SIRI SYARAHAN PERDANA PROFESOR

TURNING MALAYSIA INTO A GLOBAL HERBAL PRODUCER
A Personal Perspective

by
Ramlan Abd Aziz

INTRODUCTION

Herbs have been used throughout human history as sources of food, medicine, beauty enhancers, and fragrances. The use of herbs as medicine has a long history, starting from the Greek civilization in the West and the Arabic, Chinese and Indian civilizations in the East.

The herbal–related market includes herbs used as food or food additives, cosmetic ingredients, and herbal medicines. The current estimates for this market ranges between USD 40 to100 billion with an average growth rate of 15 to 20 percent annually. Table 1 lists out several common forms of herbal products.

A significant portion of this market are medicinal products from plant sources. Many allopathic medicines, which are produced synthetically, also derived from plants such as quinine for malaria and quinidine for hearth arrhythmia from *Cinchona* spp, and digoxin for heart failure from *Digitalis* spp. About 25 percent of drugs prescribed worldwide come from plants, 121 such active compounds being in current use.

There is a growing trend of people moving from synthetic allopathic drugs to herbal cures. Among reasons for this shift include a preference for a wellness oriented self–administered healthcare, the prevalence of chronic illnesses that cannot be cured by conventional drugs, and the high pace of life which induces higher stress and reduced free time.

In view of the potential size of the herbal–based market, and herbal medicines in particular, it is important that Malaysia builds an industry based on its natural herbal heritage. In the past, much of the chemical industry was based on agricultural and animal materials before the advent of petrochemicals. Many dyes, industrial chemicals, solvents, and food additives were derived from these sources. Much work needs to be done to develop both products and processes for this industry.

Table 1 Common Herbal Products

PHYTOCHEMICAL - comes from the Greek word 'Phyto' for plant. It refers to every naturally occurring chemical presents in plants. Plants are also the source of many modern pharmaceutical (drugs). It is estimated that approximately a quarter of prescribed drugs contain plant extract or active ingredients obtained from plant substances.
COSMECEUTICAL - the term used to describe cosmetics containing ingredients that are bioactive, exerting effects on people. It is a blend of cosmetic and pharmaceutical which has appeared only in the nineties. Examples are anti–wrinkles creams, baldness treatments, moisturizers, and sunscreens.
NUTRACEUTICAL - any substance that may be considered a food or part of a food that provides medical and health benefits, including the prevention and treatment of disease. Under this broad definition, nutraceutical might be isolated nutrients, dietary supplements or diets, processed foods, herbal products or genetically engineered 'designer foods'.
OLEORESINS - pure extractives of a spice or herb which contain concentrated natural liquid flavourings that contain both volatile and non–volatile flavour components.
ESSENTIAL OILS - volatile parts of the plant that are largely responsible for its characteristic aroma. It can be applied to enhance health through its holistic effects on the body.

CURRENT GLOBAL TRENDS

The global herbal market is valued at USD 70 billion for nutraceuticals and USD 20 billion for phytomedicines with an average growth rate between 15 to 20 percent annually.

Among the driving forces for the growth of the global herbal industry include:

- Population demographics – a large portion of the developed nations are older, thus the higher demand for anti aging and chronic disease cures
- Increasing focus on health versus disease
- Drive towards self–care and self–diagnosis

A key driving force is the growing knowledge of consumers about traditional medicines. Many consumers have come to realise that effective herbal cures are the results of thousands of years of herbal healing framework development through trial and error, observation, and study. Also, there have been some high profile natural based cures such as Taxol for Breast Cancer and the Bintangor plant for AIDS.

In several countries, traditional healing methods have been incorporated into the modern health system. In Germany, over 80 percent of doctors–prescribe a combination of modern medicines as well as herbs. In Japan, doctor prescribed phytomedicines can be claimed under the national health insurance.

A key sub–area of the herbal industry that is growing rapidly is the nutraceutical area. Consumers are showing a growing preference to consume their nutritional needs through their food rather than in a medicinal form such as capsules or tablets. Among key items are fortified food such as grains fortified with calcium or vegetables fortified with herbal extracts such as Gingko Biloba.

THE MALAYSIAN SCENARIO

Malaysia is well positioned to be a key global player in the herbal medicine industry with its rich biological heritage, cultural background, and trade links. Malaysia is listed as the 12th most biodiverse nation in the world and ranks fourth in Asia with over 15,000 flowering plants and over 3000 species of medicinal plants. Of the 3000 listed medicinal plants, only about 50 are used commercially and even less are being researched scientifically for their medicinal properties. Many more have yet to be catalogued extensively through ethnobotanical research. In additional, Malaysia is also home to three major ethnic groups of Malays, Chinese, and Indians, as well as a host of diverse indigenous groups who all have a rich tradition and knowledge of herbal use for health and healing.

At present, the Malaysian market for herbal and natural products has been estimated to be worth RM4.55 billion of which 90 percent of

the raw material used was imported. The key driving forces in the Malaysian domestic market are the changes in lifestyle, the growing emphasis on health, and the growing cost of synthetic medicines.
The Malaysian government has been strongly supportive of the development of Malaysian herbal industry. The National Agricultural Policy (1998-2010) identifies products and export oriented policy as one of the thrust areas–herbal cultivation easily falls under this category. In addition, the Ministry of Health has released a Traditional/Complimentary Medicine (TCM) Policy in 2000 with the emphasis of 'rational use', the philosophy that traditional as well as modern medicines can be used concurrently.

On the industrial front, the **Malaysian Herbal Corporation** (MHC) was formed under the auspices of the Malaysian Industry–Government Group for High Technology (MIGHT) in 1998 to coordinate the efforts between the private and public sector to build up the local herbal industry. It is specifically aimed to address critical issues along the herbal value chain (shown in Figure 1) to allow the industry to become globally competitive.

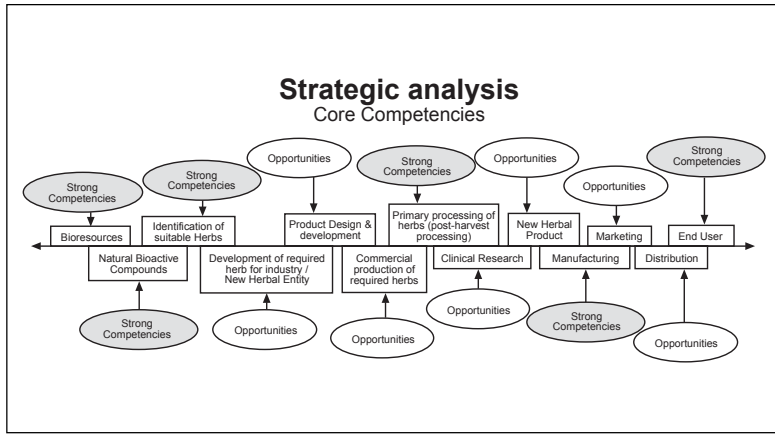

Figure 1 MIGHT analysis of herbal industry in Malaysia

Recognizing the importance of agriculture, the Prime Minister YAB Dr. Mahathir Mohamad in his recent launching of BioValley, emphasized the need to return to and enlarge Malaysia's agricultural efforts, as Malaysia is rich in agricultural resources which can be turned into biotechnological riches. Herbal and phytochemical based agriculture are examples of such endeavours.

The Ministry for Rural Development has identified the herbal industry as one of the upcoming industries to be supported by the government. One key reason is that this industry will be able to close the economic gap between the rural and the urban populations through increased economic development in the rural areas.

The Malaysian government has also given financial support to research work related to herbs in term of Intensified Research in Priority Areas (IRPA) grants, the focus areas by the National Biotechnology Directorate, as well as other grant schemes. Areas of focus include ethnobotany, phytochemicals, processing, cultivation studies, biochemistry, pharmacology, and clinical trials. Several policies, laws, and regulations related to herbs include Good Manufacturing Practice codes and Clinical Trial codes.

Another important issue that the Malaysian Government will need to address is the issue of Intellectual Property Rights with regards to herbal value in terms of indigenous species and traditional usage. The recent cases involving tumeric and neem where India successfully challenged the patents filed by the US highlights the danger of not taking active steps to protect local knowledge and plants.

A CROSS SECTION OF COMMERCIALLY VIABLE MALAYSIAN HERBS

Tongkat Ali, *Eurycoma longifolia,* is a traditional Malay and Orang Asli herb used as an aphrodisiac, general tonic, anti–malarial, and anti–pyretic. Scientifically, it has also been found to have anti–tumour and anti oxidant properties. The decoction of the roots is taken orally. Tongkat Ali has been biochemically shown to increase testosterone production and to overcome impotence. At present, one of the largest commercial producers of Tongkat Ali is Phytes Biotek, the country's first Malaysian Venture Capital (MAVCAP) investment in which CEPP played an important role in jointly developing the Tongkat Ali water extract processing technology.

Figure 2 Tongkat Ali
Source: FRIM

Kacip Fatimah, *Labisia pumila,* is a herb used in the treatment of post–partum mothers, gonorrhea, rheumatism, pile, and bone diseases. It is currently

Figure 3 Kacip Fatimah
Source: FRIM

being researched for its estrogenic and androgenic properties. If found to be viable, it will represent a good herbal medicine for hormone replacement therapy or estrogen related therapy. CEPP together with Universiti Malaysia Sabah is involved in preparing water extracts for clinical studies for a national top–down research project.

Figure 4 Hempedu Bumi
Source: FRIM

Hempedu Bumi, *Andrographis pani-culata,* is used for anti-pyretic, anti–fertility, treatment of appetite loss, anti–diabetes, anti-hypertensive, and skin condition such as eruption and scabies. It has a very bitter property and is a strong liver tonic. Its anti–diabetic and anti–hypertensive properties have been studied to produce herbal medicines at Universiti Sains Malaysia. The leaves are boiled and taken as an oral decoction.

Figure 5 Misai Kucing
Source: FRIM

Misai Kucing, *Orthosiphon stamineus,* can be used for kidney related and joint ailments such as gall stones, diabetes, arthritis, rheumatism, and gout. It has been proven to remove uric acid through its diuretic activity which is the main path for its therapeutic activity.

Figure 6 Pegaga
Source: FRIM

Pegaga, *Centella asiatica,* is a long–used Asian herb mentioned in both the Chinese Materia Medica and Ayurvedic texts for its anti aging and overall beauty enhancement properties. It works by enhancing the connective tissue activity in the skin. It is cultivated on a large scale by French in cosmetic companies as an ingredient cosmetic products. Pegaga is also one of the plants studied under the Malaysia–MIT Biotechnology Partnership Programme apart from Tongkat Ali.

FROM PLANTING TO PRODUCT: THE HERBAL VALUE CHAIN

There are several major steps in herbal product manufacturing starting from herbal crop planting to herbal product manufacturing and marketing.

Traditionally, herbs have been collected for use from wild areas. For large scale production, this presents an unfeasible solution due to the lack of reliable and abundant supply. Continuous harvesting of wild sources will lead to species endangerment and extinction. Agricultural cropping of herbs as specialty crops can ensure high quality herbal products by:

- Correct herb identification
- Adequate herb supply
- Optimal herbal planting and harvesting for phytochemical

Correct herb identification is essential as many herbal species come in many varieties which have similar appearances as well as similar usages in traditional medicine. An example of this is Phyllanthus amarus (Dukung Anak) and *Phyllanthus nururi* both of which has liver healing properties. However, both varieties have different phytochemicals as well as different phytochemical distribution profiles.

At present, countries like France and Germany have pioneered and mastered herbal cultivation for phytochemical products for plants such as Gingko Biloba and Gotu Kola (i.e. Pegaga). The plants are cultivated in farms of over many thousands of acres and cultivated and harvested over carefully planned conditions to prepare adequate supply to meet the industrial demand. In fact, Gingko, which is commercially cultivated, is purchased annually at USD 500 million sales in France and Germany.

Good Agricultural Practice is a code of practice focused on optimal use of agricultural resources coupled with environmental concerns which include:

(i) Guidelines on handling fertilizer and pesticides
(ii) Guidelines on farming waste
(iii) Guidelines on storage of agricultural chemicals
(iv) Guidelines on handling harvested material

Cultivation and harvesting are critical aspects of herbal production, as unlike bulk crops where the quantity of products can be

Figure 7 Intercroping of Tongkat Ali with Jati, Pineapple and Kayu Manis

directly observed, phytochemicals can only be determined through chemical analysis, especially as herbal extract yields are in the two to five percent range. It is, therefore, critical to have guidelines on how to cultivate and when to harvest to ensure maximum phytochemical concentration. An example of how critical harvesting time is St Johns Wort where the active ingredient can only be found in the hypercium which comes out at a specific time in the day. It is also important to use organic farming methods as heavy metals from pesticides and fertilizers can be extracted with the phytochemical extracts during processing.

In addition to improved cultivation and harvesting techniques, both crop rotation and intercropping are methods to better utilise the available agricultural land. Crop rotation, where crops are changed year by year in a planned sequence, is a method of ensuring optimal soil usage and cultivation. Intercropping where more than one crop is cultivated, duplicates nature's diversity where one plant's waste is another plant's feed. Both crop rotation and intercropping can be seen at Taman Herba Melaka as shown in Figure 7.

Once the herb is harvested, quick **preprocessing and correct storage** is required. Preprocessing involves reducing the size of the herb through chopping and grinding to prepare for processing while good storage method ensures that the active phytochemicals are maintained before processing.

Processing is a critical aspect of herbal production, especially due to the low yield of extracts. Processing methods are usually based on traditional methods such as high pressure water extraction for herbs which are traditionally boiled as decoctions. New innovative methods such as Supercritical Fluid Extraction (SFE) need to be developed to produce herbal products of higher yield, lower operating costs, and faster production time. Packaging and sale follow processing. Herbal products can be sold in a variety of forms such as capsules, tablets, tea bags, extracts, and essential oils.

Good Manufacturing Practice (GMP) is a code of practice used by the medical and health related industries including the pharmaceutical industry in an effort to maintain the highest standards of quality in the development, manufacturing and control of medicinal products. In

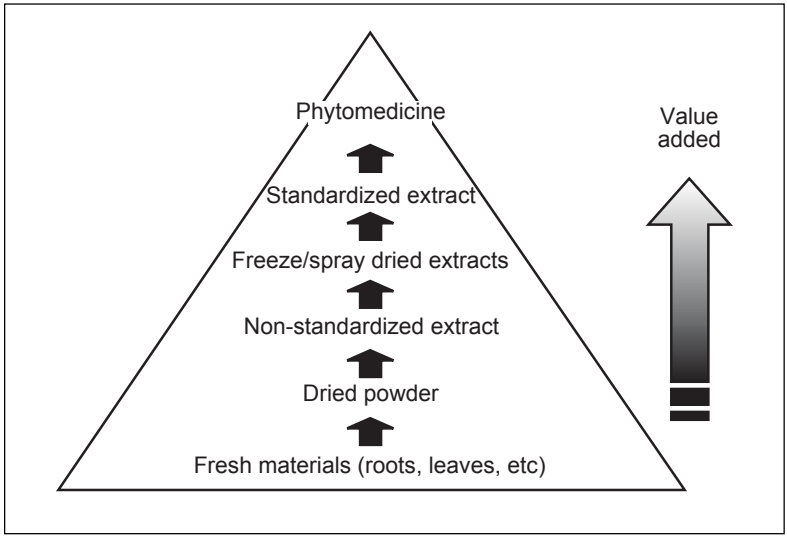

Figure 8 Market value of herbal preparations

Malaysia, the GMP certification is issued by the National Pharmaceutical Control Bureau (NPCB), as an annual Manufacturing License which can be revoked at any time if the facilities fail to meet the standards of GMP. Herbal medicine products can only be sold by manufacturers who follow GMP as it ensures that the herbal product safety and purity. In addition, manufacturers intending to export their products must ensure that their target markets accept their GMP practices.

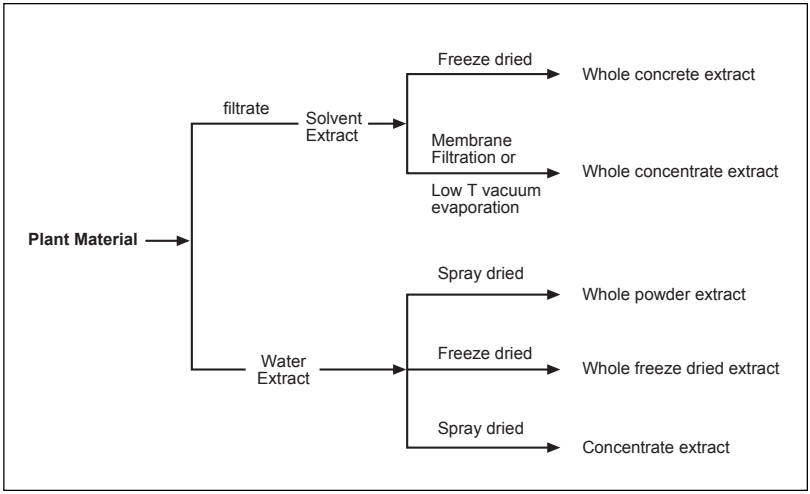

Figure 9 Herbal approach

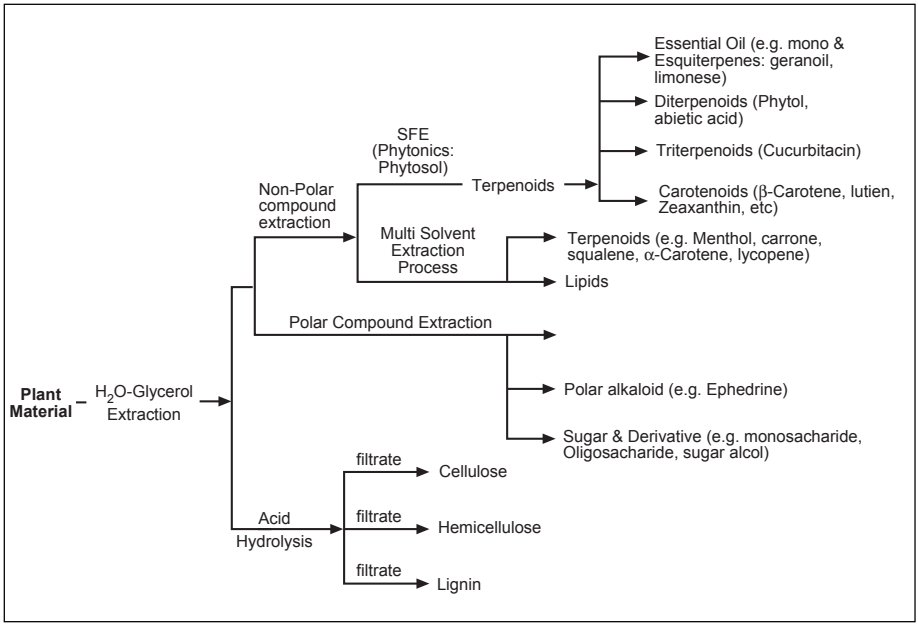

Figure 10 Phytochemical approach

A key issue in manufacturing herbal products and medicines is standardization. **Standardization** is the process of producing herbal extracts or phytochemicals in which product potency is guaranteed through consistency in active compound content level. This process requires high knowledge in phytochemical analysis and process tech- nology to ensure the quality assurance required. Figure 8 shows the increase of value in herbal products as increased processing and standardization is carried out.

Herbal products can be sold in either whole herbal extracts or pure phytochemicals as shown in Figure 9 and Figure 10. In general, it has been found that whole herbal extracts are more effective that isolated phytochemicals due to a synergistic effect between the phytochemical components. Therefore, in standardisation, it is important to assure that the herbal phytochemical profile is maintained.

CRITICAL MALAYSIAN NEEDS – A STRONG KNOWLEDGE BASE AND KNOWLEDGE WORKERS

Knowledge is the key catalyst in enabling Malaysia to become a global herbal producer. Currently, there is a lack of knowledge in three major areas: agricultural practice, pharmacology, and process technology. There is also a need to train more knowledge workers in the relevant fields.

More open knowledge on agricultural practice with respect to optimizing phytochemical content is needed in order to build the foundation of a herbal industry. Information on the best method of cultivation, duration of cultivation, on phytochemical rich parts of the plant material, are not well known for most Malaysian herbs. In addition, as herbal products are used for health and nutrition purposes, cultivation must be done with good agricultural practice as well as organic farming methods to ensure safety. A possible solution is to upgrade the current level of farming to a large scale contract farming with professional farm management, perhaps with the allocation of larger tracts of land from the state governments. The formation of a centre dedicated to studying the cultivation of herbs would also be a answer to this situation.

The critical knowledge needed to build a herbal industry based on Malaysian traditional medicine is also dependant on more research done in pharmacology and clinical testing of local herbs. At present, the available pharmacopoeia is critically lacking compared to the

available herbs. There is also a lack of knowledge in terms of active ingredients, synergy effects, critical dosages, side effects, contraindications with other herbs and medicines, animal and human tests. Without the establishment of this knowledge base, herbal medicines from Malaysia cannot be sold internationally.

Apart from agricultural and pharmacological knowledge, process knowledge also needs to be addressed. Phytochemical processing is a relatively new field in which chemical engineers and food technologists have been involved only recently. As standardization is an important aspect of increasing value of phytomedicines, processing technology innovation as well as process operating information is required for local herbs. Important areas needed in research include the development of environmentally friendly processes, the application of new and novel processing methods to local herbs, and the enhancement of existing process technology.

In addition, as the overall phytochemical yield of herbal extracts are between two to five percent, it is important to develop expertise in optimising the process as process profitability can be increased through the following steps:

- Reduction of utilities usage
- Increase in phytochemical yield
- Reduction of extraction solvents
- Reduction of processing time

Training and certification is another critical area as it will increase the number of knowledge workers in three important areas: Practitioners, Researchers, and Industrial Workers.

At present, under the Traditional/Complimentary Medicine Policy of the Ministry of Health, five bodies were incorporated to organise and represent each of the major traditional healing philosophies. It is hoped that under these five bodies, knowledge will be preserved and transferred to future practitioners so as to raise public confidence.

At present, there are no courses in natural or traditional healing at local universities. However, there is a new development where, for instance, the first programme in Bachelor of Science in Herbal Medicine was offered by Middlesex University, United Kingdom, in 1994 and a Clinical Degree in Naturopathic Medicine by Southern Cross University, Australia, in 1995. It is critical that courses such as these be designed as indigenous medical systems have their own medical knowledge base and healing paradigms.

Allopathic medicine practitioners, the modern medical doctors, need to be retrained to include traditional medicine as part of their repertoires such as already adapted in Japan and Germany. Among knowledge that is critical for practitioners are herb–drug interactions, herbal systems philosophy, and critical drug and herbal dosages. Better usage of drugs and herbs will lead to better overall health and this will subsequently lower healthcare costs.

More researchers will be needed to accelerate the rate of growth of the industry. Specifically, the important areas of research include:

- Ethnobotany studies
- New plant and drug discovery
- Phytochemical studies
- Biological and Clinical studies
- Drug testing

The establishment of a national research and development centre for herbs could address these areas under a centralised body as well as to provide a clearinghouse for information and staff exchanges. A growing herbal industry will also need well–trained knowledgeable workers in terms of industrial workers including Natural Product Chemists and Phytochemical Processing Engineers.

THE CHEMICAL ENGINEERING PILOT PLANT

Background

The idea for establishing CEPP originated while I was a student at University of Manchester Institute of Science and Technology (UMIST). The Chemical Engineering Department at UMIST has a Pilot Plant that was used for teaching, development work and training.

I realised then that a Pilot Plant would serve as a good resource in developing the Chemical Process Industry in Malaysia. A Pilot Plant would serve as a critical link between the industry and academia as it could, convert scientific data to engineering data, develop processes from lab scale to plant scale, and determine technical feasibility and economic viability of products.

Building a Pilot Plant would also overcome the 'Valley of Death' funding gap as shown in Figure 11, where funding is sorely lacking for process and product development. This is due to the fact that universities and research institutes are only funded for initial research

and discovery work while industries only fund development projects that have been proven to be viable.

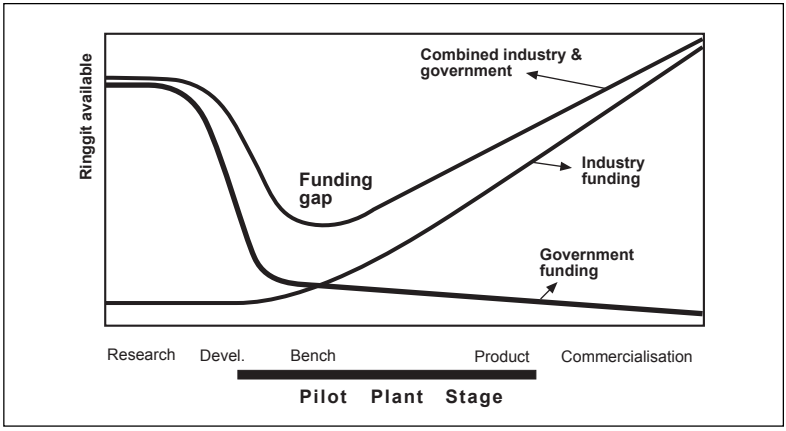

Figure 11 Stages of technology development

CEPP was originally proposed in 1984 while the Faculty of Chemical Engineering is still at the Jalan Semarak Campus. However, due to the delay in moving to UTM Skudai, the project was delayed until 1988 when it was reactivated and the permission to appoint a foreign consultant was given by the then Implementation and Coordination Unit of the Prime Minister's Department in 1989.

The planning for the facility as well as selection of process technologies was done by a local team headed by myself who then selected the external consultant, Energieconsulting Hiedelberg from Germany in 1991. The experience of working with German engineers proved to be invaluable for me as Germany was one of the oldest nations involved in the chemical industry. The training gave me the personal exposure to the German technical mind and work ethics. I had the opportunity to work closely with one of the German inventors on an innovative gas–liquid catalytic reactor which we managed to acquire for CEPP.

The focus of the Pilot Plant, would be to fully utilise sustainable Malaysian natural resources into specialty chemical products to improve human life. Through this project, I had the invaluable opportunity to visit over 30 pilot facilities run by the industries, research institutes, and universities in Europe and the United States.

Figure 12 The writer with a German inventor at his workshop in former East Germany (1992)

Together with the team of consultants and local academics and experts of multidisciplinary backgrounds, it was decided that the Pilot Plant would focus on two key areas: Biochemical Bioprocessing and Fine Chemicals Processing. Phytochemical processing, a relatively unknown area in 1991, was chosen as the fine chemical specialty area. In view of the multibillion dollar industry today, it has proven to be an ideal choice.

The construction of CEPP began in 1995 after the project proposal was approved by Ministry of Education and supported by the National Scientific Research and Development Council, and the funding approved by the Economic Planning Unit. In 1997, the three main CEPP block–Administrative, Biochemical and Fine Chemical–were completed. From 1997 onwards, CEPP has been steadily increasing its analytical and processing equipment. Figure 13 shows CEPP during its construction phase and Figure 14 shows completed buildings of CEPP today. We are indeed grateful to Jabatan Perkhidmatan Awam who approved the much needed 42 critical permanent positions to run CEPP. In fact, CEPP established a record for being the first university based R&D centre to receive the permanent research officer posts.

Figure 13 CEPP during construction (1996)

Figure 14 CEPP today

CEPP TODAY

The Chemical Engineering Pilot Plant is now considered as one of the university's centres of excellence established in June 1998 at Universiti Teknologi Malaysia Skudai. The three building blocks of CEPP cover over 10,000 square feet area. Most of its process equipment are in modular form to ease new process development.

CEPP was formed for the following objectives:

- To bridge the academic research with the practical requirements of the industry.

- To assist Malaysia in building indigenous products and process technologies
- To assist Malaysia in building up indigenous expertise

A key contribution of CEPP is its human resource development programmes it runs as well as knowledge transfer. To date, it has trained participants from 275 companies. Some areas of focus include:

- Upgrading current chemical process industry worker knowledge
- Training and building up local entrepreneurs in upcoming fields such as herbal and phytochemical processing and product formulations
- Training new technical workers for upcoming fields
- Transfer of technical knowledge in specialised areas

Figure 15 Participants of one of CEPP short course

CEPP AS ONE–STOP PHYTOCHEMICAL PROCESSING

As mentioned earlier, phytochemical processing were chosen as the focus area in the Fine Chemical section at the Pilot Plant. The primary emphasis in this area is on improving processing techniques for local herbal products and developing products for market testing as well as for small scale production.

Major equipment used for phytochemical processing include:

- Molecular Distillation
- 300 litre Extraction Vessel
- Low Pressure Super Critical Extractor
- Hydrodistillation Unit

- Spray Dryer
- Freeze Dryer
- Centrifuge
- Homogenizer
- Turbo Extractor Distiller

As the analysis of the raw materials, herbal extracts, pure phytochemical and final products are critical to quality assurance and process development, several analytical equipment are available at CEPP such as:

- High Performance Liquid Chromatograph (HPLC)
- Liquid Chromatography–Mass Spectrometer
- Spectrophotometer

SIGNIFICANT CEPP RESEARCH PROJECTS AND INDUSTRIAL COLLABORATIONS

In the short time since its formation in 1998, CEPP has been involved in several projects which include:

(i) MHCP production from Cinnamon
(ii) Phytochemical production from Zingiber Zerumbet (**Lempoyang**) and Curcuma Xanthorhizza (**Temu Lawak**)
(iii) Production of Oleoresins and Essential Oils from Zingiber officinale (**Halia**)
(iv) **Tongkat Ali** production process development
(v) Aromatherapy product development
(vi) Vitamin E product formulation

A key concept in many of CEPP's projects is the biorefinery concept where raw plant material is totally fractionated and converted into a spectrum of valuable products. Cinnamon (**Kayu Manis**), a common spice used in Asian cooking, is one such plant where this concept can be applied. Among products from cinnamon include essential oils, oleoresins, extracts, and purified phytochemicals. One high value product from cinnamon is Methyl Hydroxy Chalcone Polymer (MHCP), a phytochemical with scientifically proven anti–diabetic properties. MHCP has been found to increase cellular glucose oxidation by a factor of up to 20 fold, improve the function of insulin receptors in cells, and has a strong anti–oxidant effect.

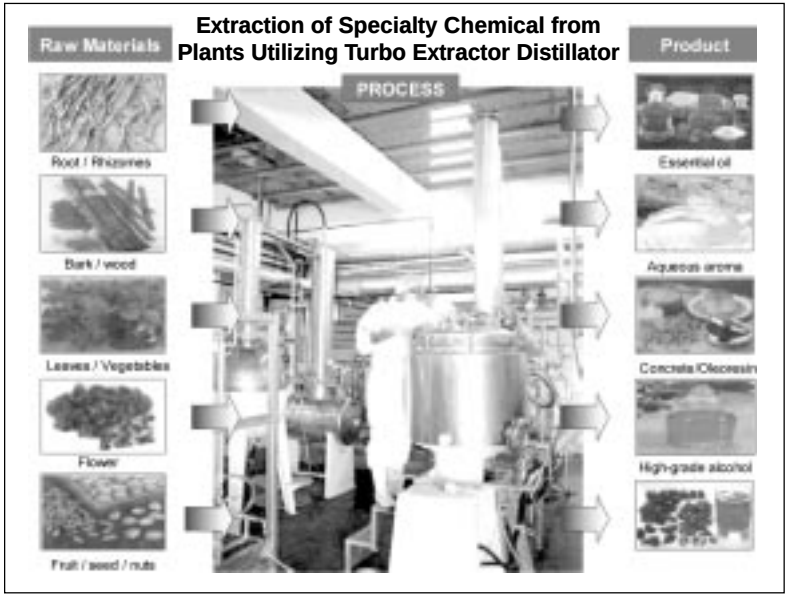

Figure 16 The Turbo Extractor Distiller and its specialty chemical products

An IRPA-funded project entitled 'Production of Speciality Phytochemicals from *Cinnamomum Zeylanicum'* is now being carried out by CEPP together with the UTM's Faculty of Science, UTM as well as industry collaborators. Its primary aim was to develop an environmentally safe and economically viable process to produce standardised cinnamon extracts and purified MHCP. These extracts would be then used as functional food additives or phytomedicines.

Apart from cinnamon, CEPP has also been involved in the production of phytochemicals from members of the *zingiberase* (**Ginger**) family, *Zingiber Zerumbet* (**Lempoyang**) and *Curcuma Xanthorrhiza* (**Temu Lawak**). Another IRPA funded project together with the Faculty of Science, SIRIM, FRIM, Universiti Kebangsaan Malaysia and Universiti Malaya was started in 2001 to develop process design to extract these two species. The active ingredients in Lempoyang and Temu Lawak are zerumbone, which has anti–viral and potentially anti–HIV properties and xanthorrizol, which has anti–bacterial properties. The process design project involves process detailed design, scale-up studies, total plant utilisation through biorefinery approach, and phytochemical purification. An example of the Turbo Extraction Distillation device and its applications is shown in Figure 16.

Another product from the ginger family developed at CEPP is the essential oils and oleoresins from the household ginger, *zingiber* officinale (**Halia**). Ginger is freely available in Malaysia at a low price, therefore value-added products can increase the value of this crop. In addition, many traditional cures in Malay, Indian, Chinese, and many indigenous groups are based on ginger. In collaboration with Universiti Malaysia Sabah, CEPP focuses on the process design and optimisation and product commercialisation of essential oil and oleoresin production from ginger.

Figure 17 Halia. *Source* FRIM

Besides IRPA funded projects, CEPP also focuses strongly on industry based development projects. A key and visible success process development at CEPP is the development of the Tongkat Ali water extract production process, which is currently utilised by Phytes Biotek Sdn Bhd and the Forest Research Institute of Malaysia (FRIM). Tongkat Ali extraction by Phytes Biotek previously had an extraction time of over four hours and low yield. After process development at CEPP, it was found that high pressure and temperature extraction increased the yield and reduced the extraction time to two hours. The process developed is shown in Figure 18 and Figure 19.

Apart from herbal extracts such as Tongkat Ali, CEPP has also developed aromatherapy products, as shown in Figure 20. CEPP has helped created several formulations in different forms such as lotions, sprays, and candles. A successful set of formulations are currently being marketed by Fyto–Elegance, another MAVCAP funded company.

CEPP has also done product formulations for spray dried Vitamin E from palm oil sources. The product formulation proved to be of high demand in countries such as Japan where in powder form it proved to be easily formulated and standardised.

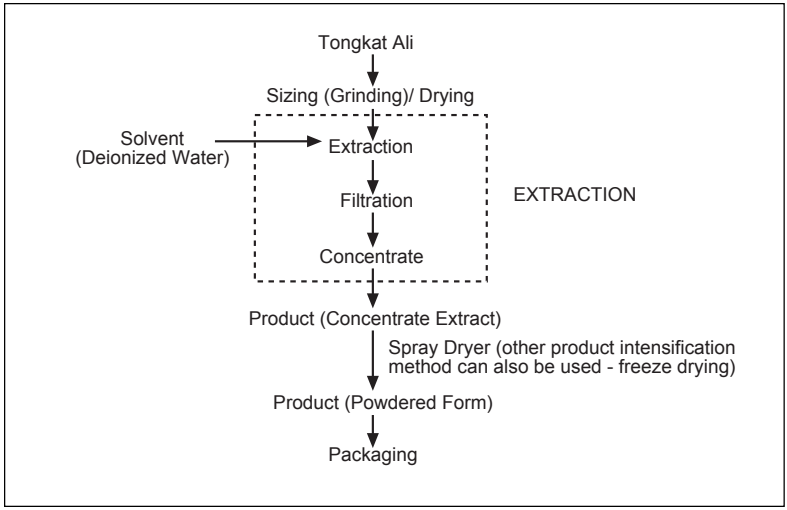

Figure 18 Tongkat Ali process flow chart

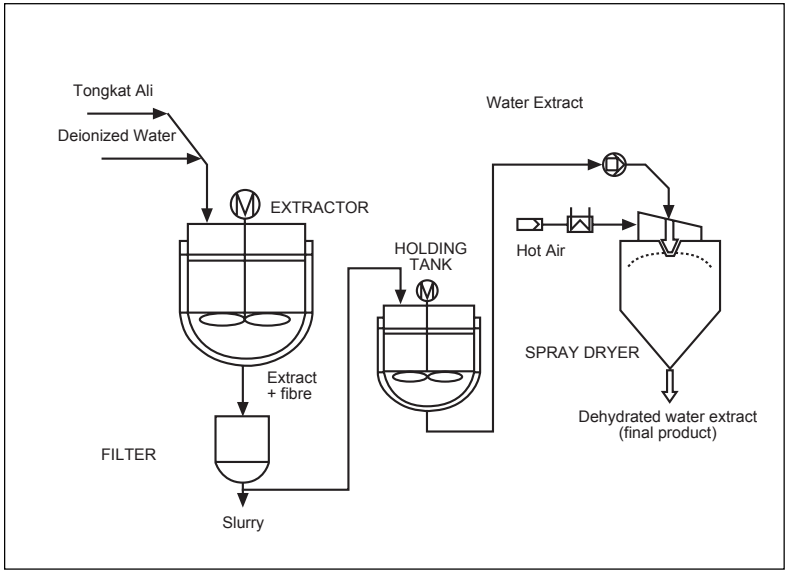

Figure 19 Tongkat Ali water extract process design

Figure 20 Aromatheraphy products developed at CEPP

FUTURE WORKS AT CEPP

In essence, CEPP intends continue pursuing work focused on **product and process development** based on national **natural resources** through **sustainable process technology**.

A key area of focus will remain the **BIOREFINERY** approach where whole plant materials will be utilised to produce high value chemicals. In addition, as the health–based industry is expected to continue growing at a high rate, more healthcare products and process development works will develop such as functional food additives. Lastly, CEPP will continue to develop more courses and training programmes to serve the needs of the nation as the demand of knowledge–based human resource continues to be the driving force of the country's economic growth.