CHAPTER 12

MEDICINAL PLANTS IN TROPICAL HOMEGARDENS

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Keywords: Aromatic plants, Bioprospecting, Indigenous knowledge, Phytochemicals, Traditional medicine, Value addition.

Abstract. Nearly 80% of the people living in developing countries depend on medicinal plants (MPs) for primary healthcare, and homegardens are an important source of production of these plants. Homegardens can fulfill the dual role of production and *in situ* conservation of MPs to overcome their dwindling supplies and threat of extinction from natural sources. MPs in homegardens are either deliberately cultivated or they come up spontaneously. They are an important constituent of homegardens, next only to food crops and fruit trees; yet their economic value is not fully recognized, let alone exploited. Homegardens offer an economically and socially viable option for large-scale production of phytochemicals from important MPs under organic cultivation. Promoting organic production of selected commercially valuable species of MPs through homegardening can, thus, augment the farmers' income, enhance rural employment opportunities, and help reduce migration of rural youth to urban centers in search of jobs. Research is needed to improve the existing germplasm, introduce suitable commercial MPs in different agroecosystems, and develop cultivation and processing techniques to increase yield and improve product quality, and exploit indigenous knowledge and market opportunities.

1. INTRODUCTION

Humans depended on certain plants for healthcare since time immemorial. Centuries of experimentation on the use of plants or products derived from them has led to the development of indigenous systems of medicine that are still respected and used in many societies. Plants have been a source of medicines for humans and livestock and pesticides to protect crops from certain pests and diseases. In India, over 200 types of vegetable drugs were in use during the *Vedic* period (3700 – 2000 BC). *Charak Samhita* (600 BC) mentioned 1270 medicinal plants (MPs), while *Sushruta*

B.M. Kumar and P.K.R. Nair (eds.), Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry, 205–232.
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Samhita (450 BC) and Vagbhatta's *Astangahridaya* (342 BC) mention about 1100 and 1150 MPs, respectively (Chadha and Gupta, 1995). America, Arabia, China, Egypt, Greece, Mexico, and many other countries in Europe and Asia too recorded the use of MPs (Principe, 1991). Furthermore, about 1800 species of MPs are reported to be used in the traditional Indian medical system of *Ayurveda*, 750 species in *Unani* or *Tib*, 500 species in *Siddha*, 400 species in the Tibetan medicine and 5000 species in the Chinese medicine. Traditional medical systems in Japan, Korea (*Kampo* system), Indonesia (*Jamu* system), South Africa (*Julu* system), Bhutan (*Gso-ba-rig-pa*), Sri Lanka (*Deshiya Chikitsa*), and Malaysia (Malay herbal medicine) also recorded a number of MPs and their uses (Principe, 1991).

An estimated 14 to 28% of the 422 000 plants occurring on earth had been used by human cultures for medicinal purposes at one time or another (Farnsworth and Soejarto, 1991). Approximately 80% of the people in developing countries rely even today mainly on traditional medicines for humans (FAO, 1996) as well as domestic animals, a major portion of which are extracts of medicinal plants or their active principles. More than 6500 species of such medicinal plants have been identified in Asia, 1900 species in tropical America and 1300 species in north-west Amazon (Farnsworth and Soejarto, 1991). Global trade in plant-based drugs was estimated at US$ 100 billion, of which traditional medicines using medicinal plants accounted for 60 billion (WHO, 2004). In addition, trade[1] in herbal teas, drug adjuncts, dietary foods etc. (sold over the counter) was estimated at US$ 5 billion in 1997. India has approximately 150 000 practitioners of traditional systems of medicine, 10 000 licensed pharmacies manufacturing plant-based drugs. The trade in medicinal herbs in India was estimated at US$ 1 billion (EXIM Bank, 2003) and the country exports medicinal herbs worth US$ 287 million annually[2].

Most of the medicinal plants (70 to 90%) have traditionally been collected from forests and natural habitats. Indiscriminate extraction over years not only reduced their supplies but also endangered some of these valuable species. The growing demand for plant-derived drugs both in modern and traditional systems of medicine[3] further exacerbated the problem in many natural habitats. This has led to the extinction of about 75 species between 1600 and 1900 and a similar number in a short span between 1900 and 1970 (Principe, 1991; Rao, 1999). It is feared that if this trend continues, about 60 000 species will become extinct in the next century (Principe, 1991). Considering the economic importance of medicinal plants, there is an urgent need to systematically cultivate them to exploit their full potential and to save them from extinction. MPs can be cultivated like any other crop(s) in different systems including agroforestry – in forest plantations, homegardens, as intercrops between trees, and as components of multistrata systems (Rao et al., 2004). This chapter reviews the status of medicinal plants in tropical homegardens and examines the scope for improving their relative contribution to the economy of rural families.

2. MEDICINAL PLANTS IN HOMEGARDENS

Homegardens being one of the earliest forms of agroforestry practiced in the tropics (Kumar and Nair, 2004), it is only logical to be expected that MPs have been an essential component of these production systems (Tables 1 and 2). Indeed, the

homegardens make a substantial contribution to the supply of MPs, which may be traded or consumed locally by the family or community (Albuquerique and Andrade, 2002). There is, however, no reliable data on the extent of homegardens in different countries (see Nair and Kumar, 2006), yields of medicinal plants, or products extracted and sold at national and international levels. Majority of MPs in homegardens are herbs/vines/climbers and they together with vegetables and spices generally constitute the lower layer (0 – 1 m), unless they are vines and climbers. Additionally, a number of homegarden shrub and tree species also have medicinal value and they constitute the second (1 – 3 m) and upper (>10 m) layers respectively (Wezel and Bender, 2003). Some species that grow spontaneously in homegardens may possess medicinal value which may or may not be recognized and used. For example, in Chiriqui, Panama, the Ngöbe community utilizes the land fallowed for soil fertility replenishment as a source of MPs (Samaniego and Lok, 1998). Nearly half of the 41 weed species found in the homegardens of Central Sulawesi, Indonesia, possess medicinal value (Kehlenbeck and Maass, 2005). In India, seasonal weeds such as *Phyllanthus amarus*, *Boerhaavia diffusa*, *Achyranthus aspera*, *Tribulus terrestris*, *Sida cordifolia*, and *Aerva lanata* that occur both in cultivated fields (including homegardens) and wild are collected for medicinal purposes (Rao et al., 1999).

2.1. Relative importance of MPs in homegardens

While some components in the homegardens have exclusive medicinal value, others are multipurpose species combining medicinal value with food, ornamental, fiber, and spice values. For example, in the Kandyan homegardens of Sri Lanka, 30% of the total 125 species found were exclusively mentioned for medicinal uses and 12% combined medicinal with other uses. Among the medicinal species, trees constituted 7%, shrubs 5%, herbs 15%, and creepers 3% of the total species (Perera and Rajapakse, 1991). Homegardens in Bukoba district in northwestern Tanzania contained species that were said to be used exclusively for medicine (*Baphiopsis* spp., *Cyperus dives*, *Leonotis nepetifolia*, *Vernonia amygdalina*, and *Solanum incanum*), those that combined medicine and fuelwood (*Senecio multicorymbosa* tree for medicines to cattle), medicine, fruit, and fuelwood (*Psidium guajava* and *Citrus limon*), and propping poles and medicine (*Ricinus communis*; Rugalema et al., 1994). The Chagga homegardens on Mt. Kilimanjaro in Tanzania were dominated by woody components; nearly 50% of the 111 species found in the region were trees, of which 30% were mentioned as medicines for humans and livestock (O'Kting'ati et al., 1984). Of the 77 useful plants (shrubs, vines, and forbs) found across 80 traditional Mayan homegardens in Quitana Roo, Mexico, nine were reported to have exclusive medicinal value and 26 species combined medicine, food, spice, and ornamental values (De Clerck and Negreros-Castillo, 2000). About 70% of 301 species in the forest and homegardens in the Yucatan, Mexico were classified for medicinal purpose; however, only 16 species were exclusively used for medicine and the rest had multiple uses (Rico-Gray et al., 1991).

Table 1. *Spices, condiments, and aromatic plants possessing medicinal value grown in tropical homegardens.*

Species	*Family*	*Part(s) used*	*Uses (for treatment of diseases/other applications mentioned)*	*Where grown?*
Trees				
Cinnamomum zeylanicum (cinnamom)	Lauraceae	bark	diarrhea, gastric debility, flatulence, nausea, vomiting, herbal tea	Sri Lanka, Indonesia, Madagascar, Brazil, Seychelles
Citrus aurantifolia (lime)	Rutaceae	fruit	source of vitamin C, cataract, bleeding gum, herbal tea, smallpox	Many countries in tropics
Syzygium aromaticum (clove)	Myrtacae	flower buds	carminative, antispasmodic, galacto purifier, antibacterial, appetizer, rubifacient	Southeast Asia , Sri Lanka, Tanzania, Brazil
Myristica fragrans (nutmeg)	Myristicaceae	seeds, aril	dyspepsia, diarrhea, hepatopathy, impotency, insomnia, cardiac disorders	Southeast Asia, Sri Lanka, West Indies
Murraya koenigii (curry leaf)	Rutaceae	leaves	carminative, skin diseases, anorexia, dyspepsia, flatulence, hair tonic, stomach ache	India
Tamarindus indica (tamarind)	Caesalpiniaceae	root, leaves, fruit pulp, seed	jaundice, scabies, smallpox, alcoholic intoxication, carminative, refrigerant	South Asia, East, and West Africa
Shrubs/herbs/grasses				
Allium sativum (garlic)	Liliaceae	bulb	antiperiodic, antibacterial, diuretic, skin diseases	throughout tropics

Allium cepa (onion)	Liliaceae	bulb	pulmonary phthisis, whooping cough, colic dyspepsia, reduces cholesterol	South and Southeast Asia, Spain, Brazil, Egypt
Capsicum annuum	Solanaceae	fruits	gout, arthritis, dyspepsia, hoarseness, flatulence	throughout tropics
Cymbopogon flexuosus, C. citratus (lemongrass)	Poaceae	leaves	source of vitamin A, leprosy, epilepsy, mosquito repellent, herbal tea	Mexico, Brazil, China, Haiti, South and Southeast Asia, Africa
Coriandrum sativum (coriander)	Apiaceae	fruit, leaf	colic, laxative, blood purifier, indigestion, sour throat	South and Southeast Asia
Cuminum cyminum (cumin)	Apiaceae	seed	dyspepsia, flatulence, diarrhea, skin diseases	East Asia, India
Curcuma longa (*C. domestica*) (turmeric)	Zingiberaceae	rhizome	antiseptic, skin allergies, viral hepatitis, anti-bacterial, wounds, anti-inflammatory, soar throat	South, Southeast, and East Asia
Elettaria cardamomum (small cardamom)	Zingiberaceae	fruit	nausea, indigestion, abdominal pains, bronchitis, respiratory infections	South and Southeast Asia
Kaempferia galanga (*candramula*)	Zingiberaceae	rhizomes, root-stock. leaves	digestive, vulnerary, anthelminthic, dyspepsia, leprosy, skin diseases, rheumatism, asthma, bronchitis, malaria, urolithiasis	India

Table 1 (cont.)

Species	*Family*	*Part(s) used*	*Uses(for treatment of diseases/other applications mentioned)*	*Where grown?*
Mentha arvensis (mint)	Labiatae	leaves	cough syrups, flavoring agent, expectorant, pain reliever	Mexico
Mentha piperita (mint)	Labiatae	leaves	flavoring agent	Mexico
Piper betle (betel vine)	Piperaceae	leaves	antiseptic, aphrodisiac, expectorant, bronchitis, rheumatism, stimulant, carminative, wounds	South and Southeast Asia
Piper nigrum (black pepper)	Piperaceae	dried berries	indigestion, chronic rheumatism, asthma, cough, throat complaints	Asia, Africa, Brazil
Trigonella foenum-graecum (fenugreek)	Fabaceae	seeds	anti-diabetic, flatulence, carminative, emollient, galactagogue	India, Middle East, Egypt, Morocco
Zingiber officinale (ginger)	Zingiberaceae	rhizome	asthma, skin diseases, de-worming, nausea, carminative, common colds	South and Southeast Asia, China, Nigeria

***Source*:** Padoch and De Jong (1991), Perera and Rajapakse (1991), Rugalema et al. (1994), Lamont et al. (1999), Rao et al. (1999), De Clerck and Negreros-Castillo (2000), Millat-e-Mustafa et al. (2002), and Wezel and Bender (2003).

Many of the economic species grown in homegardens possess complementary medicinal values. Such species may or may not be exploited commercially for their medicinal properties but are used locally within the family and community. For example, people in southeastern Nigeria uses a number of species that they grow in their compound farms—for purposes other than healthcare, for medicinal purposes (Okafor and Fernandes, 1987). Such species include *Cajanus cajan* (leaves for treating measles), *Carica papaya* (leaves for treating malaria), *Cola lipidota/ C. nitida/C. pachycarpa* (stimulant), *Kigelia africana* (bark for treating sores), *Jatropha curcas* (leaves for ringworm treatment), *Neubouldia laevis* (stem and roots medicinal), and *Invingia gabonensis* var. *gabonensis* (leaves and bark medicinal). Similarly, many plants are collected for medicinal uses from multistoried agroforestry systems in west Sumatra (Indonesia), although none was grown in the system consciously for that purpose (Michon et al., 1986). Majority of spices, a number of vegetables and ornamentals grown in homegardens also have medicinal uses (Table 1). The homegardens in Java and Sumatra were reported to contain 26 medicinal species and a similar number of spices (Kubota et al., 1992).

Agelet et al. (2000) made a detailed analysis of medicinal plants found in 155 homegardens in the mountain zones of Catalonia (north-eastern Iberian Peninsula, Spain). The gardens contained nine distinct categories of species: plants exclusively cultivated for medicinal purpose (23) mostly close to the house, the medicinal wild plants favored by homegarden structure and care (105), and seven kinds of horticultural plants with complementary medicinal values (117). There was, however, loss of about 56 taxa or 23% of the total over the years.

Despite the presence of many medicinal species in homegardens, only a few species stand out as economically important in any given region. The most frequently found species in 31 homegardens in three villages in Cuba, were *Jatropha gossypiifolia*, *Senna occidentalis*, *Xanthoxylum pistacifolium*, *Pluchea odorata*, and *Rhoeo spathacea* (Wezel and Bender, 2003). Common among species expressly cultivated for medicinal purpose in Catalan homegardens were *Tanacetum parthenium* – a plant used for intestinal antiseptic – and *Liliun candidum* for vulnerary use (Agelet et al., 2000). In the state of Kerala (India), *Kaempferia galanga* – which has been traditionally collected from forests, is now being commercially cultivated in the homegardens (Kumar et al., 2005) and as intercrop in orchard crops (Maheswarappa et al., 1998). Tribals living in the Eastern Ghats of Andhra Pradesh (India) have been growing *Piper longum* and *Curcuma angustifolia* extensively for medicinal purposes along with turmeric (*Curcuma longa*) using *Jatropha curcas* as a bio-fence in homegardens (K.P. Sastry, CIMAP Resource Centre, Hyderabad, pers. comm., July 2005). In the 'Dai homegardens' of Xishuangbanna province in China, the prominent medicinal species found were *Acanthopanax trifoliatus*, *Toona sinensis*, *Sapindus rarak*, *Tamarindus indica*, *Bryophyllum pinnatum*, *Euphorbia antiquorum,* and *Prunus persica* (Saint-Pierre, 1991). *Ammomum villosum*, which requires about 70% shade, is planted under forest cover after clearing the undergrowth and it yields 30 to 150 kg rhizomes ha^{-1} $year^{-1}$ depending on water resource availability. Homegardens even in an isolated Soqotra island in the Republic of Yemen despite containing on average 3.9 to 8.4 species per garden included medicinal plants such as *Aloe perryi*, *Jatropha unicostata*, and

Commiphora ornifolia (Ceccolini, 2002). This should indicate the importance given to MPs by rural people in the tropics.

Table 2. *Relative importance of medicinal species in relation to total species in tropical homegardens.*

Region/location	*Homegardens examined (no.)*	*Total and medicinal[a] species across gardens*	*Total and medicinal[a] species per garden*	*Reference*
Santa Rosa, Peruvian Amazon	21	168 (46)	18 to 74 (9.7)	Padoch and de Jong (1991)
Bukoba, North-western Tanzania	72	57 (10)	N/A	Rugalema et al. (1994)
Amazon, Northeastern Peru	51	161 (56)	N/A (9.5)	Lamont et al. (1999)
Catalonia, Iberian Peninsula, Spain	145	N/A (250)	N/A (30 to 60)	Agelet et al. (2000)
Congo (Zaire)	N/A	273 (74)	N/A	Mpoyi et al. (1994)
Masatepe, Nicaragua	1	98 (10)	N/A (10)	Viquez et al. (1994)
Floodplain Jamuna tributary, Bangladesh	17	125 (48)	N/A	Yoshino and Ando (1999)
Dhamrai, Bangladesh	243	N/A (71)	N/A	Millat-e-Mustafa et al. (2001)
Deltaic, dry land, hilly, and plain regions, Bangladesh	200	120 (31)	N/A	Millat-e-Mustafa et al. (2002)
Eastern Cuba	31	101 (39)	18 to 24 (4)	Wezel and Bender (2003)
Tixcacaltuyub and Tixpeual, Mexico	N/A	301 (152)	N/A	Rico-Gray et al. (1991)
Kerala, India	252	127 (25)	3 to 25	Kumar et al. (1994)
Kandy, Sri Lanka	50	125 (52)	37 to 65	Perera and Rajapakse (1991)
Central Sulavesi, Indonesia	30	149	28 to 37 (2.8)	Kehlenbeck and Maass (2005)

[a]Values in parentheses refer to medicinal species; N/A = information not available.

Immigrants from Southeast Asia to USA continued the tradition of growing many species in homegardens wherever they settled – for family use as well as for sale in the Asian markets. A survey of 59 gardens of Laotian Hmong settlers in the central Sacramento Valley, California, USA, revealed 59 taxa of which 38 had food

value, 36 had medicinal value and a few others had uses like fiber and ornamental. Nineteen taxa had exclusive medicinal value, 15 combined food and medicine, and one or two combined medicinal, with ornamental or fiber uses. Many species that are categorized as being used for both food and medicine were primarily used for food seasoning or as additives (Corlett et al., 2003).

2.2. Diversity of MPs in homegardens

The species diversity including medicinal species in homegardens primarily depends on climate, altitude, socioeconomic and cultural factors, and nearness to markets. The diversity and density of plants generally increase with rainfall and elevation. In Venezuela, high diversity was positively correlated with age and remoteness of the garden, its use for subsistence, age of the farmer, and extent of participation of family labor in the activities of the garden (Mulas et al., 2004). In Bangladesh, species number decreased with increase in homegarden size and from deltaic region to dry region (Millat-e-Mustafa et al., 2002). Homegardens in West Java, Indonesia, contained the greatest diversity with an average number of 56 species per garden, the number of species being more in the wet season than in the dry season (Soemarwoto, 1987). In contrast, species composition of Cuban gardens differed across sites, especially in terms of medicinal plants, with gardens in the semiarid climate showing greater range than those in the humid region (Wezel and Bender, 2003). Medicinal plants were recognized as the second most important group next only to cash value species in Sri Lanka (Perera and Rajapakse, 1991) and Bangladesh (Millat-e-Mustafa et al., 2002), food crops in Peruvian Amazon (Padoch and de Jong, 1991) and fruits in Cuba (Wezel and Bender, 2003) and Peruvian Amazon (Lamont et al., 1999). Homegardens close to cities were noted to capitalize on their relatively easy access to market in exploiting medicinal/other plants (Padoch and de Jong, 1991; Drescher et al., 2006).

Aromatic species are less common compared to medicinal species in homegardens. Vetiver (*Vetiveria zizanioides*) cultivation was, however, observed in the homegardens of Kerala, India (Nair and Sreedharan, 1986) and the Chagga gardens on Mt. Kilmanjaro in Tanzania (Fernandes et al., 1984). Likewise, lemongrass (*Cymbopogon citratus*) was found in the homegardens of Thailand (Boonkird et al., 1984), Kerala (Nair and Sreedharan, 1986), and Nicaragua (Mendez et al., 2001), and citronella (*Cymbopogon nardus*) in the Kandyan homegardens of Sri Lanka (Perera and Rajapakse, 1991). Homegardens in Ethiopia also contained aromatic plants (Zemede and Ayele, 1995).

2.3. Uses of MPs grown in homegardens

The MPs grown in homegardens are used to treat a variety of ailments ranging from common colds, fevers, headache, snake bites, and digestive problems to infectious and complicated diseases (Tables 1, 3, and 4). Thus, we find species yielding curatives, preventives, placebos, palliatives, nutrition supplements, and energizers. Some of the species provide medicaments to treat livestock diseases, fish baits, and

piscicides. Medicinal and aromatic species found in the homegardens are also used as biopesticides. For example, leaves of sacred basil (*Ocimum sanctum/ O. enuiflorum*) are traditionally used as a toxicant against insect pests in grain legume storage. Clove (*Syzygium aromaticum*) powder was found to cause adult mortality of bruchids (*Callosobruchus maculatus*; Rajapakse et al., 2002). Essential oils of citronella, *Eucalyptus citriodora*, and lemongrass are widely used as mosquito repellants. Parts of MPs used for medicinal purpose could be whole plants, young shoots, flowers, young leaves, stem, seed, bark, pods, rhizomes, bulbs, fruits, roots, and inflorescence depending on the species (see Tables 1, 3, and 4).

3. GENDER ISSUES AND MEDICINAL PLANTS

In many traditional societies, women are actively involved in the cultivation of food crops, while men are more concerned with the cash crops. This is true generally for Africa, the Ngöbe community of Panama (Samaniego and Lok, 1998), and the natives of Soqotra Island, Yemen (Ceccolini, 2002). Commercialization of certain products in the homegardens, however, reduced the diversity of species and income to women in a number of communities in Latin America (Howard, 2006). The proverbial reference to household treatment for common ailments, which generally are based on MPs as 'grandmother's remedies', perhaps indicates the understanding of women on these aspects. Women also may have as much role as men, if not more, in the cultivation of traditional medicinal plants, use, and sale of herbal products in village markets because of proximity. In Nicoya, Costa Rica, it was noted that although men and women had equal knowledge of the parts used, women had greater knowledge of medicinal species, the forms of preparation, and application than men (Ochea et al., 1999; Howard, 2006). In Tanzania, men harvest fuel and fodder trees, while women harvest fodder grasses and herbs (Fernandes et al., 1984). Understanding the role of women in homegardens in general and possible impact of introduction of high value medicinal plants in homegardens on gender equity and well-being of women within the family and society is important; yet, in-depth studies are lacking on these aspects.

4. SHADE TOLERANCE OF MEDICINAL PLANTS

Several MPs, especially those grown in homegardens, require or can tolerate overstorey shade. Ginger (*Zingiber officinale*) can withstand light interception by the overstorey up to 48% without experiencing appreciable yield reduction (Kumar et al., 2001). Yield and quality of galangal or *kacholam* (*Kaempferia galanga*) – a medicinal and aromatic oil-yielding herbs were, however, not affected by light interception levels by the upperstorey canopy up to 82% of the open (Kumar et al., 2005). In fact, rhizome yield of galangal as an intercrop in coconut garden was 6.1 Mg ha^{-1} compared with 4.8 Mg ha^{-1} in the open in Kerala, India. Essential oil and oleoresin contents were also greater in the rhizomes of the intercropped *kacholam* (Maheswarappa et al., 1998). Likewise, *Plumbago rosea*, *K. galanga,* and *Asparagus racemosus* performed better as intercrops in 20 year-old coconut

Table 3. *Multipurpose trees with medicinal uses grown in, or suitable for, homegardens.*

Latin name	*Family*	*Parts used*	*Medicinal uses (treatment of the diseases mentioned) and other applications*	*Where grown at present?*
Albizia lebbeck (siris tree)	Mimosaceae	flowers, seeds, bark	asthma, thoracic pain, skin diseases, leprosy, sprains, wounds, ulcers, neuralgia, night blindness, diarrhea	India, Africa
Alstonia scholaris/*A. boonei* (devil tree)	Apocynaceae	leaves, bark, milky exudates	asthma, bronchitis, leprosy, ulcers, fevers, tumors, cardiopathy, helminthiasis, debility, elephantiasis	India, Africa
Azadirachta indica (neem tree)	Meliaceae	leaves, sticks, flowers, seeds, oil, bark	bronchitis, diabetes, ulcers, haemorrhoides, skin diseases, tumors, syphilis, antiseptic, dandruff, contraception, dental care, insecticide	India, Africa
Bombax buonopozense (bombax)	Bombacaceae	leaves	antipyretic	Africa
Cinnamomum camphora/ *C. parthenoxylon* (camphor tree)	Lauraceae	leaves	fever, eruptions, measles, delirium, whooping cough, melancholia, chronic bronchitis, uterine pains, myalgia	India, China, Sri Lanka
Cedrela odorata (cedro)	Meliaceae	bark	snake bites, fever	Peru, Brazil, East Africa
Commiphora mukul (Indian bedellium tree)	Burseraceae	stem, leaves, gum, resin	rheumatic disorders, hyperchhloroesterolaemia	India
Croton lechleri (sangre de drago)	Euphorbiaceae	latex	swellings, gastric ulcers, contraception	Peru

Table 3 (cont.)

Latin name	*Family*	*Parts used*	*Medicinal uses (treatment of the diseases mentioned) and other applications*	*Where grown at present?*
Emblica officinalis (Indian gooseberry)	Euphorbiaceae	fruits	aging and general debility, acid-peptic diseases, hair loss, dyspepsia, laxative, cooling, diuretic, ulcers	India
Erythrina spp. (Indian coral tree)	Fabaceae	bark, leaves	sedative, vulnerary, lactogogue, collyrium, sterility in women, diabetes, dysentery, eye infections, insomnia, worms, joint pains, whooping cough	India, Africa
Eucalyptus citriodora (lemon-scented gum)	Myrtaceae	leaves	essential oil, perfumery, mosquito repellant	India, China
Eucalyptus spp.	Myrtaceae	leaves	essential oil, colds	India, China
Euterpe precatoria (*chonta*, *pana*)	Arecaceae	roots	diabetes, vaginal infections	Peru
Garcinia cola, *G. afzelii*, *G. efunctata*	Clusiaceae	branch sticks, seeds, fruits	anthelmenthic, cardiotonic, astringent, demulcent, emollient, antiobesity, dental care	India, Africa
Ginkgo biloba (ginkgo)	Ginkgoaceae	leaves, fruits	old-age problems, memory enhancer, general tonic, adaptogenic	China, Japan, other east Asian countries
Gliricidia sepium (Mexican lilac)	Fabaceae	leaves	insecticide	India, Africa
Hagenia abyssinica (*cusso*)	Rosaceae	flowers	anthelminthic, purgative	Africa
Jatropha curcas (furging tree)	Euphorbiaceae	leaves, stem, seeds, oil	laxative, lactogogue, leprosy, rheumatism, eczema, blisters, inflammations, ear-ache	India, Africa, China

Leucaena leucocephala (lead tree)	Mimosoideae	bark, root	emmengogue, ecbolic, depilatory, contraceptive	India, Africa, America
Madhuca longifolia (butternut tree)	Sapotaceae	bark, heartwood, flowers, seeds	inflammations, sprains, pruritus, epilepsy, strangury, verminasis, haemotysis, hepatopathy, dipsia, bronchitis, dermatopathy, cephalalgia, rheumatism, skin diseases	India
Maytenus macrocarpa (*chuchuhuasha*)	Celastraceae	bark	arthritis, diarrhea, stomach disorders, anemia	Peru
Melia volkensii, M. azadirach	Meliaceae	different parts	insecticide, anthelmintic, antiseptic, astringent, emetic, febrifuge, anti-rheumatic	India, Africa
Okoubaka aubrevillei (*oku*)	Octoknamaceae	bark	vomiting, influenza, infections, diarrhea, gastritis	Africa
Pausinystalia johimbe (*yohimbe*)	Rubiaceae	bark	male impotency, aphrodisiac, hypotensive, cardio tonic	Central Africa
Prunus africana	Rosaceae	bark	prostatitis	Central Africa
Saraca asoca (*ashoka*)	Caesalpiniaceae	bark, leaves, flowers, seeds	luecorrhoea, anthelmintic styptic, dyspepsia, ulcers, visceromegaly, pimples, cervical adenitis, vesicle calculi, haemorrhagic dysentery, diabetes	India
Terminalia arjuna	Combretaceae	bark, leaves, fruits	wounds, ear-ache, heart diseases, fractures, contusions, febrifuge, dysentery, diuretic, tonic, deobstruent, hypertension	India, Africa

Table 3 (cont.)

Latin name	*Family*	*Parts used*	*Medicinal uses (treatment of the diseases mentioned) and other applications*	*Where grown at present?*
Terminalia bellirica (beleric myrobalan)	Combretaceae	bark, fruits, gum	bronchitis, sore throat, biliousness, inflammations, strangury, asthma, astringent, dropsy, diarrhea, leprosy, gum purgative	India, Africa
Terminalia chebula (cherubulic myrobalan)	Combretaceae	fruits	asthma, soar throat, vomiting, hiccoughs, eye diseases, heart, and bladder diseases	India, Africa
Raphia hookeri (raphia palm)	Arecaceae	exudates	cosmetics, wine	Africa
Uncaria tomentosa (*uña de gato*)	Rubiaceae	bark	infections, cancer, gastritis, birth control, allergies	Peru, Brazil
Zanthoxylum rhoifolium	Rutaceae	leaves, fruits	chest infection, dental care, analgesic, antibacterial	Brazil, Columbia

***Source*:** Saint-Pierre (1991), Chadha and Gupta (1995), and Rao et al. (1999; 2004).

Table 4. *Shade-tolerant medicinal species of commercial potential that can be grown in homegardens.*

Latin name (common name)	*Family*	*Habit*	*Part(s) used*	*Uses (treatment of the diseases mentioned) and other applications*	*Where grown at present?*
Aconitum heterophyllum (monks hood)	Ranunculaceae	herb	tuberous root	astringent tonic, anti-diarrhea, dyspepsia, cough, alexitexic, anti-periodic, anthelmenthic, hemorrhoids, general debility	East Asia, Western Himalayas
Adhatoda zeylanica, *A. beddomei* (Malabar nut tree)	Acanthaceae	shrub	leaves, roots, stem bark	asthma, menorrhagia, psoriasis, chronic bronchitis, cough, body inflammation	India
Aloe vera, A. barbadensis (aloe)	Liliaceae	herb	leaves	health drink, burns, cuts, skin diseases, leprosy, piles, liver ailments, dysentery	Many countries
Alpinia galanga, *A. calcarata* (galangal)	Zingiberaceae	herb	rhizomes	asthma, bronchitis, hiccoughs, dyspepsia, diabetes, obesity, rheumatoid arthritis, stimulant, tonic	Malaysia, Indonesia
Ammomum villosum	Apiaceae	herb	fruit	stomachic, carminative, expectorant, tonic, antiemetic, antispasmodic	China
Andrographis paniculata (king of bitters)	Acanthaceae	herb	shoots	antipyretic, antiperiodic, anti-inflammatory, ulcers, bronchitis, skin diseases, intestinal worms, jaundice, leprosy, hemorrhoids	India
Asparagus racemosus, *A. adscendens* (asparagus)	Liliaceae	climber	tuberous roots	lactogogue, urinary and gynecological disorders, diseases of nervous system, hyperacidity, gastritis, cardiac debility, hypertension, oligospermea	India

Table 4 (cont.)

Latin name (common name)	*Family*	*Habit*	*Part(s) used*	*Uses (treatment of the diseases mentioned) and other applications*	*Where grown at present?*
Boerhaavia diffusa (hog weed)	Nyctaginaceae	creeping herb	whole plant	aphrodisiac, diuretic, cardiac disorders, stimulant, diaphoretic, anti-inflammatory, jaundice, anemia, general debility, myalgia, scabies, oedema	many tropical countries
Cassia senna, *C. acutifolia* (senna)	Caesalpiniaceae	shrub	leaves, pods	constipation, skin diseases	India, Sudan
Catharanthus roseus (periwinkle)	Apocynaceae	small shrub	leaves, roots	cancer therapy (leaves), hypertension (roots)	India, China, Central and South America
Centella asiatica (Indian pennywort/goticola)	Apiaceae	creeper	whole plant	memory enhancer, anxiety, neurosis, general debility, wound healing, leprosy, eczema, sporiasis	India
Chlorophytum borivilianum, C. tuberosum, C. arundinaceum (safed *musli*)	Liliaceae	herb	tubers	aphrodisiac, nervine tonic,	India
Costus speciosus	Zingiberaceae	shrub	rhizomes	contraception, aphrodisiac astringent, digestive, skin diseases, fevers	India
Curculigo orchioides (black *musli*)	Amaryllidaceae	herb	roots	erectile impotency, spermatorrhoea, general weakness, burning and fatigue piles, menorrhagia, jaundice	India
Curcuma angustifolia (arrow root)	Zingiberaceae	herb	tubers	anti-diarrheal, anti-dysenteric, coolant, health drink	India

Cymbopogon martinii var. *motia*	Poaceae	shrubby grass	flowering shoots	perfumery, flavoring, joint pains, galactogogue, febriluge, aromatherapy	South and Southeast Asia
Decalepis hamiltonii	Asclepiadaceae	twining straggler	tuberous roots	health drink, tonic, promotes digestion, cures fever	India
Dioscorea deltoides/ *D. floribunda* (medicinal yam)	Dioscoreaceae	tuberous twines	tubers	steroidal drugs, contraception, anthelmintic, leprosy	India
Gloriosa superba (glory lily)	Liliaceae	climbing herb	tuber, seeds	gout, polyploidy, rheumatism, abortifacient, chronic ulcers, piles, diarrhea, antiperiodic, anthelmintic, snake bites, scorpion stings, gonorrhea	India
Glycyrrhiza glabra (liquorice)	Fabaceae	shrub	roots	cough, general tonic, acid peptic disease anti-inflammatory, sweetener	India, China, Eurasia
Gymnema sylvestre (pepricola of the wood)	Asclepiadaceae	climbing shrub	leaves	antidiabetic, cardiac stimulant, eye diseases, diuretic	India
Hippophae rhamnoides (seabuckthorn)	Elaeagnaceae	shrub	berries	skin care, analgesic, antioxidant, antibacterial, anti-inflammatory, nutraceutical	USA, Canada, Europe, India
Holostemma adakodien (swallow wort/ring coronet)	Asclepiadaceae	climber	roots	opthalmopathy, fever, arthritis, cough, burning sensation, stomachalgia	India
Mucuna pruriens (velvet bean)	Fabaceae	climbing shrub	seeds	Parkinson's disease, anthelmintic, laxative, tonic for male virility, elephantiasis	many countries

Table 4 (cont.)

Latin name (common name)	*Family*	*Habit*	*Part(s) used*	*Uses (treatment of the diseases mentioned) and other applications*	*Where grown at present?*
Ocimum sanctum (sacred basil)	Lamiaceae	herb	flowering shoots	cold, cough, bronchospasm, general debility, stress disorders, skin infections, wounds, indigestion, nausea, essential oil in flavoring, perfumery	India, West Indies
Phyllanthus amarus	Euphorbiaceae	herb	whole plant	hepatoprotective, oedema, anorexia	many countries
Piper longum (long pepper)	Piperaceae	climbing shrub	fruit, stem, roots	bronchial asthma, throat infections, flatulence, dyspepsia, respiratory diseases, analgesic, carminative, sedative, insomnia, epilepsy, abortifacient	India
Plumbago zeylanica, P. rosea (white/red flowered lead wort)	Plumbaginaceae	herb	roots	acro-narcotic poison, abortifacient, rheumatic and paralytic affections, ulcers, leprosy, enlarged spleen, rubefacient, piles, skin diseases, leucoderma, syphilis, influenza	India
Pueraria tuberosa (Indian kudzu)	Fabaceae	large climber	tubers	arthritis, agalactia, cardiac debility, pharyngitis, leprosy, tuberculosis, spermatorrhoea	India
Rauvolfia serpentina, R. tetraphylla, R. vomitoria (serpentine root)	Apocynaceae	shrub	roots leaves	hypertension, insanity, insomnia, psychological disorders, epilepsy eczema, skin diseases opacities of cornea, psoriasis, snake and insect bites, toxic goiter, angina pectoris	India, Malaysia, Indonesia

Rosemarinus officinalis	Lamiaceae	herb	flowering shoot	perfumery, aromatherapy, digestive, nervine tonic, stimulates kidneys	Mediterranean region
Salvia officinalis (sage)	Lamiaceae	herb	leaves, oil	perfumery, digestive, nervine tonic, antiseptic, deodorant, diaphoretic	Mediterranean region
Stevia rebaudiana (stevia)	Asteraceae	herb	leaves	sweetener	Brazil, Japan, Paraguay, China, Indonesia, Thailand
Tinospora cordifolia (tinospora)	Menispermaceae	woody climber	stem	seminal weakness, urinary affections, tonic, fever, jaundice, syphilis, rheumatism, general debility, leprosy	India

Source: Saint-Pierre (1991), Rao et al. (1999), Chadha and Gupta (1995), and Kehlenbeck and Maass (2005).

plantations spaced at 7.5 x 7.5 m, and gave 69 to 97% higher net returns compared to sole crops. The performance of *Adhatoda beddomei* and *Holostemma adakodien*, however, was unaffected by the cropping systems (Kurien et al., 2003), implying that they could perform well under disparate cropping situations. Patchouli (*Pogostemon patchouli*), an important aromatic crop, is grown as an intercrop in the coconut gardens of India. Its biomass yield and quality of oil were better under shade than when grown in the open (E.V.S. Prakasa Rao, CIMAP Resource Centre, Bangalore, India, pers. comm., July 2005). Black musli or golden eye grass (*Curculigo orchioides*) planted at 10 x 10 cm spacing under 25% shade performed better than the crop in the open in terms of vegetative growth, rhizome yield, harvest index, and nutrient uptake[4].

Most of the medicinal plants harvested from forests are shade tolerant or prefer some degree of shade, so that they can be cultivated in the homegardens as well, provided they are adapted to the prevailing climatic and soil conditions. A number of medicinal and aromatic crops that are traditionally grown outside forests can also withstand some shade (Jha and Gupta, 1991; Nair et al., 1991) and such species too can be integrated into homegardens. Tables 3 and 4 list a number of species that can be promoted in the homegardens. Species requiring mild shade may be grown in the early years of newly established homegardens or in patches under partial shade, whereas those that withstand intense shade can be grown in 'mature' homegardens.

5. PROMOTING MEDICINAL CROPS IN HOMEGARDENS

With the future of homegardens themselves being uncertain (Kumar and Nair, 2004; Wiersum, 2006), its role in providing a steady supply of medicinal plants and other products is unclear. Consistent with this, some reports indicate a reduction in the supply of MPs from homegardens. For example, an analysis of the species composition of homegardens in West Java, Indonesia in 1980 and 1999 revealed that fruit trees and ornamentals constituted a high proportion of plant species in both the years. There was, however, a decrease in the number of useful species from 126 to 100 during the 1999 enumeration. The utilization of useful plants, except for fruit trees and plants for miscellaneous uses largely changed in the past 20 years especially in the case of vegetable, industrial, and ornamental plants (Kubota et al., 2002). In Catalonia, MPs declined because of the loss of original significance of certain species and death of people with particular knowledge on the cultural requirements of some plants (Agelet et al., 2000).

In spite of the above uncertainties, homegardens offer an opportunity to produce some high value medicinal crops and help smallholders earn additional incomes. For instance, in the Ba Vi National Park in northern Vietnam, the Dao people have taken up cultivation in the homegardens some of the 44 commercially important medicinal species identified in the area including *Alstonia scholaris*, *Cinnamomum zeylanicum, Tradescantia zebrine*, *Piper retrofractum,* and *Travesia palmatet* (On et al., 2001). *Ammomum villosum* in China (Saint-Pierre, 1991) and *Piper longum* and *Kaempferia galanga* in India (Kumar et al., 2005) are similarly grown for commercial purposes. In the Peruvian Amazon, younger generations were as keen as the older ones to add species potentially useful as medicine, food, cosmetics, and

other items to their collections as well as gathering knowledge on such plants (Padoch and de Jong, 1991).

In the humid tropics, the active slash-and-burn agriculture (120 million ha), secondary forest fallow (203 million ha), logged forests (136 million ha), secondary forest fallows (203 million ha), *Imperata*-infested grasslands in Southeast Asia (40 million ha), and degraded pastures in the Amazon (10 million ha) present vast degraded and abandoned areas, some of which can be put under permanent crop production systems (Sanchez et al., 1994). Homegardens and multistrata systems are regarded as some of the best bet alternatives to slash-and burn system both for the newly cleared lands as well as to bring degraded lands into permanent production. In the uplands of northern Vietnam, the need for improved homegardens using medicinal crops, rattan, quality timber, and livestock was recognized to replace shifting cultivation and to prevent opium production (Tai et al., 1995). Homegardens have been taken up by smallholders in the re-settlement projects in Southeast Asia (e.g., Indonesia) and Amazon (e.g., Brazil). The native people and migrants in the course of developing their homegardens have used a wealth of plant materials including recently developed germplasm. A survey of 33 homegardens in the uplands and 18 in the floodplains of Brazilian Amazon revealed that a total of 77 and 80 commercially valuable perennial species respectively are present (Smith, 1996). These species included, in addition to those providing food, beverages, juices, nuts, oils, thatch, and wood, those that provided folk remedies such as *juca* (*Caesalpinia ferrea*), piao roxo (*Jatropha gossypiifolia*), yellow mombim or taperebá (*Spondias mombim*), fish bait (e.g., *Colossoma macropomum*, *C. bidens*, and *Brycon* sp), and piscicide (e.g., *Ichthyothere cunabi*). The species diversity was greater if medicinal, ornamental, and vegetable species meant mostly for family use were also considered. The number of such species in gardens ranged from 4 to 27. Homegardens established recently as alternatives to slash-and-burn agriculture in cleared forests or degraded lands, however, did not contain as many medicinal species as the traditional gardens. Similarly, recently established homegardens in southern Andaman, India did not contain medicinal plants (Pandey et al., 2002).

Official recognition of traditional medicine will promote growing of medicinal plants, which in turn would help farmers earn better price to their products and citizens to get healthcare at reduced costs. Homegardens and health resorts could also promote ecotourism or 'health tourism', as is happening in the Kerala state of India (www.ktdc.com and www.keralatourism.org; last accessed: December 2005). The social benefits include revival of local traditions and protection of traditional knowledge. It is possible to patent indigenous knowledge about medicinal plants and preparations of products so that the society associated with the development of such knowledge derive the economic benefits thereof. Patenting of the stress relieving properties of *Trichopus zeylanicus*, a medicinal plant used by the Kani tribals of Agasthyar hills in Kerala is worth mentioning in this context (TBGRI, 2003). Indeed, a share of the royalty paid by the firm, which commercialized the technology, has been passed on to the tribal community that possessed this knowledge as part of their traditions. Value-addition and product development at local level wherever possible would also increase the earnings of farmers as well as create rural employment to skilled people and reduce migration to cities.

6. MARKETING OF MEDICINAL PLANTS FROM HOMEGARDENS

Local markets may not be adequate in most cases to absorb all the commercially valuable MPs and offer an equitable price to the producer; prices offered at these markets are often only a small fraction of those at the national and international markets. Lack of organized market channels, poor infrastructure, and involvement of middlemen in the supply chain from farm to factory deprive the farmers of remunerative prices to their produce. Strategies that will promote marketing of MPs and offer competitive prices to farmers are needed; these include establishment of farmers' cooperatives, contract farming with 'buyback' arrangements by the industry, declaration of minimum support price to promising MPs, and subsidies to exporters of MPs as in other sectors. Examples of such proactive policies include development of a marketing network for *Piper longum* in Andhra Pradesh (India) and the intervention by government agencies in the case of *Ammomum villosum* in China, which encouraged large-scale cultivation of these MPs in homegardens. The Girijan Cooperatives in many Indian states also help the tribals living at forest margins to market non-wood forest products. Likewise, the Mayan farmers in the Yucatan region of Mexico have organized a cooperative project for the sale of aloe (*Aloe barbadensis*) and orange juice produced from forest gardens (Neugebauer and Mukul, 2000). Dabur India Ltd., a pharmaceutical company that makes herbal medicines, relies on contract farming for the supply of Indian gooseberry (*Emblica officinalis*), *Rauvolfia*, and *Piper longum*. Maintaining quality of the produce all through the supply chain is, however, very important to earn a premium price for which the farmers, transporters, and processors should be trained properly.

7. OUTLOOK AND RESEARCH NEEDS

Clearly, not all medicinal and aromatic plants found in the homegardens are used by people, and the relative importance of these plants to local societies also varies greatly from place to place. As a first step, therefore, priority species need to be identified based on their medicinal importance, ailments for which they are used, commercial value, cost effectiveness of alternate medicines, and the potential for synthesizing alternative compounds. Research efforts could then concentrate on a few priority species in terms of improving germplasm and developing agronomic techniques, particularly effective propagation techniques, and field establishment in homegardens and forest gardens. Sustainable harvesting methods have to be developed, especially for species harvested from the wild.

Basic research is needed on the response of important medicinal species that are, and can be grown, in the homegardens to variations in quantity and quality of light; and to determine the effects of varying light regimes and organic and inorganic sources of nutrients on yield and quality. Such information helps to develop appropriate canopy management practices for multistrata systems to facilitate the growth of understorey crops. The use of MPs is based on indigenous knowledge and customs passed down from generations; the principal chemical compounds in many of these plants and their curative properties and mode of action have not yet been

elucidated properly. Such studies will give authenticity to the use of traditional medicines and help protect genuine herbalists from unscrupulous practitioners.

Globalization of agricultural trade under the World Trade Organization (WTO) regime brought with it several challenges and opportunities in the medicinal and aromatic plants sector too. The challenges include price competition, maintenance of quality, and scientific validation of claims for traditional medicines. The opportunities include global positioning of natural products obtained from medicinal plants, which have large demand. Bioprospecting for molecules of pharmaceutical or flavor/fragrance value from these plants and patenting of these molecules is going to be a future source of conflict between developed and developing countries. While the developed countries have the technology and fiscal resources, the developing countries in the tropics, where most of these MPs are grown, lack such resources. As a first step, therefore, tropical countries should make efforts to develop databases on MPs, indigenous medicinal practices, and herbal preparations in use. These will not only prevent loss of indigenous knowledge but also help promote the use of MPs. Documentation further helps native communities to protect their intellectual property rights on their genetic resources and indigenous knowledge systems and safeguard from biopiracy (Jose, 2004).

7.1. Processing of homegarden produced MPs

Medicinal and aromatic plants in homegardens can be produced at a lower cost compared to input intensive sole crops, as they benefit from common field operations and minimal use of chemical inputs. Organically produced MPs may also attract premium prices in the international markets. Processing and packaging of MPs at local level instead of selling the raw materials will further increase the value of the products and benefit the growers. Some typical value-addition practices are: (1) drying and powdering of relevant plant parts, (2) distillation of aromatic plants, (3) isolation of menthol crystals from mentha oil (*Mentha* spp.) following chilling and centrifuging, (4) pulverizing and encapsulation (e.g., peeled and dried tubers of *Chlorophytum borivilianum* in India), (5) preparation of herbal extracts, and (6) preparation of simple products such as incense sticks, perfumed candles, soaps, and herbal drugs. Powdering medicinal plant parts is the simplest activity, which can be taken up at the farm-level; e.g., tribals cultivating *Curcuma angustifolia* in Andhra Pradesh state, India, prepare a white powder from the tubers of this plant. Other processes may need establishment of facilities at village- or community-level as cottage industries. Nevertheless, it may increase profits to the farmers and generate employment to the local people. For instance, in Karnataka state of India, incense sticks are made mostly by women and children using plant-derived raw materials, adding value to these products and enhancing household incomes. Farmers have to be encouraged and trained, if necessary, to take such value-addition processes either individually or collectively at the farm- or village-level to realize better prices for their products. Good packaging, branding, organic labeling, and quality certification by authorized agencies for finished products will also increase the value of herbal medicines and its consumer acceptability.

8. CONCLUSIONS

Homegardens will continue to be an important land use system for the small-scale farmers in humid and subhumid tropics. They can be turned into future 'biofactories' for the production of commercially important phytochemicals. Furthermore, organically grown MPs can be an important income and employment generating village enterprise in many rural localities. Promotion of ecotourism to herbal/homegardens and health resorts catering to aromatherapy or herbal therapy will have its spin off in terms of additional income and rural employment. Training farmers in improved cultivation and processing practices, contract farming, and establishment of institutions that provide market information and ensure quality standards will go a long way in promoting MPs in the homegardens.

ACKNOWLEDGEMENTS

The authors sincerely thank Dr. J.S.K. Prasad, Central Research Institute for Dryland Agriculture (CRIDA), Santhoshnagar, Hyderabad 500 030, India, and Mr. Solomon G. Haile, School of Forest Resources and Conservation, University of Florida, Gainesville, Florida, USA for providing some useful literature in the course of preparing this paper.

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