FINAL REPORT

A STUDY FOR THE DEVELOPMENT OF A HANDBOOK OF SELECTED CARIBBEAN HERBS FOR INDUSTRY

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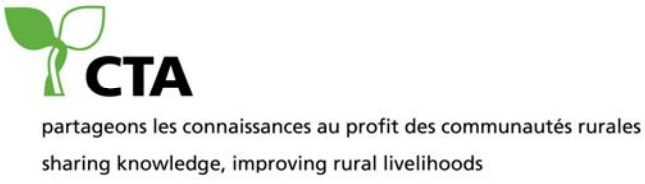


TABLE OF CONTENTS

Acknowledgements

We wish to thank the Technical Centre for Agriculture and Rural Cooperation (CTA) in the Netherlands, the Inter-American Institute for Cooperation on Agriculture (IICA) and the Caribbean Herbal Business Association (CHBA) Offices in Trinidad and Tobago, for providing support to carry out this study. In particular, for their unstinting guidance in this work, we would like to express our indebtedness to Christine Webster (CTA), Aaron Parke (IICA) and Karen Lee Lum (CHBA).

We wish to recognize with gratitude the valuable contributions made to this study by the following persons: Annette Arjoon, Terence Arthur, Yasmin Baksh-Comeau, Audia Barnett, Cheryl Bowles, Glenroy Browne, Samaroo Dowlath, Cecile La Grenade, Guido Marcelle, Pedro Mellilo, Sylvia Mitchell, Shaliza Mohammed, Vindra Naipaul, Angela Nevers, Sonia Peter, Joan Petersen-Polo, Denzil Phillips, Lionel Robineau, Gloria Simon, Patmanathan Umaharan, Jorge Murillos Yepes.

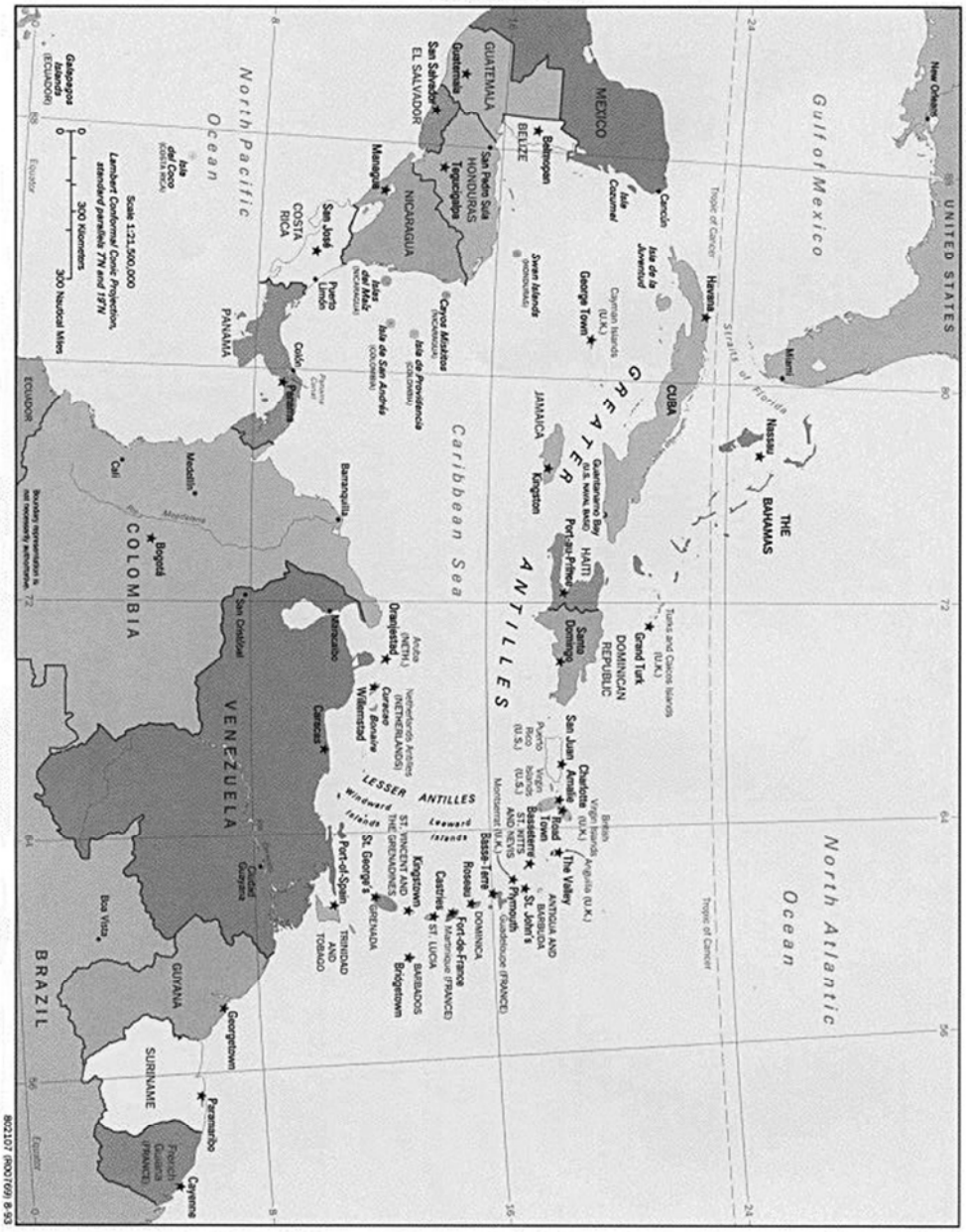
We also wish to thank the owners for granting us permission to use their colour pictures for the plant profiles described in this study.

DISCLAIMER

The views and opinions expressed in this handbook are those of the authors and contributors alone and do not necessarily reflect those of CTA, IICA or the CHBA.

This manual contains information about the production of the medicinal and aromatic plants and herbal remedies. It is intended for guidance only, as some of the medicinal plants described may be harmful and quite toxic. Some of the solvents, procedures and equipment described can be harzardous if used improperly. Neither the authors nor the publishers can be held responsible for claims arising from the mistaken identity of plants, their improper processing or inappropriate use.

Map of the Caribbean



The Selected Caribbean Plants

Scientific Name (FAMILY)	Common or other Local, Multilingual Names (used in the Caribbean)
Aloe vera (L.) Burm. f. (LILIACEAE-ALOACEAE)	Aloe, Aloes, Barbados Aloe, Barbados Aloes, Curacao Aloe, Sempervivum, Simple Bible, Sinkle Bible
Andrographis paniculata (Burm. f.) Wall. ex Nees (ACANTHACEAE)	Rice Bitters, Chiretta, Green Chiretta, Kalmegh, King-of-bitters, Kirata, Wild Rice
Carapa guianensis Aubl. (MELIACEAE)	Carapa, Andiroba, Bastard Mahogany, Caraba, Crabwood, Crapaud, Crappo, Figueroa, Karaba, Krappa, Randiroba, Sapo, Tangare, Tololo, White Crabwood
Colubrina arborescens (Mill.) Sarg. (RHAMNACEAE)	Mauby, Blackvelvet, Bois Mabi, Coffee Colubrina, Corazon de Paloma, Mabi, Mawbie, Snakewood
Croton eluteria (L.) Sw. (EUPHORBIACEAE)	Cascarilla, Cascarilla Bark, Comcomcoli, Eleuthera Bark, Kouli, Quina Aromatica, Quina Falsa, Quina Morada, Sassafras, Serosee, Sweetwood Bark
Curcuma longa L. (ZINGIBERACEAE)	Turmeric, Chichima, Curcuma, Haldi, Indian Saffron, Jhijhima
Cymbopogon citratus (DC.) Stapf. (GRAMINEAE)	Lemon Grass, Cana de Limon, Citronelle, Fever Grass, Hierba de Limon, Limoncillo, Limonera, Te Limon, Sitwonel, West Indian Lemon Grass, Zacate Tay, Zacate Limon
Eryngium foetidum L. (UMBELLIFERAE-APIACEAE)	Fit Weed, Acapate, Bhandhania, Cardo Santo, Chardon Beni, Chardon Etoile Fetide, Chicoria, Cilantro, Coulante, Culantro, Fit Bush, Mexican Coriander, Recao, Sawtooth Coriander, Shado Beni, Spirit Weed
Hibiscus sabdariffa L. (MALVACEAE)	Sorrel, Jamaica Sorrel, Lozey, Red Sorrel, Roselle

Scientific Name (FAMILY)	Common or other Local, Multilingual Names (used in the Caribbean)
Lippia alba (Mill.) N.E. Br. (VERBENACEAE)	Santa Maria, Anis de Espana, Cariaquito Blanco, Carmelitana, Catmint, Cidreira, Colic Mint, Melissa, Oregano, Salvia Americana, Teasam
Maranta arundinacea L. (MARANTACEAE)	Arrowroot, Amaranta, Araruta, Bermuda Arrowroot, Djitam, Mouchaz Babade, Obedience Plant, Plantanillo, Toloman
Momordica charantia L. (CUCURBITACEAE)	Coraili, Balsam Apple, Balsam Pear, Bitter Gourd, Bitter Melon, Caryla, Cerasee, Kerala, Maiden Apple, Pomme Coolie, Sorrow Seed, Wild Cerasee
Myristica fragrans Houtt. (MYRISTICACEAE)	Nutmeg, Mace, Nutmeg and Mace
Pimenta dioica (L.) Merrill (MYRTACEAE)	Pimento, Allspice, Jamaica Pepper, Malagueta, Piment Jamaique, Pimenta, Pimienta Gorda, Dulce, Spice, Tabasca, Toda Especial, Toute Epice
Pimenta racemosa (Miller) J.W. Moore (MYRTACEAE)	Bayrum Tree, Bay Leaf, Bay Tree, Fey Buradenn, Bayberry, Bois d'Inde, Matagueta, West Indian Bay, Wild Cinnamon
Quassia amara L. (SIMAROUBACEAE)	Quassia, Bitter Wood, Quashie Bitters, Quassia-Bitters
Senna alata (L.) Roxb. (LEGUMINOSAE-CAESALPINIOIDEAE)	Wild Senna, Candlestick, Christmas Candle, Desay, French Guava, Gacajabo, Impetigo Bush, Kasyalata, Kassialata, King-of-the-forest, Money Bush, Tarantan, Ringworm Shrub, River Guava, River Senna
Smilax regelii Killip & Morton (SMILACACEAE)	Sarsaparilla, Bejuco de Corona, Brown Sarsaparilla, Chaspawey, Jamaica Sarsaparilla, Honduran Sarsaparilla, Spanish Bayonet, Zarzaparilla
Vetiveria zizanioides (L.) Nash (POACEAE-GRAMINEAE)	Vetiver, Cockroach Grass, Khus Khus, Pachouli Valeriana, Vetive
Zingiber officinale Roscoe. (ZINGIBERACEAE)	Ginger, Ajenjible, Common Ginger, Djiendje, Gingembre, Gengivre, Jengibre, Jenjan, Jingible

1. EXECUTIVE SUMMARY

Introduction

In December 2002, a wide cross-section of representatives from the herbal industry around the world met in Jamaica for the Caribbean Herbs Business Forum (CHBF) - "Fostering commercial partnerships for sustainable and economic use of biodiversity". At the forum, several important recommendations were made to address the constraints facing the Caribbean herbal industry and a key constraint identified was the lack of instructional manuals on what and how to grow, process, and package herbals for profit.

Objectives of the study

This study is intended to produce a handbook, for the growers, extension workers, and other partners in the industry. It will provide up-to-date information on twenty Caribbean herbs selected for their possible economic potential. The objectives will be achieved by making the handbook available also as reference material to research institutions and herbal organizations.

Methodology

The plants were selected on the basis of their perceived potential for production and transformation into commodities for a sustainable herbal industry. Collecting the data was a multi-disciplinary exercise, based on the agronomy, botany, chemistry, pharmacognosy, pharmacology, plant taxonomy and post-harvest processing and quality issues, as appropriate to each plant. The data was collected from a variety of information sources, and then thoroughly entirely reviewed by experts from regional and international research organizations, the private sector and herbal practitioners. Only information for which there was scientific evidence has been used to compile profiles of the plants which are presented in the handbook, in alphabetical order, by their scientific names.

Expected results

The herbal profiles would be developed in such a way as to encourage the grower, processor and distributor to produce commercially viable products, whether as fresh herbs, herbal teas, exotic herbal drinks, liquid extracts, cosmeceuticals, essential oils, herbal remedies or nutraceuticals. The study would elaborate the concept that, not only crop, but also product diversification is crucial in Caribbean agri-business, while plants possibly at risk of extinction would be identified, in the context of the need to conserve Caribbean biodiversity.

Findings

Nearly all the plants selected were difficult to recognize solely on the basis of their common names, thus they have been identified by their current scientific names, and by the use of colour pictures. Most of the plants demonstrated multi-purpose uses for industry, but many are not cultivated species.

In most cases, the information about agro-technology and germplasm collections was not available in the Caribbean region, and had to be accessed from the publications of CYTED and TRAMIL in Latin America, and the PROSEA Foundation in South-East Asia.

Hardly any reliable market trends and trade statistics were available for single herbs - even for the better known commodities based on *Croton eluteria, Myristica fragrans, Quassia amara* and *Zingiber officinale*. However, Caribbean farmers treasure their small holdings in *Aloe vera, Cymbopogon citratus, Eryngium foetidum, Lippia alba, Momordica charantia, Senna alata* and *Smilax regelii*. Of these, the best documented in science and technology appear to be *Aloe vera, Curcuma longa, Vetiveria zizanioides* and *Zingiber officinale*. Vetiver remains the "thin green line" against the scourge of soil erosion and land slippage which are environmental disasters in the region. At present *Aloe vera, Andrographis paniculata, Curcuma longa, Hibiscus sabdariffa, Quassia amara, Senna alata* and *Zingiber officinale* are established and approved sources of their respective cosmeceuticals, nutraceuticals or phytomedicinals.

Conclusions

Generally, proper identification of the selected plants posed a serious challenge, because their scientific names (and the richness of Caribbean biodiversity) were not familiar to stakeholders in the industry.

In some cases, there was little scientific evidence to identify biologically-active principles in the plant. However, a recent discovery is the proven and effective treatment for symptoms of the common cold found in the phytomedicine prepared from *Andrographis paniculata*.

Roughly half of the selected herbs have never been cultivated commercially in the region, and appropriate agro-technological data was scarce. Breeding of herbs and spices is generally accepted as lagging far behind that of the major food crops.

The good news is that the markets today seem to favour "ethnic" herbal preparations from such plants as *Cymbopogon citratus* and *Pimenta dioica* but this raises questions about the sustainability of supplies of quality products for these niche markets. Another question is: Are harvesting practices for herbal products from *Colubrina arborescens* and other forest plants also sustainable?

Another consideration is that there are no or only few reliable trade data available for single herbs anywhere in the world.

Recommendations

It is strongly recommended that, to encourage the sustainable use of Caribbean plant biodiversity, training courses should be provided urgently to build individual and institutional capacity in the area of plant taxonomy in the region.

In the case of carapa seed oil, sarsaparilla root and others, there is need for research work, not only to determine their active constituents, but also to establish standards for quality, safety and efficacy of their extracts, and for the development of monographs.

Closer collaboration should be encouraged between Caribbean stakeholders and the CYTED and TRAMIL organizations in neighboring Latin American countries. This would bring benefits to the agro-technological aspects of *Lippia alba, Maranta arundinacea* and other herbs. There is need also to pursue organic farming for some of the herbs; and, in certain cases, to consider the application of modern biotechnology.

The ICS-UNIDO and other international agencies should be invited to provide training in good agricultural and collection practices for Caribbean growers and processors of especially carapa seed, cascarilla bark, mauby bark, quassia wood and bayrum leaf.

With the objective of promoting diversification in the agri-business sector, more serious initiatives should be taken to collect trade statistics and to access world markets for novel industrially-prepared herbal products from *Cymbopogon citratus, Eryngium foetidum, Lippia alba, Hibiscus sabdariffa* and *Myristica fragrans.*

2. INTRODUCTION

2.1 Background

While the international market for herbal products has been expanding rapidly, the Caribbean herbal industry for various reasons has remained under-developed; and yet, there are many reasons why agencies in the Caribbean should be interested in developing the herbal industry, such as:

- the need to diversify agriculture
- to conserve foreign exchange by substituting local for imported herbal products
- the herbal industry is labour-intensive and can serve to reduce unemployment
- integration of herbal business with tourism enables the development of the herbal/ecotourism industry
- to capitalize on the rising global interest/usage of herbs

A key constraint on the sustainability of a thriving herbal sector is the lack of user-friendly technical manuals to provide information on what and how to grow medicinal and aromatic plants to produce fresh herbs, herbal teas, exotic herbal drinks, liquid extracts, flavourants, fragrances, fixed oils for soaps and other cosmeceuticals, essential oils, herbal remedies and nutraceuticals in the Caribbean region. To assist the reader in understanding terms used in the modern herbal industry, a Glossary is provided in Annex 4 of this report.

While a substantial amount of scientific data exists concerning certain Caribbean herbs, the information is often incomplete and at best fragmented across a wide spectrum of publications. In addition, there is little or no reliable trade statistics for even the better known plants of direct use to farmers, extension workers and promotional organizations trying to grow, process and export Caribbean herbal products.

It is against this backdrop that the Caribbean Herbs Business Forum (CHBF) - "Fostering Commercial Partnerships for Sustainable and Economic Use of Biodiversity" was held in Jamaica in December 2002. The CHBF accommodated a wide cross-section of persons representing the herbal sector/industry from around the world. Several important recommendations were made to address the constraints facing the Caribbean herbal industry, and these were sub-divided into a three-track approach, namely:

1. Re-branding and re-positioning Caribbean herbals;
2. Enabling regulatory issues in the Caribbean herbal industry;
3. 3. Exploring the potential for herbals in crop and product diversification.

The present study is a response within the framework of recommendations made especially in the latter track; and it is made possible through the collaborative efforts of the CTA, IICA and the Caribbean Herbal Business Association.

2.2 Objectives and Scope of the Study

The overall objective of the current study is to increase the availability of knowledge on the special attributes of Caribbean herbals, so as to improve and expand their commercial viability within the context of expanding regional and global demands for herbal products.

This will be achieved in the form of a handbook of selected Caribbean herbals for industry, starting with twenty medicinal and aromatic plants which have good prospects for commercial viability. It will address the information needs of growers, processors, distributors and other stakeholders in the herbals and botanicals business. The handbook will be made available also as reference material for research and herbal organizations.

2.3 Methodology

The first step was to select plants not only for crop diversification, but also for transformation into diverse value-added products for trade. Market surveys and traditional usage were used by the stakeholders to assist the process.

The first twenty (20) plants selected were categorized as follows:

- 5 well known and currently utilized herbs, namely ALOE (*Aloe vera*), GINGER (*Zingiber officinale*), NUTMEG (*Myristica fragrans*), TURMERIC (*Curcuma longa*) and VETIVER (*Vetiveria zizanioides*)

- 10 herbs which are widely used in the industry, but about which less information is available, namely ARROWROOT (*Maranta arundinacea*), BAYRUM TREE (*Pimenta racemosa*), CASCARILLA (*Croton eluteria*), CORAILI (*Momordica charantia*), LEMON GRASS (*Cymbopogon citratus*), MAUBY (*Colubrina arborescens*), PIMENTO (*Pimenta dioica*), QUASSIA (*Quassia amara*), RICE BITTERS (*Andrographis paniculata*), and SORREL (*Hibiscus sabdariffa*);

- 5 with commercial potential and in which there is general intererest in the industry, but still not being widely used, namely CARAPA (*Carapa guianensis*), FITWEED (*Eryngium foetidum*), SANTA MARIA (*Lippia alba*), SARSAPARILLA (*Smilax regelii*) and WILD SENNA (*Senna alata*).

Using only the local or common names for herbs in the multi-cultural milieu of Caribbean society usually leads to confusion and to their mis-identification. Therefore, in order to ensure that the attributes of quality, safety and efficacy were indicated accurately, the current scientific name and synonyms were recorded for each selected plant. Colour photographs of the plants also were included to facilitate their identification.

A multi-disciplinary methodology based on the botany, chemistry, pharmacology, agronomy, horticulture and post-harvest processing appropriate to each herb has been

used to collect and collate data for this study. Reliable data was first collected from official pharmacopoeias and specialized monographs; for the least documented herbs, data collection, with critical review, started with the consultation of electronic databases. In all cases, searches were made of a wide spectrum of reference books, review articles, primary sources and other literature, as indicated in later sections of this report. The main author was supported by reviewers expert in agronomy, pharmacognosy and plant taxonomy. Additional input was received from colleagues at regional and international research institutions, from private sector herbal businesses, and from herbal practitioners.

2.4 How to Use this Handbook

The information contained in this handbook has been derived from experts, published articles and technical databases. Therefore, consultation with the experts is strongly recommended to anyone engaged in growing, processing, sale and use of these herbals.

The section **"3. Herbal profiles"**, which forms the major portion of this handbook, elaborates the profile of each herb under the headings:

- Scientific name and family
- Colour photograph
- Common or other local, multi-lingual names (used in the Caribbean)
- Synonymy (for the scientific names)
- Botanical Description
- Distribution/Ecology
- Active Principles
- Parts Used/Key uses
- Quality, safety, efficacy and regulatory framework
- Cultivation Practices and Harvesting
- Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage
- Germplasm/Collection/Seed Sources
- Research Needs
- Bibliography

In order to avoid confusion, the reader will note that the plants are always identified by their currently approved scientific names. Specific herbal products and preparations are described by their commonly used (trade) names. For convenience a Glossary of Terms used is presented separately in the Annex 4.

"**4. Conclusions and Recommendations**" is the last section of this report. It presents an overview of the challenges met in compiling the handbook, and it exposes the various information gaps, and highlights the research efforts and infrastructural developmental work needed to make the growing, processing, packaging and sale of herbals into a profitable industry. This handbook should contribute significantly to attempts to diversify the agricultural sector in the Caribbean region.

3. PLANT PROFILES

3.1 Aloe vera

ALOE

(LILIACEAE-ALOEACEAE)

Common or Other Local, Multi-lingual Names
Aloes, Barbados Aloe, Bitter Aloes, Curacao Aloe, Sempervivum, Simple Bible, Sinkle Bible

Synonymy
For *Aloe vera* (L.) Burm. f., the synonyms are *Aloe perfoliata* var. *vera* L., *Aloe barbadensis* Mill., and *Aloe vulgaris* Lam.[1, 2, 3]

Botanical Description
A succulent herb with a stout stem supporting a compact rosette of fleshy, erect leaves up to 55 cm long x 8-10 cm wide at the base, tapering to a long slender sharp tip and curved spines along the margins of the leaves, young leaves with white streaks and dots, mature leaves green but white at the base where it clasps the stem; inflorescence a raceme 1 - 1.3 m tall from the center of the rosette; flowers yellow. The leaf when

cut yields a free flowing yellow, bitter tasting, yellow viscous sap and a clear gelatinous sap.

Distribution/Ecology
It is native to southern and eastern Africa, and subsequently introduced and established in the West Indies [3]. It occurs naturally in the driest soils, and is not suitable for water-logged soils.

Active Principles
The major active principles are purgative cathartic agents, which are hydroxyanthrone derivatives, mainly of the aloe-emodin-anthrone 10-C-glucoside type. They are present in "the drug Aloe" of the international pharmacopoeias, which is the solidified, bitter, yellow exudate which originates from the bundle sheath cells of the leaf. The major constituent known as barbaloin (aloin) is in fact a mixture of the glucosides aloin A and aloin B, which are aloe-emodin.

Parts Used/Key Uses
According to the official pharmacopoeias, the powdered, dried latex/juice, "Aloe" which is made for oral use, occurs in dark chocolate-brown usually opaque masses; fracture, dull waxy, uneven, and frequently conchoidal, with characteristic disagreeable odour and very bitter taste. Short term treatment with "Aloe" for occasional constipation is proven to be effective by clinical research and its mechanism of action is well understood [1].

Not to be confused with "the drug Aloe" is "Aloe Vera gel". The latter originates from the (fleshy) parenchymatous cells in the leaf and containing mainly polysaccharides (mannose derivatives) which are effective as external treatments for minor wounds and skin disorders [1]. Traditionally, the preparations made from the leaf contain a mixture of the both the bitter-tasting exudate and the parenchymatous gel. These traditional remedies are taken for colds, asthma, skin bruises, inflammatory and various other conditions. The freshly sliced leaf is applied to skin wounds; for headaches, it is tied to the head and used as a rectal suppository for constipation.

In the case of "Aloe Vera Gel", the clear mucilaginous gel is a commercial preparation and hence is quite unstable. Hence, only the fresh gel is recommended. It is widely used for external treatment of minor wounds and skin disorders, including burns, bruises and abrasions, and may be effective as a hydrating ingredient in creams and ointments for the cosmetics industry [1]. Extracts of the gel have been shown scientifically to be mildly anti-inflammatory, due to a mixture containing acemannan (acetylated mannan) and other constituents [4]. Acemannan is a polysaccharide constituent which recently has also been the subject of research in the management of HIV/AIDS [5]. The patented compound is about 8×10^4 daltons in size [4].

Quality, safety, efficacy and regulatory framework
(**a**) For the established herbal drug "Aloe", standard quality tests have been described in detail in the official pharmacopoeias, such as the United States Pharmacopeia, the Japanese Pharmacopeia and the European Pharmacopeia. In assays, the chromatographic data for barbaloin is used, because it is primarily the laxative constituent. The correct individual dose (often less than 100 mg) is the smallest

amount required to produce a soft-formed stool, and should be limited to adults and children over 10 years old [(1)].

NOTE: "Aloe" in commerce may sometimes be adulterated with black catechu, pieces of iron, and stones. These adulterants can be detected by examining alcohol-soluble extracts under ultraviolet light, which give a deep brown colour with the "Aloe", and a black colour with catechu.

WARNINGS: The major symptoms of overdose are griping and severe diarrhoea. The treatment is supportive with the intake of generous amounts of fluid and electrolytes. As with other stimulant laxatives, products containing "Aloe" should NOT be used in patients with intestinal obstruction, stenosis, atony, severe dehydration with electrolyte depletion, or chronic constipation. Moreover, Aloe-containing products should be used only if no effect can be obtained through a change of diet or the use of bulk-producing (laxative) products; and, in any case, should NOT be used continuously for longer than a fortnight. The absorption of other orally-administered medicines may be reduced due to the decreased intestinal transit time caused by "Aloe". Aloe should NOT be used during pregnancy, except under medical supervision [(1, 4)].

(b) "Aloe Vera Gel" has the appearance of a viscous, colourless, transparent and odourless liquid, with only slightly bitter taste. Generally, identity tests are established in accordance with national requirements, usually for its polysaccharide composition.

WARNINGS: The gel may be stabilized by pasteurization at 75°C, for less than three minutes. "Aloe Vera Gel" is contra-indicated in cases where the patient is known to be allergic to plants in the Liliaceae family [(1, 4)].

(c) There must be few plants whose reputed medicinal properties have been given to so much review and controversy as in the literature on *Aloe vera.* [(4, 5, 6, 7)]

Cultivation Practices and Harvesting

Propagation can be done through seed or sucker or by cuttings. When it is necessary to produce large quantities of buds, the adult plants are decapitated at about 10 cm above the ground, removing all the leaves and buds. Forty days later numerous buds about 5 cm in length emerge. When they reach 10 cm in length, they are cut off and then sown to yield plantlets 25 cm tall after 3 months, which are then ready for planting in the field at a spacing of 90 cm x 70 cm (or a the rate of over 4, 000 plantlets per ha.). Planting may be done the year round.

These plantlets grow in any soil, preferably poor soils, ideally calcareous, dry sandy and well-drained, but not in swamps [(8)] and is drought resistant[1]. No special conditions of soil preparation are required, and any system can be used which ensures rooting growth and development can occur, with conservation of the soil structure.

In conventional practice, good productivity results can be achieved through asexual reproduction with buds. When the demand increases the techniques of clonal micro-propagation may be employed. *In vitro* propagation yields the most favourable genotypes, and generates plants with high concentrations of active principles, resistant

[1] Cf.: <www.hort.purdue.edu/newcrop/CropFactSheets/aloe

to disease and the climate change [9].

Flowering begins late December to early January and into March, but rarely has the formation of fruits been observed. Dry capsules in which the dehiscence of the fruits, already mature, occurs has been observed about 90 days after flowering has started. Although seeds can be produced, as soon as set occurs, the plant produces numerous buds which can be used for the purpose of propagation [8].

Fertilization is with good supplies of nitrogen, or alternatively with some 30 to 40 tons of organic matter per hectare. Light watering is required to guarantee plant survival with frequent weeding necessary at the beginning of plant growth, and especially between the furrows.

Generally, harvesting begins two years following planting, and then again at six month intervals. Gloves and long-sleeved shirts are recommended for persons who do the harvest. Manually, and with the help of knives, incisions are made at the extreme base of the lower (oldest) leaves, and then the cut leaves (6 to 8 per plant) are separated [9]. Average yields are reported as 35t/ha leaves per harvest [9]. In Cuba, the aloe plantations can be exploited for productivity for more than 15 years [8].

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

The harvested leaves are washed and disinfected to minimize microbial contamination. Batches of 10 kg each, washed with running tap water at first are then submerged in 100 litre stainless steel tanks of water.

(a) For the preparation of "Aloes" or "Bitters", the collected leaves are placed with the cut ends above special collectors for the exudate inside a well-ventilated area for 2 to 3 hours, and allowed to dry [8, 9].

(b) For the preparation of “Aloe Vera Gel", the harvested leaves are washed with water and a mild chlorine solution. Outer layers of the leaf are removed, including the pericyclic cells, leaving a "fillet" of gel (pulp). Care should be taken not to tear the green rind which can contaminate the fillet with leaf exudate. If the gel is held at higher temperatures than 80°C, and for longer than 3 minutes, during pasteurization, its chemical composition may be altered and quality reduced [1]. More details of the industrialization process for the preparation of gel for dermatological and cosmetic use is available [4].

(c) "Aloe juice" is obtained by adding water and other ingredients to the gel, and it is used variously in cosmetics and pharmaceutical preparations [4, 9].

(d) "Aloe concentrates" are obtained by reducing the water content of the gel, using various techniques, and the percentage in solids then moves from 5% in the gel up to 20% in the "concentrate' (Visit:<www.genemco.com/aloe/faq.html>).

Note: The largest bulk of aloe products in the world markets is supplied by the USA and the demand for it continues to rise[2]. This herb continues to be a good candidate for cultivation and trade.

Germplasm/Collection/ Seed sources
No sound information is available.

Research Needs
More laboratory work is needed to make stable aloe gel preparations, because they tend to deteriorate over a short period. Clinical trials are still required to substantiate the healing powers of acemannan for AIDS, and of the whole leaf extract of *Aloe vera* for cancer, for lowering blood sugar in diabetic patients, reducing hyperlipidemia, for arthritis, gastric ulcers and colitis.

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[2] World trade in aloe-based finished products is estimated at US$25 million. (Visit:<www.safedmusli.net/nandannewsletter.htm>).

3.2 Andrographis paniculata

RICE BITTERS

(ACANTHACEAE)

Photo extracted from http://altcancer.silvermedicine.org/andcan.htm

Common or Other Local, Multi-lingual Names
Chiretta, Green Chiretta, Kalmegh, King of Bitters, Kirata, Wild Rice

Synonymy
Synonyms for *Andrographis paniculata* (Burm. f.) Wall. ex Nees are *Justicia latebrosa* Russ.; *J. paniculata* Burm. f.; *J. stricta* Lam. ex Steud [1, 2].

Botanical Description
A tap-rooted annual bushy herb up to 1 m tall with square stems; leaves opposite, 4-12 cm long and 1-2.5 cm wide, tapered at both ends; the main inflorescence a panicle with racemose branches; flowers 11-13 mm long, two-lipped, purple or white with purple streaks; fruit a 12-seeded cylindrical capsule 13-21 mm long and 3.5 mm wide, with gland-tipped hairs.

Distribution/Ecology
Andrographis paniculata is native to India and Pakistan and thrives best in hot and humid tropical conditions. It is common in waste places and gravelly banks in the Greater Antilles, Dominica, St. Vincent & the Grenadines and other Caribbean lands, where it is naturalized.

NOTE: A related species is the popular medicinal plant *Justicia pectoralis* Jacq. (= *Dianthera pectoralis* (Jacq.) Murr.) in northern South America, known locally in the West Indies as "carpenter grass" or "freshcut" in the West Indies.

Active Principles

The key chemical constituents are andrographolide and related diterpenoid lactones (in both the free and glycosidic forms), and they are present in the highest concentrations in the leaves [2,3]. The roots contain a significant flavone[3].

Parts Used/Key Uses

Traditionally, the intensely bitter-tasting preparations from the whole plant have been used to treat such ailments as colds and fevers, dyspepsia, flatulence and diarrhea, and, even as a tonic and an anthelmintic agent, in Ayurvedic, Thai, Chinese and Caribbean folk medicine.

The dried aerial parts constitute the established plant drug *Herba Andrographidis*, which is available in tablets and capsules. This drug is clinically proven as a treatment for upper respiratory infections such as the common cold and uncomplicated sinusitis, bronchitis, and lower urinary tract infections [2, 3]. Dosages are indicated at about 2 g powdered leaves thrice daily after meals.

The approved usage of this phytomedicine is part of the fabric of modern healthcare and is evidence-based as a result of on-going scientific research which supports both the safety and effectiveness of Herba Andrographidis [2, 3, 4, 5].

Quality, safety, efficacy and regulatory framework

Guidelines have been published by the World Health Organization on the quality control methods to be applied for medicinal plants and their products, and these clearly apply to the scientific assessments to be performed on this herb.

The commercial preparations of *Herba Andrographidis* are generally standardized and analyzed by chromatography to the content of andrographolide and related lactones [2, 4] . Large oral doses may cause gastric discomfort and loss of apetite. *Herba Andrographidis* should not be used during pregnancy or lactation, or administered without medical supervision to children [2, 3]. All dosage forms of this herbal drug should be stored in well-closed containers, protected from light and moisture.

Cultivation Practices and Harvesting

This herb grows quite easily in all types of soils, but applications of Nitrogen and Phosphorus will increase the yields. The applications of nitrogen should be split in two doses over an interval of one month. The seeds remain dormant for 6 months. Seeds should be soaked for 24 hours and then dried, before being sown with germination starting after one week. In the natural habitat, propagation of this herb is through the shattered seeds.

Vegetative propagation can be carried out. Cuttings consisting of 3 nodes taken from

[3] Visit:<http://www.geocities.com/andrographis/botany.htm>.
[4] Visit:<http://www.phytomedicine.com.au/files/articles/andrographis_paniculata.pdf>

the upper third of one year old plants have given the best results. In special cases layering is carried out, as each node is capable of producing sufficient roots.

For raising crops in one hectare, three beds of 10 x 2 m size should be tilled, pulverized and leveled around May.

In the nursery, liberal use of organic manure is advised for raising healthy seedlings. Very thin layers of soil and compost mixture should cover the seeds. Beds should be irrigated regularly until the seedlings emerge, after six days. Transplanting of seedlings is done by mid-June at a row and plant spacing of 45 to 60 cm and 30 to 45 cm respectively. Beds must be irrigated immediately after planting. Shading at a 20% level is optimal.
Poultry manure or FYM at 10t/ha may be used as fertilizers. (Visit:<www.indianmedicine.nic.in>)

Crop duration is over 90 to100days.
Maximum herb biomass can be obtained in 3 months, beyond which the leaves start shedding, and flowering is initiated. At this time, the active principles, the andrographolides, are high in content in the leaves. Since the whole plant contains the active principles, the entire plant is harvested and then dried in the shade and later powdered [6, 7].

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging, and Storage
The biomass harvest of the herb should be spread on a floor, and it should be covered at night to protect from dew. One week drying under shade is required; and the yields from a well maintained crop can reach four tons of dried herb per hectare, and, a net income in India of Rs. 33 000 [6]

Note: This herb has important development potential for the Caribbean: as a proven medicinal crop, its therapeutic attributes having been well documented.
Its best prospects are as preparations for use as a general tonic, and its refined extracts (phytomedicinals) are effective treatments for the common cold [7, 8].

Germplasm/Collection Practices/Seed Sources
For information concerning the germ plasm for *A. paniculata*, contact the Centre for Advanced Studies in Botany, University of Madras, Guindy Campus, Chennal, India.
There are no named varieties (Visit:<http://www.indianmedicine.nic.in/html/plants/mcmain.htm#kal>).

Research Needs
Further studies need to be done on the extracts and the purified diterpenoids/ andrographolides and the flavonoids from the plant for a multitude of their pharmacological effects [7, 8]. The callus techniques applied to this plant should be improved further to produce better yields of the andrographolide constituents [7, 8].

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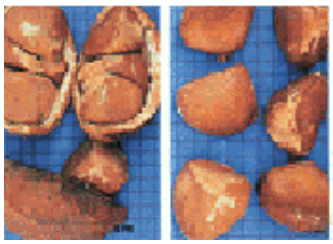
3.3 Carapa guianensis

CARAPA

(**MELIACEAE**)



Common or Other Local, Multi-lingual Names
Andiroba, Bastard Mahogany, Caraba, Crabwood, Crapaud, Crappo, Figueroa, Karaba, Krappa, Randiroba, Sapo, Tangare, Tololo, White Crabwood.

Synonymy
No synonyms are known for *Carapa guianensis* Aubl.

Botanical Description
A tree 30-40 m tall with low buttresses at the base of the trunk, bark flakes off into strips; leaves compound with 4-7 pairs of opposite leaflets and an odd leaflet at the tip, leaflets oblong-elliptical 10-30 cm long and 5-9cm broad; inflorescence a panicle with small white flowers ca. 5 mm long; fruit is a rough, woody, brown 4-angled capsule ca. 8-10 cm wide x 8 cm high containing up to 12 angular seeds ca. 5 cm long and 4 cm wide [(1)]

Distribution/ Ecology
Carapa can tolerate a wide variety of environmental conditions and is native to and widespread in the Caribbean forests. It prefers habitats which are swampy ground or low-lying forest, located from Belize to Guyana and from Cuba to Trinidad and Tobago. This tree would be more plentiful in today's forests had it not been so widely exploited by the loggers. The wood of the highland *Carapa guianensis* in Guyana is superior to that of trees growing in the swamp, but the latter tend to produce seeds with a higher yield of oil[5]. In Trinidad, the seeds are eaten and dispersed by agoutis and other animals [(1, 2)].

Active Principles
Triglycerides are in the fixed oil ("crab oil") which is obtained by expression of the seed.
Tannins are important constituents in the tree bark [(1, 3, 4)].

Parts Used/Key Uses
Traditionally, the bark, leaves and seed are used medicinally in folk medicine, from Trinidad and Central America through Venezuela to Amazonian Brazil [(1)]; for

[5] Personal communication with Ms. Annette Arjoon

example, a decoction of the bark is drunk to treat diarrhoea. The expressed seed oil is applied on sore feet, on the head to get rid of lice, for skin diseases, and as a mosquito and sand fly repellent [1, 3].

Industrially the seed oil is used for illumination and for soap making [1], and is of increasing importance as an active ingredient, moisturizer or as a carrier in cosmetic products. The oil is also used for treating wood to prevent insect attack.

The wood of this tree is hard, reddish and insect resistant, considered "one of Amazonia's noble timbers", much valued for furniture and house building [4]. The trees have a very promising potential in agroforestry systems.

Quality, safety, efficacy and regulatory framework

Carapa seeds contain approximately 74% kernel and 26% shell. The kernel contains over 50% oil which is transparent yellow in colour, solidifies at temperatures below 25°C, consists of about 9% glycerides, principally olein and palmitin. The properties of the oil appear to be very similar, whether the seeds are harvested around June or around November, in Guyana[6]. At 15°C, the oil has a density of 0.923 and a saponification index of approximately 200. It is extremely bitter, whether pressed cold or hot. When obtained by hot press, it becomes cloudy if left standing, condensing out a solid white fat which is mainly palmitin. This solid fraction is used for making sodium soaps in north-western Guyana and northern Brazil [4].

Cultivation Practices and Harvesting

This tree is, occasionally, cultivated on the dry uplands, generally on well-drained clay soils, where it grows well averaging two trees per hectare [4].The seeds germinate well sown in sand and covered in sawdust a week after falling from the tree. Germination is complete in 3 months and the seedlings can be transferred to plastic nursery bags. Sowing directly into the nursery bags also is recommended. Nursery or field grown seedlings are susceptible to rodent attacks and to shoot borer (*Hipsiphylla grandella*) attack.

After the tenth year the mature tree will produce seeds, which are collected from the ground nearby, as soon as possible after falling, so as to avoid predation by mammals and insects. The annual nut yield can reach 300 pounds per tree[7]. Researchers in Brazil suggest that the trees have great potential for forest enrichment and as agroforestry species. In Guyana it fruits in the rainy season of May to July, and for a second season in October to November.

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

After the seeds have been collected, the oil extraction methodologies applied to them vary, from community to community. Complete extraction may take from one to two weeks. In Guyana, in general, the seeds are boiled in water and then allowed to decompose for a few days. The hard outer protective covering is broken and the soft cotyledons are then scooped out. The cotyledons may then be "cold pressed" by squeezing by hand or using a "matapee" (a long basket designed also for use in

[6] Personal communication from Ms. Annette Arjoon.

[7] A single packet of two seeds (per nut) is recorded to have been sold for US$4 (Visit: <http://www.tropilab.com>).

cassava processing). Mixing a small amount of broken shells often assists in producing more oil from the paste.

Alternatively, a "hot melt" procedure is done, by kneading the soft cotyledons daily under the sun and spreading the paste on corrugated aluminum sheets. The aluminum sheets are place at an angle so as to allow the oil exuding to drain out by gravity. Then the oil is collected at the lower end of the sheet. The soft cotyledons are also heated in a pot to help release the oil.

Storage of the oil in stoppered amber bottles and away from light is highly recommended.
In Amazonia, carapa ("andiroba") oil is extracted in small processing plants using hydraulic presses kept of the "Cage Press" or "Expeller" type kept at 90°C.

Germplasm/Collection/ Seed sources
No reliable data has been found.

Research Needs
Quality assurance systems should be established as early as possible so as to encourage the production of good quality carapa seed oil. In Guyana, the Iwokrama Programme is working closely with local forest communities to assess the environmental, social and economic impacts of harvesting and processing the carapa oilseeds, and getting the oil as part of a sustainable cottage industry into the market place.

More work should be done with *Carapa guianensis* in agroforestry systems and in multi-purpose forest management in the Caribbean region, because its potential as a multi-purpose (oil-wood) crop seems enormous [(4)].

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3.4 Colubrina arborescens

MAUBY

(RHAMNACEAE)

Photo courtesy http://www.rain-tree.com/Plant-Images

Common or Other Local, Multi-lingual Names
Black Velvet, Bois Mabi, Coffee Colubrina, Corazon de Paloma, Mabi, Mawbie, Snakewood.

Synonymy
Colubrina arborescens (Mill.) Sarg. has the synonyms *Ceanothus arborescens* Mill.; *Ceanothus colubrinus* (Jacq.) Lam; *Colubrina colubrine* Mill; *Colubrina ferruginosa* Brongn.; *Rhamnus colubrinus* Jacq.[1, 2].

Special Note:
The equally popular mauby or mawbie tree of the Lesser Antilles, which is the mabi in Puerto Rico, and elsewhere, grows to 4 - 6m high, and with the trunk about 10cm in diameter. This is *Colubrina elliptica* (Sw.) Briz. & Stern which has the synonyms *Colubrina reclinata* (L'He'rit.) Brongn.; *Rhamnus ellipticus* Sw. *Colubrina elliptica* often is found as a smaller tree, but with very similar features compared with *C. arborescens* [1, 2].

Botanical Description
A shrub or tree growing up to 13 m high with woolly rust–coloured hairs on twigs and leaves when young; leaves alternate up 12cm x 6cm, ovate-lanceolate; flowers small, greenish petals ca. 3 mm long; fruit a brownish-black, rounded capsule 7-8 mm long with long, shiny black seeds ca 4 mm long.

Distribution/Ecology
Colubrina arborescens (Mill.) Sarg. is native to the West Indies, and like its sister species *Colubrina elliptica* (Sw.) Briz & Stern. may often be found growing in clusters in sunny or partially shaded locations, in rocky limestone and drier woodland

areas, from Florida and the Bahamas through the Caribbean south to Barbados and St. Vincent [1, 2, 3].

Active Principles

A complex mixture of saponins has been identified as constituents in the bark of *Colubrina arborescens* [4]. Important constituents of the bark of *C. elliptica* are a mixture of bitter-tasting saponins (triterpenoid glycosides) [5], as well as condensed tannins (0.15%) which contribute to the astringency (body and fullness of flavour) to the special taste of mabi drinks. Alkaloids (scutianine and its derivative compounds) occurring in the bark make only minor contributions [6].

Parts Used/Key Uses

Traditionally, decoctions of the bark and the leaves of *C. arborescens* are added to the bath to treat injured skin, and aches and joint pains [1, 3]. The bark from both *C. arborescens* and the sister species *C. elliptica* are used to make the popular refreshing beverage called mabi, or mauby, or mawbie. The unsweetened decoction of the bark also is taken as a bitter tonic and even to treat diabetes [2].

C. arborescens is considered a honey plant, furnishing both nectar and pollen to honey bees (*Apis mellifera* L.) in the months of May through December in the Dominican Republic. Its wood is hard and heavy, and because it is resistant to decay, it is used for fence posts.

Quality, safety, efficacy and regulatory framework

As a fermented drink from *C. elliptica* bark, mabi is prepared by the joint actions of microorganisms occurring in the unrefined sugar used, and the inoculant or starter, called the "pie". Preservation of the fermented mabi drink is achieved by pasteurization with added sodium benzoate, and this improves its attributes for commercial production[7].

Cultivation Practices and Harvesting

For *Colubrina arborescens*, propagation is by seeds, but after they have been subjected to a pre-germination treatment. Various methods of pre-germination treatment are available, such as soaking the seeds in hot water for 2 minutes, one day before sowing [3]. Seeds are collected when the first fruits turn a dark colour, and should be collected directly from the tree. The fruits are then dried on plastic sheets, where they are allowed to open.

Colubrina arborescens grows in a wide variety of well-drained soils in its native range, including soils of all textures, pH's ranging from about 5.0 to 8.0, and soils derived from sedimentary, igneous and metamorphic rocks. Although the species is evergreen in moist sites, in dry areas, especially in excessively drained sites, it defoliates in response to prolonged drought. It tolerates salt spray and moderate amounts of salt in the soil. *C. arboresens* grows in full sun and partial shade of low forest or broken high forest. Growth is slow in dry forest areas and generally moderate in moist fertile soils. Its flowers are insect-pollinated. Seeds are flung a short distance when dry and the fruits pop open [8, 9].

Colubrina arborescens helps protect the soil, contributes to the aesthetics of the forest, and furnishes food and cover for wildlife [8]. In Florida *C. arborescens* is

known as coffee colubrina, or wild coffee, and it is cultivated, using a spacing of 1 m. or more, as an ornamental and also as a hedge plant [9].

Protection from weeds, vines, and faster-growing trees for two or more years is imperative. No pests or diseases should cause problems with this plant [8, 9].

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

No detailed information is available for the production of the tree bark.

Germplasm/Collection/Seed Sources

For *C. arborescens*, flowering and fruiting occur around January, and the seeds collected around March. When stored in dry well ventilated rooms, the seeds maintain their viability for one year [3].

Research Needs

Stock assessments and management plans for wild stocks of *Colubrina arborescens* should be updated to avoid risk of extinction, while trials should be carried out for its potential in agro-forestry development.

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3.5 Croton eluteria

CASCARILLA

(EUPHORBIACEAE)

Croton eluteria (L.) Sw.
Image processed by Thomas Schoepke
www.plant-pictures.de

Common or Other Local, Multi-lingual Names
Cascarilla Bark, Cocomcoli, Eleuthera Bark, Kouli, Quina Aromatica, Quina Falsa, Quina Morada, Sassafras, Serosee, Sweetwood Bark

Synonymy
The synonyms for *Croton eluteria* (L.) Sw. are *Clutia eluteria* L.; *Croton glabellus* of F. & R. not L.; *Croton nitens* Sw. [1, 2].

NOTE: *Croton glabellus* L. and also *Croton eluteria* Bennet have also been the scientific names given to cascarilla[8].

Botanical Description
It is an aromatic shrub 1.5-3 m or a tree up to 12 m tall. Leaves alternate, oblong-elliptical, gland-dotted, 2-15 cm up to 20 cm long and 6.5 cm broad with soft silvery scales below; inflorescence a branched raceme 3-12 cm long; male flowers with 10-12 stamens, female flowers with white petals ca. 5mm long, fruit a subglobose capsule 7-9 mm long with oblong-oval seeds about 8 mm x 6 mm [(1)].

Distribution/Ecology
It is native to the West Indies, in thickets or woods on limestone from Cuba and the Bahamas to Mexico [(2)].

Active Principles
The constituents of the bark include cascarillin, tannins, resins and an essential oil which together produce the pungent, bitter and astringent properties of extracts of the bark. The bitter-tasting diterpenoid which is Cascarillin A is possibly the ingredient which makes cascarilla extracts effective treatment for stomach indigestion [(3)].

Parts Used/Key Uses
The twigs, leaves or bark are used traditionally to make a tea as a remedy for colds and fever and also as a stimulating tonic. The tree bark is an important export from the Bahamas to Europe for the manufacture of tonics, **Campari** and **Vermouth** and in herbal treatments for diarrhoea.

Quality, safety, efficacy and regulatory framework
The powdered dried bark (cascarilla) is readily identified and distinguished from possible adulterants, microscopically by: the characteristic cork cells with their embedded crystals of calcium oxalate, the bast fibres, and the cells with oily secretions. A tincture of the bark is officially known as *Tinctura Cascarillae,* B.P. used in tonics and as a flavourant, such described in the British Pharmaceutical Codex[9]. Health risks or side-effects following the proper administration of designated therapeutic doses are not recorded [(4)].

The essential oil is an international commodity, which is produced by steam-distillation and by hydrodiffusion from the bark. The specifications for the steam-distilled essential oil show its major constituents to be alpha- and beta-pinene followed by myrcene and beta-selinene[10].

In the perfumery business, cascarilla bark essential oil is said to provide a fresh spice woody black pepper sweet anise odour[11].

Cultivation Practices and Harvesting
No information was available.

[8] Visit:<http://mobot.mobot.org/W3T/Search/vast/html>.
[9] Visit:<www.ibiblio.org/herbmed/eclectic/b.>.
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Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage
No information was accessible.

Germplasm/Collection/Seed Sources
No data was available.

Research Needs
The research needs for cascarilla are enormous if it is to contribute to a sustainable industry, starting with the development of quality standards for the oil.

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3.6 Curcuma longa

TURMERIC

(ZINGIBERACEAE)

Common or Other Local, Multi-lingual Names
Chichima**,** Curcuma**,** Haldi, Indian Saffron, Jhijhima.

Synonymy
The synonyms for *Curcuma longa* L. are *Amomum curcuma* Jacq.; *Curcuma domestica* Valeton, *Curcuma rotunda* L., *Curcuma xanthorrhiza* Naves and *Stissera curcuma* Raeusch [1, 2].[12]

CAUTION: *Curcuma longa* L. is also known as Indian saffron, and this association with the saffron of European origin (*Crocus sativus* L.) is disastrous in cooking, since the former is not a saffron substitute, having the same colour but definitely not the flavour.

Botanical Description
A robust perennial herb with leave blade ca. 30-60cm long and 11cm wide with distinct sheathing bases arising from an underground rhizome; inflorescence a cone-shaped spike 10-55 cm long and 5-7 cm wide arising out of the centre of the shoot, flowers yellowish-white; rhizome round about 1.5-2 cm thick producing secondary and tertiary branches forming dense clumps with brownish scales on the surface and bright orange tissue on the inside with a distinctive taste and smell.

[12] Visit:http://mobot.org/W3T/search/vast.html.

Distribution/Ecology
Curcuma longa is native to India and Sri Lanka, where it is cultivated on a considerable scale. It has been introduced and become naturalized and cultivated in Haiti and Jamaica and elsewhere in the West Indies. Since it is naturally a plant of the open forests, partial or intermittent shade is desirable for high yields, especially in warm and moist conditions[3].

Active Principles
The major colouring principles are the curcuminoids, mainly a mixture of curcumin and its derivatives (dicinnamoylmethane compounds) present at 3%-5% in the rhizome (spice). They are responsible for its use as a colourant, a major ingredient of curry powders and pastes, and in mustard pickles, like piccalilli [3, 4, 5, 6].

Parts Used/Key Uses
The rhizome is used also in cosmetic preparations, topically to treat acne and other skin conditions. It also has fungicidal and insecticidal properties. The younger shoots and young rhizomes can be eaten fresh as a spicy vegetable [3, 5].

Traditionally, turmeric has been used medicinally to treat a range of conditions such as pain and inflammation, peptic ulcers, haemorrhages, bruises, colic and menstrual difficulties. Therapeutic indications include symptomatic treatment of mild digestive disturbances and minor biliary dysfunction [2, 4].

The dried rhizome is known officially as *Rhizoma Curcumae Longae*, an aromatic bitter-tasting drug, characterized in the pharmacopoeias, as containing not less than 4% volatile oil, and not less than 3% curcuminoid constituents. The use of this herbal drug to treat acid, flatulent, or atonic dyspepsia has been validated by clinical data; and, an oral infusion of up to one gram taken thrice daily is recommended [2].

Turmeric (essential) oil and turmeric oleoresin (extract) find similar applications as the ground rhizome (spice) [3] and increasingly as anti-oxidants, in nutraceuticals and functional foods.

Quality, safety, efficacy and regulatory framework
With respect to turmeric as the spice of international and retail trade, acceptance of the dried rhizome is basically determined by its general appearance, and the organoleptic properties of its volatile/essential oil.
CAUTION: In some local markets, ground turmeric rhizome is found to be adulterated with lead chromate, yellow earth, sand or cheap talc [3].

Qualitative and quantitive analyses are carried out on turmeric for total curcuminoids, as well as microscopic and purity and other identity tests. The chemical composition is variable, depending on the cultivar and the cultivation practices used [3].

No toxic effects have been reported in taking *Rhizoma Curcumae Longae* as a drug [4]. Its efficacy as an anti-inflammatory and free radical-scavenging agent has been supported by laboratory experiments [2]. It is contra-indicated in cases of biliary obstruction.

The yellow essential oil derived from turmeric is composed mainly of a number of

monoterpenes and sesquiterpenes, including zingiberene and turmerone.
(**CAUTION**: Major adulterants of turmeric oil are the oils of the sister species *C. aromatica* and *C. zedoaria* the latter which are detected by the presence of camphor and camphene in both [1].

In the United States, the regulatory status 'generally recognized as safe' has been accorded to turmeric oil (GRAS 3085) and turmeric resin (GRAS 3087).

Cultivation Practices and Harvesting
This plant is propagated vegetatively using rhizomes or fingers. However, in vitro culture of excised buds from sprouts or tissue culture results in large numbers of plantlets, and is an excellent method of rapidly increasing clonal material.

Land preparation depends on whether it is to be grown in a pure stand or intercropped (e.g. with maize, chillis, aubergine or other fast-growing vegetables), or alongside ginger. If the latter is the case, the land is prepared to suit the most important component. Lands are usually prepared as for *Zingiber officinale*. Turmeric should preferably not be planted on the same land for more than two successive crops, with a four-year interval before re-planting.

Curcuma longa thrives naturally on a forest-type loam with a high humic content, which encourages rhizome development, but is grown commercially on a range of slightly acid soils, pH 5.0 - 7.5, including alluvial or clay loams, tropical red earths, sandy loams and rice paddies. Management is generally more important than soil type. Turmeric has a high nutrient requirement and commercial crops require substantial amounts of fertilizer to produce high rhizome yield. No accurate data are available on the total water use of turmeric or on changes in usage during plant growth. Growers rely on their own experiences. Over-watering, however, can be fatal.

In general, the pests of importance to *Zingiber officinale* also cause most damage to *Curcuma longa*, both in the field and in storage. The diseases attacking *Curcuma longa* are generally more important and damaging than pests. However, although a number of leaf diseases have been recorded, few are of major importance.

The rhizomes are ready for harvesting (digging) when the lower leaves turn yellow, usually after 7 or 8 months of growth. Care should be taken not to damage the rhizomes, and to ensure that the whole clump is lifted together with the dry plant. Leafy tops are then cut off, roots and adhering earth removed, and the rhizomes are well-washed [3].

Rhizome yields directly reflect the standard of crop management, and range from 5 000 to 10 000 kg per hectare and higher.

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

Curing (cleaning) the harvested rhizomes produces a yellow-tinted material, which is then dried in modern hot-air driers and polished. Polishing can be done by hand or by shaking the rhizomes in a gunny bag filled with stones[13]. The dried rhizomes are usually chemically-treated or fumigated before storage to prevent insect and fungal infestation. They should be stored in sealed containers in cool, dry, dark sheds, as they rapidly lose their colour. Turmeric enters into international trade mainly in the form of cured dried whole rhizomes(3).[14]

Steam-distilling fresh or dried rhizomes yields 2% - 10% of an essential oil; depending mainly on the cultivar and the oil is orange-red, slightly fluorescent, with a different aroma from the spice (3). Supercritical carbon dioxide extraction of the ground tubers is of growing importance.

The oleoresin may be obtained by solvent extraction from coarsely ground rhizomes, as for *Zingiber officinale*. Oleoresin yield is 6 to 10%, and it is rich in the curcuminoids. The oleoresin is the preferred alternative to the ground spice in many industrial applications, for seasoning and flavourings (3).

Germplasm/Collection/ Seed sources

Substantial germplasm collections are held at the National Repository of Plant Genetic Resources, Idukki, the National Bureau of Plant Genetic Resources, Thrissur and also at the various Institutes for Spice Research in India. A wide range of local cultivars are recognized in India (1). Clonal selection is being applied to exploit the naturally occurring variation, and mutation breeding has been practiced. The major breeding objectives are high yield and resistance against rhizome rot (3).

Research Needs

The two dominant types of *C. longa* on the world market "Madras" and "Alleppey" contain about 2% curcumin and 4% - 7% curcumin, respectively. When compared, plants produced in the Caribbean possess lower levels of essential oil and the curcuminoids. Crop improvement, agronomic research and pest management need to be undertaken as activities to obtain higher production levels and good quality (3).

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3.7 Cymbopogon citratus

LEMON GRASS

(GRAMINEAE)

Photo courtesy http://www.tropilab.com/

Common or Other Local, Multi-lingual Names
Cana de Limon, Citronelle, Fever Grass, Hierba de Limon, Limoncillo, Limonera, Te Limon, Sitwonel, West Indian Lemon Grass, Zacate Tay, Zacate Limon.

Synonymy
The synonym for *Cymbopogon citratus* (DC.) Stapf is *Andropogon citratus* DC. [1, 2, 3] Other synonyms such as *Cymbopogon nardus* subvar. *citratus* (DC.) Roberty are also suggested[15].

Botanical Description
A perennial, robust, lemon-scented, grass forming dense clumps; the leaf-blades ca.1m long and 5-15 mm broad tapering at both ends, the margins rough; inflorescences a panicle, rarely produced in some places, 30-60 cm with sessile, linear, spikelets.

Distribution/Ecology
Cymbopogon citratus is probably of Indian origin. However, it is now naturalized and found along pathsides in the West Indies, and commonly cultivated in humid, tropical and sub-tropical regions of the world, especially where the annual rainfall is over 2,500 mm.[(3)].

CAUTION: It is difficult to distinguish *Cymbopogon citratus* (DC.) Stapf from the sister species *Cymbopogon nardus* (L.) Rendle (Synonym: *Andropogon nardus* L.). *Cymbopogon nardus* is called Citronella grass, and it possesses a different odour of its essential oil compared with *Cymbopogon citratus* [(2)].

[15] Visit: http://mobot.mobot.org/W3T/Search/vast.html.

Active Principles
From the leaves, its oil is rich in citral, and other terpenes, such as myrcene. Due to its easy polymerization, Myrcene is responsible for the early deterioration of the oil [(3)].

(**NOTE**: Pure citral is isolated from the oil and used as a key raw material in the manufacture of Vitamin A).

Parts Used/Key Uses
The essential oil from the leaves is used in aromatherapy, soaps and perfumery[16]. Traditionally, the leaf infusion is widely used to treat colds and fevers. The rhizome has also been used in oral healthcare, as a diuretic, and as an abortifacient [(1)]. The aerial parts are sold in herbal teas, used commercially in baked foods and confectionary, and also are used in sachets as an insect repellent. The essential oil shows significant antimalarial activity in the four-day suppressive in vitro tests in mice [(4)].

Quality, safety, efficacy and regulatory framework
It is listed as a drug (*Cymbopoginis citrati herba*). Its derivative "West Indian Lemon grass oil is *Cymbopoginis citrati aetheroleum*" in the German Commission E Monographs [(5)], howeber scientific data to validate its traditional therapeutic uses is inadequate.

Cymbopogon citratus is generally recognized as safe for human consumption, whether as the plant extracts or its essential oil [(6)]. It is a highly rated folk medicine in Brazil, in the form of an infusion of 2 or 3 fresh or dried leaves in 150 mL hot water[(7)].

The essential oil has been approved for food use by the USFDA as "generally recognized as safe" GRAS No. 2624. It is registered in the Council of Europe under 38n. It possesses the International Standardization Organization standard as ISO 3217 since 1974. The Research Institute for Fragrance Materials (RIFM) has published a monograph on the physiological properties of lemon grass oil [(3)].

"In trade statistics hardly any distinction is made between the 2 major sources of lemongrass oils: West Indian lemongrass (*Cymbopogon citratus*) and East Indian lemongrass (*Cymbopogon flexosus* Nees ex. Steudel)" – J.F. Watson [(3)]

Cultivation Practices and Harvesting
Since the plants rarely flower or set seed, propagation is by root or plant division. Offshoots from healthy plants are cut back to 12 cm, trimmed of dead or extensive roots and treated with fungicide. Planting is done mainly on the flat, 10-15 cm deep, with spacing 50-90 cm x 50-60 cm. A high plant density is maintained by filling in gaps as required for highest yields.

Good drainage is the most important soil requirement, usually of pH 5.5 - 7.5 [(6)]. Deep planting and earthing up are beneficial on sandy soils; but on heavy soils these practices are not advisable as the young plants are susceptible to root rot. When

[16] Visit:<www.hort.purdue.edu/newcrop/med-aro/factsheets/LEMONGRASS.html>.

grown for its oil, the plant is rarely intercropped, because it needs ample water and full sunshine. Careful weeding is extremely important, as weedy grasses may quickly invade a new plantation and once established are difficult to remove. The plant is often irrigated and has a modest nitrogen fertilizer requirement. Only the young expanding leaves actually synthesize and accumulate the essential oil [(3)]. *Cymbopogon citratus* can be a useful understory crop, since if it grows too tall the oil yield may be reduced.

Helminthosporium cymbopogi causes serious leaf spot disease but no serious pests of this grass are known.

The first harvest is about 6 months after planting, and it can be done manually, in the morning time. The plants may then be harvested about four times each year. If harvested too often the productivity of the plant will be reduced and the plant might die. Mechanical harvesters are adjusted to cut at a height of 21 cm for best yields [(3)]. Harvested yields of 80 kg/ha/year have been recorded [(8)].[17]

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

Wilting the herbage of lemon grass before distillation reduces moisture content, and has little effect on oil yields, but increases the citral content. Drying in full sunlight for 3 days reduces oil yields but has little effect on oil quality.

Steam distillation is done on finely chopped fresh or partially dried lemon grass leaves harvested preferably in the morning time[(3)]. The oil is brownish with a grassy citrus earthy undertone. It specific gravity is about 0.9 and it is levorotatory. The yields are 0.25-0.50% oil from the herbage[(3)][18].The spent grass can be dried, composted and returned to the field or used as fodder.

Germplasm/Collection/ Seed sources

Several institutions in South and South-East Asia possess systematic collections of germplasm of *Cymbopogon*, such as in Kerala, India, the Research Institute for Spice and Medicinal Crops (RISMC), Bogor, Indonesia, and the National Board of Genetic Resources, New Delhi, India[(3)]. Some breeding programmes have developed new varieties of lemon grass[(5)][19].

Research Needs

Further research is recommended into this grass not only in organic farming, but also for the development of value-added products such as "aqua-resins", but also as a grass barrier and as a source of natural pesticides [(11)]. A comprehensive monograph on *Cymbopogon* is available from India [(12)].

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[18] Visit: <www.oils4life.co.uk>.

[19] Visit: <http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?12797>.

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3.8 Eryngium foetidum

FIT WEED

(UMBELLIFERAE --APIACEAE)

Photo extracted from http://www.worldcrops.org/crops/Culantro.cfm
Photo by Frank Mangan

Common or Other Local, Multi-lingual Names
Acapate, Bhandhania, Cardo Santo, Chardon Beni, Chardon Etoile Fetide, Chicoria, Cilantro, Coulante, Culantro, Fit Bush, Mexican Coriander, Recao, Sawtooth Coriander, Shado Beni, Spirit Weed [(1)].

Synonymy
The synonym for *Eryngium foetidum* L. is *Eryngium antihystericum* Rottb., *Eryngium molleri* Gand[(2, 3)].[20]

Botanical Description
A biennial pungently smelling herb with fleshy roots; older leaves form a basal rosette, thin, dark green, glossy and lanceolate, 3-27 cm long and 1.5-5 cm wide, inflorescence wide spreading on a long shoot ca 15-30 cm long, flower-heads cylindrical ca 1.5 cm long subtended by a whorl of unequal bracts resembling leaves, flowers tiny and white, fruit ca. 2 mm long.

Distribution/Ecology
This plant is native to continental tropical America and the West Indies and was introduced around the 1880's into South-East Asia by the Chinese as a substitute for coriander (*Coriandrum sativum* L.)[(2)].

It grows naturally in shaded, moist and heavy soils near cultivated areas. Plants do not usually grow close together but appear as individual weeds.

[20] Visit:<http://mobot.mobot.org/W3T/Search/vast.html>.

Active Principles
The aerial parts are rich in calcium, iron and riboflavin, with approximately 0.1-0.95% essential oil [4] and a peculiar saponin [5].

Parts Used/Key Uses
In cooking, the leaves are used for their unique pungent aroma as an important seasoning for foods, such as meat dishes, sauces, chutneys and preservatives.

The plant has been studied for its anti-inflammatory and other pharmacological properties[6, 7, 8]. It is used traditionally in an infusion taken for fevers, flu, diabetes and constipation, as a diuretic and as an anti-convulsant treatment.

Quality, safety, efficacy and regulatory framework
The essential oil from this plant growing in Malaysia and in other countries has been characterized [8, 9, 10], and the conclusion is that "The analytical data from (the) Malaysian (plant) samples differ markedly from data obtained from samples of other origins"[2].

NOTE: Coriander leaves (of *Coriandrum sativum* L.) as well as of other plants, such as *Eryngium creticum* Lamk., *E. floridanum* Coult. and *E. maritimum* L. are used in trade and commerce as substitutes for *Eryngium foetidum* [2].

Cultivation Practices and Harvesting
Plants are usually started from seed which germinate in about thirty days, and for home gardens can be cultivated in containers or wooden boxes. For this type of cultivation, a slow release fertilizer can be incorporated in the soil mix.

Although the plant grows in a wide variety of soils, it does best in moist well-drained sandy loams high in organic matter, particularly under full light. Precise fertilizer recommendations have not been made, but high nitrogen fertilizers or manure can promote leaf growth. Studies to prevent bolting and early flowering under long day conditions have produced increases in the leaf yields and higher marketability of the crop [4]. This herb is relatively pest and disease-free, although ants may eat the broadcast seed [2, 4].

Quite often, harvesting can begin 60 days after cultivation. Individual tender young leaves are harvested and marketed as fresh and as soon as possible, since the shelf-life is about four days. The topmost 3 leaves are left intact on the plant, and from 10 to 15 leaves can be harvested per plant in 5 to 10 harvests at intervals of one to two weeks, before flowering intervenes. Rough estimates in the Philippines are of yields of 80 tons/ha for a total crop [2]. Commercial planting is to be encouraged [11].

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage
While there are few reports on cultivation and fertilizer requirements for fit weed, there has been some research on post-harvest techniques for the herb.

In a refrigerated storage trial, unpacked fit weed was found to become un-marketable within four days of storage [4]. Another conclusion drawn was that, when packaged

chilled or frozen for transport, leaves can be stored for two weeks at 10°C [2, 3].
Plants harvested with the roots intact and dipped in gibberellic acid and stored in non-perforated low density polyethylene bags were found to maintain external marketing quality, retain their green colour, freshness and turgidity, and were decay-free without development of off-flavour or a reduction in pungency for up to 17 days at 28°- 30°C [12].

Trinidad and Puerto Rico are exporters of 'saw-tooth coriander' to North America and Europe. "The increased interest in exotic cuisine through contacts with migrant communities and international travel helps the introduction of new crops. Vietnamese refugees in the United States not only brought along their traditional spices, such as *Eryngium foetidum* L.....but also generated a local market and initiated local production" [2].

Germplasm/Collection/ Seed Sources
"There are no known germplasm collections or breeding programmes (for this herb)"[2].[21]

Research Needs
Eryngium foetidum is becoming increasingly a crop of international trade, and thus deserves further post-harvest study and research [2, 13]. Plant regeneration from the mature leaves and roots of the plant should be further researched to produce sufficient material through mass multiplication for commercial planting [11, 14].Research is being recommended to study the plant also as an understory crop for inter-cropping systems [15].

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3.9 Hibiscus sabdariffa

SORREL

(MALVACEAE)

Photos courtesy http://www.tropilab.com/

Common or Other Local, Multi-lingual Names
Jamaica Sorrel, Lozey, Red Sorrel, Roselle

Synonymy
For *Hibiscus sabdariffa* L., the synonyms are *Abelmoschus cruentus* Bertol.; *Hibiscus cruentus* Bartol.: *Hibiscus digitatus* Cav.; *Hibiscus cordafanus* Turez.; *Hibiscus fraternus* L.; *Hibiscus palmatibus* Baill.; *Sabdariffa rubra* Kostel.[22]

Botanical Description
Shrubby annual growing up to 2 m high, with or without hairs on the stems; leaves 3-5 deeply lobed up to15 cm x 4 cm, margins serrate, nectary gland present at base of midrib beneath; flowers solitary with short peduncle in upper axils, calyx 1.5 – 2cm long in flower and increasing to 3 – 3.5 cm long and becoming bright red in fruit; petals light yellow with maroon spot at base, 4-5cm. long; fruit a capsule 2-2.5cm long, glabrate to rough with short firm, stiff hairs; seeds 4-5mm long, numerous, rough with fine short hairs.

[22] Visit:<http://mobot.mobot.org/W3T/Search/vast.html>.

Distribution/Ecology
Hibiscus sabdariffa is most probably of African origin, but is now widely distributed and cultivated pantropically.[23]

Active Principles
The plant acids (15 - 30% in the calyx) include citric, malic and tartaric acids and others which together give sorrel drinks a pleasant and refreshing acid taste. The anthocyanin constituents colour the sorrel tea wine-re, reach about 1% content in the calyx, and, they are mainly the glycosides of delphinidin and cyanidin. Other flavonoids as well as mucilage polysaccharides and pectins also are known in the aqueous extracts of sorrel.
Sorrel tea acts as a mild laxative, when it is taken in large amounts, because of the constituent acids which are difficult to absorb [(1, 2)].

Preliminary tests have suggested the presence of anti-hypertensive constituents in the plant [(3)] while polysaccharide constituents seem to possess useful properties for dermatological or cosmetic applications [(4)].

Parts Used/Key Uses
Traditionally, the calyces are used to make teas and cold beverages.

Commercially, the fresh calyces are used in jams, juices and jellies and in wines. In coarse ground form the calyx is of growing international importance in herb teas for its reddish colour and pleasant acid taste [(5)].

The official herb drug is *Hibisci flos*, as described in the German Commission E Monographs consists of the dried calyx, collected during the fruiting period. It is made available for international sale in tea bags [(2)].

Quality, safety, efficacy and regulatory framework
Methods for its authentication are given in detail by Bisset [(2)] and it has been approved and regulated officially as safe [(5)]. A useful quantitative standard for quality of the calyx is a laboratory estimation of the plant acids being not less than 13.5% calculated as citric acid.

Cultivation Practices and Harvesting
This plant can be grown from seed, or propagated from stem cuttings and seed viability is about 85% [(1)]. While it is relatively easy to grow, it is more difficult to produce consistent high quality. This is a function of seed stock, local growing conditions, harvest time and post-harvest handling, in particular the drying process. The plant grows well in most soils that are well-drained. It tolerates poor soil, and is often grown as a supplemental rather than a primary crop. It requires 13 hours of sunlight during the first 4 to 5 months of growth to prevent premature flowering. It also requires a monthly rainfall over 5 inches in the first 3 to 4 months of growth. Dry periods can be withstood and are desirable in the last months of growth. Rain or high humidity during the harvest time and drying can downgrade the quality of the calyces

[23] (Visit: <http://www.hort.purdue.edu/newcrop/morton/roselle.html>)

and reduce the yield [6, 7].

The herb is a deep-rooted crop, so deep ploughing is recommended in preparing the seed bed. To produce a large calyx, up to 2, 000 pounds of manure are added per acre. Seeds are planted at the rate of 6 to 8 pounds per acre approximately, 1 cm deep, are best planted at the beginning of the rainy season with less than 1 m between rows and about 50 cm within rows. The reduced planting rate produces a larger calyx. While weeding can increase yield and calyx size, but may also reduce profit for the farmer.

The plant is very sensitive to changes in the length of the day. Flowering is induced as the days become shorter and light intensity reduces, from around October or later when the entire field is in bloom. Later, the flowers begin to drop and seed pods begin ripening from the bottom and proceed towards the top. In *H. sabdariffa*, pinching the apical bud induces branching: it is a primarily self-pollinating crop and flowering lasts for about 2 months. Fruit ripening takes 2 to 3 months from pollination [1].

The major diseases are stem and root rot. Prevention techniques can include monitoring water in an irrigated field as well as avoiding the planting of crops that are also prone to these diseases. Damage is done by insects such as the stem borer and flea beetles and the cutworm. Very significantly, the Hibiscus mealybug affects this plant and also the ornamental *Hibiscus species*. This insect is *Macomellicoccus hirsutus,* and it is controlled successfully by the natural enemies, namely the Australian beetle (*Cryptolaemus montrouzieri*), and the Asian wasp (*Anagyrus Kamali*) [8].

The harvest is timed according to the ripeness of the seed. The wet red fleshy calyces are harvested after the flower has dropped but before the seed pod has dried and opened. The more time the capsule remains on the plant after the seeds begin to ripen, the more susceptible the calyx is to sores, sun-cracking, and general deterioration in quality. Special care must be taken during manual/hand harvesting operations to avoid contamination by extraneous material. Clean bags or containers should be used for transport from the field to the drying location. In addition the time between harvest and drying should always be kept at a minimum. The field is harvested approximately every ten days until the end of the growing season. The calyx is separated from the seed pod by hand, or by pushing a sharp-edged metal tool through the fleshy tissue of the calyx, separating it from the seed pod.

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

Drying can be accomplished by different methods. Drying with adequate ventilation, using woven nylon mats, for example, prevents sunbaking, which can reduce quality.
A clean sheet of plastic placed on the ground can also be used with the sorrel spread thinly on top, however, this method is prone to insect infestation and mould.
Spreading the calyces on screens or frames would improve ventilation further and reduce drying time. Such frames could also be stacked or hung in a well-ventilated building.
If heated drying methods are used, care must be taken so that the temperature does not exceed 43°C. Hot air dryers such as the "Solar drying tunnel" provide significant

efficiencies[24]. Total yield of one metric tonne per hectare under cultivation is feasible, and for every hundred kg of fresh calyx, eleven kg of dry calyx is produced[25].

As the flower withers rapidly, it is not an economical product to export fresh over long distances. Therefore, it is mainly sold whole and dried, packaged in bales. Each buyer typically has his/her own product specifications. Cleanliness is key, and in general, no pesticides should be used.

For the results of a recent market survey, including prices and quality standards and packaging specifications for *Hibiscus sabdariffa*, visit: <http://www.raise.org/natural/pubs/hibiscus/hibiscus.stm>, for the complete PDF version.

Germplasm/Collection/Seed Sources

There are over one hundred cultivars or seed varieties of *H. sabdariffa* L. The major commercial varieties are those grown in China, Thailand, Mexico, Sudan, Senegal and Mali. Large germplasm collections of *H. sabdariffa* L. as a fibre crop are maintained in Australia, India and the Germplasm Resources Laboratory in Maryland, U.S.A. [(6, 7)].

Research Needs

Further research is needed for callus tissue derived from the seedlings to produce the anthocyanin pigments which are food colourants.

More agrotechnical details for sorrel cultivation in individual countries, including Cuba, and the US Virgin Islands, as well as about organic cultivation in Costa Rica should be sought with a view to enhancing yield and quality of product [(7)].[26]

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3.10 Lippia alba

SANTA MARIA

(VERBENACEAE)

Common or Other Local, Multi-lingual Names
Anis de Espana, Cariaquito Blanco, Carmelitana, Catmint, Cidreira, Colic Mint, Cullen Mint, Guinea Mint, Melissa, Oregano, Salvia Americana, Teasam

Synonymy
Synonyms for *Lippia alba* (Mill.) N.E.Br. are *Lantana alba* Mill. and *Lippia geminata* Kunth.[(2)]. Others such as *Lantana germinata* (Kunth.) Spreng. have been suggested.[27]

Botanical Description
Aromatic shrub 1-1.5 m high with many long, straggling, slender 4-angled branches; leaves opposite or in threes, 1-3 cm. long, oblong-elliptical, obtuse to rounded at the tip, margins serrate, upper and lower surface lightly covered with soft, wooly hairs, veins prominent beneath, inflorescence a head or spike ca. 2 cm. long; flowers tubular 4.5 mm x 1.5 mm, white, pink or light pinkish-purple.

Distribution/Ecology
It grows wild on roadsides near rivers, and gravelly waste places near the sea, throughout the West Indies, and in South America, mainly Brazil [(1, 2)].

Active Principles
Extracts and, separately, the essential oil from the leaves have demonstrated antiseptic, astringent and other health benefits [(3, 4, 5, 6, 7, 8)]. Very recently, these extracts have been shown to have anti-*Candida albicans* activity [(9)].

[27] Visit:<http://mobot.mobot.org/W3T/Search/vast.html>.

Parts Used/Key Uses
Traditionally, the decoctions of the plant, alone or mixed with other herbs are taken as a stomachic, to reduce fevers, for liver complaints, as an anti-spasmodic, emmenagogue and decongestant. Also, the fumes from the crushed leaves are inhaled to induce sleep.

Quality, safety, efficacy and regulatory framework
The main constituents of extracts from *Lippia alba* (Mill.) N.E. Brown growing in Brazil and Colombia are quite variable [8, 10]. The chemical and biological studies of the essential oils of the various chemotypes of this plant are of increasing importance [9, 11, 12].
Sweetman reported that in very high doses, the essential oil may cause nausea, diarrhoea and vomiting [13].

Cultivation Practices and Harvesting
This is a shrub which favours much sunshine, and it can withstand periods of 4 or more months without rain. In conditions of high humidity, it tends to thrive producing high quality branches and leaves. As a native of the Caribbean, its cultivation has been the subject of little investigation, but several local initiatives have revealed in certain countries significant factors for its cultivation [14].

The seeds have a low percentage of germination. Plant propagation is vegetative, using stem cuttings about 20 cm long and 0.5 cm diameter, showing some buds, but with the leaves removed. Planting can be done all year round in full sunshine. The cuttings are placed vertically in the soil, burying approximately a third of the length. The rooting soil is made of a mixture of soil and organic matter, with water sprinkling. In certain areas, planting has to be done about 40 days after the preparation of the stem cuttings. Plant spacing depends on the variety used, but generally, 10 cm x 40 cm is sufficient. It is recommended to fertilize with organic manure while weeding should be practiced throughout the growing period of the plant.

The larva of an un-identified insect seems to be one of the pests responsible for rolling up of the leaves, thereby causing significant loss of leaf yield.

The first harvest can be done 4 months after planting, and is carried out annually. Up to 5 harvests per year can be achieved, at intervals of 75 days. Cutting should be done about 30 cm from the surface of the soil, to enable re-growth without loss of useful material.
It is useful to note that, if the branches bearing leaves are collected, placed in a pile under a blanket and covered with plastic for 3 days, then the leaves are found to be easily detached from the branches [4, 10]. The foliar biomass yields are up to about 15 tons/ha per harvest, in four harvests during a single year [10]. In the Caribbean, yields of 1 000 kg dry weight/ha have been recorded, during the first year and the useful lifetime is about 5 years in the humid tropics [14].

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage
The leaves should be stored in a cool place and should be air-dried, preferably in a drying house at 40° C. The dry to fresh weight ratio is 1:4. Studies on harvesting

seasons in Brazil have shown that in the summer the leaves at the base section of the stems produced more essential oil than leaves from the apical section. Yields of the essential oil are about 0.3 - 0.4% [10].

Germplasm/Collection/ Seed sources
Different natural varieties are found in several areas in north-west Brazil [10].

Research Needs
More research is needed, and some has started to select planting material of good quality for the production of leaf teas, and also for the production of essential oils for trade [15].

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3.11 Maranta arundinacea

ARROWROOT

(MARANTACEAE)

Photo extracted from http://www.instituteofjamaica.org.jm/NHD/maroons.html

Common or Other Local, Multi-lingual Names
Amaranta, Araruta, Bermuda Arrowroot, Djitam, Mouchaz Babade, Obedience Plant, Platanillo, Toloman.

Synonymy
The synonyms for *Maranta arundinacea* L. are *Maranta indica* Juss., *Maranta ramossima* Wall., *Maranta protraca* Miquel., *Maranta silvatica* Roscoe [(3)]. Others have been suggested including *Phrynium variegatum* N.E.Br.[28].

Botanical Description
Perennial herb up to 1m tall with a fleshy, white, starchy, scaly, rhizome; leaves closely overlapping open-sheath at the base, the petioles, terete ca. 7 cm with a pulvinus below the 22 cm x 8 cm leaf-blade ; flowers white, tube 1.3 cm and lobes 8-10 mm long; fruit a capsule 7-10 mm long; seeds 8-9 mm long with ridges, pale red with a yellow aril.

NB: Two cultivars of arrowroot are grown in St. Vincent and the Grenadines [(1, 2, 3, 4)]:

1. The 'Creole' cultivar which produces long, thin, rhizomes spreading widely and deeply in the soil. In poor soil, a thin, useless 'cigar root' rhizomes tend to develop; it can last for a week without deteriorating.
2. The 'banana' cultivar produces a shorter, thicker rhizome, in clusters, close to the soil surface, it is higher yielding, less fibrous and easier to process but deteriorates rapidly in two days.

[28] Visit:<http://mobot.mobot.org/W3T/Search/vast.html>.

Distribution/Ecology
It is native to Brazil, now introduced and cultivated in the tropics and sub-tropics and require over 2 m rainfall per annum. It grows wild in a wide range of soils. It is a major crop in St. Vincent and the Grenadines, in the West Indies [2, 3, 4]

Active Principles
Starchy carbohydrates together with beta-carotene, niacin and thiamine are present in the mature rhizomes, so that when they are peeled and cooked they become a very digestible, nutritious food. The extracted rhizome starch is used commercially as a rubifacient and emollient, and it is listed in the "Martindale. The Extra Pharmacopoeia", 1993 UK [3].[29]

Parts Used/Key Uses
The powdered rhizome is also used as a body powder because of its fine, light texture, and also as a component of sweets and ice creams and in the fabrication of tablets[30].

Quality, safety, efficacy and regulatory framework
Microscopical examination of arrowroot powder is a necessary check for its purity. Occasionally, potato, sago, rice and tapioca starches are used as substitutes for it[31]. The main grading criteria for arrowroot starch are its viscosity (after time-heat cycle), colour, cleanliness, pH, ash content, moisture and microscopic appearance (at 15-17mm length). It is of moderate calorific value and its analysis has revealed 27% starch, 3%fibre, 1% ash, and 63% water [3, 5].

CAUTION: *Maranta arundinacea* should not be confused with "Florida arrowroot" which is the poisonous cycad (*Zamia integrifolia*). Other commercial sources of starch also known as arrowroot are "Indian arrowroot" (*Curcuma angustifolia* Roxb.*)*, and "Queensland arrowroot" (*Canna edulis* Ker.*)*, as well as the "Brazilian arrowroot" which is cassava (*Manihot esculenta* Crantz.)[32].

Cultivation Practices and Harvesting
Maranta arundinacea grows well in a range of soil types, but while it is tolerant to dry periods, humid conditions are preferred and water-logging is not tolerated. It thrives on rich sandy loams which facilitate the harvesting process.

It produces seeds, but the plant is propagated rapidly asexually from well-developed rhizomes with flowering starting mid-year or 3 months after planting. The plant bears fruit, little berries or capsules entering a dormant period at the end of the flowering period. With the coming of rains, new aerial shoots emerge [3, 6].

The soil is ploughed and harrowed if necessary to produce a crumbly tilth. In St. Vincent, the rhizomes are planted whole or as "bits" (fragments with 3 nodes each, roughly 6-8 cm long). Over 3, 000 kg of bits, of good quality, with spacing of 20 cm along rows, are required to plant one hectare. Forking the cultivation once or twice

[29] Visit also:<www.naturalcosmeticsupplies.com/arrowroot.htm>.
[30] Visit: http://www.tropilab.com/arrowroot.htm and also:
<http://www.foodnet.cgiar.org/market/Tropcomm/part2ab.htm>.
[31] (Visit:<http://www.botanical.com/botanical/mgmh/a/arrow064.html>).
[32] (Visit:<www.starch.dk/isi/starch/arrowroot>).

enables the soil to be as loose as possible. Cultivation is done in full sun or partial shade and in moist soil. Organic matter at rates of 30 or more tons/ha can be used as fertilizer. On planting, irrigation should be applied until the shoots are established and weeding is recommended about twice per crop.

The plant exhibits marked increase in growth up to about 8 months after planting. Decrease in growth rate is indicated by the tendency to lodge, reduction in leaf numbers and yellowing of the leaves. Rhizome growth is slow during the period of rapid leaf growth, and maturity occurs around 9 months after planting [(4)].

Maranta arundinacea is cultivated both in pure stands and in various mixed-cropping systems, which often involve coconut, pigeon peas, corn, yams, pumpkins and cassava in St. Vincent. It should be noted that if the various agro-products were to be marketed more efficiently, the inter-crops would become significant income-generating resources for the farmers [(4)].

Of the two major cultivars recognized in St. Vincent, the "creole" is widely grown on peasant holdings, producing "cigar roots" for rhizomes growing on poor soils. It can remain for up to seven days without serious deterioration before processing. The "banana" cultivar is easier to harvest and more amenable to mechanized harvesting, higher yielding and with rhizomes less fibrous and easier to process than the "creole", but tending to more rapid deterioration. This cultivar must be processed within two days of harvesting; and it is grown mainly on the larger estates [(4)].

Reports of pests or diseases of economic importance are not many, except for burning disease caused by *Rosellina bunodes* (B. &Br.) Sacc. in St. Vincent, under high rainfall and poor drainage conditions. In addition, as portions of rhizomes remain in the soil after harvesting, these provide part of the ratoon crop: they are difficult to eradicate when the fields are used for other crops [(4)].

The plant grows for 9 to 12 months before harvest[33]. Harvesting should begin once yellowing and drying of the aerial shoots is observed. Thereafter, the starch content declines and sugar content increases.

Yields of 10 000kg/ha rhizomes and higher have been reported. The same cultivation can be harvested for up to 5 years in St. Vincent [(3, 4, 6)]. According to the International Starch Institute, 1 acre (0.4 ha) of plant yields about 6 tonnes of rhizomes from which about 1 tonne starch is obtained [(7)].[34]

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

The post-harvest practices for this plant have been described as being similar to that described for cassava in the July 1989 issue of the IICA Miscellaneous Publication No: A2/TT-89-03, which is a training manual for marketing tropical root crops [(8)].

The rhizomes are washed and agitated to eliminate dirt, stones and excessive "hair", both mechanically and by hand-picking. They can be stored in a cool, dry place; and

[33] Visit: http://www.tropilab.com/arrowroot.htm >.
[34] Visit:<http://www.starch.dk/isi/starch/arrowroot.htm>).

may be held in cold storage, if necessary, until they are re-planted [6].

In the processing process, the rhizomes are ground at high speed in barrel mills against saw blades to release the starch from the cells. The starch particles are suspended in clean water and allowed to settle through two successive separation cycles, passing through shakers and screens to remove both coarse and fine "bitty".

After being finally deposited overnight, and excess water has evaporated, the starch is air-dried, in the shade, over chicken-wire for a period of 7 to 14 days, to granular form, to the exclusion of dust and insects, for transport using bags (in St. Vincent to the Arrowroot Association) [5, 7].

Germplasm/Collection/ Seed sources
No data is available.

Research Needs
Further research and development is highly recommended where arrowroot aerial forage has been proven to be good feedstuff for ruminants [9]. The *in vitro* propagation of arrowroot, using the culture of stem sections, seems a viable line for more productive research [10].

In 1972, recommendations were made for an arrowroot industry development programme in St. Vincent. This included integrated action, including research on new varieties for mechanical harvesting, better commercial dehydration methods, coordination of root delivery with the grinding schedules in the factories, and improving the public image of the industry [5].[35]
More research also into novel uses for arrowroot is highly recommended [11].

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3.12 Momordica charantia

CORAILI

(CUCURBITACEAE)

Photo courtesy http://www.tropilab.com/

Common or Other Local, Multi-lingual Names
Balsam Pear, Balsam Apple, Bitter Gourd, Bitter Melon, Caryla, Cerasee, Karela, Maiden Apple, Pomme Coolie, Sorrow Seed, Wild Cerasee

Synonymy
Synonyms for *Momordica charantia* L. are *Momordica elegans* Salisb.; *Momordica chinensis* Spreng.
NOTE: *Momordica charantia* L. should NOT be confused with *Momordica balsamina* L. which also is called cerasee, and which is much more common in the drier parts of the old World tropics [1, 2].

Botanical Description
Momordica charantia L. is a slender -stemmed tendril climber growing to 6 m long, often becoming flattened and fluted as it gets older. Leaves are characteristically pungent-aromatic; flowers yellow and short-lived. Fruits are indented and are either green or white when immature and orange when ripe, 8 to 15 cm long; seeds covered with red pulp.

Distribution/Ecology
M. charantia was possibly first domesticated in eastern India and southern China. It now has a pantropical distribution, with wild and cultivated populations. This plant grows well all year round, in tropical and subtropical climates, and while it tolerates a wide range of soils, it does not tolerate water logging. In the Caribbean region it is common on fences and hedgerows and on shrubs growing in disturbed areas and

lowland forests [1, 2].

Active Principles
Blood-sugar lowering and anti-hyperglycaemic constituents have been sought in a diverse array of animal models, as described in hundreds of scientific publications [3, 4]. The fruit has demonstrated both insulin secretagogue and insulin mimetic activity [5]. The plant remains a significant candidate for possible development into a modern antidiabetic phytomedicine.

MAP30 is the name given to an antiviral protein (30kDa) extracted from the plant which has the potential to be an anti-HIV agent [2]. At least two bitter-tasting glycosides called momordicosides K and L [6] have been isolated from the plant.

Parts Used/Key Uses
Doses of 100mL juice expressed from the unripe fruit can produce anti-diabetic effects in adults [7]. The mechanism of hypoglycemic activity displayed in test animals remains unclear; and it appears to be more acute transient than cumulative [2].

The fruit is a nutritious vegetable as it is also rich in carotenoids [8]. Traditionally, the fruit juice and leaf decoctions are taken for a wide variety of conditions, from diabetes and hypertension to malaria, and also for intestinal worms.

Quality, safety, efficacy and regulatory framework
No relevant data was found.

Cultivation Practices and Harvesting
Momordica charantia is mostly propagated by seed. Pre-germinated seed results in even establishment. Optimum plant density differs per cultivar, but ranges from 6500 to
11 000 plants per ha. In conventional husbandry, fertilization and furrow irrigation as cropping techniques are important for growing the plant on trellises. The plant usually takes 15 to 20 days after fruit set to mature. A fruit yield of 29 to 30 tons/ha is considered satisfactory [2].

Serious diseases of the plant are *Cercospora* leaf spot and downy mildew and bacterial wilt. Fruit fly (*Daucus cucurbitae*) is the most destructive insect pest of this plant.

Post-harvest/Manufacturing Practices: Handling. **Processing, Packaging and Storage**
Mature fruits are split and seeds and fruit pulp are separated. The fruit pulp is dried at low temperatures and an oil can be extracted. This oil which is rich in beta-carotene is used to treat for night blindness [2].

All parts of the plant are packaged for trade, e.g. 1 lb of the herb is sold for US$ 15; and 1 kg seeds for US$ 725[36].

[36] Visit:<http://www.tropilab.com/momordica-cha.html>.

Germplasm /Collection/Seed Sources

The world collection of *Momordica* germplasm is held at NBPGR, New Delhi, India. Elsewhere, collections are held in several institutions in India, The Philippines, South Africa, Taiwan and the USA. In many South-East Asian countries, commercial F1 hybrids have been released which often are twice as productive as the traditional open-pollinated cultivars [(2)].

Research Needs

"Since the results with *M. charantia* in the treatment of diabetes are still somewhat contradictory, more research needs to be done on its hypoglycaemic activity" [(2)].

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3.13 Myristica fragrans

NUTMEG

(MYRISTICACEAE)

Myristica fragrans Houtt.
Image processed by Thomas Schoepke
www.plant-pictures.de

Common or Other Local, Multi-lingual Names
Mace, Nutmeg and Mace

Synonymy
The synonyms for *Myristica fragrans* Houtt. are *Myristica amboinensis* Gand., *Myristica aromatica* Lamk., *Myristica moschata* Thunb., *Myristica officinalis* L.f. [(1)].

NOTE: *Myristica fragrans* should not be confused with the various other "nutmeg" plants, such as the California nutmeg, *Torreya californica* Torr. (Taxaceae) [(1, 2, 3)].

Botanical Description
Aromatic tree, 8 m or more tall with a dense crown. Leaves alternate, oblong 13 cm x 6.5 cm, dark green above and pale waxy beneath; flowers dioecious, small, creamy-yellow; fruit pear-shaped to globose drupe, 4-5 cm in diameter, yellowish, fleshy, splitting to reveal the seed (nutmeg) covered with a red, lacy, aril (mace) [1, 2].

Distribution/Ecology
Myristica fragrans may be a native to the Moluccas, Indonesia although it is seldom found as a truly wild plant. However, because of its popularity as a spice, nutmeg trees have been planted wherever conditions are suitable. Its natural habitat is the wet tropics and trees thrive with high, well-distributed annual rainfall, with little seasonal variation and temperatures over 25 - 35 C [1].

The history of nutmeg since the 16th century is closely related to an aggressive history of mankind. Plants were introduced into Grenada in 1843, and Grenada has become the second major world producer after Indonesia [3].

Active Principles
Medicinally, the nutmeg is said to have stimulant, carminative and astringent properties. Its hallucinogenic properties are ascribed to the aromatic ethers myristicin, elemicin and safrole [3].

The red pigment in mace is mainly lycopene, identical to the red colourant in tomato.

Parts Used/Key Uses
Nutmeg and mace are used extensively as flavour ingredients in many food products, including the Jamaican jerk paste spice[37]. The pulpy pericarp (young husk) is used to make jellies and preserves.
Nutmeg butter can be obtained by pressing the nutmeg under heat; it contains mainly trimyristin and essential oils [3].

The use of mace extracts to prevent dental caries in Ayurvedic medicine seems to be validated partly by the recent studies which show the mixture of eugenol and lignan-type compounds present in the nutmeg to be anti-cariogenic [4].

Traditionally, the seed decoction is drunk as a treatment for asthma and even for malaria. Sufferers from a stroke keep a piece of nutmeg seed in their mouths, and this is expected to ward off further attacks.

Essential oils (mostly nutmeg oil from the seed and mace oil from the aril, but also from the bark, leaf and flower), and, the extracts (e.g. oleoresins) also are used as flavourants in the canning industry, in soft drinks and as a fragrance in soaps and cosmetics [3]. The essential oils are also used in certain analgesic ointments, to alleviate bronchial troubles, and in other medicines [5]. Nutmeg oils are anti-oxidant agents, and they also exhibit strong antimicrobial and insecticidal properties [1].

[37] Visit:<http://www.iisr.org/spices/nutmeg.htm>.

Quality, safety, efficacy and regulatory framework

The International Standardization Organization (ISO) has declared standards (6577 of 1990) for the physical properties of dried West Indian nutmeg and mace; for West Indian mace oil (ISO 4734 of 1981) and for West Indian nutmeg oil (ISO/DIS 3215 of 1994) (Ref. 3). Nutmeg products are generally regarded as safe, by the US regulations, nutmeg is GRAS 2792, nutmeg oil is GRAS 2793, mace is GRAS 2652, mace oil is GRAS 2653, and mace oleoresin is GRAS 2654.

A detailed description of the morphology and histology of the seed and aril has been published by Parry since 1965 [(1)].

Myristicae semen or *Myristica fragrans* is the subject of a German therapeutic monograph [(5)]. Monographs on the physiological properties of nutmeg oil and mace oil have been published by the Research Institute for Fragrance Materials (RIFM).

Nutmeg with quality "BWP" (broken, wormy and pinky) and mouldy nutmegs are often used for distilling essential oil. The pericarp (husk) of the nutmeg also is a source of essential oils [(7)].

Nutmeg essential oils vary significantly in composition, with methyleugenol at approximately 0.2% of the volatiles. Indonesian and West Indian oils differ. The former are higher in myristicin, while the latter are low in alpha-pinene and safrole, and are considered of finer quality than the Indonesian oils [(1)]. The maximum permitted level of nutmeg oil in foods is about 0.08%.

Little information is available on the characteristics or composition of supercritical fluid carbon dioxide-extracted nutmeg oils, and they are presumed to be similar to the distilled oils which they are rapidly replacing. Distilled nutmeg oil is placed in the fresh, spicy-woody group. Major components are monoterpene hydrocarbons, at 60% to 68%, oxygenated monoterpenes at 5% to 15%, and aromatic ethers at 2% to 18% [(1)].

CAUTIONS:

1. When used in large doses, nutmeg can be a narcotic, producing dangerous hallucinogenic effects. The consumption of two ground nutmegs (about 8 g) is said to cause death, due to its myristicin content [(3)]. However, nutmeg intoxication is uncommon because the pharmacologically toxic dose is large. With normal doses no adverse side-effects are known [(6)].

2. Adulterants and cheaper substitutes of the true nutmeg *Myristica fragrans* are known to come from various other plants, especially the seeds and arils of other species of the genus *Myristica*, such as *Myristica argentea* Warb. The seeds of *Myristica argentea* have a much higher safrole content than does *Myristica fragrans*, and, safrole is described as being carcinogenic [(3)].

Cultivation Practices and Harvesting

Rich volcanic soils produce the highest nutmeg yields, and may be why Grenada is a highly successful producer. However, nutmeg will tolerate the common laterite soils with proper management. Nutmeg cannot tolerate water logging even for short periods, especially when young.

Since most existing plantations have a relatively low level of management and trees are usually planted on fairly fertile soil, little chemical fertilizer is applied, but its use can be beneficial. Little information is available on the effect of individual plant nutrients on tree growth, fruit yield, seed size or composition.

Cultivation techniques are preferred which allow quicker sex determination, or produce seedlings of known sex. These include vegetative production from female trees selected for high fruit yield, resistance to a local disease or similar desired characteristics.

Clonal propagation and tissue-culture methods enable large numbers of plantlets from selected trees to be produced, and although these techniques are relatively expensive, they would quickly repay a cooperative or growers' organization from the higher yields obtained.

The nutmeg tree is characterized by a very superficial root system. It takes over 4 years until the first flowering; and flowering is probably induced by short dry periods. It is said to be self-pollinating, but pollination is effected by insects, especially moths. The fruits develop over a six to nine month period. Nutmeg is not strictly dioecious [2, 3].

When seedlings are raised from seeds, the seed nutmegs must be sound, less than five days old, with testa intact and the aril removed. Nutmegs should be sown about 4 cm deep in rows 30 cm apart and seedbeds kept moist but not wet and in the shade. Germination is slow, between 45 and 80 days. Sowing seed in biodegradable pots, including banana leaves etc., which can be placed intact into planting holes without root disturbance is recommended. Before field planting, temporary shade from gliricidia, cocoa or banana, as may be appropriate, should be well established. Seedlings are ready for planting out after 6 months when around 15 cm high, and preferably at the beginning of the rainy season. Spacing is 6 m x 6 m with alternate trees removed after ten years to allow the remainder to expand as they mature. Seedlings require temporary shade, and banana or palm leaves are suitable.

Where water is available to supplement rainfall, it should be applied when the first flowers appear and as necessary while fruit is maturing. Watering should cease before fruit ripens to ensure the ground is dry under the canopy so that fallen fruit will not rot.
Inter-cropping commercial plantations of young trees is possible with any local low-growing crop such as legumes or *Capsicum* peppers, but in mature trees is not recommended as the largely superficial roots can be damaged.

Weeds should be kept in check by occasional slashing, and the cut material can be applied to the base of the trees in the form of mulch[38]. Weeds and grasses must be controlled in newly established plantations and a cleared area maintained around young trees to reduce insect damage. Small livestock may be allowed to graze under mature trees, but goats and cattle are excluded.

[38] For a technical brief on "Processing of nutmeg and mace", visit:<www.itdg.org>.

Trees raised from seed begin bearing at 5 to 9 years, but those vegetatively propagated begin at 4 to 7 years. Fruit ripens in 5 to 9 months after flowering. Trees reach maximum production in 15 to 20 years and continue bearing for decades.

Trees are well-branched and to facilitate harvesting, to allow easy access to fallen fruit and weed control, the lower branches should be carefully removed during early growth. Parasitic plants must be carefully removed.

The principal economic pests of nutmeg attack the fruit and seed, but chemical control is infrequent, because the degree of economic damage is usually too low to warrant control. The total damage caused by disease is much greater than that caused by insects, but the same remarks regarding chemical control apply.

A serious disease in the Caribbean is Nutmeg Wilt caused by *Rosellina spp*. Nutmeg root rot is described as the most serious disease of nutmeg in Grenada. It is caused by the soil fungus *Pythium species*, especially in areas of excess soil moisture and poor drainage. Control is best achieved by an integrated approach of prevention, cultural practices, and treatment [(8)].

Trees fruit year round, but fruit is harvested only when it has split and the seed enclosed in its aril is clearly visible. Fallen fruit must be collected daily to avoid soil contamination and insect and disease damage. Fruit yield per tree is very variable and dependent mainly on the standard of management, especially adequate pest and disease control. In Grenada, the annual average is 1,500 fruits per tree and higher. The yield of mace varies similarly, but from sound healthy nutmegs averages 15% - 20% by weight [(1, 2)].

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

Following collection, the seed (nut) with surrounding aril is separated from the fruit, and the aril (mace) is detached. The seed may be dried above a slow burning and smoking fire or in the sun. When properly dried the kernel rattles in the shell [(3)].

After drying, nuts are shelled and become the spice nutmeg. The shelling and related processes are given in detail in the technical brief "Processing of nutmeg and mace" published by the Intermediate Technology Development Group of the U.K.[39]

The detached fresh mace is carefully flattened by hand or preferably between boards to avoid breakage that reduces its quality and value. Grenadian mace is sun-dried for about 3 hours and then stored in darkness for up to 4 months, gradually becoming brittle and pale orange-yellow. Nutmegs should be comminuted to a coarse powder prior to distilling, and then transferred immediately to the still.

Nutmeg trees produce three main products: nutmegs and mace used directly as spice, nutmeg and mace oils and oleoresins used as spice and flavourings, leaf oil and other derivatives. Nutmegs and mace are normally sold by smallholders to traders, who further clean and grade them before local marketing or selling to exporters. When

[39] Visit:<http://www.itdg.org>.

traded on the international market they must generally conform to recognized grades related to physical characteristics, such as size or colour. For instance, sound nutmegs are graded as 80s or 110s according to size in number per pound (454 g) [3]. Lower grade nutmegs from Grenada are rejects from the grading process. Grenada mace is exported as whole pale mace, No.1 broken mace, and also No.2 broken mace (without the desired pale colour).

The commercially more important nutmeg oil has been more intensively studied than mace oil, but the two oils, when produced from the same geographical area, are usually very similar in quality and are generally interchangeable in flavourings.

Nutmeg and mace oleoresins are prepared by extracting comminuted spices with organic solvents, and they also contain steam-volatile oil, fixed oil and other extractives soluble in the chosen solvent. Such a solvent may be hydrocarbon (hexane), ethanol or acetone. Commercial nutmeg oleoresins are graded in volatile oil content (mL per 100 g) [2].

"Since July 1987 the Grenada Cooperative Nutmeg Association and the Indonesian Nutmeg Association have reached an agreement on yearly sales on the international market. Indonesia is allowed to sell 6 000 tons of nutmeg and 1250 tons of mace, and Grenada 2 000 tons of nutmeg and 350 tons of mace" [3]. Nutmeg fetched a price of US$7/kg, and mace US$13.5/kg during the 1990's. "However the very limited market for nutmeg products makes breeding efforts uneconomical"[3].

A very useful booklet was written by Buckmire on nutmeg production in Grenada and more information can be obtained from the Caribbean Agricultural Research and Development Institute (CARDI) in Grenada [9].

Germplasm/Collection/Seed Sources

No varieties of *Myristica fragrans* are recognized, but many local cultivars exist. *Myristica* germplasm is maintained at the Research Institute of Spice and Medicinal Crops at Bogor, Indonesia, and at the Indian Institute of Spice Research, Calicut, Kerala[1].

There are no known substantial germ plasm collections of *Myristica fragrans* itself [3].

Research Needs

The challenge remains for Caribbean producers to move on to adding value to the conventional products from nutmeg and mace.

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3.14 Pimenta dioica

PIMENTO

(MYRTACEAE)

Photo courtesy of www.tradewindsfruit.com/

Common or Other Local, Multi-lingual Names
Allspice, Jamaica Pepper, Malagueta, Piment Jamaique, Pimenta, Pimienta Gorda, Dulce, Spice, Tabasca, Toda Especial, Toute Epice

Synonymy
Synonyms for *Pimenta dioica* (L.) Merrill are *Eugenia pimenta* DC.; *Myrtus dioica* L.; *Myrtus pimenta* L.; *Pimenta officinalis* Lindley [(1)]; but others have been described elsewhere.

Botanical Description
Tree up to 15 m tall with a pale brown bark. Leaves simple, opposite, entire, oblong – elliptical, 6-20 cm long, punctuate with pellucid glands which give off the odour of all-spice when crushed; inflorescence a many-flowered panicle 4-12 cm long; flowers fragrant, with 4-5 white petals, 1.5 mm long; fruit globose, 4-6.5 mm in diameter, sweet and spicy, deep purple to glossy black when ripe.

Distribution/Ecology
Pimenta dioica is native to the Caribbean region, especially Jamaica and Cuba; and trees grow naturally at a mean average temperature of 18°C - 24°C. Pimento is a forest tree and its seedlings benefit from shading until established. Like clove, pimento may require quite specific environmental conditions to flourish. Attempts to introduce pimento as a commercial crop into many countries outside the Caribbean

region have failed for unspecified reasons [1, 2].

Active Principles
Considerable variation has been reported to exist in the chemical composition of the essential oils from the pimento berry, and from the leaf collected from different areas in the Caribbean region. The major constituent in the oils is eugenol (up to 90%), but the two oils are organoleptically quite distinct. Other significant constituents of the berry essential oil are eugenyl methyl ether, cineole, and caryophyllene.

The essentials oil and the oleoresin (extract) obtained from the fruits are used commercially to flavour other fruits. The berry essential oil is a scenting agent in the manufacture of soap and men's perfumes [1, 2] and is anti-bacterial.

Parts Used/Key Uses
The dried, green-mature fruit is the commercial flavourant and curing agent. Its extract is an essential component in the classic liqueurs Chartreuse and Benedictine, and in the local Jamaican drink Pimento Dram. Ground fruits are preferred in desserts, relishes, sausages and preserves.

Traditionally, a water extract of the berries is used to treat flatulence and diarrhea while the powdered fruit is used for corns, neuralgia and rheumatism. Young woody shoots of pimento are popularly made into walking sticks and umbrella handles [2].

Quality, safety, efficacy and regulatory framework
The three main pimento products are the berry, whole or ground, and the volatile oils of the berry, and of the leaf. These products are important in the food industry and generally recognized as safe (GRAS).

In the United States of America, the regulatory status for pimento is GRAS 2017, for pimento berry oil is GRAS 2018, for pimento oleoresin is GRAS 2019, and for pimento leaf oil is GRAS 2901. The maximum permitted level of pimento berry oil in food products is about 0.25% [2].

The best quality (Jamaican) pimento spice is derived from the dried fruits/berries, with uneven surface, and weighing 13 fruit per gram. They are dark brown in colour, have a pleasant odour characteristic of the spice, with no mustiness, are never bitter-tasting, and are described as a combination of cinnamon, cloves and nutmeg, hence the name allspice.

The ground spice usually contains approximately 8% water, 6% protein, 9% fat and 22 % fibre and 5% ash. Dried pimento leaves yield 0.7 to 3%, and fresh leaves 0.3 to 1.3% of a brownish-yellow essential oil (pimento leaf oil) [3]. The major component of the leaf oil is also eugenol, but the concentration is higher (65 -95%) than in the berry oil, and its taste is quite different.

Pimento oleoresin is a brownish to dark green oily liquid obtained by solvent extraction of the crushed spice. Its quality and strength are more consistent than the essential oil, and its application presents a smaller risk of bacterial contamination. Monographs on the physiological properties of pimento berry oil and pimento leaf oil have been published by the Research Institute for Fragrance Materials (RIFM) [2].

NOTES:

1. Eugenol itself is toxic in large amounts and can cause contact dermatitis; the spice itself also can be a skin irritant.

2. Ground pimento is sometimes adulterated with clove stems and starchy products. A mixture of pimento leaf oil and clove stem and leaf oils can serve as a relatively inexpensive substitute for the pimento berry oil.

Cultivation Practices and Harvesting

Pimenta dioica can be propagated vegetatively by grafting, budding, approach grafting and top working. Tissue culture methods also can be employed successfully for its propagation. Pimento can be propagated using seeds, which are collected especially from fruits of high-yielding trees. The fruits are soaked overnight in water and rubbed and then the seeds are extracted. Seeds are sown in nursery beds, pots or basins. To enhance germination, the beds are mulched with dried leaves, straw, paper or gunny bags. Seeds germinate by 9 to 15 days[40].

Six- to ten-month old seedlings should be planted singly into pots or baskets and allowed to grow until about 30 cm, when they are ready for transplanting into prepared pits in the plantation. Pits about 60 cm deep and 30 cm in diameter may contain fertilizers. Well-rotted manure plus surrounding topsoil or a small amount of phosphate is placed in planting holes and young trees may be mulched. They thrive in a wide range of soils. Young plantations can be inter-cropped for 1 or 2 years with crops such as bananas and low-growing food crops. Shade and regular irrigation should be provided during the early stages of growth of the plants. Little is recorded on the nutritional requirements of pimento as most trees are left to grow virtually untended once established.

Leaf-eating caterpillars and other insects have been known to cause damage in the field.

Many diseases are recorded for *Pimenta species*, including leaf rust caused by *Puccinia psidii* (2); but in general, information is sparse. Proper hygiene can be a major factor in reducing the degree of infection.

Flowering usually coincides with the onset of the rains and fruit (berries) are picked (manually) about 3 months later when they are fully mature but green in colour. Too many small or overripe berries reduce the overall oil yield.

In general, a healthy well-managed tree can produce 10 kg green berries annually averaged over ten years. A considerable amount of leaf oil is produced from leaves remaining from berry harvesting, which are collected and delivered to independent distillers or cooperative stills. Leaf yield varies between 10 and 30t per hectare, dependent on the standard of management (1).

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

Leaves may be stored for two to three months prior to distilling with little effect on

[40] Visit:www.iisr.org.

volatile oil yield or phenol content. Berries destined to be used as spice must be treated with care, as quality is assessed mainly on appearance, colour, flavour and essential oil content. Those destined for distilling must be left in heaps or sacks for up to five days to ferment. They are then spread on outdoor drying floors, turned daily to ensure uniform drying, and with minimal microbial contamination. While drying, the berries turn from green to a dull reddish-brown. Dried berries give a crisp rattling sound when shaken[41]. At the end of the period, the yield from 100 kg green berries is 55 kg to 65 kg dry product.

Berry oil is obtained by crushing berries immediately prior to loading, and distilling by direct steam for about ten hours usually with cohobation; and in Jamaica, to total oil yield of 3 to 4%. Little loss of essential oil occurs when the spice is correctly stored, but prolonged storage is detrimental to both oil content and flavour, and can also allow mould growth.

Whole correctly dried fruit can be stored in sacks, or in small-volume bulk bins, before re-cleaning if required, then graded and packed for export. Essential oils should be stored in full, sealed, opaque containers until required for use or shipment (1).

Jamaica is the largest producer and exporter of pimento, accounting for 70% of the world's exports. Jamaican pimento also is considered the best quality. The annual world trade in pimento averages 3 000 to 4 000 tons valued at US$5 to 7million. The average annual pimento leaf volatile oil production is 30 to 60 tons (1).

Germplasm/Collection/ Seed sources

Germplasm collections are maintained by the Jamaica Department of Agriculture (in addition to breeding and selection programmes, which have produced named cultivars), and, also at the Indian Institute of Spices Research, Calicut, Kerala, India[42].

SPECIAL NOTE: A number of unrelated species with aromatic fruit are incorrectly referred to as "Allspice", including Carolina allspice (*Calycanthus floridus* L.), and Japanese allspice (*Chimonanthus praecox* (L.) Link).

Research Needs

"Research and development efforts should focus on novel uses of pimento coupled with new marketing strategies to promote the spice" (2).

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3.15 Pimenta racemosa

BAY RUM TREE

(**MYRTACEAE**)

Photo courtesy http://www.tradewindsfruit.com/

Common or Other Local, Multi-lingual Names
Bay Leaf, Bay Tree, Fey Buradenn, Bay Berry, Bois d'Inde, Matagueta, West Indian Bay, Wild Cinnamon

Synonymy
Synonyms for *Pimenta racemosa* (Miller) J.W. Moore are *Amomis caryophyllata* (Jacq.) Krug & Urban; *Caryophyllus racemosus* Mill.; *Myrcia acris* (Swartz); *Myrtus caryophyllata* of Jacq.; *Pimenta acris* (Swartz) Kostel [1, 2].

Botanical Description
Tree up to 15 m tall with a smooth whitish bark; the wood is hard and heavy. Leaves simple, opposite, entire, elliptical to obovate, 5-13 cm x 3-5 cm, leathery, dark, shiny green, crushed leaves with odour of bay rum; petals white, 3 mm long; fruit an ellipsoid, brownish berry 8 -10mm long.

Distribution/Ecology
The Bay rum tree is native throughout the Caribbean region and is cultivated in Jamaica. It prefers an annual rainfall of 2,500 mm spread evenly throughout the year [1, 2]. The fruits are eaten by birds which are the main dispersal agents for the seeds.

Active Principles
In the essential oil, distilled from the leaf or berry, approximately 80 components have been described, including 20 monoterpenes, and 19 sesquiterpenes. The major constituents are: eugenol and its derivatives, around 40%, myrcene up to 32% and chavicol up to 11%, and they contribute to the significant antiseptic and disinfectant actions of the oil [3, 4].

Parts Used/Key Uses
Traditionally, the bay leaves are distilled with rum to produce bay rum, which has soothing and antiseptic properties, and has been a very popular toilet water and hair tonic[4].

Traditionally, the leaf oil itself is used to treat chest colds, flus, stroke, rheumatism and toothache. The TRAMIL group highly recommends its use for toothache [3, 5].

In the trade bay leaf oil (also called Myrcia oil) is used in hair lotions, with minor amounts in perfumery and in food flavouring [4, 6].

The timber from mature trees is used for general carpentry, posts and is an excellent fuel [2].

Quality, safety, efficacy and regulatory framework
The essential oil of commerce is called Bay leaf oil or Myrcia oil. It is yellow to dark brown depending mainly on the still used. Stainless steel stills produce the lightest coloured oils. The crude oil has a sweet, rather penetrating odour, strongly phenolic with a fresh, spicy, sweet balsamic undertone and a pungent, warm spicy, somewhat bitter taste. Myrcia oil is "generally recognized as safe" by the USA and is GRAS #182.20 [6], and by the International Standardization Organization, it is ISO 3045 since 1974 [4].

Terpeneless bay leaf oil is obtained when the low boiling point monoterpenes are removed from the crude oil, leaving the sesquiterpenes behind. It is especially used to blend with aromatic materials in the manufacture of perfumes [4]. Bay leaf oil absolutes are very pale oils produced from steam-distilled de-terpened oils, and lack monoterpenes and sesquiterpenes. The oleoresin can be produced separately for use in flavourings and fragrances [2].

NOTE: Bay leaf oil is frequently adulterated with clove leaf, lime or synthetic terpenes, and oils with a phenol content above 65%.

Cultivation Practices and Harvesting
The propagation of *Pimenta racemosa* is mostly by seed. Seedlings may be collected from natural stands or are grown in nurseries. The seeds are obtained from mature fruits collected from August to October. After washing, the seeds are planted within two days, and will germinate in 2 to 6 weeks. Seedlings are ready for transplanting to the field in 18 to 24 months. Before planting, the stem is topped to15 cm and the taproot pruned to 7 cm so as to encourage lateral rooting. Some fertilizer is applied at planting. After planting, protection from direct sunlight until the seedlings are well established is beneficial. Good husbandry is important. Weeding should include

removal of spontaneous seedlings which do not yield commercially acceptable bay leaf oil.

The most serious disease is leaf rust caused by *Puccinia psidii*, especially in areas with fog or heavy dew. Leaf-eating caterpillars are the most damaging pests.

Well-managed groves of bay rum trees are harvested once per year, and harvesting can be done year round. One person can harvest up to 300 kg leaves per day[4]. Leaf oil content is often highest during periods of warm weather [4].

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

Harvested leaves should be processed immediately or stored for up to a week in well-aerated conditions [4]. Water or steam distillation of the leaves yields bay (or Myrcia) oil.

When local varieties or races of *Pimenta racemosa* are available and distilled, these may yield leaf oils rich in other compounds such as geraniol, methyleugenol or neral or methylchavicol.

NOTE: Indiscriminate harvesting and distillation of these other varieties together with the true bay rum leaves produces inferior quality Myrcia oil [2].

Major producers of bay oil are the Commonwealth of Dominica and Puerto Rico; but no statistics are available on production and trade in this commodity.

Germplasm /Collection/Seed Sources

The life of plantations of the trees is indeterminate, as trees regenerate from stumps. Individual trees as old as 50 years old are known [4].

Research Needs

Although there is ample leaf supply from the natural stands and cultivated trees to satisfy demand, selection studies should be undertaken for the high yielding trees [4].

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3.16 Quassia amara

QUASSIA

(**SIMAROUBACEAE**)

Photo courtesy http://www.rain-tree.com/Plant-Images

Common or other Local, Multilingual Names
Bitter Wood, Quashie-Bitters, Quassia-Bitters

Synonymy
Synonyms for *Quassia amara* L. are *Quassia alatifolia* Stokes, *Quassia officinalis* Rich[43].
CAUTION: *Quassia amara* L. must not be confused with Jamaica Quassia or Bitter wood which is a tree, with green flower petals, growing to over 20 m high, namely, *Picrasma excelsa* (Sw.) Planch, for which the synonyms are *Quassia excelsa* Sw. and *Picraena excelsa* (Sw.) Lindl. (1)

Botanical Description
Quassia amara L. **is a** shrub **or** small tree **up to** about 3 m tall. Leaves alternate with usually 2 pairs of opposite and a terminal and a terminal leaflet. Flower petals 5, about 3cm long and red. Fruit of 5 ellipsoid drupes, free from each other on a fleshy red receptacle.

Distribution/Ecology
Quassia amara L. is native to tropical South America, and is widespread elsewhere in the Tropics
CAUTION: It must be distinguished from Jamaica Quassia or Bitter wood (*Picrasma excelsa* (Sw.) Planch. which is a tree, also of the Simaroubaceae family, growing to

[43] Visit:<http:mobot.mobot.org/W3T/Search/vast.html>.

over 20m, common in hillside pastures, relict woodlands and along roadsides, and native to the Greater Antilles [1].

Active Principles
The key constituents are the quassinoids (seco-triterpenoid compounds), including quassin responsible for the bitter taste (fifty times more bitter than quinine), and also certain indole alkaloids (derivatives of canthin-6-one) [2, 3].

Parts used/Key Uses
Traditionally, the pale yellow chips of the woody stem are soaked in wine or water, and the infusion swallowed to restore loss of appetite, and also as a bitter tonic for diabetes. The roots are steeped in water overnight and the infusion taken for fevers including malaria fever.

Commercially, the wood extracts are available as food flavourants, for beverages and baked goods, and also in certain laxative medications [5].[44]
Quassia wood tincture is very effectively applied to control head lice, without side-effects, thereby confirming this traditional usage. A novel compound from the wood bark also is an effective treatment for gastric ulcers [4].

Quality, safety, efficacy and regulatory framework
Quassia extract is regarded as safe as a food flavourant by the Council of Europe and the international regulatory agencies. In foods it can be included at doses not exceeding 5mg/kg body mass. The permitted concentrations in alcoholic beverages are up to 50mg/kg [6].

Acute toxicity of the orally administered aqueous extracts of quassia has NOT been observed in standard tests with mice and rats [2]. Tests show that pure quassin can have anti-fertility action [7] and larvicidal activity as well [8]. Several pharmacopoeias allow both the wood of *Quassia amara* L. (from Suriname) and the wood of *Picrasma excelsa* Planchon (from Jamaica) to be transformed into the herbal drug simplex *Quassiae lignum*, used to stimulate the apetite and for other purposes. To differentiate between these two sources, the wood of only *Quassia amara* might be officially recognized as "*Quassiae lignum Surinamense*", or "*Quassiae lignum verum*"[2]. Thin layer chromatography is used to examine and validate *Quassiae lignum* [3]. This drug must not be taken by children or during pregnancy.

NOTE: The British Herbal Pharmacopoeia deals with *Picrasma excelsa* (Jamaica Quassia), which also is known to contain bitter-tasting quassinoid compounds [9].

Cultivation Practices and Harvesting
Propagation may be done starting with plantlets each between 30 cm and 40 cm long, which have been removed from the natural forest. The roots are cut off, leaving 15 cm of the aerial parts which then are sown in low shade with saran plastic cover. About 98% of these cuttings can take root over a 4-week period of care [10]. *Quassia amara* can also be grown from seed or by means of air-layering [10]. It does not tolerate poorly drained soils.

[44] Visit www.tropilab.com.

Natural stands of the tree exhibit little damage from diseases or pests. Harvesting is by cutting the branches so as to sustain health and vigour of the plants to ensure future harvests [2]. For example, the bark and wood may be cut from the stems with an average diameter over 20 cm at a height of 1 m above ground [10].

There is no substantial information available on the organic farming of quassia [10].

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

The branches should be cut into smaller pieces to facilitate drying and to prevent infection by pests that would decrease their quality. The properly dried wood can be kept for a considerable time. The crude drug is usually marketed in the form of these chips.

Germplasm /Collection/Seed Sources

No significant information is available.

Research Needs

Since 1989 in Costa Rica, CATIE started a series of studies with the rural population in Talamanca with the objective of promoting the sustainable development and conservation of forest trees including *Quassia amara*. In 1994 CATIE carried out studies on the commercialization of Costa Rica medicinal plant products, and stated that a volume of about 2.3 tons of quassia (as dried wood) was produced annually [10]. More studies of this kind are required to develop Quassia products.

Generally, the quassinoids and also the canthin-6-ones isolated as pure compounds from quassia wood display good potential for drug development for malaria and other conditions [11] and should be researched further.

The *in vitro* production of bio-active chemical compounds is based on growing both callus and suspension cultures of *Quassia amara* stem and leaf ex-plants as sources of quassin. The addition of naphthalene acetic acid or 2,4-D in callus culture can promote quassin production as high as 0.25mg/L per day [2]. More of these studies need to be carried out.

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3.17 Senna alata

WILD SENNA

(**LEGUMINOSAE-CAESALPINIOIDEAE**)

http://www.rain-tree.com/Plant-Images/Cassia_alata_p2jpg.jpg

Common or Other Local, Multi-lingual Names
Candle Stick, Christmas Candle, Desay, French Guava, Guajabo, Impetigo Bush, Kasyalata, Kassialata, King-of-the-Forest, Money Bush, Tarantan, Ringworm Shrub, River Guava, River Senna

Synonymy
Synonyms for *Senna alata* (L.) Roxb. are *Cassia alata* L.; *Cassia alata* var. *perennis* Pamp.; *Cassia alata* var. *rumphiana* DC.; *Cassia bracteata* L. f.; *Cassia herpetica* Jacq.; and *Herpetica alata* (L.) Raf.[45] .
NOTE. Since the 1980's the genus *Cassia* was split into 3 genera: *Cassia* sensu stricto, *Chamaecrista* and *Senna*. There are about 260 species in the genus *Senna* [(1, 2, 3)].

[45] Visit:http://www.mobot.mobot.org/W3T/search/vast.html.

Botanical Description
It is a glabrous shrub up to 3.5 m tall. Leaves pinnately compound with 6-12 pairs of oblong leaflets, blunt at the tip, unequal at the base, the terminal pair up to 15 cm long and 8 cm broad; inflorescence a terminal raceme with numerous roundish, brilliant, golden-yellow flowers; fruit a 4-winged pod, 10-15 cm long, black when ripe; seeds 7 mm long, angular, arranged transversely in the pod.

Distribution/Ecology
It is native of tropical America, but now widespread in warm countries across the globe. *Senna alata* is often seen in disturbed weedy land, and swampy places, and grows quickly like a weed.

Active Principles
The antibacterial, antifungal and also the laxative constituents of the leaf, are mainly the sennosides anthraquinoid compounds, aloe-emodin, chrysophanol, chrysophanic acid, and rhein (cassic acid), and the flavonoids, but apparently no saponins [3, 5, 6, 7, 8, 9, 10].

Parts Used/Key Uses
Traditionally, tea made from the leaves is taken as a treatment for constipation and intestinal worms. The leaves are rubbed on the skin to cure eczema and "ringworm". This latter treatment is validated in the recommendations of the TRAMIL research group, to use an infusion of 15 to 20 leaflets per litre of water to wash affected areas of the skin. This extemporaneous preparation should NOT be kept for more than one day [11]. The bark is rich in tannins and seeds are a good source of gums for use in ointments and herbal soaps.

NOTE: Many official pharmacopoeias have detailed monographs on the sister species of *Senna alata*, published by ESCOP, the WHO, and the British Herbal Pharmacopoeia [12, 13].

Quality, safety, efficacy and regulatory framework
TRAMIL researchers have shown that following peritoneal dosing in rats at 2g/kg, the ethanolic extractive from the leaf showed no significant toxicity. Extemporaneous aqueous preparations should NOT be kept for more than one day.

NOTE: The limits of sennoside content (extracted from *Senna species*) should be specified (not less than 2.5%). The sennosides are contra-indicated in cases of obstruction, acute intestinal inflammation, ulcerative colitis, appendicitis and abdominal pain of unknown origin; and for children under the age of 12. With chronic use, hypokalemia may occur. During the first trimester of pregnancy, senna pod preparations should be used only if a therapeutic effect cannot be obtained with a change in diet or through the use of bulk laxatives.

Cultivation Practices and Harvesting
Propagation is by seeds rather than by cuttings [3]. The seeds should be soaked in water for at least 24 hours before sowing. Germination can take from 3 to 4 days and is about 90 to 100%. The plant prefers moist well drained soil [14]. Planting can be done the year round, with spacings of 180 cm x 100 cm, for about 600 plants/ha. Fertilization is with organic matter at 30 t to 40 t/ha. It flowers from November to

April, and the flowers are visited by large black bees which presumably pollinate them [2, 4].

The leaves are harvested without pruning the branches and terminal buds, to allow the plants to recover. The first harvest is done in 5 months after planting, and the second some 6 months later. The productive cycle can last 2 or 3 years [15]. The leaves are harvested when needed; and the active constituents are probably most abundant prior to flowering, which is why the leaves are preferably collected at that time [3].

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

After harvesting, the leaves are air-dried and may be stored in cool, dry containers until needed [3].

Germplasm/Collection/Seed sources

S. alata is reported as being neither endangered nor liable to genetic erosion [3].

Research Needs

This plant is a very good candidate for researches in agronomy, because there is a growing commercial interest in its leaves.

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3.18 Smilax regelii

SARSAPARILLA

(SMILACACEAE)

Missouri Botanical Garden
Herbarium specimen
Voucher: CALZADA 835

Photo courtesy http://digitalis.mobot.org/mrsid/bin/mosid/mosid.pl

Common or Other Local Multi-lingual Names
Bejuco de Corona, Brown Sarsaparilla, Chaspawey, Jamaica Sarsaparilla, Honduran Sarsaparilla, Spanish Bayonet, Zarzaparilla

Synonymy
There **are no** synonyms for *Smilax regelii* Killip & Morton**.**
NOTE: However, other plants are known locally also as sarsaparilla (sasparilla), such as the sister species, *Smilax aristolochiaefolia* (Mexican sarsaparilla), *Smilax febrifuga* (Ecuadorian sarsaparilla), and even *Smilax ornata* Hook.f. (Jamaican sarsaparilla) and *Smilax domingensis* Willd. (Jamaican sarsaparilla) [1, 2, 3, 4].

Botanical Description

A spiny, climbing or scrambling shrub with sharply quadrangular stem and tendrils rising above the base of the petiole. Leaves 15-21 cm long x 7.5 –13.5 cm wide, on main stem, but smaller on the branches, ovate to oblong, variable in shape at the base, thin and papery when dry; flowers dioecious, male flowers 5.5 mm long; fruit a berry.

Distribution/Ecology
S. regelii is native to the Guianas and widely distributed in the Caribbean islands [(1)].

Active Principles
The very limited phytochemical studies done so far, have suggested the presence of saponins (glycosides) in the plant [(5)]. There is little or no evidence to validate therapeutic usage [(6)].

NOTE: The sarsaparilla saponins extracted from other species of the genus *Smilax* have been used as chemical intermediates in the partial synthesis of cortisone and other steroidal drugs [(6)].

Parts Used/Key Uses
The extracts of the roots have been used to treat various conditions including skin infections, the latter having been scientifically tentatively validated [(7)].
S. regelii root extracts also are widely used in the food industry to flavour soft drinks, ice-cream, confectionery and bakery products.

SPECIAL CAUTION: The roots of different species of the genus *Smilax,* and even of the genus *Philodendron* are used -- according to the Caribbean tradition -- alone or in mixtures to make decoctions popularly taken as tonics and as reputed aphrodisiacs [(3, 8)].

Quality, safety, efficacy and regulatory framework
Sasparilla is listed by the Council of Europe and the British pharmacopoeias as a safe natural source of food flavourants (Category N4). No toxicity data seems to be scientifically documented. However, large doses may irritate to the gastro-intestinal mucosa and should therefore be avoided [(6)].

SPECIAL NOTE: Sarsaparilla (or sasparilla) is a popular name applied to different species of *Smilax,* including especially *S. ornata* Hook. f., the bark of which has been a significant import into the United Kingdom from Central America, via Jamaica, and *S. domingensis* Willdenow of Central America [(9)].

Cultivation Practices and Harvesting
Propagation occurs by seed, suckers or root division. The soil must be well-drained, either in direct sunlight or partial shade [(2)].
In harvesting at the end of the rainy season, the roots are lifted by severing larger roots near the crown, leaving smaller roots to develop [(2, 5)].

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage
The roots are collected and dried in the sun. The dried material is then made into bundles, and then into bales. Generally sarsaparilla is exported in large bales bound by wire. Each bale contains numerous bundles which are generally the same size [(5)].

Germplasm/Collection/Seed Sources
No data is available at present.

Research Needs
A two-year project was started in 2000 in Costa Rica, to study the taxonomy, ecology, chemistry, transformation and marketing of the *Smilax species* of plants. CATIE is Centro Agronomico Tropicale de Investigacion y Ensenanza[46]. The research results were intended to teach scientists how to select species and populations of the genus *Smilax* with the greatest potential for use in natural and agroforestry ecosystem management systems. Much more work of this kind is needed to be done in the Caribbean countries.

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[46] The project was conducted by Mr. Roger Villalobos Soto at CATIE -- email: rvillalo@catie.ac.cr or communicacion@catie.ac.cr.

3.19 Vetiveria zizanioides

VETIVER

(POACEAE-GRAMINEAE)

Common or Other Local, Multi-lingual Names:
Cockroach Grass, Khus Khus, Pachuli Valeriana, Vetive' [(1)]

Synonymy:
Vetiveria zizanioides (L.) Nash also may be indexed as: *Andropogon zizanioides* Linn; *Andropogon squarrosus* Hack; *Andropogon muricatus* Rete; *Andropogon nardus* Blanco; *Andropogon nigritanus* Stapf; *Andropogon festucoides* Presl; *Andropogon echinulatum* Koenig; *Anatherum zizanioides* Beauv; *Agrostis verticillata* Lam and *Phalaris zizanioides* Linn. [(2)]

Botanical Description
Perennial grass 1-2 m tall, forming large compact clumps, leaf-sheaths keeled, the leaf blades smooth, firm, 30-100 cm long, 4-10 mm broad, margins rough; inflorescence a panicle, 20-30 cm long, spikelets purplish 4 mm long with short spines

NOTE: According to the Missouri Botanical Garden Database Tropicos, the current

name of this plant is *Chrysopogon zizanioides* (L.) Roberty, and there are several more synonyms.

Distribution/Ecology
Vetiver is native to India, but grows well in Haiti, Cuba, Jamaica and other Caribbean lands. It is a hydrophyte, often dominant in fresh-water swamps, flood-plains and on stream banks. However, it can also grow well under alternating very wet and very dry conditions, at average temperatures of 25°C – 35°C. It should not be shaded permanently, is tolerant of very poor and adverse soil conditions and is grown on heavy clays and on leached, poor sands. It can survive fire, rough trampling and grazing [(3)].

Active Principles
The essential oil distilled from vetiver roots is a major component in 36% of all western quality perfumes [(4)]. It is a highly complex mixture of sesquiterpene alcohols and hydrocarbons, and is one of the most viscous essential oils with an extremely slow rate of volatility, which may reach as much as 1% to 3% content in the roots [(3)].

Parts Used/Key Uses
A decoction made from the roots is taken traditionally for abdominal pain, fever and influenza. The multipurpose features of the root include its use and that of the young leaves as fodder for animals, dried roots as mulch or mattress stuffing, and also in sachets stored between clothes to give a pleasant smell and repel insects. Roots also are used in medicinal preparations, and as raw material for handicrafts products, as mats, baskets, fans, bags and curtains.

The growing plant itself has been used for soil conservation in the sugarcane industry in Fiji and in the West Indies. Its very dense root system grows downwards naturally and effectively anchors strips of plants and soil behind it. It is economically important because of its ability also to act as a natural barrier against soil erosion and soil pollution[(1, 2, 3, 4, 5)].

With a few drops of the oil, a variety of products are generated such as household deodorants, personal hygiene products (soaps) and household cleaning agents [(2, 4)].

Quality, safety, efficacy and regulatory framework
Vetiver oils which have high specific gravity, vetiverol content and ester values tend to be considered as superior from a perfumery viewpoint. These oils may be yellow to yellow brown, with a full-bodied scent, rich, sweet, woody and persistent odour.
The International Standardization Organization (ISO) standards for vetiver oil are ISO4716 of 1987, and, it is approved by the US Food and Drug Administration under No. 172.510 for use in alcoholic beverages only [(3)].

Vetiver oil in commerce has been known to be adulterated by adding cheap sesquiterpenes such as caryophyllene and its derivatives [(3)]. Vetiver oil is known to produce caustic effects on contact with the skin.

When liquid carbon dioxide extraction of the harvested root is done, the vetiver oleoresin obtained is another valuable product which is enriched with polar components and quality odour.

Cultivation Practices and Harvesting
Clumps divided into splits consisting of one or a few shoots of 15 – 20 cm lengths with a portion of the roots are used for planting.

Planting for soil conservation uses the young cuttings inside polystyrene bags which are placed at regular intervals of 10-20 cm apart. Emergency irrigation is provided to ensure a high number of cuttings will take root. Growth is generally slow during the first 3 months. The root system needs 1 year to become well developed. Some roots may reach a depth of up to 4 m, and about 0% of the roots are found within a radius of 20 cm from the plant. Clumps that grow out intertwine with neighbouring plants, forming a dense sod [(3)].

Planting for essential oil extraction implies the cultivation of vetiver for at least two years, with a view to obtaining a sufficient yield of root biomass with optimum characteristics as appropriate to proceed to the distillation phase. Planting is done on level ground preferably rich in organic matter and nutrients, or, on light sandy soils, and, if possible, adequately irrigated. The plots should be medium textured, deep and without skeletons, to allow the roots to develop in depth without encountering obstacles. Vetiver culms with short roots (3 cm to 5 cm) and 20 cm lengths of leaves are used for planting and transplanting. It is wise to use the appropriate fertilizers on the soil prior to planting. Weed control is important in the first phase of plant growth. Vetiver can be planted along with other plants, or, in coconut plantations, without disturbing growth or competing for nutrients [(2)]. Two months after field planting of vetiver, the soil is earthed-up into ridges 30 cm wide and 20 cm high [(2, 3)].

Vetiver is extremely resistant to insect pests and diseases. Studies have shown that vetiver itself is not a threat as a potential weed, nor is it generally an invasive species -- as it forms clumps via stolons and rhizomes.

Harvesting the roots is done in clearly defined stages whenever there is need to produce the oil. On sloping land, harvesting can cause serious erosion. The roots are dug up after the second year of cultivation when they have grown considerably. The soil must not be too moist in order to avoid collecting excessive amounts of soil residues with the roots. First the vegetation is cut and then the cut material is collected with approximately 20 cm of stem left behind. Next the cuttings are dug up, using machines like tuber or root diggers. The digging is done to a depth of 60 cm, where the majority of vetiver roots are concentrated. The undermined roots are pulled out of the soil, and separated from the crown, using shears or circular saws and then stored in a cool place.

An average root production is over two tons per hectare. Assuming an oil yield of 2-4% approximately 50 kg of essential oil is produced. Haiti is a major supplier of vetiver oil on the world market. In 2004 the traded value of 1 kg of oil was over US$69[47].

NOTE: The present development of in vitro plant propagation and breeding provides a powerful means for the genetic improvement of vetiver grass. Plant propagation

[47] Visit: < www.tradeforum.org/>.

using shoot cultures, that is, micro-propagation, supplies growers with a highly uniform plant population, useful for commercial exploitation and for the maintenance of secure genetic stocks of plant material for breeding, genetic transformation and germplasm conservation. The latter subject is essential for crops which produce short-lived seeds and for those which are normally propagated vegetatively, like vetiver grass.

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

The culms (50 per plant) collected after the harvest can be separated and used for subsequent transplants for reproduction of vetiver, with clear savings in costs and labour.

Preparation of the roots for oil extraction consists of washing, then drying in the shade, to 10 to 15% moisture content, storing if necessary, and then cutting up into pieces of a few centimetres in length, using conventional shredders for the latter stage. Storing the roots for about 6 months has been reported to improve oil quality.

Various distillation techniques, with equipment for differing production capabilities, are available for use with the chopped roots, mainly involving steam distillation. Liquid solvent and, more recently supercritical carbon dioxide extraction also may be employed. The latter process yields higher quality oil, but requires more highly specialized personnel than the former processes.

In order to improve quality and increase its shelf-life, the freshly distilled oil must be dehydrated by anhydrous sodium sulphate or by other means. It is then allowed to mature by natural oxidation for about six months, before storage in dark glass bottles. "The production of the essential oil has in recent times faced no difficulty in keeping pace with demand and the main sources of vetiver oil" such as Haiti [(2)].

Germ plasm/Collection/ Seed Sources

Several germplasm accessions are maintained at the Central Institute of Medicinal and Aromatic Plants (CIMAP) of Lucknow, India, from which several cultivars have been released, and in other Asian countries as well. In Thailand, the Department of Land Development started germplasm collections of vetiver, in the late 1990's, as part of a soil erosion control programme [(2, 3)].

Research Needs

Since vetiver grass has been used significantly in St. Vincent for several decades, and Haiti has been a major vetiver oil producer, at over 50 t per year in the 1990's [(4)], there may be need for a Caribbean Vetiver Network to complement the global intiative[48]. Further research is urged with regard to the ecotypes of the plant found in the Caribbean region. Pharmacological studies of the essential oil should be pursued.

[48] Visit: < www.vetiver.com/>.

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3.20 Zingiber officinale

GINGER

(**ZINGIBERACEAE**)

Common or Other Local, Multi-lingual Names
Ajenjible, Common Ginger, Djiendje, Gingembre, Gengivre, Jengibre, Jenjan, Jingible

Synonymy
Synonyms for *Zingiber officinale* Roscoe. are *Amomum zingiber* L., *Zingiber blancoi* Massk, and *Zingiber zingiber* (L) Karst. [1, 2, 3].

Botanical Description
An erect perennial herb, 0.3-1 m tall, rhizomes, pale brown, covered with small scales, thick, hard 1.5-2.5 cm in diameter, aromatic, pale yellow inside; leaves linear 5-25 cm long and up to 2 cm wide; inflorescence 3.5-5 cm long; corolla tube, 35-50 mm with 3 greenish-yellow lobes and a labellum 12-15 mm long, dark purple with cream spot at the base; fruits a thin-walled 3-valved capsule with black arillate seeds are seldom produced.

Distribution/Ecology
The plant is probably native to south-east Asia, and it is cultivated successfully in Jamaica, and other tropical regions globally.

Active Principles/
The essential oil from the rhizome has the aroma and flavour of the spice, but lacks pungency. It is used for flavouring and also as a fragrance. The oleoresin (4-7.5% w/w) which is extracted contains non-volatile mixtures, including the pungent (hot) phenolic compounds 6-gingerol and other gingerols, paradols, shogaols and zingerone, apparently responsible for the scientifically validated therapeutic activities[4, 5, 6, 7, 8, 9, 10]. The oleoresin has the aroma, flavour and pungency of the spice itself [9].

Parts used/Key Uses
Traditionally the rhizome is used to make teas to treat stomach complaints and colds and the flu. Its aqueous extracts also are sweetened with sugar to make a special beverage.

Ginger preparations are sold also as nutraceuticals in North America.

Quality, safety, efficacy and regulatory framework
The quality tests for ginger are well documented, and they appear in several official pharmacopoeias globally.

The peeled finger-long fresh or dried rhizome constitutes the official herbal drug *Zingiberis rhizoma* in the European Pharmacopoeia, Council of Europe [3, 4]. Dosages equivalent to one gram powdered rhizome are clinically proven prophylactic treatments for motion sickness and nausea in adults [4, 5]. The caution is that in sensitive persons contact dermatitis of the fingertips has been reported [4, 5].

The material of commerce is supplied in "completely scraped" (peeled), "partially scraped", or "unpeeled" rhizomes. The quality of whole dried ginger product is determined by its appearance while its aroma, pungency and volatile oil content are important factors for the extraction of its oils. Dried ginger rhizomes contain per 100 g edible portion: 10 g water, 10-20 g protein, 10 g carbohydrate, 2-10 g fibre and 6 g ash [9].

In the United States, the regulatory status "generally recognized as safe" is accorded to ginger (GRAS 2520), ginger oil (GRAS 2522) and ginger extract/oleoresin (GRAS 2521, 2523). The Food Chemicals Codex also has set standards for ginger oil [9]. The essential oil component (0.25-3.3% V/m) in the rhizome is a complex mixture, variable according to the producer country, which contains zingiberene and other volatile terpenes and non-terpenoid compounds.

A monograph on the physiological properties of ginger oil has been published by the Research Institute for Fragrance Materials (RIFM) and by the European Scientific Cooperative on Phytotherapy (ESCOP) [9].

Cultivation Practices and Harvesting
Ginger is grown from smallholder level to large-scale fully mechanized operations to service a range of markets. The land should be thoroughly ploughed and pre-planting operations aim at removal of roots and previous crop residue, with maximum weed reduction. Subsequent cultivation should produce the fine tilth required to produce well-shaped, clean rhizomes.

Ginger is usually vegetatively propagated from small portions of rhizome (setts or seed pieces) from the previous year's harvest, but can also be micro-propagated using meristems, rhizome sections or tissue culture.

The depth of planting usually is not critical, however, the time of planting is important since the soil must be moist and not dry out once the setts are sown, around April-May in Jamaica and the other Caribbean islands. During the last phase in the sequence of development of annual ginger, shoot and leaf growth virtually cease, and rapid rhizome development occurs.

Ginger plants must be kept free of weeds until foliage is sufficiently dense to suppress weed control. Weeding is essential to obtain a high yield of good quality rhizomes, so too is adequate irrigation. Ginger is often underplanted in coconut, orange and young coffee plantations, and high, light shade can be beneficial. Growers also alternate several rows and of ginger with yams, chillis and vegetable crops. A rotation in

which 2 to 3 years of ginger is followed by two years of soybean, chillis or vegetables can reduce the incidence of pests and soilborne disease.

Many of the common pests of ginger can be controlled by pesticides, but their use is limited by increasingly stringent regulations covering chemical residues in the rhizomes and their extracted oil. Diseases are generally more damaging than insects, as the widespread transfer of ginger rhizomes and plants in ancient and modern trade routes helped spread the pathogens. Disease prevention or control is an essential component of commercial ginger growing and its neglect is disastrous. Rhizome rots are the most destructive.

Harvesting requires that plants between 8 and 9 months of age are carefully lifted from the soil to prevent rhizome damage. At maturity much of the foliage has withered and presents few problems. Rhizome yield is basically determined by the cultivar grown, and thus agronomic and climatic factors can only assist in obtaining the highest yield, which can be two tons per hectare and higher. Oil content tends to fall with age of rhizome, and not merely in relation to its total fibre content.

The *in vitro* production of active compounds and essential oils from the shoot tips in different growth media has been reported [(9)].

Organic cultivation has been done systematically in Costa Rica within the following two categories, namely:

a. "Natural system": The crop is planted on soils that have been fallow for several years, and it is established under conditions of natural shade, planted in small areas without the benefit of any input whatsoever. This system has the inconvenience of diminishing the productivity per unit of area.
b. "Organic System"; The crop receives diverse inputs, such as calcium carbonate, fertilizers of organic origin, and manual weeding, and normally produces an adequate yield [(12)].

To be sold as "organic", a product must be certified by an accredited certification body.
IFOAM, the International Federation of Organic Agriculture Movement has established organic production, processing and trading standards, and has tried to harmonize the certification systems worldwide. Thus, for the spices and oleoresins, ionizing radiation and the use of volatile synthetic solvents are prohibited in the production processes.

Post-harvest/Manufacturing Practices: Handling, Processing, Packaging and Storage

Following lifting, the rhizomes are washed and roots removed; then they are killed by immersion for ten minutes in boiling water, dried and stored, as soon as practicable after lifting. A major problem with smallholder ginger is that the traditional methods used allow rhizomes to become heavily contaminated with microorganisms which must then be eliminated or rejected.

Dried ginger in large enough quantities can be traded as spice internationally. Jamaican gingers have a reputation of high quality, like the Indian (Cochin) ginger, with a light colour and a delicate flavour [(13)]. The other important ginger products are

ginger oil and ginger oleoresin used in flavouring. Dried rhizomes are comminuted to a coarse powder immediately prior to being loaded into the still for steam-distilling the oil. In the trade, the powdered rhizome should be stored in a well closed container (not plastic) to protect from moisture and light.

Ginger oleoresins are obtained by solvent extraction of the powdered dried rhizomes in liquid carbon dioxide under high pressure and these are then recovered. Volatile oils and oleoresins are preferred over dried spices as flavouring by the food industry, because they are more stable, cleaner and free from contamination, and can be standardized by blending oils from different sources.

Germplasm/Collection/Seed Sources

Germplasm collections for ginger are maintained at the Indian Institute for Spice Research in Calicut, Kerala, India, and at the Research Institute for Spices and Medicinal Crops in Bogor, Indonesia[49].

CAUTION: Other species of the genus *Zingiber* and their essential oils are known in the international trade to be used as substitutes and as adulterants for authentic ginger and its products (9, 10).

Research Needs

There is need for more information than that given in "Economics of Ginger Root Production in Hawaii" by K. Fleming and D. Sato. 1998. College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa. More details are provided in the Indian Herbal Pharmacopoeia (14).

More crop improvement programmes are needed towards the selection of cultivars for resistance to rhizome rot and bacterial wilt (9).

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4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

For this study, 20 medicinal and aromatic plants were selected and their profiles developed. Their selection was based on the perceived potential for their production and transformation into commodities, which may be categorized as: fresh or dried, comminuted raw herb, tea, exotic herbal drink, cosmeceutical, essential oil, flavourant, fragrance, nutraceutical, phytomedicine, or, other refined herbal extract with defined constituents and biological effects.

It was difficult to identify most of the selected plants, solely on the basis of their common names. Sometimes the same name (sarsaparilla, for instance) was given to plants which are distinctly different species (for example, *Smilax species* versus *Philodendron species*). In other cases, different local names were used for the same plant, located in different areas of the Caribbean region. In order to meet this challenge in nomenclature, not only were the scientific names necessary, but high quality colour photographs also were also included in the plant profiles[50].

Several Caribbean herbs are in fact introductions into the region, having originated mainly from countries in South-East Asia and tropical America. No surprise, therefore, that except for *Colubrina arborescens*, *Croton eluteria* and *Lippia alba*, all the plants in this study have been given detailed coverage in the multi-volume handbook, by the PROSEA Foundation, on the plant resources of South-East Asia [(1)]

Roughly half of the selected plants in this study have never been cultivated systematically in the Caribbean region.

For most of them and their products, including the better known *Croton eluteria* (cascarilla) bark from the Bahamas, *Vetiveria zizanioides* (vetiver) oil from Haiti, and *Maranta arundinacea* (arrowroot) from St. Vincent, very little data on agronomy and post-harvest practices could be accessed from Caribbean sources. As a consequence, the major information sources were publications and books (in Spanish) from the CYTED and the TRAMIL organizations in neighbouring Latin American countries [(2, 3, 4, 5)]. Notably, *Carapa guianensis*, *Momordica charantia*, *Myristica fragrans* and *Smilax regelii* were not discussed in these books. It is noted also that globally, "only a small fraction of the research on medicinal plants is oriented toward agronomic aspects" [(6)]. This shortage in bibliography is being remedied in the newly emerging journals, such as the *Journal of Herbs, Spices & Medicinal Plants*.

In Table 2, a list is shown of several of the electronic web-sites visited in the course of this study. Each site was critically reviewed, so as to distinguish sound, reliable, evidence-based data from the legendary folklore generally associated with herbal medicines. The balanced viewpoint is that "many herbal therapies can be employed not only as medicines with potential pharmacological benefits, but as harmless placebos, resulting in good therapeutic response for the patients" [(7)].

[50] Permission from the owners to use these photographs is acknowledged in Table 1.

For most of the selected plants, active principles were not precisely chemically-defined, so that the potential for their use as healing agents remained unclear. However, good scientific validation was found for the medicinal uses of extracts derived from *Aloe vera*, *Andrographis paniculata*, *Curcuma longa*, *Quassia amara*, *Senna alata* and *Zingiber officinale*. The leaf extracts of *Andrographis paniculata* have recently been established as safe and efficacious for the relief of symptoms of uncomplicated upper respiratory tract infection, including the common cold. This herb ought to attract the attention of Caribbean growers and processors with interests in medicinal crops which are not patented and which can be traded freely.

Table 3 presents a summary of findings concerning the "**Proven Industry Uses**" for each herb. The specific part of each plant which is of value has been indicated, as well as its potential for development into a marketable item, whether as a nutraceutical, flavourant, cosmeceutical, or other finished herbal product. It is not intended to identify the relevant active principles as pure, single-chemical entities to be isolated from the plants. It was intended, more appropriately, to address quality and safety issues related to the botanicals concerned (8), and, through the activities of international agencies, possibilities for improving the cultivation and post-harvest and processing technologies for these neo-tropical plants[51].

Vetiver zizanioides stands out as one of the most thoroughly studied herbs for its industrial products, especially its essential oil. However, this grass may be economically more important, for communities residing in the Caribbean, through its soil conservation capability to save lives and property in flood-prone localities.

Germplasm collections were scarce or unknown in this study. A key institution for certain species of the genera *Croton*, *Cymbopogon* and *Lippia* were identified in the University of Ceara, Campus do Piei in Foraleza, CE in Brazil. Other useful institutions, located in countries in South-East Asia, were recommended in the publications of the PROSEA Foundation.

The breeding of herbs and spices is recorded as lagging far behind that of the major food crops. Therefore, more biotechnology should be employed to develop the medicinal and aromatic plants, for resistance to disease and pests, and, for their active constituents as well. More tissue culture techniques should be applied to increase both the yield and quality of *Eryngium foetidum* and other aromatic species (9).

It is possible that current harvesting practices may be destructive, for example, stripping the bark of *Colubrina arborescens* (mauby trees) to produce the very popular derived beverage. Are these plants which grow in the wild already, or potentially, endangered species (10).

According to the literature, there are no or only a few reliable trade data available for single herbs, globally, which are the sources of teas, liqueurs, sweets, cosmeceuticals, nutraceuticals, remedies, or essential oils (11). The electronic websites visited provided data only about the product ranges, but, usually without any trade and economic statistics.

[51] Visit:<www.ics.trieste.it>

Further work is needed urgently to calculate the marketing costs for herbals derived from *Carapa guianensis*, *Eryngium foetidum*, *Hibiscus sabdariffa*, *Lippia alba* and *Senna alata*[52].

4.2 Recommendations

Research should be actively pursued into the agro-technology for *Andrographis paniculata*, *Cymbopogon citratus*, *Eryngium foetidum*, *Lippia alba*, *Myristica fragrans*, *Pimenta dioica*, *Pimenta racemosa* and *Smilax regelii*, to improve yields of both the active principles and the herbal raw materials most in demand. What are the possibilities for inter-cropping certain food crops with the sorrel plant (*Hibiscus sabdariffa*)?

Agri-business interests in the Caribbean should seek to improve the infrastructure in the sector, and to become better informed about the regulatory requirements for entry into foreign markets.

To address the dire shortage of skills in plant taxonomy, it is recommended that training workshops should be conducted urgently, on the identification of medicinal and aromatic plants in the region, for agricultural and related personnel.

Training workshops should also be held on the information and the hardware, for farmers, processors and allied personnel, to implement good agricultural practices (GAP), good agricultural and collection practices (GACP), and, good manufacturing practices (GMP) in the region [12, 13].

Since *Vetiveria zizanioides* provides the established "thin green line" technology against soil erosion and land slippages on hillside slopes, it is recommended that this grass should be used more extensively by the various environmental agencies in the region.

For the next phase of this study, the following recommendations also may be appropriate:

- support the systematic documentation of indigenous knowledge/claims about the attributes of Caribbean medicinal and aromatic plants;

- encourage persons who participate in workshops to develop methods for the authentication/standardization of botanicals, and, to prepare monographs for products such as *Carapa guianensis* seed oil, *Hibiscus sabdariffa* colourant, *Momordica charantia* leaf and fruit extracts, and, *Smilax regelii* root extracts;

- urge growers to learn how to implement the requirements to enter the herbal organics markets (Visit:<www.europa.eu.int>);

- investigate the potential of *Cymbopogon citratus* and *Quassia amara* as

[52] Visit:<http:www.fao.org/docrep/U8770E/U8770E00.htm>.

sources of organic pesticides;

- study the feasibility for the certification of herbals like Carapa seed and Quassia wood as valuable non-timber forest products.

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TABLE 1 - PLANT PHOTO LOCATIONS

Plant Name	**Photo Location**
Aloe vera	www.ibiblio.org/herbmed - Copyright Henriette Kress
Andrographis paniculata	altcancer.silvermedicine.org/andcan.htm
Carapa guianensis	www.plantarum.com.br – Copyright Harry Lorenzi
Colubrina arborescens	www.rain-tree.com/Plant-Images
Croton eluteria	www.plant-pictures.de – Copyright Thomas Shoepke
Curcuma longa	www.iisr.org/spices/turmeric.htm www.plant-pictures.de – Copyright Thomas Shoepke
Cymbopogon citratus	www.tropilab.com/
Eryngium foetidum	www.worldcrops.org/crops/Culantro.cfm -

	Copyright Frank Mangan
Hibiscus sabdariffa	www.tropilab.com/
Lippia alba	www.ibiblio.org/herbmed - Copyright Henriette Kress
Maranta arundinacea	www.instituteofjamaica.org.jm/NHD/maroons.html
Momordica charantia	www.tropilab.com/
Myristica fragrans	www.plant-pictures.de – Copyright Thomas Shoepke www.tradewindsfruit.com/
Pimenta dioica	www.tradewindsfruit.com/
Pimenta racemosa	www.tradewindsfruit.com/
Quassia amara	www.rain-tree.com/Plant-Images
Senna alata	www.rain-tree.com/Plant-Images/
Smilax regelii	digitalis.mobot.org/mrsid/bin/mosid/mosid.pl www.naturprodukt24.de/pflanzenbilder/smilax.jpg
Vetiveria zizanioides	www.ibiblio.org/herbmed - Copyright Henriette Kress
Zingiber officinale	www.fao.org/inpho/compend/toc_main.htm www.plant-pictures.de – Copyright Thomas Shoepke

TABLE 2. - LIST OF WEBSITES

1. http://www.herbs.org/africa/asnappresources.html
2. http://www.cta.int/about/index.htm
3. http://www.agribusinessonline.com/
4. http://www.science.siu.edu/plant-biology/faculty/nickrent/BotImages.html
5. http://www.csir.co.za/plsql/ptl0002/PTL0002_PGE005_DIVISIONS?DIVISION_NO=1010012
6. http://www.hear.org/starr/hiplants/images/thumbnails/
7. http://www.infoagrar.ch/Informationcenter/
8. http://www.hort.purdue.edu/newcrop/default.html
9. http://www.npicenter.com/quality.asp
10. http://www.tradewindsfruit.com/
11. http://www.rain-tree.com/plants.htm
12. http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/
13. http://www.ictp.trieste.it/~twnso/plants/plants.html
14. http://www.raise.org/natural/pubs/hibiscus/hibiscus.stm
15. http://www.camid.org/links.asp
16. http://www.cardi.org/
17. http://www.agroinfo.org/
18. http://www.namdevco.com/home.asp
19. http://www.caisnet.org/
20. http://www.pcarrd.dost.gov.ph/prosea/proseaherbal/species_list.htm
21. http://www.fao.org/es/ess/toptrade/trade.asp?dir=exp&disp=countrybycomm&resource=689&ryear=2002
22. http://www.ncbi.nlm.nih.gov/gquery/gquery.fcgi
23. http://plants.usda.gov/cgi_bin/topics.cgi?earl=plant_profile.cgi&symbol=SMRE2
24. http://www.tropilab.com/plantlist.html
25. http://www.tradeforum.org/news/fullstory.php/aid/658/ITC_Today%85_Bridge-building_from_South_to_South.html
26. http://www.vetiver.com/TVN_FRONTPAGE_ENGLISH.htm
27. http://www.fintrac.com/default.asp
28. http://www.unctad.org/Templates/StartPage.asp?intItemID=2068
29. http://www.intracen.org/index.htm
30. http://www.cbi.nl/
31. http://www.medplant.net/
32. http://www.frlht-india.org/
33. http://www.worldcrops.org/
34. http://www.herbsociety.org/promplant/lalbaglobiflora.htm
35. http://www.ibiblio.org/herbmed/pictures/herbpics.html
36. http://www.itdg.org/?id=technical_briefs
37. http://www.herbalgram.org/default.asp?c=aloe
38. http://www.hort.purdue.edu/newcrop/CropFactSheets/aloe.html
39. http://www.ars-grin.gov/duke/syllabus/gras.htm
40. http://www.iisr.org/spices/allspice.htm
41. http://www.thegoodscentscompany.com/data/es1021531.html
42. http://www.libertynatural.com/bulk/1990.htm
43. http://www.catie.ac.cr/magazin.asp?CodWebSite=2
44. http://www.geographia.com/bahamas/investment/invest01.htm

45. http://www.foodnet.cgiar.org/market/Tropcomm/part2c1.htm
46. http://www.bahamasb2b.com/news/wmview.php?ArtID=156
47. http://www.cdi.be/english/coop_e/count_e/car/bahamas/bahamas2.htm
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50. http://www.traffic.org/dispatches/archives/march2001/mednews.html
51. http://www.worldwildlife.org/trade/faqs_medicinal.cfm
52. http://www.dbtmicropropagation.nic.in/plantcataloguemedicinalaromatic.htm
53. http://www.genemco.com/aloe/faq.html
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59. http://home.hiroshima-u.ac.jp/shoyaku/PP2002B.htm
60. http://www.instituteofjamaica.org.jm/NHD/maroons.html
61. http://www.naturprodukt24.de/ pflanzenbilder/smilax.jpg
62. http://www.itis.usda.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=43340

TABLE 3 – PROVEN INDUSTRY USES

Plant (Part used)	Specific Extract (Industry use)	Prospects
Aloe vera – (ALOE) (LEAF)	(a) Leaf latex (Phytomedicine, laxative) (b) Leaf gel : (i) Nutraceutical, (ii) Cosmetic (c) Aloe "Juice" (d) Aloe powder concentrate for addition to cosmetics	Extremely popular. Can the Caribbean compete with the rest of the world? Need for development of value added products.
Andrographis paniculata – (RICE BITTERS) (AERIAL PARTS)	(a) *Herba Andrographidis* (Phytomedicine for upper respiratory infections)	Not the most familiar weed -- But clearly a most promising substitute for conventional cold and flu medicines.
Carapa guianensis (CARAPA) 1.SEED 2.WHOLE TREE	(a) "Andiroba" or Carapa seed fixed oil (i) Cosmetic (ii) Soap-making, etc. (b) Timber (Furniture- making)	A test case for S&T and R&D for forest product usage and IWOKRAMA environmentally-sensitive issues--cf. Mauby
Colubrina arborescens (MAUBY) 1.BARK 2.WHOLE TREE	(a) Bark extract (Beverage) (b) Whole Tree (is a honey tree)	Highly recommended for agro-forestry development -- compare Carapa.
Croton eluteria (CASCARILLA) (BARK)	(a) Bark extract : (i) Bitter tonic; (ii) Phytomedicine for indigestion (iii) used in making Campari (b) Essential oil used in Perfumes	Preferring limestone terrain, but very little agrotechnology data is available.
Curcuma longa (TURMERIC) (RHIZOME)	(a)Ground Rhizome (Spice) (b) Rhizome essential oil (Flavourant) (c) Oleoresin (i) Colourant (ii) Spice (d) *Rhizoma Curcumae Longae* (Phytomedicine for impaired digestion)	An established spice with good agrotechnology data and improving markets as a nutraceutical, flavourant, anti-oxidant, food colourant and cosmeceutical
Cymbopogon citratus (LEMONGRASS) (LEAVES)	(a) Essential oil: (i) Perfumery (ii) Aromatherapy (b) Comminuted herbage: (i) Herbal tea (ii) Insect repellent	Good agrotechnical data and scientific support for a wide range of uses Investigation of Cymbopogon as an organic pesticide or biocide is also suggested.
Eryngium foetidum (FIT WEED) (HERB)	(a) Comminuted Herb (Spice) (b) Herb as an understory crop in intercropping systems	Agrotechnology is good. Farmers are doing well in the "ethnic" markets

Plant (Part used)	**Specific Extract (Industry use)**	**Prospects**
Hibiscus sabdariffa (SORREL) (CALYX)	(a) Calyx extracts: (i) Herbal tea (ii) Beverage (iii) Nutraceutical	Potential for organic farming (USAID has much R&D in Africa, with good germplasm and agrotechnology
Lippia alba (SANTA MARIA) (LEAF)	Leaf extracts (Phytomedicine as topical antiseptic)	Good agrotechnology prospects
Maranta arundinacea (ARROWROOT) (ROOT)	(a) Root (Nutritious food) (b) Root Starch (Phytomedicine as emollient)	Good for intercropping with yam, pigeon peas, pumpkin, and cassava. Arrowroot needs much modern upgrade as a plantation industry.
Momordica charantia (CORAILI) 1.FRUIT 2.LEAF	(a) Unripe fruit juice (Nutraceutical as a potential anti-diabetic agent?) (b) Fruit (Carotenoid-rich food) (c) Leaf (Herbal tea)	The agrotechnology seems good, but should be improved.
Myristica fragrans (NUTMEG) 1.SEED 2.ARIL	(a) Seed and aril (Spice) (b) Nutmeg butter (c) Aril (mace) pigment is lycopene (d) *Myristica semen* (Nutraceutical as carminative) (e) Essential oils Phytomedicine as (i) an analgesic (ii) anti-oxidant) (f) Oleoresin (Flavourant)	The national industry for Grenada -- a world leader with the need to diversify further the product range
Pimenta dioica (PIMENTO) 1. FRUIT 2. LEAF	(a) Ground, dried gren mature fruit (i) Flavourant (ii) Curing agent (b) Essential oil: (i) Perfumery (ii) Flavourant (c) Oleoresin (Flavourant)	Major crop for Jamaica a world leader with potential for further diversification of the product lines
Pimenta racemosa (BAY RUM TREE) 1. LEAF 2. FRUIT 3. WOOD	(a) Essential oil: (i) Hair lotions (ii) Antiseptic agent (b) Timber (Furniture)	Major crop in Dominica. Need for much R&D in all aspects of the industry
Quassia amara (QUASSIA) (WOOD)	a) Wood tincture (Traditional topical remedy for head lice) (b) Wood extracts: (i) Bitter tonic (ii) Flavourant (c) Refined extracts (Phytomedicine to treat gastric ulcers) (d) *Quassia lignum* (stimulates the appetite) (e) The quassinoids and other isolated chemical constituents (as potential antimalarial agents)	Too little research done on this well-known medicinal plant of the forests. Compare the conservation issues for Mauby and Carapa. Additional investigation of Quassia for use as an organic pesticide or biocide is also suggested.

Plant (Part used)	**Specific Extract (Industry use)**	**Prospects**
Senna alata (WILD SENNA) (LEAF)	(a) Leaf: (i) Herbal tea; (ii) Phytomedicine (as laxative) (b) Leaf decoctions are highly recommended as topical antimicrobial treatments by the TRAMIL research group	Urgent need for agronomic research, and standardization to support the demand for this commodity
Smilax regelii (SARSAPARILLA) (ROOT)	(a) Root extract (Flavourant) (b) Root extracts (Phytomedicine topically for skin infections)	More research into its use in agroforestry systems is needed. Compare the case of Mauby
Vetiveria zizanioides (VETIVER) 1.ROOT 2.WHOLE PLANT	a) Dried root: (i) Mulch (ii) Fragrance (iii) Mattress stuffing (iv) Insect repellent (b) Essential oil (Perfumery) (c)Whole plant for soil conservation	A well researched plant It is the thin green line against soil erosion
Zingiber officinale (GINGER) (RHIZOME)	(a) Rhizome (Spice) (b) Rhizome (Beverage) (c) *Zingiberis rhizoma* (Phytomedicine as a proven prophylactic agent for motion-sickness) (d) Essential oil: (i) Flavourant (ii) Fragrance	Further crop improvement is required to select for resistance to rhizome rot and bacterial wilt good market prospects for organically farmed

ANNEXES

Annex 1. Terms of Reference

STUDY FOR THE DEVELOPMENT OF A HANDBOOK OF SELECTED CARIBBEAN HERBALS FOR INDUSTRY: PHASE 1

1. Background

International trade in botanicals as herbal extracts and semi-finished products exceeds US thirty billion dollars per year. About fourteen hundred different herbal preparations are commonly used in the countries within the European Union. It is also estimated that Europe imports about 400,000 tonnes of medicinal plant products with an average annual market value of US one billion dollars from Africa and Asia alone.

While the international market for herbal products has been expanding rapidly, the Caribbean herbal industry comprising some ninety companies has remained under-developed due to, *inter alia*:

- the absence of large scale cultivations upon which sustainable local production and processing systems may be built;
- uncertainty in the supply and quality of raw materials;
- non-harmonised regulatory frameworks among countries;
- lack of knowledge on the safety / efficacy of the herbs;
- a shortage of specialists such as taxonomists;
- deficiencies in the infrastructure for agricultural crop production;
- the high costs of inputs;
- lack of education on herbs to the general public
- negative connotations of 'folk medicine'
- etc.

There are however many reasons why the Caribbean should be interested in developing its herbal industry:

- the need to diversify agriculture;
- to conserve foreign exchange by substituting local herbs for imported herbal products;
- the herbal industry is labour-intensive and can serve to reduce unemployment;
- the integration of herbal business with tourism and thereby the potential to develop the herbal / ecotourism industry;
- greater utilisation and traditional usage of the indigenous knowledge of herbs existing in the Caribbean region;
- to capitalise on the rising global interest / usage of herbs;
- important potential for income generation.

It is against this backdrop that the Caribbean Herbs Business Forum (CHBF) – "Fostering Commercial Partnerships for Sustainable and Economic Use of Biodiversity" was held in Jamaica in December 2002. The forum was funded by several international agencies[53] and brought together a wide cross-section of representatives from the herbal sector / industry (practitioners, researchers, growers, processors, private sector companies, regulators, …) from the Caribbean, the Americas, Europe and Australia. The CHBF made a number of key recommendations sub-divided into a three track approach[54] aimed at tackling the constraints facing the Caribbean herbal industry namely:

[53] CDE, CTA, ComSec and IICA.

[54] Cf. report - Caribbean Herbs Business Forum – "Fostering Commercial Partnerships for Sustainable and Economic Use of Biodiversity", pp. 40-43.

1. re-branding and repositioning Caribbean herbals;
2. enabling regulatory issues in the Caribbean herbal industry;
3. exploring the potential for herbals in crop and product diversification.

The present study is therefore within the framework of recommendations made for the latter track.

2. Main issues

Several reports and presentations prepared before and after the December 2002 Caribbean Herbs Business Forum (CHBF) have drawn attention to the fact that there is insufficient technical information available in a single document on the attributes of key Caribbean herbs with the potential for supporting a sustainable herbal products industry in the region. While a considerable amount of scientific work has been undertaken by research organisations both within and outside the Caribbean on Caribbean herbs[55], the information is often incomplete and at best, fragmented across several local and regional publications, and of little use to farmers, extension workers and promotional organisations trying to grow, process and export Caribbean herbs and extracts on a commercial basis.

Additionally, the lack of user friendly technical manuals providing information on what and how to grow a variety plants which are used by local manufacturers of herbal remedies, nutraceuticals, natural fragrances and cosmetics, was identified as one of the key constraints on the development of a thriving medicinal plant farming sector. This was clearly expressed in presentations made during the CHBF, where it was noted that many companies have to resort to importing most of their herbal raw materials.

Finally, there is much need for information on the safety, efficacy and quality attributes of the products to be developed for a commercially viable Caribbean herbal industry. This was seen as major bottleneck to the development of the Caribbean herbal industry and its multiplier effects.

3. Objectives and scope of the study

3.1 Overall Objective

To increase the availability of knowledge on the special attributes of Caribbean herbs, so as to improve and expand the commercial viability of those commodities within the context of expanding regional and global demands for herbal products.

3.2 Project Purpose

To prepare a handbook of selected Caribbean herbals for industry that contains the attributes of twenty herbs of the region which have good prospects for commercial viability within the Caribbean herbal industry.

To have a herbal handbook that can be made available to all research and herbal organisations as reference material.

4. Methodology

The consultant(s) will use a combination of methods including:

- desk review of available literature, information sources and databases on Caribbean herbs e.g. CARDI, IICA, UWI – three campuses, CARAPA, TRAMIL, CYTED, OAS, FAO, PAHO, WHO, Ministries of Agriculture and relevant institutions / groups in Caribbean states;
- make and document a selection of twenty herbs requiring more in-depth examination and which will form the basis for elaboration of the Handbook of Selected Caribbean

[55] Cf. various studies and works undertaken by TRAMIL, a.o.

herbals for industry as follows: 5 well-known and currently utilised herbs; 10 widely used herbs in the industry but about which less information is available; 5 with commercial potential and for which there is general interest in the industry but are not being widely used;

- liaise closely to exchange information, etc. with Caribbean & regional research institutions, private sector herbal companies and the CHBA.;
- interviews with herbal practitioners

5. Expected output

The production of a 'Handbook of Selected Caribbean Herbals for Industry' that will be a valuable user-friendly asset for business people such as the members of the CHBA and other stakeholders involved in the herbal business. It will provide accurate and up-to-date information on the identification; propagation, harvesting and processing of approximately 20 wild managed and/or cultivated Caribbean medicinal and aromatic plants. The study will also document the commercial value of those identified herbs[56] in the preparation of essential oils, nutraceuticals, fragrances, flavourants and cosmetics[57].

The attributes of each plant will be presented under the headings: Common or Other Local, Multi-lingual Name; Scientific and Local Name (including family and synonyms); Botanical Description (picture, hard copies and web pages); Active Principals; Part Used/Key Uses (medicinal); Aspects of quality, safety, efficacy, regulatory, etc.; Agronomy/Horticulture; Distribution/Ecology; Germplasm/Collection/Seed Sources; Propagation, Cultivation Practices, Harvesting; Post-harvest Practices: Handling, Processing, Packaging, Storage; Research Needs (e.g. conservation, chemical analysis/validation, organic farming); Bibliography.

It is therefore expected that this comprehensive and instructional handbook will provide the CHBA and other stakeholders with the requisite knowledge and reference for developing and expanding those identified products into commercially viable products. The herbal industry in the Caribbean will be better poised to contribute to the diversification effort of regional agriculture and generate further income. Consumers will benefit by having access to more reliable information on the herbal products being consumed.

6. Reporting

The report will be structured as follows:

Main report

1. Executive summary
2. Introduction including methodology used
3. Herbal profiles (20)
4. Conclusions and recommendations

Annexes

1. *Terms of reference*
2. *Profile of institutions / organisations active in the research of Caribbean Herbs*
3. *Bibliography*

7. Timing

- Draft final document is submitted within 5 months after contract signature.
- Final report due three weeks after receipt of comments from stakeholders and funding agencies.

8. Expertise

[56] See preliminary list in Annex 1.

[57] A glossary of terms is included in Annex 2.

A team of two consultants:

- The *lead consultant* should be the holder of a Ph.D. in Pharmacology or related science (pharmacy, botany, agriculture, biotechnology, …) and have at least 15 years experience in conducting research on medicinal plants and herbs in the Caribbean region. He/she should also have in-depth knowledge of the Caribbean herbal industry in terms of major players, key herbs and plants being used, traded, etc., stakeholders and research institutions active in the region. He/she should also have first-hand experience in scientific technical writing and be able to translate complex scientific terminology into language which is easily understood by stakeholders in the industry.

- The *researcher* should have a Masters degree or Ph.D in Agronomy or related science on medical aromatic plants and at least 10 years experience in crop production and research. In-depth knowledge of Caribbean herbals will be an advantage as well as experience in technical writing.

9. Division of responsibilities

CTA
- Direct provision of funds and overall project manager
- Approves consultancy team
- Provides feedback on and approves draft and final reports / handbook
- Facilitates translation (if necessary) of TRAMIL's "Manual de Cultivo y Conservacion de Plantas Medicinales" or other pertinent work
- Identifies and provides expert team to review for the handbook to ensure its quality, appropriateness and accuracy.

IICA & CHBA Secretariat
- Identifies consultancy team i.e. lead consultant and researcher
- Acts as regional coordinator for the study
- Monitors, follows-up and provides advice to the project team
- Provides secretarial assistance to the project team via CHBA Secretariat
- Facilitates access to institutional databases and contacts which the project team may need
- Provides feedback on the draft handbook and documents produced
- Ensures project timing is respected

Project team
- Will consist of a *Lead consultant* with overall responsibility for report writing and quality control as well as all scientific related aspects of the herbs (cf. point 5 – Expected output); and a
  Researcher responsible for all agronomic related issues of the herbs (cf. point 5 – Expected output) and will contribute to report writing
- Will conduct extensive literature / database research

10. Implementation schedule
- Preparation/Finalisation of ToR: January – July 2004
- Identification / short-listing and selection of consultants of (potential) consultants: July – August 2004
- Contractual arrangements : August – September
- briefing: October 2004
- Implementation period: 15 October 2004 – 14 July 2005

11. Key documents / information sources to be consulted
- *Report – Caribbean Herbs Business Forum – "Fostering Commercial Partnerships for Sustainable and*

Economic Use of Biodiversity"

- TRAMIL's "Manual de Cultivo y Conservacion de Plantas Medicinales
- Databases and research conducted by CARDI, IICA, UWI – three campuses, CARAPA, TRAMIL, CYTED, OAS, FAO, PAHO, WHO
- A preliminary list of twenty-five major documents and twenty-five websites.

Appendix 1. List of selected Caribbean herbs (and geographic region of origin)

1. *Aloe vera*	S. & E. Africa
2. *Andrographis paniculata*	India and Pakistan
3. *Carapa guianensis*	Caribbean
4. *Colubrina arborescens*	Caribbean
5. *Croton eluteria*	Caribbean
6. *Curcuma longa*	India and Sri Lanka
7. *Cymbopogon citratus*	S. & South-East Asia
8. *Eryngium foetidum*	Caribbean
9. *Hibiscus sabdariffa*	Africa
10. *Lippia alba*	Caribbean
11. *Maranta arundinacea*	Brazil
12. *Momordica charantia*	E. India and S. China
13. *Myristica fragrans*	Indonesia
14. *Pimenta dioica*	Caribbean
15. *Pimenta racemosa*	Caribbean
16. *Quassia amara*	Tropical S. America
17. *Senna alata*	Tropical America
18. *Smilax regelii*	Caribbean
19. *Vetiveria zizanioides*	India
20. *Zingiber officinale*	S.E. Asia

Annex 2. Profiles of Institutions/Organizations Active in the Research of Caribbean Herbs

NOTE: Not all of the organizations listed below are solely concerned with the research of Caribbean herbs.

Caribbean Agricultural Research and Development Institute (CARDI) was formed in 1975 to serve the agricultural research and development needs of the members countries of the Caribbean Community (CARICOM). CARDI provides technical services in organic production systems (for herbs and other species) and technical assistance in agri-business and marketing. CARDI implements its work programme through collaboration with local and international research and development organizations, including the Technical Centre for Agricultural and Rural Cooperation (CTA).
Contact: CARDI,
University Campus, St. Augustine,
Trinidad.
Tel: 1 868 645 1205/6/7
Fax: 1 868 645 1208
Website: www.cardi.org

Caribbean Association of Researchers and Herbal Practitioners (CARAPA).
This is a multi-disciplinary network which includes scientists who carry out research on Caribbean medicinal and aromatic plants. CARAPA is incorporated under the laws of the Republic of Trinidad and Tobago. It was founded in 1998 to share only sound information on the virtues of Caribbean herbs. CARAPA disseminates information about Caribbean herbs through its newsletters and the Proceedings documents from its annual international conferences.
Contact: The CARAPA Secretariat,
Pharmacology Unit, Faculty of Medical Sciences,
The University of the West Indies,
St. Augustine, Trinidad,
Republic of Trinidad and Tobago.
Tel/Fax: 1 868 663 8613
Email: yuriclem@yahoo.com

Caribbean Research and Development Institute (CARIRI)
CARIRI was established by Act of Parliament on 1st January 1970 under the laws of Trinidad and Tobago. Its role is to provide technical and industrial services to the industrial enterprises. Its slogan is "quality solutions.....innovation driven". Its food/biotechnology services advise manufacturers on process development and problems about quality standards. It has a history of work with *Aloe vera*, and cinnamon and other aromatic species, and their essential oils.
Contact: CARIRI
The University of the West Indies,
St. Augustine Campus,
Trinidad and Tobago
Tel: 1 868 662 7161/2

Fax: 1 868 662 7177
Email: mail@cariri.com
Website: www.cariri.com

Centro Agronomico Tropical de Investigacion y Ensenana (CATIE) (Tropical Agricultural Research and Higher Education Center (CATIE)
On 1st July 1973, CATIE was created through an agreement between IICA and the costa Rican Government. CATIE focuses on research and higher education and it has done work on *Smilax species* and *Quassia alata* and other herbs.
Contact: CATIE
Turrialba,
Costa Rica
Tel: 506 558 2320
Website: catie.ac.cr

Iberoamerican Program of Science & Technology for Development (CYTED)
CYTED is a multilateral program of cooperation aimed at fostering scientific and technological integration of 21 participating countries. The head office is located in Madrid. The CYTED program was initiated in 1984. Its subprogram X (Fine Pharmaceuticals Chemistry) is one of 17 subprograms, since 1990, and it has involved over 1500 scientists from Latin America, Spain and Portugal in research on natural products from the Latin American and Caribbean flora. CYTED has published many herbal documents and books including "Cultivo y Agrotecnologia de Plantas Medicinales Iberoamericanas".
Contact: Dr. Mahabir Gupta,
Facultad de Farmacia,
Apartado 10767,
Estafeta Universitaria,
Panama, Re. de Panama.
Tel: 597 269 7655
Website: www.up.ac.pa

Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA).
EMBRAPA is a de-centralized research unit of the Brazilian government, which focuses on genetics and biotechnological resources (including for herbs which grow in the Caribbean). The mission of EMBRAPA is the sustainable development of agro-business, transferring appropriate knowledge and technology for the benefit of the people of Brazil.
Contact: Embrapa Recursos Geneticos e Biotecnologia,
Parque Estacao Biologica,
Caixa Postal 02372,
Brasilia, DF,
Brasil 70770-900
Tel: (61) 448 4700
Fax: (61) 340 3624
Website: www.cenargen.embrapa.br

Scientific Research Council (SRC)
SRC was established as a statutory body in May 1960; and it is an agency of the Ministry of Commerce, Science and Technology in Jamaica. SRC is responsible for the fostering and coordination of scientific research and the promotion of its application. Most of the Council's projects support the growth and development of the agro-industrial sector in Jamaica. It pursues R&D work with herbs such as ginger and turmeric and lemon grass, and others, through tissue culture work, with the potential for commercialization into industrial products.
Contact: Scientific research Council,
P.O. Box 350, Hope Gardens,
Kingston 6,
Jamaica
Tel: (876) 927 1771-4
Fax: (876) 927 1990
Email: PRinfo@src-jamaica.org

TRAMIL is the acronym for **TRAditional Medicine in the IsLands**.
TRAMIL is an applied research programme that is focused on validating the traditional uses of medicinal plants used popularly within the Caribbean Basin. TRAMIL was started in 1982 by ENDA-Caribe in the Dominican Republic and Haiti, and it has developed as a multi-national multi-disciplinary network which involves several institutions and some 90 investigators across 18 Caribbean countries. TRAMIL's work also supports the conservation of biological diversity in the Caribbean region.
TRAMIL disseminates the knowledge generated, through its workshops and conferences, in its books, manuals and pamphlets. A very recent TRAMIL publication is the 2nd edition of its "Caribbean Herbal Pharmacopoeia", containing a selection of 99 validated medicinal plants and their uses.
Contact: TRAMIL Coordinator,
Apdo. 3370, Santo Domingo,
Dominican Republic
Tel: (809) 535 5450
Email: ecaribe@verizon.net.do
Website: www.funredes.org

The University of the West Indies (UWI)
The University of the West Indies is an autonomous regional institution supported by and serving 15 different countries in the West Indies. It was founded in 1948 at the Mona campus in Jamaica. The St. Augustine campus in Trinidad was started in 1960. The Cave Hill campus in Barbados was established in 1963. The UWI focuses on teaching and research on Caribbean issues, including medicinal and aromatic plants and their products.

At Mona campus the characterization of the Jamaican flora and evaluation of the ackee (*Blighia sapida*), spirit weed (*Eryngium foetidum*) soursop (*Annona muricata*) and other s are research activities carried out by staff in the faculties of science and of medicine and the Biotechnology Centre and associated institutions on that campus. There have been numerous publications from this campus on the "Medicinal plants of Jamaica".
Contact: The UWI,

Mona Campus,
Jamaica.
Tel: (876) 927 1660-9
Website: www.mona.uwi.edu

At St. Augustine in Trinidad members of the faculties of science, of agriculture, of medicine and of engineering have done chemical and biological evaluations of a number of Caribbean herbs, such as *Andrographis paniculata*, *Colubrina arborescens*, *Lippia alba* and *Momordica charantia*. Issues of biodiversity conservation and the economic biology of Caribbean herbs also have been pursued systematically through the National Herbarium of Trinidad and Tobago. An important publication is the "Guide to the Medicinal plants of Trinidad and Tobago".
Contact: The UWI,
St. Augustine,
Trinidad
Tel: (868) 662 2002
Website: www.sta.uwi.edu

At the Cave Hill campus in Barbados, members of the faculties of science and of medicine research the local medicinal plant flora. An important book from this campus is "Wild Plants of Barbados".
Contact: The UWI,
Cave Hill,
Barbados,
Tel: (246) 417 4000
Website: cavehill.uwi.edu

University of Guyana
This university was established by the House of Assembly in April 1963 in Guyana. Research on the natural products from Guyanese plants has been a feature of its faculty of science. In collaboration with the Institute of Applied Science and Technology (IAST) its staff has produced the "Guide to the Medicinal plants of Coastal Guyana" and other publications on Caribbean herbs.
Contact: University of Guyana,
Turkeyen,
P.O. Box 101110,
Greater Georgetown,
Guyana
Tel: (592) 222 5402
Fax: (592) 222 2490
Email: pro@uog.edu.gy

The **Institute of Applied Science and Technology** (**IAST**) was established in March 1980 as an implementation arm of the National Science and Research Council to focus on R&D technology transfer in Guyana. Its researches have included the essential oils of orange, vetiver, and other local medicinal and aromatic plants.
Contact: Institute of Applied Science and Technology
University Campus,
Turkeyen,
Greater Georgetown,

Guyana.
Fax: (592) 222 4229
Email: iast@networksgy.com
Website: www.iastguyana.org

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Annex 4. Glossary of Terms Used

Agroforestry	land-use systems in which trees or shrubs are grown in association with crops (agricultural crops or pastures) in a spatial arrangement or a rotation in which there are both ecological and economic interactions between the trees and the other components of the system
Air-layering	a form of layering in which soil (rooting medium) is brought to the branch to be layered; the ball of soil in a polyethene cover is wrapped around the girdled branch; after adventitious roots grow out above the girdle, the layer can be separated
Annual	a plant that completes its life cycle from seed in one year
Anti-oxidant	a substance that opposes oxidation or inhibits reactions promoted by oxygen or peroxides; many of these substances are used as preservatives in various products
Aril	an expansion of the funicle enveloping the seed, arising from the placenta; sometimes occurring as a pulpy cover (arillus)
Aromatherapy	the treatment of disorders in humans by the use of essential oils; essential oils are usually used in diluted form as massage oils or preparations for the bath, or in products acting as odour carriers for the purported psychological benefits of essential oils when smelled
Aromatic plant	a plant the extract of which is odorous, fragrant, savoury and/or responsible for its value as a spice, cosmetic, flavouring or medicinal agent
Botanical	material of plant origin
Calyx	the outer envelope of the flower, consisting of sepals, free or united
Carminative	causing expulsion of gas from the stomach or bowel
Chromatography	A method for separating and purifying the constituents in a plant extract, (or other mixture). There are 4 major chromatographic techniques, namely paper chromatography (PC), thin-layer chromatography (TLC), gas-liquid chromatography (GLC) and high performance liquid chromatography (HPLC). The choice of technique depends largely on the solubility

	properties and volatilities of the components being separated
Clones	plants reproduced by vegetative propagation from a common ancestor. All these individually have the same genetic make-up
Comminuted	divided into small parts, or powdered
Cosmeceutical	a cosmetic drug or a therapeutic cosmetic, which like a cosmetic is topically applied but contains ingredients that influence the biological function of the skin. Botanical ingredients like curcumin (extracted from turmeric) are said to act as anti-oxidants
Cultivar (**cv**., **plural cvs**)	an agricultural or horticultural variety that has originated and persisted under cultivation, as distinct from a botanical variety. A cultivar name should always be written with an initial capital letter and given single quotation marks (e.g. banana 'Gros Michel')
Cyanidin	a flavonoid, different from delphinidin, but of the same chemical class of organic compound known as anthocyanidin
Decoction	an extract made by boiling the plant part(s) in water
Delphinidin	a flavonoid, different from cyanidin, but of the same chemical class of organic compound known as anthocyanidin
Dietary supplement	strictly defined by the U.S.F.D.A. under its Dietary Supplement Health and Education Act (DSHEA, 1994)
Dioecism	the state of dioecious plants is that in which some plants only have male flowers and others only have female flowers and therefore subsequently bear the fruits
Emmenagogue	an agent that stimulates or promotes the menstrual discharge
Emollient	softens and protects tissues
Endemic	exclusively native to a specified or comparatively small region; also used as a noun for a taxon thus distributed.
Essential oil	a volatile oil, or essence usually aromatic and steam-distillable, and of very complex chemical composition, obtained from an aromatic plant tissue

Extract	a substance extracted from a plant and containing its active principles as a complex mixture in concentrated form
Exudate	a substance oozing out (through the pores) of the biological material
Finished herbal products	a herbal preparation made from one or more herbs, and may contain excipients in addition to the active ingredients, but not to which chemically defined active substances have been added
Fixed oil	non-volatile oil, chemically a triglyceride of fatty acids; many fixed oils from plants have faint odours, even when purified, showing that they contain traces of volatile compounds
Flavonoids	organic chemicals with molecular structures based on a 15-carbon skeleton, usually phenols, which range in colour from yellow to pink and blue. The pink and the blue flavonoids are also called anthocyanidins; while the yellow flavonoids include the flavonols. The flavonoids usually occur in plants as in the form of their glycosides, each glycoside consisting of a sugar chemically bound to the flavonoid (aglycone) fragment
Functional food	is a medicinal food
GACP	Good Agricultural and Collection Practices for herbs as set out by the Guidelines (published in 2002) by the WHO
Glabrous	covered with fine short hair, or even having a surface devoid of hair
Germplasm	the genetic material that provides the physical basis of heredity
GMP	Good Manufacturing Practice: regulations and principles for the appropriate manufacture of herbal products of good quality
Glycoside	a compound, which is usually water-soluble, and made up of a sugar fragment chemically bound to a non-sugar (aglycone) fragment
Herb	this item includes the root, leaf, bark, seed, flowers and/or fruits of a shrub, tree, vine or any herbaceous plant, and sometimes (quite loosely) the extract of any

	of them valued for its aromatic, savoury/spicy or medicinal qualities
Herbal materials	these include herbs, fresh juices, gums, fixed oils, essential oils, resins and dry powders of herbs
Herbal medicines	include herbs, herbal materials, herbal preparations, or finished herbal products
Herbal preparations	these are the basis for finished herbal products and may include comminuted or powdered herbal materials, or extracts, tinctures and fatty oils of herbal materials
Herbal product	a plant material or alternatively the plant extract of complex chemical composition which is derived from specific part(s) of the plant
Indigenous	native to a particular area or region
Inflorescence	a group or a cluster of flowers
Infusion	an extract made by steeping plant part(s) in hot water or other liquid
In vitro	outside the living body, and in an artificial environment
Lanceolate	long and narrow, broadest at the base, and gently tapering towards the tip
Medicinal food	is a functional food; a food or food ingredient with a health benefit beyond the traditional nutrients it contains
Medicinal plant	a plant the extracts of which are used as medicines, whether or not the therapeutic constituents are actually identified
Monoecious	with unisexual flowers, but male and female flowers borne on the same plant
Niacin	another name for nicotinic acid, which is a component of the vitamin B complex
Natural product	a phytochemical – such as cascarillin, the bitter principle in the bark of cascarilla (*Croton eluteria*)
Neotropical plant	a plant growing in the Caribbean and tropical Latin America
Nutraceutical	any food substance (not limited to one of plant origin) which provides medical or health benefits

Oleoresin	a plant product consisting of a viscous mixture of essential oils and non-volatile solids
Organoleptic	making an impression on an organ of special sense, such as taste or smell
Peduncle	a flower stalk, supporting either a cluster or a solitary flower
Pharmaceutical	a chemical substance, whether natural or synthetic used to produce a biological effect, usually to treat disease conditions
Pharmacognosy	an applied science dealing with the composition, production, use and history of drugs of plant or animal origin
Pharmacology	the properties and reactions of drugs especially with relation to their therapeutic value
Pharmacopoeia	(also pharmacopeia): a book containing a selected list of drugs, chemicals and medicinal preparations with descriptions of them, tests for their identification, purity and strength, and formulas for making the preparations; one issued by official authority and recognized as a standard
Phytochemical	(or natural product): a pure single-chemical entity, sometimes called an extractive, such as cascarillin or quassin isolated from the appropriate plant extract
Phyto-drug	a phytochemical, sometimes called a phytopharmaceutical, with medicinal qualities, such aloin from a plant to treat mild constipation
Phytomedicine	a botanical medicine or herbal medicine, usually obtained by refining a simple (crude) plant extract to form a product mixture which is more concentrated in terms of the allegedly therapeutic constituent(s)
Phytotherapy	the treatment of ailments with herbal medicines
Plant extract	the mixture of constituents of a plant obtained by the use of a liquid (solvent) such as water (to make a “tea”), or such as alcohol (to make a tincture)
Polysaccharide	a carbohydrate polymer such as starch or cellulose composed of the residues of many simple sugar units

Pulvinus	a cushion-like swelling at the base of a leaf or leaflet, at the point of junction with the axis
Purgative	a strong laxative
Quality	A measure of the suitability of a product unit as related to requirements for use
Raceme	an inflorescence in which the flowers are borne on small short stalks lying along a common axis
Rhizome	an underground stem which is distinguished from a root by the presence of nodes, buds and leaves or scales
Rubefacient	an agent that reddens the skin by producing an excess of blood in a part, due to the relaxation of minute arteries
Saponin	any of a group of amorphous organic compounds, often glycosides, characterized by an ability to form emulsions, and to foam, on being shaken in water
Stimulant	an agent that assists functional activity of the body and thereby increases energy
Sustainability	Cultivating and /or collecting practices in which the exploitation of the environment and plants must be ecologically and sociably tolerable and economically remunerative.
Taxonomy	the study of principles and practice of classifying living organisms (also called “systematics”)
Terpenoids	molecules usually found as complex mixtures making up the aromatic oils, or maybe related to the steroids
Terete	slender and smooth, with a circular transverse section
Thiamine	a chemical component of the vitamin B complex, essential for normal functioning of the nervous system
Tissue culture	a body of tissue growing in a culture medium outside the organism
Tonic	a stimulant substance that is invigorating when consumed
Variety	a botanical variety which is a sub-division of a species; an agricultural or horticultural variety is referred to as a cultivar

Weedy plant	a weed, or a plant growing where it is not desired, or it is objectionable, or interferes with the activities or welfare of mankind
Woody plant	a plant which, strictly speaking, is not a herb, and survives over years. It develops woody (hard, fibrous lignin tissue) beneath the bark in trees and shrubs.