

The Sir Joseph Banks Centre and the Economic Botany Collections at Kew

R. B. Hastings

In early 1990, the new Sir Joseph Banks Centre for Economic Botany is due to open at the Royal Botanic Gardens, Kew, marking a crucial stage in the development of economic botanical research there. For the first time since their inception, the Economic Botany Collections will be housed under one roof with a computerized accessions list and their own library facilities. It is expected that having all the materials together will attract visitors and researchers from all around the world, just as the nearby and vast Herbarium, with over five million dried plant specimens, draws the world's taxonomists.

Economic botany may be defined as the study of plants that are of use directly or indirectly to man. Kew's involvement with economic plants dates back to the early years of the Gardens. Two Kew gardeners accompanied Captain Bligh on his voyage in the *Bounty*, which set sail on 23 December 1787. The purpose of the voyage was to collect Breadfruit plants (*Artocarpus altilis*) from the Society Islands to deliver them to the West Indies via Java. The mutiny on the *Bounty* and the failure of this attempted introduction are well known. (Perhaps it is less well known that the gardener who stayed with Bligh and survived the arduous boat trip died two days later of fever, while the other was later killed during troubles on Pitcairn [1]).

George III owned the Royal Gardens at Kew at this time, but they were directed with verve by Sir Joseph Banks, President of the Royal Society and the outstanding scientific figure of his day. During this golden age of exploration, Banks placed great stress on the discovery of economic plants and on their distribution to any part of the British Empire where they might prove of value as a crop. Following Banks' death in 1820 the Gardens went into a steady decline, so that 20 years later the Government was faced with the choice

between closing them down or taking them under public control. Fortunately they chose the latter course and in 1841 W. J. Hooker, later Sir William Hooker (figure 1) was appointed the first official Director [2].

It was William Hooker who began amassing the Economic Botany Collections that are currently being moved into the building named after his illustrious predecessor, Sir Joseph Banks. To establish the collections at the outset, in September 1847, he contributed his own extensive set of specimens, and further donations came from eight other sources, including a large collection of eastern and Pacific items from Captain Sir E. Home of the Royal Navy. For the first 10 years the collections were housed in what has become known as No. 2 Museum. This had begun life as the fruit store used by the Royal Family at Kew but William Hooker converted it into the first museum of economic botany in the world. The collections were not only exhibited for the public's pleasure but were seen as providing botanists – and all who employed plants in trade, manufacture, or medicine – with a reference set of raw materials which had been accurately named. In 1857 parts of the collections were moved into the new, purpose-built No. 1 Museum which had been designed by Decimus Burton. During this period in the 19th century, Britain enjoyed extensive trade with its many colonies and there was considerable interest in the plant products that each colony had to offer. As in the Banks era, Kew had a central role both in the exploration for economic plants and in their transportation around the world. The Economic Botany Collections attracted a great variety of donors which ensured that they grew constantly.

If any one of these donors should be singled out then perhaps it should be Richard Spruce, who is often regarded as the father of Amazonian ethnobotany (the study of plant uses by ethnic groups). Spruce was born in Yorkshire

in 1817; he showed much promise as a botanist in his younger years and at the age of 32 he was sent out to South America to undertake one of the most epic of all plant collecting adventures. He arrived in Para (now known as Belem) at the mouth of the Amazon on 12 July 1849 and proceeded to travel westwards along the whole length of that great river. He endured enormous hardships, coming close to starvation and death by drowning; he even survived a murder plot conceived by his own 'Indian' porters. In 1860 he collected seeds of Red Bark trees (*Cinchona*) which were later used by the Indian Government to establish plantations in India and Ceylon. As a source of quinine these plantations brought protection and relief from malaria to millions, in fact opening up the whole region to development. In the later stages of his expedition, Spruce lived in Ecuador and Peru and he finally sailed back to England from Peru an invalid on 7 May 1864, after nearly 15 years in South America [3]. However, his extensive collections and incredible endeavours still inspire many of today's ethnobotanists working in the Amazon. Many of Spruce's items were donated by him to Kew, between the years 1849 and 1866.

The Economic Botany Collections contain not only the products of herbaceous plants, but also some 28 000 samples of woods. The first major items were received in 1863 as a set of very large timbers from the Colonies obtained from the London International Exhibition of 1862. Over subsequent years many important additions were made, notably the specimens of Indian timbers received from the Indian Forest Department in 1878 and the timbers from the Colonial and Indian Exhibition of 1886. As with the herbaceous material, the idea was to make the wood collections as valuable as possible for study by manufacturers and traders. To this end all interested parties, including officers in the various Colonial

Rupert B. Hastings, B.Sc.

Was born in London in 1955 and graduated in zoology at Aberdeen University. He joined the Museums Division at Kew in 1978 and is now a member of the Economic and Conservation Section of the Herbarium. His research has ranged from medicinal plants of Mexico to the history of Kew's involvement with the Howrah Botanic Garden, Calcutta. This article has been developed from a paper that he gave at the International Symposium on Plant Resources in Kunming, China, in October 1988.

Endeavour, New Series, Volume 13, No. 4, 1989.
0160-9327/89 \$3.00 + 0.00.
Pergamon Press plc. Printed in Great Britain.



Figure 1 William Hooker was the first official Director of Kew. He inaugurated the Economic Botany Collections by displaying his own specimens (formerly used in teaching at Glasgow University) on trestle tables in the old fruit store that later became No. 2 Museum. (Picture: Royal Botanic Gardens, Kew).

Forestry Departments, were encouraged to contribute typical specimens in commercial sizes to the collection.

Recent developments

Today the Economic Botany Collections contain some 70 000 items. While it is true that most of the acquisitions were made prior to the 1930s, it is still the case today that no year has passed without many quality additions being made. Especially significant was the arrival of the museum collection of the Pharmaceutical Society of Great Britain, in April 1983. This collection was begun by Daniel Hanbury in the 19th century and includes about 9000 items, zoological as well as botanical, all acquired because of reputed medicinal properties. The collection has formed an excellent complement to the medicinal material already housed at Kew and it is hoped it will now receive fresh attention in its new home.

Another important development came in September 1985 when the Economic and Conservation Section (ECOS) was formed at Kew as part of the Herbarium Division (now Department). ECOS was given responsibility for the Economic Botany Collections from the former Museums Division, which was disbanded. Work was immediately begun to catalogue the collections and capture all relevant data for an economic plant data base prior to the move to the new Sir Joseph Banks Centre (figure 2). All the specimens are being cleaned and, in most cases, placed in an appropriate storage box or jar. All the details of each specimen are being recorded on a specially created computer program which will ultimately constitute the first ever complete catalogue of the collections. At the same time, nearly all the specimens, apart from the woods, are being photographed to create a separate visual catalogue which it

is hoped will be made interactive with the data base. The single large storage room in the Banks Centre contains a purpose-built compactor system made up of 396 metal cabinets standing 2.6 m high, in 33 rows each 11 m long (figure 3), together with 11 rows of racking each also 11 m long and designed to hold the biggest specimens. The air temperature and humidity in the room are computer-controlled and filtered extractor fans have been fitted to remove dust.

Some current examples from the Collections

The articles shown in figures 4 and 5 may at first seem quite unrelated, but in fact they are all examples of useful plant species belonging to the sub-family Papilionoideae, of the large and economically valuable family Leguminosae. These examples have been chosen to indicate the many different uses of plants as well as the diversity of economic plants in the Collections, ranging from well known species to ones that look suitable for further investigation and exploitation. The great array of uses are best dealt with under a series of categories, as follows.

Food and drink. The sub-family Papilionoideae is of essential importance worldwide because of the number of food plants that it contains. Many are herbaceous species whose seeds and pods are rich in proteins as well as minerals. Examples are numerous and include the pea (*Pisum sativum*), green bean (*Phaseolus vulgaris*), broad bean (*Vicia faba*), lima bean (*Phaseolus lunatus*), pigeon pea (*Cajanus cajan*), mung bean (*Vigna radiata*), lentil (*Lens culinaris*), and soybean (*Glycine max*). The two examples from the Kew collections are shown in figure 4. The red packet contains the roasted and ground seeds of chick peas (*Cicer arietinum*), packaged in Puerto Rico and used to make a coffee-like beverage. Chick pea is the world's third largest legume crop, after pea and green bean. It is eaten fresh or dried, made into flour or coffee substitutes or used as fodder. In contrast, the tepary bean (*Phaseolus acutifolius*) is a locally used food plant of arid lands, having been grown by the Papago Indians of the Sonoran Desert, Arizona, for hundreds of years. The nutritious beans are easily cooked without soaking and they have a pleasant flavour reminiscent of lima beans. This food plant might well be suitable for introduction into other arid areas of the world, to help ameliorate the overwhelming food problems of these regions.

Forage. Many important forage crops are provided by this sub-family, notably white clover (*Trifolium repens*) and lucerne (*Medicago sativa*) in temperate



Figure 2 The new Sir Joseph Banks Centre, showing the public entrance and the central glasshouse, which will house live plants, with the exhibition hall to the left. (Photo: Royal Botanic Gardens, Kew).

regions, though a huge number of other examples can be found worldwide, belonging to at least 27 genera [4]. A lesser known example, shown in figure 5, is culen, (*Psoralea glandulosa*) which is a valuable fodder plant in Chile.

Domestic. Domestic uses are illustrated by two specimens of *Aeschynomene aspera*, an aquatic plant with a high content of lightweight pith. Figure 4 shows a heat-resistant tumbler cover made of this pith and obtained from India via the Amsterdam Exhibition of 1883. This material has high insulating properties and is also used for making sunhats, as well as fishnet floats and life belts [5]. It can also be attractively carved, as shown by the fine model of a rose in figure 5.

Timber. Many Papilionaceous trees are sources of timber, prominent examples being *Brya*, *Dalbergia*, *Leucaena*, *Phyllonoxylon*, *Pterocarpus*, and *Robinia*. Figure 5 shows an oriental figure carved from *Dalbergia* wood.

Environment. Legumes are noted for the nitrogen-fixing bacteria inhabiting their root nodules, and so enriching the soil for other crops. Soil stabilisers include *Arachis* species, closely related to the peanut (*A. hypogea*); these might be grown not for food but to help combat the insidious spread of deserts around the world. The Papilionoideae also provide many highly prized garden ornamentals such as lupin (*Lupinus*), broom (*Cytisus*), *Wisteria*, *Baptisia*, and *Laburnum*.

Fibres. The uniformly pale cloth in figure 5 was made from the stem fibres of the Ko plant, *Pueraria lobata*. This cloth was obtained from Niampo, China, and donated by Consul Cooper in 1886. This twining plant of China and Japan can also be used as a fodder and cover crop, for erosion control.

Toxins. Though the Papilionoid legumes include many food plants, they also include a number of highly poisonous species. *Abrus precatorius* is a

famous example; figure 5 shows a necklace made from the bright red and black seeds of this plant. Such warning colours should be heeded, for the seeds contain highly poisonous alkaloids; it should be considered dangerous to include these seeds in such articles as they can be so attractive to children and so easily placed in the mouth or swallowed. The box in figure 4 contains ordeal beans of Old Calabar, belonging to the species *Physostigma venenosum* of West Africa. These poisonous seeds were fed to prisoners as a form of trial by ordeal; those fortunate enough to survive were judged to be innocent.

Medicinal. Plants noticeable for their content of toxic chemicals can also be a source of medicinal compounds. The difference may lie just in the dosage and the method of application. For example, the ordeal beans above yield the alkaloid physostigmine which is used in ophthalmic medicine and which reverses the neuromuscular blocking properties of curare [6]. Papilionoid legumes contain many different alkaloids and a great variety of species have medicinal uses. Figure 4 shows the large seed of arisourou, *Pterocarpus* species, which is used as a cure for ringworm by the Indians of Guyana; also a small pile of stems and leaves of honigthee, *Cyclopia genistoides*, from South Africa, used to make an expectorant bush tea for cases of chronic catarrh. In figure 5 is a small packet of medicinal tea made from *Pueraria lobata* var. *thomsoni*, purchased in Brunei.

Chemicals. The seeds of *Pongamia pinnata* yield an oil which has many indust-

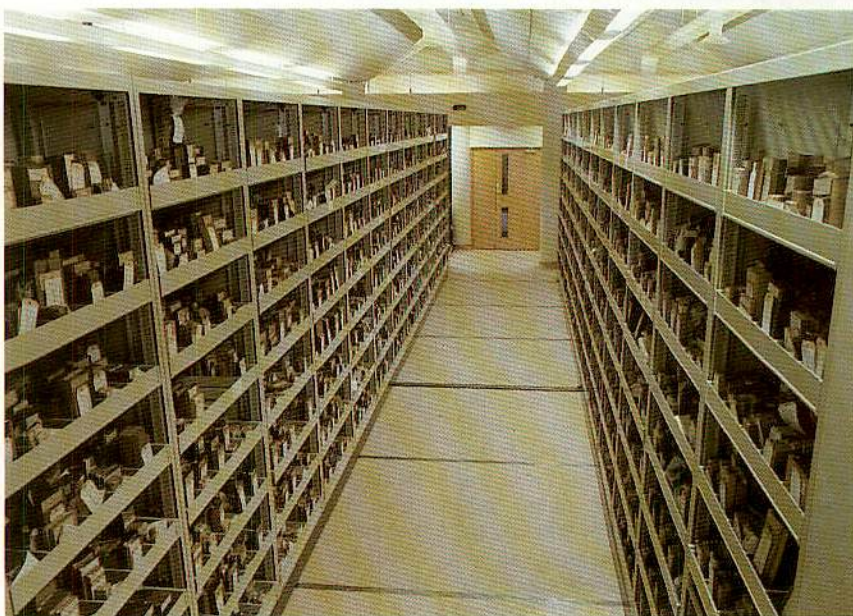


Figure 3 The majority of the specimens are to be stored on a compactor system, with sliding drawers for ease of access. Shown here in place are some of the 25 000 wood samples. (Photo: Royal Botanic Gardens, Kew).

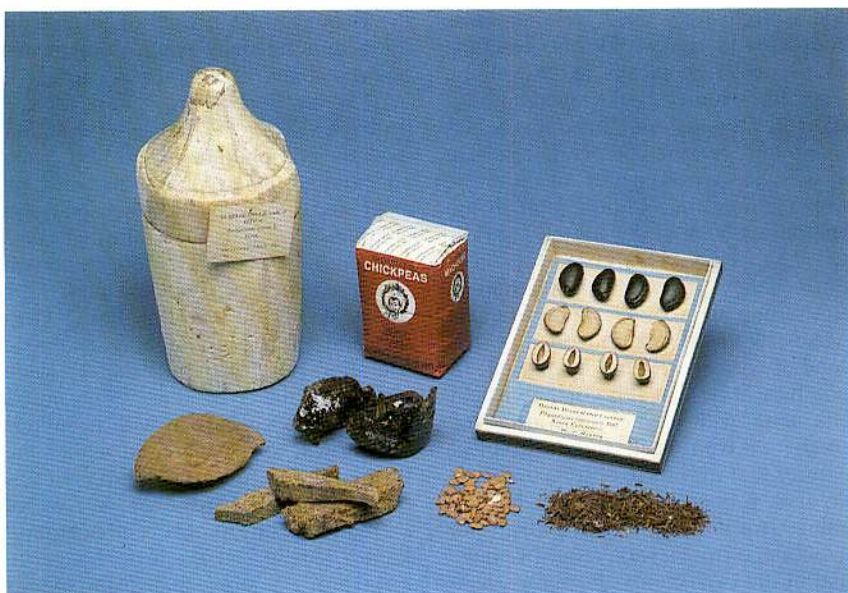


Figure 4 Some of the many diverse uses of plants, illustrated by Papilionoid legumes. Back row, left to right: a tumbler-cover of *Aeschynomene aspera*, a packet of chick peas (*Cicer arietinum*) and a boxed display of ordeal beans (*Physostigma venenosum*). Front row, left to right: a large seed of *Pterocarpus*, oil cake from *Pongamia pinnata* in front of gum from *Virgilia capensis*, tepary beans (*Phaseolus acutifolius*), and leaf and stem material from *Cyclopia genistoides*. (Photo: Royal Botanic Gardens, Kew).

rial and medicinal uses. It is used, for example, for leather dressing, soap making, and lubrication, and is applied in scabies, herpes, leucoderma, and other cutaneous diseases [5]. The cake left after expression of the oil has a high nitrogen content and is mostly used as a manure; however, this residue has also been used as an adhesive material in the

manufacture of Indian Felt or Namda, as recorded on the specimens shown in figure 4 which were formerly in the India Museum. Also shown in figure 4 are two lumps of gum exuded from the bark of *Virgilia capensis*; this gum has been used as a substitute for starch by bush women in South Africa. In figure 5 is some cotton cloth dyed blue with



Figure 5 Further products of Papilionoid legumes. Back row, left to right: plant material of *Psoralea glandulosa*, model of a rose made of *Aeschynomene aspera*, and a figure carved from *Dalbergia* wood. Front row, left to right: cotton cloth dyed with Yoruba Indigo (*Lonchocarpus cyanescens*) on top of cloth made from the fibres of *Pueraria lobata*, a necklace made from the seeds of *Abrus precatorius*, and a packet of tea bags containing *Pueraria lobata* var. *thomsoni*. (Photo: Royal Botanic Gardens, Kew).

yoruba indigo, *Lonchocarpus cyanescens*, from Nigeria. This is not the same as true indigo, however, that is also obtained from Papilionoid legumes in the genus *Indigofera*. Apart from this dye, *Lonchocarpus* species also yield the insecticide rotenone and several are used as fish poisons.

Future research on the Collections

The movement of material from all over the Gardens into the Banks Centre will continue for some considerable time, but it will not be until the last specimen has been installed that our calculations for the space required to house the estimated 70 000 items will be validated and the expansion space identified. A major task will be the editing of the computer-generated catalogue, primarily to update the old scientific names found on the material, and also to modernize the geographical names. When this lengthy editing phase is completed, the catalogue will offer previously unknown opportunities to locate, for example, all the material for a particular purpose and even more precisely from a particular country, or all the specimens collected by a particular person in a particular year or region. All this data will also be incorporated on the larger ECOS data base.

There seem to be three principal ways in which future research may be carried out on the Economic Botany Collections. Firstly they are an information resource. As we have seen in the cases of the Papilionoid legumes, many of the specimens have notes about their uses. Sometimes these are quite extensive. For example the label on a jar of silk-cotton collected by Richard Spruce from the tree *Ceiba samauma* reads 'Used by the Indians of the Amazon for wrapping round the end of arrows used with the blow-pipe, also for stuffing cushions'. Continuing this important ethnobotanical theme, some fruits of *Hicksbeachia pinnatifolia* from Australia bear the note 'eaten by the aborigines' (1884). This aboriginal bush-food, also known as rose nuts, has recently attracted attention as a potential arid land food source, the nutritional composition of the fruits being examined only in 1985 [7].

Many of the notes on specimens refer briefly to medicinal properties, as on a plant of conchalagua, *Centaurium texense*, from Mexico, on which the label reads 'used as a bitter tonic and as a substitute for quinine'. Such medicinal properties may not be well recorded in the literature. There is a specimen of the 'anti-opium plant', *Combretum sundaicum*, 'chopped and dried ready for roasting'. During the early 1900s this plant was widely believed to cure addiction to opium; however, its use gradually declined until it died out completely

[8]. Earlier chemical examinations revealed a resin and tannic acid but no alkaloids; nevertheless, this species might repay further investigations today.

Even when a label bears no such information on usages there is still an alternative. When each item was accessioned, its details were recorded in an entry book. These entry books date back to the start of the collections in 1847 and they hold a variety of additional information that was sometimes too extensive to repeat elsewhere. The inclusion of this data will be undertaken on completion of the catalogue. Even when there is no information on a specimen's uses, its very existence in the Collections should be a spur to further research since the majority of the items were donated for an economic reason. That reason may not now always be evident and there are clearly many more discoveries to be made.

The second research approach relates to the chemical or physical examination and testing of the specimens themselves. The chemical constituents have to be investigated in plants that have notes indicating medicinal or poisonous properties. There are many examples in the collections, like that of the bright red and black seeds of *Ormosia emarginata*, which are a rich source of alkaloids. The well-known poison curare, for example, is held in our collections in two gourds; the curare made from the bark of *Strychnos toxifera* was collected by Spruce in Guyana. It has been demonstrated by David Phillipson of the London School of Pharmacy that ancient, dry plant specimens may still retain their alkaloid content to a considerable age [9]. To give a particularly striking example, he identified ten alkaloids in a herbarium specimen of *Strychnos nux-vomica* which had been collected in Sri Lanka in 1675. Chemical examinations of our collections of oils, gums, and resins are also expected to yield interesting compounds. Lundy Pentz in Virginia, USA, has investigated many of our resin samples of frankincense (*Boswellia*) and myrrh (*Commiphora*). The chemical profile that he obtained from each species has enabled him to identify the botanical origin of some of these resins that have recently been imported into the USA. Gretchen Shearer, of the Institute of Archaeology in London, has investigated the chemical composition of many pine (*Pinus*) resins from the collections and from these has then been able to identify the botanical origins of pine resins found in archaeological deposits.

On the physical side, the wood collec-

tion is frequently used by anatomists from around the world who examine samples microscopically as one of the very few sources of taxonomically authenticated material, in addition to the family and generic characters that can be used in archaeological and forensic investigations. In addition, staff in the Anatomy section of the Jodrell Laboratory at Kew have recently begun a project in which they are combining anatomical data, using up to 280 characters per species, with information on how the wood of each species has been used. In time they hope that this computer-held data base will predict new uses for woods, derived from the anatomical features that they have observed. Other physical properties can also be examined, for instance in fibres which can be obtained from a wide range of plants held in the Collections. *Pueraria lobata* has already been referred to but another Papilionoid legume that yields a stem fibre is *Derris trifoliata* and we have a fine sample of cord from that species, made by inmates of the Ceylon Lunatic Asylum. The suitability of fibres for particular uses can be investigated both on a large scale and also by examining small samples under the microscope.

Finally, it should not be forgotten that many of the specimens have a historical value. For example, the unique and incomparable Parkes Collection of Japanese paper samples is partly deposited at Kew (the remainder is in the Victoria and Albert Museum in London). The items in this collection were gathered in Japan in the middle of the 19th century, when the use of such material was in its heyday. Many of the samples were made from the inner bark of the paper mulberry tree, *Broussonetia*; the range of products is enormous. They include simple stationery, hard hats, umbrellas, imitation leather, ladies' hair ornaments, and even a string vest made from recycled account books, complete with blotches of ink in the material (though no longer anything legible!). There is an extensive set of quinine barks (*Cinchona*) which were collected by the 19th century pioneers Pavon and Howard. A range of interesting and idiosyncratic items from China includes 'old man's eyebrows', fancy tea donated in 1872; a humorous teapot incorporating models of fruits and nuts with a mushroom for its lid, made about 1770; and a set of apparatus for smoking opium, obtained from Hong Kong in 1881, and presumably not used in the last 100 years.

In conclusion, I hope I have given some indication of the rich past of the Economic Botany Collections at Kew;

the current great revival of interest in them; and the many exciting opportunities that they offer for future research and application to resolving today's problems. There is much information here for ethnobotanists and historians, and numerous specimens that may be examined directly by biochemists, wood anatomists, and textile and other commercial researchers. The collections will all be conveniently housed under the one roof of the Sir Joseph Banks Centre, and the new computer catalogue will allow rapid searching under a wide range of subject headings. The books and journals concerned with economic botany will also be housed within the Banks Centre itself. In addition, ECOS runs two data bases: the Survey of Economic Plants for Arid and Semi-arid Lands (SEPASAL) which holds information on more than 5000 species [1], and a bibliographic data base that contains over 130 000 economic botany references, which is updated weekly. When the move to the Banks Centre is completed, researchers interested in economic botany will be warmly encouraged to visit Kew and pursue their own investigations into the literature and the specimens. In this way it is hoped that the Economic Botany Collections will enter their third century while receiving much fresh attention, to the benefit of science and mankind.

Acknowledgment

I am very grateful to Gren Lucas, Keeper of the Herbarium at Kew, for his many valuable comments during the preparation of this article.

References

- [1] Wickens, G. E. *Span*, 29, 62-64, 1986.
- [2] Hepper, F. N. (ed) 'Kew Gardens for Science and Pleasure', HMSO, London, 1982.
- [3] Sandeman, C. *J. Royal Hort. Soc.*, 74, 531-544, 1949.
- [4] Roecklein, J. C. and Leung, P. 'A Profile of Economic Plants', Transaction Books, New Brunswick and Oxford, 1987.
- [5] Council of Scientific and Industrial Research, 'The Wealth of India', CSIR, New Delhi, 1948-72.
- [6] Nickalls, R. W. D. and Nickalls, E. A. *Anaesthesia*, 40, 572-575, 1985.
- [7] Brand, J. C., Cherkoff, V. and Trusswell, A. S. *Food Techn. in Austr.*, 37, 275-279, 1985.
- [8] Burkill, I. H. 'A Dictionary of the Economic Products of the Malay Peninsula', Ministry of Agriculture and Cooperatives, Kuala Lumpur, 1966.
- [9] Phillipson, J. D. *Phytochem.*, 21, 2441-2456, 1982.