ʻawa was important in many aspects of Hawaiian life. Uses of ʻawa ranged from ceremonial observances and offerings—including ceremonies in the affairs of state—to residential use. It is not uncommon to learn from kūpuna around the Hawaiian Islands that, following a hard day's toil in the agricultural fields or upon the ocean fishery, their own kūpuna often found comfort and restoration in a cup of ʻawa.

In reading this small collection of historical accounts, I also share with you a saying taught to me by my kūpuna hānai (adoptive grandparents) on Lānaʻi —

O ka mea maikaʻi mālama, o ka mea maikaʻi ʻole, kāpae ʻia.
(Keep that which is good and set that which is not good aside)

---

[1] '*Awa* — the ancestors of the Hawaiian people came from Kahiki (various islands of lower and middle Polynesia), as early as ca. 500 A.D. Those who are familiar with Polynesian cultures can see many aspects of the religious, political, social, and material culture of the Hawaiians that resemble those of the people of Kahiki. Upon study, it is also clear that in Hawaiʻi, over the centuries, the cultural attributes of the Polynesian ancestors underwent change, adapting to the unique and isolated environment of the Hawaiian Archipelago. In the Hawaiian word ʻ*awa*, we see one of the localized modifications that occurred in the spoken language. A glottal mark – ʻ – in a Hawaiian word emphasizes the pronunciation of the vowel that follows it. Use of the mark also tells us that in the older spoken language, there was a – **t** or **k** – at the place where the glottal mark occurs. Thus, the word ʻ*awa* is a unique, centuries old, Hawaiian adaptation from the ancestral word "*kawa*" or "*tawa*" (*i.e.*, *kava*). It will be seen in the native accounts cited in this paper, that not only the word ʻ*awa* was changed in Hawaiʻi, but also the forms of its use also evolved. In Hawaiʻi, uses of ʻawa ranged from ceremonial to medicinal, and ʻawa was also enjoyed casually by the makaʻāinana (people of the land).

ʻAwa was the food of the gods, just as poi was to the Hawaiians.
No religious ceremony was complete without the ʻawa.
Ms. M.K. Pukui ca. 1942

There are several native traditions regarding the origin of ʻawa in Hawaiʻi. Perhaps the most significant narratives describe ʻawa as having been brought to Hawaiʻi from Kahiki (the ancestral homelands) by the akua (gods) Kāne and Kanaloa. These two akua — Kāne, a Hawaiian god and ancestor of the chiefs and commoners, a god of sunlight, fresh water, verdant growth, and forests; and Kanaloa, a god of the ocean, marine life, healing, and a companion of Kāne (cf. Pukui 1973) — planted ʻawa at various localities throughout the islands. In places where no water could be found with which to prepare the ʻawa, Kāne even caused water to appear, thus forming many springs and streams in the islands (cf. Kamakau 1961:193 & Handy et al., 1972:189).

Writing in the 1860s, Hawaiian historian, Samuel Mānaiakalani Kamakau (born in ca. 1815) wrote that:

> ʻAwa was one of the choice foods of the planter. ʻAwa is a handsome plant, with nicely rounded leaves and stems and shiny jointed sections. . . . ʻAwa grows well on lands with plenty of rain, and on warm lands… From of old there are places made famous by the intoxicating quality of their ʻawa, such as Koʻukoʻu on Kauai, Hena on Oahu, Lanakila on Maui, and Puna on Hawaii. In places where wauke and dry taro are planted, ʻawa may also be planted. These plantings together with those of bananas and sugar canes, were the pride of the farmer. . . . It takes from two to three years for ʻawa to mature, and it will keep on growing for many years and be a bequest to one's descendants. [Kamakau 1976:41-42]

A later account written by native historians of the early twentieth century recorded a mele (chant) used to cause the newly planted ʻawa to grow abundantly. Thus even in cultivation protocol was set in place. In this mele, the agriculturist—in a dryland environment—called upon the goddess Ka-ʻohu-kolo-mai-iluna o ka lāʻau (The-mist-which-crawls-atop-the-forest) to cause the ʻawa to grow—

E Ka-ʻohu-kolo-mai-iluna-o-ka-lāʻau	Hail Ka-ʻohu-kolo-mai-iluna-o-ka-lāʻau
E hoʻoūlu aʻe ʻoe i ke aka o ka ʻawa	You who cause the ʻawa stalks to grow
E Hoʻolaupaʻi aʻe ʻoe i ka lau o ke ʻawa	Cause the leaves of the ʻawa to increase
E hoʻopiha aʻe ʻoe a piha ka mākālua	And fill the planting holes
I ka ʻawa hiwa a ka ʻiole e ʻai ai	With the dark ʻawa which the rat likes to eat
I ka ʻawa lau a ka manu i lawe ai	The ʻawa of the gods, planted by the birds
I ka ʻawa kapu a kuʻu makuakāne	The sacred ʻawa of my father
A Pōhaku-o-Kāne-maka-iʻa e	Pōhaku-o-Kāne-maka-iʻa
E Ka-ʻohu-kolo e	Say Ka-ʻohu-kolo-mai-iluna-o-ka-lāʻau
Hoʻoua ʻia i ulu ka ʻawa a kāua	Let the rains increase the ʻawa growth
E ola iaʻu la Ka-Miki la	Let life come to me, Ka-Miki

Ka Hōkū o Hawaiʻi, March 26, 1914; Maly, translator

In Kamakau's writings, we also find detailed descriptions of cultivation techniques and uses of 'awa. While he records that 'awa was important as an offering in rituals and ceremonies, he also informs us that 'awa was also in general use among the people of the land. In his narratives, we learn of the broad significance of 'awa in Hawaiian culture:

> Ka po'e kahiko [the ancient people] liked 'awa as a means of reducing weight. When a man saw himself growing too fat, or perhaps constantly being sick, then 'awa was the thing to restore health or to slim the body. The way to do it was to drink 'awa like the 'aumakua [family gods] or the kaula prophets, that is, copiously, until the skin scaled. . . . 'Awa was a refuge and an absolution. Over the 'awa cup were handed down the tabus and laws of the chiefs, and the tabus of the gods, and the laws of the gods governing solemn vows and here the wrongdoer received absolution of his wrongdoing. [Kamakau 1976:43]

'Awa — In the Customs and Practices of Hawai'i

Kamakau observed that it was through prayers and offerings of 'awa that the ancient people of Hawai'i sought to ensure the well-being of the native population. Planters offered 'awa to ensure the success of future crops, and the fishermen did so, to ensure bountiful catches (ibid.: 43-44). Eldest of the nineteenth century Hawaiian historians, David Malo (born in ca. 1793), wrote about the customs of canoe makers going to the mountains to choose a koa log for a canoe (Malo 1951). 'Awa was one of the offerings made in the ceremonies of the kahuna kālai wa'a (master canoe maker-priest). After the kahuna had gone to the mountain to pray and make offerings, he then determined which tree was best. He then returned to the people and:

> 5. …Preparations were made accordingly to go into the mountains and hew the koa into a canoe. They took with them, as offerings, a pig, cocoanuts, red fish (*kumu*), and *awa*.
>
> Having come to the place they camped down for the night, sacrificing these things to the gods with incantations (*hoomana*) and prayers, and there they slept.
>
> 6. In the morning they baked the hog in an oven made close to the root of the koa, and after eating the same they examined the tree . . . to measure the part suitable for the hollow of the canoe. . . .
>
> 7. Then the *kahuna* took the ax of stone and called upon the gods: "O Ku-pulupulu, Ku-alana-wao, Ku-moku-halii, Ku-ka-ieie, Ku-palalake, Ku-ka-ohia-laka. . . . " "O Lea and Ka-pua-o-alakai, listen now to the ax.
>
> This is the ax that is to fell the tree for the canoe . . . ." [Malo 1951: 126-127; see also p. 88]

Paraphrasing several other early native accounts, ethnographer Martha Beckwith (1970) provides readers with further documentation of practices and uses of 'awa in Hawaiian culture:

> Different varieties [of 'awa] are distinguished by their color and markings and by the size of the root sections. Babies were given the juice of the nene variety as a soothing syrup. "This is a fretful (onene) child and must be given the awa nene," is the saying.[3] Only the most common variety could be used by the commoner; the rarer kinds were reserved for the chiefs. For the gods and on ceremonial occasions the moi[4] (royal), hiwa (black), and papa (recumbent) were used, the papa from which the moi was often an offshoot, being specially offered to female deities. The most highly prized was that which sprouted upon trees so that the roots to be gathered grew exposed on the tree. It was called awa "resting on trees" (kau laau) or "planted by the birds" (a ka manu).
>
> Awa offered to a god was either poured or sprinkled over the image, or, if there was no image, the kahuna sprinkled it in the air and drank the remainder in the cup. The cups used were always made of polished coconut shells, cut lengthwise in the shape called kanoa. The cups were

[3] In this case, use of the word *nēnē* is symbolic of murmuring, like the soft chatter of the native geese. By the play on the word *nēnē*, use of the *'awa nēnē* was believed to help temper the voice of the youngster.

[4] Pronounced *mō'ī*.

never placed on the floor itself but on a piece of bark cloth spread before the priest or server, and never where they might be stepped over or otherwise desecrated. As soon as the ceremony was over, they were washed, placed in a net (koko), and hung from the rafters. The strainer was also carefully washed and hung in a tree to dry. The order of serving also was important. At the entertainment of a guest, it was considered an insult to the host if the guest refused the cup or passed the cup handed to him, as guest of honor, to an inferior chief. Before war especially all chiefs drank together a cup of awa, which passed from hand to hand in order of rank. In passing the cup to a chief it was customary to utter some appropriate remark or sing a chant, but no particular form was fixed by tradition. [Beckwith 1970:94]

In an account of ceremonies of the hālau hula (schools of chant and dance), native historian Mary Kawena Pukui (1943) presented readers with examples of mele that were used in offering ʻawa to the gods and in partaking in the ʻawa drink:

> A portion (apu) of ʻawa was given to each dancer. The first portion was poured as an oblation upon the altar while the master chanted:

Eia ka ʻawa, e ke akua!	Here is the ʻawa, o god!
He ʻawa lani wale no.	It is only heavenly ʻawa for you.
Inu a ke kama iki;	Drink of the beloved child;
I ka ʻawa lau lena,	The ʻawa of the yellow leaf,
I ka ʻawa Ke-ahi-a-Laka	The ʻawa of Ke-ahi-a-Laka [in Puna]
Hālāwai akula me Pele,	Meeting with Pele,
Ke ako ala i ka lehua,	Plucking the lehua,
Ke kuʻi ala i kai o Hōpoe, la.	Stringing it [into a garland] down by Hōpoe [on the shore of Keaʻau].
He ʻawa no nā kāne	ʻAwa for the men,
A me nā wahine o ka lani	And women of the heavens,
He ʻawa no nā kāne	ʻAwa for the men,
Me nā wahine o ka lua.	And for the women of the pit [volcano].
Pēlā aku, pēlā mai,	Thus it was, thus it is,
E mū ka waha, e,	Silence the mouth,
E holoi i ka lima.	Wash the hands.
Elieli kapu, elieli noa,	Sacred is the taboo, sacred is the freeing,
Noa ke kapu, noa ka hele,	The taboo is lifted and one can go,
Noa kānawai a ke akua	The law is lifted by the gods

Pukui 1943:216-217

‘Awa—He Mo‘olelo Ka‘ao (A Native Tale)

In the period between 1914 to 1917, several native historians compiled and wrote a traditional account of the journey of two brothers around the island of Hawai‘i via the ala loa (an ancient trail system), which encircled the island. Titled “Ka‘ao Ho‘oniua Pu‘uwai no Ka-Miki,” or “The Heart Stirring Story of Ka-Miki” (Maly, translator), the narratives provide us with several detailed accounts of ‘awa—sources, preparation, ceremony, and customs—and rich place name accounts. Selected excerpts from the tradition for the districts of Kona, Kohala, Hāmākua, Hilo, and Puna are presented below:

> Ka-Miki and his brother Maka-‘iole, the great grandchildren of the forest and earth-form goddess Ka-uluhe-nui-hihi-kolo-i-uka were trained in all manner of Hawaiian martial arts. The purpose of their training was to have them rid the trails and royal communities of individuals who abused the people and lands around Hawai‘i.
>
> When their training had been completed, Ka-uluhe instructed Ka-Miki to journey to the hālau ali‘i (royal compound) of one of their elder relatives, Poli‘ahu on Mauna Kea. Poli‘ahu and her companion Lilinoe were the guardians of Waiau and the sacred water of Kāne. Maka-‘iole was instructed to go collect the ‘awa (*Piper methysticum*) of the god Luanu‘u at Waipi‘o. These two items would be used in an ‘ai-lolo (ceremony of graduation), commemorating sacred nature of the brothers and completion of their training in ‘ōlohe skills. Ka-uluhe told the brothers —
>
> You, Maka-‘iole, are to fetch the ‘awa ili lena (yellow barked ‘awa) which the gods drink till they are drunk, and bleary eyed. Till their eyes are reeling, it is the ‘awa that is there along the sacred cliff of Waipi‘o in the breast (the ledge) of Ha‘iwahine, at the long plain of ‘Āpua… And you, Ka-Miki, are to fetch the sacred water of Kāne which is there atop the summit of the mountain [Mauna Kea], at the royal compound of Poli‘ahu, Lilinoe, and their ward Ka-piko-o-Waiau. The water is there below the ledge of the platform of Pōhakuakāne, from where you may look down to Pōhakuloa; they are your family through your father’s genealogy. You are to fetch the water that will be used to make the ‘awa for you two. . . .
>
> Ka-uluhe also told the brothers that they were to go to the place of their ancestress Lani-ku‘i-a-mamao-loa (whose name is commemorated in the place name Lani-mamao at Waimea); for she had the kānoa (‘awa bowl) that was called Hōkū‘ula and the mau‘u ‘awa (strainer) Ka-lau-o-ke-Kāhuli, which would be used in preparing the ‘awa ceremony.
>
> Ka-uluhe then told Ka-Miki—“dip the kānoa ‘awa into the sacred water of Kāne and Kanaloa and hold it close to your breast while returning. You shall be at the heights of the mountainous region, at the whitened peaks, leaping on the mountain top, the sacred and astonishing mountain, that causes people to go astray, and the voice is wearied by calling out—indeed it is so.” Ka-Miki and Maka-‘iole then set out to complete their tasks, first traveling to meet their ancestress Lani-mamao on the windward plains of Waimea (in the region of Mahiki). [February 5, 1914]
>
> The brothers greeted their kupuna with genealogical chants, and gained her recognition of their descent. When Lani-mamao inquired of their journey and quest, Maka-‘iole called out to her with a mele (chant):

Aia la ilalo o Waipi‘o,	[The ‘awa] is there below in Waipi‘o
I ka pali o Kaholokuaīwa	Along the cliff of Kaholokuaīwa
I ka ‘awa ‘ili lena	The yellow barked ‘awa
I ka papa lohi o ‘Āpua	of the long glistening plain of ‘Āpua
A kini o ke akua	[‘Awa] of the 40,000 gods
A ka mano o ke akua	[‘Awa] of the 4,000 gods
A ka lehu o ke akua e inu a—i	[‘Awa] which the 400,000 gods drink.

Lani-mamao then asked, "What is your kupuna thinking of, sending you to fetch the cherished ʻawa of Luanuʻu-a-nuʻu-pōʻele-ka-pō-loa, king of the hordes of ghosts who dwelt at Waipiʻo? And where is the water that she told you to fetch?" Ka-Miki answered — "It is the sacred water of Kāne and Kanaloa at the sacred platform of Pōhaku-a-Kāne, overcome by the mists Kākīkepa, that is like the steaming mists of the woman [Pele] who dwells at the crater."

Because of the great challenges the brothers would face while going to fetch the ʻawa and water of the gods, Lani-mamao tested their ʻōlohe [fighting skills]. Because Ka-Miki was so adept at the arts, Lani-mamao told Ka-Miki that he would need to fetch the ʻawa of the ghost king Luanuʻu. [February 12, 1914]

Ka-Miki agreed to go to Waipiʻo, and Lani-mamao sent Maka-ʻiole to fetch the strainer Ka-lau-o-ke-kāhuli [from the plain of Waikōloa]. Lani-mamao warned Ka-Miki not to make any sounds lest he awaken the gods as he drew near the ledge of Haʻiwahine — When you reach the hill of Puaʻahuku, gaze below to the heiau of Pākaʻalana, and look upon Waipiʻo, there you will see the cliff of Kaluahine. Then look to the side and go into the ʻōhiʻa forest of Kaʻauana. It is there that you will find the ʻawa container called Ka-pāpāiaoa [Ka pāpāiaʻawa (The ceremonial ʻawa)], which Luanuʻu-a-nuʻu-pōʻele-ka-pō uses as his pillow so that no one may take it. Luanuʻu will be there in the center of his hālau hale aliʻi (royal compound), and the assembly of 4,000, 40,000, 400,000 ghosts will be outside."

Upon finishing her instructions Ka-Miki disappeared, leaping to the forest of Mahiki. Leaping again, Ka-Miki arrived at Puaʻahuku, and he looked upon the beauty of Waipiʻo. Ka-Miki then turned and leapt to the heights of Kaʻauana, and went to the cliff of Kaholokuaīwa where he saw the royal compound of Luanuʻu along the ledge of Hea-ke-Akua, overlooking Nā-poʻopoʻo (The nooks and crannies), in Waipiʻo, not Kona.

Indeed, there were innumerable ghost beings throughout the region. Ka-Miki called upon Ka-ʻohu-kolo-mai-iluna-o-ka-lāʻau, and a thick mist settled on Waipiʻo, even covering the compound of Luanuʻu. Ka-Miki then leapt and landed upon the ridge pole of the gods' long house. Ka-Miki parted the bird feathers, for this is what the house was thatched with, and looked in. He saw that the god and those with him were sleeping, nestled in the mists of the ʻawa. Now those in the house were of various shapes and sizes, some with hollow eyes, others with long thin necks, or hands that reached to their feet, truly, things which living people would fear.

While Ka-Miki was looking in the house, he heard the voice of Luanuʻu's lead ghosts, Hio and Nana-nui call out in a chant. When the lesser ghost heard the call, they all arose and left Luanuʻu alone in his house with only his guardians Mū-kī and Mū-kā, who also served as Luanuʻu's messengers.

Before taking Luanuʻu's ʻawa, Ka-Miki played a trick on Luanuʻu and awakened him from his ʻawa induced sleep. Ka-Miki then hid unseen amongst the rafters of the hālau. Luanuʻu called upon his kūkini, Mū-kā and Mū-kī, commanding that they capture the one who would attempt stealing his cherished ʻawa. He sent his messengers to places where ʻawa was grown or would be consumed. Mū-kā was sent to the cliff of Mōlīlele by Palahemo, Kaʻū. Mū-kī was sent to start at the cliff of Kaʻenamakaohue (at Neue, Kohala), where the wind entered along the cliff Makanikāhiō. Mū-kī was then to encircle the island searching, Kapākai and Kahuā (Kohala), Kalinaʻōpelu, on the plain of Kanikū (at Puʻu Anahulu); and ascend the hills of Anahulu (Kona) to look for a sign from the image of the god Kapu-ko-malo.

They were also instructed to circle around to the heights of Humuʻula and inquire of the deity ʻŌmaʻokoili and ʻŌmaʻokanihae if either of them knew who this rascal thief was. "Encircle Ka-piko-o-Waiau, the ward of the chiefesses Poliʻahu and Lilinoe. Peer down upon the multitudes, and watch the sacred water of Kāne mā[5]. Look too, to where they dug the ʻauwai (water channel)." Then Luanuʻu commanded them to go to Puʻu-o-Moeʻawa in the forest of Mahiki and stand guard.

[5] *Mā* is a Hawaiian word that means "and companions, friends," or "and others."

Mū-kā and Mū-kī departed and the multitudes of other ghosts wandered (ʻauana) through the depths of forests of Mahiki and Pōkāhi in search of this rebel. Ka-Miki heard the indistinct voices of these many ghosts ascend the cliff, and pass through the forests to the heights of Pūʻawaliʻi in the thick mist which ensnares the fished birds (Pōkāhi). When all the ghosts were gone Luanuʻu fell back to sleep with the ʻawa container as his pillow. Ka-Miki then leapt from the ridge pole and took Ka-pāpāiaoa which was filled with ʻawa that had been made ready to use and bundled into balls [wrapped] with limu pāʻihiʻihi (*Nasturtium sarementosum*).

Luanuʻu arose greatly angered thinking that he would ensnare this rascal upstart in the net of Nanananana-nui-hoʻomakua (Nana-nui was also one of Luanuʻu's ghost marshals). But unseen, Ka-Miki hid on the ridge pole of the hālau hale aliʻi where he held the ʻawa container [February 19, 1914].

Luanuʻu, who was also called Pahulu-nui, then leapt to the place where the sacred pahu (drum) Lono Hāwea was kept at the heiau of Pākaʻalana. Striking the pahu, he called all the wandering ghosts to return to the lowlands of Waipiʻo. The voice of this drum was a great sign that all of the pathways were to be sealed. The command was heard by all; along the hulaʻana cliffs from Waipiʻo to the ledge of Makanikāhiō; heard by those who were at Koholālele and Maulua; heard by those who were by the steep cliffs looking to the uplands of Kaleiʻeha (Humuʻula); and heard by those who were in the forest of Mahiki. And so all of the pathways and swimming trails were blocked, and the net trap was set.

While all of this occurred Ka-Miki remained hidden in the rafters of the hālau. One of the ghosts looked inside and saw Ka-Miki upon the ridge pole and prepared to call out on the hōkio (gourd nose flute) which would alert the ghosts that the upstart had been found. With great speed, Ka-Miki then leapt from Heakeakua up to the ridge heights, and landed on a kāwaʻu (*Ilex anomala*) tree branch. Ka-ʻohu-kolo-mai-iluna-o-ka-lāʻau then covered the region in a thick mist, blocking everything from sight.

The cry of the ghost hordes could be heard from uplands to shore, as they hungrily looked for Ka-Miki, having been thwarted in their attempts to ensnare him in their supernatural net Nanananana-nui-hoʻomakua, just as birds were caught. Because the ghosts wandered along the cliffs and forests of Kaʻauana (Kohala side of Waipiʻo) and Mahiki (Hāmākua side of Waipiʻo), and were unable to catch Ka-Miki, they went hungry. Under the cover of his ancestress' mist body form, Ka-Miki leapt from the kawaʻu tree to Puʻu-o-Moeʻawa in the forest of Mahiki. The ghosts wandered hungrily about and two place names commemorate their wandering and having gone hungry: Ka-ʻauana (The wandering), and in Mahiki, Pōloli-ke-akua (The gods [ghosts] are hungry) which is also called Pōloli-(i)-ka-manu (Hungry for the bird). At Puʻuomoeʻawa, Ka-Miki met with the ghost runner Mū-kī who had been stationed there by Luanuʻu [February 26, 1914].

Ka-Miki thwarted his efforts at catching him by throwing foul smelling dirt (dabs of excrement) at him. Though many other ghosts arrived for the fight, they were all driven off, as Ka-Miki began destroying them. Hio and Nananui, Luanuʻu's ghost marshals told their chief about the events at Puʻuomoeʻawa, and Luanuʻu blew the conch Hā-nō, also called Kiha-pū, which was the conch that the supernatural dog Puapualenalena stole from the ghosts of Waipiʻo. Hearing the call of the conch, the remaining ghosts fled from Puʻuomoeʻawa, leaving Ka-Miki who returned to Lanimaomao. Ka-Miki presented the sacred ʻawa container Kapāpāiaoa and ʻawa to his ancestress, and she bathed him in her rains, and caused lighting and thunder to praise his accomplishments… Lanimamao then gave Ka-Miki the kānoa ʻawa (ʻawa bowl), Hōkūʻula—with the kapu of Lono-Makahiki—so that he could go get the wai kapu (sacred water) of Kāne and Kanaloa (at Mauna Kea). [March 5, 1914].

Ka-Miki then leapt and disappeared in the mists that seem to crawl upon the forest growth. Arriving at the spring, Ka-Miki began dipping the ladle into the sacred water of Kāne, to fill the

ʻawa bowl Hōkūʻula. At that time, Pōhakuakāne and Pōhakuloa, guardians of the water, saw the water rippling, and overflowing from the spring. As they went to investigate, they saw a shadow pass them by. Because of the overflowing of the water, the spring came to be called Ka-wai-hū-a-Kāne (The overflowing waters of Kāne), and so it remains named to this day. It overflowed because Ka-Miki scooped the water, filing the ʻawa bowl of the god. Ka-Miki then joined Maka-ʻiole at Holoholokū on the plain of Waikōloa. As they traveled along the hilltops, the wind goddess Wai-kō-loa (Water carried far) caused the water to splash over the brim of Hōkūʻula. Some of the water was carried afar by the wind and fell, forming a new spring. When the spring appeared, Pōhaku-a-Kāne fetched some of the water. And because of this, that place is called Wai-kiʻi (Water fetched) to this day. This happened near the hills of Puʻu Kekeʻe. Pōhaku-a-Kāne then took the water he retrieved to the base of the cliffs of Mauna Kea and dug into the earthen plain of Pōhakuloa and placed the water there. From Pōhakuloa, the water flowed under ground and appeared as springs at several other places, including Ana-o-Hiku at Hanakaumalu, Honuaʻula, and Kīpaheʻe-wai on the slopes of Hualālai. [March 12-19, 1914]

As noted earlier in this paper, ʻawa was cultivated in various places on Hawaiʻi and around the islands. At each of those localities, special techniques of cultivation and preparation were developed. Also, there evolved the practice of using certain "pūpū ʻawa" (condiments eaten or mixed with the ʻawa) which were known for their ability to intensify the strength of the ʻawa or for the symbolism in their uses. Several of those ancient places or pūpū ʻawa are commemorated in sayings recorded in native writings (in *Ka Hōkū o Hawaiʻi*). Among the accounts are:

- ʻAwa ʻili lena a ke akua i ka pali kapu o Waipiʻo — The yellowed barked ʻawa of the gods . . . grows on the sacred cliff of Waipiʻo.
- Ka ʻawa ʻili lena a ka manu i kanu ai iluna o ka lāʻau — The yellow skinned ʻawa planted by birds atop the tree branches (grown in Puna)
- Ka ʻawa kau lāʻau a ka manu i Kealakomo — The ʻawa of Kealakomo, placed upon the branches by the birds (grown in Puna)
- The famous ʻawa of Kaʻawaloa grew amongst the ʻili-ahi (sandalwood trees) at Manuʻa. The type of ʻawa grown here was the ʻawa hiwa (black ʻawa) called Mōʻī, and it was known as the ʻawa kapu o Manuʻa (sacred ʻawa of Manuʻa). The fragrance of ʻili-ahi permeated the ʻawa patch.
- On Maui, the ʻawa of Hāna was known for its potency. A drink of the ʻawa would put one in a state of comfortable sleep, likened to being nestled by the — ua liʻiliʻi noenoe o Hāna ua lani haʻahaʻa e iho mai la o ka ʻawa ʻililena i ka uka o Kailua (fine mists of Hāna with the low heavens descended with the yellow skinned ʻawa which grows at Kailua, Maui).
- At Niumalu, Kona, the pūpū ʻawa was made of the hīnālea (wrasse fish) found along those shores.
- At Kalapana (Puna), there grew the famous coconut stand called Niu moe o Kalapana (Reclining coconut trees of Kalapana), also known as Niu-a-poe in ancient times. In Puna, the water from the coconuts of Niu-a-poe was used as the pūpū ʻawa, while preparing a highly coveted ʻawa drink, for aliʻi and dignitaries.
- In the native account of Kekuhaupiʻo (born ca. 1730), the famous warrior-instructor and companion of Kamehameha I, it is recorded that the eyes of the niuhi (great white shark) were used in the ʻai lolo (completion of training ceremonies) which Kekuhaupiʻo underwent as a young warrior. To complete his training, Kekuhaupiʻo had to catch and fight with a niuhi off of Nāpuʻuapele, Kaʻū. Being victorious, Kekuhaupiʻo offered one of the shark's eyes to Kāne and Lono in the temple above the bay of Kapuʻa, and the other eye was mixed with the pūpū ʻawa and eaten by Kekuhaupiʻo (in *Ka Hōkū o Hawaiʻi*).
- In 1810, when King Kamehameha met with King Kaumualiʻi of Kauaʻi, the two shared ʻawa together. Prepared by Kaumualiʻi, he used the choice sugar cane of Halaliʻi, Niʻihau (puna kō momona o Halaliʻi) as the pūpū ʻawa.

Accounts of ʻAwa Cultivation and Use in the Early 20th Century

Over the years, I have been fortunate to speak with kūpuna around the islands. While most of my research is land, cultural resources, and family based, I do occasionally have the opportunity to speak with someone about ʻawa. From those conversations we learn about the continued use of, and adaptation of cultural practices to, the changing Hawaiian environment (both social and economic). Below are a few excerpts from some oral historical records, in which the interviewees discuss ʻawa.

> At Kalapakī, Kauaʻi, there is a black stone just off of the shore, named Pōhaku-manō (Shark-rock). Up until about the 1920s, Tūtū Enoka, would periodically go out to that stone, dressed only in a red malo, carrying an ʻumeke (calabash), in which he had prepared ʻawa root for his shark deity. Calling out in a chant, a shark would draw near the shore and Tūtū would feed the shark and scrape the barnacles off of it. Under this care, the shark served as a guardian of the bay. Whenever, malihini (foreign) sharks would swim into the bay, the friendly shark would chase them off, or nudge the swimmers out of the water. (pers comm. Gabriel ʻĪ; Apr. 1985)

> At Kaʻūpūlehu–Kalaemanō, Kona, up till about 1925, the elders there still fed an ancestral shark deity. Calling to the great shark in mele (chants), ʻawa was one of the choice foods given to the shark. Cut up in pieces, the kūpuna fed the shark several pieces at each encounter. Then, when out in their canoes, fishing for ʻōpelu and larger fish, the shark would drive the fish to their nets, and also cared for them if a canoe should be overturned. (pers comm. C. Kinihaʻa Keākealani Pereira; Nov. 7, 1996)

Describing ʻawa growth and use in the Keahialaka-Oneloa vicinity of Puna in the 1920s to 1930s:

> ʻAwa, you see ʻum, you can see. They went plant that, it was common. When get maʻi [sick], they went to go get that. Some for inu [drink], some for lāʻau [medicine], eh. The old people, some take the coconut juice, water. Because they mahi ʻai [farm], the kino ʻeha [body is sore], the poʻe mahi ʻai [the farmers]. Soon as the poʻe [people] no mahi ʻai [farm], ah no more maʻi [sick], because no hana [work] eh? Mahi ʻai poʻe, that's different kind poʻe that. (pers comm. John Hale; June 12, 1998)

Describing ʻawa collection and sales in the 1930s:

> We used to go get ʻawa down by Kaliʻu. Me and my mother, and my sister and brother. We go up to ʻohi [pick] the ʻawa. Big kind [gestures circling arms around the root]! We bring ʻum home…we had one wooden station wagon, Ford, and we put all the ʻawa inside there, and bring ʻum home. The patch was about three miles from our house. So we pick ʻum and take ʻum down, and then we chopped ʻum up. Kaulaʻi [dry it], and the trust company, that's the one that bought that. They took it to Hilo and shipped it to Germany… And the stalk, they don't throw it away, they planted it again to make new ʻawa… (pers comm. Gabriel Kealoha; June 12, 1998)

Manaʻo Pani (Closing Thoughts)

As seen above, there is a deep cultural-historical relationship between the Hawaiians and ʻawa. We have much to learn about the varieties, cultivation techniques, and the protocols for continued use of ʻawa. The poʻe kahiko (ancient people) identified many values and uses of the ʻawa, and we are only skimming the surface—recapturing some of that knowledge, and perhaps making history ourselves. I urge anyone that knows elders who have knowledge of ʻawa and other native cultivars to try and record some of that history. It is important for us to know where we have come from, and to pass as much of that legacy on to those who will follow us.

"O ka mea maikaʻi mālama, o ka mea maikaʻi ʻole, kāpae ʻia"
(Keep that which is good and set that which is not good aside)

Chapter 3

The Active Ingredients in 'Awa (Kava, *Piper Methysticum*)

Mel C. Jackson, Ph.D.

The known active ingredients in 'awa are the kavalactones. There are around eighteen of these, but only six of them are routinely measured, as they represent greater than 90 percent of the total. They are:

Table 3.1. Kavalactone Numbering System

Kavalactone	Identifying number
desmethoxyyangonin	1
dihydrokavain	2
yangonin	3
kavain	4
dihydromethysticin	5
methysticin	6

The kavalactones are very similar two ring structures made up of a pyrone ring and a benzene ring, only differing by as little as two hydrogen atoms either in the hydrocarbon chain joining the two rings (kavain and dihydrokavain) or within the pyrone ring itself (kavain and yangonin). In addition, some kavalactones differ by only a methoxy group on the benzene ring. (To see the chemical structures of the six major kavalactones, see Figure 4.2 on page 21.)

In all cases, the differences are relatively minor. However, minor variations on the two-ring structure appear to cause differences in effect when ingested.

The relative concentration of the six major kavalactones in 'awa root can be used to discriminate between 'awa plants from different geographical locations and between plant parts from the same plant. In order to facilitate discrimination, Lebot and Lévesque (1989) have assigned a numbering system for this discrimination. The numbering system is set out in Table 3.1 above. This has now become an accepted way to discriminate between 'awa plants from different locations. A six-digit code can be generated to qualitatively describe the relative concentrations.

A unique feature of Hawaiian 'awa cultivar samples (composed of a mixture of root and stump) is that they have a six-digit sequence that almost without exception starts with the numbers 46, followed by a combination of the four remaining digits. This indicates that the Hawaiian 'awa cultivars almost all have kavain as the highest relative kavalactone followed by methysticin.

In general, this starting sequence indicates that the 'awa will have a pleasant psychoactive effect when drunk. This also probably reflects the narrow genetic base of 'awa in Hawai'i suggesting that only a very few 'awa plants were originally brought to Hawai'i from the South Pacific and that the numerous cultivars seen today were selected from this very narrow base.

In contrast, in the South Pacific, there are many 'awa varieties, with many differences in the relative concentrations of the kavalactones. For example, in the islands of Vanuatu where there are at least 80 different 'awa cultivars, the six-digit sequence may start with 26...., or 25...., indicating that the kavalactones in highest concentration are dihydrokavain and methysticin, and dihydrokavain and dihydromethysticin respectively. Those cultivars that have a sequence starting with 25.... or 52.... are not prized as good drinking 'awas, because the highly potent dihydrokavain and dihydromethysticin are thought to cause nausea in the unwary drinker.

This does not mean, though, that the islands of Vanuatu have poor drinking 'awa. On the contrary, the island of Pentecost is the home of an 'awa variety called Borogu, famous for its excellent psychoactive effects. It has the six-digit sequence 245613, with dihdrokavain followed by kavain as its highest concentration kavalactone constituents (Lebot, Merlin and Lindstrom 1992).

This difference in relative concentration has been called a chemotype, however, this is not strictly true, as the relative concentration of the six major kavalactones can vary between the underground and above ground parts of the same plant. Given this discrepancy, it is advisable to list the plant part before giving the relative kavalactone concentration sequence.

In Hawaiian ‘awa cultivars, there are differences in the relative concentration of kavalactones and the overall kavalactone concentration in different plant parts. As part of a collaborative study to optimize ‘awa cultural practices, undertaken by Hawaii Agriculture Research Center and the University of Hawai‘i College of Tropical Agriculture and Human Resources, one year old Hawaiian ‘awa cultivar (Mō‘ī) and a Papua New Guinea cultivar (‘*Isa*’) were harvested after growing under exactly the same conditions. The whole harvested plant was split into roots, stump, lower stem, middle stem, upper stem and leaves and then analyzed for kavalactones. The table below shows the relative kavalactone content of each plant part as given by the six-digit sequence.

Table 3.2 Chemotype Comparison

Plant part	Isa	Mō`ī
Leaf	254316	254136
Upper stem	523416	523416
Middle stem	254316	254361
Lower stem	254361	425631
Stump	254631	426531
Root	245631	462531

It can be seen that, while the relative kavalactone content in the root and stump differ markedly between cultivars, this difference is gradually lost as parts further up the plant are analyzed. Any significant distinction is lost by the time the middle portion of the stems is reached.

Typically, ‘awa beverage is made from a mixture of stump and root, usually in the ratio of 2/3 to 1/3 respectively. Kavalactone concentrations were determined for this mix of root and stump in a number of cultivars harvested at two years old. It was found that kavalactone concentrations do not vary much between cultivars of the same age. For example, if plants are harvested at two years, Mō`ī has an average kavalactone content of 8.5% and generally exhibits a relative kavalactone content ranging from 423561 to 463251. Nēnē at harvest contains on average 7.5% kavalactones and has a relative kavalactone content ranging from 436125 to 462531. Mahakea has an average kavalactone content of about 8.2% and a relative kavalactone content ranging from 456231 to 413625.

Conversely, for typical South Pacific varieties from such islands as Tonga, Fiji, and Vanuatu, average kavalactone content is around 7.0% and the general relative kavalactone content ranges from 134652 to 423516.

The kavalactones have been studied for their physiological effects. In the 1960s, German researchers undertook many studies to determine the effect of kavalactones on the brain. One of the main findings was that the kavalactones have a pronounced sedative effect (Meyer 1966), with the unsaturated kavalactones (kavain, methysticin, yangonin) more potent than the others.

However, Kretzschmar and Teschendorf (1974) showed that the kavalactones do not induce sleep like true sedatives and do not inhibit the sensitivity of sensory nerves, nor do they reduce motor activity, but rather act as muscle relaxants and enhancers of deep sleep. Unlike sedatives, the kavalactones appear to work on the limbic system of the brain.

Holm et al. (1991) have shown that kavain increases the sensitivity of an area of the limbic system (hippocampus), an area indirectly associated with emotional excitability, due to its inhibition of the emotional centers of the brain cortex. It is interesting to note that the researchers found a more pronounced effect when an ‘awa extract was used, than kavain alone. This is probably because ‘awa extracts contain the other kavalactones which interact with the limbic system more completely than kavain alone. This agrees with ‘awa drinkers perceptions that ‘awa has a calming effect.

More recently Zi and Simoneau (2005) have reported that a chemical in ‘awa, flavokawain A, has tumor suppressing activity in bladder cancer cells. (The chemical structure of flavokawain A is shown in Figure 4.3 on page 23.) Zi and Simoneau showed that this compound appears to selectively kill these types of cells.

This work follows on from an intriguing epidemiological study by Steiner (2000) of cancer incidence in

Pacific island nations, which showed that "age-standardized cancer incidence for kava drinking countries is one-fourth to one-third the cancer incidence in non-kava drinking countries and non-kava drinking Polynesians." In addition, three kava drinking countries (Vanuatu, Fiji, and Western Samoa) have a lower incidence of cancer in men than in women. This is intriguing, because in these countries, men are much more likely to drink ʻawa.

[The supplement to this book provides information about more recent studies on potential health effects of ʻawa.-Editors.]

Chapter 4

Chemistry, Pharmacology, and Safety Aspects of Kava

Klaus Dragull, G. David Lin, and Chung-Shih Tang

Introduction

Kava (*'awa* in Hawaiian) consists of complex chemicals and thus potentially has profound pharmacological and toxicological effects, some of which are known and some still unknown. Kava beverage has been enjoyed by the Pacific Islanders for over two thousand years. Due to the anxiolytic and sedative properties of kavalactones, kava extract products gained popularity in Western countries over the last two decades. Moreover, kava use has grown in Hawai'i as we gained an appreciation of the high quality of Hawaiian cultivars and learned about its importance in Hawaiian culture.

The safety of kava was called into question in recent years after it was implicated in several liver failure cases (see Table 4.4), leading to its ban in many countries, although liver toxicity remains unproven. This has prompted wide discussion on the relative benefits and risks of kava as a social beverage and herbal remedy.

The major active ingredients in kava are known as kavalactones and are concentrated in the rootstock and roots rather than in the aerial parts (stems and leaves), which contain kavalactones in smaller amounts. Interestingly, leaves and peelings from stems contain another class of compounds called alkaloids, notably pipermethystine, and these alkaloids are potentially dangerous to ingest.

South Pacific Islanders use only the rootstock to prepare kava beverage and avoid using stem peelings and leaves. They knew and practiced this long before the chemistry of kavalactones and alkaloids were scientifically investigated. Their traditional wisdom in using appropriate parts of appropriate kava cultivars for ceremonial occasions and for medicinal purposes to treat specific illnesses, as documented in *Kava: The Pacific Drug* by Lebot, Merlin, and Lindstrom (1992), is extraordinary and should be respected at all times.

An unresolved modern issue is the potential liver toxicity (also known as "hepatotoxicity") associated with the use of kava products in pharmaceutical dosage forms prepared from concentrated extracts using ethanol or acetone, rather than water, as extracting solvents. These organic-solvent-prepared kava products have been blamed in several cases of irreversible liver damage occurring between 1998 and 2002.

There has curiously been no report of irreversible liver toxicity in any of the animal studies, human clinical trials, large outpatient observations (some 10,000 patients), and centuries-long use of kava beverage. Based on the review of the case reports, the link between kava and hepatotoxicity is variably con-sidered weak (Gruenwald and Skrabal 2003) to very probable (Stickel et al. 2003).

Researchers have proposed several mechanisms of potential hepatotoxicity and attempted to explain the perplexing lack of such reports with the traditional drink, which apparently continues to be used safely.

Let us first take a look at the chemical composition of kava and then direct our attention to its pharmacological and toxicological properties. In so doing, we hope to provide readers with some basic understanding of how kava works as an anxiolytic agent, how to assess benefits and risks in kava, and what constitutes the appropriate use of kava.

This review can only be a snapshot of the wealth of research that has accumulated over the decades and it does not attempt to be comprehensive.

I. Chemistry

Research on the chemical constituents of kava reaches back to 1850-1860. These first studies concerned rather ubiquitous substances such as starch and little characterized crystalline material. In the 1870s and 80s, the first kavalactones were obtained in pure form and characterized. It should be pointed out that the early investigators had to work with much more cumbersome methods of isolation and identification than we do today. The chemical structures of each new compound had later to be deduced by chemical modifications.

I.1 Kavalactones

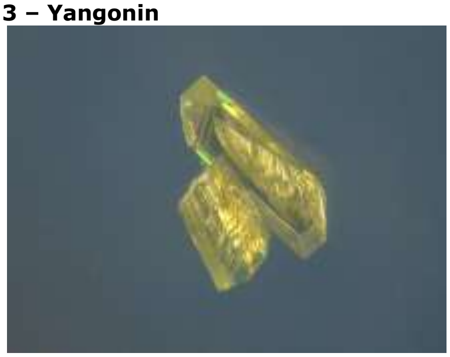
Kava chemistry is currently associated with six major kavalactones: methysticin and 7,8-dihydro-

Fig. 4.1. Crystallized kavalactones

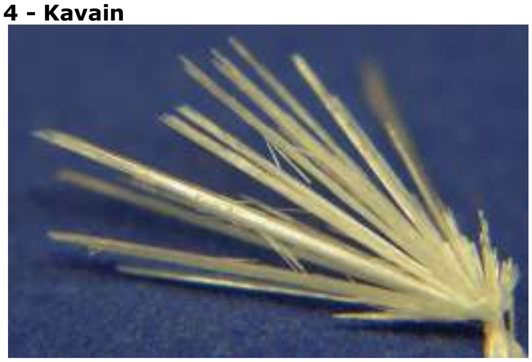
1 – Desmethoxyyangonin

2 – Dihydrokavain

3 – Yangonin



4 - Kavain



5 - Dihydromethysticin

6 - Methysticin

Photos by Klaus Dragull

methysticin, kavain and 7,8-dihydrokavain, yangonin and 12-desmethoxyyangonin (Figure 4.1 and 4.2). However, a number of variants of these basic kavalactone molecules are still being reported, and no end of discovery of minor kavalactones from kava is in sight.

Above are photographs of crystallized kavalactones taken through a macro lens.

It is not surprising that the kavalactones isolated first, yangonin (obtained in pure form first in 1874) and methysticin (1889), were the ones that readily crystallized from the solvent extract.

Much of the kava chemistry was worked out with the processing residues of "Gonosan" (a medicine once used for the treatment of gonorrhea) that was one of the first successful kava products on the European market, produced by the Riedel company in Berlin several years before 1914. Starting in 1914 and ending in 1933, Borsche and co-workers at the University of Frankfurt were dedicated to kava chemistry. From these commercial bulk materials provided for research by the Riedel company they isolated and investigated five kavalactones: methysticin and dihydromethysticin, kavain, dihydrokavain, and yangonin. Yangonin was erroneously formulated as gamma pyrone but in the 1950s was corrected to an alpha pyrone (lactone) by a Polish group working on yangonin synthesis (Keller and Klohs 1963, and references therein).

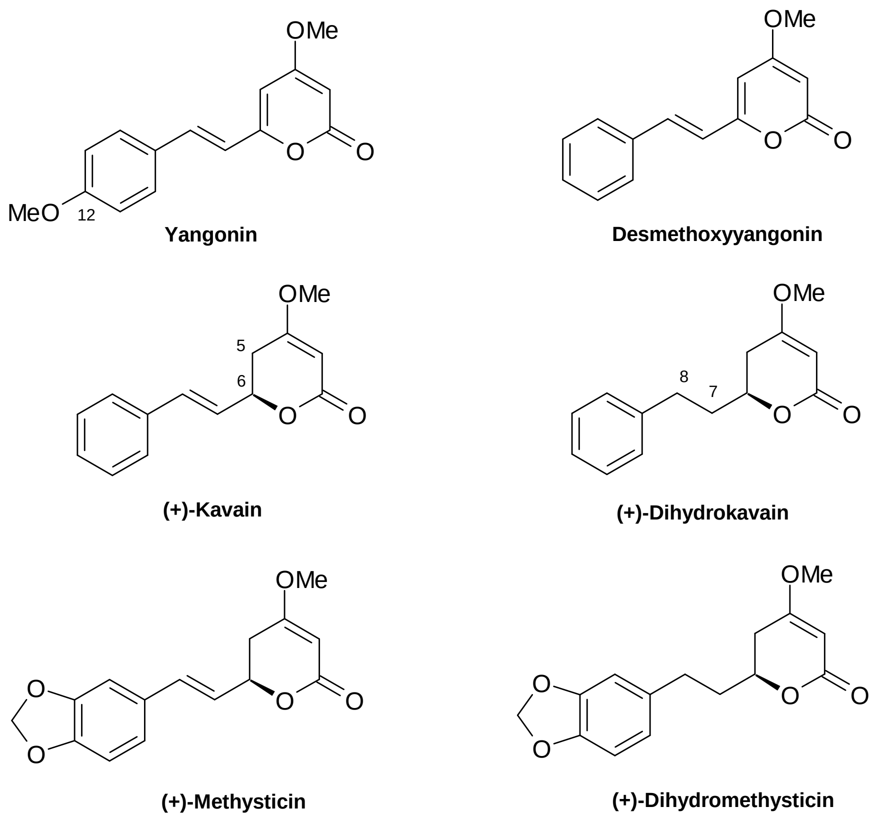


Fig. 4.2. Chemical structures of the major kavalactones present in kava beverage made from rhizomes and roots. Me=methyl group.

The major kavalactones are quite similar in physical properties, which can be illustrated on the example of "pseudomethysticin." Pseudomethysticin, a uniform, colorless crystalline material, derived from kava in the research laboratory of the Riedel company in 1908, was re-examined by Borsche et al. in 1928. They found "pseudomethysticin" to be simply a mixture of both methysticin and dihydromethysticin, which had formed uniform crystals in the laboratory. This uniformity in crystal shape is usually a property of a single pure compound and this had led to the confusion.

The sixth major kavalactone, desmethoxyyangonin, was discovered by Keller et al. at the laboratories of the Riker company, Northridge, California, in 1959. Their new "compound A" from kava was found to be identical to 5,6-dehydrokavain from an *Aniba* species (rosewood).

These six major kavalactones are lipophilic and can be dissolved in alcohol or, in the case of "Gonosan," in sandalwood oil. In water, kavalactones form an unstable emulsion. This is the reason why kava drinkers stir up the yellow, oily, and starchy bottom of their bowls often.

Kavain, usually the most abundant kavalactone in roots of Hawaiian kava, was chemically synthesized in 1950 by two different groups independently. The synthetic kavain is different from the natural form, a property called "racemic," "+/-" or "D/L." The natural form, by contrast, is the (+)–kavain.[1]

Interestingly, the natural (+) forms of kavalactones were only very recently synthesized at Williams College, Massachusetts (Smith et al. 2004). This leads to the prospect of cheaper kavalactones being available, accelerating research into their bioactivities, and having standards available for analytical methods.

It may not be that these synthetic pure compounds replace the kava beverage anytime soon, alone or in combination, since apparently kava is much more than just kavalactones.

Within the *Piper methysticum* complex, the proportions of kavalactones vary with cultivar and plant parts (see chapter 3). Progress in understanding variation among cultivars has come from the work led by Vincent Lebot, who is based in Vanuatu.

[1] (+) or D indicates that the compound rotates the plane of polarized light to the right (clockwise).

By extensive collection of root material around the Pacific Islands, followed by HPLC quantitation of the six major kavalactones and statistical analysis, Lebot and Lévesque (1996a) found six distinct kavalactone chemotypes. It should be noted that these are quantitative rather than qualitative chemotypes, meaning that none of the six kavalactones were missing in any of the chemotypes,[2] and only the ratios between them varied. Lebot et al. also found that these kavalactone profiles remain constant under different cultivating conditions and thus are constitutive rather than induced by changing environmental factors.

As a simplification, cultivars favored by the kava drinkers had a higher kavain content relative to the five other kavalactones. The cultivars disfavored, locally known for instance as "*Tudei*" (or "two-day") for the prolonged effect were especially high in dihydromethysticin relative to the five other kavalactones.

Lebot concluded that the domestication of kava was a long process that altered the ratio of kavalactones so as to improve desired effects caused by kavain and to avoid negative effects caused by a high proportion of dihydromethysticin. Actually, other factors that were not examined by this work, such as trace alkaloids, could cause negative effects as well, and causation by dihydromethysticin alone cannot automatically be assumed. Convincing evidence that this kavalactone might at least contribute to the "two-day effect" comes from earlier studies in mice in which methysticin and dihydromethysticin showed a later onset and longer lasting effect in comparison to kavain and dihydrokavain (Meyer 1967).

I.2. Other root constituents

Other groups of compounds with interesting bioactivities present in the lipophilic portion of kava root extracts include the flavokawins-A, -B, and bornyl esters of cinnamic acid and its 3,4-methylenedioxy analog (Figure 4.3), all of which have recently been tested on biological models.

Flavokawin-A has been shown to have antitumor activity (Zi and Simoneau 2005) lending more support to the inverse relationship found earlier between kava consumption and cancer incidence in various areas of the Pacific (Steiner 2000). The more kava was consumed, the lower the cancer incidence. Such correlations, however, are not to be confused with causation since kava consumption could be only indirectly linked through another factor that affects both kava consumption and lower cancer incidence.

Flavokawin-B is a typical lipophilic constituent of the kava root, and has, as well as the bornyl esters, recently been shown to be anti-inflammatory similar to aspirin *in vitro* (Wu et al. 2002). This finding supports anecdotal claims of kava use for treating inflammatory pain in traditional settings.

Roots also contain trace alkaloids, two pyrrolidines and an oxoaporphine. The same compounds are orders of magnitude more concentrated in the twigs of another pepper species, *Piper caninum,* which has recently been investigated. Compounds 1-cinnamoyl-pyrrolidine and cepharadione A were found to be major DNA damaging principles of *Piper caninum* twigs (J. Ma et al. 2004a, 2004b).

I.3. Aerial constituents

Methysticin and kavain decrease progressively from the root towards the stems and leaves relative to their 7,8-dihydro counterparts, while an alkaloid that was not detectable in roots, pipermethystine, was found to be present in the stems and leaves (Smith 1983). (The mention of pipermethystine also being in roots in an earlier report from 1979 by the same author may therefore have been in error.)

Alkaloids differ from kavalactones in that they contain the element nitrogen and are usually found to be of pharmaco-toxicological importance due to their reactivity and/or interaction with the human nervous system. A study on kava alkaloids from our laboratory (Dragull et al. 2003) found pipermethystine, together with two novel alkaloids: awaine in the young leaves and pipermethystine epoxide in stem peelings and leaves.

Pipermethystine, originally reported from two Fijian cultivars (Smith 1979, 1983), was confirmed in different cultivars from Melanesia, Micronesia, and Polynesia that are maintained in Hawai‘i.

Pipermethystine epoxide was found only in the cultivar ‘*Isa*’ from Papua New Guinea, but not in the other ten cultivars examined. This was surprising, since ‘*Isa*’ is close to other kavas in that it contains the six major kavalactones, and in addition pipermethystine and awaine. While being different from true *P. methysticum* var. *methysticum*, it is not grouped with

[2] In some plants from Vanuatu, the kavain content was very low.

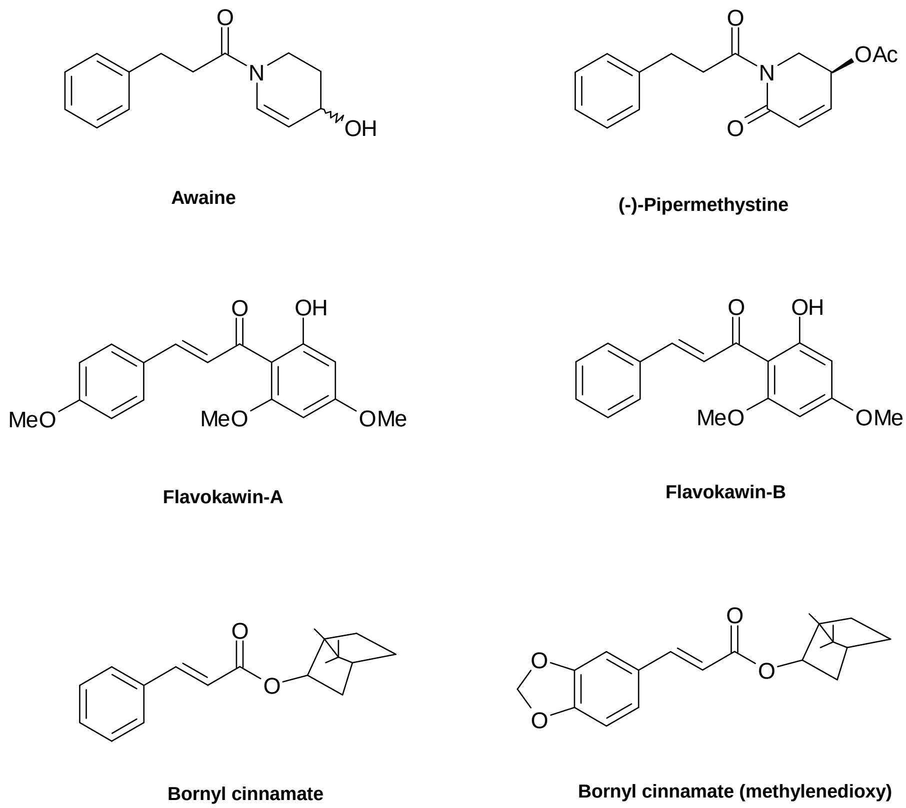


Fig. 4.3. Chemical structures of miscellaneous compounds from kava. Awaine occurs only in unopened young leaves and pipermethystine is particularly concentrated in leaves and peelings from the basal stems. Flavokawins and bornyl cinnamates are instead constituents of roots. Ac=acetyl group, Me=methyl group.

the rather wild type *P. methysticum* var. *wichmannii (=P. subullatum*[3]*)* plants.

Other than serving basic science, this study on piperidine alkaloids showed that trade in the ill-defined term "peelings" and the use of leaves may lead to considerable alkaloid contamination of resulting products. Aerial parts should therefore not be used at all. This phytochemical work in conjunction with traditional practices provided the basis for testable hypotheses regarding the kava hepatotoxicity association from 1998-2002 (see Section II.3).

I.4. Chemical Analysis

Analytical methods have typically focused on the six major kavalactones. This is understandable since much of kava's activity is linked to these major components. However, analyses of kavalactones alone will not tell us if they came from the correct plant parts (roots and stump), nor will they show us contamination coming from other materials such as leaves, stem peelings, or closely allied species not traditionally preferred for consumption. This is a current challenge for improving the safety of kava being sold as powders or extracts.

We found that, when a commonly used HPLC method was applied to aerial parts, it could not clearly distinguish between yangonin, the typical major kavalactone, and pipermethystine, the aerial alkaloid. This should not be surprising since the method was developed on root material and not on aerial parts. However, it means that, if pipermethystine was present in extracts implicated in hepatotoxicity cases, it would not necessarily have been recognized, and therefore aerial parts would likely have gone through the quality control process.

[3] *P. wichmannii* was found to be identical with *P. subullatum* by taxonomist Chew in 1992. *P. subullatum* reaches in distribution as far as the Philippines. For practical reasons we here still use Lebot's intraspecific classification proposed in 1996 into two groups of varieties, *P. methysticum* var. *wichmannii* and *P. methysticum* var. *methysticum* (Lebot and Lévesque 1996b).

Future methods will ideally include constituents that are most indicative of the correct plant part and cultivar, and not give false-positive signals if applied to possible contaminants. We find gas chromatography a true alternative to HPLC, because it can distinguish between kavalactones and alkaloids, and has a high resolving power for other lipophilic constituents.

I.5. Isolation of Kavalactones

For analytical methods and bioactivity testing a researcher may need large amounts—in the gram scale—of a purified kavalactone. However, currently the kavalactones are expensive, costing $245 US for only 10 mg. This is a serious impediment to kava research.

With expertise in chemical synthesis, there is now a method available to obtain kavalactones that way. If the expertise of the researcher is not in chemical synthesis, for instance at a biological laboratory, one can prepare kavalactones in a rather straightforward manner by isolation from root material. In this approach, further bioactives can be obtained as by-products, which is an advantage over synthesis.

Our laboratory set out to find a simple way to the kavalactones by isolation. Starting from a moderate amount of raw material, 500 g dry root of the '*Isa*' cultivar, we found that the elution behavior against silica gel and differences in crystallization are sufficient to arrive at the six major kavalactones at more than one gram for each and at 98% purity. The method does not need expensive equipment, and interesting minor by-products, such as the bornyl esters and flavokawins, are obtained (manuscript in preparation).

First, portions of yangonin and methysticin crystallize from ethyl acetate and ethyl acetate/hexane mixture, respectively. Next, the extract is fractionated with ethyl acetate/hexane against silica, the collected eluate is conveniently separated into classes of compounds and crude individual kavalactones by their increasing polarity into liter #1 the two bornyl esters, liter #2 the two flavokawins, liter #3 desmethoxyyangonin, liter #4 dihydrokavain, liter #5 kavain, after that, yangonin, dihydromethysticin, and methysticin.

In the following purification step, each collected fraction of the extract is crystallized in the freezer from ethyl acetate-hexane by seeding with a small crystal. It is continued only with the nearly colorless crystalline materials and the yellow supernatants are removed. Like yangonin and methysticin, crude desmethoxyyangonin and crude kavain can be obtained at high purity by repeated crystallization from suitable solvents. Crude dihydrokavain and dihydromethysticin, on the other hand, need to be re-run on two different columns to remove minor impurities that spontaneously co-crystallize.

Pipermethystine would elute just before the first kavalactone, but it is not detectable in roots. It can be obtained in a similar manner—after charcoal treatment of the extract by elution with the same solvents against silica—from kava leaves from the cultivar Mōʻī, for instance.

Investigating with pure compounds, scientists can better attribute beneficial or possibly harmful effects to specific components of kava.

II. Pharmacology and Toxicology

In addition to the knowledge of kava chemistry above, an understanding of various kava products and dosage forms is important since both desirable and adverse effects of kava are dependent on the kinds of products/chemicals and doses. A variety of kava products and dosage forms have been developed and formulated (Table 4.1). Some were sold as dietary supplements and some were used in pharmacological and toxicological studies, clinical trials, and toxicity case-reports, which are summarized in Tables 4.2, 4.3, and 4.4 respectively. Details are discussed as follows.

II.1. Kava Products (Dosage Forms)

Raw kava powders from rootstock for making beverage and capsules

Fresh or dried, raw kava rootstock (stump and roots) is ground and mixed with water and/or coconut water to prepare kava beverage (detailed preparation instructions are in chapter 7) for short-term consumption. Powders from dried rootstock are also filled into capsules by licensed manufacturers. This dosage form is convenient for consumers and contains approximately 500 mg of the dried rootstock powder per capsule, equivalent to 50 mg kavalactones (here after abbreviated as KL) per capsule, if we assume 10% KL content in the powder (Table 4.1).

Kava extracts from rootstock for making capsules and tablets

Kava extracts prepared from rootstock provide a more concentrated dosage form (containing 30% to sometimes as high as 70% KL) than raw kava powder (containing 3-20% KL). Commercial kava extracts usually

Table 4.1 Major kava products and dosage forms

Category	Made from	Kavalactones (KL)	Use	Dose
Traditional beverage	Fresh or dried raw rootstock in water	0.3-2% in fresh rootstock; 3-20% in the dried	For ceremonies and social recreation	Various, from one bowl to several bowls per day, depending on drinkers
Raw kava powders	Dried raw rootstock	3-20% in the dried rootstock	To make beverage or capsules	30-100 g dried powder per liter for beverage 500 mg dried powder per capsule
"Standard" kava extract powders	Concentrated extract, using ethanol and acetone as solvents	30% (standard) – sometimes as high as 70% in the extract powder	To make capsules or tablets	60-240 mg KL per day. (The concentrated extract was spray-dried on polysaccharide solids and converted to powder forms.)
Capsules	Raw kava powder	3-20% in the dried raw powder	As dietary supplements	50 mg KL per capsule, assuming 10% KL content in the raw kava powder
Capsules	Standardized extract powders	30-70% in the extract powder	As dietary supplements	60 mg KL per capsule (standardized)
Tablets	Standardized extract powders	30-70% in the extract powder	As dietary supplements	Standardized at 60 mg KL per tablet
Tinctures	One part of dried kava powder in 5 parts of ethanol-water (25:75)	10-20 mg KL per ml	For use in naturopathic and herbal medicine	7.5-15 ml per day or as directed by naturopathic doctors and herbalists
Tea bags	Dried rootstock powders	3-20% in the dried powder	As an herbal tea	2-3 g per tea bag, 1-3 cups per day
Tea bags	Occasionally kava leaves	Also contains alkaloids, pipermethystine	Should not be consumed	This type of product only appeared in late 1990s and early 2000s
Snack food	As an ingredients in health food	Generally low or very low KL per serving	As healthy food	Various, depending on consumers

use ethanol–water or acetone–water mixtures as extraction solvents, and sometimes are produced by supercritical fluid extraction, which uses carbon dioxide as an extraction solvent. In this case, no solvent residues are left in the extract, since carbon dioxide is completely escaped.

The initial liquid extract after removal of solvent is spray-dried on to a solid support such as starch, dextrose, and cellulose to form a concentrated extract powder. The powder is then sold and used for manufacturing kava capsules or tablets. If low ethanol content (less than 25%) is used as a solvent, the original extract is a tincture for herbalists or naturopathic doctors (Table 4.1). Kava tea bags are a convenient dosage form for consumption but kava leaves should not be used due to the presence of alkaloids such as pipermethystine in Figure 4.2.

II.2. Relaxing and Hypnotic Action

The relaxing and hypnotic action of kava has been demonstrated in both animal studies (Table 4.2) and clinical trials (Table 4.3). Relaxation and a feeling of well-being are the most common action of kava after normal ingestion. At higher doses hypnotic and relaxation of skeletal muscles are evident. Anticonvulsion, neuroprotection, local anesthesia, analgesia, and increased performance and concentration are also documented (Mills and Bone 2000).

To understand the multiple actions of kava, Baum and co-workers (1998) studied the interaction of kava with neuroreceptors and neurotransmitters in rats (Table 4.2). They intraperitoneally injected kava extracts (20, 120, 220 mg per kg of rat) or individual kavalactones (30, 60, 120 mg per kg) and observed the changes of neurotransmitter levels, as well as behavioral changes including muscle relaxation and sedation.

The level of dopamine, a neurotransmitter in the brain, increased in the case of kava extracts (120 mg/kg). With respect to the individual lactones, kavain at low doses decreased the dopamine levels and at higher doses either increased or did not change the dopamine concentrations. Yangonin on the other hand decreased the dopamine level, and desmethoxyyangonin increased it. Dihydrokavain, methysticin and dihydromethysticin did not produce significant changes of dopamine levels. Furthermore concentrations of 5-hydroxytryptamine (5-HT, another neurotransmitter) were also affected by kavalactones, notably kavain causing a decrease in 5-HT levels. The activation of the dopaminergic neurons may explain the relaxing and slightly euphoric actions, and the

Table 4.2. Selected pharmacological and toxicological studies

Observed Action	Study System	Kava Preparations/ Administration	Dose and Duration	Reference
Changes of dopamine and 5-hydroxytrytomine (neuro-transmitters) concentrations, Changes of behavior	Rats, 5–12 per group	Kava extract and individual kavalactones Intraperitoneal injection	20–220 mg extract or KL per kg of rat Single dose	Baum et al. 1998
Increased sleeping time with alcohol, Increased toxicity with alcohol	Mice, 5-14 per group	Lipid soluble extract Oral	200-600 mg extract per kg mouse (KL content unknown) Single dose	Jamieson and Duffield 1990
Inhibited convulsion induced by strychnine	Mice, 10	Chloroform kava extract and individual isolated kavalactones. Oral	Various concentrations, single doses, 15 min prior to strychnine injection	Klohs et al. 1959
	Mice, 10–30 per group	Individual isolated kavalactones dissolved in peanut oil. Intraperitoneal injection	Various concentrations, single dose, 30 minutes prior to strychnine injection	Kretzschmar et al. 1970
Aqueous kava extract was not toxic to rats	Rats	Aqueous extract	Kavalactones 200 or 500 mg per kg per day, 2 or 4 weeks	Singh and Devkota 2003
Inhibition of human cytochrome P450 (CYP450) drug metabolic enzymes	Recombinant CYP450	The six major kavalactones	Various concentrations	Zou et al. 2002
Organic kava extract caused glutathione depletion, but not aqueous extract	Amoeba cells	Ethanol, acetone, and aqueous kava extracts	Various concentrations and treatments to the cells	Whitton et al. 2003
Pipermethystine was more cytotoxic than kavalactones	Human liver cancer cells (HepG2)	Isolated pipermethystine, dihydrokavain, dihydromethyscin, and desmethoxyyangonin	Various concentrations up to 200 micro mole per liter Exposed to cells for hours to days	Nerurkar et al. 2004
Cytotoxic synergy between kavain and pipermethystine	HepG2 cells	Isolated kavain and pipermethystine	A range of contractions (0.1 to 1000 µg/ml) exposed to cells for 48 hours	Lin et al. 2005

reduction of the activity of 5-HT neurons could account for the sleep-inducing action.

Jamieson and Duffield (1990) found that the sleep time induced by kava increased with co-administration of ethanol to mice, and this would also increase the toxic effect of alcohol and possibly kava as well. Kava extracts and kavalactones were noted for anticonvulsion action when they were administered orally (Klohs et al. 1959) or intraperitoneally (Krezschmar et al. 1970).

In a randomized and double blinded trial involving 40 patients, Malsh and Kieser (2001) concluded that standardized kava extract was significantly superior to placebo in the treatment of anxiety disorders of nonpsychotic origin at a dose of 300 mg/day for three weeks after benzodiazepine treatment was tapered off over two weeks. Lehmann and co-workers (1996) observed similar results with 58 patients over four weeks (Table 4.3).

In a 25-week study involving 100 patients, Volz and Kieser (1997) observed a significant reduction of nervous anxiety and tension in patients treated with standardized kava extract at 210 mg kavalactones per day.

More convincing evidence came from a systematic review of seven appropriately designed clinical trials (randomized, placebo-controlled, double-blinded studies) by Pittler and Ernst in 2000, who concluded that kava extract significantly reduced anxiety.

In a recent study conducted over the internet, kava was not more effective than placebo for treating anxiety and insomnia (Jacobs et al. 2005). This contradicts the earlier studies. The use of the internet to conduct randomized, placebo-controlled and blinded trials needs further verification.

Foo and Lemon (1997) studied the interaction of aqueous kava extract (beverage) with alcohol in 40 human volunteers and observed that co-administration of kava extract and alcohol increased sedation and intoxication, and impaired cognition and coordi-

Table 4.3. Selected clinical trials or studies

Observed Action	Subjects and Numbers	Kava Preparations/ Administration	Dose and Duration	Reference
Superior to placebo in the treatment of anxiety disorders of nonpsychotic origin	40 anxiety patients previously treated with benzodiazepines	Standard kava extract Oral	Kavalactones 50-300 mg per day 5 weeks	Malsh and Kieser 2001
Kava significantly reduced anxiety compared to placebo	Systematic review of 7 published human clinical trials	Standard kava extract Oral	Kavalactones 60-240 mg per day 1 - 24 weeks	Pittler and Ernst 2000
Significant reduction of nervous anxiety, tension, restless of nonpsychotic origin	100 patients, randomized, placebo-controlled, double-blinded	Standard kava extract Oral	Kavalactones 210 mg per day 25 weeks	Volz and Kieser 1997
Significant reduction of anxiety of nonpsychotic origin	58 patients, randomized, placebo-controlled, double-blinded	Standard kava extract Oral	Kavalactones 210 mg per day 4 weeks	Lehmann et al. 1996
Kava did not relieve anxiety or insomnia more than placebo	391 subjects recruited through internet, randomized, placebo-controlled	Standard kava extract in softgel capsules Oral	Kavalactones 300 mg per day 28 days	Jacobs et al. 2005
Potentiated sedation, intoxication, and impairment of cognition/co-ordination with alcohol	Human volunteers, 40 (9–11 per placebo, kava, alcohol, and combination group)	Beverage (kava powder 1g per kg body wt. in 500 ml water) Oral	500 ml beverage 0.75 g alcohol per kg body wt. Single dose	Foo and Lemon 1997

nation. This is a typical example of drug interaction, which may lead to adverse effects or toxicity.

II.3. Potential Liver Toxicity and Possible Causes

In recent years, kava has been implicated in several liver failure cases (Table 4.4), notably in Europe. This led to its ban or restricted use in many countries including Germany, Switzerland, France, Britain, Canada, and Australia. On March 25, 2002, the Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration issued a warning to consumers that kava-containing dietary supplements may be associated with severe liver injury.

Liver damage appears to be rare. The causality of the case reports of liver toxicity and the German official assessment were questionable. The FDA believes consumers should be informed of the potential risk of liver-related injuries, which include hepatitis, cirrhosis, and liver failure. Symptoms of serious liver disease include jaundice (yellowing of the skin or whites of the eyes) and brown urine. Non-specific symptoms of liver disease can be nausea, vomiting, light-colored stools, unusual tiredness, weakness, stomach or abdominal pain, and loss of appetite.

Consumers may identify kava products or kava components in dietary supplements by reading the product label. The following are commonly used names for kava:

ava	kawa-kawa
ava pepper	kew
awa (Hawaii)	*Piper methysticum*
intoxicating pepper	*Piper methysticum* Forst.f.
kava (America)	*Piper methysticum* G. Forst.
kava kava	rauschpfeffer
kava-kava	sakau
kava pepper	tonga
kava root	kavakavawurzelstock
kawa (Europe)	yangona (Fiji)
kawa kawa	wati

Potential toxicity of kava may be due to the following mechanisms:

a. Interaction with Cytochrome P450 enzymes responsible for drug metabolism

Zou and co-workers investigated the effect of the individual kavalactones kavain, dihydrokavain, methysticin, dihydromethysticin, yangonin, and desmethoxyyangonin on recombinant human cytochrome P450 (CYP450) enzyme isoforms. It was observed that concentrations as low as 0.1 microgram per ml would inhibit CYP450 enzymes and thus reduce the ability of these enzymes to metabolize drugs and toxic substances in the body. This indicates that kava has a high potential for causing drug interactions. However, no systematic studies investigating interactions between kava and specific drugs or other herbs have been carried out.

Table 4.4. Selected case-reports (severe liver failure cases)

Patient and Observation	Kava Preparations	Dose and Duration	Co-medication	Reference
A 56-year-old female Fatigue, jaundice, liver Necrosis, death	Tablets, label-claimed KL 60 mg per tablet and contained passionflower and skullcap.	One tablet, 3 times a day. 4 months	Three more dietary supplements	Gow et al. 2003
An 81-year-old female Fulminant liver failure, death	Standardized kava extract	230 mg kavalactone per day. 10 months	None	Stickel et al. 2003
A 61-year-old female Fulminant liver failure, death	Standardized kava extract	120 kavalactone mg per day. 2 months	Ginkgo Omeprazole	Stickel et al. 2003
A 32-year-old male Fulminant liver failure, alive	Standardized kava extract	240 mg kavalactone per day, 3 months	None	Stickel et al. 2003
A 45-year-old female Fulminant liver failure, death	Standardized kava extract	120 mg kavalactone per day, 4 months	None	Stickel et al. 2003

In contrast, increase rather than inhibition in the activity of a specific CYP450 isoform (CYP3A23) has been found in response to desmethoxyyangonin and dihydromethysticin treatment (Y. Ma et al. 2004).

Yet another aspect of CYP450 activity is the ability to form reactive metabolites, specifically from the methysticins (Johnson et al. 2003). As the methysticins are typical components of kava, the relevance of this finding to kava toxicity depends on occasional sensitivity of patients or saturation of the detoxifying pathways.

b. Interactions with central nervous system depressants

The known sedative effects of kava (Tables 4.2 and 4.3) have led to the assumption that kavalactones in isolated forms or in extracts would interact with CNS-depressants like benzodiazepines, barbiturates, and alcohol.

c. Different preparation methods

Whitton and co-workers (2003) demonstrated that kava extracts prepared in water contained much higher levels of glutathione, a powerful antioxidant, than those extracted using organic solvents (Table 4.2). When amoeba cells were exposed to both types of extracts, kava extracts made with organic solvents were more toxic to the cells than the aqueous extract. It appears the glutathione in aqueous extract protects amoeba cells from harm.

d. Cytotoxic kava alkaloids and synergic interactions with kavalactones

Dragull and co-workers (2003) at the University of Hawai‘i showed that kava leaves and stem peelings contain considerable amounts of pipermethystine, an alkaloid. Nerurkar et al. (2004) demonstrated that pipermethystine is more toxic to human hepatoma cell line HepG2 than kavalactones (Table 4.2). Lin and co-workers (2005) studied the combined effect of pipermethystine and kavain on HepG2 cells and revealed that the combined mixture showed synergistic (here meaning 1 + 1 > 2) toxicity. In other words, the combined mixture produced more toxic effect than that of pipermethystine or kavain alone. These studies open another dimension in our warning that the alkaloid-rich kava leaves and stem peelings may have adverse effects on the liver and should not be consumed.

II.4. Risks, Benefits and Ways to Avoid Toxicity

None of the proposed mechanisms of liver toxicity in section II.3 above could satisfactorily explain the liver failure observed in Table 4.4. Relevant hepatotoxic effect of kava still needs to be proven, as stated by the Society for Medicinal Plant Research (2003). It appears more likely that the several cases of liver damage were caused by rare idiosyncratic-immunological reactions, sometimes induced by drugs or allergens. This phenomenon can occur after taking prescription drugs or even over-the-counter drugs. The frequency of hepatotoxicity possibly caused by kava is still lower than many conventional drugs.

Herbal medicines, like conventional drugs, are quite likely to be associated with low frequency of hepatotoxicity. The question is: what level of risk is acceptable from a public health point of view? A number of clinical trials have indicated that kava is effective for the treatment of anxiety, which is prevalent in today’s life. Kava should be available for the public, or naturopathic doctors and herbalists. Banning a popular supplement like kava in some countries will not keep people from obtaining it in today’s globalized environment and internet age. Educating consumers and manufacturers in the appropriate use of low-risk supplements may be the key. Or it may be necessary to make them available only on professional advice.

Liver toxicity is associated with multiple factors. Lipophilic extracts of kava rootstock and possible contamination with alkaloid-containing raw materials, such as stem peelings, are more likely to have caused the hepatotoxic reactions in the affected patients. If the quality and appropriate use of kava are ensured, liver toxicity could be avoided. This means use the best cultivars (and Hawaiian cultivars are among the best for desirable psychoactive effects), older plants (three years or more), the correct plant parts (rootstock and no aerial parts), water as the extraction solvent, and moderation in consumption. Consumers also must avoid using kava with alcohol or other central nervous system depressants.

[The supplement to this book provides information about more recent studies on potential health effects of ʻawa.-Editors.]

III. Concluding remarks

One difficulty in interpreting kava phytochemical work is that often the botanical material from which the new compounds were obtained is poorly characterized. In the literature we find batch numbers of commercial kava extracts, or commercial "kava root," without cultivar name or voucher deposition. (A voucher specimen is a dried plant that is accessible for other scientists to verify the plant's identity by comparing morphological features with those of related plants.) Therefore, compounds reported as new for kava could be specific to only the particular material it was taken from.

'*Isa*' might not be the only odd cultivar. For instance, 11-methoxy-nor-yangonin has been reported from a PNG plant designated P. sp. Wormersley (Haensel et. al. 1966), which was well described in the phytochemical paper as anatomically distinct from other true *Piper methysticum*, but which has later been lumped together with the *Piper methysticum* var. w*ichmannii* group. Differences between materials further concerns 5-hydroxy-7,8-dihydrokavain. Cheng and co-workers (1988) had found the compound after water treatment in material from Vanuatu, but the authors were unable to detect it in dried or fresh roots from Fiji using identical conditions.

The chemistry and botany of kava and its closely allied, rather wild-type plants need more detailed clarification. Many questions are still waiting to be resolved. The maintenance of diverse cultivars is a prerequisite for preserving an array of interesting plant chemicals and for better understanding the ongoing kava domestication process.

Kava, if used appropriately, is an effective anxiolytic agent and an alterative to many chemical drugs. There is need for further investigations in pharmacology and toxicology to fully understand its clinical significance and its potential adverse effects or toxicity in kava users.

Further Readings

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Chapter 5

Hawaiian Cultivars

Ed Johnston and Helen Rogers

ʻAwa was never completely forgotten in Hawaiʻi. People still occasionally cultivated it, even in the latter half of the 20th century. However, in the 1980s, Joel Lau of the Nature Conservancy was actively looking for it. His job took him all over the wild places of the Hawaiian islands. When he ran across an ʻawa variety, he took a cutting to preserve in his collection, which he generously shared with botanical gardens and private collections.

In the late 1990s, a number of ʻawa enthusiasts formed the Association for Hawaiian ʻAwa and began organizing workshops to inform people about this little-known gift of the ancient Pacific horticulturists. More people began to drink ʻawa privately and with friends. ʻAwa bars started up.

ʻAwa drinking is increasing in Hawaiʻi as people become aware of its uses and effects. However, as of now, because of concerns about potential liver damage, it is doubtful that ʻawa will become the important export for Hawaiʻi that was envisioned in the 1990s.

Deciding on Cultivar Names

The traits distinguishing the cultivars can be difficult to perceive. In describing the plant, Margaret Titcomb reported that "The stems are jointed, the spaces between the joints sometimes determining the native name of the species, as do also the intensity of the green of the leaves, the colour of the stems and the quality of the root" (Titcomb 1948, 109).

This is not so different from the way we tell the cultivars apart in Hawaiʻi today. We rely more on the characteristics of the stalks than on the leaves. The leaf characteristics of Hawaiʻi's cultivars are quite similar, unlike in Vanuatu where there is a greater amount of variation in their ʻawa. The color of the leaf piko (where the leaf blade meets the stem) is not usually too helpful in making distinctions. The piko tends to be the same color as the stem.

To identify a plant, we use the central portion of a mature plant's stalks (at least 18 months old). The more upright stalks display the unique traits of the cultivar most consistently. Traits such as stem color and internode configuration (stripes, spots, etc.) and length are all shown on the following cultivar pages, as well is each cultivar's overall growth habit: erect, normal, or prostrate (see figure 5.1).

Identification often rests on the appearance of the stem's lenticels (from the Latin *lenticella*, meaning

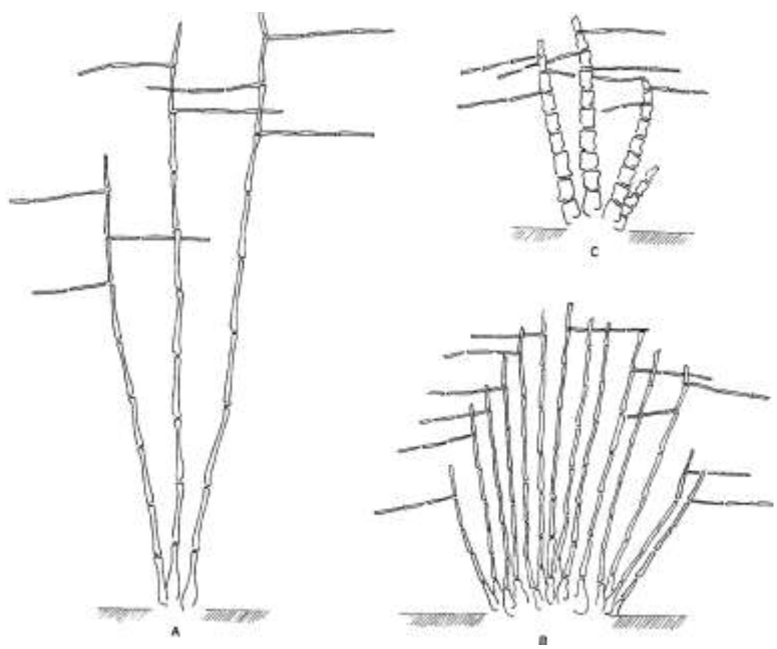


Fig. 5.1. Variations in the growth habit of ʻawa plants. A=erect, B=normal, C=prostrate
Picture by Vincent Lebot, reproduced with permission of National Tropical Botanical Garden

"small window"). These are "spongy areas on the surface of the stem . . . " appearing as spots or speckles (Raven, Evert, and Eichhorn 1986, 734).

As ʻawa growers found new cultivars, we began to call them by the names associated with physical traits documented in ethnographic accounts. (Kāwika Winter's 2004 master's thesis provides an excellent compilation of ethnographic references to different Hawaiian cultivars.) The unfinished task of applying the old names to cultivars is complicated by a number of factors. The few descriptions that have come down to us are quite sketchy. Also, the same cultivars were called by different names in different localities. The old Hawaiian cultivar names used in the present book are: Hiwa, Kūmakua, Mahakea (also called Mākea), Mōʻī, Nēnē (also called Kua ʻea), Papa ʻeleʻele, and Papa kea (also called Keʻokeʻo).

The remaining six Hawaiian cultivars profiled in this book cannot be recognized in the written or oral evidence identified thus far. These cultivars have been given names that relate to the places where they were discovered or to physical characteristics. We call them: ʻOpihikao (also "spotted Hiwa"), Papa ʻele ʻele puʻu puʻu, Mapulehu, Hanakāpīʻai (or Nēnē ʻeleʻele), Panaʻewa, and Honokāne Iki.

Right or wrong, these are the names that are now being used in our plant nurseries and botanical gardens. Information may come to light in the future to correct some of the names. Until then, the names at least allow us to tell the cultivars apart.

Chemotypes

This chapter also provides each cultivar's chemotype (kavalactone profile), which is most likely the key to why the Hawaiians chose to keep a particular variety in cultivation. (Refer to chapter 3, "The Active Ingredients in ʻAwa," by Mel C. Jackson, for a concise explanation of the six-digit chemotype characterizing the relative concentration of the six major kavalactones in the plants.)

The kavalactone levels reported in the present chapter are for lateral roots only, and the analyses were all done by Madis Botanicals for the 1999 *Economic Botany* paper by Lebot et al. Keep in mind that most drinks are made by combining the lateral roots with the stump, which generally has a chemotype nearly identical to the lateral roots but a lower total percentage of kavalactones.

Close readers of this chapter will notice that, within cultivars, chemotypes in the lateral roots can vary slightly from plant to plant, even when analyzed in the same laboratory. [1] While the chemotype is determined by cultivar rather than the environment in which the plant grows or by the cultivation methods used to raise it (Lebot, Merlin, and Lindstrom 1992, 79), there are slight variations. The difference does not seem to be enough to affect the drinking experience.

In fact, the chemotypes of all the Hawaiian varieties are so similar that drinkers in Hawaiʻi today do not often report experiencing differences in psychoactive effects from one cultivar to another. This may not have been the case, however, for native Hawaiians in the pre-contact period, whose perceptions would have been sharpened by a much wider and deeper experience with ʻawa, since its use permeated so many aspects of the culture.

Kavain is the predominant kavalactone in all Hawaiian varieties, and it lays the foundation for the excellent drinking experience to be had with our varieties. Kavain creates the feeling of well-being or mild euphoria that is the hallmark of the ʻawa experience. It also acts quickly--within ten minutes or so.

The first three kavalactones in the lateral roots of Hawaiian cultivars, almost always representing over 65 percent of the total, are generally kavain, methysticin, and dihydrokavain. In Vanuatu, there are many quite distinct ʻawa varieties used for different purposes, and cultivars rich in these three kavalactones are the ones used for a pleasant and fast-acting daily drink, instead of ceremonially or medicinally (Lebot and Siméoni 2004, 23).

Hawaiian varieties also have a low proportion of dihydromethysticin (DHM). According to Lebot, Merlin, and Lindstrom, "chemotypes with a high percentage of kavain and a low percentage of DHM induce the most desirable psychoactive effects" (1992, 78).

[1] The results of kavalactone analyses tend to vary greatly between laboratories (Ram 1999b, 7). Here are a number of factors that can affect the outcome:

- the manner in which the ʻawa is extracted
- the solvents used
- the analytical tool (for instance high pressure liquid chromatography, gas chromatography-mass spectrometry, ultraviolet spectrometry, etc.)
- sampling method

Hanakāpīʻai

Hanakāpīʻai has also gone by the name "Nēnē ʻeleʻele," however, neither are traditional names that have come down to us through chants or ethnographic studies.

This cultivar has been found, growing on its own, in only one area of Hawaiʻi, the Na Pali Coast of Kauaʻi, in Hanakāpīʻai Valley. When Joel Lau collected the cutting in 1983, he noted "One aggregation of this cultivar was observed" (notes on file at Waimea Arboretum on Oʻahu).

A Hawaiian settlement once flourished in this stunningly beautiful, remote, and archaeologically rich area. Literally translated, the name means "bay sprinkling food" (Pukui, Elbert, and Mookini 1974, 40).

This tall plant has an erect growing habit and can attain a height of ten feet or more, depending on the environment. Growing in the full sun, it may remain under eight feet.

It is a dark ʻawa with many spots and purple nodes. Under some conditions, this cultivar can develop a waxy shine on its stalks.

Table 5.2. Hanakāpīʻai
Kavalactone Analysis of Air-Dried Lateral Roots
(Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	**APN10**	**APN11**	**PAH3**
Chemotype	423615	423651	462351
Age of Plant (Years)	6	3	2.3
Soil Type	Hāmākua	Hāmākua	Pāhoa
Location (Hawaiʻi Island)	Hāmākua coast	Hāmākua coast	Puna
Shade (1=full sun; 4=full shade)	1.5	2	2
Growing Methods	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized	Cultivated, rainfed, some fertilizer
Damage	No damage	No damage	No damage
Lateral Root Size	>2 cm.	1-0.5 cm.	>2 cm.
Percentage Kavalactones			
Kavalactone			
Desmethoxyyangonin (1)	1.50	1.03	0.75
Dihydrokavain (2)	2.75	2.33	1.90
Yangonin (3)	2.67	2.07	1.63
Kavain (4)	4.54	3.52	3.27
Dihydromethysticin (5)	1.43	1.18	1.05
Methysticin (6)	2.63	1.97	1.95
Total Kavalactones	**15.52**	**12.1**	**10.55**

Scale is in inches.

Fig. 5.2. The stems are especially dark around the node.

Fig. 5.3. The appearance overall is similar to ʽawa Nēnē, but Hanakāpīʽai is darker. (Photo by G. Brad Lewis)

Fig. 5.4. This stem has a waxy look.

"Hiwa, the darkest of all varieties, was the ritualistic awa used by the kahunas and may have been reserved for such use. All the other varieties were common awa which anyone might use" (Handy 1940, 204).

Oscar P. Cox, in a letter to G.R. Carter in 1930, comments on Hiwa: "They also use this kind of Awa in the sacrificial ceremonies of Pele-worship."

Kāwika Winter's thesis (2004, 239) provides a quote from H.E.P. Kekahuna's unpublished papers, housed in the Hawaiʻi state archives:

> The most highly esteemed liquor of ancient Hawaiʻi was the ʻawa drink, favorite beverage of the gods, priests, and chiefs, and a first and most essential of the offerings to deity…. There are approximately two dozen Hawaiian varieties, some of which are known by different names in different localities, each of which shares its name with the drink it produces.
>
> The most sacred of these varieties were the ʻAwa hiwa, with dark green somewhat long stem internodes, dark at each node when mature; and the ʻAwa mōʻī, with dark stems and internodes not quite as long as those of the ʻAwa hiwa. The drink from these varieties was especially offered to mighty Volcano-Goddess Pele and other deities. A chant was offered, and then the drink itself. This involved dipping one's finger into the ʻAwa and snapping it either upward, backward, or both. The essence of the drink (ke aka, literally the shadow) was first offered to the gods, whereupon it was the duty of the priests (kahuna-s) to ceremonially consume the remaining substance (ke kino, the body; ka ʻiʻo, the flesh).
>
> The great chiefs, for their pleasure, also imbibed the sacred ʻAwa, permitting only the use of non-sacred varieties to the humble commoner, unless a kahuna used a sacred variety to treat a sickness.

The reverence for Hiwa in old Hawaiʻi is evident in this portion of a chant recorded by N.B. Emerson and quoted by Handy and Handy (1991, 512). "This refers to the cup of sacramental *ʻawa* brewed from the strong, black *ʻawa* root (*ʻawa hiwa*) which was drunk sacramentally by the *kumu hula*":

> The day of revealing shall see what it sees:
> A seeing of facts, a sifting of rumors,
> An insight won by the black sacred ʻawa,
> A vision like that of a god!

Winter (2004, 51-52) describes a hula prayer for inspiration which contains the line, "He ʻike pū ʻawa hiwa." Pukui and Elbert (1986, 96) translated this as "a knowledge from kava offerings." Winter explains that ʻawa, especially of the Hiwa variety, was offered to hula deities in return for knowledge and inspiration.

Hiwa has long internodes with few lenticels. The plant has an erect growing habit and may reach heights of eight feet or more in the full sun.

Only one lateral root sample for this variety was analyzed for the 1999 *Economic Botany* paper:

Table 5.3. Hiwa
Kavalactone Analysis of Air-Dried Lateral Roots
(Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	APN17
Chemotype	462351
Age of Plant (Years)	5.5
Soil Type	Hāmākua
Location (Hawaiʻi Island)	Hāmākua coast
Shade (1=full sun; 4=full shade)	3.5
Growing Methods	Cultivated, irrigated, fertilized
Damage	Fungi
Lateral Root Size	>2 cm.
Percentage Kavalactones	
Kavalactone	
Desmethoxyyangonin (1)	0.80
Dihydrokavain (2)	2.09
Yangonin (3)	1.78
Kavain (4)	3.26
Dihydromethysticin (5)	1.11
Methysticin (6)	2.19
Total Kavalactones	**11.23**

Scale is in inches.

Fig. 5.5. Internodes can be quite long.

Fig. 5.6. Hiwa's growth habit is erect.

Fig. 5.7. The stalk is shiny with few lenticels. The leaf piko is dark.

Honokāne Iki

ʻAwa Honokāne Iki is named after the valley where it was once abundant. The name is not a traditional one found in ethnographies, chants, or oral histories. Honokāne Iki is a valley in the Kohala District on the island of Hawaiʻi, just beyond Pololū and Honokāne Nui valleys.

We know that the valleys between Waipiʻo and Pololū were inhabited by Hawaiians for centuries. After the Kohala Ditch was completed in 1906, much of the stream water was diverted to sugar cultivation. Residents from Pololū to Honopue gave up their homes and farms and moved away (Clark 1985, 149).

This cultivar was also found in the old ʻawa fields of the South Kona district.

With its conspicuous lenticels, long internodes, and erect growing habit, Honokāne Iki is sometimes mistaken for the Nēnē variety. Honokāne Iki has fewer spots than Nēnē has and they are farther apart. Striation may be seen on many of the lower stalks.

Table 5.4. Honokāne Iki
Kavalactone Analysis of Air-Dried Lateral Roots
(Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	**APN18**
Chemotype	463251
Age of Plant (Years)	3
Soil Type	Hāmākua
Location (Hawaiʻi Island)	Hāmākua coast
Shade (1=full sun; 4=full shade)	3.5
Growing Methods	Cultivated, irrigated, fertilized
Damage	No damage
Lateral Root Size	>2 cm.
Percentage Kavalactones	
Kavalactone	
Desmethoxyyangonin (1)	0.96
Dihydrokavain (2)	2.30
Yangonin (3)	2.37
Kavain (4)	4.33
Dihydromethysticin (5)	1.39
Methysticin (6)	2.73
Total Kavalactones	**14.08**

Scale is in inches.

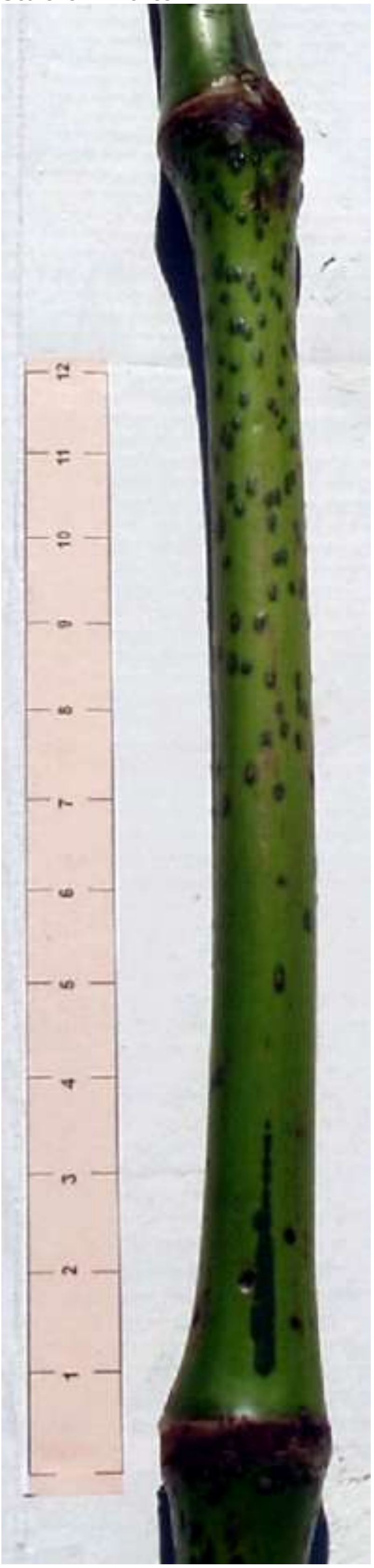


Fig. 5.8. There are more lenticels on the top half of the internode.

Fig. 5.9. Honokāne Iki looks somewhat like ʻawa Nēne but has fewer lenticiels and its stem is brighter. (Photo by Kāwika Winter)

Fig. 5.10. The shorter sample is from the bottom of the stalk, where striation often occurs.

Kūmakua

The *Hawaiian Dictionary* describes Kūmakua as "a variety of ʻawa with green internodes of medium length" (Pukui and Elbert 1986, 34). Recently, this cultivar has been called "Puna green."

Kūmakua is a dull green with few lenticels. Young shoots show striation and mottling, but, as they mature, the stalks lose these markings. The plant's growth habit is normal.

A reference to this cultivar is found in the writings of the Reverend Stephen L. Desha, which were translated from the Hawaiian for the book *Kamehameha and His Warrior Kekūhaupiʻo* (2000, 145). Desha says that "*ka ʻawakūmakua*" was among the offerings Kamehameha set before his god, Kūkāʻilimoku, with the body of Kīwalaʻō after the battle of Mokuʻōhai.

Kāwika Winter's master's thesis comments that:

> Athough no records are known to exist about the meaning of this name, it could possibly be a shortened version of the word "kū-ma-kuahiwi," or "stands in the mountains." If this is true, then its name could possibly be an indication of its ecological habitat. It might suggest that this is a variety that is suited for mountainous areas (2004, 86).

Cuttings of this cultivar were collected in 1996 in an abandoned ʻawa field on the slopes of Mauna Loa in upper Kalapana, Puna. It was part of an old planting that extended through several acres of ʻōhiʻa and hāpuʻu forest on state-owned land. The site had other features of Hawaiian gardens, such as rock walls, and could have been considered a historic site.

Around that time, the high prices being paid for ʻawa on the U.S. mainland and in Europe put historic forest plantings at risk from pillagers, who were shipping out large quantities of ʻawa. Their method was to rip out the ʻawa completely without replanting.

That is what ultimately happened to this huge patch, which consisted of Kūmakua and Mahakea varieties and may have been there for hundreds of years. Because access required an hour of forest hiking, the thieves constructed a roadway to the ʻawa with a bulldozer. They completely eliminated the planting and destroyed the historic site.

Table 5.5. Kūmakua
Kavalactone Analysis of Air-Dried Lateral Roots (Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	**KAL2**
Chemotype	462351
Age of Plant (Years)	100?
Soil Type	Pāhoa
Location (Hawaiʻi Island)	Puna
Shade (1=full sun; 4=full shade)	3.5
Growing Methods	Not cultivated, not irrigated, not fertilized
Damage	No damage
Lateral Root Size	<0.5 cm.
Percentage Kavalactones	
Kavalactone	
Desmethoxyyangonin (1)	0.73
Dihydrokavain (2)	2.21
Yangonin (3)	1.55
Kavain (4)	3.16
Dihydromethysticin (5)	1.54
Methysticin (6)	2.23
Total Kavalactones	**11.42**

Scale is in inches.

Fig. 5.11. The stem above and at lower right is from an 18-month-old plant.

Fig. 5.12. This is a very old plant from the "wild" patch in Puna. Stalks are covered in algae.

Fig. 5.13. Stems have very few lenticels.

Mahakea

ʻAwa Mahakea was one of the more common ʻawa cultivars surviving in Hawaiian forests. Pukui and Elbert's *Hawaiian Dictionary* defines the "ʻawa mahakea" as "a name for *ʻawa ākea*, *ʻawa mākea* at Kaʻū, Hawaiʻi" (1986, 34).

Its long internodes are a dull green with purple shading at the bottom, sometimes nearly black depending on the age of the stalk and the light conditions. The node is purple and the leaf piko is green. It is known as a fast, strong, erect grower, often producing a large root and stump within a couple of years.

When the Hawaiian cultivars underwent DNA fingerprinting, Mahakea was one of only two Hawaiian cultivars showing distinctive bands for any of the 21 pairs of primers assayed. Mahakea's eleven distinctive bands (out of a total of 1149, or 0.9%) indicate that it varies somewhat genetically from the other Hawaiian cultivars, which, except for the cultivar Papa kea, showed no difference from one another (Lebot et al. 1999, 414).

Vincent Lebot speculates that "cultivar Omoa collected in the Marquesas seems to be related to Oahu 241 from Hawaii" (Lebot 1991, 197). The morphological description of Oʻahu 241 matches that of Mahakea. (At the time that Lebot labeled this accession Oʻahu 241, no attempt was being made to relate the cultivars to their traditional names.) If, as is believed, all Hawaiian ʻawa varieties trace their ancestry back to a single plant that arrived with the early settlers from the Marquesas, it could be interesting to compare Omoa closely with Mahakea—perhaps Omoa was the ancestor of Hawaiʻi's ʻawa varieties.

Five different Mahakea plants of different ages and growing in various conditions were analyzed for the *Economic Botany* paper. In the table below, note the variation in the total kavalactone percentages for the five samples. The table sheds light on the ways the growing environment can affect the total amount of kavalactones that develop.

Roots of old forest ʻawa tend to be lower in kavalactones than roots of cultivated plants that have been fertilized, irrigated, and cared for. Growing in full sun can also increase the amount of kavalactones eventually present in the lateral root. ʻAwa growers have taken note of findings like these and adjusted their growing practices accordingly.

Table 5.6. Mahakea
Kavalactone Analysis of Air-Dried Lateral Roots (Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	**APN7**	**APN8**	**KAL1**	**PONO1**	**PUUAL**
Chemotype	461235	426315	462531	462351	461235
Age of Plant (Years)	5.5	2	100?	30?	2
Soil Type	Hāmākua	Hāmākua	Pāhoa	Pāhoa	Hāmākua
Location (Hawaiʻi Island)	Hāmākua coast	Hāmākua coast	Puna	Puna	Hāmākua coast
Shade (1=full sun; 4=full shade)	1.5	1	3.5	3.5	3
Growing Methods	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized	Wild, not irrigated, not fertilized	Wild, not irrigated, not fertilized	Certified organic cultivation, irrigated, fertilized
Damage	No damage	No damage	No damage	No damage	No damage
Lateral Root Size	>2 cm.	>2 cm.	<0.5 cm.	<0.5 cm.	<0.5 cm.
Percentage Kavalactones					
Kavalactone					
Desmethoxyyangonin (1)	1.75	1.38	0.95	0.47	1.35
Dihydrokavain (2)	1.74	2.50	1.46	1.17	1.10
Yangonin (3)	1.40	2.02	1.20	0.87	1.05
Kavain (4)	2.76	3.69	2.13	1.90	1.89
Dihydromethysticin (5)	1.06	1.23	1.35	0.81	0.72
Methysticin (6)	2.01	2.19	2.06	1.71	1.56
Total Kavalactones	**10.72**	**13.01**	**9.15**	**6.93**	**7.67**

Scale is in inches.

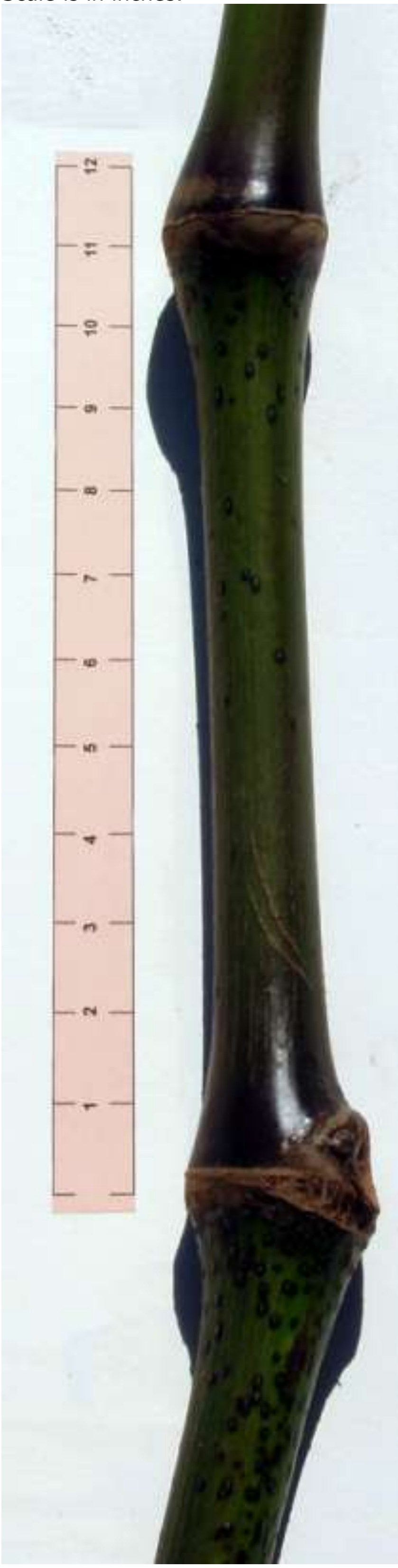


Fig. 5.14. Mature stalks have long internodes.

Fig. 5.15. The purple at the bottom of each internode, fading upwards into a dull green, is characteristic of Mahakea.

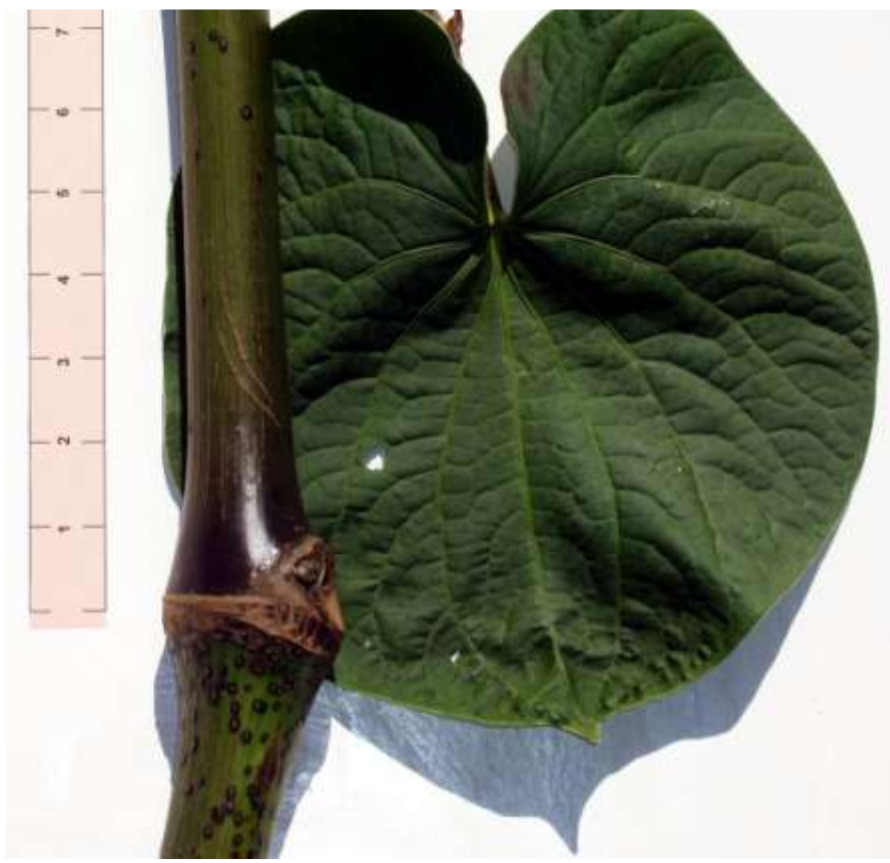


Fig. 5.16. Lenticels crowd together underneath each node.

Mapulehu

The name of this ʻawa is taken from the ahupuaʻa and stream along the southeast coast of Molokaʻi, where the cultivar was found. It is not a traditional Hawaiian name for an ʻawa variety.

Plants were found inland from the Iliʻiliʻōpae Heiau along an historic trail that extends from Pūkoʻo over the mountain and down to the bottom of Wailau Valley. This same cultivar has been found in abundance in Wailau Valley on Molokaʻi's north shore.

Mapulehu is an erect growing ʻawa with long internodes showing few spots. Often there is a dark patch just above the node and growing bud.

Table 5.7. Mapulehu
Kavalactone Analysis of Air-Dried Lateral Roots
(Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	**PAU6**	**PAPIO**
Chemotype	462351	462531
Age of Plant (Years)	3.2	10
Soil Type	Hāmākua	Hāmākua
Location (Hawaiʻi Island)	Hāmākua coast	Molokaʻi
Shade (1=full sun; 4=full shade)	2	3.5
Growing Methods	Cultivated, irrigated, fertilized	Wild, not irrigated, not fertilized
Damage	Nematodes	No damage
Lateral Root Size	1-2 cm.	<0.5 cm.
Percentage Kavalactones		
Kavalactone		
Desmethoxyyangonin (1)	0.51	0.42
Dihydrokavain (2)	1.30	1.42
Yangonin (3)	1.07	1.18
Kavain (4)	2.36	1.93
Dihydromethysticin (5)	0.61	1.39
Methysticin (6)	1.42	1.91
Total Kavalactones	**7.27**	**8.25**

Scale is in inches.

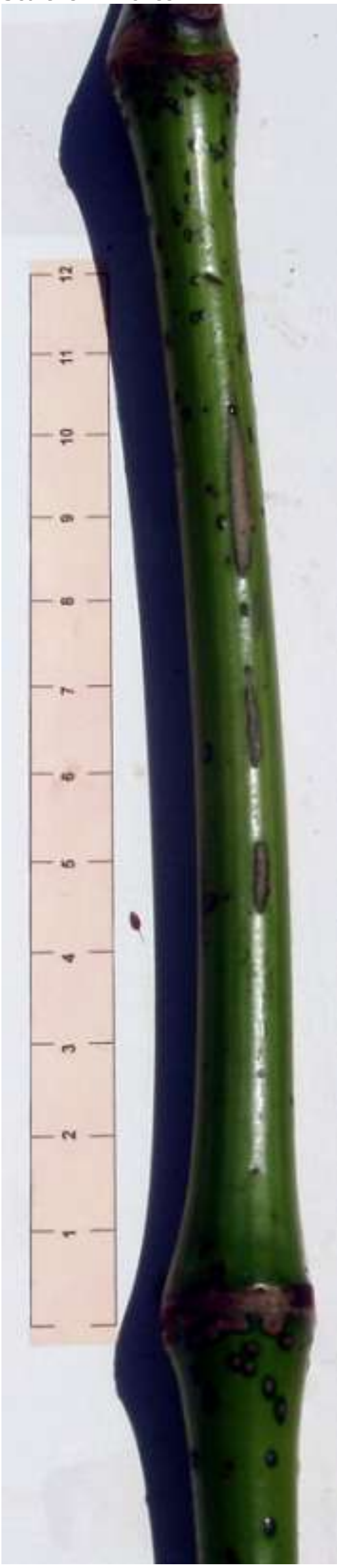
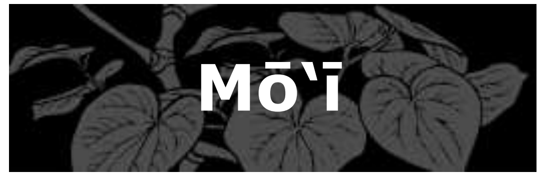


Fig. 5.17. The internodes are long.

Fig. 5.18. The overall growth habit of Mapulehu is erect. (Photo by Harry Brevoort)

Fig. 5.19. The dark triangle just above the node helps identify this cultivar.



ʻAwa Mōʻī is another of the dark, sacred ʻawa varieties so important in Hawaiian religious and ceremonial life. Kāwika Winter points out that "certain offerings reserved for the gods were often black in color" (2004, 36). For instance, the gods might be offered a black pig along with a dark ʻawa like Mōʻī or Hiwa.

H.E.P. Kekahuna describes Mōʻī as having "dark stems and internodes not quite as long as those of the Awa hiwa. The drink from these varieties was especially offered to mighty Volcano-Goddess Pele and other deities" (see the full quote under "Hiwa," p. 36; Kekahuna unpublished papers, quoted in Winter 2004, 87).

Oscar P. Cox, in his 1930 letter to George R. Carter, stated that "the skin or bark of the stem of this variety of awa-root is red or sort of brownish. The priests of old use this kind of Awa in the sacrificial ceremonies to Pele." According to Kāwika Winter, "Pele is one of the very few akua who is offered ʻAwa in all three forms—as drink, whole plant, and whole root section" (2004, 47).

In all probability, the chiefs could also partake of this ʻawa, and it had its place in medicine. Mōʻī is one of the varieties most effective against urinary problems. It was also used to treat "splitting headache" (Chun 1994, 53-54).

Kamakau ([1869] 1976, 41) says "the stems of … the *moʻi* [variety] grow straight up, with sections like those of the *honuaʻula* sugar cane." It has a normal growth habit.

Cuttings were collected along a high ridge in the Waimā area of Waipiʻo Valley in 1988 by Joel Lau and Ed Johnston.

Table 5.8. Mōʻī
Kavalactone Analysis of Air-Dried Lateral Roots
(Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	**APN1**	**PAU1**
Chemotype	462351	463251
Age of Plant (Years)	6	3
Soil Type	Hāmākua	Hāmākua
Location (Hawaiʻi Island)	Hāmākua coast	Hāmākua coast
Shade (1=full sun; 4=full shade)	2	2.5
Growing Methods	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized
Damage	Fungi	No damage
Lateral Root Size	>2 cm.	<0.5 cm.
Percentage Kavalactones		
Kavalactone		
Desmethoxyyangonin (1)	0.95	0.73
Dihydrokavain (2)	2.01	1.48
Yangonin (3)	1.53	1.52
Kavain (4)	3.65	2.47
Dihydromethysticin (5)	1.04	0.93
Methysticin (6)	2.12	1.92
Total Kavalactones	**11.3**	**9.05**

Scale is in inches.

Fig. 5.20. Internodes are of medium length. Nodes are beige.

Fig. 5.21. "The skin or bark of the stem . . . is red or sort of brownish" (Cox 1930). (Photo by Kāwika Winter)

Fig. 5.22. The leaf piko is dark, like the stem.

Nēnē

The *Hawaiian Dictionary* describes ʻawa Nēnē as "A variety of ʻawa, stems green with dark green spots." The dictionary notes that it is also called "*ʻawa kua ʻea*," literally "turtle back" (Pukui and Elbert 1986, 34 and 168). According to *Native Hawaiian Medicines* (a recent translation of a work originally compiled in 1922):

> ʻAwa Kuaʻea is the secret name. The stalks of this ʻAwa are like the ʻAwa Mākea. Furthermore, its general appearance is spotted and kind of lumpy like the spots of a turtle's back or also like the Moa hulu Nēnē (Chun 1994, 58).

Ethnographer Martha Beckwith has said, "Babies were given the juice of the nene variety as a soothing syrup. 'This is a fretful (onene) child and must be given the awa nene'" (1970, 94). In Chapter 2, cultural historian Kepā Maly explains that "in this case, use of the word *nēnē* is symbolic of murmuring, like the soft chatter of the native geese. By the play on the word *nēnē*, use of the *ʻawa nēnē* was believed to help temper the voice of the youngster."

This ʻawa is easily recognized by its long, green internodes with raised lenticels and its erect growing habit. The leaf has a green piko.

Today, plants of this variety are relatively common. It seems also to have been a popular cultivar in old Hawaiʻi. It has been collected from a number of Hawaiian valleys: Waipiʻo, Honokāne Nui, and Hanakāpīʻai.

Table 5.9. Nēnē
Kavalactone Analysis of Air-Dried Lateral Roots (Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	APN12	APN13	PAU9	NENE
Chemotype	463251	463251	463251	462531
Age of Plant (Years)	6.2	3	1	20
Soil Type	Hāmākua	Hāmākua	Hāmākua	Pāhoa
Location (Hawaiʻi Island)	Hāmākua coast	Hāmākua coast	Hāmākua coast	Puna
Shade (1=full sun; 4=full shade)	3.5	3	2.5	3.5
Growing Methods	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized	Wild, not irrigated, not fertilized
Damage	Not damaged	Not damaged	Not damaged	Not damaged
Lateral Root Size	1-2 cm.	1-2 cm.	>2 cm.	<0.5 cm.
Percentage Kavalactones				
Kavalactone				
Desmethoxyyangonin (1)	0.69	0.54	0.40	0.69
Dihydrokavain (2)	1.63	1.29	1.03	1.25
Yangonin (3)	2.29	1.59	1.11	0.73
Kavain (4)	3.39	2.63	2.09	1.66
Dihydromethysticin (5)	1.07	0.80	0.84	0.90
Methysticin (6)	2.61	1.98	1.67	1.51
Total Kavalactones	**11.68**	**8.83**	**7.14**	**6.74**

Scale is in inches.

Fig. 5.23. ʻAwa Nēnē's many lenticels are its most distinguishing feature.

Fig. 5.24. The cultivar has an erect growing habit.

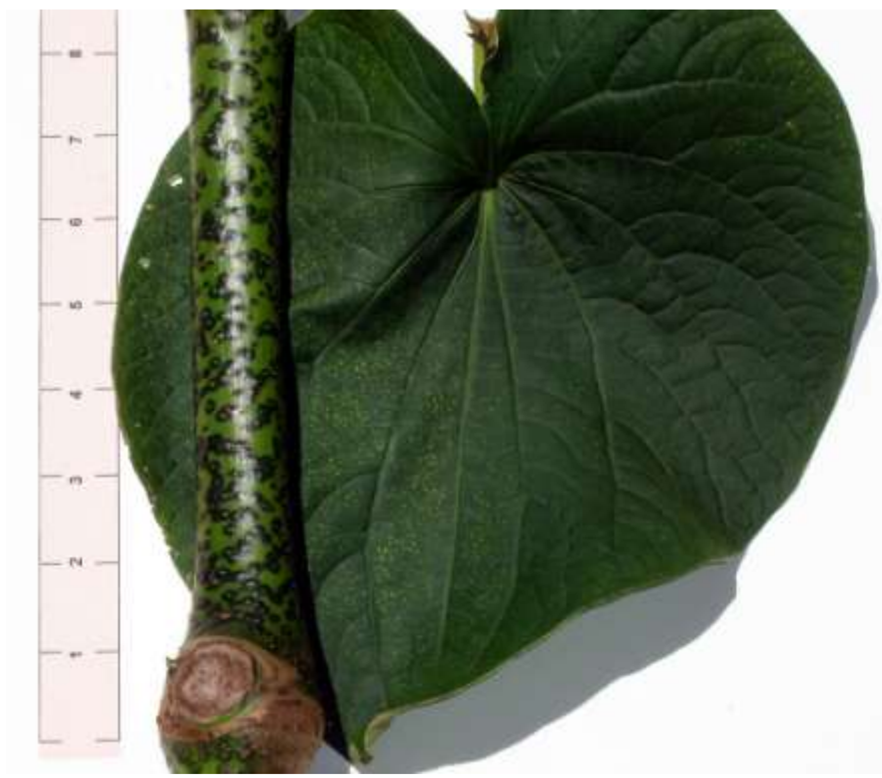


Fig. 5.25. Lenticels are distributed over the entire internode.

‘Opihikao

‘Awa ‘Opihikao was the name recently applied to a cultivar found along the ‘Opihikao Ridge on the island of Hawai‘i. Other names sometimes used today for this cultivar are "spotted Hiwa" or "Hiwa pu‘upu‘u."

Its growing habit is erect. ‘Opihikao has been known to reach twelve feet and higher. The internodes are very dark and long—up to twenty inches—with many lenticels.

To the best of our knowledge, this cultivar was only located in one area of ‘Opihikao and nowhere else. In the late 1990s, AHA President Jerry Konanui discovered the three extremely large plants and took cuttings for propagation and root samples for analysis. Thanks to that action, we now have ‘Opihikao in cultivation.

Very soon afterwards, the abundant ‘awa along the ‘Opihikao Ridge simply disappeared. Included in this patch were numerous Mahakea, Nēnē, and Papa ‘ele‘ele pu‘upu‘u plants, which also are all gone now.

The ‘Opihikao roots analyzed for the 1999 *Economic Botany* paper were from this relict patch. The overall kavalactone level was the lowest of any of the root samples analyzed for that paper: 4.85%.

The clones of the original plants have now grown up, and additional analyses have been done. These show kavalactone levels that are more in line with the other Hawaiian varieties. For instance, the lateral roots of a two-year-old plant, which was cultivated in partial sun and fertilized liberally, had a total kavalactone content of 11.76 percent.

Table 5.10. ‘Opihikao
Kavalactone Analysis of Air-Dried Lateral Roots
(Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	**APN18**
Chemotype	462531
Age of Plant (Years)	50?
Soil Type	Pāhoa
Location (Hawai‘i Island)	Puna
Shade (1=full sun; 4=full shade)	3.5
Growing Methods	Wild, not irrigated, not fertilized
Damage	No damage
Lateral Root Size	<0.5
Percentage Kavalactones	
Kavalactone	
Desmethoxyyangonin (1)	0.49
Dihydrokavain (2)	0.85
Yangonin (3)	0.66
Kavain (4)	1.11
Dihydromethysticin (5)	0.71
Methysticin (6)	1.03
Total Kavalactones	**4.85**

Scale is in inches.

Fig. 5.26. Distinguishing characteristics include its extremely long internodes, dark color, and shiny surface.

Fig. 5.27. Interior stalks of a mature ʽawa ʽOpihikao.

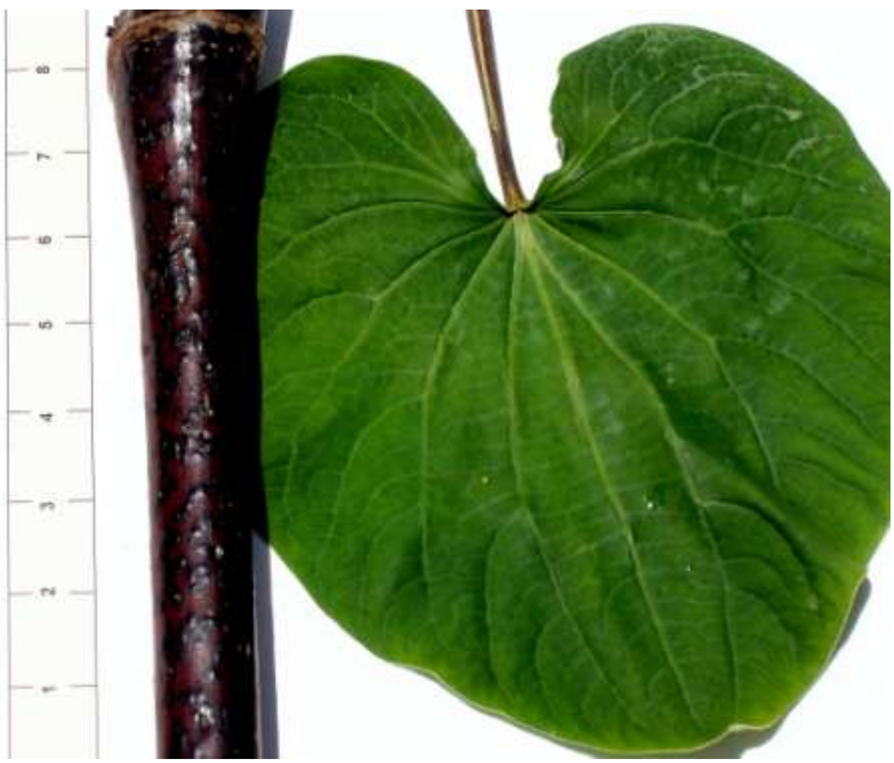


Fig. 5.28. Lenticels are visible all along the internode.

Pana‘ewa

‘Awa Pana‘ewa is not a name we can trace back to old Hawai‘i. When first collected, this cultivar was tagged as "short internode green" or "SIG," a misleading label but one which persists despite the purple color above the nodes. Kūpuna in the Hawaiian Homelands area of Pana‘ewa have preferred to call it "Pana‘ewa" because it was once very prevalent there.

This cultivar has also been found growing in other areas on the island of Hawai‘i, for example, in Maulua gulch and a spot near the village of Honomū.

Otto Degener comments in *Flora Hawaiiensis* that "Awa has been planted by the Board of Agriculture and Forestry on the wet *aa* lava between Olaa and Hilo, a region well suited to it" (Degener 1946, under the entry "Piperaceae"). The remaining forest stands of Pana‘ewa may be those plantings from the Territorial Board of Agriculture and Forestry.

‘Awa Pana‘ewa is a low- to medium-growing plant with a mostly prostrate growth habit. The young plant starts out with very short internodes but, as the plant grows larger, they elongate somewhat. Both characteristics are often found on one plant, with very short internodes on the newer growth.

Table 5.11. Pana‘ewa
Kavalactone Analysis of Air-Dried Lateral Roots
(Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	**PANAE**	**KOLE**
Chemotype	463215	462351
Age of Plant (Years)	5	55?
Soil Type	Pāhoa	Hāmākua
Location (Hawai‘i Island)	Puna	Hāmākua coast
Shade (1=full sun; 4=full shade)	2	3.5
Growing Methods	Wild, rainfed, fertilized	Cultivated, rainfed, not fertilized
Damage	No damage	No damage
Lateral Root Size	>1-0.5 cm.	<0.5 cm.
Percentage Kavalactones		
Kavalactone		
Desmethoxyyangonin (1)	1.61	0.42
Dihydrokavain (2)	2.01	1.36
Yangonin (3)	2.61	1.03
Kavain (4)	4.19	2.63
Dihydromethysticin (5)	1.14	0.95
Methysticin (6)	2.97	2.03
Total Kavalactones	**14.53**	**8.42**

Scale is in inches.

Fig. 5.29. This is a characteristic older stem, with internodes elongating to medium length.

Fig. 5.30. Note the purple band above each node. (Photo by G. Brad Lewis)

Fig. 5.31. The stem nodes are purple, and the leaf piko is green. There are very few lenticels.

Papa ʻEleʻele Puʻupuʻu

Papa ʻeleʻele puʻupuʻu is a name which was devised recently to match the appearance of this ʻawa. It is named after the dark Papa ʻeleʻele variety with the addition of the word "puʻupuʻu," which means "full of protuberances, lumps" (Pukui and Elbert 1986, 360).

Typical characteristics of this cultivar are its short to medium internodes and dark, highly spotted stalks. Its growth habit is normal, and its leaf piko is dark.

As with any ʻawa plant, the amount of light plays a role in its overall growth. If grown in full sun, the internodes will be shorter than if grown in shade.

Papa ʻeleʻele puʻupuʻu was collected from forest stands in Honolua and Kīpahulu valleys on Maui and in ʻOpihikao in the Puna district of the island of Hawaiʻi. The patch in ʻOpihikao has since been destroyed.

Table 5.13. Papa ʻEleʻele Puʻupuʻu
Kavalactone Analysis of Air-Dried Lateral Roots (Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	APN6	PAU7	PAH1	PAH1* (Clone of PAH1)	PONO2
Chemotype	463215	463215	462531	463251	463251
Age of Plant (Years)	4	3	20?	2.4	30?
Soil Type	Hāmākua	Hāmākua	Pāhoa	Pāhoa	Pāhoa
Location (Hawaiʻi Island)	Hāmākua coast	Hāmākua coast	Puna	Puna	Puna
Shade (1=full sun; 4=full shade)	4	3	3.5	2	3.5
Growing Methods	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertlized	Wild, not irrigated, not fertilized	Cultivated, not irrigated, not fertilized	Wild, not irrigated, not fertilized
Damage	Not damaged	Not damaged	Not damaged	Not damaged	Not damaged
Lateral Root Size	<0.5 cm.	1-2 cm.	<0.5 cm.	<1-2 cm.	<0.5 cm.
Percentage Kavalactones					
Kavalactone					
Desmethoxyyangonin (1)	0.83	1.60	0.75	0.97	0.98
Dihydrokavain (2)	1.34	1.93	1.03	1.89	1.29
Yangonin (3)	1.42	2.90	0.85	2.48	1.52
Kavain (4)	2.93	4.34	1.36	4.09	2.46
Dihydromethysticin (5)	0.73	1.29	0.90	1.18	1.07
Methysticin (6)	1.60	3.19	1.32	2.64	2.39
Total Kavalactones	**8.85**	**15.25**	**6.21**	**13.25**	**9.71**

Scale is in inches.

Fig. 5.35. Speckled, short to medium internodes characterize this cultivar.

Fig. 5.36. The growth habit is somewhat more upright than Papa ʻeleʻele. (Photo by Harry Brevoort)

Fig. 5.37. Spots are distributed throughout the internode.

Papa ʻEleʻele

Papa ʻeleʻele is one of the most desirable cultivars. It has short, deep purple to green internodes and beige nodes. Its leaf has a dark piko. The growth habit is prostrate.

Historian Samuel Kamakau mentions this cultivar: "The low-growing *papa ʻeleʻele* and *papa kea* varieties of ʻawa grow to be very handsome and decorative" ([1869] 1976, 41). Kaaiakamanu and Akina reported that it resembles ʻawa Mōʻī, but "its segments are considerably shorter . . . and it grows wildly, its branches scattering here and there among the shrubs" (1922, 19).

Papa ʻeleʻele is sometimes called "the Queen's ʻawa" or "Luʻukia." It was the dominant cultivar found in an area of Waipiʻo Valley that some valley residents call the "Queen's ʻawa patch." The name Luʻukia belonged to the wife of the ruler ʻOlopana, and, according to tradition, she lived for a time in Waipiʻo, perhaps in the 1300s (Cordy 2000, 141).

In addition, this ʻawa is sometimes called "Ālia 3." It has also been referred to as "Mōʻī," but that is now thought to be incorrect. The variety we are now calling "Mōʻī" is described earlier in this chapter.

Chun's compilation of early medicinal lore lists Papa ʻeleʻele among the varieties especially useful in treating urinary conditions (1994, 1:53-54).

This variety has been found growing wild in Waipiʻo and Waimanu valleys on the island of Hawaiʻi, as well as in Kīpahulu Valley on Maui.

Some Papa ʻeleʻele plants have had very high kavalactone levels. The first sample of dried lateral roots in the chart below shows 20.8 percent total kavalactones, with kavain at 6.69 percent.

For the home garden, where space may be limited, consider this variety for the following advantages:

- low-growing and wind-resistant
- ornamental
- stout, sturdy stalks
- disease resistance
- it makes a great drink.

Table 5.12. Papa ʻEleʻele
Kavalactone Analysis of Air-Dried Lateral Roots (Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	**APN2**	**APN3**	**APN4**	**APN5**	**PAH2**	**PAU3**	**PAU4**	**PAU5**
Chemotype	436215	462351	463251	463215	463251	463215	463215	463215
Age of Plant (Years)	4	3	3	4	2.3	2	1	5.5
Soil Type	Hāmākua	Hāmākua	Hāmākua	Hāmākua	Pāhoa	Hāmākua	Hāmākua	Hāmākua
Location (Hawaiʻi Island)	Hāmākua coast	Hāmākua coast	Hāmākua coast	Hāmākua coast	Puna	Hāmākua coast	Hāmākua coast	Hāmākua coast
Shade (1=full sun; 4=full shade)	4	3	3	4	2.3	2	1	5.5
Growing Methods	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized	Cultivated, not irrigated, some fertilizer	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized
Damage	No damage	No damage	No damage	No damage	No damage	No damage	No damage	Bacteria
Lateral Root Size	>2 cm.	>2 cm.	>2 cm.	<0.5	1-2 cm.	1-2 cm.	<0.5	1-2 cm.
Percentage Kavalactones								
Kavalactone								
Desmethoxyyangonin (1)	1.67	0.78	0.88	1.54	0.95	1.30	1.17	1.47
Dihydrokavain (2)	3.12	1.50	1.60	1.58	1.63	2.21	1.45	1.97
Yangonin (3)	4.25	1.18	1.95	1.59	1.73	2.70	1.96	2.38
Kavain (4)	6.69	2.94	3.17	3.01	3.19	4.72	3.15	4.16
Dihydromethysticin (5)	1.54	0.85	0.92	0.75	0.96	1.13	1.00	0.99
Methysticin (6)	3.53	1.70	1.98	1.89	2.25	3.01	2.62	2.47
Total Kavalactones	**20.8**	**8.95**	**10.5**	**10.36**	**10.71**	**15.07**	**11.35**	**13.44**

Scale is in inches.

Fig. 5.32. Internodes start out purple at the bottom, often shading to green going up.

Fig. 5.33. True to its prostrate form, this ʻawa's outer branches are creeping along the ground.

Fig. 5.34. The piko of the ʻawa tends to be the same color as the stalk. This one is hard to see, but it is dark like the stem. There are a few lenticels and they tend to appear just under the node.

Papa Kea

The ʻawa variety that the Hawaiians called Papa kea is described by Handy as being "like the Papa eleele as to internodes and habit, but has light green stalk" (1940, 202). He also mentions that this cultivar is probably the same as the ʻawa called Keʻokeʻo. Kamakau tells us that Papa kea is one of the low varieties that "grow to be very handsome and decorative" ([1869] 1976, 41).

In recent years, we have called this cultivar by the name "ʻApu" but now believe, thanks to Kāwika Winter, that there is stronger evidence for it to be called Papa kea. ʻApu seems to have been described by only one informant, the Rev. Oliver P. Emerson (1903, 131), who said its joints "are short and green" and that Mākea's are lighter. However, none of the other Hawaiian cultivars could be described as lighter than the cultivar pictured on the opposite page.

The *Hawaiian Dictionary* says that ʻawa Papa kea (or Keʻokeʻo) is "the commonest variety" (Pukui and Elbert 1986, 34). It thus seems likely that Papa kea would be one of the cultivars to survive to the present.

Its growth habit is prostrate. Rarely reaching five feet in height, Papa kea is an attractive and manageable plant.

Plants of this cultivar have been found in old ʻawa fields in Puna. Joel Lau collected it in 1983 by a tributary of the Kamoʻoaliʻi stream system in Kāneʻohe, Oʻahu. It has also been cultivated in the collection donated by Vincent Lebot at the National Tropical Botanical Garden site in Hāna, Maui, where the cultivar was labeled Oʻahu 237.

When the Hawaiian cultivars underwent DNA fingerprinting for the 1999 *Economic Botany* paper, Papa kea (labeled "ʻApu") was one of only two Hawaiian cultivars to be identified as slightly different genetically from the other Hawaiian cultivars. It exhibited eight distinctive bands (out of a possible 1149 or 0.7 percent difference) over three of the 21 pairs of primers assayed.

This cultivar is very susceptible to the shothole disease (*Phoma* sp.), and every precaution should be taken to prevent it. See chapter 9 for more information on controlling this fungal disease in ʻawa.

Table 5.1. Papa Kea
Kavalactone Analysis of Air-Dried Lateral Roots
(Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	PAH4
Chemotype	462351
Age of Plant (Years)	3
Soil Type	Pāhoa
Location (Hawaiʻi Island)	Puna
Shade (1=full sun; 4=full shade)	3
Growing Methods	Cultivated, rainfed, some fertilizer
Damage	No damage
Lateral Root Size	1-2 cm.
Percentage Kavalactones	
Kavalactone	
Desmethoxyyangonin (1)	0.82
Dihydrokavain (2)	2.00
Yangonin (3)	1.75
Kavain (4)	3.43
Dihydromethysticin (5)	1.04
Methysticin (6)	2.12
Total Kavalactones	**11.16**

Scale is in inches.

Fig. 5.38. Internodes are quite short.

Fig. 5.39. Papa kea is a handsome plant suitable for the home garden.

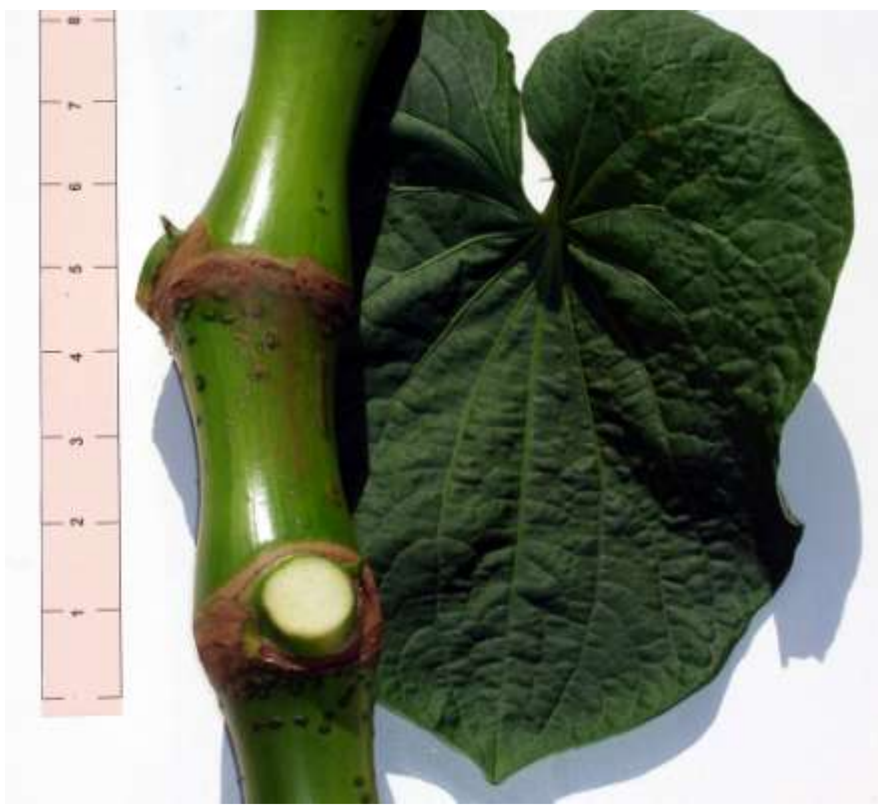


Fig. 5.40. Most of Papa kea's few lenticels appear right underneath the node.

Chapter 6

Non-Hawaiian Cultivars Grown in Hawai'i Today

Ed Johnston and Helen Rogers

We are aware of seven ʻawa cultivars grown in the state that are not of Hawaiian origin (though very likely more cultivars have been brought in by people who moved here from Pacific Island countries). Vincent Lebot introduced the seven cultivars in the mid-1980s from a number of South Pacific islands. The University of Hawaiʻi's Lyon Arboretum propagated the cuttings, and they were planted between breadfruit trees at the Hāna satellite of National Tropical Botanical Garden (Lebot, personal communication). The non-Hawaiian cultivars we have seen are:

Table 6.1. Non-Hawaiian Cultivars

Place of Origin	Cultivar Names
Pohnpei, FSM	*Rahmwanger* and *Rahmedel*
Fagaloa, Upolu, Western Samoa	*Ava La'au*
Madang, Madang Province, PNG	*Iwi* and *Isa*
Longamapu, Vava'u, Tonga	*Akau huli* and a cultivar labeled "*Hina* Tonga" at the Hāna satellite of National Tropical Botanical Garden

Pohnpei, Federated States of Micronesia

"To understand Pohnpei–and Pohnpeians–you must understand *sakau*," these are the words of Bill Raynor, Nature Conservancy Director in Micronesia. *Sakau* is their word for ʻawa. The indigenous people of Pohnpei never gave up their traditional drink, and it has remained an important part of their culture throughout their history.

The most widely grown cultivar of *sakau* in Pohnpei is *Rahmwanger*, which made up 97% of all the ʻawa plants recorded by Bill Raynor in an island-wide study he did in 1987 for his master of science degree. The most popular Micronesian ʻawa in Hawaiʻi is also the *Rahmwanger*. It is hardy and quite easy to grow, adapting to both lowland and mountain conditions.

Rahmwanger is a tall plant with an erect growing habit and long internodes. It is pastel green with dark spots throughout the stalks. It can be distinguished from the Hawaiian cultivar Nēnē by the pastel green coloration and the quick fading of its spots as the stalk ages on the plant. Perhaps the most tell-tale difference is the tough, fibrous integrity of the stalks, which are closer in structure to the PNG cultivars, *Iwi* and *Isa*.

Cuttings of this and the other Pohnpei cultivar, *Rahmedel*, were brought to Hawaiʻi by Pohnpeians who moved here as well as by Vincent Lebot.

Bill Raynor comments that *Rahmedel*

> is much less common [than *Rahmwanger*], and while all kava is known traditionally as the property of the *Nahnmwahrkis* (high chiefs), this cultivar is known as the cultivar that was reserved for their use. My observation is that it is slower growing and not as hardy. It takes a bit more work, or more fertile soils to grow well. Many people say it is the "stronger" of the two cultivars and the oldest and largest plants presented in traditional feasts and funerals are often *Rahmedel* cultivar (Raynor, personal communication 2005).

Rahmedel is a medium tall ʻawa plant with light green internodes of medium length. A band of purple color appears just above each node. Its stalks have fewer lenticels than *Rahmwanger* has.

In the 1999 Hawaiian ʻawa study (Lebot et al, 414), the DNA of both Pohnpeian cultivars showed slight differences from the DNA of the Hawaiian cultivars.

Western Samoa

In Samoa ʻawa is spelled *ava*. On the island of Upolu in Western Samoa, the land above Fagaloa Bay is the principal *ava* growing area (Lebot and Lévesque 1989, 263) and the place where Vincent Lebot collected the *Ava Laʻau* that he brought to Hawaiʻi. *Ava Laʻau* is nearly identical in appearance to Hawaiʻi's own ʻawa Nēnē. The difference is in the raised lenticels or spots along the stalks, which protrude more on Nēnē.

Papua New Guinea

Both of the ʻawa cultivars from Papua New Guinea were originally collected by Vincent Lebot from Madang, where ʻawa is seldom consumed.

Isa is a tall plant with dark green stalks and dark spots. The long stalks and portions of the leaf are covered with a fine down or fuzz known as "pubescence." *Isa* has a normal growth habit and is extremely tolerant of diseases and pests. Lebot et al. (1999, 414) compared the DNA of *Isa* with the Hawaiian varieties and reported that *Isa* "appeared to be the most genetically distant from other accessions."

Here in Hawaiʻi, the *Isa* cultivar is sometimes mixed with other ʻawa cultivars to produce a drink. *Isa* adds a strong, sharp, peppery taste.

The cultivar called *Iwi* is a lighter shade of green along its long stalks. It's also spotted, but it lacks pubescence. *Iwi* has a normal growth habit. Lebot and Levèsque (1989, 266 and 280) report that *Iwi* roots they analyzed had 29.62 percent total kavalactones with a chemotype of 256431. This is the chemotype of a "*tudei*" ʻawa (Lebot, Merlin, and Lindstrom 1992, 76), given this name because the effects last for two days.

Both *Isa* and *Iwi* are fibrous plants with strong, tough stalks, stumps, and root systems. *Iwi* is even tougher than *Isa*. Their stalks stay slender as the plants age.

Tonga

In Tonga, *P. methysticum* is called *kava*. Most Tongan cultivars are named by farmers using a traditional classification system based on the characteristics of the stem color and shape of the internode.

For the variety called *Akau huli*, *Akau* means long internodes and *huli* means black or purple (Lebot and Levesque 1989, 262-263). Thus, *Akau huli* should be called by its whole name and not shortened to *Akau*.

Akau huli has medium to long internodes, deep purple in color with spots throughout. This cultivar has been mistaken for *Kasa akau*, a Tongan ʻawa which we have not seen in Hawaiʻi.

The only kavalactone analysis we have of *Akau huli* is from Lebot and Levèsque (1989, 271-273), and the method differs from the one used to analyze the Hawaiian varieties in 1999 (Lebot et al.). *Akau huli*'s overall kavalactone content was 17.90 percent, with a chemotype of 264531.

The identification of the second Tongan variety is more problematic. Like *Akau huli,* it was preserved at the Hāna satellite garden, where it was labeled "*Hina* Tonga." *Hina* means white or light green, and this is a green variety. However, Lebot, Merlin, and Lindstrom describe the Tongan variety called *Hina* as having short internodes (1992, 94), and the internodes of the cultivar at Hāna are medium to long. It is highly speckled and erect in habit.

There is another Tongan cultivar called *Leka hina*, but its name indicates that it, too, has short internodes (*leka* meaning short or dwarf). Thus, it seems unlikely that the plant we have is *Leka hina*. Perhaps one day we will obtain an exact identification.

Table 6.2 Non-Hawaiian ʻAwa Varieties
Kavalactone Analysis of Air-Dried Lateral Roots (Lebot et al. 1999)
HPLC Analysis by Madis Botanicals, Inc.

Sample Name	APN 23 Ava Laʻau[1] (Samoa)	PAU10 Rahmedel (FSM)	APN22 Rahmwanger (FSM)	PAU11 Rahmwanger (FSM)	ISA (PNG)
Chemotype	463251	463251	463251	463251	246531
Age of Plant (Years)	2	2.5	2.5	2	2
Soil Type	Hāmākua	Hāmākua	Hāmākua	Hāmākua	Hāmākua
Location (Hawaiʻi Island)	Hāmākua coast	Hāmākua coast	Hāmākua coast	Hāmākua coast	Hāmākua coast
Shade (1=full sun; 4=full shade)	4	2	3.5	2.5	3
Growing Methods	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized	Cultivated, irrigated, fertilized
Damage	No damage	No damage	No damage	No damage	No damage
Lateral Root Size	>2 cm.	1-2 cm.	1-2 cm.	1-0.5 cm.	>2 cm.
		Percentage Kavalactones			
Kavalactone					
Desmethoxyyangonin (1)	0.99	0.61	0.62	0.65	0.56
Dihydrokavain (2)	1.94	1.40	1.40	1.20	2.87
Yangonin (3)	2.80	1.77	1.79	2.12	1.34
Kavain (4)	3.99	3.48	3.29	3.58	2.15
Dihydromethysticin (5)	1.05	0.66	0.85	0.82	1.72
Methysticin (6)	2.87	2.21	2.24	2.93	2.14
Total Kavalactones	**13.64**	**10.13**	**10.19**	**11.30**	**10.78**

[1] Incorrectly labeled "*Ava Lea*" in the 1999 paper by Lebot et al.

Fig. 6.1. *Rahmwanger* from Pohnpei, FSM, is distinguished by its bright green color and the fact that its spots fade as the plant ages.

Fig. 6.2. *Rahmedel* from Pohnpei, FSM.

Fig. 6.3. *Ava laʻau* from Upolu Island, Western Samoa. This cultivar can be distinguished from ʻawa Nēnē, whose lenticels protrude more along the stem and are rougher to the touch.

Scale is in inches.

Fig. 6.4. *Isa* from Papua New Guinea.

Fig. 6.5. *Iwi* from Papua New Guinea, a *tudei* ʻawa.

Fig. 6.6. "*Hina* Tonga" from Longamapu, Vava'u, Tonga. It looks similar to Hawaiʻi's ʻawa Nēnē except the lenticels of "*Hina* Tonga" are greener in color and have blurred outlines. Its internodes also tend to be shorter than Nēnē's.

Fig. 6.7. *Akau huli* from Longamapu, Vava'u, Tonga.

Chapter 7

Preparing the Drink

Ed Johnston and Helen Rogers

Traditional use of ʻawa spans 3,000 years in time and 4,300 miles of the Pacific Ocean. Today, methods of use vary from country to country and range from chewing the root fresh from the ground all the way to sipping highly refined, standardized extracts.

Isabella Abbott (1992, 43) describes how the native Hawaiians once made ʻawa:

> Children with strong teeth chewed the root to crush and soften it, depositing the results in a special calabash called a *kanoa*. When the desired quantity was accumulated, water was added, and this was sometimes allowed to sit for a while. Next the contents of the *kanoa* were strained into another bowl through a bundle of *ʻahuʻawa*[1] fibers laid in either a perforated gourd or a *niu* "shell," its three small "eyes" serving as drainage holes.

According to Margaret Titcomb, one coconut shell portion was "the amount commonly taken before a meal." After drinking, Hawaiians would rinse their mouths with water and a bit of food (pūpū) would be eaten to clear the taste of the ʻawa, which most people find somewhat objectionable (1948, 116-119).

Learning to drink ʻawa has been compared to acquiring an appreciation for different types of wine. ʻAwa drinkers do enjoy trying different cultivars, but generally not for their taste, appearance, smell, or how they complement food. Drinkers are interested in ʻawa's psychoactive effects, and these are influenced by the chemotype of the particular cultivar being consumed.

Traditional fresh drink is a water-based mix of thoroughly pulverized, strained rootstock served cool or at room temperature. Preparation varies by country and region, but it always begins with a wet fibrous pulp made from a combination of the ʻawa's stump and lateral roots. Vanuatu and Micronesia are famous for their fresh ʻawa drinks, which are quite strong and fast-acting.

In Fiji, the ʻawa rootstock is more likely to be dried and ground into a powder from which the drink is made. Fresh ʻawa drinks are stronger than drinks made from dried ʻawa, and for some people, one serving of fresh ʻawa is sufficient.

Whether the ʻawa is fresh or dried, pay attention to the variety being used and to the effect it is producing. Allow fifteen minutes after each cup to feel the drink's effects before deciding whether or not to have another.

It's best to drink the ʻawa right away or refrigerate it. ʻAwa that has been sitting out for hours acidifies and degrades in warm temperatures (Lebot and Siméoni 2004, 26).

Composition of ʻAwa

Fresh root and stump is 80% water. Dried rootstock is 43% starch, 20% fiber, 12% water, 3.2% sugars, 3.6% proteins, 3.2% minerals, and between 3 and 20% kavalactones.

The ʻawa drink contains fifteen amino acids, four sugars, and seven minerals, as follows:

Table 7.1. Composition of kava stump and roots % dry matter

Sugars		Amino acids		Minerals	
Saccharose	0.50	Aspartic acid	0.28	Potassium	2.237
Maltose	0.10	Threonine	0.08	Calcium	0.372
Fructose	1.75	Serine	0.11	Magnesium	0.179
Glucose	0.85	Glutamic acid	0.26	Sodium	0.111
		Glycine	0.11	Aluminum	0.150
		Phenylalanine	0.07	Iron	0.106
		Histidine	0.05	Silica	0.090
		Lysine	0.10		
		Arginine	0.08		
		Alanine	0.16		
		Valine	0.11		
		Methionine	0.02		
		Isoleucine	0.07		
		Leucine	0.14		
		Tyrosine	0.06		

From Lebot and Cabalion 1986, quoted in Lebot, Merlin, and Lindstrom 1992, 60-61.

Refer to Chapter 3, "The Active Ingredients in ʻAwa," and Chapter 4, "Chemistry, Pharmacology, and Safety Aspects of Kava," for details on ʻawa's psychoactive ingredients. Some warnings to be aware of are summarized on page 4.

[1] *Mariscus javanicus*, a native sedge.

Fig. 7.1. How to Make Fresh ʻAwa Drink

1. Grinding fresh ʻawa root in a Corona hand-cranked grinder.*

2. Place 16 ounces of pulp into mixing bowl.

First, chop the fresh material to a size that will fit through a Corona corn mill or sausage grinder. For large quantities of root/stump, a Hobart Industrial Food Chopper or a LaMilpa Power Mill is excellent. The object is to process the fresh ʻawa to as fine a consistency as you can. The more completely it is processed, the greater will be the release of kavalactones.

3. Add 4 to 6 cups of water. (Coconut water may also be used.)

4. Hand mix pulp into water vigorously, then squeeze and knead the mixture.

Mix the ʻawa into the liquid so that it's distributed. Start kneading it (squeezing and pressing).

5. Pour into silkscreen strainer.

6. Knead pulp in strainer. Liquid filters out into bowl.

After the liquid becomes thick and resinous and has turned a greenish gray color, you then squeeze it through a fine mesh strainer such as silkscreen.

7. Squeeze and press pulp through the strainer.

8. Serve fresh ʻawa drink.

Fresh ʻawa prepared this way is much more potent than drinks made from dried ʻawa. It is best to drink a single five- or six-ounce serving quickly, then wait fifteen minutes to feel the effect before deciding on a second cup.

(Photos 2-8 by Jeffrey Burger)

*Alternatively, cut root into 1" pieces and stump into 1" or smaller cubes. Put in blender with water to cover. Blend and follow steps 5-7 above. Follow this procedure two more times (placing the pulp in the blender, covering with water, blending, etc.). It should yield about a 1 to 5 ʻawa to water ratio (Bittenbender 2006, personal communication).

Fig. 7.2. How to Make the Drink from Dried ʻAwa Powder

Place the powdered ʻawa into your mesh bag.

The drink is made traditionally in many Pacific Island cultures by straining the dried ʻawa powder in water or coconut water. You could use a fine, silkscreen cloth that has been sewn to resemble a bag. Another method is to just tie cotton string around the silkscreen cloth so that the powder does not leak out into the water.

Immerse it in water. (Coconut water may also be used.)

The amount of water will vary according to individual preference, but a good rule of thumb is 16 ounces of good ʻawa powder to a gallon of water. Place the powder into the strainer bag, hold its edges together at the top so that none of the whole powder escapes, and immerse the bag into a bowl of cool water.

Holding the bag closed, knead the ʻawa until the consistency is right.

(Photos by Rune Pedersen)

Use your other hand to knead the bulk of powder under the water. If the ʻawa has a high kavalactone content, it will feel oily, almost like a ball of greasy clay. This is the kavalactone resin. The longer you press and squeeze the bag, the less oily it will feel and the more oily the water will feel and look. The water should begin to look like mud. To get the most from the already wet ʻawa powder, some people place it again in a smaller amount of water and continue the kneading process, then combine this weaker mix into the stronger.

Traditionally, each serving of this prepared ʻawa is swallowed in one or two quick drinks from a coconut shell. It's a good idea to space servings at least fifteen minutes apart. Kavain, the kavalactone highest in most Hawaiian ʻawa varieties, is usually felt quite soon after drinking, but the other kavalactones' effects may not register for 20 minutes or so.

Store your dried ʻawa in an airtight container in the freezer.

Chapter 8

‘Awa Production in Hawai‘i

Jeri J. Ooka, Jerry Konanui, Scot Nelson, Jim Henderson, Ed Johnston, Tom Osborn

Production Systems

Bringing an ‘awa crop to a successful harvest involves many things. The land available, its topography and growing zone are major determining factors on the production system selected. In general, ‘awa needs good moisture, good drainage, and wind protection. The physical attributes of the site need to be modified to optimize these conditions.

Five production systems based on soil type or planting method are being used in Hawai‘i. These are: 1) deep soil, 2) rocky soil, 3) forest planting, 4) lava soil, and 5) basket planting. These systems can be modified to fit most situations in areas where ‘awa can grow.

Deep Soil

Lands formerly in sugarcane or pineapple often have deep, well developed soils. Such soils can be plowed and rotovated. They should be amended before planting as indicated by soil analysis.

If the soil is well drained, ‘awa can be planted on the flat. However, flat planting makes harvesting difficult. Hilling, mounding, ridging or raised beds facilitate lifting the plants with more roots intact. Raised beds of some kind are therefore encouraged. Raised beds are an advantage in heavier soils to discourage accumulation of water in the root zone. The raised beds may be as wide as 4 feet and 1 to 3 feet high. These soils are the most amenable to mechanization of farming operations.

Fig. 8.1. Deep soil planting method: row-cropping ‘awa on mounds.

Rocky Soil

Some well developed soils are similar to soils of the deep-soil category but have a lot of rocks, which makes fine cultivation difficult or impossible. While building beds with a rotovator may not be possible, other conventional hilling devices such as mould board plows and disks on a tool bar or bed builder (metal box attached to tractor three point hitch, see figure 8.2) can generally be used to build raised beds in these soils.

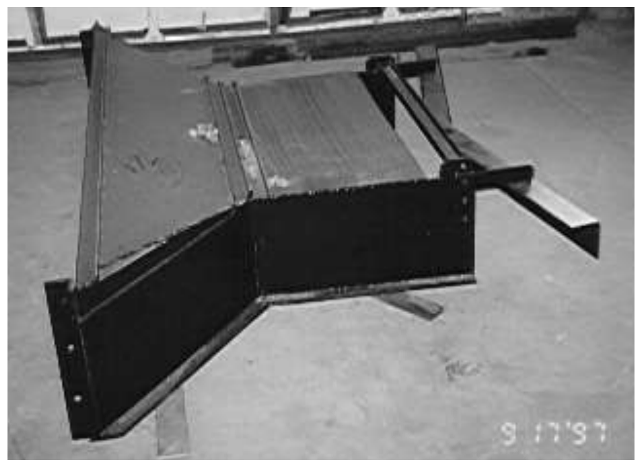


Fig. 8.2. Bed builder, which attaches to tractor with three-point hitch, for forming mounds in deep soil or rocky soil. Not commercially available. This one was constructed by a welder.

Forest Planting

In some cases ‘awa is planted into lands where the existing vegetation, generally large trees, is not removed. Forest plantings enjoy natural shade, good soil moisture, wind protection, and low pest populations. Under story plants are cut or pushed down, and access lanes are cleared.

These forests usually have rocky soil or are on lava lands of the ‘a‘a type (see the next category). Where the soil is thin, the ‘awa is planted on mounds of planting media brought to the site. The medium is generally a cinder-based mix with added compost, soil, and fertilizer.

Problems in the forest environment have included pigs, goats, and plant thieves. If isolated, abundant natural rainfall is generally needed. If there are annual rainy and dry seasons, catchment tanks or ponds can be constructed to collect water for the dry season.

Lava

On the island of Hawaiʻi, large areas of lava land are so new that soil has not developed. These lands are mostly ʻaʻa rock and may have a thin surface layer of organic material. Lava land is relatively inexpensive and also less conducive to root rot or nematodes but is susceptible to leaching and retains water and fertilizer poorly. Such sites may be in native forest or have been cropped with papaya, anthurium, or other plants.

These lands are usually bulldozed to clear them of vegetation and shape the surface. The land may be ripped to break up pahoehoe or plow soles formed during previous crops. A cinder-based planting medium is generally brought in and mounded for the ʻawa plants. Material scraped from the site may be used to form rocky ridges on which plants are planted into "starter" media.

Fig. 8.3. Lava soil planting: young, irrigated `awa plants on cinder mounds, Puna District of Hawai`i Island. Spacing is 6 feet between plants and 8 feet between rows.

Basket Planting

Planting in wire mesh baskets lined with weed mat can be an attractive method for small-scale farmers and hobbyists. Weed mat is a woven polypropylene fabric usually laid on the soil for weed suppression. The cylinders can be 2 to 4 feet high and up to 3 to 4 feet in diameter. Any wire mesh that can form a free-standing cylinder strong enough to support the weight of the planting medium may be used, including hog wire, welded wire, and concrete reinforcing mesh. A weed mat bottom in the cylinder is optional. Large weed-mat planting bags of about 30 gallons (e.g. GrowBag®, Easi-Lift®), available commercially, could also be used.

The basket method reduces labor for maintenance and harvesting. While experimental data has not yet been collected, reduced pest and disease incidence may be a benefit of this method. On the other hand, labor and materials costs are high. In addition, baskets must be regularly watered and carefully protected from wind.

Fig. 8.4. `Awa is being grown in weed mat baskets on a limited experimental basis in Hawai`i.

Several of these production methods rely on supplementing the existing soil resource with a growing medium brought to the site. The principles of the "virgin soil technique" (Ko 1971) developed to cope with the papaya re-plant problem on ʻaʻa lava lands should be considered when moving growing media to fields formerly cropped with papaya or anthurium. These fields will probably have significant levels of fungal pathogens and nematodes.

The success of the "virgin soil technique" depends on media being almost free of plant parasitic nematodes and plant-pathogenic organisms and being biologically active. That is, it must have a good population of microorganisms antagonistic to the plant pathogens. In the context of the papaya re-plant problem virgin soil was any soil from a site where papayas had never been planted. This unfortunately, did not always mean that the soil was disease suppressive.

Well prepared and cured compost and relatively sterile materials such as newly mined cinder can usually be safely used for this purpose. Mixing the cured compost with the cinders insures that beneficial microorganisms will colonize the cinders first. Caution is advised whenever mineral soil, which may harbor pathogens, is part of such medium.

Planting Material

Now that we have some recent local experience growing ʻawa, we can more critically look at the topic of planting material. Your market has a significant influence on the cultivars you plant. If you are planting for the beverage market you want to plant good drinking cultivars. If you are planting for the pharmaceutical market high producers of kavalactones are desired. However, the long crop cycle of ʻawa probably dictates that a mixture of cultivars with good drinking quality and good kavalactone production be planted to hedge on market conditions at crop maturity.

Regardless of the market segment targeted, the planting material used needs to be from healthy plants free of pests. Since ʻawa can only be vegetatively propagated, this cannot be emphasized enough. Your stock plants must be free of systemic diseases.

Once you have selected your healthy stock plants, the type of cuttings taken will be determined by whether you will transplant rooted plants or plant cuttings directly in the field. The advantages of transplanting generally outweigh those of planting cuttings directly in the field.

Propagating ʻAwa

Insufficient planting material was probably the major short-term constraint to realizing the potential of ʻawa as a crop in Hawaiʻi during the 1990's. Innovations to maximize the scarce planting resource have been great. An excellent method of producing vigorous cuttings from a small number of stock plants is called the tipping-and-pinching technique.

Apical dominance in a stalk is removed by cutting off the terminal, which stimulates the buds at lower nodes on the stalk to grow. When these buds have grown to about the size of a pencil they too, are tipped and, in turn, their secondary buds are stimulated to grow. At this stage, the top-most node can be removed from the source plant for rooting, and so forth down the stalk. This technique produces excellent rooted cuttings that do well in the field.

To preserve the stock plant and ensure a good and sustainable yield of nodes, certain steps must be followed. This begins with obtaining your stock plants from a reputable source of healthy plants. The plants should be free of diseases such as cucumber mosaic virus, Pythium root rot, and nematodes. (There is as yet no program in Hawaiʻi to certify pathogen-free ʻawa propagation materials, so the buyer must beware). Examine the plants for insects, mites, and other pests. Remove these pests before bringing the plant to your stock plant area.

New plants should be isolated from other nursery or production plantings. The area should be free of plants that are known hosts of cucumber mosaic cucumovirus. Plant the ʻawa in containers or in the ground. Make sure the medium is well drained, has high nutrient levels, and is pathogen free.

Keep the plants free of insect and other pests by examining them regularly and treating them promptly with the appropriate materials or methods. Insecticidal soaps and vinegar and chili pepper water repellents may be used to control insects. Hand picking or traps baited with stale beer can be used for slugs and snails. Systemic acquired resistance to many fungi can be induced by using composts on the plants.

A system of record-keeping should be devised and maintained for stock plants to prevent overuse and track a plant's progeny. These records may help in obtaining certification for the nursery and stock plants if such a system should be established.

Once the plants are established, the tipping-and-pinching process can begin. Start tipping the plants one to two weeks after they receive their normal monthly application of fertilizer. This is to insure that the plants have the nutrients and energy available to put into the new growth stimulated on a stalk by removing apical dominance.

Tipping is the removal of the terminal of a mature stalk. This application of a well-known scion wood preparation technique will accelerate the lateral flushes on the main stalk. Do not remove leaves and secondary branches yet. This often causes the individual stalk to die. Mature stalks require a fair amount of pressure to penetrate the internodes with a thumbnail. If your thumbnail easily penetrates the stalk, it is too soft. Do this test two or three internodes down from the tip.

Removing the tips stimulates the axillary buds to grow. Nodes from secondary branches are not used. They produce crawling, vine-like ʻawa plants.

Pinching removes the tip of the new bud, stimulated to grow by tipping, when it is at least 1 inch long. Pinching the newly stimulated bud removes the apical dominance that it exerts, which allows buds already initiated on its little stalk to begin growing.

The rooted cutting will thus have multiple stems instead of only a single stem. When a multiple stemmed ‘awa is transplanted to the field it grows more rapidly than a single stemmed plant. This is especially noticeable in the size of corm and root mass.

Fig. 8.5. Stalk that was tipped some weeks prior. Sprouts shooting from the nodes are ready to be pinched to stimulate other buds on those nodes to sprout. Note leaves were left on stalk when it was tipped.

The node is ready to cut from the stalk when the buds below the pinched bud begin to swell and show some growth. The node is cut from the stalk about 0.75 to 1 inch from the nodal plate with clean, sharp pruning shears, loppers, or a saw. The internode is removed 0.75 to 1 inch above the nodal plate on the next node. The cuts are made close to both sides of the node because the wounds heal and harden more rapidly when most of the internodal material is removed.

All nodes with buds beginning to grow should be removed from the stalk. The remaining nodes are harvested as they become ready. However, the last one or two nodes nearest the stump should not be harvested. This protects the stump from infection by microorganisms, which could rot the stump. Again, don't forget to remove the internode, cut close to the node.

The harvested nodes should be carefully handled to prevent the stimulated bud from being damaged. Pinching lowers the profile of the shoot thus reducing the chance of the bud breaking off when the node is removed from the stalk and placed in a bucket in contact with other nodes.

Using sphagnum moss or other cushioning materials is desirable but not always feasible when dealing with thousands of nodes at a time. However, a 5-gallon plastic bucket containing a bed of moist sphagnum moss is an ideal container for protecting and transporting high value harvested nodes. A single layer of nodes is placed on the sphagnum moss. When that layer is complete, enough moss to cushion them is placed over the nodes and another layer of nodes is added until the bucket is full. Approximately 100 standard-sized nodes can be held in a bucket packed this way. The sphagnum moss will reduce the physical injury to the nodes as well as provide some inhibition of bacterial and fungal growth on the nodes.

Rooting Stem Cuttings

The nodes should be kept cool and prepared for planting as soon as possible after harvest--at the most, within 24 hours of harvest.

Lay the nodes on seed flats with the buds facing up. The preferred seed flats are plastic trays with 1/4-inch mesh on the bottom. A common flat size is 17 inches square and 2 inches deep. These provide better drainage than perforated, solid-bottomed trays. Seed flats allow processing with a minimum of handling.

The node-filled seed flat is immersed in a solution of dilute disinfectant, such as 10% Zerotal, to kill bacteria and fungi on the exposed surfaces and retard rotting. After a timed immersion of one to two minutes the flat is removed from the bath and drained. The nodes are lightly rinsed with fresh clear water immediately after draining to minimize damage to tender young buds. The nodes are air-dried before going into the next bath. (This step is optional.)

The nodes are then soaked in a nutrient bath of seaweed extract and high-phosphate foliar mix for 5 minutes at the concentration recommended on the product label. The nodes are then removed, drained and air dried. (This step is optional.)

The cut ends of the nodes may be sealed with a horticultural pruning paint to retard moisture loss. (This step is very optional.)

Place the flat of nodes on a misting bench for rooting. The bench should have 60 to 80% shade and a timer to provide mist for 5 seconds every 30 minutes during daylight hours. The timing cycle will, of course, depend upon the equipment used and the environment where the nursery is located.

Check the flats daily to remove stubs of cut secondary branches, which separate from the stems after a few days, and any cuttings showing signs of rot.

While thus grooming the flats, use a stream of water to wash the cuttings. Look for roots arising from the nodes and remove any cuttings with roots for potting.

The nodes may be soaked or sprayed weekly with a nutrient mixture of seaweed extract and high-phosphate foliar fertilizer mix. (This step is optional.)

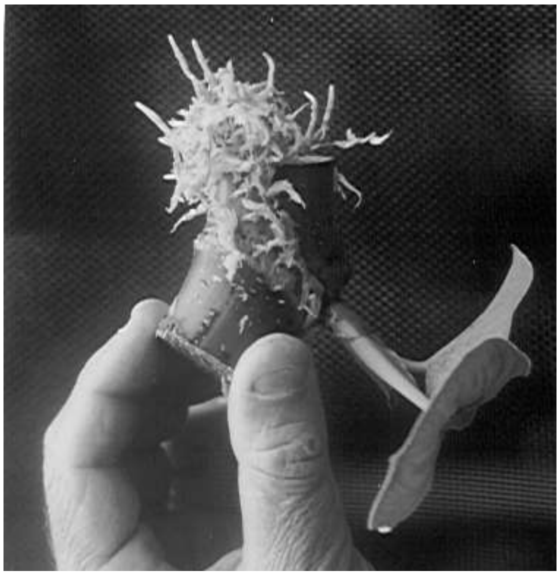


Fig. 8.6. Rooted node ready to be planted in a pot. (Photo by David Rogers.)

Potting and Grow-out

Rooted nodes removed from the misting bench should be potted in pathogen-free media. The size of the container used depends on the desired size of the plant at transplanting and may also be dictated by the cost of potting materials. The container may be as small as 1-pint size, but, although more medium and bench space is required, planting a rooted node into a 1-gallon container allows more options for plant handling and field preparation. Using 1-gallon pots is highly recommended for the small-scale or part-time grower, where time and labor are limiting factors.

The potted plants should, like the misting bench, be under 60 to 80% shade in a protected nursery area, such as a greenhouse or shade house. During very wet weather, it may be desirable to keep the plants under a solid-roofed greenhouse structure so that moisture in the media can be controlled.

The potting medium should be free of soil-borne pathogens such as root-knot and burrowing nematodes and pathogenic fungi such as *Pythium splendens* and *Rhizoctonia solani*.

A suitable mix contains volcanic cinders or perlite and compost (prepared without adding soil) in a ratio of 4 parts cinder to 1 part compost. A medium of all cinder or perlite without the compost is a good second choice. Using newly mined cinders, new perlite and properly matured and cured compost for your medium greatly increases the probability of having a pathogen-free medium. Any good soil mix is enhanced by adding endomycorrhizal inoculant.

Irrigating the pots with a sprinkler, mist, or drip system controlled by a timer is desirable, but watering by hose or sprinkler once or twice daily works as well most of the time. An automatic sprinkler system is a labor saving device and must be adjusted to give the plants enough water for a given site and environment.

Fertilize the pots with a 3-month slow-release complete fertilizer with micronutrients. A teaspoon per gallon container is generally a good rate to use with a cinder/compost medium. In addition, apply a foliar fertilizer every other week. The foliar formulation may be the same seaweed-extract, high-phosphate mixture used in the node rooting procedure, or use any commercial soluble fertilizer at about half the recommended concentration for vegetables. For instance, use Miracle-Gro all-purpose water soluble plant food (15-30-15 NPK) at ½ tablespoon per gallon and spray just to wet the leaves.

Compost extracts and teas can also be used for foliar feeding. A nice compost extract can be made from 500 to 1,000 grams of cured compost in 20 liters of water. Put the compost in a cloth bag or old nylon stocking and squeeze water through it until the water is light to golden brown. This is then sprayed on the plant every week or every other week.

Compost teas are brewed products that may be made from the same compost as the extract. Unlike the compost extract, which is used immediately, the compost tea requires an incubation time of 24 to 96 hours to allow the microorganisms in the compost to become active and multiply. There are many recipes for the two major categories of compost teas: non-aerated and aerated. Some experimentation needs to be done to adjust the strength of the compost extracts and teas to best benefit the plants.

The plants should be hardened off (acclimatized) before transplanting them to the field. Move the plants from the nursery in one or two stages of increasing sunlight. If your nursery has 80% shade, it would be safer to use a two-stage hardening-off process. From nursery shade at 60 to 70%, one-stage hardening-off at 30% shade can be successful. Hold the plants at each stage for about a week.

Consider field conditions and pests when transplanting ‘awa. Small plants under a foot tall are best used in shaded fields with few weeds, insects, slugs, and snails. Large plants over a foot tall can tolerate full sun and compete with weeds and pests better than small plants.

‘Awa Nursery Beds

For an established ‘awa farm where planting material is abundant, a nursery bed system may be an efficient approach to plant propagation. This method would have most of the advantages of single node propagation while being initially less labor intensive.

The nursery beds should be located on well-drained land free of soil pathogens with access to irrigation. Structures for shading the nursery should be built over the nursery beds. Healthy stem cuttings, of two to many nodes from the woody mid portion of the stalk, are laid horizontally across the bed 4 to 6 inches apart with buds up. (The soft tops of the stalk will rot, and the buds on the lower portion of the stalk will not germinate.) The stalks are then covered with about 1 to 2 inches of topsoil, cured compost, or potting mix and well watered.

The beds are kept moist but not waterlogged until the first sprouts appear in about 4 weeks. If node stalks are used, this is the time to carefully cut the germinated nodes off and transplant them to pots for growing to field size. If two-node cuttings are used, a foliar feeding schedule can commence followed by a granular fertilizer schedule as the plants enlarge. As they approach a foot in size, they can be transplanted into gallon-sized pots or directly to the field.

Planting 1- to 4-node cuttings directly into pots is another method of propagation used in a nursery setting when planting material is not limited. Depending on the size of the pot and cuttings, one to three cuttings can be placed at a 20 to 30 degree angle from vertical in each pot. Be sure that the top of the stalk is up and the bottom down. The plant will grow slower if it is planted upside down. Four-node cuttings grow faster than two-node cuttings in general.

Direct Planting of Cuttings

Direct planting of cuttings in the field is traditional in many areas. For the casual grower of a few plants or the grower with many plants but no immediate commercial goals, this may be all right. For commercial production, this method generally is not an efficient way to establish a field that can be easily cared for and harvested.

While cuttings used for direct planting can be of any number of nodes, 6 nodes or a stalk about 2 to 3 feet long seems to be the norm. They may be planted horizontally or vertically. CTAHR extension specialist Skip Bittenbender reports good success with direct planting of 3-node stem pieces trimmed at the ends close to the nodes and planted horizontally 0.5 to 1 inch below ground in well drained, moist soil (pers. comm. 2006).

Many times the hole from which the parent plant is harvested is where its stalks are placed, covered with soil and mulch, and left to fend for themselves.

Soil Fertility Management

‘Awa requires the right soil conditions for optimum growth. To begin with, Lebot (1992, 83) recommends soil with a pH of 5.5 to 6.5. The Cooperative Extension Service of the University of Hawai‘i, College of Tropical Agriculture and Human Resources on your island can test your soil and make recommendations for the appropriate soil amendments.

Controlled experiments to study fertilizer effects on ‘awa growth and yield in Hawai‘i's conditions, such as Bittenbender 2004, are still few in number. Bittenbender 2004, in a small study, sought to research the roles of fertility, shading, and pruning on kavalactone concentration and yield in ‘awa. The major conclusion on fertility was ‘awa does not require high levels of commercial nitrogen when grown in a basket culture medium of 60% black volcanic cinders and 40% compost made from plant-only feed stocks.

Bittenbender's rates of nitrogen application were 220 kg/ ha/ year and 560 kg/ ha/ yr applied as a 12N, 4P, 16K 180 day rated slow release formulation. There was no control (0 kg/ ha/ yr commercial N added). After a year the variety Mō‘ī produced 1280 kg dry wt stump and root / ha and 89 kg of kavalactones/ ha at the 220 kg N/ ha/ yr rate. At the higher N rate of 506 kg N/ ha/ year, 1590 kg dry wt stump and root/ ha and 78 kg kavalactones/ ha were produced. It appears that higher fertility produced more biomass but reduced the percentage of kavalactones. The 1 to 2 percent depression of kavalactone percentage in the 1-year-old Mō‘ī plants is also seen in the 2-year-old *Isa* plants.

The methods shared here by growers reflect their attempts to develop "best management practices" for ‘awa production, and they are given as suggestions for others to start their own trials. Many different methods to provide plant nutrients to ʻawa crops are being tried. To discover the best techniques for ʻawa production, farmers have experimented with a wide range of fertilizer formulations, placement, rates and application frequencies. Many have drawn on their experience with other root crops, such as ginger and taro. Foliar application of fertilizer is emerging as an important component of fertilizer programs for ʻawa, both for starting out the plants and, in some systems, for the maturing crop.

This section describes a conventional approach to nutrient management using inorganic fertilizer formulations. The case study given later in this guide describes an organic fertilizer program. One schedule of fertilizer application:

Monthly application: NPK
14-14-14 slow-release formulation (1st 3 months)
14-14-14 granular (1 year)
16-16-16 granular (1 year)
10-20-20 granular (6 months)

Another schedule applies 14-14-14, then 10-20-20, then back to triple-14 or triple-16. Many farmers are supplementing applications of broadcast fertilizers with applications of foliar formulations such as Foliar 62® (12-24-24) twice a month.

A small handful (1/8 lb) of a complete fertilizer is spread around and over the mound for small plants. One schedule applies a handful to plants 1 foot high, evenly broadcast around the plant. The application increases to 1/4 to 1/2 lb of fertilizer for a plant over 4 feet tall. To avoid burning the roots, it is important to broadcast the fertilizer evenly within the drip line of the plant and not to throw handfuls of fertilizer into piles at the base of the plant. It is better to have more frequent, light applications of fertilizer than less frequent, heavy applications.

C. Brewer & Company's Hawaiian Pacific Kava Company grew 20 acres of ʻawa in Pepeʻekeo in the latter half of the 1990s. They conducted many nutritional trials and had kavalactone tests conducted on cultivated as well as wild-collected root samples. They concluded that fertilizer can be used to increase kavalactones and developed a fertilizer schedule. At planting, lime with 2 parts calcium carbonate and 1 part dolomite to achieve a soil pH of 5.8-6.5, apply treble super phosphate (0-45-0), and split application of potassium chloride or potassium sulphate (at planting and six months later). Following planting, apply 10-20-10 with full spectrum minors every 3 months throughout a 14-month "kava-grow" period. After 14 months of regular applications, a "kava-ripe" blend is applied, which is 5-19-19 plus 8% magnesium until harvesting the plants at two years old (John Cross and Matthew Archibald, pers. comm., 2006).

Elevation

ʻAwa grows best at lower elevations where there is high rainfall, generally below 1,500 feet on the windward sides of the islands and below 2,500 feet on the leeward sides. Lebot (1992, 83) specifies rainfall needs: over 85 inches per year if under 1,200 ft. elevation. Above that, at least 70 inches is needed.

Handy (1940, 203) reports that "Hawaiians planted it in or just below the borders of the lower forest zone, in clearings within the lower ranges of the forest, along streams, and in pockets along the base of and upon wet escarpments. ... In Kaʻu, Hawaiʻi, it was customary to plant ʻawa in the forest above the upper taro plantations." He goes on to quote Kamakau as saying "Some [Hawaiians] planted fields of ʻawa, but mostly it was planted along the borders of wauke and taro plantations."

Weed Management

Weeds can be a major problem for newly transplanted and young ʻawa plants. Weeds compete for sunlight and soil nutrients and may be alternate hosts for pathogens and pests of ʻawa. On the other hand, the shade and wind protection weeds provide may be beneficial to establishing the young ʻawa plants by conserving moisture during the hot summer months.

Fig. 8.7. ʻAwa mounded and mulched at Puʻu O Hoku Ranch on Molokaʻi.

Waiting until the ‘awa plants are large in the nursery can help them compete with weeds for sunlight after transplanting. But a preferable strategy may be to inhibit weeds by mulching around the ‘awa plants and planting intercrops that will shade the interrows and serve as windbreaks (figure 8.7). As the ‘awa canopy closes and provides enough shade to stop weeds from growing, the intercrops can be cut and used for mulch or composted for later application to the field.

A major reason for controlling weeds before planting ‘awa and maintaining a weed-free field is that weeds may be hosts of plant pathogens. A plant pathogen requiring special attention is cucumber mosaic cucumovirus (CMV), which is found in the weed known as "honohono" (*Commelina diffusa*). Almost all honohono in Hawai‘i is infected with this virus, and it should be thoroughly removed before planting ‘awa.

CMV causes a "kava die back" that kills small ‘awa plants within two to four weeks after infection. Larger ‘awa plants decline and die over several months. To make sure your ‘awa plants are not exposed to CMV, control honohono in the vicinity of the nursery and keep the ‘awa free of aphids, the CMV vector, which transmit the virus from plant to plant.

No herbicides have been cleared by the Environmental Protection Agency for use in plantings of ‘awa in Hawai‘i. Therefore, in-field use of herbicides is not an option. Nonchemical weed control methods such as mulching, mechanical cultivation, torching, and shading are the only legal methods at present. Many herbicides can, however, be used for post emergence control of weeds before planting ‘awa, as well as to control weeds in areas adjacent to ‘awa fields.

Considerable care needs to be taken to protect ‘awa from contact with "drift" of herbicides used to control weeds in nearby areas. ‘Awa is extremely sensitive to glyphosate (Roundup®), a nonselective, systemic herbicide commonly used for roadside vegetation control. Depending on the dose, it takes from one to three weeks before the plants begin to show symptoms. A light drift causes the plant to stop growing for several months; the leaves may develop chlorotic margins, newly emerged leaves may shoestring or are thin and brittle. There may be minor defoliation and stalk death. Heavier doses result in a rapid and severe onset of symptoms, major defoliation, and death of the entire plant. Glyphosate (*e.g.*, Roundup®) should not be sprayed near ‘awa.

Irrigation

Irrigation is essential for ‘awa in dry, leeward sites, and it is often needed even in windward areas during their periodic droughts. A combination of drip tape and spinner sprinklers or mini-sprinkler nozzles mounted below the canopy probably is best for total coverage of the root zone. ‘Awa needs plenty of water but does not tolerate waterlogged conditions for any length of time. Impact sprinklers may also be used, but these may not use water efficiently as the plants get larger because of interference to water distribution caused by the canopy. Ask the advice of your irrigation specialist to design a system for your unique environment and resources.

Fig. 8.8. Young, irrigated ‘awa plants, Pu‘u O Hoku Ranch, Moloka‘i. Note temporary windbreaks made from shade cloth. Weed mat can also be used as temporary windbreak.

Relying on natural rainfall is the norm in many of the ‘awa producing areas of Hawai‘i. The farmer needs an intimate knowledge of rainfall patterns and must be prepared for both wet and dry periods. The hot and often dry summer months will tax the farmer's ingenuity in developing practices to conserve moisture. The effects of wind and altitude also must be factored into water management strategies.

For high-rainfall areas, large, well drained planting hills or beds allow excess water to move rapidly through the root zone and off the field without creating waterlogged conditions. In addition to being well drained, the soil in these beds, and the media placed in planting pockets to nurture the ‘awa, must have enough organic material to retain moisture during the drier times of the year. Soil structure, tilth, and organic matter levels should be optimum. Media used should have some component of suitable size to ensure enough pore spaces for quick drainage during wet times, and it should contain enough organic matter to hold moisture during dry times. In dry, windy areas, pore spaces need to be smaller to slow the movement of water through the hill, and various water conservation techniques need to be employed.

Windbreaks reduce plant transpiration (water loss) caused by dry air moving across the ʻawa leaves; they also provide some shade, depending on their orientation. If nitrogen-fixing plants are used for windbreaks, they may enhance soil fertility. Mulching with organic or artificial materials helps retain moisture and suppress weeds. Groundcover crops may also help in moisture conservation and management.

Spacing and Shading

As more ʻawa is planted and farmers have become familiar with the growth habit of the plant, the spacing of plants has moved from dense spacing, as close as 2 feet apart in the row and 4 feet between rows, to wider spacing that makes field operations easier and gives the plants more room to grow. The distances between rows have increased to about 6 feet and may go up to 12 feet. In-row spacing ranges from 3 to 8 feet. In general, planting at 6 x 6 ft or 8 x 8 ft seems to be good for the ʻawa plant.

Wind protection appears more important than shading in conserving moisture for young plants at mid-elevations (300 to 600 feet) on windward sites. Sunlight has been shown to increase kavalactone content (Lebot 1999, 412). On low-elevation leeward sites, where hot temperatures and drying winds are common, both shade and wind protections are necessary for small ʻawa plants. Partial shade and wind protection may be provided by shrubs such as pigeon pea, or harvestable crops such as taro and cassava. While papaya, ginger and bananas can also serve in this capacity, they are hosts to pathogens of ʻawa. Papaya and ginger are good hosts of root knot nematodes and should not be used. Banana is a host of the cucumber mosaic cucumovirus (CMV). It may be best to avoid using banana for a windbreak or shade interplanting until more is known about the relationship between banana as a host of CMV and ʻawa decline.

Fig. 8.9. Hawaiian Pacific Kava Company's ʻawa plantings organized by cultivar. Spacing is 5 feet between plants and 6 feet between rows. Windbreak is sudan grass.

When the ʻawa is large enough, usually about a year after transplanting, the shade trees may be pruned or removed to allow more sunlight. The prunings may be chipped and used as mulch for water conservation and weed control or composted.

Fig. 8.10. ʻAwa plants grown in the shade of *Acacia angustissima*, Hawaiʻi Island.

Pruning

To obtain planting material rapidly from a small number of source plants, they must be drastically pruned. From 10 to 30 percent of a healthy ʻawa plant's stalks may be removed twice a year without adverse effect.

Judicious pruning results in larger plants when outer, older branches are removed, exposing the inner, younger, soft, and succulent branches to sunlight. This causes them to develop and mature. Pruning the stalk terminal removes apical dominance and stimulates dormant buds in the stump to develop into stalks, which causes the plant to produce more roots.

Pruning is also believed to enhance production of kavalactones in the stump and roots. The ancestors were probably right to believe that the strength of *ʻawa kau laʻau*, the famous tree growing ʻawa of Puna, came from the roots growing in the sun (Handy 1940, 203). Pruning exposes the stump and roots to the sun just as the roots of *'awa kau la'au* were exposed as they grew to the ground along the trunk from an aerial perch in a tree. *'Awa kau la'au* can be any variety of 'awa growing from material thought to be taken into trees by birds (Handy 1940, 202).

Plant Height and Yield

The height of the 'awa plant varies with the variety and, within varieties, can be affected by exposure to sunlight. Plants with short internodes can be as short as 4 to 6 feet at maturity, while plants with long internodes can grow 12 to 16 feet tall in node-elongating shade conditions.

A 3-year-old 'awa plant can yield 20 to 40 pounds of fresh 'awa root and stump. One farmer has reported an average yield of 37 pounds per plant in 12 months, with unspecified cultural practices.

Organic 'Awa Production in Hawai'i

An organic approach to growing 'awa has been taken at Pu'u O Hoku Ranch, on the east end of the island of Moloka'i. This approach makes philosophical and economic sense to the owners of Pu'u O Hoku, who believe that the niche market for organic 'awa is significant and expanding in the USA.

Fig. 8.11. Certified organic 'awa fields at Pu'u O Hoku Ranch, Moloka'i.

Because the nutrient requirements for producing the greatest yield and kavalactone content of 'awa are not known, the fertilizer program was based on knowledge of other plants' needs. Foliar fertilizer applications were used to ensure that the nitrogen supply was not limiting.

The soils at this site are deep and well drained humiclatosols in the puuohoku series with pH 4.5 to 5.0. This is a non-phos-phorous fixing soil series. Soil analysis, however, indicated it was low in phosphorous and calcium. This calls for liming with 1 ton of $CaCO_3$ per acre to increase calcium levels and to raise soil pH. To correct the low phosphorus levels, 500 lbs per acre of P was recommended. The amendments added were oyster shell lime and soft rock phosphate, both at 1 ton per acre.

A green-manure crop of sudan grass (*Sorgum bicolor* var. *sudanese*) or sunn hemp (*Crotalaria juncea*) was then planted and incorporated into the soil at peak flowering approximately three to four months after sowing. The material was allowed to decompose for two to three months before planting beds were formed and 'awa transplanted into the field. While the sunn hemp was not inoculated with rhizobium to maximize its nitrogen fixing capabilities, good nodulation was present.

The 'awa was planted on raised beds about 4 feet wide at the top, 6 feet wide at its base, slightly higher than a foot, and of variable length. The beds were formed on 7-foot centers with 12-foot roadways between every eight beds. The beds were formed on the contour of the land to minimize water erosion.

One pound each of oyster shell lime, soft rock phosphate, Norwegian kelp meal (Algit®), fish meal, and diatomaceous earth were added to each planting hole and mixed with the soil. These are for calcium, phosphorus, minor elements, nitrogen, and silica respectively. Nitrogen can also be supplied by blood meal, but the fear of mad cow disease has restricted the use of blood meal in organic farming. Diatomaceous earth, fossilized shells of diatoms, can control soft bodied insects. A 3-month-old 'awa plant 8 to 12 inches tall was transplanted into the hole. The plant spacing within the row is 5 feet. Compost was broadcast on top of the bed at 30 pounds per 100 feet of bed. The bed was capped with a 4-inch layer of wood-chip mulch for weed control.

Irrigation is provided by running two drip tapes down the bed on either side of the plant. As the plant grows, the tape is moved nearer to the edge of the bed to prevent it from becoming crimped in the growing plant. When the canopy closes and the roots begin to fill the beds, spinner sprinklers were placed between every other bed at intervals to cover 4 plants each. This ensures adequate moisture distribution.

Windbreaks are needed to protect the plants at this site, but shading is not necessary. Windbreaks of shade cloth 5 feet high, sudan grass, or woody shrubs such as pigeon pea, gliricidia, and sesbania are provided for every 8 rows of ʻawa. The windbreaks may be removed as the plants grow. Ironwood, Formosan koa, or timber bamboo on the valley ridges surrounding the planting are the major windbreaks. These are from 30 to 500 feet from the nearest ʻawa plants.

Except for collecting nodes for propagation and removing damaged or poor stems, the plants are not pruned. This allows the canopy to close and shade out weeds. Hilling is done six months after transplanting.

Foliar fertilizer is applied every three weeks throughout the life of the crop with a tractor-mounted power sprayer. Maxicrop® foliar fertilizer (0.1% N, 0.0% P, 1.0% K) and Mermaids® fish powder (12% N, 0.25% P, 1.0% K) are normally used at 20 lbs formulation per 100 gallons of water per acre. Yucca extract (ThermX 70) as a spreader sticker, hydrogen peroxide for oxygen, and vinegar as a pH modifier may be added to enhance the fish powder and foliar fertilizer.

Six months after transplanting, the ʻawa was side-dressed with 500 lb of soft rock phosphate, 500 lb oyster shell lime, and 125 lb blood meal per acre. Twelve months after transplanting, Algit ® for potassium and fishmeal for nitrogen were each applied at 500 lb per acre. This cycle is to be repeated at 18 and 24 months, and harvest is projected to be done at 30 to 36 months.

At about two-thirds of the way through the life of the crop, disease problems have been limited to a few plants that died from root rot (*Pythium splendens*). *Rhizoctonia sp*. and *Fusarium sp*. have also been isolated from the roots and stalks of a few poorly growing plants. A shot-hole type leaf spot associated with a *Phoma sp*. and an unidentified ascomycete periodically appears. Insects, mites, and nematodes have caused problems in the crop. Feeding by katydids, African snails, and slugs did minor damage to younger plants.

A three-crop rotation cycle is followed after the initial ʻawa is harvested. The field is plowed and fallowed for several weeks to a couple of months. A cover crop is planted, allowed to flower, and plowed down as a green manure (approximate time = 3 to 4 months), *e.g.*, Sunn hemp for nitrogen fixing and root knot nematode control, sudan grass for nematode control. After the green manure decomposes (2 to 3 months) the field is prepared for planting the next crop in the rotation cycle. Papaya has been the follow on crop. The third crop in the cycle is dry-land taro. Following this crop, the field is to be prepared for the next ʻawa crop.

Compost at 5 tons per acre and chitinous material (crab or shrimp meal) at 500 pounds per acre is worked into the soil. Planting beds are created, drip irrigation installed, and plants transplanted. Compost at 30 pounds per 100 feet is broadcast on top of the planted bed which is then capped with a three inch layer of semi-composted wood chip mulch for weed control and moisture conservation.

The plants are foliar fed every three weeks with compost tea and fish emulsion throughout the life of the crop. Six months after planting the plants are side-dressed with soft rock phosphate (500 lb/ac), oyster shell lime (500 lb/ac) and fish meal (125 lb/ac). Twelve months after planting Algit ® (500 lb/ac) and fishmeal (500 lb/ac) are applied. This application is repeated at 18 and 24 months into the growth cycle.

The plants are normally harvested 30 to 36 months after transplanting but may be allowed to grow for 60 or more months before harvest.

Harvesting Methods

There are a number of ways to harvest ʻawa, depending on the size of individual plants, the number of plants the farmer intends to harvest, and the planting method the farmer used.

Fig. 8.12. Harvesting ʻawa with a small backhoe at Puʻuʻala Farm and Ranch.

To harvest large individual plants manually, cut the stems just above the first node. Begin exposing the lateral roots by carefully scraping back the soil with a potato fork. As more soil is removed, you should be able to begin rocking the plant back and forth to loosen more soil around the base. Some farmers use an

ʻōʻō bar. Continue scraping away soil with the potato fork. As the plant is loosened from the soil, it can be lifted out of the ground. Harvesting is far easier when ʻawa has been planted on mounds and the soil has been aerated with mulch and compost.

Mechanized harvesting of ʻawa is uncommon but will likely become a regular practice if high density monocropping systems increase in Hawaiʻi. Some farmers are using small backhoes to harvest ʻawa (see photo below). A backhoe can help you harvest quickly, but some lateral roots may be lost.

Other farmers are considering more specialized equipment such as potato harvesters and the Egedal Side digger (which has moving fork prongs to lift plants out of the ground). This system will probably be most useful when farmers harvest plants growing on mounds.

Harvested stumps with laterals are given a quick wash with a hose and then are cut up using cane knives or machetes. Some farmers use electric powered pressure washers. Cut laterals off the stump leaving a small portion of stump, just enough to hold a few laterals together. Then cut the stump itself into manageable sections.

Place the plant material on the washing table. Ideally, the washing table will have a plastic mesh screen to allow water to drain, but corrugated plastic or metal at an angle can also work. Wash the root and stump, without removing peelings. Washed root and stump should be immersed in a light bleach solution and thoroughly rinsed again.

It is important not to let the ʻawa mold or rot. Therefore, even if you are selling your ʻawa as fresh root, it is important to remove excess moisture and to coordinate the harvest with the shipping schedule.

Fig. 8.13. Harvested ʽawa is cut into smaller pieces for washing.

Fig. 8.14. Washing the root and stump with a pressure washer. (Photo by Jeri Ooka.)

Fig. 8.15. Clean ʽawa root and stump ready for drying or fresh processing. (Photo by Jeri Ooka).

Commercial Parts of the ʽAwa Plant

In light of the liver problems possibly associated with above-ground parts of the plant, commerce should be restricted to the roots and rootstock of the ʻawa plant.

Lateral roots. Since these are high in kavalactones (generally ranging from 8 to 16%), they are the most in demand on the international market.

Stump. Kavalactones usually vary from 3-8%. This is traded on the international market.

Peelings of the rootstock. These are high in kavalactones (7-11%) and are sometimes sold on the international market.

Stem. Relatively low in kavalactones. The basal stem (lowest on the plant) has a higher percentage of kavalatones (3-5%) than the topmost part of the stem. Stems have been dried, chopped up and used as ingredients in teas. The use of stems in products is not recommended.

Leaves. These contain kavalactones, mostly yangonin, dihydromethysticin and dihydrokavin, in low concentrations. Leaves have been used as ingredients in a calming tea. This is no longer a recommended use of leaves. Fresh leaves have been used in a hot bath to relax sore muscles. Dried leaves are being ground into a powder and included in oil for massage.

Resources

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

In the University of Hawaiʻi at Mānoa's College of Tropical Agriculture and Human Resources, the Department of Plant and Environmental Protection Sciences, or PEPS, brings together faculty in several fields (plant pathology, entomology, weed science, integrated pest management) that are dedicated to protecting both crops and the environment. The department's purpose is to develop and disseminate environmentally friendly plant protection principles and practices for the tropics and subtropics, protect the structural integrity of buildings from destructive pests, provide strong programs in fundamental science and provide a quality education in related areas.
http://www.ctahr.hawaii.edu/peps/index.htm

Information on ʻawa can be found on CTAHR's Farmer's Bookshelf under "nutraceuticals":
http://www.ctahr.hawaii.edu/fb

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Chapter 9

Integrated Pest Management for ʻAwa (Kava, *Piper methysticum*)

Scot Nelson

Piper methysticum, a tropical, forest-dwelling shrub, called ʻawa in Hawaiian and also known as kava, is the source of a relaxing root extract esteemed as a ceremonial beverage throughout the Pacific region. It has traditionally been grown in relatively pristine native forest ecosystems by indigenous horticulturists who made extensive varietal selections and recognized the optimal environmental conditions for the plant. Growing it as an agricultural crop often removes the plant from its optimal habitat, and its successful field production generally requires considerable patience, knowledge, and skill.

Numerous pests and plant diseases are a constant threat to large-scale ʻawa cultivation and can cause irreversible damage and crop loss. Growers must generally wait two years before the plants have accumulated sufficient amounts of root kavalactones, the pharmacologically active substances, that they can be harvested. That is a relatively long period of time to expose a sensitive, vulnerable plant like *P. methysticum* to the aggressive pests, parasites, and pathogens common in agricultural environments, which are highly contaminated compared to the traditional growing environments in native forest ecosystems. Problems can be especially severe when ʻawa is grown as a field crop in sole stands.

Successful ʻawa growers must recognize the various pest problems when they occur and know how to manage them effectively. Growers in Hawaiʻi and the Pacific do not use many pesticides for growing ʻawa. They deal with their problems strategically by integrating various cultural practices.

This publication identifies, describes, and illustrates the most important pests and diseases of ʻawa in Hawaiʻi, and then it suggests strategies for their management. The tables accompanying the text contain photographs of pests and symptoms and give additional pertinent data useful in bringing ʻawa to maturity in good health. A list of additional readings is provided for access to more in-depth coverage of these topics. The information in this article is derived mainly from the author's experience and research in Hawaiʻi and Micronesia; it is intended to be a concise and useful resource for Hawaiʻi's ʻawa growers.

Integrated pest management (IPM) of significant ʻawa pests in Hawaiʻi

A "pest" is considered here to either be a plant disease, weed, insect, or other organism such as slugs. Disease can be caused either by pathogenic microorganisms or by non-living factors within the plant's environment. Both pathogens and insects may be food-seeking parasites of ʻawa in Hawaiʻi. Weeds can harbor pests and compete with ʻawa plant establishment and growth. Following are descriptions of the most damaging ʻawa problems in Hawaiʻi and suggestions for their effective management.

Kava dieback

A viral disease, kava dieback, is the major threat to *Piper methysticum* cultivation throughout the Pacific. As its name implies, this disease can kill plants, especially in their first year of growth. The virus is the cucumber mosaic cucumovirus (CMV), which has a wide host range, infecting various common weeds and crops in Hawaiʻi. Controlling this disease can mean success or failure for kava growers.

The virus is transmitted between plants by the melon aphid (*Aphis gossypii*, also known as the cotton aphid), a small, sap-feeding, and sometimes winged insect. Ants spread, tend, and protect the aphids and eat their post-feeding secretions. Dieback in the field spreads most rapidly when aphid and ant populations are large.

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Infected node cuttings from diseased stems can also introduce kava dieback into a nursery or field. CMV-infected ʻawa plants and weeds can display a wide range of symptoms; a single plant may have several symptoms. The initial ones usually include leaf mosaic, yellowing, curling, and puckering of the youngest leaves on a stem. ʻAwa plants should be inspected weekly for symptoms, especially when they are in a monocrop planting or are near vegetable production areas, where the virus may be common.

Stems with symptoms should be broken off immediately, about two nodes from the base of the stem. Wilting plants should be dug out and destroyed. Before breaking off stems, look for aphids, and destroy them first.

Virus-free node cuttings must be used to start new plants, and aphids must be controlled in the nursery. If the first leaves growing from a node have symptoms such as mosaic or large ringspots, they should be destroyed immediately, and the remaining plants should be examined and monitored closely for symptoms and aphids. Aphids may be killed or knocked off plants with a strong spray of water or may be killed with sprays of approved insecticidal soaps or oils. The only pesticides legally allowed for use on ʻawa in Hawaiʻi list *Piper methysticum* on the product label. The best course is to consult the Hawaiʻi Department of Agriculture with questions about specific products and their approved crops in Hawaiʻi.

Windbreaks provide shade and protection, which can reduce kava dieback disease levels in some cases. Companion plants should not host aphids, nematodes, or CMV.

Certain weeds that host aphids and CMV must be controlled in and around the ʻawa field where CMV is present. Otherwise, attempts to manage or eradicate the disease within plantings may fail.

Selecting the right location for planting can help to avoid infection and dieback. Forest or secluded plantings are much less at risk from kava dieback than are open, exposed ʻawa monocrops in agricultural areas. Intercropping with plants that are not hosts of aphids or CMV may help slow down epidemics.

Plants wilting from kava dieback do not respond well to irrigation; in fact, excessive water and especially excessive fertilizer can promote a deadly root rot for such plants.

Best management practices

Select a remote location or lightly forested site.

Use windbreaks and shade plants for the first year, then cut them back.

Use only CMV-free node cuttings.

Monitor plantings for symptoms and rogue diseased stems and plants immediately.

Control aphids and ants.

Do not prolong the harvest of mature, diseased plants.

Minimize plant stress factors; stressed plants may be attractive to aphids (plants may be yellow) and predisposed to dieback.

IPM strategies

Modify fertilizer practices—excessive use of nitrogen fertilizer promotes plant succulence, which attracts aphids and allows them to develop large populations rapidly.

Look and select for varietal resistance to the disease—one variety, ʻ*Isa*ʼ from Papua New Guinea, is probably resistant to CMV.

Pythium root rot

The *Pythium* pathogen can quickly destroy the most important part of an ʻawa plant—the root system—and thus kill entire plants of any age. The disease is mainly a field problem and in Hawaiʻi is usually caused by the plant pathogenic, soil-dwelling, fungus-like organism *Pythium splendens*. The disease can also occur in potted ʻawa plants.

This disease tends to occur where soil drainage is poor or when flooding occurs. Saturated soil allows the pathogen to disperse and infect roots. Avoiding flood-prone areas is important. Growers should also be aware of how subsurface soil water moves or collects in the field.

Pythium is very aggressive and destructive under saturated and flooded conditions, and infection and disease development can be quite rapid. Diseased plants can wilt and die quickly, and it is useless to try to replant ʻawa in the same location.

Avoidance of susceptible locations is the best strategy. Plants that are stressed or damaged in some way, as by too much or too little fertilizer, are more prone to infection and severe damage. Too much fertilizer can easily burn ʻawa roots, leading to an overall root rot and plant wilt that resembles *Pythium* root rot very closely. It is not unusual for the two conditions to appear together in a field.

There is no known resistance to *Pythium* in ʻawa. Planting in raised baskets filled with a well drained medium such as cinder can help minimize the risk. There are no registered fungicides for *Pythium* control in ʻawa.

Mulching or compost dressings around plants before they are infected may help to protect them, and widely placed plantings or intercrops may help reduce or minimize disease and pathogen spread. Diseased plants, especially when their roots are rotting and leaves are wilting, should not be irrigated excessively or fertilized but rather should be uprooted and destroyed.

Best management practices
Avoid disease-prone sites.
Use disease-free planting material.
Apply compost.
Improve drainage.

IPM strategies
Select sites carefully—consider the potential for this disease in low-lying areas.
Practice attentive crop husbandry—plant stress factors may predispose plants to root rot.

Phoma shot hole

Epidemics of "shot hole" caused by the *Phoma* fungus can wreak havoc where ʻawa is grown in monocrops in a wet and humid environment. Entire fields of ʻawa plants can become virtually defoliated where these environmental conditions are pronounced and the disease is not managed in some way.

Phoma is dispersed by wind and splashing rainwater and can infect ʻawa stems, petioles, and leaves. After infection, small circular lesions form; the centers of the lesions often fall out, hence the disease name. Leaves turn yellow and fall off. Severely affected stems die prematurely. Overall plant vigor is severely compromised.

Some ʻawa varieties may prove to be more susceptible at a given location. Generally, the varieties with emerald or green stems tend to sustain greater damage in Hawaiʻi than some dark-stemmed varieties.

Plants should be kept well fertilized and growing vigorously to compensate for damage from *Phoma* infection. Although there are no fungicides currently registered for use on ʻawa in Hawaiʻi, slight control of *Phoma* leafspot may occur where foliar sprays of sulfur are applied to control mites.

Best management practices
Intercrop.
Maintain good field sanitation.
Manage humidity in the field by maximizing aeration.
Apply fungicides.

IPM strategies
Consider this disease when selecting a variety or choosing a planting style or location—the Papua New Guinea cultivar ʻ*Isa*ʼ is highly resistant to shot hole.

Root-knot nematode disease

Meloidogyne nematodes are destructive root parasites that can reduce ʻawa yield and quality enormously. Nematodes are microscopic roundworms that infect kava roots, causing them to swell, crack open, and rot inside and out. Opportunistic fungi and bacteria associated with the infections cause root tissues to become spoiled and virtually unpalatable.

It is important to keep nematodes out of propagation media and nurseries and to test media and field soils for nematode presence before planting. Nematode-infected plantlets should not be outplanted, and nematode-infested fields should be avoided.

Root-knot nematodes have a wide host range and usually are present in most agricultural soils. Their numbers diminish in soils that are fallowed for a period of time, provided that weeds in the field do not host them.

The first sign of root-knot disease may be poor growth, leaf yellowing, and drooping of petioles. Upon inspecting roots of diseased plants, the swellings can be seen. Later, plant dieback and stump rot can follow. Do not delay the removal of severely diseased plants.

High natural levels of organic matter or regular additions of compost can help to suppress root-knot nematodes, to a degree. Cultivating ʻawa in baskets filled with nematode-free media can help avoid the problem altogether. No ʻawa varieties have shown resistance to root-knot disease.

Although no effective nematicides are registered in Hawaiʻi for post-plant control of nematodes in ʻawa, growers may have some pre-plant pesticide options is some cases.

Best management practices
Avoid growing in soil with nematodes.
Apply compost regularly.
Harvest early.

IPM strategies
The nematode status should be a major consideration during site selection and plant propagation.

Spider mites

If ignored, spider mites can completely defoliate an ʻawa crop. Growers in Hawaiʻi can use a form of sulfur as a foliar application to control mite outbreaks.

Where ʻawa is grown in a dry environment or during extended dry periods, plants should be monitored for mite populations by inspecting the lower leaf surfaces. That is where sprays should be directed if mite populations are large. Repeated sprays and some pruning may be necessary.

Monocrops of 'awa in open, windy, dry areas are most vulnerable to attack. All varieties are probably susceptible to spider mites, but some may perform better in particular locations. Plants should be kept healthy and unstressed so that mite and insect infestations can be better tolerated.

Best management practices

Select a site not in an open, dry, windy area.
Intercrop with non-host plants.
Scout for mites on lower leaf surfaces.
Spray mites with sulfur.
Keep the crop healthy and vigorous.

IPM strategies

Integrate site management with site selection.
Avoid monocropping in dry, windy areas.
Scout for mites.
Control fungal leaf spot while controlling mites (insecticidal sulfur also acts as a fungicide).

Melon aphids

Aphids pose a significant threat to 'awa because they acquire viruses from infected plants and later transmit them to healthy plants, leading to kava dieback disease. Aphids can also stunt young plants in nurseries. It is very difficult to control them in 'awa monocrops.

Best management practices

Select a site that is not near vegetable or fruit crops; avoid very dry locations. Intercrop with non-host crops. Scout regularly for aphids. Control ants in and around 'awa nurseries and fields.

IPM strategies

Scout for aphids and ants.

Node rot

Node rot is a nursery disease when nodes are used to start new plants, usually in trays. It is caused by unfavorable environmental conditions and is associated with various opportunistic microbes including fungi and bacteria. Node rot is also caused by fertilizer burn; do not apply granular fertilizers before new leaves have emerged. Dilute liquid fertilizers may be applied periodically at any stage.

Node cuttings from healthy, unstressed, vigorous mother plants are less prone to rot than cuttings from weak plants. Cuttings should be planted as soon as possible and not allowed to dry out or crack. Cuttings should not remain waterlogged or be exposed to high temperatures.

Sterile or inert media, or at least pathogen-free media, should be used. Clean water should be used to mist the cuttings to stimulate rapid rooting. Fertilizers should not be used in early stages or node tissues might burn.

Avoid excessive heat in propagation areas and remove diseased nodes and destroy them as they are identified. There are probably no resistant varieties. This disease is quite dependent on environment. Do not dip 'awa node cuttings into bleach or peroxide solutions before planting; these solutions can injure the node tissues and allow rot to occur.

Best management practices

Plant healthy, vigorous cuttings into a clean environment.

IPM strategies

Consider this problem in light of fertilizer use in the nursery and in relation to the health of mother plants from which cuttings are taken. Fertilizer burn can lead to node rot, and stressed mother plants do not provide vigorous cuttings for propagation.

Locally severe and minor pests

Various other pests common in kava plantings are usually only nuisances, but some can become locally severe. Information on these pests is presented in the tables. A few pests cause only sporadic damage, including two caterpillars, the Mexican leafroller, and the green garden looper. Some insects may only pose a problem in greenhouses or shadehouses (mites, whiteflies, and some scales, for example).

Weeds

'Awa crops can be severely threatened by weed presence in certain situations. Already mentioned is the potential of weeds to harbor CMV, other 'awa pathogens, and serious insect pests such as aphids. Also, many weed species can easily choke out young 'awa plants and must be controlled. It is important to manage weed populations within an 'awa field very early in the cropping cycle, especially during the first year of growth. Thereafter, most growers rely on the plants' leaf canopy to shade out weeds. The challenge, then, is how to control weeds within and around the crop during the first year.

The herbicide glyphosate may be used to control weeds in areas adjacent to an 'awa planting and as a preplant herbicide within ʻawa fields. However, extreme caution is warranted when using glyphosate near ʻawa plants, which are hypersensitive to glyphosate injury, easily damaged by spray drift, and susceptible to damage by glyphosate residues in soils. Care should be taken not to over-apply glyphosate or to plant ʻawa immediately after the herbicide has been used. Weeds in ʻawa fields postplanting are best controlled manually (hand-pulling or chopping) or physically (mulches, weed mat, etc.).

New herbicides may appear on the market, and some may be labeled for use in ʻawa plantings. Any question about the legality of use of an herbicide or other pesticide with ʻawa in Hawaiʻi should be referred to the Hawaiʻi Department of Agriculture.

Pesticides for ʽawa in Hawaiʽi

Most diseases and pests of ʻawa must be controlled by using non-pesticidal strategies. ʻAwa growers in Hawaiʻi have very few approved pesticide options as of 2005. The main one is Drexel sulfur, which has a 24-c label for mite control; however, it expires in 2005. With other products (herbicides, pre-plant materials, organic products, etc.), it is recommended that a label interpretation be obtained from the Hawaiʻi Department of Agriculture before using them.

Further information

For more information on the pest problems mentioned here, please contact the Cooperative Extension Service office near you or consult the sources listed below.

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Table 9.1. Effect of some IPM tactics on the principal pests of ʽawa.
An "x" in the table indicates that the tactic can have a significant effect upon the occurrence and/or severity of the corresponding pest problem.

	Kava dieback	Pythium root rot	Phoma shot hole	Root-knot nematode	Spider mite	Melon aphid	Node rot	Other insects	Weeds
Site selection	x	x	x	x	x	x		x	x
Nursery practices[1]	x	x		x	x	x	x	x	
Fertilizer practices[2]		x	x			x	x	x	x
Irrigation	x	x	x	x	x	x	x	x	x
Drainage	x	x	x						
Plant stress	x	x	x	x			x	x	
Compost		x		x					x
Sulfur			x		x			x	
Soaps						x		x	
Variety	x		x						
Avoidance	x	x	x	x	x	x	x	x	x
Intercrop	x	x	x	x		x		x	x
Basket planting		x		x					x
Scouting	x	x	x	x	x	x	x	x	x

[1] Nursery practices include choice of mother plants for node cuttings, nursery sanitation, choice of propagation media and containers, environment, pesticide applications, etc.
[2] Fertilizer practices include choice of fertilizer, mode of application, amount used, frequency, and timing of application.

Table 9.2 Kava dieback

Kava dieback	Cause	Symptoms	Risk	Management
Infected plants can display a wide range of symptoms; from one to several of the following symptoms may appear on a given plant.	***Virus:*** cucumber mosaic cucumovirus (CMV) ***Insect vector:*** melon aphid (*Aphis gossypii*) ***Other:*** ant species tend and protect aphids (*e.g.*, longlegged ant, bigheaded ant, Argentine ant, whitefooted ant).	***Leaves:*** mosaic, ring-spots, yellowing, necrosis, wrinkling and deformation, vein clearing or necrosis ***Stems:*** dieback, wilt, collapse, black lesions, blackened veins ***Roots:*** rotten, soft, black ***Plants:*** dieback, wilting, death	***High risk:*** this disease may be fatal to young plants and spreads quickly; the disease is less of a threat and more manageable in older plantings through the practice of regular scouting to identify and remove diseased plants or individual stems.	Keep a virus-free nursery, practice vigilant ant and aphid control, use tall windbreaks, control weeds that are hosts for the virus, scout field regularly for diseased plants, rogue out infected plants or stems, locate the field in isolation from other 'awa plants or farms, plant a resistant variety (the Papua New Guinea cultivar '*Isa* ' is immune to the disease), intercrop.

Leaf mosaic

Leaf puckering and wrinkling

Black veins within stem (break open stem to observe this symptom)

Ringspots on leaves

Black veins in leaves, leaf curling and wrinkling

Curled apical leaves with conspicuous mosaic symptom

Yellow or "cleared" veins in leaves

Wilting and complete dieback (left) is possible and can happen very rapidly

Black stem lesions, stem collapse

Melon aphids (here highly magnified) are the insect vectors that transmit CMV. They are often tended and protected by one of several ant species

Table 9.3. Phoma shot hole

Phoma shot hole	Cause	Symptoms	Risk	Management
This disease was first recorded in Hawaiʻi in 2001 and is most severe during wet and humid weather	***Fungus:*** *Phoma* sp., a highly contagious fungus that is favored by wet weather and is dispersed by wind and splashing water; symptoms appear about 2-3 weeks after infection; it is not known if there are any other hosts besides ʻawa for this pathogen.	***Leaves:*** small, black spots (1/8 inch diameter) on leaves that develop whitish gray centers that fall out, lending a shot-hole appearance to leaf; leaf yellowing; defoliation ***Stems:*** Lesions with brown margins and whitish to tan centers, circular at first and developing irregular shapes later; whitish gray centers and dark margins ***Plants:*** Dieback, death	***High risk:*** extremely high risk is associated with this disease (massive defoliation and sometimes plant death are likely).	Periodically trim severely diseased stems; use approved fungicides, use host resistance (the Papua New Guinea variety '*Isa*' is resistant), use wider plant spacing, control weeds to reduce relative humidity in canopy, promote good aeration within plant canopy, promote good soil drainage, intercrop.
 *Massive defoliation, leading to denuded stems*	 *Leaf yellowing and spotting*	 *Plant dieback*	 *"Shot holes" in leaves that can be easily seen when holding the leaf between your eyes and the sun*	 *Stem lesions, circular at first and developing irregular shapes that coalesce to create large, longitudinal blighted areas on the stem.*

Table 9.4. Node rot

Node rot	Cause	Symptoms	Risk	Management
 *Node rot lesions on an ʻawa node cutting in a propagation bed*	***Fungi:*** *Fusarium* sp. (fungus); other fungi are associated with the disease. ***Bacteria:*** *Pseudomonas* sp., *Erwinia* sp. are associated with the disease ***Insect:*** *Drosophila* larvae (fruit fly) (incidental); insect feeding can create wounds in nodes that allow pathogens and opportunistic microbes to enter and infect tissues.	***Nodes:*** dark lesions on nodes that often coalesce to form large blighted areas, soft rot, all tissue may turn black or mushy, death of cuttings; node rot can be caused by fertilizer burn and is favored by waterlogged or poorly aerated media.	***High risk:*** the disease may destroy node cuttings before plants become established, causing losses up to 100%; however, once conditions and methods are improved, the risk is very low.	Irrigation and temperature control during propagation; protect cuttings from excess sun and rain; use sterile or inert media; keep nursery clean through sanitation practices; accelerate rooting by applying hormones; use clean, sharp pruning knives to obtain node cuttings with smooth cuts; use approved fungicides; plant node cuttings promptly before they dry out and form cracks for pathogens to enter; obtain cuttings from healthy, vigorous plants; remove and destroy severely diseased nodes promptly; avoid heavy use of fertilizers in propagation beds

Table 9.5. Root-knot disease

Root-knot disease	Cause	Symptoms	Risk	Management
This disease can reduce 'awa yields and quality	***Nematodes:*** *Meloidogyne* sp., the root-knot nematode; these are internal root parasites that may infest nursery soils and field plantings; no 'awa varieties are known to be resistant.	***Roots:*** swelling, galling, knotting, internal rot, stunting, stubbiness ***Basal stems:*** although rare, galls can form on basal stems where plants are "hilled" with infested media after planting ***Leaves:*** yellowing, wilting, defoliation	***Moderate to high risk:*** plants are not usually killed, but root quality can be severely affected. (Severely affected roots must be discarded, and moderately affected roots produce a discolored and foul-tasting product.)	Use nematode-free media in the nursery; avoid planting in heavily infested soils; use compost and organic soil amendments (green manure, mulches, etc.), intercrop, crop rotations, fallowing of field, use approved pre-plant nematicides.


Knotted or galled roots


Galls on basal stems


Deformed and rotting roots


Swollen and cracked roots


Yellow leaves, wilting


Internal root rot


Blackened, swollen roots

Table 9.6. Stump rot

Stump rot	Cause	Symptoms	Risk	Management
 *Rotten stump*	***Fungi:*** various species (*Fusarium* sp., others), slugs feeding injury, fertilizer burn	***Stump:*** decay and disintegration of stump, internal, rot of stump	***Moderate risk:*** Although moderate risk, the disease can be locally severe and ruin a harvest.	Avoid contact between granular fertilizers and stump, control slug feeding or other sources of mechanical injury, do not prune stems too close to stump, avoid pesticide injury, promote good drainage and minimize plant stress.

Table 9.7. Root rot

Root rot	Cause	Symptoms	Risk	Management
Infected plants of all ages can die very quickly after infection  *Stunted, unthrifty plants*	***Fungi:*** *Pythium splendens*, *Rhizoctonia solani* ***Nematodes:*** *Meloidogyne* spp. (root-knot nematodes). ***Fertilizer burn:*** quick-release ammonium fertilizers can easily damage ʻawa.	***Roots:*** rotten, soft, black. ***Foliage:*** wilting and collapse of leaves and stems; yellowing; stunting; leaf curl; leaf marginal scorching; basal stem rot. The disease can resemble nitrogen deficiency at first, or drought stress. ***Plants:*** poor growth; wilting; stunting; death	***High risk:*** The disease is fatal. The fungi that cause this disease can survive in soils for a very long time; infection and disease progress very rapidly during wet weather; even very old or mature plants can die rapidly; some planting areas must be abandoned when infested with the root-rot pathogens.	Plant ʻawa on raised beds or hills; use disease-free planting material only; ensure good drainage around plants; use compost; avoid over-fertilization and over-watering; plant ʻawa in baskets; intercrop ʻawa with other plants; no effective fungicides are approved for controlling the disease in the field.


Stem wilting and dieback, leaf yellowing and collapse


Plant death


Wilting


Blackened roots and basal stem rot

Table 9.8. Crinkle leaf (aphid burn)

Crinkle leaf (aphid burn)	Cause	Symptoms	Risk	Management
 *Crinkled leaf due to aphid feeding, with lady beetles and aphid lions present*	***Insects:*** the melon aphid *(Aphis gossypii)* ***Associated:*** ants obtain food from aphid excretions, protect aphids, and move aphids from plant to plant.	***Leaves:*** distortion, curling, wrinkling, or crinkling with black or dark spots or small ringspots, leaf stunting ***Plants:*** stunting and unthrifty growth (young plants)	***Low to moderate risk:*** plants can recover from the damage; aphids are potential CMV vectors and in high numbers can destroy a young plant.	Spray soap plus water, exclude ants from plantings, plant ʻawa in enclosed nursery, use elevated benches, increased plant spacing, promote beneficial insects that are aphid predators (*e.g.*, lady beetles).

Table 9.9. Environmental and abiotic disorders

	Cause	Symptoms	Risk	Management
Environmental and abiotic disorders  *Rotted node cuttings (brown spots) in perlite were "burned" by excess fertilizer (yellow granules)*	Wind, cold, altitude, sun, rain, drought, pesticide injury, fertilizer burn, fertilizer deficiency	***Foliage:*** tattered leaves; thin stems; blackened or necrotic leaves; defoliation; stunting; wilting; slow growth; yellow-ing; leaf marginal burn, leaf curl, and distortion; leaf bleaching; leaf yellowing; leaf spotting; leaf blight; leaf wrinkling	***Moderate risk:*** These problems are usually not fatal and are often correctable.	Use windbreaks; acclimatize plants with stepwise hardening; do not over-water or over- or under-fertilize; grow 'awa at appropriate elevation to avoid chill; use only approved pesticides and follow label directions; avoid waterlogged soils.


Pesticide injury (diazinon)


Wrinkled leaves (sun damage)


Pesticide injury (leaf bleaching)


Nutrient deficiency, probably iron


Sunburn

Table 9.10. Slug and snail damage

	Cause	Symptoms	Risk	Management
Slug and snail damage	Gray garden slug (*Deroceras laevae*), other slugs, various snails	***Leaves:*** irregular shaped holes in leaf centers or margins ***Stems:*** Basal wounding and rot (see below)	***Low to moderate risk:*** these pests are most damaging to young plants; however, where feeding damage is severe, the basal stems can rot and ruin the stump tissues	Use approved slug and snail baits; manually remove slugs; use of slug traps or deterrents; locate slug hiding places and destroy them; use geese, chickens, or ducks


Large holes in leaves created by slugs


The gray garden slug

Table 9.11. Minor leaf spots

	Cause	Symptoms	Risk	Management
Minor leaf spots	***Fungi:*** *Colletotrichum* sp., *Phyllosticta* sp., algae (*Cephaleuros virescens*)	***Leaves:*** dark or chocolate colored spots of various diameters	***Low risk:*** restricted in occurrence to very wet environments	Sanitation (leaf removal); pruning; humidity control (weed management, good drainage); intercropping; foliar spray of insecticidal sulfur has moderate fungicidal effect

Algal leaf spots (left): brown spots are caused by a plant-parasitic alga (Cephaleuros virescens): green spots are superficial algae that do not infect the leaf

Fungal leaf spot

Fungal leaf spot disease (rare)

Pin-prick lesions associated with the fungus, Colletotrichum *sp.*

Not leaf spots, but a variegated plant

Table 9.12. Locally severe insects, mites

	Cause	Symptoms	Risk	Management
Locally severe insects, mites	***Insects:*** spiraling whitefly (*Aleurodicus dispersus*); fringe guava whitefly (*Aleurotrachelus* sp.); banana silvering thrips (*Hercinothrips bicinctus*) ***Mites:*** carmine spider mite (*Tetranchyus cinnarbarinus*); broad mite (*Polyphagotarsonemus latus*); false spider mite (*Brevipalpus phoenicis*); flat mites	Leaf yellowing; necrosis, and/or defoliation	***Moderate risk:*** damage potential is high with these pests if populations are allowed to grow without control	Use approved insecticides or insect repellents; irrigation and fertilizer management (insects are attracted to heavily fertilized plants); windbreaks; weed control; use sulfur for mite control; use neem oil.

Thrips feeding injury causes blackening of leaves near veins

Aphids are usually tended by ant species, such as the longlegged ant (above, right)

Spider mites can be serious greenhouse and field pests, causing defoliation and unthrifty plant growth

A colony of the spiraling whitefly; many sap -feeding insects usually feed on the undersides of ʻawa leaves

Table 9.13. Troublesome weeds and other plants

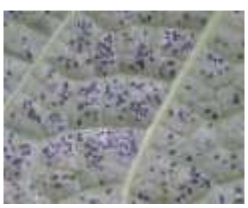
A number of common range, pasture, canefield, and residential weeds can interfere with ‘awa cultivation by competing with ‘awa or by harboring insect pests and plant diseases. Grasses, which compete strongly with ‘awa root systems, must be controlled. Some weeds harbor severe diseases or insect vectors of diseases that can seriously affect ‘awa. Honohono grass (*Commelina diffusa*) and *Glycine* sp. harbor CMV, the cause of ‘awa dieback, and aphids, the insect vectors of CMV. Where the virus is present, avoid intercropping ‘awa with hosts of the melon aphid (*Aphis gossypii*), such as solanaceous food crops and cucurbits. Impatiens and noni and many other plants or weeds are hosts for the destructive root-knot nematode, *Meloidogyne* sp., and should not be planted near ‘awa in locations where root-knot nematodes have infested the soil.

Glycine *sp., a common weed in pastures and waste areas showing mosaic symptoms of infection by CMV (cucumber mosaic cucumovirus), cause of ‘awa dieback disease*

*Honohono grass (*Commelina diffusa*) showing mosaic symptoms of infection by CMV (cucumber mosaic cucumorvirus), cause of ‘awa dieback disease; right: a colony of melon aphids feeding on a honohono leaf — melon aphids can transmit CMV from honohono to ‘awa*

A year or more after planting, the ‘awa canopy is so large that most weeds are shaded out and no further weed management is needed

Table 9.14. Minor insect pests

Minor insect pests	Cause	Symptoms	Risk	Management
 *Pupae of the fringe guava whitefly*	***Insects:*** Coconut scale (*Aspidiotus destructor*); green scale (*Coccus viridis*); planthopper (*Kallataxila granulate*); mealybugs; Mexican leaf-roller (*Amorbia emigratella*); Chinese rose beetle (*Adoretus sinicus*); katydids; green garden looper (*Chrysodeixis eriosoma*); root mealybugs; barnacle scale (*Ceroplastes cirripediformis*)	Holes in leaves; rolled leaves; leaf yellowing; sooty mold; leaf necrosis	***Low risk:*** damage caused by these pests is sporadic, not widespread, and of relatively minor economic importance.	Encourage natural predators and pathogens; exclude ants; modify the environment; intercrop.

Katydid

Coconut scale

Barnacle scale

Root mealybugs in greenhouse

Chinese rose beetle damage

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Supplement to the Web Edition

Recent Studies on Potential Health Effects of ʻAwa

The information in this "web-friendly edition" is virtually unchanged from the book. However, since the science associated with ʻawa has advanced in the past few years, we wanted to note some of the recent research on ʻawa's potential effects on human health.

ʻAwa and Cancer

This book's introduction and the chapters entitled "Active Ingredients in ʻAwa" and "Chemistry, Pharmacology, and Safety Aspects of ʻAwa" cited early studies of ʻawa's potential in cancer prevention. In 2008, Johnson et al. published research on ʻawa and lung cancer in mice that had been given carcinogens. ʻAwa reduced lung tumor multiplicity when administered concurrently with carcinogens and when administered after carcinogen treatment. Best results occurred when ʻawa was administered along with carcinogens and continued after carcinogens were discontinued: lung tumor multiplicity was reduced by 56% compared to mice that received carcinogens but no ʻawa.

The study above appeared in *Cancer Prevention Research* in November of 2008. The same issue included an article by Tang et al. adding to prior research on the effects on bladder cancer of a particular ʻawa constituent, flavokavain A.

In 2009, an article by Shaik et al. suggested that the kavalactone methysticin may be the chemical in ʻawa that appears to prevent lung cancer. This study also indicated that methysticin is not toxic to liver cells.

ʻAwa and Alzheimer's Disease

We would like to call attention to a recent study suggesting that ʻawa may be of use against Alzheimer's disease (Wruck et al., 2009). The kavalactones methysticin, kavain and yangonin were tested in vitro and shown to protect neural cells. The article concludes, "If studies using kavalactones in an in vivo model of Alzheimer's disease prove this beneficial effect, the use of kavalactones might be considered as an adjunct therapeutic strategy to combat neural demise in Alzheimer's disease . . . ."

Potential Liver Toxicity

Chapter 4, on "Chemistry, Pharmacology and Safety Aspects," discusses the chemistry of ʻawa and potential liver toxicity in some detail. A number of studies have been conducted since this chapter of the book was written, but the results are still inconclusive.

The World Health Organization performed an extensive assessment published in 2007. The resulting opinion stated:

> Evidence of our review of case reports suggests that kava lactones in any type of product may rarely cause hepatic adverse reactions because of kava-drug interactions, excessive alcohol intake, metabolic or immune mediated idiosyncracy, excessive dose or pre-existing liver disease. . . . In addition to this background incidence, products made from acetonic and ethanolic extracts appear to be hepatotoxic on rare occasions, seemingly from non-kava lactone constituents. . . (WHO 2007: 63).

Fu et al. (2008) review many of the studies done up to that point. Baker (2008) also provides a review of the literature on ʻawa's effects on the liver as well as insights on the divergent opinions with respect to the safety of ʻawa.

Jhoo et al. (2006) examined extracts from leaves, roots and stems for liver toxicity using a number of different solvents. Flavokavain B was noted for cytotoxicity in this study. The article by Shaik mentioned above found flavokavains A, B and C to be toxic to liver cells. These flavokavains were found in the commercial product tested but not in the traditional water extract.

Zhou et al. (2010) have shown flavokavain B to be toxic to HepG2 liver cells and in vivo with mice. If this proves to be the explanation for the rare cases of liver damage associated with ʻawa, it has been proposed that extracts be developed to exclude the flavokavains.

—Ed Johnston and Helen Rogers, September 2010

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