



WONDERS

OF

NATURAL
PRODUCTS

IN

MALAYSIA

FREDDY KUOK SAN, YEO
SIONG FONG, SIM
NOR HADIANI ISMAIL

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FOREWORD

Sarawak is an ideal state for ecotourism. The richness in biodiversity as well culture diversity provides a wide experience to visitors. There are different themes of ecotourism. Ecotourism revolving around the theme of learning and appreciation can be aligned to the platform created by The Regional Conference & Exhibition on Natural Products, Traditional Medicines and Herbs 2021.



Local communities in Sarawak have been exploiting natural resources for generations. Their traditional knowledge on the application of natural resources in their everyday life is the preliminary reference for scholars to explore further on the different potential usage of the natural resources. In return, not only an acknowledgment of the traditional knowledge, but different stakeholders can also come together to create sustainable ecotourism projects in the theme of learning and appreciation to amplify and boost the income of the local communities. With properly planned activities, visitors may experience the nature where the communities harvested the natural resources, go through an educational trip, and appreciate the cultural value of a community.

This coffee table book, “Wonders of Natural Product in Malaysia” may serve as a trigger and the first motivational force to scholars and innovators of multidiscipline, to work together towards, not only to explore sustainably the potential uses of natural resources, but also to reciprocate or returning the favour to the communities.

YB Dato Sri Haji Abdul Karim Rahman Hamzah
Minister of Tourism,
Arts and Culture Sarawak

FOREWORD

The Regional Conference & Exhibition on Natural Products, Traditional Medicines and Herbs 2021, is a platform for different stakeholders to share



or display their innovations as well as findings. It is hope that this conference will foster interdisciplinary collaboration and create new opportunities. To expand the platform for innovators as well as researchers, this coffee table book, “Wonders of Natural Product in Malaysia” is published in conjunction with this conference, to showcase the diverse sources of natural products, along with their various applications. The editors and the article contributors have organized a selection of innovations and research findings to be shared, diffused and enjoyed by every walks of life.

In addition, this book deliberates on the importance of conserving the biodiversity of Malaysia. Scholars from different disciplines are encouraged to investigate in orchestration, to exploit sustainably natural resources and identify different potential natural products. They are also encouraged to publish research findings and share innovations to the public, to complete the knowledge and innovation cycle.

Mr. Hii Chang Kee
Permanent Secretary, Ministry of Tourism,
Arts and Culture Sarawak Malaysia



PREFACE

Natural products, in chemistry, refers to secondary metabolites or compounds synthesized by living organisms. In a broader sense, natural products also refer to green products i.e., products that are created using only natural ingredients.

In conjunction with the Regional Conference & Exhibition on Natural Products, Traditional Medicines and Herbs 2021, dedicated authors from various organizations and institutions have come together to share their innovations and research findings related to natural products, which allow the editors to produce this book, *Wonders of Natural Products in Malaysia*.

This book aims to showcase the innovations and potential uses of various valuable plants, microbes and agrowastes in Malaysia. The innovations and research findings published in this book are supported by numerous grants. The editors are grateful to all contributors and hopefully this book will trigger future collaborations between various stakeholders towards sustainable exploration of natural resources in Malaysia.

Freddy Kuok San, Yeo
Siong Fong, Sim
Nor Hadiani Ismail



ACKNOWLEDGEMENT

The editors would like to thank Tun Ahmad Zaidi Chair for inspiring and supporting the Regional Conference & Exhibition on Natural Products, Traditional Medicines and Herbs. The Chair supports theoretical and application research in local natural products in the area of chemistry, biochemistry, pharmacology, social science, socio-economy and social demography. The editors would like to extend their sincere gratitude to Ministry of Tourism, Arts and Culture Sarawak for the Tourism Event Grant to sponsor this conference and allow the production of this book.

Special thanks are due to Sarawak Trade and Tourism Office Singapore (<https://statos.com.sg>) and Business Events Sarawak (<https://businesseventssarawak.com>). Their valuable contributions have made the conference meaningful and significant to the tourism of Sarawak.

The editors also would like to acknowledge the continued support and effort from the conference organizers. Profound appreciation goes to Universiti Malaysia Sarawak (UNIMAS) for the continuous encouragement and assistance.

Finally, the editors cherish the authors in this book, who have contributed diverse, interesting and informative articles.

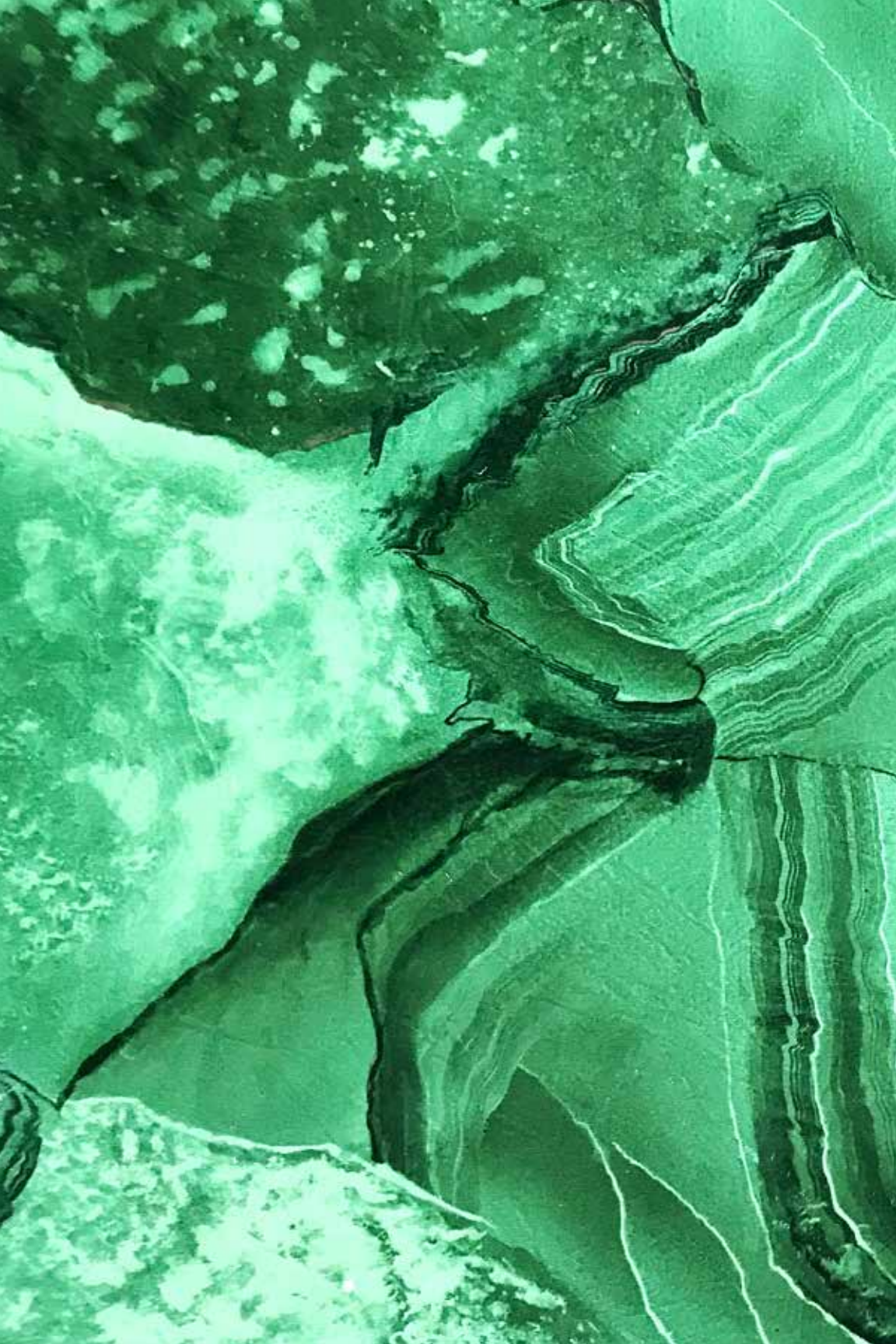


INTRODUCTION

Malaysia is blessed with bountiful biodiversity, from which, various flora and fauna are at the disposal of humankind as food sources, medicine, building materials and many more. There are still much to be discovered and explored.

Authors from eight institutions have contributed their innovative products and research findings in this book. About 30 species of plants and microbes were discovered of which 27 species were studied for their properties and secondary metabolites whilst 5 species were innovations in natural products with values of commercialization.

Overall, this book has taken a modest snapshot of the wealth of Malaysian biodiversity which consists of more than 160,000 species, not including microorganisms (<https://www.cbd.int/countries/profile/?country=my>). It is hoped that the interesting knowledge discovered by the researchers in natural products in this region can be shared with the public.





**FROM
NATURAL PRODUCTS TO
INNOVATIVE PRODUCTS**



New Invention of Mosquito Repellent Containing Beta-Caryophyllene Extracted from Pepper (*Piper nigrum*) Stalk

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Mozi-Repellent is a mosquito repellent containing extracts from pepper (*Piper nigrum*) stalks. Pepper stalk was found to exert the strongest mosquito repellence activity compared to peppercorns, leaves and stems. Extracts from pepper stalks were subjected to phytochemical and antioxidant analyses to determine the compound responsible for the anti-mosquito property. Caryophyllene is the major compound found in the pepper stalk, contributing to the mosquito-repellent activity. Laboratory and field evaluation of mosquito repellent efficacy were carried out. Laboratory testing of mosquito repellent was in accordance with Malaysian Standard (MS1497:2007). No skin irritation such as allergy, eczema, hives, or redness was observed, four hours after application. This naturally formulated mosquito repellent product can be found as pepper spray, lotion stick or sunscreen lotion. The formulation is free of synthetic ingredient such as DEET (N,N-Diethyl-meta-toluamide); it is suitable for use by kids and adults and it offers protection against mosquitoes for up to two hours.

MOSQUITOES?



with



PEPPER
Mozi-Repellent
No more worries!

Black Pepper Oil

Nurasyikin Abdul Rahman
nurasyikin@mpb.gov.my

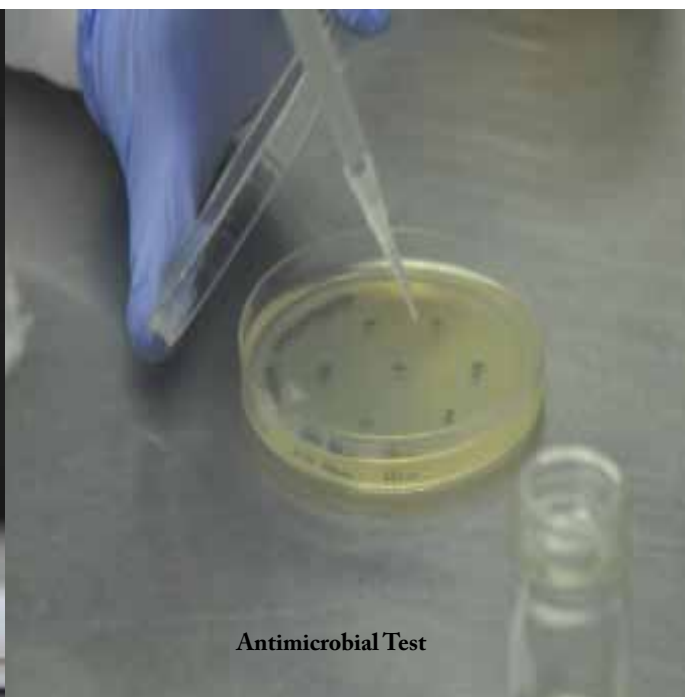
Black pepper oil has remarkable health benefits. The oil contains about 70-80% monoterpenes, 20-30 % sesquiterpenes and less than 4% oxygenated constituents. The prominent terpenes found in black pepper oil are beta-caryophyllene, limonene, alpha-pinene and phellendrene. These bioactive compounds are scientifically proven with remarkable therapeutic potentials, useful for various applications especially in food, cosmetics & personal care, pharmaceutical and nutraceutical industries. Due to the unique aroma of black pepper oil, it has also been applied in perfumeries.

The therapeutic properties of black pepper oil:

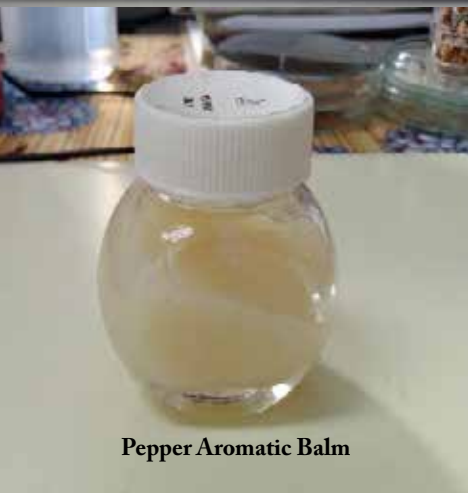
- Anti-oxidant
- Anti-melanin
- Anti-inflammatory (hyaluronidase)
- Anti-bacterial

Sarawak black pepper oil is extracted using the supercritical carbon dioxide extraction technology, a green technology replacing the traditional organic solvent extraction approach. The superiority of the product:

- Well preserved phytochemical contents
- Zero-solvent residuals
- 100% purity



Antimicrobial Test



Pepper Aromatic Balm



Pepper Soap

Antioxidant, Bioflavonoid-Enriched Extract from Oil Palm Leaves (*Elaeis guineensis*) for Wound Care

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The oil palm was introduced as an ornamental plant to Malaysia in 1857 from West Africa. Since its first commercial planting at Tennamaram Estate in Kuala Selangor in 1917, oil palm has become a top commodity for Malaysia. Although the fruits are the economic part of the tree, other parts are also medicinally useful, for example, for treating skin infections, headaches, gastrointestinal disorders and malaria, among others.



Elaeis guineensis Jacq. The oil palm tree is an enormous, pinnate-leaved tree possessing a solitary columnar stem or trunk with short internodes. The foliage is called the fronds which forms the crown (or top) of the plant. A mature tree has a continuous succession of leaf buds that separates laterally from the apical meristem in its crown. Oil palm leaflets were cut into small pieces, oven-dried (35°C), pulverized into powder and subjected to an integrated extraction process.

The sustainable use of the resources provided by agricultural biomass is a key pathway to achieve circular economy for the country. To this end, we explored the viability of converting oil palm leaves into useful end product(s). A report that an indigenous community in Ghana uses the powdered leaf or leaf juice to treat chronic wounds and based on scientific evidence of the leaves having antioxidant, anti-inflammatory, and wound healing properties, it convinced us that we were pursuing a worthy cause.

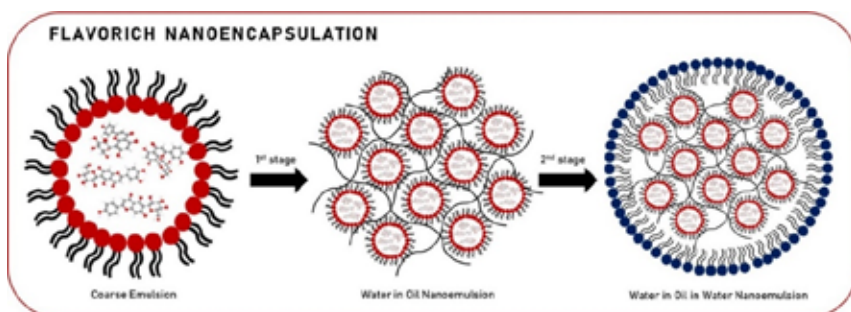
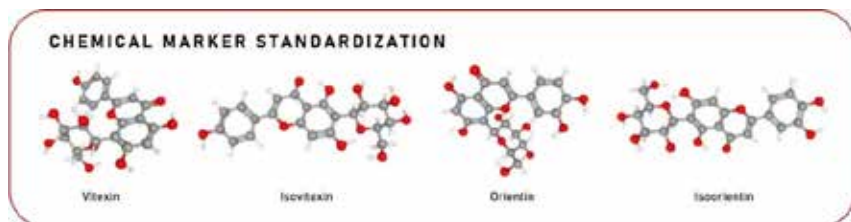
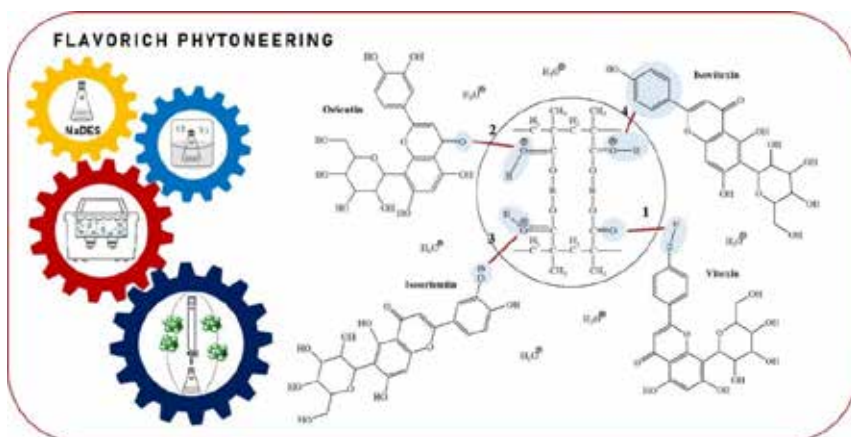
Indeed, detailed chemical analysis showed that the biomass is a rich source of bioflavonoids (luteolin and apigenin types), reported in the literature to be potent antioxidants. Further studies using state-of-the-art metabolomics technology, coupled with *in vitro* cell-based assays and *in vivo* zebrafish model assays, we successfully showed that the bioflavonoids were largely responsible for the wound healing effect. Working towards the sustainable utilization of the biomass, an efficient process for extracting the bioflavonoids was developed. FlavoRich, a standardized bioflavonoid-enriched extract exhibited significant wound healing effect *in vitro* and *in vivo*, with no observed toxicity. The activity was further enhanced by its nanoemulsion form. Overall, the research findings have served to emphasize the “waste to worth” potential of the agricultural biomass. From the perspectives of quality control and assurance of therapeutic efficacy, the results provide a strong basis for its exploitation as botanical healthcare products.



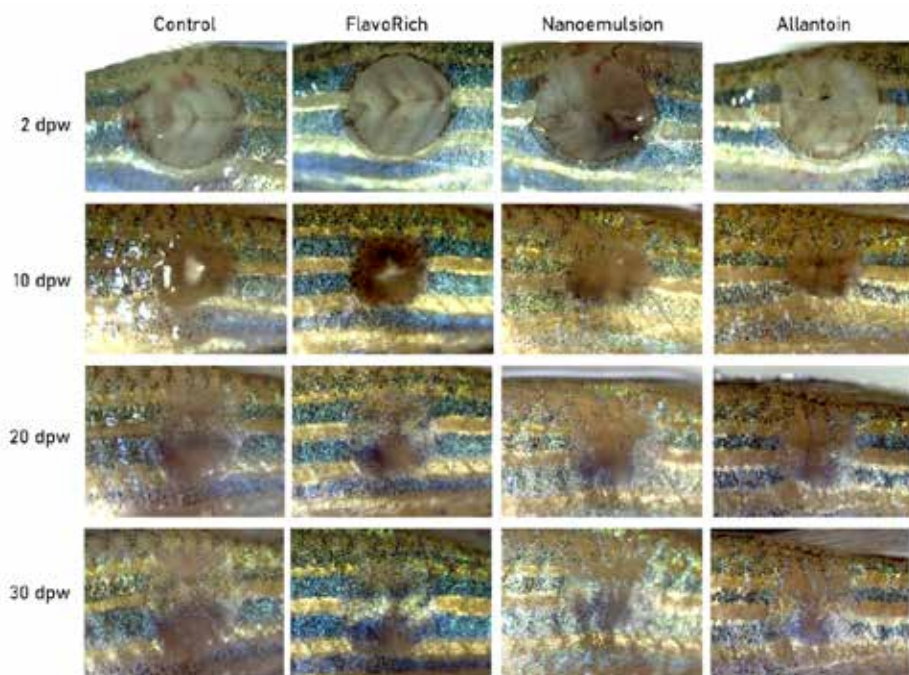
Enriching the extract. Conducting dynamic adsorption and desorption experiments on a resin-packed column to determine optimal conditions for preparing a bioflavonoid-enriched extract from oil palm leaves. Several macroporous resins and solvent systems were evaluated for the best yield of total flavonoids contents. Combination of a commercially available resin (Amberlite® XAD7HP) and 80% aqueous ethanol ultimately gave 3.6-fold enhancement in total flavonoids yield.



Wounding and healing the zebrafish model. Making a biopsy punch wound on an adult zebrafish – an innovative wound healing model assay. Inflicted wounds were treated with FlavoRich and its nanoemulsion for a period of 30 days. Wound closure was monitored optically every two days. The model assay was developed and conducted at Chungnam National University, Daejeon, Republic of Korea in collaboration with Prof. Mahanama De Zoysa and Prof. Cheol-Hee Kim.



FlavoRich phytoneering. The optimized extraction-enrichment process, integrating ultrasonic-assisted green solvent extraction, chemical pretreatment and adsorption on macroporous resin. Also shown is the schematic representation of the postulated interactions between target bioflavonoids and resin, consisting of hydrogen bonding, ion dipole interactions, electrostatic attraction and cation- π interactions. FlavoRich was standardized to four isomeric flavonoid *C*-glycosides using state-of-the-art UHPLC-UV/PDA and LC-MS/MS technologies. To enhance the delivery of the bioactive flavonoids, FlavoRich was further encapsulated to form a nanoemulsion via two stage ultrasonication-emulsification technique.



FlavoRich promoted wound healing *in vitro* and *in vivo*. Pre-clinical data on wound healing efficacy of FlavoRich and its nanoemulsion evaluated using *in vitro* scratch assay on 3T3 fibroblast cells and *in vivo* biopsy punch wounding on adult zebrafish models. Results suggested that oil palm bioflavonoids were instrumental in promoting the wound healing process by showing rapid proliferation (> 90% activity) and migration of the fibroblast cells, as effective as allantoin which was used as a positive drug control. Proliferation and migration of cells are crucial for wound healing especially during reformation of surface layer tissue of the skin (re-epithelization). Rapid proliferation of fibroblasts will provide sufficient supply of cells to migrate rapidly and cover the wound site.

The background of the image is a soft, out-of-focus green, suggesting a natural setting like a forest or garden. The colors range from light lime green to a darker, muted green, creating a bokeh effect.

INTERESTING FINDINGS ON NATURAL PRODUCTS



The First Glycaemic Index (GI) Study on Sago-Based Products in Sarawak

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Having undertaken bioequivalence studies since 2nd March 2013, Clinical Research Centre Sarawak General Hospital recently embarked on food science industry-sponsored research. With experience and systems established from bioequivalence studies, we conducted our first Glycaemic Index (GI) study on 14th-21st June 2019 on sago products sponsored by CRAUN Research Sdn Bhd. The study also highlights research collaboration among three Sarawak based research institutions: Clinical Research Centre Sarawak General Hospital, Borneo Kinetics Sdn Bhd, and CRAUN Research Sdn Bhd.

The GI, first proposed in 1981, is used to classify food based on their postprandial blood glucose raising potential. The GI of a food relies on how rapid its carbohydrates are digested and absorbed. The GI is defined as incremental area under blood glucose response curve after consuming a test food containing 50 g of available carbohydrate, expressed as the percentage of response against the same amount of carbohydrate from a standard food (such as glucose or white bread) consumed by the same individual. $GI \leq 55$ is considered low, 56-69 is medium, and ≥ 70 is high. Low-GI food reduces both glycaemic and insulinaemic response in our body and low-GI diet is associated with reduced risk of developing type 2 diabetes mellitus. Studies also show that a low-GI diet has beneficial clinical effect on glycaemic control in patients with diabetes and reduces triglycerides in individuals with hypertriglyceridemia.

Sago (*Metroxylon sagu* Rottb.) is one of the oldest agricultural crops in the Southeast Asia. Sarawak has been one of the world's biggest producers of sago

since the 1970s'. Generally, sago starch contains high amylose/amylopectin ratio (24-31%) as compared to short-medium grain rice (15-18%) and glutinous rice (4%) that are commonly consumed in Asia. Food containing high amylose starch generally exhibits low GI value. This is because starch with a higher ratio of amylose/amylopectin will form a firm gel, thus reducing its digestibility (due to high amount of resistant starch formed by amylose). Modification on sago starch increases the resistant starch content further to 74% which is comparable to other resistant starch products in the market, such as Fibersym™ (MGP, USA) and HiMaize™ (Ingredion, USA).

In this study, we determined and compared the GI values of food products made with sago starch with other sources of starch, including a commercially available resistant corn starch. Four products with glucose drink as the standard food were tested and a total of 1,344 glucose tests were carried out in the study.

The most challenging part of the GI study was the timing and study duration. To maintain the commitment of our volunteers in this study, we ensure minimal disruption to their daily routine. The study started as early as 5.00 am for seven days in a row! We are grateful to the commitment of our volunteers as well as the great teamwork that leads to the success of this study.

Upon completion of the first GI study, CRC is confident and determined to lead clinical research in pharmaceutical, health and food science to support related industries benefiting the public. We will continue to strive for excellence to meet the local and international standards, ethical and regulatory requirements in our services.



Sago (*Metroxylon sagu* Rottb.)



The first glycaemic index study by Clinical Research Centre (CRC), Sarawak General Hospital was conducted on 14 – 21 June 2019 at CRC Research Ward, Sarawak Heart Centre. It was a collaboration study with CRAUN Sdn Bhd and Borneo Kinetics Sdn Bhd on snack bars made of sago starch. Picture (left) showed preparation of the investigational food products before commencement of the clinical study. Picture (top right) showed preparation of the healthy volunteers before consuming the investigational food products after a night of fasting. Picture (bottom right) showed capillary blood glucose level after taking the investigational food product.

Sequential Solvent Extraction Method in Isolating the Mitragynine from Different Genus of *Mitragyna speciosa* Leaves Planted in Sarawak

Aishah Binti Abdul Aziz*, Hazalinawati Binti Zailani, Nurul 'Ain Binti Azman & Muhammad Zulkipli Bin Muhammad Shafiq Chen

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Mitragyna speciosa is an ethno homeopathic plant herb that is commonly found in the Southeast Asian including Malaysia. In Malaysia, this leaf is known as *ketum* or *biak-biak*, while in Sarawak, the local called it *ketum ayam*, *ketum putih* or *ketum jambu*. The leaves of *M. speciosa* have been traditionally used to treat coughing, diarrhoea, intestinal infection and for muscle relieve since the early 19th century Mitragynine is the main active alkaloid derived from *M. speciosa* and is scientifically known as 9-methoxycorynantheidine, in which the composition may differ according to geographical locations. In this study, the sequential solvent extraction method was applied to isolate mitragynine from the three types of *M. speciosa* leaves found in Sarawak in order to identify its potential as a therapeutic agent.



Three types of *Mitragyna speciosa* leaves planted in Sarawak



Mitragyna speciosa leaf



Sequential solvent extraction method



**Ethonopharmacology-led Discovery of an
Anti-inflammatory Drug Lead from Leaves of *Tenggek
Burung (Melicope pteleifolia) (Champ. ex Benth.) T.G.
Hartley***

Khozirah Shaari*, Chau Ling Tham & Alicia Chean Hui Ng

* Corresponding author: khozirah@yahoo.com.my

Funding agencies:

- Ministry of Science, Technology and Innovation
 - Ministry of Higher Education
 - Universiti Putra Malaysia

Patents:

- Leukotriene inhibitor and method for producing the same (PI201000968).
- Mast cell stabilizer in allergic diseases (PI2016702942).

Tenggek burung (Melicope pteleifolia), also vernacularly known as tapak itik, cabang tiga, or pauh-pauh, is a well-known herb in Asian countries including Malaysia. It is a popular *ulam* among the Malays and is commonly grown in herbal gardens throughout Malaysia. Among a myriad of traditional medicine uses, the herb is said to be beneficial in treating itches, wounds, skin diseases, stomach-ache, colds, remittent fevers, spleen inflammation and rheumatism. Scientific studies have reported *M. pteleifolia* with potentials of antioxidant, anti-inflammatory, antinociceptive, antipyretic, analgesic, antimicrobial, and anti-proliferative activity against cancer cells, as well as beneficial for male infertility.



Melicope pteleifolia (Champ. ex Benth.) T.G. Hartley. A small, slender tree, tenggek burung is a common sight in herbal or home gardens of Malaysia. Its vernacular name literally refers to the fact that birds love to perch on its branches to peck on the ripe fruits/seeds, which the plant produces abundantly all year round.

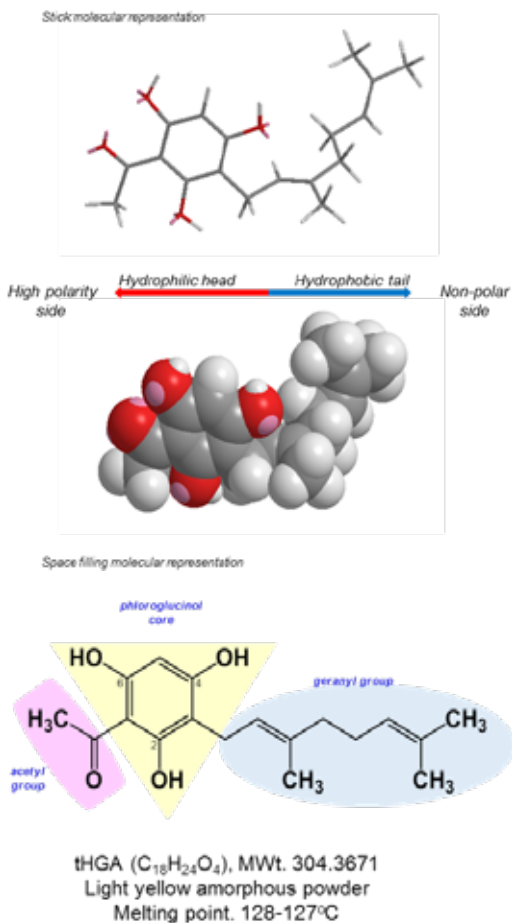


Light green leafy shoots of tenggek burung. The tender shoots are much favoured by Malays for its 'kelat-kelat' (creamy and tangy) taste, and also claimed to be an excellent appetizer by some. The young shoots are among the popular *ulam* (traditional vegetable) sold in local wet markets around the country.

Using its ethnopharmacological application to treat inflammatory conditions, our research on the leaves of the herb led to the discovery of prenylated phloroglucinols as the bioactive principles. Based on potency and ease of synthesis, 2,4,6-trihydroxy-3-geranyl acetophenone or tHGA was singled out for further research. Extensive chemical and pharmacological studies on the simple, drug-like molecule, spanning almost a decade, revealed it to be particularly effective in alleviating allergic inflammatory diseases including asthma, atopic dermatitis and anaphylaxis. The molecule acts by stabilizing mast cells and was effective both topically and orally.

Mast cells are the major effector cells of allergic inflammation, involved in the pathogenesis of allergic inflammatory conditions through mast cells activation and degranulation. When mast cells are activated and undergo degranulation, the contents in the granules, which include histamine and proinflammatory cytokines such as interleukin-4 and tumour necrosis factor- α , will be released to trigger allergic inflammation reactions. Apart from anti-allergic conditions, tHGA has exhibited other interesting pharmacological activities including anti-inflammatory, endothelial and epithelial barrier protective and anti-cancer. Our in-depth investigations found

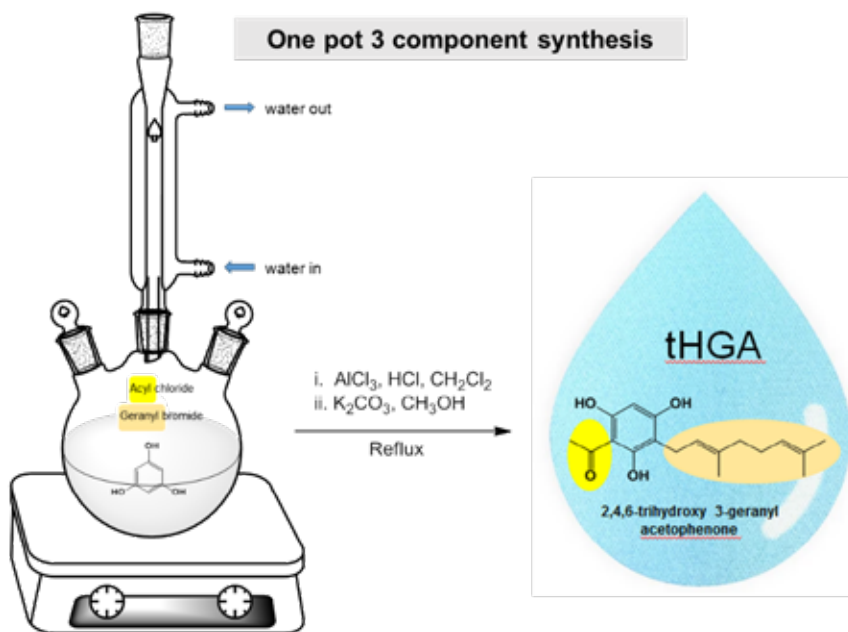
that these activities were attributable to the modulatory actions exerted by tHGA on specific molecular targets. All these beneficial characteristics have collectively enhanced the drug-like properties of tHGA, thereby strengthening its potential as a drug lead that may be of great interest to the health industry.



Molecular structure tHGA. The chemical structure of tHGA is made up of an aromatic phloroglucinol core substituted by an acetyl and geranyl substituents on each side, respectively. The long carbon chain of geranyl group imparts a non-polar or hydrophobic (water-fearing) character to one side, while the acetyl & phenolic groups impart a high polarity or hydrophilic (water-loving) character to the other side of the elongated molecule. These characteristics give the molecule good ability to traverse across cell membranes.

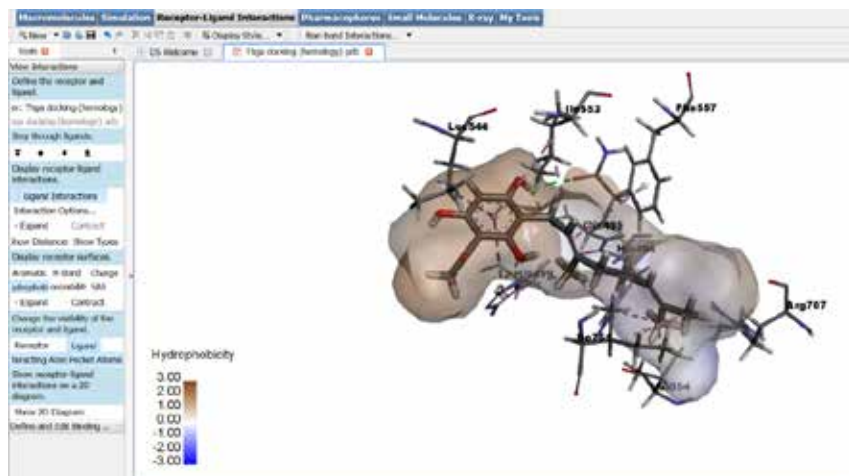


Discovering tHGA. A postgraduate student diligently isolating and purifying tHGA and other compounds from the leaf extract of tenggek burung, using column chromatography, prior to carrying out crucial chemical structure confirmatory analysis and determination of biological activities.



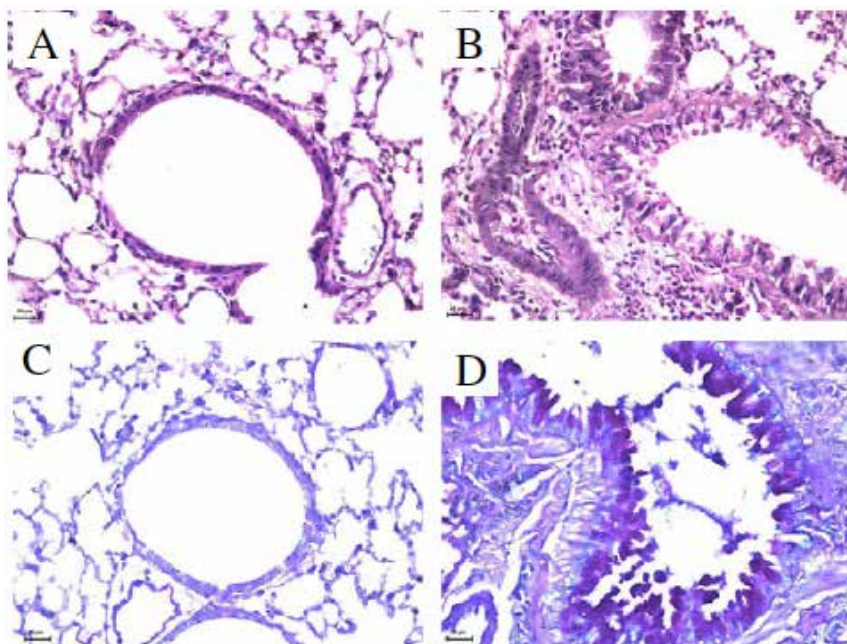
Synthesizing tHGA. A brief schematic for the simple, one-pot synthesis of tHGA. One of the main bottlenecks in drug discovery research is ensuring the availability of an adequate quantity of the drug molecule for pharmacological evaluation, particularly in animal models. Simple, low cost and rapid synthetic procedure are often the requirement to bring the research further downstream of the drug discovery research workflow.

Molecular docking analysis was performed *via* computer simulation using Discovery Studio^{® 3.1} (Accelrys, Inc., San Diego, CA, USA) to predict the binding modes of tHGA with the disease target. tHGA was stabilized by the hydrogen bonding interactions. Molecular modelling studies are conducted to help rationalize the drug's tHGA activity towards the disease target, providing an insight into biomolecular interactions to understand the enzyme inhibitory mechanism. The analysis of interacting amino acid residues within the tHGA-binding site using Discovery Studio Visualizer will provide crucial information which is important for further drug-optimization studies on tHGA and other potential analogues of the lead molecule with improved drug properties.



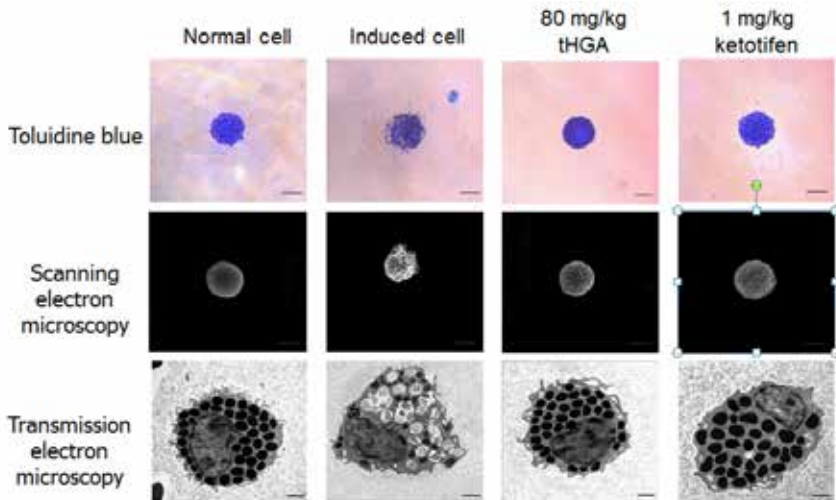
tHGA, a potent lipoxygenase enzyme inhibitor. The image shows the *in silico* molecular docking analysis of tHGA in the bioactive site of the protein structure of lipoxygenase, a key enzyme involved in the pathophysiology of asthma. Through strong binding interactions with crucial amino acids of the protein structure, tHGA inhibited the enzyme by blocking the entry and distorting the geometry of the active pocket of the enzyme, thus preventing it from the subsequent production of biochemicals that mediates inflammation in the body (leukotrienes and cysteinyl leukotrienes).

Scientific evidence showed that in allergen-sensitized mice which have been induced to develop airway inflammation or asthma, oral administration of tHGA attenuates significant pathological changes in the airway. tHGA reduces the infiltration of eosinophils and mononuclear cells around the airways and vessels, as well as suppressing goblet cell hyperplasia.



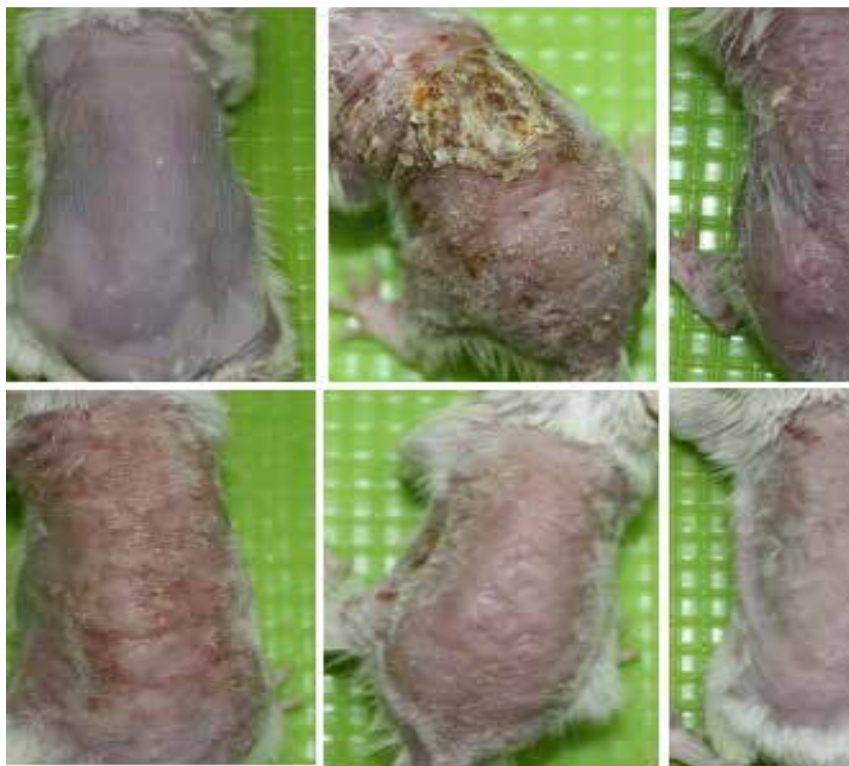
tHGA alleviates asthma. Lung tissues of normal mice (A, C) and allergen-sensitized mice (B, D) were stained with hematoxylin and eosin (A, B) or Periodic Acid Schiff (C, D) and examined by light microscopy. While allergen-sensitized mice (B, D) showed robust pathological changes in allergic pulmonary inflammation (eosinophil and mononuclear cell infiltration around airways and vessels and goblet cell hyperplasia), mice treated with tHGA demonstrated significant attenuation of pathological changes, which was similar to that of the normal mice (A, C). Reprinted with permission from Tan, J.W., Israf, D.A., Harith, H H., Md Hashim, N.F., Ng, C.H., Shaari, K. & Tham, C.L. (2017). Anti-allergic activity of 2,4,6-trihydroxy-3-geranylacetophenone (tHGA) via attenuation of IgE-mediated mast cell activation and inhibition of passive systemic anaphylaxis. *Toxicology and Applied Pharmacology*, 319, 47–58. Copyright (2017) Elsevier.

Scientific evidence showed that under allergic inflammatory conditions, oral administration of this small natural product molecule stabilizes peritoneal mast cell (PMCs), which are the major effector cells of allergic inflammation, making it a potential drug lead for treatment of allergies.



tHGA alleviates allergy. Morphological changes of PMCs were accessed by performing toluidine blue staining scanning electron microscopy, and transmission electron microscopy examinations. Normal PMCs appear rounded in shape with smooth cell surface, and no granules present in the surrounding area. Transmission electron microscopy (TEM) also showed the granules within the cells to be round/oval, appearing homogeneously dense. Activated PMCs (under allergic inflammatory condition), the cells are irregular in shape and degranulated, releasing the granules into the surrounding area. TEM also showed various irregular-shaped secretory granules that exhibited different degrees of densities. The cell structures of PMCs treated with tHGA or control drug (ketotifen fumarate) are stabilized, cells appear smooth and degranulation has been inhibited, preventing the release of granules into the surrounding area. Reprinted with permission from Ismail, N., Jambari, N.N., Zareen, S., Akhtar, M.N., Shaari, K., Zamri-Saad, M., Tham, C.L., Sulaiman, M.R., Hj Lajis, N. & Israif, D.A. (2012). A geranyl acetophenone targeting cysteinyl leukotriene synthesis prevents allergic airway inflammation in ovalbumin-sensitized mice. *Toxicology and Applied Pharmacology*, 259(2), 257–262. Copyright (2012) Elsevier.

Scientific evidence showed that both oral and topical administrations of tHGA attenuate chemical-induced atopic dermatitis like skin lesions in mice, by suppressing serum levels of IgE and of IL-4, which further inhibit infiltration of mast cells into the skin lesions.



tHGA alleviates atopic dermatitis. Mice that were topically induced with a chemical called 2,4-dinitrochlorobenzene (DNCB) developed atopic dermatitis like skin lesions that can be characterized by four classical symptoms – erythema (redness of the skin), erosion (wet lesion), dryness (lack of moisture) and lichenification (the thickening of the skin). The level of the skin lesions can be determined by using a scoring system known as SCORAD, which is the summation of these four symptoms. Both oral and topical administrations of tHGA have been shown to significantly attenuate SCORAD, by alleviating all the four classical symptoms – erythema, erosion, dryness and lichenification. This figure shows the effects of topical administration of tHGA at 0.2%, 1% and 5% on atopic dermatitis-like skin lesions in mice.

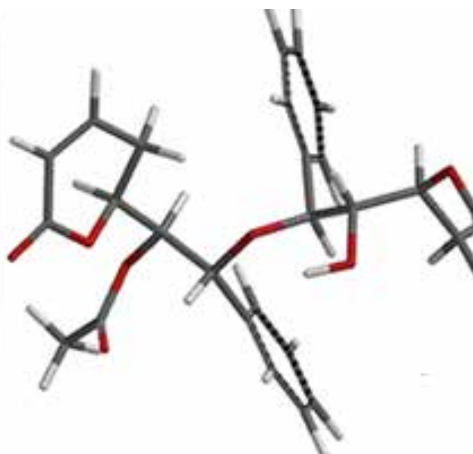
***Goniothalamus lanceolatus* Miq. – Cytotoxic Endemic Plant from Sarawak**

Nur Vicky Bihud, Nurulfazlina Edayah Rasol, Syahrul Imran Abu Bakar, Fasihuddin Badrudin Ahmad, Khalijah Awang, Chun Wai Mai & Nor Hadiani Ismail*

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Goniothalamus lanceolatus Miq., an indigenous plant from Sarawak, locally known as *selukai* or *gertimang*, is used by the ethnic community as traditional medicines to treat various illnesses. A small amount of the dried roots or stem bark is boiled in water over medium heat for about 30 minutes, and the decoction is consumed twice a week. The leaves are boiled in water and used for bathing to treat skin infections, as well as for quenching fever. It is also used for abortion of embryo at less than four months old. Preliminary cytotoxic screening on the crude extracts against lung and colorectal cancer cell lines showed promising results from all parts of the plant. In view of the interesting ethno-medicinal and biological properties, a detailed phytochemical study was conducted to provide scientific data for this plant. A total of 30 chemical compounds were discovered in the barks and roots of the plant including 11 new alkaloids and styrylactones. Amongst the new compounds, seven were bis-styrylactones. Cytotoxicity assessment revealed that several of these compounds are active against human lung and colorectal cancer cell lines in the low micro-molar (μM) range, while sparing the human non-cancerous lung and colorectal cells. Docking studies of the active compounds showed that they were able to bind with EGFR tyrosine kinase and cyclin-dependent kinase 2 through hydrogen bonding interactions with the important amino acids. This data is useful scientific information and serves as foundation for further investigation in

the discovery of important medicinal agents of plant origin. The scientific knowledge generated substantiates the role and usage of the plant in the traditional medicinal practice.



Goniothalamus lanceolatus Miq., an endemic plant from the rainforest jungle of Sarawak, is a medium tree with rarely exceeding 30 m tall. Rare bis-styryllactones have been isolated from this plant with cytotoxic activities. Reprinted with permission from Bihud, N.V., Rasol, N.E., Imran, S., Awang, K., Ahmad, F.B., Mai, C., Leong, C., Cordell, G.A. & Ismail, N.H. (2019). Goniolanceolatins A–H, Cytotoxic Bis-styryllactones from *Goniothalamus lanceolatus*. *Journal of Natural Product*, 82(9), 2430–2442. Copyright (2019) American Chemical Society.



Antifungal Property of *Curcuma longa*

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Curcuma longa or commonly known as turmeric is a member of ginger family, *Zingiberaceae* which can be found in subtropical and tropical regions, especially in Asian countries. The turmeric powder from rhizomes has been used for flavouring and colouring. Apart from its uses in cooking, turmeric also is applied as a traditional medicine in the Chinese and Ayurvedic systems. Turmeric has been used traditionally for the treatment of such as menstrual pain, jaundice, inflammatory conditions of joints, sore throat, skin allergy and wounds.



Curcuma longa.



Rhizome.

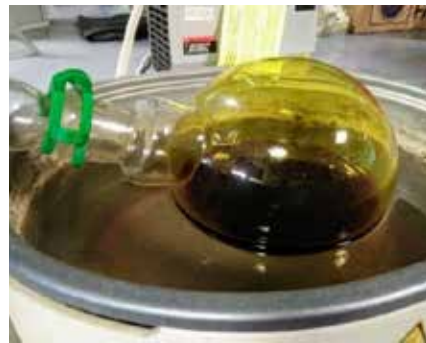


Turmeric powder and sliced rhizome.

The flavonoid compound, curcumin gives the yellow colour of turmeric rhizomes, and this component is important in the anti-inflammatory effects, antimicrobial and antioxidant activity. The turmeric extract is shown to inhibit the growth of *Aspergillus flavus*, a fungus which can cause diseases on several economically important crops, particularly crops containing oil such as peanut, maize and cotton seed. Also, it may cause health problems to humans and animals through inhaling the fungal spores or ingesting fungal toxin-contaminated food or feed. The inhibition of fungal growth by the turmeric extract is indicated by the reduction of *A. flavus* colonies size on the potato dextrose agar. The observation suggests that turmeric has the potential application as a natural agent for fighting against fungus particularly *A. flavus* in crops.



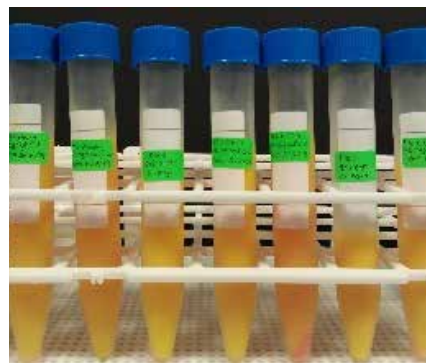
Full grown *A. flavus* on potato dextrose agar.



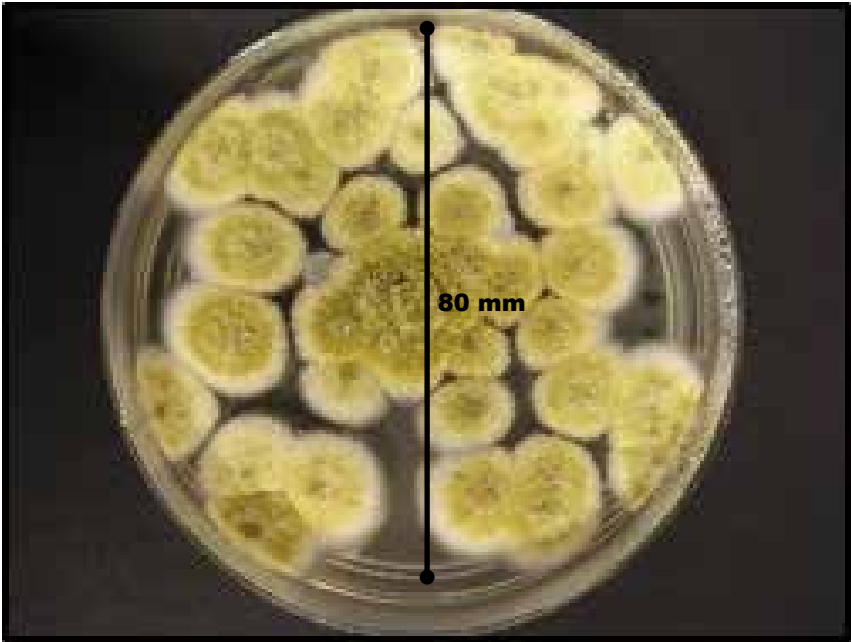
The evaporation process of the crude extract using rotary evaporator.



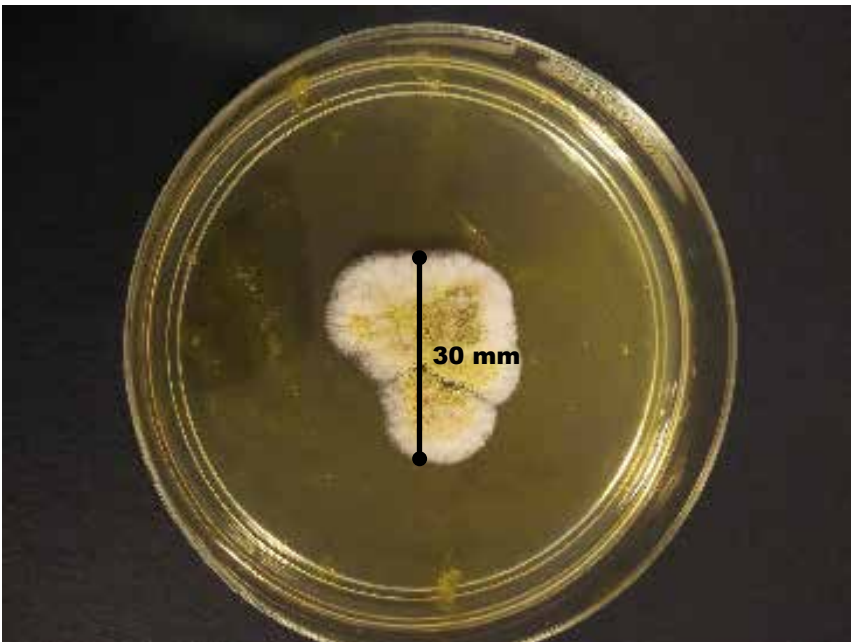
A. flavus under microscope (4x).



Ethanolic extract of turmeric



A. flavus colonies on potato dextrose agar are observed in green colour.



A. flavus growth on potato dextrose with turmeric extract. Reduction of fungal colony size can be observed.

Endophytic Fungi Associated with Marine Seaweed have Anti-Microbial and Cytotoxic Potential

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Endophytic fungi are a group of fungi that spend their entire life cycle living symbiotically within the plant tissue without showing any apparent symptoms. The host plant provides restful habitation and profuse nutriment, in return for protection from biotic and abiotic stresses by the fungi.



Endophytic fungus *Penicillium* sp.

Marine seaweed is well-known for their health benefits. According to medicinal research, marine seaweed metabolites possess several bioactivities i.e. antioxidant, anti-cancer, anti-viral, antimicrobial, etc., and have been used therapeutically to treat human diseases. Endophytic fungi have previously been recorded to possess similar biological activities as their host plant. Our research

has successfully isolated twenty fungi from marine brown seaweed (*Padina* sp.) and screened for their anti-microbial and cytotoxic activities. Several techniques have been well established in anti-microbial activity detection, with most involving the diffusion of the bioactive compounds through solid or semi-solid culture media to kill or to inhibit the growth of the testing microorganism. Agar diffusion, cross-streaking and agar well assays are some of the simple and relatively fast techniques that have been used in the anti-microbial activity detection of the isolated fungi. Out of the 20

pure isolated fungi, 11 extracts recorded the ability to inhibit the growth of the bacteria *Escherichia (E.) coli* via agar diffusion assay. One fungal isolate (*Penicillium* sp.) showed the inhibition of both yeast and fungus. Moreover, *Penicillium* sp. also displayed cytotoxicity activities against brine shrimp (*Artemia nauplii*), which could potentially be a good candidate for anti-cancer research.

Multi-drug resistant bacterial pathogen is persistently developing into a significant threat to public health and the healthcare systems worldwide. It is predicted to become the number one cause of death by 2050. Enterobacteriaceae is one of the most threatening drug-resistant bacteria groups, and *E. coli* is one of them. Although the *E. coli* strain used in our present studies were not the drug resistant strains, the observed anti-*E. coli* activity from multiple isolated endophytic fungal strains indicates that marine brown seaweed associated endophytic fungi are potentially a source for novel antibiotics to fight against the rise of super bugs.



Unidentified endophytic fungi *Penicillium* sp.





**EXAMPLES OF
POTENTIAL RESOURCES
OF NATURAL PRODUCTS**

Black Pepper (*Piper nigrum*)

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Piper nigrum L. or known as black pepper has been cultivated in Malaysia since centuries. To-date, Sarawak remains the largest producer of pepper in the country (accounting approximately 98% of the national's total production) and thus putting Malaysia among the world's top producers and exporters of high-quality pepper in the world. Currently, Malaysian Pepper Board has recommended three different cultivars namely Cultivar Semongok Aman, Cultivar Semongok Emas and Cultivar Kuching which are contributing to the national's total production. Peppercorns remain one of the key commodities which the rural community has dependent on for years. Pepper extracts particularly oleoresins have shown remarkable benefits to mankind due to its aromatic sensation and pungency taste.



Piperine and its potential

Piperine is a yellowish needle-like crystal and a novel compound of *P. nigrum*. It can be extracted from oleoresin *via* crystallization process. The alkaloid is responsible for hot and spicy tastes which are essential to increase appetite. Pharmacological studies indicated that the piperine possesses anti-hyperlipidemic, anti-hypertensive, anti-asthmatic, cognitive action and fertility activity, anti-cancer, digestive activity, drug carrier and insecticide.



Oleoresins



Piperine crystals

Nineteen Medicinal Plants as Potential Source of Natural Products

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Italian basil/Kemangi/Selasih Itali (*Ocimum basilicum*)

An annual plant with green and ovate leaves that can grow from one to five feet tall. An annual plant with green and ovate leaves that can grow from one to five feet tall. The plant has a distinctive scent and minty taste that can be eaten raw with spicy paste *sambal belacan* or used to add flavour in cooking or for medicinal purposes.



Asiatic pennywort/Pegaga air (*Centella asiatica*)

A prostate herb with circular, heart-shaped leaves and commonly planted on the ground.

Often eaten raw with a spicy dip called *sambal belacan*. This plant is believed to contain anti-aging properties and promotes youthful skin.



Turmeric/Kunyit kuning
(*Curcuma longa*)

A perennial plant with aromatic deep orange-yellow rhizomes. Used in cooking and sometimes are blended into a juice called *air kunyit* and is believed to contain health benefits especially to women during their menstruation period or after giving birth.



White turmeric/Kunyit putih
(*Curcuma zedoaria*)

A fragrant plant with an edible rhizome which tastes similar to ginger but with a very bitter aftertaste.

Used in cooking and is used to treat skin ailments. Believed to contain anti-inflammatory properties.



Black turmeric/Kunyit hitam
(*Curcuma caesia*)

Has a similar appearance to ginger, the outer part of the rhizome is light brown while the flesh is a bluish-purple colour that can appear entirely blue in light and dark concentric circles. It is believed to contain powerful antioxidant and anti-inflammatory properties.



**Indian jujube/Indian plum/Bidara
(*Ziziphus mauritiana*)**

When mature, the fruit is red, soft, juicy with wrinkled skin and pleasant aroma. Both flesh texture and taste are reminiscent of apples.

A nutritious plant that is rich in vitamin C, higher than citrus or apples. The fruit can be consumed raw or stewed.



Stevia (*Stevia rebaudiana*)

A small seasonal plant with elongated leaves that grow along the stems and line-up against each other. Used as a natural sweetener and sugar substitute. May have a bitter, licorice-like aftertaste.



**Cilantro/Pokok ketumbar
(*Coriandrum sativum*)**

A soft plant with leaves having a tart, lemon/lime taste. The herb is commonly used in cooking and added as a condiment in a dish such as laksa Sarawak, chicken or beef soup and porridge.



**Peppermint/Pokok daun mint
(*Mentha piperita*)**

A perennial plant with a distinct aromatic minty smell. Often added to cooking for flavouring. In Sarawak, the peppermint paste is also used as flavouring in certain Sarawak layered cakes or *Kek Lapis* Sarawak.



Aromatic ginger/Cekur (*Kaempferia galanga*)

A small perennial herb with edible rhizomes. Often added in cooking to improve flavouring. Can also be blended to make healthy drinks called *jamu* which is believed to improve digestion.



**Javanese ginger/Temulawak
(*Curcuma zanthorrhiza*)**

A small perennial herb with edible yellow rhizomes. Often blended into a juice and is believed to contain anti-inflammatory benefits.



**Greater galangal/Lengkuas galangga
(*Alpinia galanga*)**

A plant with edible pink rhizomes which has a pungent smell and strong taste reminiscent of black pepper and pine needles. Often added in cooking to improve flavouring.



**Cucumber tree/Belimbing buluh
(*Averhoa bilimbi*)**

A tree that bears a small and sour fruit. The fruit is used to make a popular dip known as *sambal belimbing buluh*.



**Vietnamese coriander/Daun kesum
(*Persicaria odorata*)**

A perennial plant that grows in tropical climates. The top of its leaf is dark green, with chestnut-coloured spots, while the leaf's bottom is burgundy red. Can be eaten raw or added in cooking to improve taste and flavouring. Often used in Malay dishes such as *nasi kerabu* and *asam pedas*.



Curry tree/Sweet neem/Pokok kari (*Murraya koenigii*)

A sub-tropical plant which produces leaves with an aromatic and pungent curry smell. Curry leaves are often added in cooking and can be made into paste.



Habanero chili/Cili geronong (*Capsicum chinense*)

A hot variety of chili with variation of colours between orange, green and red. Often added or blended to make spicy sauce or dip.



Torch ginger/Bunga kantan (*Elingera elatior*)

A perennial plant that blooms with showy pink flower. Often used in cooking to enhance flavouring. One of the herbs used to make *ayam pansuh*, a famous Dayak delicacy in Sarawak. Also commonly used in Malay dishes such as *nasi kerabu* and *asam pedas*.



Upa tepus (*Etlingera littoralis*)

Often used in cooking to enhance flavouring. One of the herbs used to make *ayam pansuh*, a famous Dayak delicacy in Sarawak. Normally it is used to enhance the flavour of cooking e.g., soups, fried vegetables or ground tapioca leave.

E. littoralis have various traditional uses, even the young shoots, flower buds and the fruits are consumed by the indigenous communities. Besides, the cores of young stems of *E. littoralis* which are also known as *Tepus* are edible and very popular food among the Dayak community in Sarawak.



God's crown/Buah mahkota dewa (*Phaleria macrocarpa*)

A flowering plant with greenish bark, white wood and green, tapered leaves. It is believed to contain powerful antioxidant and anti-inflammatory properties.

Kemunting (Rhodomyrtus tomentosa)

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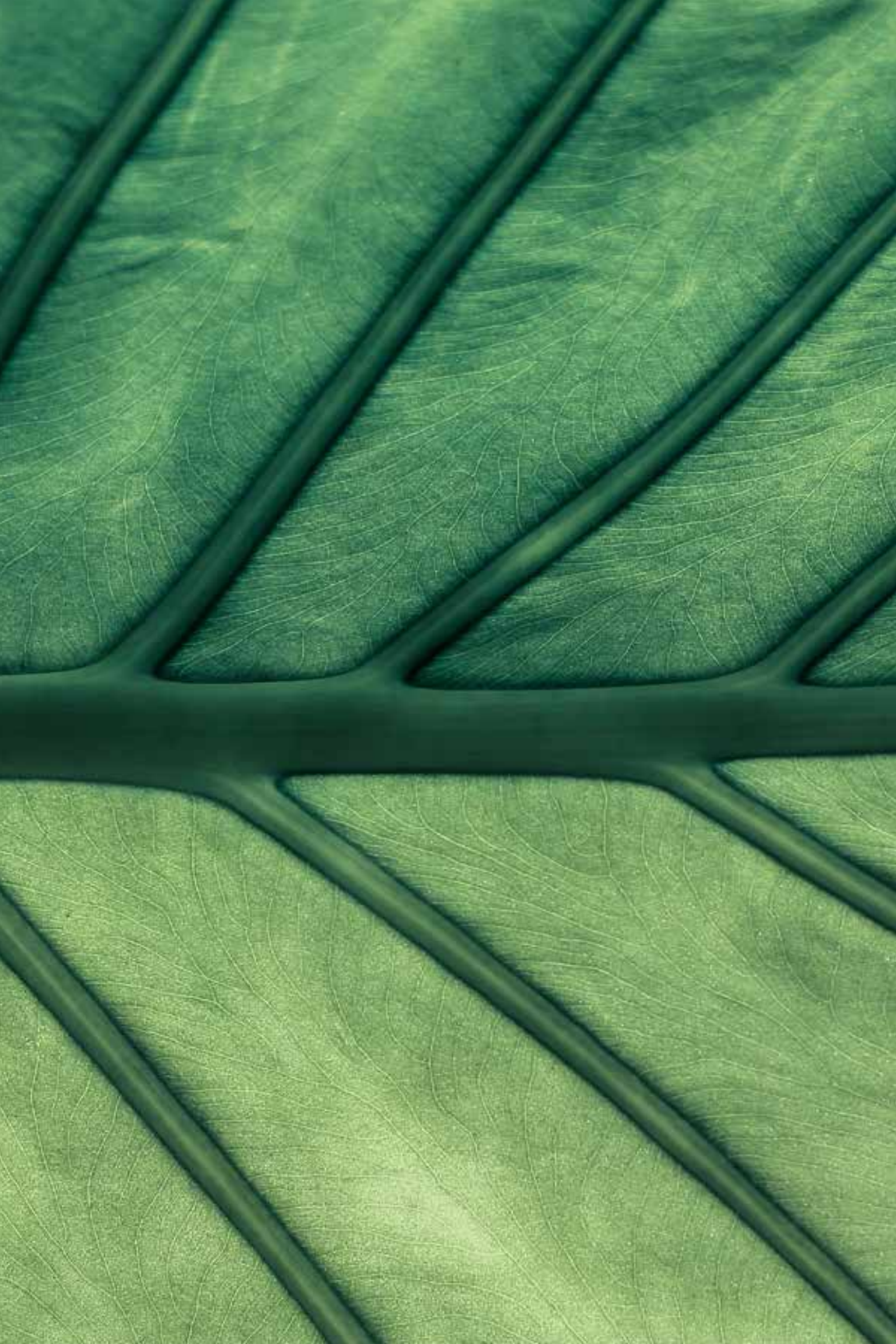
Rhodomyrtus tomentosa, or *kemunting* is a well-known medicinal plant used to treat various sickness. It is native to the Southern and South-eastern Asia including Malaysia. The plant can grow up to about 3-4 m in height. The leaves are oval, and rounded tips. The flowers have five bright pink petals that fade to pale pink as they age. It has five sepals at the base and numerous stamens in the centre. The fruits are edible, oblong-shaped purple berry, and crowned by the persistent sepals. The chemical constituents from leaves, stems and fruits showed antimicrobial activity such as gram-positive and gram-negative bacterial strain, namely *Escherichia coli* and *Staphylococcus aureus*, respectively. The plant also exerted strong antioxidant and anti-inflammatory activity. Thus, this plant is worth to be commercialized as supplementary nutraceutical product since it was safe to be consumed and ingested.



Flower of *kemunting*



Fruit of *kemunting*



A close-up photograph of several green leaves, showing their intricate vein structure. The leaves are layered, with some in the foreground and others behind, creating a sense of depth. The lighting is soft, highlighting the texture of the leaf surfaces.

INTERESTING PRODUCTS FROM NATURE



Gluten Free Flour from Banana Peels

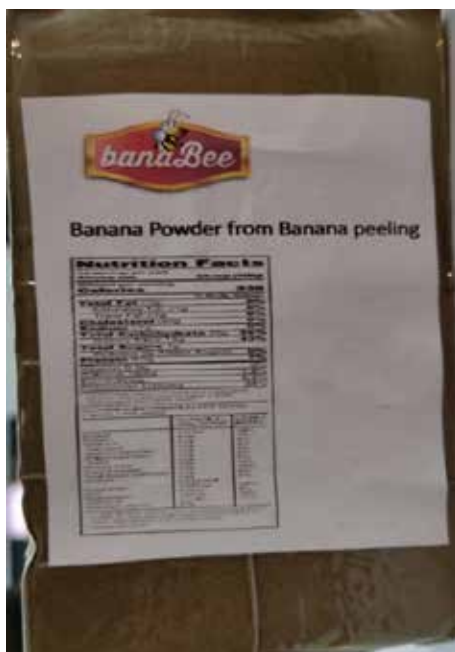
Khong Heng Yen
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Banana is a unique perennial single harvest plant. The harvesting requires the decapitation of the whole plant. Collectively, the waste that a single plant produces can make up to 80% of the total plant mass. Only 20% is fully utilised (fruit). In Malaysia, most of the banana waste is underutilised, missed out on potential income generation, and poses significant environmental risks. Research conducted on bananas showed that the peels are rich in minerals like potassium, phosphorus, magnesium, fibre, and calcium. Moreover, high contents of Vitamin A, C, E, and carotenoids are reported abundantly found in the peel. In addition, the protein content in peels is about two times higher than the fresh. Thus, the dried powder of banana peels is a good natural source of gluten-free and nutrient-rich flour, turning waste into a quality food source. This gluten-free flour derived from banana peels

has won several recognitions from the expert panels at the National and International Innovation Expo:

- **Best Innovation Special Award**, Innovation Inclusive Challenge 2016 (Sarawak zone) by Yayasan Inovasi Malaysia and SME Corp.
- **Gold Medal**, International Invention, Innovation & Design Exposition 2017 (iidex 2017).
- **Silver Medal**, Malaysia Technology Expo (MTE) 2018, The 17th International Expo on Inventions and Innovations.
- **1st Runner Up of Special Award for Commercialisation Product**, International Invention, Innovation & Design Exposition 2017 (iidex 2017).
- **High Impact Programme 2 (HIP2) Fund 2017** from Platcom Venture Sdn Bhd, in collaboration with Banana Trees Sdn Bhd.



This product has registered two IP (Trade Secrets). The gluten-free flour global market exhibits stunning growth potentials and is estimated to reach USD 5279 million by 2022 at a cumulative annual growth rate (GAGR) of 7.5% until 2028. It is expected to generate massive revenue. Therefore, UiTM Sarawak branch welcomes all potential partners which they have the production facilities and marketing arm. The lead researcher, Professor Khong Heng Yen will provide them the technical support in the production processes of high-quality gluten-free flour on an industrial scale to meet the demand of consumers in local and foreign markets.

Plant Based Plastic and Leather-Like Material

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Synthetic plastic and animal leather: we love both. Plastic is convenient, and leather is durable and elegant. However, have we ever thought about their downsides? United Nations Environmental Programme has warned us that we are drowning in plastic pollution. Leather and its production process, on the other hand, pose damaging effects on environment and on human health. Probably, it is the time for us to change. But would it be possible? The answer is yes.

Scientists, engineers, and designers have been endeavouring to create ecologically friendly materials such as biodegradable plastics and leather-like materials. Fermentation is one of the technologies currently being employed in production of plastic and leather substitute. Substrates used in the fermentation process involve plant-based materials (viz. grain and tuber starch, fruit juice and brewed tea). Fungi and bacteria are used to

turn these organic matters into biomass – polymer – which then be dehydrated and compressed to produce desired materials. The microbial polymer can also be grown into any desired shape and structure to meet the needs of different applications. The polymers produced by bacteria and fungi were reported to have good physical and mechanical properties, such as high elasticity, tensile strength, and absorbency.



Leather-like sheets made from fermentation of brewed tea, pulp of fruit juice and coconut water.

We are presenting herewith some prototype products, which were synthesised naturally by yeasts and a bacterium from a home-made fermented tea using various plant-based substrates (brewed tea, pulp of fruit juice, fruit peels, vegetable wastes and soybean pulp). The resultant pellicles from the fermentation process were coloured with plant-based dyes (beet root or turmeric), moisturised with coconut oil, sun dried before being assembled into products (bags and purse). The synthesised materials are non-toxic as they were produced from edible materials. They are also compostable, thus environmentally friendly. However, more work is required to produce the materials which are more refined that meet consumer aesthetic and functional expectations.



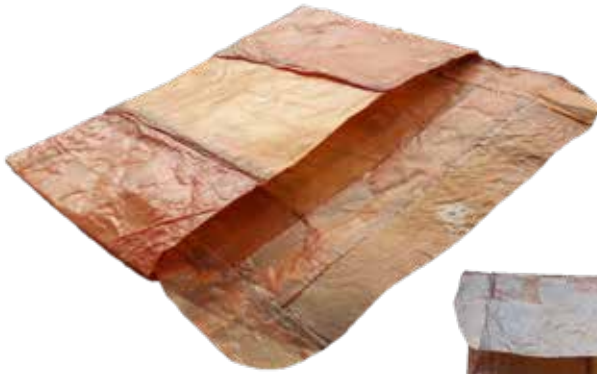
Wrapping sheet produced from fermentation of soy pulp.



Bag produced from fermentation of soy pulp.



Bag made of sheets produced from fermentation of brewed tea, pulp of fruit juice and coconut water.



Purses made of sheets produced from fermentation of brewed tea.



Value Addition in Pepper Pepper Based Food Products

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Green pepper in brine

Pickled green pepper or green pepper in brine is another product in line after black and white pepper berries. It is produced by harvesting the young berries (4-6 months of age after the initial fruit development) which is then separated from its stalk and clean thoroughly. Proper cleaning and rinsing must be done to the berries as to avoid any contamination to the final product. Once cleaned, the berries are soaked in water while the next process is preparing the brine solution. Brining is only done after the berries are soaked in water and the purpose of soaking is to avoid the berries from drying and change colour. The brining preparation requires local and easy to get ingredients such as filtered water, salt and vinegar which will be added to the green pepper berries. Berries will be soaked in the brine solution and normally the completion of the brining period for the berries will take about 1 month whereby after this period, the green pepper in brine is ready and can be used to produce other value-added pepper-based food products such as green pepper sauce, green pepper vinaigrette and green pepper sambal. Quality monitoring throughout the brining period must be done to ensure the green pepper in brine maintained its salinity and acidity level based on the required standard and above all, it is preservatives free. Poor production and less monitoring from time to time, shall cause product spoilage such as mouldiness and brownish brine solution. Basically,

in Malaysia, green pepper in brine is still something new as consumers are more familiar with black and white pepper. Nevertheless, there are many other value addition products from green pepper in brine as mentioned earlier, which can be further commercialised and benefit the Malaysian pepper industry and the local food industries.



Dehydrated pepper in brine

Dehydrating food products is a fantastic way to store fresh produce for a long time. Removing the moisture from fresh products inhibits the growth of moulds, making them shelf stable for months. Whether you're cooking with them, creating a spicy seasoning, or flavouring a pot of soup, dehydrated pepper in brine is an amazing ingredient. Dehydrated pepper in brine is a product dehydrated by using a 3kW dehydrator for a period of 4 hours. The dehydrator

was developed and fabricated in-house and used at a laboratory scale for testing. The dehydrated pepper in brine has low moisture level which is between 9%-10% with less saltiness and pungent taste of green pepper berries. It is less pungent which makes it suitable for salad dressing and can be used as seasoning for all types of dishes be it in powder or cracked form. As the product originates from the green pepper in brine, it requires no further preparation process before the dehydration stage. Like black



Purses made of sheets produced from fermentation of brewed tea.

pepper and white pepper, it can be used in whole or powdered form depending on preference and type of dishes. Apart from that, it can also be transformed into paste form by submerging them hot water for 10 minutes or more and then blended, which makes it suitable for soups, stews, pasta or even our curry dish depending on one's creativity.

Condiments

Condiments are used to flavour or complement food whereby it can be in any form whether powder or liquid. The condiments which have been developed and readily available are:

a) Black pepper salt

Combination of Sarawak Black Pepper and other blended local ingredients which can be used in any type of dishes. This product has no preservatives with two years of shelf life

b) White pepper salt

Combination of quality Sarawak White Pepper and other blended local ingredients which can be used in soups, porridge and as seasonings. This product has no preservatives with two years of shelf life.

c) Coarse garlic pepper

A new version of garlic pepper powder which emphasised on the usage of dehydrated coarse garlic and coarse black pepper. The dehydrated coarse garlic will impart the aromatic garlic flavour once penetrated by heat and then combined with the coarse black pepper will give the pungency taste of pepper. This product has no preservatives with a shelf life of one year.

d) Green pepper sambal

An instant powder for seasoning or flavouring of dishes such as fried rice and fried noodles with the dehydrated pepper in brine as the main ingredient. This product is easy to use and has no preservatives with a shelf life of one year.



Dry condiments

Green pepper vinaigrette

Vinaigrette is a sauce made typically of oil, vinegar and seasonings and used especially on salads, cold meats, or fish. With the addition of green pepper in brine, the final product of green pepper vinaigrette offers fresh flavour of Sarawak Pepper. The green pepper in brine is used as the main ingredient in the development of this product and can be at the same level with other western vinaigrettes brands in the market. Blended with palm oil and other ingredients with no preservatives and less salty, the product shelf life is two years and can be kept in room condition.



Pepper chocolate

In general, the pepper chocolate is a blend of dark chocolate and pepper oleoresin with a balanced aftertaste of sweetness and pungency. It has a shelf life of 1 year and is packed in laminated box. Development of pepper chocolate emphasised on the pepper extract in the form of pepper oleoresin as food flavouring, and it can be used in dry or in a liquid form. It can be extracted by using solvent extraction but due to residue leftovers, major producers of oleoresin are using Supercritical Fluid Extraction (SFE) to extract oleoresin. This method produced better yield of pepper oleoresin with no residues. Pepper oleoresin as a flavouring ingredient is common in the production of pepper sweets and pepper jellies whereby the development of pepper

chocolate blended with pepper oleoresin was in line with the value addition of commodities-based products such as cocoa and pepper at the Federal and Government policy level.

Pepper tuak

Tuak which is famously known in Sarawak or rice wine is produced by fermentation process of ingredients such as sugar and rice with the addition of yeast. The traditional alcohol drink is made from the fermentation of rice (usually glutinous rice) using yeast and enzyme which is naturally available in ragi.



The enzymes break the starch in the rice into sugar and the yeast converts the sugar into alcohol, which is the fermentation process. Fermentation process also produces carbon dioxide, apart from alcohol. It is normally made in large volumes with the help of sugar mixed with water, often boiled and left to cool before it is added to the fermenting mix of rice and ragi.

In Sarawak, there are many varieties of tuak which are available nowadays such as pineapple tuak, ginger tuak, roselle tuak and others, just to name a few. All these tuak or rice wines are produced using the same methods but may differ in terms of formulations and types of yeast used. Nevertheless, the quality of tuak in terms of taste, alcohol level and aroma are influenced by maintaining the quality of the yeast used in the production of tuak. In the development of pepper tuak, stringent quality standards are implemented in the yeast making hence the pepper tuak is of the same standard in terms of taste, aroma, colour, and alcohol value. The alcohol value of pepper tuak is 10% and is standardised with the usage of in-house developed yeasts. The pepper tuak can be consumed directly or used for cooking.

Black Pepper Charcoal-Based Products

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Statistically, about 11.68-14.78 mt of industrial by-products particularly mixture of pepper stalk, light berries, pin head and dust were generated from MPB Sterilization Unit and about 80% of extract by-product can be collected from SFE unit.

Due to the high content of carbon, the pepper industrial wastes were found suitable to be transformed into charcoal. By adopting green technology, the environmentally friendly black pepper charcoal is 100% zero chemical and is safe to be used as an exfoliating agent in personal care products.

Diversification of pepper industrial by-product is essential to produce various value-added products and at the same time, the concept of 'Zero Waste' and 'From Waste to Wealth' can be applied in the pepper industry.

Black pepper charcoal soap

Black Pepper Charcoal Soap effectively removed dirt and dead skin. The exfoliating mechanisms and fresh fragrance from pepper and lemon oil give extra cleanse and freshness to the skin. The Black Pepper Charcoal Soap is non-irritant thus suitable to be applied by any consumer.



Facial scrub and mask

Facial Scrub is specially formulated with Black Pepper Charcoal. The organic deep exfoliating helps to get rid of oil, dead skin cells and reduce black pigment on the face makes skin smooth, soothing and glowing. Coupled with hyaluronic acid serum that helps rejuvenate facial skin.



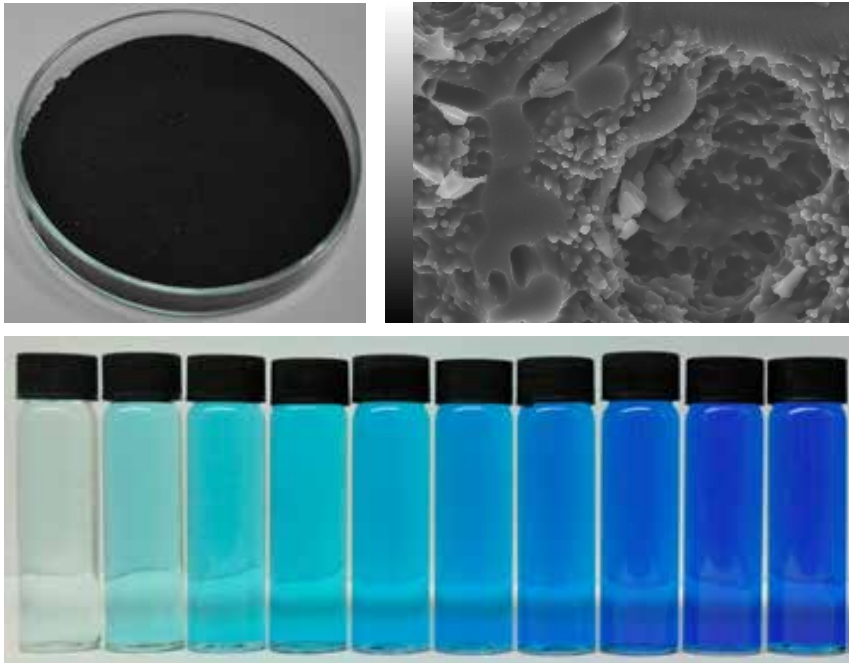
Body scrub

Body Scrub is formulated with Black Pepper Charcoal which is enriched with rosehip oil to implement deep cleansing for a brighter and silky body. The addition of rosehip oil helps to hydrate and reduce inflammation.



Odour and colour adsorbent

The carbonization process has successfully produced macro-pore structures on Black Pepper Charcoal. The pores are responsible to entrapped and eliminate unpleasant odours. Suitable to be placed in house cabinets, car and office. The high surface area of pores structure enables adsorption of colour pigment.



Plant growth booster

The macro-pore structures on black pepper charcoal helps to improve soil fertility, increase carbon storage and reduce nutrient leaching which is essential for developing lateral roots and to increase yield.

More Than Just Fulfilling - The Glycaemic Control Sago Snack Bar

Sal Nazreen Bugam
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Craunera™ Glycaemic control Sago snack bar is made primarily from Sarawak Sago starch. It is coated in delectable rich dark chocolate and also contains honey, peanut butter and nuts and grains - guaranteed to satisfy a sweet tooth! But worry not, the Craunera™ Glycaemic control

Sago snack bar blend will not cause blood sugar to spike or crash! This Craunera™ Glycaemic Control Sago snack bar was clinically tested* and found to have a low Glycemic Index (GI) of 26. The key rests in two things: first, the functionality of Sago starch, which is naturally high in a type of dietary fibre known as resistant starch (RS). RS escapes the human digestive system thus results in a slow and gradual increase of blood sugar hence a low GI. Second, the process to produce this snack bar is one that has been thoughtfully considered to maintain the RS in the final product. So, if you are a diabetic or simply need to be on the glucose watch, this patented** blend of Craunera™ Sarawak Sago snack bar is the perfect solution to help curb hunger and satisfy sugar craving whilst keeping the blood sugar in check. 100 percent worry free!

*Clinical trial approval: Malaysian Medical Research Ethics Committee
NMRR-19-376-46331

**Malaysian Patent Application – PI2020004322



Craunera
SAGO SNACKBAR

GLYCAEMIC CONTROL SNACK
Craunera
HOMESTYLE

SAGO SNACKBAR

GLYCAEMIC CONT
WITH SAGO STARCH
LOW GLYCAEMIC INDEX
HIGH FIBRE

Growing Pineapples in Sarawak

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Since its establishment, tissue culture has been a key component of CRAUN's operations. Starting off with the production of clonal planting materials for Sago (*Metroxylon sagu*), to date CRAUN has expanded into some other plant tissue culture products including the MD2 pineapple. The research and development (R&D) which we have embarked from 2014 has now shown to be fruitful. In a mass planting trial with around 5,000 MD2 pineapple clonal materials, over 80% have produced commercially acceptable fruits, comparable to that of the standard MD2 fruits defined by the Malaysian Pineapple Industry Board.



MD2 pineapple planting materials from tissue culture.

Nonetheless, we persistently push to improve the quality of our clonal planting materials through continuous R&D endeavoured. To date, CRAUN has been supplying MD2 pineapple tissue culture materials to commercial pineapple growers, as well as individual home growers all around Sarawak. Thus, this MD2 pineapple tissue culture material is hoped to overcome pineapple planting materials shortages in Sarawak and provide some relief in family expenses to individual home-growers, particularly during this trying period.



MD2 pineapple clonal fruits.



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WONDERS OF NATURAL PRODUCTS IN MALAYSIA

THIS BOOK AIMS TO SHOWCASE THE INNOVATIONS AND POTENTIAL USES OF VARIOUS VALUABLE PLANTS, MICROBES AND AGROWASTES IN MALAYSIA. THE INNOVATIONS AND RESEARCH FINDINGS PUBLISHED IN THIS BOOK ARE SUPPORTED BY NUMEROUS GRANTS. THE EDITORS ARE GRATEFUL TO ALL CONTRIBUTORS AND HOPEFULLY THIS BOOK WILL TRIGGER FUTURE COLLABORATIONS BETWEEN VARIOUS STAKEHOLDERS TOWARDS SUSTAINABLE EXPLORATION OF NATURAL RESOURCES IN MALAYSIA.


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