FERMENT THIS: THE TRANSFORMATION OF NONI, A TRADITIONAL POLYNESIAN MEDICINE (*MORINDA CITRIFOLIA*, RUBIACEAE)[1]

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Dixon, Anna R., Heather McMillen, and Nina L. Etkin *(Department of Anthropology, University of Hawai'i, 2424 Maile Way, Honolulu, Hawai'i 96822 USA).* FERMENT THIS: THE TRANSFORMATION OF NONI, A TRADITIONAL POLYNESIAN MEDICINE (*MORINDA CITRIFOLIA*, RUBIACEAE). *Economic Botany 53(1):51–68, 1999. Research on the use of plants and other complementary medicines in Hawai'i drew our attention to* Morinda citrifolia *(Rubiaceae). Noni, as it is commonly known, is representative of both currently popular medicinal plants in Hawai'i and the pharmacopoeias of traditional cultures of this polyethnic population. It is also prominent among the increasing number of botanicals currently promoted by the "herbal" and "health foods/supplements" industry. Noni is unique in view of the large number of medical indications that characterize claims for its efficacy, the little that is known about its pharmacologic potential compared with other popularly used botanicals, and its rapidly evolving commercial success. This paper explores how the cultural novelty of noni, in conjunction with its equivocal pharmacology, contribute to its explosive market success in contemporary Hawai'i, and worldwide.*

E HO'OMALAMALA KĒIA: NO KA LOLI'ANA O KA NONI, HE LĀ'AU KU'UNA O POLENEKIA (*MORINDA CITRIFOLIA*, RUBIACEAE). *I kō mākou noi'i 'ana e pili ana i nā lā'au lapa'au o Hawai'i nei, ua hoihoi loa mākou i ka noni (*Morinda citrifolia, *Rubiaceae). He mea ho'ohālikelike maika'i ka noni o nā lā'au lapa'au ma'amau o Hawai'i i kēia mau lā, a me nā lā'au ku'una o kekahi mau po'e 'ē a'e e noho ana ma'anei nō ho'i. Kaulana ka noni mawaena o nā lā'au ho'opi'i 'ia e ka 'oihana "'ai olakino." Lua 'ole ka noni no nā mea penei: nā 'ano ma'i he nui "ho-'ōla" 'ia e ka noni; ka 'ike hemahema o kona mau kemika; a me kona holomua 'imi kālā. I kēia pepa, hō'ike mākou i ka mana'o hou e pili ana i kēia lā'au "ku'una", kona kemika kākālule, a me kona makemake nui 'ia i kēia au ma Hawai'i a kahi 'ē.*

Key Words: *Morinda citrifolia,* noni, complementary medicine, Hawai'i, Polynesia.

COMPLEMENTARY MEDICINES

Our research on the use of complementary medicines in Hawai'i reveals that, as across the U.S. Mainland and in Europe, these "unorthodox" treatments are very popular, even among cosmopolitan, financially secure residents of a state that offers some of the most liberal access to biomedical (allopathic) health care in the U.S. (for characteristics of the study population and methodology consult Dixon, Etkin, and Nishimoto 1995; Etkin et al. n.d.). Interviews with the 185 study participants identified a total of 346 medicinals that ranged from treatments for specific illnesses such as diabetes, to more general outcomes such as "cleansing" or "general health." While our interviews neither anticipated nor achieved consensus, they do mark a high level of agreement centering on a core of complementary medicines and why/how they are efficacious. The use patterns revealed in these interviews confirmed that the various items used are indeed complementary: they are not alternatives for biomedical health care, or for one another. Instead, consumers regard what are substantively and conceptually highly asymmetrical alternatives to be collaterals: they regard one as likely as another to be potent, disease-specific, and effective.

The most commonly used complements are plant-based, underscoring that botanicals in general figure prominently among the more popular complementary medicines. Most of these plants have been drawn from the traditional pharmacopoeias of the ethnic groups that today reside

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TABLE 1. THE MOST POPULAR COMPLEMENTARY MEDICINES IN HAWAI'I, AS REPORTED BY THE 185 STUDY PARTICIPANTS.

Common name	Species	n	%
Aloe	*Aloe barbadensis* Mill. (Liliaceae)	71	38%
Noni	*Morinda citrifolia* L. (Rubiaceae)	41	22%
Garlic	*Allium sativum* L. (Liliaceae)	35	19%
Ginseng	*Panax ginseng* C. A. Mey. (Araliaceae)[a]	32	17%
Lemongrass	*Cymbopogon citratus* Stapf (Poaceae)	33	18%

[a] Chinese or Asiatic ginseng. Today's commercial ginsengs may contain one or more of these as well: *P. notoginseng* Hoo & Tseng (sanchi ginseng); *P. quinquefolius* L. (American ginseng); *Eleutherococcus senticosus* Maxim. (Siberian ginseng).

in multiethnic Hawai'i. We discuss four of the five most often mentioned complementary medicines (Table 1) briefly below, and then turn our attention to noni (*Morinda citrifolia* L.).

ALOE (*ALOE BARBADENSIS* MILL.)

Although aloe is a recent introduction (ca. 1930), it is widely cultivated and has become naturalized in Hawai'i, where—Whistler (1992: 124) observed—many believe it to be native. Aloe is the most commonly used medicinal plant in Hawai'i today, and its medicinal uses transect ethnic lines. Widescale promotion of aloe by the cosmetic industry over the last 20–30 years further cements it in the public mind, but commercial products are not widely used in Hawai'i because aloe is so easy to grow: propagated in gardens, on balconies, and indoors, aloe is readily available and inexpensive. While our study population prepared medicinal aloe in a great variety of ways, including to mask the bitter taste when taken internally, the medicinal applications clustered in only two major categories: externally for burns, cuts, and abrasions; internally it is used for gastrointestinal disorders such as indigestion and ulcer. Aloe consumption is consistent with pan-Pacific and pan-Asian therapeutic paradigms that understand healing through internal cleansing, at least for the early stages of the therapeutic process. The bitter taste of aloe signals, and the purgative action effects, the desired cleansing. Similarly, for the skin, aloe is depurative, suiting paradigms of healing through removal of injured tissue to promote growth of new skin.

GARLIC (*ALLIUM SATIVUM* L.)

Garlic, probably of Central Asian origin, now also is cultivated worldwide and has been integrated into diverse cuisines and pharmacopoeias. Chinese regard *Allium* spp. generally as "hot," thus indicated for "cold" diseases and in the postpartum (Simoons 1991:158). Whereas study participants report that the culinary uses of garlic vary among Hawaii's ethnic traditions in contemporary Hawai'i, the medicinal uses overlap appreciably. Garlic is regarded as a "natural antibiotic" for the prevention and therapy of colds and flu, and (topically) for fungal infections and other skin disorders; garlic also is used as a "blood cleanser" for heart disease.

GINSENG (*PANAX GINSENG* C.A. MEY.)

Native to northeastern Asia, ginseng was an important element in the medical traditions of China, and later Korea and Japan. Today ginseng enjoys worldwide popularity for its "tonic" effects. Our research in Hawai'i revealed similar objectives as—especially Chinese and Japanese—use ginseng to "strengthen" and "fortify" the body to contend with environmental insults, including disease entities. Most commonly, our study population consume commercial ginseng capsules or "tea" to sustain energy and improve "immune function" for cancers, to counter the adverse effects of chemotherapy, and to potentiate chemotherapeutic agents.

LEMONGRASS (*CYMBOPOGON CITRATUS* STAPF)

Lemongrass is an introduced aromatic herb employed in many Asian cuisines and cultivated throughout Polynesia where it is used in cooking and as medicine for mouth infections (e.g., Sāmoa) and intestinal disorders (Hawai'i) (Whistler 1992:55). Our research documents its selection, especially by Hawaiians and Filipinos, for its aromatic character, which is believed to mark

"cleansing" properties, particularly for the blood. Ridding the blood of impurities is understood to be important for the resolution of cancer, stomachache, and (when applied externally) skin disorders.

Traditional and Contemporary Uses of Medicinal Plants Vis-à-Vis Their Pharmacologic Potential

Although we do not need to invoke bioscience to legitimize these medicinal applications, it is interesting to note that, with the exception of noni, the therapeutic applications of these leading medicinal plants are largely consistent with pharmacologic indications. Aloe, garlic, ginseng, and lemongrass have been phytochemically well-characterized, and extensively investigated in vitro, in vivo, and in clinical trials in both veterinary and human medicine.

For example, the purgative action of aloe latex and leaf juice is attributed to high concentrations of anthraquinone glycosides, and helps to explain the use of aloe as a "cleansing" cathartic. Consistent with its application to wounds and skin disorders, aloe latex is astringent and has bactericidal, fungicidal, and anti-inflammatory action (Chithra, Sajithal, and Chandrakasan 1998; Saks and Barkai-Golan 1995; Vásquez, Avila, and Escalante 1996; Yamaguchi, Mega, and Sanda 1993). The latex also has hypoglycemic effects (Newall, Anderson, and Phillipson 1996:25).

Garlic demonstrates broad-spectrum antibiotic and antifungal, and some antiviral and antiprotozoal activities—including against, *Staphylococcus, Escherichia, Mycobacterium tuberculosis, Herpes simplex,* and influenza (Cellini et al. 1996; Kumar and Berwal 1998; Nok, Williams, and Onyenekwe 1996). This, in conjunction with anti-inflammatory effects (Khobragade and Jangde 1996), offers a pharmacologic rationale for its use in skin disorders and colds/flu. The antimicrobial and antiparasitic actions are, coincidentally, concordant with the local medical explanatory models that understand garlic to be a "natural antibiotic" and "blood cleanser." Similarly, cholesterol-lowering (due to diallyl disulfide), antithrombic (attributed to ajoene), and hypotensive effects are well-established (Khalid et al. 1995; Newall, Anderson, and Phillipson 1996:129–131), offering a pharmacologic explanation for the therapeutic role of garlic in heart disease that also is consistent with traditional healing paradigms.

Biomedical researchers have conducted extensive investigations of ginseng since the 1950s. While the early literature was equivocal (Lewis 1986), later reports increasingly distill toward a handful of specific therapeutic indications. This research reveals hypoglycemic, antithrombic, antidiabetic, immunostimulatory, and anticarcinogenic activities (Lee et al. 1997; Park et al. 1996; Yun 1996). Both CNS-sedative and -stimulant activities have been reported as well. Collectively, these support claims for the "tonic" and "adaptogenic" (antistress/immune-modulating) effects traditionally attributed to ginseng (Newall, Anderson, and Phillipson 1966:141–142). These are the same outcomes that our study population attributes to ginseng.

Where the aromatic ("cleansing") quality of lemongrass signals its contemporary uses in Hawai'i, biomedicine comprehends a pharmacologic rationale that centers on citral, the essential oil of lemongrass. Citral has antifungal activity against plant and human pathogens (Lewisohn et al. 1998; Rodov et al. 1995), and has bactericidal (Asthana et al. 1992; Kim et al. 1995) and insecticidal properties (Rice and Coats 1994). Extracts are antimutagenic, suggesting protective effects against digestive tract cancers when lemongrass is used in medicine and food for stomachache (Awah 1994; Suaeyun et al. 1997; Vinitketkumnuen et al. 1994).

Noni Lacks the Pharmacologic Rationale that Underscores Other Popular Medicinals

Our research on complementary medicines confirmed for contemporary Hawai'i the observation for traditional Hawai'i (Abbott and Shimazu 1985) that noni ranks second among the most commonly used plants. It evokes many Polynesian therapeutic traditions and, in this way, is like the other popular medicinal plants that represent the traditional pharmacopoeias of the various cultures of contemporary polyethnic Hawai'i. Beyond that, however, noni is unusual in the large number of applications for which it is popularly indicated and its rapidly growing commercial success. This is the case, despite that—compared to some of the other medicinal plants popular in Hawai'i—relatively little is known about its pharmacologic potential: reliable laboratory assessments of noni appear only

Fig. 1. Noni—*Morinda citrifolia* L., Rubiaceae.

in the very recent literature. Thus, whereas the other popular medicinal plants have been well characterized chemically and pharmacologically, noni has not been, yet still is extremely popular. The remainder of this paper is devoted to further exploration of noni.

Noni Origins and Botany/Habitat

Native to Southeast Asia (perhaps only to Indonesia [Whistler 1992:173]), noni ranges from eastern Polynesia to India. It also has become naturalized in the New World in Mexico, Panama, Colombia, Venezuela, and throughout the Caribbean, the Florida Keys, and the West Indies (Johansson 1994; Morton 1992) (Fig. 1). It is a resilient plant: easily tolerates harsh, dry, saline, conditions that are common to coastal areas; thrives at elevation (beyond 200 meters); and grows quickly, producing fruit year-round.

> Noni ranges in size from small shrubs to trees more than 10 meters tall, with quadrangular or somewhat rounded branches and evergreen, opposite, dark, glossy, [elliptical, pointed], prominently-veined leaves. . .Small, white. . .flowers. . . are borne in globose heads. . .[that] develop into compound fruits composed of many small drupes fused into an ovoid, . . .lumpy body, 5–10 cm long, 5–7 cm thick, with waxy . . .greenish-white or yellowish. . .skin. The flesh is juicy, bitter, [yellow or white], . . .and contains. . .triangular seeds. When fully ripe, the fruit has a pronounced "rancid cheese" odor. (Morton 1992:242)

Although noni can disperse naturally via buoyant seeds that remain viable after month(s)-long sea travel, humans have played a significant role in its dissemination. The Marquesas and Tahiti were among the first, and the Hawaiian Islands among the last, to be reached by Polynesian voyagers who introduced noni to these islands. That noni plants were transported even to "the farthest outpost of Polynesia (Hawai'i) is testimony [to] their importance" (Abbott and Shimazu 1985:220).

Geographic Variation in Noni Use

For more than 1000 years (Abbott 1992:3–5) noni has been domesticated and cultivated by populations throughout Polynesia who value it as a food, dye, and medicine. The fruit was a famine food in Hawai'i (Degener 1945:286), and in the Marquesas where it was otherwise fed to hogs (Morton 1992:243). In other areas of the Pacific such as Sāmoa and Fiji, the fruit was more commonly eaten, as it was by Australian Aborigines and in Burma. Young noni leaves are food and food wraps for human, livestock, and silkworm consumption (Morton 1992:243–244). Although some Pacific Islanders consumed noni, it was always more popular as a dye, and by the mid-1950s was used so for a range of materials in Europe, Asia, Southeast Asia, and Polynesia: Javanese employed noni root for dyeing batik, Polynesians for *kapa* (bark cloth), Australian Aborigines for cotton and wool, and Indians for turbans, carpets, and yarn (Morton 1992:245). Various shades of red, purple, and yellow could be achieved by employing different mordants. For example, in Polynesia a red dye was made by mixing root with lime derived from coral, and yellow dye was made from the trunk bark (Degener 1945:286).

Beyond its utility as a food and dye, noni was also valued for its medicinal properties. In order to understand the medicinal use of noni in contemporary Hawai'i it is useful to briefly review its therapeutic applications in its places of origin in Southeast Asia and across Polynesia. These are summarized in Table 2, which documents that outside of Hawai'i, the medicinal applications of noni include predominantly leaves, and most of these are topical medicines.

Changes in the Health of Hawaiians and in the Use of Their Medicines

Prior to Captain Cook's arrival in Hawai'i in 1778, Hawaiians led comparatively healthier

TABLE 2. A REPRESENTATIVE LIST OF MEDICINAL USES OF *MORINDA CITRIFOLIA* IN SOUTHEAST ASIA AND POLYNESIA (FROM MORTON 1992).

	Medicinal application	Country
Fruit		
	unripe, charred, applied with salt for gum disorders	Malaysia; SE Asia
	pound with sugar cane and kava root for tuberculosis	Pacific Islands
	whole fresh eaten as veterinary anthelmintic	Philippines
	consumed fresh and applied for various disorders	Sāmoa*
	juice drunk to prevent adverse effects of kava	Pacific Islands
	seeds consumed as anthelmintic	Philippines
	seeds consumed as purgative	Philippines
Flower		
	juice applied to sore eyes	Guam
	topical and consumed for various disorders	Sāmoa*
Leaves		
	young leaves applied with oil for ringworm	Fiji
	poultice for boils	Marquesas
	plaster for rheumatic joints	Marquesas
	young, applied with oil for rheumatic pain	Fiji
	warmed and applied for inflammation	Marquesas
	crushed in lard, applied to the face for head colds, neuralgia	Marquesas
	chest plaster for cough and cold	Malay Peninsula
	chewed as poultice for inflammation	Fiji
	crushed in camphor oil, applied to the face for head colds, neuralgia	Marquesas
	topical and consumed for various disorders	Sāmoa*
	heated and applied to abdomen for swelling, internal bleeding and liver disease	Malay Peninsula
	poultice for ulcers	Marquesas
	poultice for gout	Marquesas
Bark		
	topical and consumed for various disorders	Sāmoa*
	astringent for malaria	Philippines
Root		
	infusion consumed for hypertension	Cambodia

* Dittmar 1993.

lives, unexposed to the infectious diseases that had already become part of the European epidemiologic landscape, and relatively free of diabetes, heart disease, and other chronic disorders. While medical specialists (*kāhuna lā'au lapa'au*) and their pharmacopoeia (*lā'au*) had successfully treated many illnesses prior to western contact, Hawaiians lacked prior exposure, and were thus immunologically naive, to high-morbidity/mortality infections such as smallpox, measles, whooping cough, tuberculosis, and sexually transmitted diseases. As a consequence, European contact contributed to a decline in the health of Hawaiians and a precipitous decrease in population size (Bushnell 1993:59; Crosby 1994:122–124; Pietrusewsky and Douglas 1994: 193–194).

These new diseases were an incentive for creating new treatments. Medical missionaries did not arrive in Hawai'i until 1820, and even then were too few to treat the local population adequately. Further, Hawaiians were not ready to "convert" wholesale to biomedicine. As a result, the range of Hawaiian medicinal treatments expanded: existing therapeutic practices endured, and were augmented by modification and the development of new preventive and therapeutic strategies (Kamakau 1991:98).

Old Hawaiian Uses of Noni: Bruises, Sprains, Other External Injuries

Because so little of Hawaiian medicine was recorded in writing, in many cases it is not clear whether a medicine or its application is authentically "traditional." This is compounded by the uncertainty that missionaries and other observers recorded correctly and that much of the literature on Polynesian ethnomedicine generally is uncritical (Etkin and Meilleur 1993). Much of our knowledge of early Hawaiian medicine is based on a two-year investigation conducted in 1838–1839 by a physician and two native Hawaiians who assessed whether traditional Hawaiian therapeutics could be used along with biomedicine. They considered the new epidemic infections that became so problematic following European contact, as well as less grave illnesses (Chun 1986). Thirty years later (1867) a number of Hawaiian medicinal treatments were recorded during interviews conducted with 21 *kāhuna* who gathered to address health concerns during the smallpox epidemic, and to discuss how to care for those affected by new and old diseases (Chun 1994a).

Traditionally, Hawaiians used medicinal noni primarily topically, not internally, and considered the plant to have cleansing properties—of the blood, intestines, and other body systems. Two representative medicines that include noni are: (1) a compound topical for sprains and swollen limbs—noni fruit is macerated with *'awapuhi kuahiwi* (shampoo ginger, *Zingiber zerumbet* Sm.) rhizome, *'awa* (kava, *Piper methysticum* Forster f.) root, and *'ilie'e* leaf (plumbago, *Plumbago zeylanica* L.); (2) for deep, open wounds on the sole of the foot or the chest, mashed *mau'u waikoloa* (unidentified herb) was applied to the area, then covered with noni leaves (Chun 1994b:180).

According to Handy, Pukui, and Livermore (1934:18–19), noni was still being used in topical medicines almost 100 years later. Interviews conducted on Kaua'i, Hawai'i, Ni'ihau, O'ahu, Moloka'i, and Maui in 1930–1931 revealed that noni fruit, leaves, bark, and seeds were applied topically for injuries and illnesses. For example, a mixture of mashed young fruit and salt was applied over bone fractures as a counterirritant; mashed green fruit was applied for concussion; sliced half-ripe fruit was applied to boils. Macerated seeds were applied to cuts. Noni leaves were applied for fever; crushed or singed leaves were applied to wounds, bruises, sores, and boils. A stem bark infusion was applied to cuts, and the root sap for skin eruptions.

Newspapers offer an interesting popular record of noni use over time and, together with recent anecdotal accounts confirm that some of the "Old Hawaiian" treatments endure. In addition, the number and variety of internal indications for noni gradually increased in the first half of the twentieth century. A 1930 issue of the *Honolulu Star Bulletin* noted a "favorite tonic" and appetite stimulant made of noni crushed with *'ihi* (probably yellow wood sorrel, *Oxalis corniculata* L.), strained, and combined with the juice of *kō manulele* (sugar cane, *Saccharum officinarum* L.) (Pope 1930:2). A 1938 report in the same newspaper credits a mixture of noni and salt with the successful healing of a thumb from which the first joint had been severed (Wise 1938). Similarly, the *Bulletin of the Pacific Tropical Botanical Garden* recorded the treatment of a sprained elbow with a poultice of macerated green fruit, and the resolution of furuncles and carbuncles with a poultice of macerated ripe noni fruit (Stewart 1972:38–39).

Noni's reputation as a powerful "cleanser" was reinforced by its use in medicines that effect purgation. Three typical preparations, probably corresponding to the 1930s, are listed here:

> Crushed ripe noni fruit, young *kalo* (taro, *Colocasia esculenta* Schott) leaves, *pohe* (marsh pennywort, *Hydrocotyle verticillata* Thunb.), and *kāmanomano* (*Cenchrus agrimonioides* Trin.) leaves, mixed with *kō manulele* (sugar cane) juice (Chun 1994a:228–229)

> Ripe noni fruit macerated and strained with *koali* (*Ipomoea* spp.) tap roots, *'ilima* (*Sida fallax* Walp.) tap roots and bark, *puakala* (prickly poppy, *Argemone glauca* (Nutt. ex Prain) Pope) leaf bud, *kō manulele* (sugar cane) juice, cooked egg yolk, and starch (Handy, Pukui, and Livermore 1934:22)

> Inner bark of *hau* (*Hibiscus tiliaceus* L.) infused and drunk, followed by an enema concocted of crushed ripe noni fruit (Chun 1994b:40)

Similarly, noni was included in medicines for blood "purification," for example:

> macerated noni fruit combined with cooked *niu* (coconut, *Cocos nucifera* L.) and *kō manulele* (sugar cane), which was combined with water and drunk (Chun 1994b:5). In another blood cleanser, ripe noni fruit was combined with *lumaha'i* (unidentified)

bark, *ahakea* (*Bobea* spp.) bark, *'ōlena lelo* (turmeric, *Curcuma longa* L.) rhizome, *hapu'u* (*Cibotium splendens* Krajina ex. Skottsb.) pith, *kī* (ti, *Cordyline fruticosa* A. Chev.) stem, *koali pehu* (*Ipomoea alba* L.), *ko'oko'olau* (*Bidens* spp.) flower buds and leaves, *kō honua'ula* (sugar cane) stem, *moa holokula* (*Psilotum nudum* P. Beauv.), and *koa* (*Acacia koa* A. Gray) bark; this mixture was decocted, strained, and drunk. (Chun 1994b:198–199)

Other internal applications for noni that were in evidence by the 1930s include: intestinal worms (Kaikainahaole 1971; Morton 1992); hemorrhage and obstetrical/gynecological disorders (Chun 1994a:174; 1994b:55–56; Handy, Pukui, and Livermore 1934:18); sexually transmitted diseases (Chun 1994b:27); weakness and respiratory disorders (Chun 1994b:33, 36). By mid-century noni was included in a widely popular tuberculosis medicine: noni fruit macerated with *uhaloa* (*Waltheria americana* L.), *'ōhi'a lehua* (*Metrosideros polymorpha* Gaud.), *kō manulele* (sugar cane), and *niu* (coconut) meat—the mixture was strained and drunk (Stewart 1972:38–39). Noni was included in other tuberculosis medicines as well (Degener 1945:286), as Hawaiian experience and medical knowledge adjusted to a shifting epidemiology, which included dramatic increases in morbidity and mortality from tuberculosis.

By the 1970s, these applications still were still in use, although the ingredients with which noni was compounded and the modes of preparation were different. Some recent and contemporary users of noni consider all applications to be drawn directly from traditional Hawaiian medicine, whereas others describe how the novel application was learned (e.g., Kaikainahaole 1971).

Medicinal Noni in Contemporary Hawai'i

From Ferment to Capsule

At present the most popular "traditional" means of preparing noni in Hawai'i is fermentation: typically the fruit is sealed in a large glass jar, which is left out in the sun for hours, days, or weeks (Fig. 2). The "juice" that accumulates is consumed in variable quantity and on both traditional and other dosing schedules. For example, a traditional Hawaiian instruction might recommend collection of the plant at sunrise, observing rules that apply to left and right, and to take medicine for 5 days, rest 2 days, and resume for 5 days, etc. This mode of preparation may derive from, or at least is likely to have been influenced by, the Chinese since they traditionally prepare fermented foods and medicines in this manner (e.g., Simoons 1991:374): the Chinese are one of the more prominent ethnic influences on local culture, having comprised a significant proportion of Hawaii's population since the mid-1800s. The fermented liquid contains methyl and ethyl alcohols and may lose much of the objectionable odor and taste of the fresh fruit. This "juice" is variably viscous, and ranges in color from yellow/gold to black, perhaps reflecting different preparation/storage: variable fruit age, exposure of jar contents to air and sunlight, character of fermenting vessel, additives, refrigeration, and duration of fermentation.

Fig. 2. Noni fruit, fresh (right) and fermenting in a glass jar.

Because the popularity of fermented noni is a relatively recent phenomenon, most of the information about it is anecdotal. The earliest published account of noni fermentation was based on interviews conducted in 1930–1931 and noted that "the juice of the ripe fruit boiled is used as a remedy for diabetes, and fermented, as a tonic for heart trouble and 'high blood pressure'" (Handy, Pukui, and Livermore 1934:18–19). A Honolulu resident recalled that during the late 1940s she collected noni for her mother, who fermented the ripe fruit in a crock, strained and boiled the "juice," refrigerated it, and drank "a small glassful before meals. . .for her diabetes" (Kaikainahaole 1968:37). Other variations

include fermenting in burlap, later plastic, bags (Naone, personal communication)[1]; flavoring the noni "juice" to mask its taste; and, very recently, using commercial products confected as capsules, tablets, and beverages. The presence of fermenting vessels on countless *lānai* (porches) and rooftops across neighborhoods islandwide is taken as an affirmation of noni's efficacy, at the same time that it evokes a sense of community—a key element in the success of complementary medicines.

Our study of complementary medicine use in Hawai'i documents that until the early 1990s, noni products fell within the domain of home production. The fruit could be harvested from residential yards and in the "wild," or purchased in Honolulu's Chinatown and local open-air markets. Starting in 1990–1991 the demand for noni escalated dramatically, with the result that (according to anecdotal accounts) trees in private yards were stripped of fruit overnight, presumably for sale at local markets. The height of the local noni "craze" was documented in a February 1992 newspaper article (Ten-Bruggencate 1992). Ethnobotanist Beatrice Krauss likened the popularity of noni to "the earlier aloe fad—at one time, everyone had to have aloe; now it's noni;" and demand was so high that often it was difficult to find the fruit (Shirkey 1996:B6).

Maui massage therapist Herbert Moniz asserts that in 1990 he dreamed of a way to dry noni fruit and encapsulate the powder and in 1992 introduced these capsules into the local market (Moniz 1998). But that same year, the State of Hawai'i Department of Health became concerned that so many people were using noni, and issued a news release cautioning that insofar as claims of efficacy in the treatment of kidney disorders, hypertension, etc. had not been substantiated for noni, its promotion was in violation of Food and Drug Administration regulations (FDA) (State of Hawai'i 1992). Fresh noni fruit, however, was not banned and remained popular for home fermentation. The expanding celebrity of fermented noni also concerned some local *kāhuna,* and prominent healer Papa Henry Auwae (1993) has been an outspoken critic of the wholesale use of noni since the fad took hold.

Our complementary medicines study recorded that in Honolulu's Chinatown, noni sold for as little as 99 cents per pound in September 1992; one month later vendors were selling the fruit for prices ranging from $2 to $3 per pound. Importantly, in a setting where prices are usually negotiable, the price of noni was fixed—a sure index of its popularity. By late 1992, markets in Chinatown were selling quart jars of noni juice that had been fermented on high shelves inside the market, then strained and refrigerated. Although the jars sold for $10.00–$15.00 each, the product was not actively advertised. At the same time, some herbalists in Chinatown, whose activities were less public than Moniz', also sold capsules containing noni. However, interviews with noni users revealed a great deal of suspicion about the herbalists' formulation: the capsules were rumored to be adulterated with noni leaves and other substances in order to maximize profit. At best, the efficacy of these capsules was regarded with suspicion; at worst, they were considered potentially harmful. The price of noni fruit stabilized at $3 per pound throughout 1993, although some vendors charged much higher prices (as much as $8 per pound [Shirkey 1996:B6]). In 1994 FDA guidelines were revised through passage of the Dietary Supplements Health and Education Act (DSHEA), which relaxed labeling regulations. This made it possible to advertise noni and other complements as "health foods" and "dietary supplements." Fresh noni still can be purchased in Chinatown, but only from a very few vendors, whose prices in the last year averaged only 49 cents per pound, a fraction of what noni cost during the early 1990s.

Noni's niche has continued to expand in contemporary Hawaiian medicine and into complementary medicine outside of Hawai'i. People in Hawai'i today direct their attention to diseases that biomedicine cannot cure, and in some cases cannot even manage effectively. Our research on complementary medicines in Hawai'i recorded cancers, high blood pressure, and diabetes as the most common indications for noni. It also is used by our study participants in more traditional therapeutic applications: topically for psoriasis, boils, and other skin disorders; as a decongestant for colds (Etkin et al. 1998). Beyond that, anecdotal accounts confirm there is a seemingly infinite catalogue of concerns for which

[1] Personal communication via telephone on 2 and 11 March 1998. Kapiioho Lyons Naone is a practitioner of Hawaiian medicine and educator.

people use noni, ranging among cramps, dry skin, and drug addictions.

Bioscientific Investigations of Noni

Although bioscientific inquiry on noni began at least 50 years ago, the small number of studies is incommensurate with the great popularity of this plant. Some research has been motivated to test the efficacy of a "traditional Hawaiian medicine." Other, especially recent, studies are compelled by the commercial potential of noni among the rapidly growing number of "health foods" and "natural medicines."

Through the 1970s occasional reports noted in vivo antiascariasis activity for noni leaf (Kaleysa 1975); antidiabetic, hypotensive, anticoagulant, and antiseptic actions (Farine et al. 1996 and sources cited therein); in vitro histaminergic effects and smooth muscle-stimulant activities in guinea pig ileum (Mokkhasmit et al. 1971). None of these actions has been corroborated by recent studies using more rigorous laboratory protocols.

A report issued in the 1980s claimed to have identified a new alkaloid in noni, "xeronine" (Heinicke 1985), to which was attributed a wide range of therapeutic actions. Biochemists familiar with the research dismissed it almost immediately as methodologically flawed. Heinicke's findings have not been confirmed by other researchers, who continue to regard "xeronine" as suspect (M. Bennett, personal communication, 1998[2]). Nonetheless, many—especially in the commercial and public sectors—continue to refer to this singularly affirmative "proof" of the efficacy of noni when, in fact, it has not been corroborated. Heinicke continues to promote noni and has lent his approval to one commercial product, Tahitian Noni™ (discussed below).

The presence of high concentrations of anthraquinones in noni has been well-established by laboratory analysis (e.g., Bassetti and Tramper 1995; Hagendoorn, Jamar, and van der Plas 1997). These powerful purgatives very likely accomplish the "cleansing" action sought in some traditional Hawaiian treatments. The traditional Hawaiian and contemporary topical applications of noni also are supported by recent studies that confirm weak antimicrobial activity against *Candida albicans, Cryptococcus neoformans,* and *Tricophyton rubrum*[3]; other antiseptic and antimicrobial effects (Farine et al. 1996); very high vitamin A content (Aalbersberg et al. 1993). High titers of the fatty acid octanoic acid account for insecticide activity in the fruit pulp (Farine et al. 1996; Legal, Chappe, and Jallon 1994) and support traditional Hawaiian uses of noni fruit as an insecticidal shampoo for people and dogs (Degener 1945; Naone 1998).

A recent biochemical characterization of noni partly confirms earlier analyses (e.g., Leistner 1975) and catalogues 20 acids (including linoleic, oleic, palmitic, acetic); 7 alcohols, including eugenol; 11 esters; 2 ketones; 2 lactones; and 9 miscellaneous compounds (Farine et al. 1996). Other reports note sedative and analgesic effects (Younos et al. 1990:431) and immunoregulatory action (thymocyte, T-cell, and macrophage stimulation) in mice (Hiramatsu et al. 1993; Hirazumi et al. 1996). But these recent studies have not been confirmed; and none of the constituents has been linked to a specific therapeutic or preventive pharmacologic action. In fact, an extensive literature review (assisted by NAPRALERT, AGIS, and Dr. Duke search engines) yielded many studies that failed to find antmicrobial, spermicidal, anti-inflammatory, antispasmodic, analgesic, anticonvulsant, diuretic, hypoglycemic, hypotensive, uterine-stimulant, antifertility, or antitumor activities.

In summary, then, scientific evidence does not support a role for noni in the prevention or therapy of diabetes, cardiovascular diseases, and the myriad other conditions for which it is used today. It signifies that many of the disorders for which noni is used are chronic conditions from which patients do not fully "recover" or experience clear landmarks of improvement. Even when patients are monitored by "objective" standards—blood pressure, serum glucose, and cholesterol measures—and attribute their normalizing values to noni, one cannot establish with certainty that diet, activity patterns, and pharmaceuticals are not responsible as well, or instead.

The equivocal nature of these findings is not unique to noni but reflects instead how scientific

[2] Personal communication. 25 May 1998. Dr. Michael Bennett is a pharmacologist and practicing clinical pharmacist.

[3] Etkin, N.L. Summary, 1993, of bioassays of *Morinda citrifolia* crude extracts. Laboratory studies directed by Steven King, Shaman Pharmaceuticals. San Francisco, CA.

knowledge is created and evolves. Most germane for the present discussion is that it underscores that phytochemical and pharmacologic knowledge of noni is emergent (as was knowledge of aloe, garlic, ginseng and lemongrass 10–20 years ago). It also signifies that, whatever efficacy this growing corpus of research may ultimately reveal for noni, it will have been established only after the enormous popularity of this plant evolved—in all its myriad applications. In other words, the case of noni is unique because this plant became extremely popular before sufficient evidence had accumulated to establish its efficacy according to biomedical criteria; the popularity of the other plants discussed in this paper developed gradually, more or less in pace with research that establishes the bioscientific efficacy of these botanicals.

Why Is Noni So Popular?

Noni in the Marketplace

In view of the absence of pharmacologic and clinical evidence of noni's efficacy, what accounts for its great popularity? Is its cultural salience potent enough to explain the phenomenon? We think not, and argue that noni's traditional role in Polynesian therapeutics is a contributing, but not sufficient, condition. A more compelling explanation for its current success rests in the convergence of several factors, all of which are mediated by powerful commercial input.

The production and use of noni at the household level continues in Hawai'i today, but starting in 1995 noni made a formal move to commercialization when Herbert Moniz introduced his new product, Maui Noni. Since 1992, when his original product was banned by the FDA, Moniz had persisted in his quest to market noni. In 1995 he finally obtained a patent for his drying process (No. 5,288,491), and noni was placed on the FDA Generally Recognized as Safe products list. As noted above, commercialization was facilitated as well by passage of the DSHEA in 1994.

The transformation of noni from a home-based, traditional medicine to a burgeoning commercial concern is reflected in the recent proliferation of companies that sell noni products and of third-party literature on the plant (which does not endorse a single product, but can be displayed and sold in health food stores for "educational purposes"). While some of this is primarily informational summary of research findings (Elkins 1997), other "tracts"consist of claims that can only be described as unusual in their use of hyperbole (e.g., Fairechild 1998). Since 1995, the number of companies manufacturing and/or distributing noni products has grown exponentially. In the last two years alone, at least eight companies have begun to market an array of noni-based capsules, drink powders, liquids, and lotions (Table 3). The majority of these companies are network marketers, also known as multilevel marketing firms (MLMs), which rely on independent distributors to sell their products. Three companies are based in Hawai'i (Maui Noni, Hawaiian Herbal Blessings,™ and Rabbi Moshe); the others are based on the U.S. Mainland.

Preparation and Constituents of Commercial Noni

The lack of standardization in preparation and the wide range of uses that characterized noni before commercialization continue to define commercial noni products (Table 4), perhaps in part because new products need to claim unique qualities for market success. This wide range of preparations and ingredients makes pharmacologic assessment and comparison among products difficult, and underscores our contention that the popularity of noni is advertising-driven and reflects appeal to a more diverse pool of consumers. For example, some commercial noni products have been modified to make them more palatable, while others include noni root, leaves, and other natural products. The growing number of encapsulated noni products illustrates the advantage of products that have a long shelf life, are easily transported and stored, and lack the repugnant taste and odor of noni.

In the liquid and powdered beverage products the percentage of noni juice ranges from 10%–96% (according to product literature). Some of the noni juice products are pasteurized, others are not, the issue hinging on the belief that heat destroys enzymes and other chemicals ("proxeronine" and "xeronine") that are purportedly the active ingredients of noni. Even with pasteurization, noni juice products present production, storage, and shipping problems that the capsules do not have. Many of these companies seem to hedge their bets by offering both capsules and liquid noni products. The "outlier"

TABLE 3. COMPANIES THAT SELL NONI AND THEIR PRODUCTS.

Company	Co. type*	Product	Form	Size	Price	On MKT
Body Systems Tech. Casselberry, FL	MLM	Polynesian Noni™	juice	32 oz.	$28.50	1997
Cell Tech Klamath Falls, OR	MLM	Alpha Gold® (#125)	capsules (500 mg.)	120 ct.	$45.00	1997
		Alpha Gold® (#255)	capsules (500 mg.)	120 ct.	$38.00	1997
Enrich™ International Orem, UT	MLM	Hawaiian Noni	capsules	—	—	1996
		Hawaiian Noni	drink powder	21 oz.	$42.95	1997
Hawaiian Herbal Blessings™ Haiku, Maui, HI	direct	Hawaiian Noni Juice	juice	12 oz.	$25.00	ca. 1996
		Noni Pulp	fruit pulp	4 oz.	$15.00	ca. 1996
		Noni Leaf Extract	tincture	1 oz.	$13.00	ca. 1996
		Maui Organic Gingerade	concentrated extract	2 oz.	$12.00	ca. 1996
		Noni Ginger Throat Spray	concentrated extract	1 oz.	$10.00	ca. 1996
Innovative Health, Inc. Provo, UT	direct	New Innovations	softgel (? mg.)	—	—	—
		bulk product	powder (for capsules)	—	—	—
		bulk product	liquid	—	—	—
LAMETCO© Castle Rock, CO	MLM	Hawaiian Noni©	capsules (375 mg.)	60 ct.	$35.00	1998
Maui Noni Maui, HI	direct	Maui Noni	capsules (620 mg.)	60 ct.	$21.00	1992, 1995
Morinda™, Inc. Provo, UT	MLM	Tahitian Noni™	juice	32 oz.	$40.00	1997
		Noni Hoa I	drink powder	—	$35.00	1998
		Noni Hoa II	drink powder	—	$35.00	1998
		Tahitian Noni™ supplement	skin emollient	6 fl. oz.	$25.00	1998
Nature's Sunshine Provo UT and Spanish Fork, UT	MLM	Liquid Morinda	juice	2/32 oz	$80.00	1997
		Morinda capsules	capsules	100 ct.	$24.00	1997
Rabbi Moshe's Kīlauea, Kaua'i, HI	direct	Wild Hawaiian Noni	"fruit leather"	2 oz.	$40.00	1997

* MLM = multilevel marketing firm; direct = direct sales and/or supplier.

company, Rabbi Moshe, is a small cottage industry on Kaua'i that produces dried, sliced ripe noni fruit. The primary selling point of this product is that it is "kosher and *kahuna* blessed." Morinda™ also offers a kosher version of its Tahitian Noni™ juice.

Hawaiian Herbal Blessings™ products deserve special mention here. Maui organic farmer David Marcus developed this line of noni products after training with *kahuna lā'au lapa'au* Kalua Kaiahua. His Hawaiian Noni Juice and Noni Pulp are similar to products that Kaiahua uses in his own practice. The juice is a concentrate that is mixed with water and drunk one to three times a day on an empty stomach. Marcus incorporates traditional Hawaiian dosing prescriptions in his products—e.g., take noni juice for five days, rest for two, repeat the cycle. Similarly, Noni Pulp can be used topically, as in traditional Hawaiian medicine, or taken internally. Marcus' other products are less traditional, ". . .inspired by Ancient Hawaiian, Chinese and Indian herbal traditions, combined with the best of New England folk medicine" (Hawaiian Herbal Blessings 1998). Hawaiian Blessings™ products, like those of local manufacturers Maui

TABLE 4. INGREDIENTS IN NONI PRODUCTS.

Company	Product	Form	Ingredients (from product literature)
Body Systems Tech.	Polynesian Noni™	juice	97% noni juice from fruit with tropical flavor
Cell Tech	Alpha Gold (#125)	capsules (500 mg.)	blue-green algae with bee pollen, noni, turmeric, wheat grass juice, green tea powder, Siberian ginseng, ginkgo
	Alpha Gold (#255)	capsules (500 mg.)	identical to #125 but without ginseng and ginkgo
Enrich™ International	Hawaiian Noni	capsules	—
	Hawaiian Noni	drink powder	Hawaiian and Indian noni with aloe vera and papaya
Hawaiian Herbal Blessings™	Hawaiian Noni Juice	juice	100% aged and fermented noni juice
	Maui Organic Gingerade	concentrated extract	apple cider vinegar, *'awapuhi pākē, 'ōlena,* noni, Hawaiian honey
	Noni Ginger	concentrated extract	same as Maui Organic Gingerade, but with more noni
	Throat Spray		
	Noni Pulp	fruit pulp	100% aged and fermented noni fruit pulp
	Noni Leaf-Extract	tincture	High potency alcohol tincture of leaf: 23% alcohol, 5% vegetable glycerine
Innovative Health, Inc.	New Innovations	softgel	—
	bulk product	powder (for capsules)	—
Innovative Health, Inc.	bulk product	liquid	—
LAMETCO©	Hawaiian Noni©	capsules (375 mg.)	freeze-dried whole noni fruit
Maui Noni	Maui Noni	capsules (620 mg.)	dried noni fruit minus seeds
Morinda™, Inc.	Tahitian Noni	juice	90% noni fruit juice, 10% grape juice with blueberry juice; pasteurized
	Noni Hoa I	drink powder	13 vitamins and 16 chelated minerals, 80 trace minerals, and flavoring
	Noni Hoa II	drink powder	citrus bio-flavonoid complex; antioxidant fruit, amino acid, whole food, plant enzyme, and food source cell pigment blends; carotenoids in a base of vegetable and grain solids
	Tahitian noni skin supplement	emollient	noni juice with noni fruit pulp and noni seed oils
Nature's Sunshine	Liquid Morinda juice		noni fruit juice and other natural flavors
	Morinda capsules	capsules	dehydrated fruit, leaf and root of *M. citrifolia* and root of *M. officinalis*
Rabbi Moshe's	Wild Hawaiian Noni	"fruit leather"	ripe noni fruit, dried

Noni and Rabbi Moshe, are direct sales items and are not as widely distributed as products of the large MLM firms.

Health Claims

As noted earlier, the DSHEA that was passed in 1994 created a new class of products called dietary supplements, which can be advertised to afford "nutritional support" or to provide "structure and function" utility. That is, if the statements are supported by documented evidence, such as scientific tests, it is acceptable to state that, for example, the product "supports urinary tract health," or "improves well-being." The DSHEA specifies that

> . . .claims may not be made about the use of a dietary supplement to diagnose, prevent, mitigate, treat, or cure a specific disease [unless approved under the new drug provisions of the FD&C (Food, Drug and Cosmetic) Act]. For example, a product may not carry the claim "cures cancer" or "treats arthritis." Appropriate health claims authorized by FDA—such as . . . linking folic acid and reduced risk of neural tube birth defects and . . . that calcium may reduce the risk of osteoporosis—may be made in supplement labeling if the product qualifies to bear the claim. (Grimes and Reese 1998)

Whatever uniformity exists in noni product literature is attributable to DSHEA regulations, in accordance with which manufacturers cite whatever pharmacologic and ethnobotanical literature exists for noni. Almost all companies refer to Heinicke's claims that "xeronine" can regenerate cells, despite that his claims have not been corroborated (see above). Most also cite the evidence of Hirazumi et al. (1996) for anti-tumor activity in noni; some reference Hiramatsu et al. (1993) and Younos et al. (1990), who reported analgesic, dermatologic, and anti-cancer effects. Commercial literature usually includes disclaimers taken verbatim from DSHEA regulations, for example

> [this information] is not intended for medical or nutritional claims, but for informational and educational purposes. Please consult a health professional for medical advice. These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure or prevent any disease. (Supreme Health 1998)

But the DSHEA has no control over some of the more colorful health claims made by these companies, most of which are vague, evoke "what Polynesians have traditionally done," or are based on personal testimonials. Ethnobotanical sources such as Abbott and Shimazu (1985), Chun (1994b) and Dittmar (1993) serve as templates for claims that appeal to noni's status as a traditional medicine, interspersed with the language of DSHEA. For example,

> Noni Juice has been used for centuries by native Samoan, Hawaiian, Tahitian and South Seas Islanders to maintain optimal health. Noni's active ingredients Xeronine and Proxeronine are thought to be responsible for real healing for almost anything that afflicts you, and brings you a feeling of well being. . . The Noni Juice has been used to treat chest, eye, skin, mouth and throat infections, also diabetes, high blood pressure, headaches, arthritis, problems with digestion and given as a health tonic to treat the general effects of aging. Used for centuries as the universal health elixir, Polynesian Noni™ Juice tastes great! (Body Systems Technology 1998)

Product names and advertising capitalize on the "traditional," "natural," and "pure" aspects of noni—to wit, "Polynesian," "Tahitian," "Maui," and "Hawaiian" noni. Polynesian Noni™ is collected by "Native Samoan people. . .in the old-fashioned way, unhurried, and with strict attention to detail" (Body Systems Technology 1998). Or,

> Thousands of years ago, people living on the islands of present-day French Polynesia discovered the powerful health-supporting properties of a fruit that grows in abundance in the region—the Tahitian Noni™ fruit. These people began using Noni in all of their preparations, making it the health foundation of their civilization. (Morinda 1998)

Drawing on traditional therapeutic paradigms, both local and non-local marketers emphasize noni's strong smell and taste. The locally-produced noni products, which appeal to people who are more familiar with *lā'au lapa'au,* are largely not flavored and in one case (Hawaiian Blessings™) are accompanied by traditional dosing instructions. In contrast, non-local noni products are often sweetened and otherwise flavored: by ceding to what compels the larger pool of potential users, manufacturers mask the very qualities that mark noni's importance for its original users.

Conclusion

The celebrity of noni is out of proportion to the facts. One factor that lends cachet to its ther-

TABLE 5. HEALTH CLAIMS FOR NONI PRODUCTS.

Company	Product	Form	Health claims (abbreviated)**
Body Systems Tech.	Polynesian Noni™	juice	cell regeneration, arthritis, headaches, fever, indigestion, inflammatory disorders, respiratory problems, immune system strengthener, anti-aging, diabetes, diarrhea, intestinal parasites, ulcers, chest infections, cough, tuberculosis, asthma, menstrual cramps, regulation of menstrual cycle, childbirth, pregnancy, sore gums, sore throat with cough, thrush, gingivitis, toothache, abscess, boils, abrasions, blemishes, wounds, infections, internal disorders, high blood pressure, kidney problems, bladder problems
Cell Tech	Alpha Gold (#125)	capsules	. . . the ingredients . . . work synergistically with the algae for physical well-being and mental clarity; noni fruit for cardiovascular health, blood purifier, blood cleanser (antibacterial), immune system stimulant, strengthens and revitalizes cells, prevents activation of the Epstein-Barr virus
	Alpha Gold (#255)	capsules	same as above
Enrich™ International	Hawaiian Noni	capsules	—
	Hawaiian Noni	drink powder	help(s) support the body's respiratory, immune, digestive, and structural systems; weight loss and cleansing
Hawaiian Herbal Blessings™	Hawaiian Noni Juice	juice	unusual healing power; cellular repair
	Maui Organic Gingerade	conc. extract	—
Hawaiian Herbal Blessings™ (cont'd)	Noni Ginger Throat Spray	conc. extract	—
	Noni Pulp	fruit pulp	skin-related problems
	Noni Leaf-Extract	tincture	Bio-protectant and restorative
Innovative Health, Inc.	New Innovations	softgel	diabetes, arthritis, skin disorders, intestinal parasites and asthma
	bulk product	powder	—
	bulk product	liquid	—
LAMETCO©	Hawaiian Noni©	capsules	joint pain, immune problems, pain relief, and cellular regeneration
Maui Noni	Maui Noni	capsules	high blood pressure, menstrual cramps, arthritis, gastric ulcers, sprains, injuries, mental depression, senility, poor digestion, arteriosclerosis, blood vessel problems, drug addiction, pain, breast cancer, and eye problems
Morinda™, Inc.	Tahitian Noni	juice	cell regeneration, anticancer; Company does not make explicit claims, but relies on personal testimonials
Morinda™, Inc.	Noni Hoa I	drink powder	accelerates the production of xeronine in the body; vitamin drink

TABLE 5. CONTINUED.

Company	Product	Form	Health claims (abbreviated)**
Morinda™, Inc.	Noni Hoa II	drink powder	accelerates the production of xeronine in the body; nutrition supplement drink
Morinda™, Inc.	Tahitian Noni Skin Supplement	emollient	humectant, emollient, anti-aging
Nature's Sunshine	Liquid Morinda	juice	digestive, immune, intestinal and respiratory disorders, painful joints, skin disorders, well-being, high blood pressure, menstrual cramps, arthritis, gastric ulcers, injuries, mental depression, poor digestion, arteriosclerosis, blood vessel problems, general aches and pains
	Morinda capsules	capsules	same as above
Rabbi Moshe's	Wild Hawaiian Noni	"fruit leather"	high blood pressure, immune problems, nervous system, cancer, anti-bacterial, anti-fungal, anti-parasite, migraine, lupus, AIDS, anti-depressant, anti-senility, diabetes

** Abbreviated information is taken from corporate websites and other commercial literature; this is to avoid inclusion of multilevel marketing company distributors' own personal opinions or commentary, which may not be endorsed by the parent company. The original wording, which is omitted here to conserve space, reflects companies' compliance with FDA regulations.

Body systems Technologies: http://www.bodysystemsinc.com
Cell Tech: http://www.celltech.com
Enrich® International: http://www.enrich.com
Hawaiian Herbal Blessings: http://www.hawaiian-noniworks.com
Innovative Health, Inc.: http://www.innhealth.com
LAMETCO©: http://www.lametcointl.com
Maui Noni: http://www.energyforlife.com
Morinda™, Inc.: http://www.morinda.com
Nature's Sunshine: http://www.nsponline.com
Rabbi Moshe's: http://www.hawaiian.net/~noni

apeutic merits is its reputation in traditional Hawaiian and other Polynesian pharmacopoeias. The repulsive taste and smell of both fresh and fermented noni are consistent with formal and lay paradigms through which various ethnic groups in contemporary Hawai'i apprehend those qualities as signs of special medicinal import, especially metaphors of power and cleansing. As we illustrated above, this cultural appeal continues to figure large in the commercial promotion of noni.

A second element that contributes to noni's popularity is the chronic nature of the illnesses that it purportedly benefits. Subjective and objective measures of symptom diminution in serum cholesterol, cardiac function, blood pressure, and the like cannot identify the actions of noni independent of other elements that are likely to foster improvement—exercise, pharmaceuticals, diet, etc.

One might anticipate that people have more confidence in medicines that have been well defined with respect to phytoconstituents and pharmacologic action; indeed, we have argued that such characterization helps to explain the use of other popular complements in contemporary Hawai'i: aloe, garlic, ginseng, and lemongrass. Paradoxically, rather than discouraging users, because of potential risk or otherwise, the absence of corroborated bioscientific information has actually encouraged great latitude in the use of noni. People attach equal probative weight to testimonial claims for noni's curative powers as they do to the limited pharmacological studies available to date. Further, product literature describes noni as a "food," due to the FDA's regulations concerning dietary supplements, further dissociating it from its pharmacological properties and thus implying that it is sufficient (even better) to be "nutritive" and "natural" than to be pharmacologically sanctioned.

In summary, we argue that a suite of factors

cohere to explain the popularity of noni: its link to Polynesian therapeutic traditions; the chronic nature of most illnesses for which individuals use noni; the equivocal/emergent nature of pharmaco-clinical information on noni that prevents one from knowing with certainty what its actions are and are not; and, finally, the success with which the industry has appropriated traditional therapeutic metaphors and capitalized on the ambiguity of both the DSHEA and scientific knowledge of noni.

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LITERATURE CITED

Aalbersberg, W. G. L., S. Hussein, S. Sotheeswaran, and S. Parkinson. 1993. Carotenoids in the leaves of *Morinda citrifolia*. Journal of Herbs, Spices, and Medicinal Plants 2:51–54.

Abbott, I. 1992. Lā'au Hawai'i: traditional Hawaiian uses of plants. Bishop Museum Press, Honolulu.

———, **and C. Shimazu.** 1985. The geographic origin of the plants most commonly used for medicine by Hawaiians. Journal of Ethnopharmacology 14: 213–222.

AGIS Phytochemical Database. 1998. U.S. National Agricultural Library Phytochemical Database. Website. URL:http://probe.nalusda.gov.8300/cgi-bin/browse/phytochemicals.

Asthana, A., R. A. Larson, K. A. Marley, and R. W. Tuveson. 1992. Mechanism of citral phototoxicity. Phytochemistry and Photobiology 56:211–222.

Auwae, H. 1993. Traditional Hawaiian medicines for HIV/AIDS. A talk presented to the Big Island AIDS Coalition. Hilo, Hawai'i. 17 March.

Bassetti, L., and J. Tramper. 1995. Use of nonconventional media in *Morinda citrifolia* cell cultures. Plant Cell, Tissue and Organ Culture 43:93–95.

Body Systems Technology. 1998. Website. URL:http://toronto.planeteer.com/~horizon/rnon.htm.

Bushnell, O. 1993. The gifts of civilization: germs and genocide in Hawaii. University of Hawaii Press, Honolulu.

———, **M. Fukuda, and T. Makinodan.** 1950. The antibacterial properties of some plants found in Hawaii. Pacific Science 4:167–183.

Cellini, L., E. di Campli, M. Masulli, S. di Bartolomeo, and N. Allocati. 1996. Inhibition of *Helicobacter pylori* by garlic extract (*Allium sativum*). FEMS Immunology and Medical Microbiology 13: 273–277.

Chithra, P., G. B. Sajithlal, and G. Chandrakasan. 1998. Influence of *Aloe vera* on the healing of dermal wounds in diabetic rats. Journal of Ethnopharmacology 59:195–201.

Chun, M. N., trans. 1986. Hawaiian medicine book: He Buke Laau Lapaau. Bess Press, Honolulu.

———, **ed. and trans.** 1994a. Must we wait in despair: the 1867 report of the 'Ahahui La'au Lapa'au of Wailuku, Maui on native Hawaiian health. First People's Productions, Honolulu.

———, **ed. and trans.** 1994b. Native Hawaiian medicine. First People's Productions, Honolulu.

Crosby, A. W. 1994. Germs, seeds and animals: studies in ecological history. M.E. Sharpe, Armonk, NY.

Degener, O. 1945. Plants of Hawaii National Park illustrative of plants and customs of the South Seas. Edwards Brothers, Ann Arbor, MI.

Dittmar, A. 1993. *Morinda citrifolia* L.—use in indigenous Samoan medicine. Journal of Herbs, Spices and Medicinal Plants 1(3):77–92.

Dixon, A. R., N. L. Etkin, and P. W. Nishimoto. 1995. Preliminary findings on the current use of complementary medicine among Hawaii's residents. Invited Plenary Address presented at the *E Ola Mau* Symposium "Health and Healing: Ancient Traditions in a Modern World." Wai'anae, Hawai'i. 31 March–1 April.

Dr. Duke's Phytochemical and Ethnobotanical Databases. 1998. www.ars.grin.gov/duke/. Agricultural Research Service.

Elkins, R. 1997. Noni. Woodland Publishing, Pleasant Grove, UT.

Etkin, N. L., and B. A. Meilleur. 1993. Ethnomedicine in Polynesia: past trends and future directions. Journal de la Société des Oceanistes 96:19–27.

———, **A. R. Dixon, P. W. Nishimoto, and P. J. Ross.** n.d. Medicinal foods in multiethnic Hawaii. *In* A. Guerci, ed. Anthropology, nutrition and health. Erga Edizioni, Genova, Italy.

Fairechild, D. 1998. Noni—aspirin of the ancients. Flyana Rhyme, Anahola, HI.

Farine, J.-P., L. Legal, B. Moreteau, and J.-L. Le

Querre. 1996. Volatile components of ripe fruits of *Morinda citrifolia* and their effects on *Drosophila.* Phytochemistry 41:433–438.

Grimes, K. D., and S. M. Reese. 1998. The MLM Law Website. URL:http://www.mlmlaw.com.

Hagendoorn, M.J.N., D.C.L. Jamar, and L.H.W. van der Plas. 1997. Cell division versus secondary metabolite production in *Morinda citrifolia* cell suspensions. Journal of Plant Physiology 150:325–330.

Handy, E. S., M. K. Pukui, and K. Livermore. 1934. Outline of Hawaiian physical therapeutics. Bishop Museum Press, Honolulu.

Hawaiian Herbal Blessings. 1998. Website. URL: http://www.hawaiian-noniworks.com.

Heinicke, R. M. 1985. The pharmacologically active ingredient of noni. Pacific Tropical Botanical Garden Bulletin 15:10–14.

Hiramatsu, T., M. Imoto, T. Koyano, and K. Umezawa. 1993. Induction of normal phenotypes in *ras*-transformed cells by damnacanthal from *Morinda citrifolia.* Cancer Letters 73:161–166.

Hirazumi, A., E. Furusawa, S. C. Chou, and Y. Hokama. 1996. Immunomodulation contributes to the anticancer activity of *Morinda citrifolia* (noni) fruit juice. Proceedings of the Western Pharmacological Society 39:7–9.

Johansson, J. T. 1994. The genus *Morinda* (Morindae, Rubiodeae, Rubiaceae) in New Caledonia: taxonomy and phylogeny. Opera Botanica 122:1–67.

Kaikainahaole, M. 1968. Hawaiian uses of herbs—past and present. Newsletter of the Hawaiian Botanical Society vii (5):31–38.

———. 1971. Is it lost? Graduate student paper for University of Hawaii, Honolulu.

Kaleysa, R. R. 1975. Screening of medicinal plants for anthelmintic action against human *Ascaris lumbricoides.* Part II. Indian Journal of Physiology and Pharmacology 19:47–49.

Kamakau, S. M. 1991. Ka Po'e Kahiko. Bishop Museum Press, Honolulu.

Khalid, Q., L. Sultana, Y. Ahmad, M. Sarwar, and Y. Ahmad. 1995. Beneficial effects of *Allium sativum* Linn. in experimental cholesterol artherosclerosis. Part II: curative effects. Pakistan Journal of Scientific and Industrial Research 38:11–16.

Khobragade, V. R., and C. R. Jangde. 1996. Anti-inflammatory activity of bulb of *Allium sativum* Linn. Indian Veterinary Journal 73:349–353.

Kim, J. K., M. R. Marshall, J. A. Cornell, J. F. Preston, and I. C. Wei. 1995. Antibacterial activity of carvacrol, citral, and geraniol against *Salmonella typhimurium* in culture medium and on fish cubes. Journal of Food Science 60:1364–1374.

Kumar, M., and J. S. Berwal. 1998. Sensitivity of food pathogens to garlic (*Allium sativum*). Journal of Applied Microbiology 84:213–215.

Lee, Y., E. Chung, K. Y. Lee, Y. H. Lee, B. Huh, and S. K. Lee. 1997. Ginsenoside-Rg1, one of the major active molecules from *Panax ginseng,* is a functional ligand of glucocorticoid receptor. Molecular and Cellular Endocrinology 133:135–140.

Legal, L., B. Chappe, and J. M. Jallon. 1994. Molecular basis of *Morinda citrifolia* (L.): toxicity on drosophila. Journal of Chemical Ecology 20:1931–1943.

Leistner, E. 1975. Isolation, identification, and biosynthesis of anthraquinones on cell suspension cultures of *Morinda citrifolia.* Planta Medica 27:214–224.

Lewis, W. H. 1986. Ginseng: a medical enigma. Pages 290–305 *in* N. L. Etkin, ed. Plants in indigenous medicine and diet: biobehavioral approaches. Gordon and Breach, New York.

Lewisohn, E., N. Dudai, T. Yaakov, I. Katzir, U. Ravid, E. Putiewsky, and D. M. Joel. 1998. Histochemical localization of citral accumulation in lemongrass leaves, *Cymbopogon citratus* (DC) Stapf., Poaceae. Annals of Botany 81:35–39.

Mokkhasmit, M., W. Ngarmwathana, K. Sawasdimongkol, and U. Permphiphat. 1971. Pharmacologic evaluation of Thai medicinal plants. Journal of the Medical Association of Thailand 547: 490–504.

Moniz, H. 1998. Maui Noni. Website. URL:http:// www.energyforlife.com/html/herbert.html.

Morinda. 1998. Website. URL:http/www.morinda.com.

Morton, J. 1992. The ocean-going noni, or Indian Mulberry (*Morinda citrifolia,* Rubiaceae) and some of its "colorful" relatives. Economic Botany 46(3): 241–256.

Newall, C. A., L. A. Anderson, and J. D. Phillipson. 1996. Herbal medicines: a guide for health-care professionals. Pharmaceutical Press, London.

Nok, A. J., S. Williams, and P. C. Onyenekwe. 1996. *Allium sativum*-induced death of African trypanosomes. Parasitology Research 82:634–637.

Park, H.-J., J.-H. Lee, Y.-B. Song, and K.-H. Park. 1996. Effects of dietary supplementation of lipophilic fraction from *Panax ginseng* on cGMP and cAMP in rat platelets and on blood coagulation. Biological and Pharmaceutical Bulletin 19:1434–1439.

Pietrusewsky, M., and M. Douglas. 1994. An osteological assessment of health and disease in precontact and historic (1778) Hawaii. Pages 179–196 *in* C. S. Larsen and G. Milner, eds. In the wake of contact: biological responses to conquest. Wiley, New York.

Pope, K. 1930. Native healing as found in Hawaii. Honolulu Star Bulletin 19 July:2.

Rice, P. J., and J. R. Coats. 1994. Insecticidal properties of several monoterpenoids to the house fly (Diptera: Muscidae), red flour beetle (Coleoptera: Tenebriomidae), and southern corn rootworm. Pesticide Science 41:195–199.

Rodov, V., S. Ben-Yehoshua, D. Q. Fant, J. J. Kim, and R. Ashkenazi. 1995. Preformed antifungal compounds of lemon fruit: citral and its relation to disease resistance. Journal of Agriculture and Food Chemistry 43:1057–1061.

Saks, Y., and R. Barkai-Golan. 1995. *Aloe vera* gel activity against plant pathogenic fungi. Postharvest Biology and Technology 6:159–165.

Shirkey, W. K. 1996. Smelly, fermented noni finding new adherents. Honolulu Advertiser 23 September: B6.

Simoons, F. J. 1991. Food in China. Boca Raton, FL: CRC Press.

State of Hawai'i. 1992. Hawai'i Poison Center Report. Honolulu: State Department of Health.

Stewart, M. 1972. Noni: The Lore of Hawaiian Medicinal Plants. Bulletin of the Pacific Tropical Botanical Garden 11(2):37–39.

Suaeyun, R., T. Kinouchi, H. Arimochi, U. Vinitketumnuen, and Y. Ohnishi. 1997. Inhibitory effects of lemon grass (*Cymbopogon citratus* Stapf) on formation of azoxymethane-induced DNA adducts and aberrant crypt foci in the rat colon. Carcinogenesis 18:949–955.

Supreme Health. 1998. Website. URL:http://www.supremehealth.com/noni_animals.html.

TenBruggencate, J. 1992. Native plants can heal your wounds. Honolulu Sunday Star-Bulletin and Advertiser 9 February.

———. 1998. Stinky noni proves to be useful plant. Honolulu Advertiser 6 April.

Vásquez, B., G. Avila, and B. Escalante. 1996. Anti-inflammatory activity of extracts from *Aloe vera* gel. Journal of Ethnopharmacology 55:69–75.

Vinitketkumnuen, U., R. Puatanachokchai, P. Kongtawelert, N. Lertprasertsuke, and T. Matsushima. 1994. Antimutagenicity of lemon grass (*Cymbopogon citratus* Stapf) to various known mutagens in salmonella mutation assay. Mutation Research 341:71–75.

Whistler, W. A. 1992. Polynesian Herbal Medicine. National Tropical Botanical Garden. Lawai, Kauai, Hawaii.

Wise, J. H. 1938. The medicine of the old Hawaiians. Honolulu Star Bulletin 22 January.

Yamaguchi, I., N. Mega, and H. Sanda. 1993. Components of the gel of *Aloe vera* (L.) Burm.f. Bioscience, Biotechnology, and Biochemistry 57: 1350–1352.

Younos, C., R. Allain, J. Fleurentin, M. Lanhers, R. Mislin, and F. Mortier. 1990. Analgesic and behavioural effects of *Morinda citrifolia.* Planta Medica 56:430–434.

Yun, T.-K. 1996. Experimental and epidemiological evidence of the cancer-preventive effects of *Panax ginseng* C.A. Meyer. Nutrition Reviews 54:S71–S81.

Book Review

***Pinus* (Pinaceae). Flora Neotropica Monograph 75.** Aljos Farjon and Brian T. Styles. 1998. New York Botanical Garden, 293 pp. (hardcover). $31.00, plus shipping. ISBN 0-89327-411-9.

The genus *Pinus,* with some 110 species, is thought to be almost exclusively a temperate, Northern Hemisphere, genus. However, over 50 species are found from northern Mexico to the Caribbean, and through Central America to Nicaragua, where the genus finds its southernmost geographical range.

Until the publication by Jesse Perry, Jr. of his *Pines of Mexico and Central America* (1991, Timber Press), regional botanists could only attempt taxonomic work based on Maximino Martinez' *Pinos de Mexico,* first published around 1945. Brian Styles' sudden demise in June 1993 almost obliterated the possibility of having this monograph, what he thought of as his *magnum opus,* were it not for his careful notes and excellent illustrations by Rosemary Wise which aided Aljos Farjon of Utrecht and himself an expert on conifers, to achieve the very difficult job of polishing, finishing and overseeing to publication someone else's work. Farjon has done an splendid job, and the result sets the standard nomenclature for the pines of this neotropical area.

The format of this publication is that of the series which is now appearing in hardcover. Whereas the user can think this an advantage for copies that will get frequently used, the monographs are not so easy for field work, nor is the binding strong enough (two of the last books from NYBG with same binding have come apart within days of office use). The book is a must for all botanical institutions and botanists interested in the pines, particularly those of the Mesoamerican-Caribbean area.

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