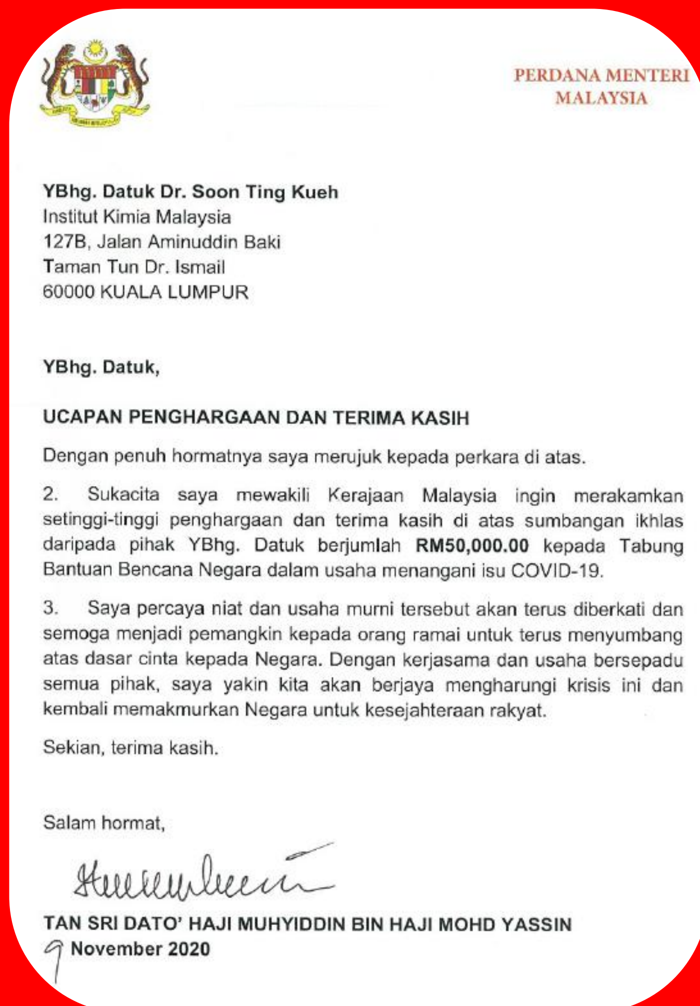
Berita IKM - Chemistry *in* Malaysia

December 2020



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9 **November 2020**

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Contents

Message from the President

IKM Post COVID-19 - the New Normal
For the year 2020, the whole world is seriously being affected by the COVID-19 pandemic. COVID-19 was first found in China in January 2020, but it then erupted very quickly to Americas and Europe in March and subsequently, the rest of the world. Our country, Malaysia, is not spared and the first cases of COVID-19 started in February. While China put in very strict control measures and manage to control further spread of the coronavirus within a period of 6 months, Europe and USA are not so fortunate and COVID-19 pandemics are still ragging on in these countries. With the anti-COVID-19 vaccines being introduced at the end of 2020 and beginning of 2021, there may be light at the end of the tunnel.

But I would like to caution that these vaccines are not panacea that will exterminate the coronavirus all together; but rather, in order for them to be effective, at least two-thirds of the population must be inoculated. This will probably take years and as such, strict control to prevent the spread of coronavirus are still necessary. Furthermore, we are still not sure of the exact efficacy of these vaccines and their long-term effects considering that they only undergo a fast-track two-month clinical trial period. However, we do have hope that out of so vaccine candidates, we would find one or two which are efficacious and safe.

The Malaysian Scenario
At the current moment, the COVID-19 pandemic in Malaysia seems to be entering the third wave. For the period from August onwards, COVID-19 cases per day are hovering around single digit and the lower end of double digit. However, beginning November, the cases exploded to 3 digits and is now maintaining at around one thousand a day. The initial jump in COVID-19 cases is due to the Sabah election where people are just not following the Standard Operation Practices (SOP) as recommended by the Ministry of Health. This is followed by the third wave attributed to large number of foreign workers living in very cramp and unhygienic conditions. I believe that the relevant authorities are now working very hard to control this situation and prevent further spread of COVID-19. With the government announcing that we are getting 12.9 million doses of the Pfizer vaccines, I believe that the COVID-19 pandemic will be under control soon, as early as first quarter of 2021.

IKM – 2020 at a glance
Looking back, we have managed to minimise our “losses” over the year. We have to postpone our 53rd Annual General Meeting (AGM) but fortunately we managed to hold our 53AGM on 25th July 2020 and elected the new Council for 2020/2021.

The IKM LMIC Examination Refresher Course also proceeded as planned from July to August. The LMIC Examinations 2020 was held from 19 – 21st September 2020 at University of Malaya, Kuala Lumpur.

However, some courses at the Professional Centre scheduled for November and December 2020 have to be postponed or cancelled.

Unfortunately, our two scientific meetings, the International Congress on Pure & Applied Chemistry (ICPAC) and the 20th Malaysian International Chemistry Congress (20MICC), both supposed to be held in Kota Kinabalu, Sabah, have to postponed to 2021.

For Kuiz Kimia Kebangsaan Malaysia (K3M), some schools managed to sit for the quiz on 5th November 2020. But the majority has to do it either online or at home due to the schools being closed until 20th January 2021. However, this year we do have a record 39,068 candidates sitting for K3M 2020.

We are pleased to announce that the IKM Law Hieng Ding Foundation has been incorporated under the Companies Act 2016 on 22nd October 2020.

Our next big social event will be Malam Kimia 2020 which has been postponed to 18th December 2020 at the Berjaya Times Square Hotel, Kuala Lumpur. We are hoping that this will be able to take place.

We are also expecting the Chemists Rules 2020 to be ready by the end of 2020 or early 2021. This is the first time that we have made amendments to the Rules since our inception in 1967. The new rules are quite comprehensive and covers six major areas. Once approved by the Honourable MOSTI Minister, it will be distributed to our members.

IKM as a responsible corporate citizen
For 2020, we have also done something very special. As a responsible corporate citizen, IKM donated a sum of RM50,000 to the Tabung COVID-19. Financially, 2020 may not be a good year but IKM Council felt that we should do our part as a responsible corporate citizen to help our people to overcome the problems arising from the COVID-19 pandemic. We believe that if every Malaysian citizen can do his or her part for the country, we should be able to overcome the problems arising from the COVID-19 pandemic. We have reproduced here a Letter of Appreciation from the Righteous Honourable Prime Minister of Malaysia, YAB Tan Sri Dato' Haji Muhyiddin bin Haji Mohd. Yassin, on our donation to Tabung COVID-19.

2021 – IKM and the New Normal
We are going full steam ahead in 2021. The usual programmes and activities such as AGM, Refresher Course, LMIC Examination, Professional Centre programmes, K3M and the branches activities including Karnival Kimia Malaysia, or K2M, will be back to normal. We shall also organise ICPAC KK and 20MICC in Kota Kinabalu, Sabah, at the end of July 2021. LabAsia 2021 will be held from 19 – 21st October 2021 in Kuala Lumpur Convention Centre (KLCC), Kuala Lumpur. A new event, Symposium on Best Practices and Innovations in Laboratory Management (BPI Lab) 2021 will be held in conjunction with LabAsia 2021 in KLCC.

IKM Law Hieng Ding Foundation will also start its business of promoting chemistry education and public understanding and appreciation of chemistry. IKM is also planning for a new website that would be more interactive with our members and the general public. The new website will cover all aspects of IKM functions and activities, and acts as a mean of communication between IKM and our members. For 2021, what would be the new normal for IKM? First, many of our functions and activities will be going online. Such functions as membership application and processing will be done online. Kuiz Kimia Kebangsaan Malaysia (K3M) 2021 will have two options, both online and on site. Some seminars and symposia will be web-based and most meetings will be hybrid, that is both physical and online. However, such important events where social interactions are essential, such as Annual General Meeting and Malam Kimia, will still be held in the normal format with people being present.

On the accreditation of chemistry programmes in Malaysian universities, we expect the Joint Technical Committee (JTC) to complete its work to come up with a standard chemistry programme in the first half of 2021. Then the Malaysian Qualification Agency (MQA) under the Ministry of Higher Education can proceed with the accreditation of chemistry and chemistry-related programmes in Malaysian universities. On the personal side, we still expect our members to practice good personal hygiene and maintain social distancing at crowded places whenever necessary. Of course, we would encourage members to get vaccinated against COVID-19.

2021 will be a challenging year. We would expect our members to participate actively in our programmes and activities. In the longer term, we are organising IUPAC 2025, which is the IUPAC 53rd General Assembly (53GA) and the 50th World Chemistry Congress (50WCC) in Kuala Lumpur in 2025. We shall start some initial works soon. In 2026 we are having MACRO 2026 which is the 50th IUPAC World Polymer Congress, in Kuching, Sarawak. We hope to mobilise all IKM members to work together towards making these global events most successful and memorable for the participants. IKM will be a strong, and influential professional scientific organisation in Malaysia recognised by the chemistry community all over the world.

Thank you and with best wishes.

Datuk ChM Dr Soon Ting Kueh
President, Institut Kimia Malaysia
Date: 1 December 2020

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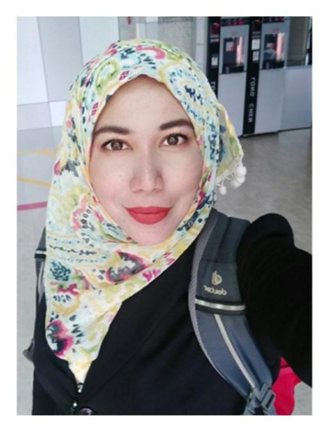

Driving Green Chemistry Through Life Cycle Thinking

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A Symmetrical Relationship between Product Stewardship and Green Paradigm

The development of chemical industry has improved our quality of life. However, questions about effects of products from chemical industry have raised concerns over humankind's impact on population and nature. This environmental concern has been ignited since the early 1960s when the book "Silent Spring" was first published by Rachel Carson. Silent Spring became one of the most-influential books in the modern environmental movement.

As a consequence, various initiatives have been established to provide better understanding of the relationships between environmental sustainability performance and competitive outcomes of green manufacturing practices to meet the goals of sustainability. Green chemistry is one of the concepts adopted for environmental management to move from conventional to green chemicals processes and products. Using the pollution prevention principles, several concepts aim at achieving sustainability have been introduced including green engineering, industrial ecology, cleaner production, eco-efficiency and life cycle thinking. Recently, consumers have started asking for more environmentally products, thus requires industry to deal with the increasing demand for sustaining ecosystems and human well-being. To address this consciousness, the concept of life cycle thinking has been promoted as one of the important instruments in research and decision-making process.

Figure 1. A cradle to grave concept of LCA

Life cycle thinking is a way of minimizing potential environmental impacts from a holistic perspective (1). Life cycle assessment (LCA) is a systematic decision-support technique for both industry and policy makers to evaluate their potential environmental impacts associated with all the stages in a product's life and processes (2,3,4). LCA is carried out by taking into account all stages from raw materials extraction, manufacturing process, transportation, packaging, distribution to consumer, consumption/use and final disposal (either to landfill, incineration, recycle, reuse or treatment) (Figure 1) (5,6). LCA had its roots in the 1960's and early 1970s with the analysis of energy consumption. This is due to the concern over the limitations of energy resources and raw materials. Since 1980's, the industry showed interest in incorporating other aspects including environmental impacts in their assessment. The application and development of the LCA method boosted in 1992, when the first framework for the impact assessment in LCA was proposed (5).

LCA is carried out in four different stages (Figure 2), standardized under ISO 14040 and ISO 14044 standards (5). The first stage defines the goal and scope of the assessment and the system under study, including determining its system boundaries, functional unit, methodology used and data requirement. The life cycle inventory (LCI) is the second stage which involves input and output data collection for all processes of the product system. Input data cover all raw materials, chemicals, water, energy, etc. used, and output data cover emissions, effluents and wastes released to the environment. In the third stage, the potential environmental impacts (such as global warming, eutrophication, ecotoxicity, ozone depletion, smog, acidification, etc.) associated with inputs and releases are determined in the life cycle impact assessment (LCIA) phase. The last stage in an LCA framework is related to the interpretation of the results obtained in the earlier stage to lead to the conclusion whether the goal and scope was met. Incorporating a life cycle perspective into green chemistry can expand its scope and increases its environmental benefits.

LCA is a systemic framework that takes a holistic view of the production and consumption of a product or service and assesses its impacts on the environment through the entire life cycle. However, there some misconceptions about LCA especially related to greenwash claim misused by manufacturers to support environ-

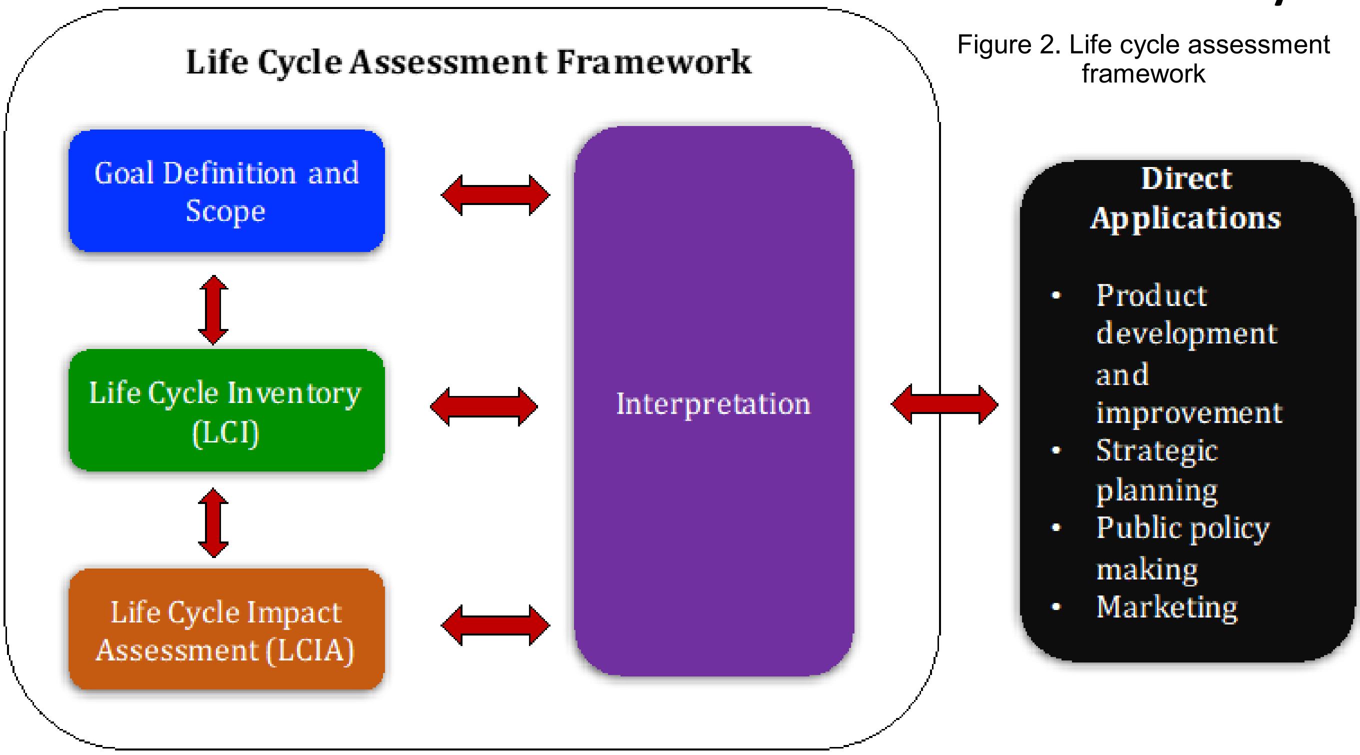

Figure 2. Life cycle assessment framework

mental claims. For marketing purposes, some manufacturers promote their products as green products without having a third-party verification that their product LCAs followed the ISO standards and the relevant product category rules - Environmental labels (Type III) and declarations (EPD). Common reason for not having an LCA study is due to lack of accurate data available which makes the LCA meaningless. However, much of the data in an LCA is calculated, not collected from observations of a product's actual life cycle. Various databases are available for conducting an LCA study. Another misconception is the aim of implementing LCA into green chemistry is not solely for comparison, but more into improvement. It is about quantifying impacts and seeing if, how and where we can improve. Therefore, awareness and knowledge about LCA need to be enhanced at different levels of stakeholders.

Benefits of Life Cycle Assessment in Green Manufacturing

LCA methodology has gained wider acceptance as a powerful tool for process development, strategic planning and policy-making. The implementation of LCA in green manufacturing provides a quantitative manner in determining the potential environmental impact of processes and services of any product. In LCA, negative impacts are minimized while avoiding the transfer of these impacts from one life cycle stage to another, thus, enable a meaningful strategy for implementing effective sustainability strategies in product design, production processes and a decision-making aid. LCA is an interdisciplinary and flexible environmental tool, where different expertise; environmentalists, scientists, engineers, economists, policy makers, sociologist, etc. can all contribute to identify the hotspots throughout

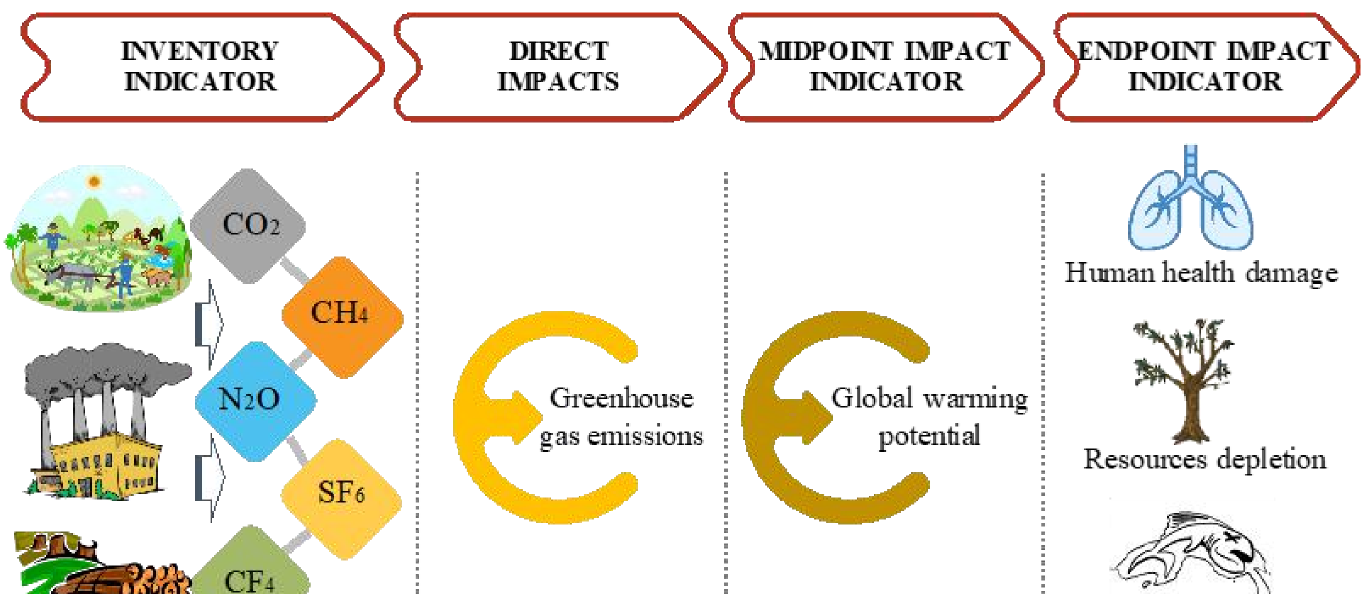

Figure 3. Cause-effect pathway of pollutant

the full supply chain of green product's manufacturing. This tool requires multi-disciplines to assess the fate, transport and exposure rates of the chemical substances in the environment for assessing ecological and human health risk related to the chemicals. In LCA, the cause-effect pathway of specific pollutant is identified to assess the impact at midpoint or endpoint level (Figure 3). Understanding the environmental mechanism on how the emissions of the pollutants are linked to their consequences makes the LCA findings more meaningful. Expressing the impact of pollutant in term of its emission concentration into the loss of life year or species extinction makes this LCA approach more relevant to policy making decisions.

The role of Green Chemistry in Supporting SDGs

The Sustainable Development Goals that were adopted by all United Nations Member States are the framework to achieve a better and more sustainable future for all. The SDGs, set in 2015 address the global challenges, consisting of 17 global SDGs and 169 targets under the 2030 Agenda. The agenda is committed to ensure no one is left behind by considering all sustainability aspects including those related to poverty, education, inequality, climate, clean energy, health, economic growth, innovation, biodiversity, resources, environmental degradation, partnership, prosperity, peace and justice. Green chemistry plays an important role in supporting the SDGs.

Green chemistry concept was developed in an Environmental Protection Agency (EPA) program in the United State of America and later evolved into a worldwide community including Malaysia. According to Anastas and Warner (7), there are 12 principles of green chemistry as illustrated in Figure 4. The first principle of waste prevention is always seen as the most important than waste treatment in green chemistry. The idea of designing the synthetic methods to maximize inclusion of all materials used from a cradle to grave approach is stated in the second principle; atom economy. It is advisable that whenever practicable, synthetic methods should be designed by using substances that pose less or no toxicity to human health and ecosystem. In principle 4, chemical products should be introduced to maintain its function and efficacy, while minimizing toxicity. Other principle stated that the use of auxiliary substances should be avoided. In green chemistry, the use of energy should be optimized especially those activities related to heating, cooling, pumping, electrochemical and separation processes during the manufacturing stage. The use of renewable materials should be always a priority whenever technically or economically practicable.

Another key principle of green chemistry is minimization of unnecessary derivatives in order to reduce the use of reagents and generation of waste. Catalytic reagents are greater to stoichiometric reagents. Efficient resources utilization can be obtained from selective catalysis for safe and environmentally benign processes. The design of chemical products should consider at the end of their life and function so that the impacts will not persist in the environment. Prior to the formation of hazardous substances, analytical methodologies need to be further improved to make sure the monitoring activity is based on the real-time analysis. The final principle explains about the minimization of the potential chemical accidents of the substance used in a chemical process. These 12 principles of green chemistry enable organizations and manufacturers to align their business strategies with the SDGs. Significant contribution to the achievement of SDGs agenda can be made possible by working in partnership with other stakeholders. Since SDGs are not legally binding, the successful implementation of SGDs can be directly and indirectly obtained through life cycle thinking with support from the government and relevant agencies and industries.

From Linear to Circular Economy

Demand and supply challenges due to rapid population growth, climate variability, changing land use practices, increased urbanization combined with natural disaster intervention require a better understanding of the interactions between human and environment. Lack of effective relationship between various stakeholders also contributes to the unsuccessful establishment the human-environment nexus. These challenges pose stresses on water, energy and resources. Fundamental and innovative studies related to sustainable water consumption, green materials, green technology, energy efficiency, smart system, natural-based solu-

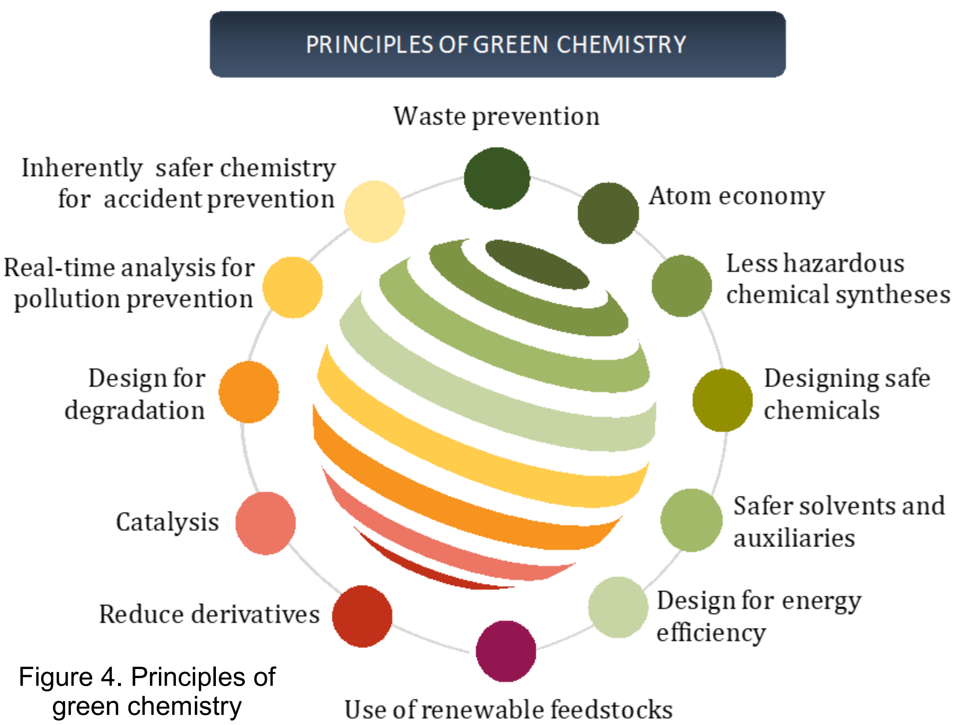

Figure 4. Principles of green chemistry

tions, etc. need to be carried-out based on the life cycle thinking perspective to explore the links between resource efficiencies and circular economy. The implication of these challenges increases the urgency of addressing the complexity of the nexus to ensure future prosperity of Asian countries, particularly Malaysia. Successful and resilience adoption of green chemistry can be achieved through development of robust approach and active participation of various relevant stakeholders.
Organizations have to be more environmentally responsible with respect to their products and processes to meet regulatory requirements, product stewardship and potential competitive advantages. As the need for more efficient use of raw materials is identified as one of the key challenges of the 21st century, demand and supply challenges require a better understanding of transforming linear to circular economy following an LCA approach. The key to the transition from linear economic system towards regenerative and sustainable circular economy needs effort to ensure wellbeing of life and translates the concept into policy. Opportunities for a Circular Economy can be achieved through various consensuses and collaborations on sustainable and inclusive business industry. Life cycle thinking and circular economy require triple helix effort by strengthening government-industry-community relationship. This will help to inculcate different stakeholders with a sense of duty towards safeguarding human health and environmental and product stewardship. Thus, the life cycle thinking can be established through transdisciplinary-based efforts which integrate and move beyond discipline-specific approaches to address a common problem (Figure 5).

Conclusions

Green chemistry and technologies offer substantial opportunities as an integrated solution to manage human-environment nexus. It is anticipated that integrating green initiatives into the nexus can provide a significant contribution towards safeguarding human health in the anthropocene epoch. Various criteria for improving environmental impacts of products and processes can be practised including establishment of comprehensive framework of the human-environment nexus, improvement of the sustainability of the nexus, optimization of consumption and distribution of resources, reduction of waste and pollution generation and enhancement of knowledge and learning capabilities. Advances in green chemistry is important to maintain a sustainable economy of green manufacturing sector. Establishing quantitative metrics like LCA can help to demonstrating the benefits of practising green chemistry and bridging the gaps between short term and long term profits of an organization. This is due to the fact that implementing LCA into green chemistry can potentially reduce cost and time by identifying the full credit of green manufacturing for the long-term investment. The ability to demonstrate the life cycle thinking into green chemistry in a quantitative way will encourage government agencies, industry players and researchers to invest all sorts of assistance needed for further research and development toward environmentally friendly products and processes in Malaysia.

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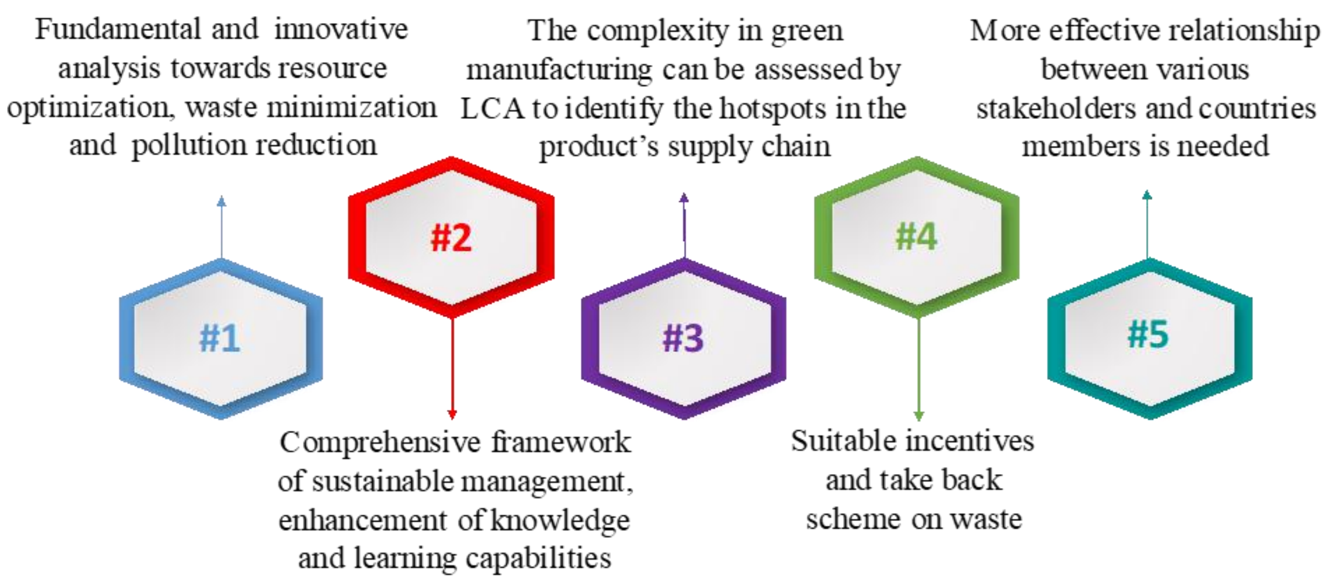

Figure 5. Initiatives to close the loop among various stakeholders

Titanium Dioxide Nanoparticles: An Excellent Photocatalyst for Wastewater Treatment

Nurul Hidayah Mohamad Idris and Hooi Ling Lee*
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Pollution is an environmental issue that gives negative impacts, especially to human health, animal life and economic development which become a major concern for the world [1]. Among all, water pollution is one of the most severe environmental issues which occurs due to the release of industrial waste into the environment that can impact the quality of soil and groundwater. The common water pollutants are heavy metal ions (mercury and lead), radioactive substances (radium and uranium), polyaromatic hydrocarbons (naphthalene), pesticides (imidacloprid and myclobutanil), pharmaceuticals (aspirin) and dyes (methylene blue and methyl orange) [2]. Most of these pollutants are toxic and potentially carcinogenic that can disrupt human health [3]. Researchers have discussed several attempts to conquer this barrier [4]. Among these methods, photocatalysis is observed to be the most popular technique as compared to adsorption, chemical precipitation and biological methods. It is an excellent approach to degrade the toxic pollutants from the aqueous system.

Photocatalysis technology is environmentally friendly, energy-saving and highly efficient for the removal of contaminants from the environment [5]. It involves a solid semiconductor which is irradiated by the light of a certain spectrum of wavelength [6]. The technique requires mild reaction without causing secondary pollution to degrade the pollutants into small non-toxic chemical molecules [7]. Therefore, the properties of the photocatalyst will determine the performance of the photocatalysis reaction [8].

Several types of semiconductor photocatalysts have been reported in previous studies such as titanium dioxide (TiO_2) [9], zinc oxide (ZnO) [10] and copper oxide (CuO) [11]. The utilisation of TiO_2 was popular since 1972 when Fujishima and Honda firstly reported photolysis of water on crystal titania (TiO_2) electrode [12]. TiO_2 possesses good traits such as high chemical inertness, corrosion resistance, non-toxicity, cost-effectiveness and environmentally friendly [9]. However, it has a wide bandgap energy of 3.2 eV which restricts its application under visible light as it can only be activated upon ultraviolet light irradiation [13]. To overcome this limitation, the researchers implemented strategies such as doping TiO_2 with metal or non-metal elements, forming TiO_2 nanocomposites and increasing the specific surface area of TiO_2 to enhance their photocatalytic activities [14].

An and co-workers [9] reported that there was a synergistic effect when Ag_3PO_4 is incorporated with TiO_2 and showed a low bandgap of 2.43 eV. Besides, it created the surface heterojunction which could facilitate the electron and hole charge separation. The obtained TiO_2-Ag_3PO_4 nanocomposites resulted in 96% of the efficiency degradation of methylene blue. Furthermore, doping of the non-metal such as nitrogen (N) to TiO_2 modified the electronic band structure of titania by lowering bandgap energy to 2.85 eV as reported by Cheng and co-researchers [15]. The N-doped TiO_2 is expected to increase the oxygen vacancies and thus, it exhibited higher photocatalytic activity under visible light irradiation.

In our previous work, we successfully synthesised TiO_2 nanoparticles using the green chemistry sol-gel method [16]. The bandgap energy of the obtained TiO_2 nanoparticles was reduced from 3.2 to 3.0 eV and hence, the photocatalyst was active at near to visible light region. Furthermore, these TiO_2 nanoparticles have higher specific surface area due to their nanosized and more oxygen vacancies that helped to boost photocatalytic activities when conducted in methylene blue solution under sunlight. In addition, the photocatalyst was able to reuse up to ten cycles with good stability. As such, these synthesised TiO_2 nanoparticles have great potential in wastewater treatment.

On the contrarily, Li and co-researchers [14] prepared a high specific area of TiO_2 (HS TiO_2) that possessed higher bandgap energy (4.2 eV) than anatase TiO_2 (3.2eV) due to the quantum size effect. The quantum size effect was caused by the reduced particle size of TiO_2 nanoparticles. HSTiO_2 has higher surface-active sites which could modify the photocatalytic performance. Besides, the deposition of Ag nanoparticles to HSTiO_2 decreased the bandgap energy to 3.0 eV and prolonged the lifetime of the photogenerated electrons attributed to Ag acted as good electron storage capacity. During photocatalysis process of Ag-HSTiO_2 with methyl orange solution (Figure 1), the valence band (VB) electrons (e^-) of TiO_2 were excited to the conduction band (CB) and simultaneously, they generated holes (h^+) in the valence band. Then, the electrons in the conduction band of TiO_2 were transferred to the Ag and caused a high efficiency of charge carrier separation to occur. Photogenerated electrons reacted were then with oxygen adsorbed on the surface of the Ag to form superoxide radicals ($\cdot O_2^-$). Whereas, holes in the valence band (VB) of TiO_2 absorbed electrons on the hydroxyl group ($\cdot$OH) and produced hydroxyl radicals ($\cdot O_2^-$). Thus, the generated active substances of superoxide radicals ($\cdot O_2^-$), hydroxyl radicals ($\cdot$OH), and photogenerated holes ($h^=$) could degrade methyl orange dye with 99% of photodegradation efficiency in 90 minutes under visible light irradiation [14].

Currently, TiO_2 photocatalyst is in powder form and its utilisation in wastewater has some challenges. For instance, photocatalyst in the slurry form is difficult to be recovered and recycled due to its shortcoming in the filtration technique. These disadvantages limit the broader application of TiO_2 in wastewater treatment. To circumvent these drawbacks, the development of the immobilisation of TiO_2 particles on the floating substrates has been suggested [17]. For example, calcium alginate beads were employed as floating substrates for TiO2 [18]. Besides, An and co-workers have reported the immobilisation of TiO_2/Ag_3PO_4 particles onto the hollow glass microspheres that acted as a buoyant substrate [9]. Both mentioned models have shown that the calcium alginate beads and hollow glass microspheres could be reused up to seven cycles and five cycles, respectively. Besides, the floating photocatalysts have the advantages of enlarging the surface contact area with light, recovery and improves the reusability process.

In conclusion, TiO_2 is an ideal photocatalyst for photodegradation of pollutants in wastewater. The properties of the photocatalyst are improved by doping metal or non-metal elements. Meanwhile, higher surface-active sites could be produced by increasing the surface area of TiO_2. In addition, the issue of recovery can be resolved by employing floating substrates such as beads, polymer or hollow glass microspheres. We foresee in the future that the development of floating TiO_2 photocatalysts will be substantial, especially in the visible light-based wastewater treatment applications.

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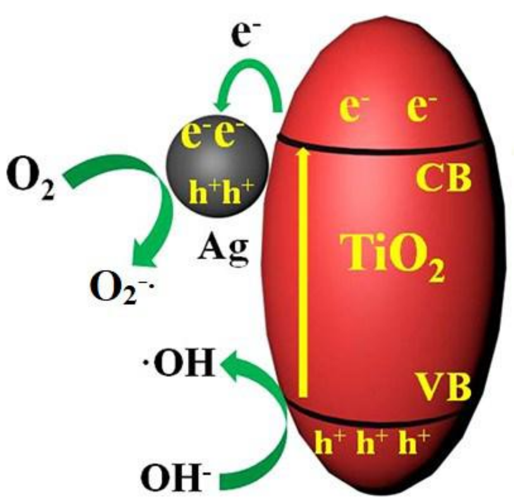

Figure 1. Photocatalytic activity of $Ag/HSTiO_2$ under visible light irradiation [14]

The Quality Control of Traditional Medicines

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Abstract: A discussion is presented of a selection of the integrated scientific efforts necessary to enhance the quality of the traditional medicines presented to patients.

Key words: Traditional medicines, quality control, integrated technologies, holistic approach, standardization

What do William Shakespeare, the management expert W. Edwards Deming, the Chicago architect Louis Sullivan, and the poet Robert Frost, have to do with the quality control of traditional medicine? A clue: it's about something they said. More on that as we proceed. Let's begin at the end. We are all patients. It is highly probable that you are, have been, or will be, at the end of the production process for a traditional medicine (or dietary supplement). What is it that you expect from any medicinal agent, whether that is a formal prescription, or an over-the-counter (OTC) drug, or a traditional medicine, or a dietary supplement? Probably, safety would be the highest priority (does no harm), followed by efficacy (it works to your expectation), and consistency (it has the same beneficial effect the next time it is purchased). Those factors arise from inherent "quality". For you to acquire the medicine, it has to be available from its point of origin, a forest or a farm, and be affordable; that makes it accessible. A few years ago, the author grouped these considerations in an acronym, QSECA, for **Q**uality, **S**afety, **E**fficacy, **C**onsistency, and **A**ccessibility (*1-3*). Do you, the patient, experience those qualities in the traditional medicines you have access to now? If not, why not? Quality health care was declared a human right in the WHO Constitution in 1948, and was reaffirmed in 2017 by the Director-General of the World Health Organization (WHO) (*4*). By considering the perspective of the patient first, the respective roles and responsibilities of the manufacturer, the researcher, the regulator, and even the collector of the medicinal plant, become clearer. This scenario creates a new model for consideration for the provision of traditional medicines, as shown in Figure 1. The architect Louis Sullivan held that "…… form ever follows function." So before considering the journey, assess the destination. W. Edwards Deming, the management guru who developed the fourteen points for Total Quality Management (TQM) (*5*), stated that "quality is an intention". Applied to traditional medicines it is essential to assess what is the function in a health care system, and what is the intention of the efforts to establish and ensure "quality". It must be to serve the stated requirements for the patient, the QSECA.

In December 2019, a group of scientists, meeting at Oxford University in the UK, and concerned about the quality of medicines on a global basis, issued the Oxford Statement (6). One aspect of that document was a call to action for governments to invest in stronger measures, and policy changes at the local level, to eliminate fake or adulterated medicines which obviate the human right to health care. They cited a WHO estimate that less than 30% of the regulatory bodies for medicines in the world actually had the capacity to assure the quality of the drugs in the local marketplace (7). In the renowned play Romeo and Juliet by William Shakespeare, Juliet muses about Romeo's rival family "What's in a name? That which we call a rose by any other name would smell as sweet". This concept is at the heart of traditional medicines, phytotherapeuticals, and dietary supplements, indeed of all medicinal agents. It is the biological function of the constituents that is the raison d'être for the health benefits of the product and the expectation of the patient, or in the case of the rose, the sniffer. The name, what that medicinal agent is called, or what label and description is on the box or bottle or packaging, matters for naught. It is only the reproducible biological effect that matters. That is what the patient wants and expects, consistently. Period. If the reproducibility to meet the patient expectation is not being met, what can be done?

For the future quality control of traditional medicines in health care systems the world is at the crossroads of status quo and quality improvement for the patient. Which pathway shall we take in the future? The poet Robert Frost poses it this way in his poem "The Road not Taken": "Two roads diverged in a wood, and I - I took the one less traveled by, And that has

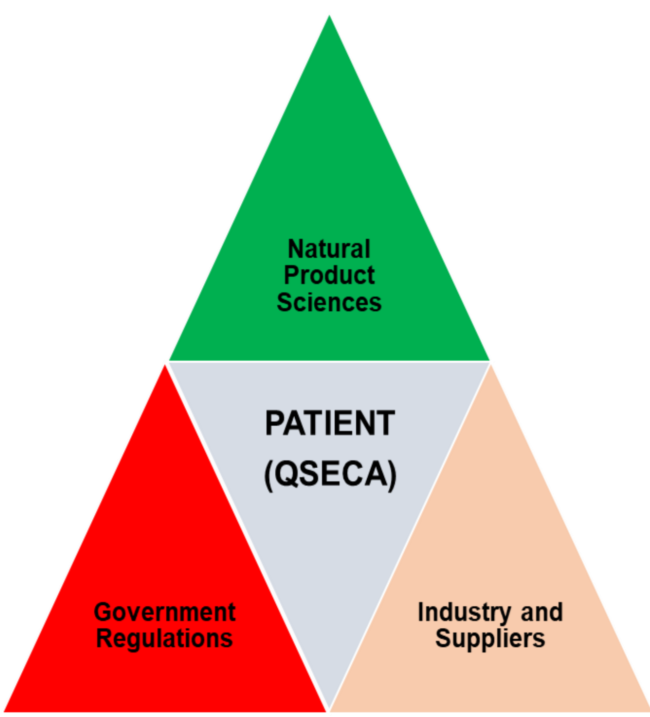

Figure 1. Putting the Patient at the Focus for the Quality Control of Traditional Medicines

made all the difference." As responsible scientists, we must take that less travelled pathway, for the benefit of the patient, and make sure it makes a difference. This is the pathway that the pioneers in the integrated botanical, chemical, and biological analysis of medicinal plants are carving out for the world to follow in the future. We must help the regulators and industry translate that new analytical and biological capacity into the quality of the product required for the patient. For it will indeed make all the difference, especially for the health of the patient, and therefore the society. Back to W. Edwards Deming. When referring in the early 1950s to the quality of Japanese goods in the market place he indicated: "We have lived in a world….. of defective products. It is time to adopt a new philosophy." (5). That is our untrodden pathway for the future. We are going to effect the transformation of traditional medicines into products of assured QSECA. How does that happen? What is involved? Who is involved? With what type(s) of expertise? Who's in charge of the process? Where do we start? How long will it take? How does the patient see the benefit? Critically, who pays? Malaysia, in the past 30 years, has made a very significant investment and major improvements in the products, the facilities, the practitioners, and the status of traditional medicine in the health care system. There are now seventy-six monographs on medicinal plants used in Malaysia, generated by the Institute for Medical Research, Ministry of Health (MoH) which are available to view on-line (8). Are these standards reflected in the marketed products? Are the monographs alive, and revisited for updating every other year at least? Much remains to be done, and a blueprint for the next 10-year phase of traditional medicine activities was presented in 2017 by the Traditional and Complementary Division in the MoH (9).

As initiatives to improve the quality of traditional medicines are considered, it is useful also to mention the Four P's of Quality. Beyond the quality control of the Plant material(s) in a traditional medicine preparation, there are three other considerations where quality is essential: People, Places, and Practices. The People are the collectors, the manufacturers, the practitioners, the regulators, and the patient. The Places include the origin of the plant, the quality and international standards of the operations at the storage site, the research and manufacturing facilities, the sales locations, the advertising and on-line web-sites, and the education sites where knowledge about TM is acquired by practitioners. Finally, there are the Practices which reflect the processes employed to manufacture TMs, the relationship of the prescribing of a product to a holistic health care system, and the level of education, of the formal and on-line systems, used to train and qualify students and practitioners, and to inform the patients. In this brief article, the focus will be on the plant materials, and aspects of their analysis and assessment which enhance their quality control to benefit the patient. One of the long-standing concerns with traditional medicines globally has been the quality of what the patient receives. In two senses quality control is a continuum. Quality for the plant material begins in the field or the forest, and carries through the processing to the end product; that process, which may take weeks, months, or years, requires the appropriate elements of control at every processing step. Quality control, and its improvement, is an on-going activity as new and improved technologies are applied to assess and assure the authenticity and the appropriate quality of a plant matrix to meet an evidence-based standard.

It is a reasonable question to ask why is the quality control of a traditional medicine even necessary? After all, if a traditional medicine has been used for hundreds (or perhaps thousands) of years, isn't it established to be safe and effective? And if the plant is identified correctly, isn't that enough? Even if the plant part used traditionally is the leaf and the fruit is being applied? And if the traditional medicine preparation was to boil in water, and now it is extracted with cold aqueous alcohol, isn't that okay? And if the plant originated in Sabah, and is now being grown in Serdang, that doesn't matter, right? The truth is that it all matters, every potentially variable aspect can change the metabolite profile. There can be no assumptions of similarity, safety, or efficacy. Nature does not allow that luxury when dealing with the variability of biosynthetic processes in a plant, and the myriad of polarities in the plethora of metabolites. The need is for quality control with different technologies at different stages in the process, and having due consideration of the circumstance at every stage. It is why, in earlier discussions, this author has employ the phrase "A plant is not a plant", using the varying hotness of the chili pepper, Capsicum annuum, as an example. There are four significant facets to be considered regarding the quality control of traditional medicines, as parameters to be applied when approving and maintaining standards for human consumption. It was recognized in the WPRO document, The Regional Strategy for Traditional Medicine in the Western Pacific (2011-2020) (10), that individual nations will take time and a long-term financial and dedicated commitment to make the required transformation from their present status along the quality continuum. The emphasis for the WHO in advancing traditional medicine is on contemporary evidence, and sustainability. Which brings us to the need to dispel a few of the myths of traditional medicine (11).

The first myth is that because a plant has been used in traditional medicine for hundreds or even thousands of years, that it is safe and effective. A second is that the biological activity will be the same, no matter the origin of the plant, the plant part used, or the extraction method. Other myths are that "wild-crafted" plants are more active than cultivated ones, that complex mixed plant preparations cannot be analyzed or simplified, that the plants and the indigenous knowledge will always be there, and that older plant materials are less active. The veracity of these statements will vary depending on the particular plant and its biological effects; in each instance they necessitate contemporary exploration. As Malaysia has discovered through its former EPP1 program under the National Key Economic Areas (NKEA) initiative, each important medicinal plant is a significant research project which requires in-depth study and scientific evidence in the context of the anticipated, contemporary, approved use of a particular preparation. When applied to a multi-component traditional medicine, for example from the Chinese or Ayurvedic systems, examination of the chemistry and the bioactivity profile becomes highly challenging, and yet possible with contemporary chromatographic, spectroscopic, and spectrometric systems. It is worth emphasizing that when examining the historically reported applications of a traditional medicine, the current research study is not a validation, for that concept has an inherent bias. As scientists it should be described in a neutral manner, as an "assessment", an "evaluation", or an "investigation". The four core elements of quality control are information, botany, chemistry, and biology, built on a foundation of sustainability and accessibility. Importantly, the scientific outcomes define the regulations, and the timeframe for their implementation; it would be improper to have regulations which could not be met. In addition, loss of an important plant material due to over-harvesting from the wild, or cost to the patient that is excessive, renders the product of no healthcare value; it becomes inaccessible. These elements and their foundation are not independent of each other, and, like all other aspects of QSECA, must be integrated into an individual, rational, research approach with a defined, graduated series of outcomes, depending on the nature and the quality of the prior research on the plant. As in any science-based program, the key aspect of long-term success is reproducibility, and in part, for the patient, that comes from traceability. Traceability is an undervalued aspect of traditional medicine quality control. It is the ability, once a manufacturing process is complete, to be able to document the complete history of the plant material(s) in a product from the date of acquisition to a final product in the marketplace and beyond.

With regulations regarding quality comes responsibility, and the development of a system to manage and maintain that responsibility. Is the manufacturer responsible for assuring aspects of QSECA, or is it up to the government to assure compliance with standards and regulations through routine in-market analyses and corporate facility and program inspections? Or are both responsible parties? One of the most important needs, also promoted by WHO (10, 12), is a major international collaborative effort leading to the harmonization of regulations (and local plant names!) between countries and throughout regions. That would relieve manufacturers from meeting different product and marketing requirements across international borders. It is said that the biggest problem with quality in traditional medicines is realizing that there is one. In part, that is a systems issue. For example, where do traditional medicinal agents "fit" (i.e. their "function") in the health care plans for Malaysia? To a significant extent, where they fit defines the quality control issues in acquisition and processing for that role. All indications are that there is a dedication towards integration into the health care system (9). At what level? Who are the scientific and other groups involved, and who and where are the people who will address all the elements cited above? What is the present regulatory situation for traditional medicine in Malaysia, and do those regulations fit the long-term role and meet patient needs? Some countries are examining the possibility of a third class of drugs, as "approved natural products", which meet selected criteria, and are registered and regulated, but for which only limited medical claims can be made. That strategy is being used to separate and establish a quality differential in the marketplace with the expectation that more ethical manufacturers and products will be eligible for marketing that class of approved product, resulting in a benefit for the patient. On-site analyses of 483 manufacturers of dietary supplements in the US and other countries by the U.S. Food and Drug Administration (FDA) revealed numerous infractions related to not positively identifying the plant material in the product, lack of a formula to assure consistency, adulteration, insect and rodent contamination, etc.. As an example, in 44 product samples from 12 companies, only 2 companies had the correct plant material in their product (13). Wheat, soy, and rice were common "fillers". Adulterated samples remained in the marketplace even after FDA orders to withdraw were issued, and 63% of the re-introduced products had the same adulterant. The patient is not well-served under these circumstances. From a global marketing perspective, Malaysia could also do better in meeting its' international responsibilities in terms of product quality. There are several examples of Malaysian-made products, stimulant "coffees" in particular, marketed on the internet with false claims and adulterated with potent synthetic ingredients. Some of these products were specifically ordered withdrawn by the FDA (14). As with many countries, the ability to control the quality of products sold by local manufacturers on the internet is a very serious health care situation demanding aggressive action. The misleading advertising claims associated with traditional medicines or plant-based products, particularly those appearing on-line, are both a healthcare and an ethical issue, and some suggestions made to tighten existing Malaysian laws have been made (15). To prevent deception, approval of the Malaysian Advertising Board (MoH) is required for all advertisements under the Medicines (Advertisement and Sale) Act 1956, Section 2. In 2014, over 500 warning letters were issued pursuing companies making exaggerated product claims. It was not clear how many of these were from on-line advertising. Proven violations are a criminal offence and result in modest fines. The authors (15) considered that the monitoring teams were too limited, given the breadth of internet advertising opportunities, and that the fines for violations should be dramatically increased to serve as a more serious deterrent. However, quality control needs to be applied to the on-line products themselves, not just their advertising, especially since they are locally produced. The advertising doesn't threaten the health of the patient, the product itself does.

The development of quality traditional medicines will rely on a series of technologies relating information, botany, chemistry, and biology through an integrated network of artificial intelligence systems. Metabolomics analysis and metabolite networks will form the basis of correlating the morphological and PCR identification of a plant with its projected biological outcomes on a quantitative basis. The notion of a single (and probably not related to the biological activity) marker as being a quality control element is no longer acceptable as a monograph standard, without prior holistic research (16). HPLC/MS fingerprinting, possibly together with TLC systems, is now a relatively cheap standard to be reached and should be developed, in conjunction with a bioassay, for every monographed plant. Relating the molecular networking of untargeted MS/MS data (17) with extract data can be an effective dereplication tool (18), leading to extract prioritization and a relationship with a biological outcome. Annotation of unknowns in GC-MS data analysis can be established (19), and an extension to 2D-NMR data would foster the identification of known, and possibly new, marker compounds (20). Of notable concern is that human intervention continues to examine for potential ambiguity in the AI structure conclusions, particularly when a metabolite identification is based on the HREIMS of a single ion, without considering the fragmentation pattern or the context of the source material (21). As Birch wisely opined, "Nature does not produce what it cannot produce". The issues related to the curation of data, and the sharing and accessibility of compiled data have been discussed (21). They include intellectual property concerns, and the challenges of correlating data derived from different MS, GC, or UPLC instruments, although some progress in this regard is being made through the Allotrope Foundation data standard initiative for different manufacturers.

Much of the data in the literature with respect to the biological activity of plant extracts is either uninterpretable due to the absence of control compounds, or non-reproducible because the material being tested was not analyzed, and is therefore of unknown (and unknowable) composition. For a complex mixture, the chemical profile or fingerprint of a specific extract is necessary to monitor chemical consistency and therefore generate a reproducible biological outcome (16). A holistic approach to standardization was developed based on detailed chemical and biological analysis, which then effectively identifies a single standard to define the quality of a plant material. This technique is now being accepted in both the United States and Chinese Pharmacopoeias (16). Such a strategy, which transitions from a complex, comprehensive analysis to a single standard fosters the notion that, following monograph approval, industry can use simpler and more economical methods for quality control, and not have to invest in very sophisticated NMR or UPLC/MSn instrumentation. At each stage in the traditional medicine production process, it becomes important to establish quality control standards that reflect and monitor the continuing fate of the bioactive marker constituent(s). It is not appropriate to conduct such an analysis only on the original dried plant material, that is merely a beginning. The nature of the marker compound is very important. It should not be one of the ubiquitous, bioactive marker compounds. These are referred to as pan assay interference compounds (PAINs), and they have the characteristic of showing activity in a wide range of assays, and are widely distributed taxonomically (22, 23). An extension of these compounds includes those designated as invalid metabolic panaceas (IMPs) (24). Together, these are metabolites which frequently confound the identity of the true bioactive constituent in an extract, leading to confusion in drug discovery (25), and in traditional medicine standardization (16). Important natural products which appeared in the NAPRALERT-generated IMPs list and on the PAINs list included: quercetin, gossypol, rutin, catechin, caffeic acid, gallic acid, and luteolin. Those metabolites specifically on the IMPs list included β-sitosterol/stigmasterol, ursolic acid, kaempferol, and α- and β-pinene, among others. Therefore, importantly, none of these compounds should be used as marker compounds for the quality control of a traditional medicine, especially to rationalize the bioactivity, nor should they be included in monographs as marker compounds for standardization. Greater emphasis will be needed from the biologists to develop simple, quick, effective, and reproducible bioassays for final product assessment, and to establish the relevance of synergism and/or antagonism in a particular extract. Testing the same, standardized extract in the product in vitro, in vivo, and in humans is a requirement for acceptable bioactivity and toxicity testing; to do less is not scientifically acceptable The challenge is to meet that determined standard over time, batch to batch. That is why reproducibility in the product begins with the quality in the field, and why it is important to assess, probably remotely with hand-held devices, the plant material in its location prior to harvest. Unless a harvesting standard is reached, it is entirely unlikely that an effective, consistent, patient-centered product can be achieved without extensive post-harvest blending. Recall also that analyzing a harvested plant is a snapshot of the metabolome at a particular time, not a phytochemical video of metabolic modulation; although certainly that technology will be available soon. The desperate need for global integrated data systems meeting FAIR (findable, accessible, inter-operable, and reusable) principles for natural products research has been documented (21, 26). Databases are needed which can accumulate curated information on traditional use, taxonomy, individual compound characteristics, biochemical testing, and plant genomics, with information on bioactivity in relation to standards, to previous extract samples of the same plants, and to other organisms. Chemical information should be correlated with the open access chromatographic and spectral data that relate to the metabolome of that sample of the plant with regard to other samples, and the relationship of that information to the established or projected structures of the metabolites. Core information from those resources is the basis for a "live" plant monograph.

Restrictive access and licensing practices in the publications industry continue to have a negative effect on research development, particularly in countries where literature access is limited by economic consideration. This will inevitably lead to other approaches to the publication of data. Only then will the timeframe for the translation of data from bench to society (i.e. the practitioner and the patient) be markedly reduced, and the situation become ethically acceptable (27). The concept of exceptionalism in publishing is not serving society well. It is not enhancing collaborative and integrated research. The highest priority must be to optimize the shareability and the actual sharing of datasets, and the interpretation of the results from those datasets. That necessitates community commitment, as well as technical, management, and legal solutions (1). The short and long-term impacts of climate modulation remain a poorly researched aspect of traditional medicine. The key concern, like any environmental change (warmer, cooler, wetter, drier, and, if near the ocean or rivers, the impact of salinity or inundation from flooding) when a plant is gathered from a different location, is the question of whether changes in the metabolome, due to modulation of the gene regulation profile, have occurred. More investment is needed at the government level to sponsor programs for the assessment of which medicinal plants are either growing wild, or are cultivated, in areas where climate change, in whatever form, is likely to have an impact. This fundamental research parallels the urgent need for comparable studies with respect to food crops, and the anticipated agricultural yields associated with those crops. Another under-explored facet relating to the biological activities observed for traditional medicines, and the differences in metabolite profile and overall biological activity when plants originate from different regions of different countries, is the endophyte profile associated with the plants (28). Endophytic fungi and bacteria have the capacity to produce a very wide range of potent compounds, including a diversity of known and previously unknown metabolites (29, 30). The endomicrobial profile is not predictable or reproducible, and thus, for a given plant in a particular location, the range of microorganisms and their metabolite fingerprint will change in ways that at the present time is not controllable. Whether these endophytic metabolites affect the biology observed for the medicinal plant (part) under study requires more dedicated research. In terms of monograph or production quality control standards the possibility of endophytic compounds interfering in analyses is now an essential consideration. Finally, there is the question of "who?" Who will do the work to accomplish these high-level goals of a quantum leap in the quality of traditional medicines? It will require enhanced levels of collaboration and the integration of the skills of numerous scientists and technologists, including, analytical chemists, natural product chemists, botanists, agronomists, biochemists, biologists, enzymologists, plant genomics experts, network pharmacologists, pharmaceutics experts, pharmacokineticists, clinicians, lawyers, pharmacoeconomists, marketing experts, regulators, information specialists, artificial intelligence professionals, etc. This effort is about so much more than the field of natural product chemistry; it is about assembling relevant expertise and developing action plans for the benefit of the patient. There is an African proverb which is applied when contemplating a journey. It says "If you want to go fast, go alone. If you want to go far, go together." Let's go far.

Conclusions

The quality of traditional medicines is a global health issue. The classical comments cited at the beginning of this article, that traditional medicines need a well-enumerated function in healthcare, that the pathway for an intentional higher quality must be newly trodden, and that the essential quality is in the content, not the label, have been discussed. Considerations are offered for the need to develop quality standards that are holistic and can be simplified and implemented by industry, and are on the pathway of QSECA for the benefit of the patient. The preparation of more contemporary and sophisticated monographs to include advances in technology and biological activity is encouraged. The effects of climate modulation on and the presence of endophytic fungi in traditional medicines are factors which need to be considered as regulatory standards are developed. Broad expertise in a coordinated multi-team approach is necessary for success.

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Transformation of Gadong Tuber Starch into Sophisticated Material

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Dioscorea hispida or locally known in Malaysia as 'ubi gadong' is a starchy tuber which belongs to the genus Dioscorea within Dioscoreaceae family. It is a poisonous creeping plant with a prickly stem twining to the left which can reach up to 20 meters in height, possesses a hairy trifoliate leaf, and produces a small, pale yellow flowers. It forms a bulky tuber with white to yellow flesh. *D. hispida* easily grows in the shade or near streams and can simply be found in the secondary forest of India, Southern China including Southeast Asia to New Guinea. There are about 1137 species of *Dioscorea* around the world however only 600 of them are edible. Dioscorine, with a molecular formula of $C_{13}H_{19}O_2N$ is one of the water-soluble extremely toxic alkaloid found in the tuber of *D. hispida* . Chemicals such as alkaloid, tannin and saponin may attribute to the toxicity of the tuber. Tannins give an acrid taste whereas saponins cause the bitterness. Uniquely, although this tuber is septic in nature, it can be eaten after a thorough washing process (3-7 days) (1-2). Traditionally, the tuber can be detoxified by boiling, roasting or soaking it in flowing water. Detoxified *D. hispida* was consumed as a staple food in the rural areas, where the people in the old days made it into flour, cakes, pancakes and porridge. However today, these food preparation are no longer deployed due to the difficulties of traditional detoxification process. The safe amount of tuber that can be consumed as set by World Health Organization (WHO) in 1988 is below 10 mg hydrogen cyanide (HCN) per kg body weight. If the tuber is consumed excessively (without further purification), it may result in cyanide poisoning with the symptoms such as vomiting, nausea, stomach pains, diarrhea and impart serious health complication. For severe cases of alkaloid intoxication, it may cause fatal reactions leading to death. Contrary to the drawbacks, *D. hispida* has many beneficial functions due to their active components which were isolated but the starch content is often neglected and discarded. Extensive research have been conducted by our group to identify the *D. hispida* starch properties and also to investigate the possibility of their further application into sophisticated materials.

i. *Dioscorea hispida* starch-based hydrogels and their beneficial use as disinfectants—Tanaka's pioneer work on 'volume-phase transition' in 1978 has activated an innovative idea in the researchers' mind and contributes significantly to current the hydrogel development. Hydrogel which may be considered as "intelligent material" or "smart material" is a water insoluble three dimensional structure that has the capability to swell and retain large quantities of water or biological fluids within its network. This material behaves in some ways like a liquid and other ways like a solid. The presence of certain functional groups within the hydrogel network makes it often sensitive to the conditions of the surrounding environment. However, such changes are reversible; therefore, these stimulus responsive hydrogels are capable of returning to its initial state once the trigger is eliminated. These stimuli-responsive hydrogels are pH-sensitive, thermally sensitive, has ionic strength and are solvent dependent. Additionally, the presence of polar functional groups along the backbones of polymers such as carboxylic acid provide not only bio-adhesion properties, but also pH-sensitivity to these polymers. Owing to hydrogel uniqueness, now it has becomean incredibly popular material and used worldwide in almost all fields mainly biomedical, pharmaceutical, water treatment, oil recovery, cosmetics as well as soil conditioner and nutrients carrier. Since its invention in the 1950s, hydrogels with antimicrobial activity have been widely used in biomedical applications, especially in wound dressing. In many reported cases, the infection was affected by bacteria or fungi such as *Escherichia coli, Staphylococcus aureus*, and *Aspergillus niger* and in severe cases have led to death. To overcome the problems, many innovations were made using several types of gels and resins with antibacterial and anti-fungal abilities. Modified starch-based polymers can be engineered for specific properties by combining starch with synthetic polymers through a graft copolymerization process. Our group have established starch-based hydrogel made of *D. hispida* starch grafted polyacrylamide(3-4). The hydrogel has shown inhibition activity of bacteria species such as *E. coli, S. cerevisiae, S. aureus*, and *Salmonella typhi.* This may possibly be related to the existence of alkaloids in the tubers, especially dioscorine which gave highly remarkable disinfection effects. In general, dioscorine is part of a group of toxic alkaloids that contain large amounts of nitrogen. The presence of a cyclic chain with nitrogen bonding with the carbon group (C–N) gives antioxidant ability, including antibacterial properties against certain bacterial species. The toxicity test carried out showed that the zebra fish embryo survived after exposure for 72 hrs to the *D.hispida* starch based hydrogel. Similar result was obtained using the FHs-74-Int cell line, where it has more than 85 % of cell viability which was considered as safe especially in biomaterial applications (5-6).

Ii. Green Wood Coating—Wood is a natural polymeric composite which is widely used for home furnishings and construction materials. Although this organic multifunctioning material offers many applications, the unprotected wood is susceptible to wood rotting fungi and termite, which resulted in quality curtailment particular in its mechanical strength. In order to extend the service life, wood products are therefore normally treated with preservatives such as creosote, alkaline copper quaternary (ACQ), and copper azole (CuAz). These chemicals were used as protector due to their impregnation ability into the wood cell and furthermore improve their physical durability. A range of different chemicals are readily available to improve the permanence as well as to help the resistance to decay, insects, weather or fire. Some of the preservative agents are highly toxic that will be phased out in a short period of time as it largely imposed adverse impact on human health and polluted the environment. Therefore, the quest for alternative phytochemicals with lower environmental and mammalian toxicity has currently becomes a major concern. In our study, the *D. hispida* starch-based exhibited both fungistatic and fungicidal activities against the test molds, the white-rot decay fungus *Pycnoporus sanguineus* and termite *C. curvignathus*. Therefore, *D.hispida* based anti-fungal and anti-termite bio-pesticides can be potentially used as alternative to the synthetic pesticides because of their minimal toxicity, widespread availability and relatively low cost (7-8).

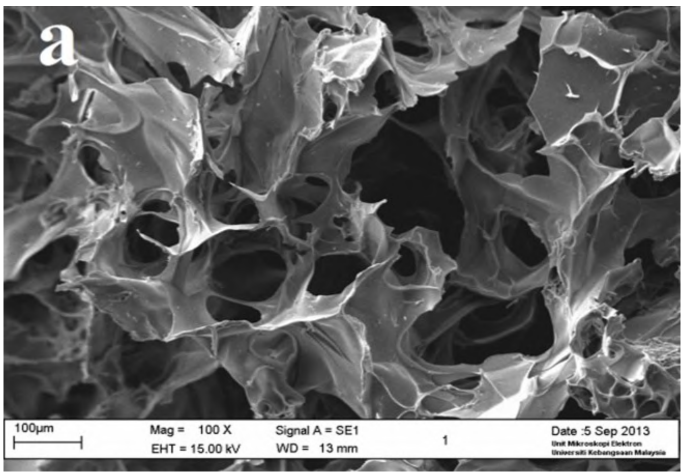

Figure 2: SEM of *D. Hispida* Hydrogel

iii. Highly luminescent carbon nanodots from *Dioscorea hispida*—Recently, carbon based quantum dots known as carbon nanodots (C-dots) have drawn considerable interest due to their stable photoluminescence property, less toxicity, high biocompatibility, cost effectiveness, good fluorescent properties, easy-functionalisation, excellent water solubility, high sensitivity, excellent selectivity to target analyte, tunable fluorescence emission and excitation and high quantum yield. The transformation of carbon intro high-tech material is tremendously interesting especially as material for sensing as example various analytes or cells imaging owing to their tenacious photoluminescence biocompatibility as well as photo and chemical stability. In this research we have successfully modified *D. hispida* C-dot as a nanocarrier incorporated with xanthone, α-mangostin, bovine serum albumin and arginine. We demonstrated that C-dots was non-toxic, biocompatible with possible applications in optical bio-imaging, bio-sensing and relevant to biomedical applications (9-10).

Conclusion—Looking at a different angle, our research group has modified and transformed these poisonous tubers into sophisticated material. As an example, the starch was grafted with synthetic monomers as such acrylamide or acrylic acid to produce hydrogels. Various techniques such as conventional, microwave, gamma and UV irradiation have been applied in order to prepare the hydrogels. These natural based composites were further applied as drug carrier and absorbent. Not only was the starch used as wood and fruit coating, their test results showed good performance in protecting the product from fungi, white rots, termites and bacteria. Further modification has been made where the starch was transformed into carbon nanocrystals and carbon nanodot. These nano-sized particles were incorporated with enzyme, xanthone and DNAs which can be used as carrier or bio-detector. The starch was also converted into electrolyte polymer which can potentially be applied in solar cells employment. Although the gadong tubers have flaws yet it offers many beneficial applications as sophisticated materials which potentially can be used in various fields.

Figure 3: C-Dot under normal light and UV and luminescence reflect under UV

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IKM Terengganu Branch Committee Member Promoted as Professor at Universiti Malaysia Terengganu (UMT)

Prof. Ts. ChM Dr. Wan Mohd Khairul Wan Mohamed Zin was born in 1980 in Kota Bharu, Kelantan. He earned his BSc (Hons) in Chemistry from Universiti Putra Malaysia in 2002. He continued his postgraduate studies at Durham University, United Kingdom and graduated in 2004 and 2007 for his MSc (by thesis) and Ph.D respectively. His focus of study was in synthetic inorganic and organometallic chemistry focusing on developing functional molecules for molecular electronics interests. Upon return to Malaysia, he was appointed as a Lecturer at Universiti Malaysia Terengganu (UMT) in 2007. He was promoted to Senior Lecturer in 2009 and Associate Professor in 2011 respectively. Due to his achievements, he was promoted to full Professor in September 2020.

In 2013, he joined Institut Kimia Malaysia (IKM) as a member and had participated at various activities and programmes within the Terengganu branch as well as the national level. As an IKM member, he has been invited to share his experience, thoughts and research outcomes to the community and colleagues particularly at Karnival Kimia Malaysia (K_2M) programme. STEM awareness promotion at schools is one of his ways in promoting science particularly chemistry to the younger generation.

Due to his continuous involvement with IKM Terengganu branch, he was elected as Vice Chairman of IKM Terengganu branch for 2019/2020 session and currently as a committee member to date.

As an academician, his current research interests focus on the synthesis, characterisation and application of functionalized molecules of organic (treated as ligands) and inorganic compounds which involve designing novel compounds, product isolation and utilizing numerous spectroscopic and analytical techniques with green chemistry approaches. The focus of his research is in fundamental aspects and development of advanced materials especially in the area of molecular electronics, specializing in the behaviour of molecules in this area of interest. His main research activities are understanding the behaviour and roles of these designated molecules by exploiting their molecular framework contributed by a variety of elongation conjugations, substituents and metallic insertions. He specializes in molecular studies for optoelectronics interests, i.e. molecular solar cells, chemosensors, organic light emitting diodes (OLEDs), molecular transistors, thin films and application in biological activities.

IKM Terengganu branch congratulates Prof. Ts. ChM Dr. Wan Mohd Khairul Wan Mohamed Zin for his achievements and hope this article will inspire younger generations to strive for excellence.

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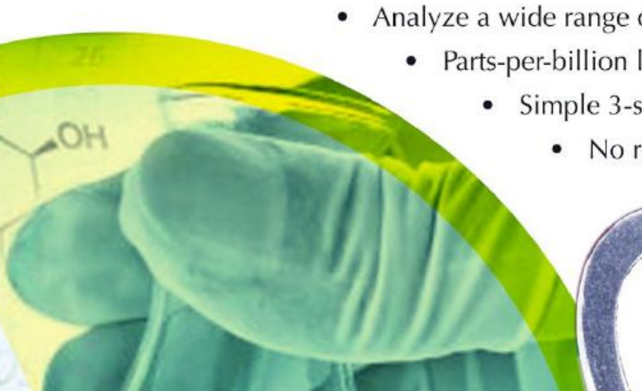

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Malaysian Young Chemists Network – MYCN Logo Competition

The Malaysian Young Chemists Network, MYCN, established on August 21st, 2019 is a network under the umbrella of Institut Kimia Malaysia. MYCN consists of a group of young Malaysian chemists (IKM members of 45 years of age or younger) dedicated to promote and contribute towards Chemistry and professionalism in Chemistry. The network is currently chaired by Assoc. Prof. ChM Dr. Juan Joon Ching.

In February 2020, MYCN organised a logo competition in search for the best logo to represent the network. Within the duration of the search, the competition managed to attract 15 participants ranging from secondary school students to working adults. The contested logos were judged based on originality, relevance, adaptability and aesthetics.

One logo, in particular, has been highly praised by fellow MYCN members as it looks young and energetic, in line with what MYCN was looking for in a logo to represent the network. The impressive logo which was designed by Ms Noor Hayati binti Mohd Sidik, a postgraduate student in Microbial Biotechnology, Universiti Putra Malaysia (UPM), is now the official logo of MYCN.

MYCN hosted an Online Award Ceremony on Aug 8th 2019 to celebrate the winner of the competition. The live session was later released on MYCN's Facebook page as a video premier. In the session, the winner of the competition, Ms Hayati got the chance to share about her background, her design inspirations and motivation to join the competition via an engaging Q&A with the host of the session, ChM Dr Yvonne Choo (MYCN Media Ambassador Chairperson). The session ended with the virtual presentation of a certificate and cash prize of RM300, which was later mailed and banked in directly to the winner.

More about the Winner of MYCN Logo Competition

Ms Noor Hayati binti Mohd Sidik is a freelance designer and a postgraduate student in UPM. She is currently doing her master's research in Microbial Biotechnology. In 2015, she graduated with a Bachelor's degree in Microbiology and have been actively engaged in the research field ever since. In the interview, Ms Hayati explained that her research aims to optimise and boost the production of a fungus-derived enzyme of interest – capable of extracting natural fibres from Kenaf and to test the efficacy of the enzyme on bigger volume of Kenaf fibre, in hope to make it ready for industrial use.

When asked what she had planned after her masters, she enthusiastically mentioned her intentions to deliver the knowledge and understanding of Microbiology to a bigger audience (digital platform) by making good use of her experience and knowledge in the field and her interest in digital design. She added that her first digital design job greatly inspires her to pursue both fields – science and digital art. The job was a collaboration between Malaysian Biotechnology Information Center (MABIC) and Biosafety Department of the Ministry of Water, Land and Natural Resources to produce a Biosafety kit on GMO regulations in Malaysia through a comic-based storyline catered for all level of audiences. She added that she had learned a lot from the experience, particularly on how to deliver such scientific messages in a form that is understood by many. Ms Hayati plans to pursue a PhD in 5 years time.

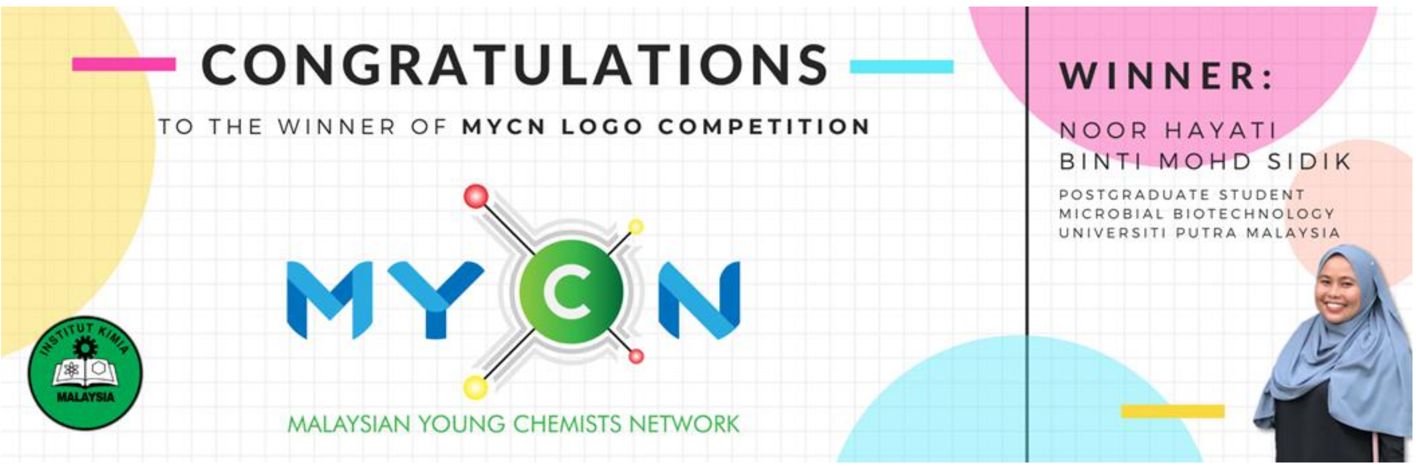
More about the MYCN Logo

"Inspired by a minimal and modern concept, the red, blue, white, and yellow tones represent Malaysia, while the green tones represent the Malaysian Institute of Chemistry (IKM). The letter C in 'MYCN' is symbolized as the Carbon atom, a representation of the chemistry unit as the fundamental building block of life. The grey lines circulating around the carbon atom represent the networking system serves as the foundation of the organization in transferring, exchanging and communicating Chemistry."

What Motivated Her to Join MYCN Logo Competition?

Ms Hayati was browsing through social media one

MALAYSIAN YOUNG CHEMISTS NETWORK



evening and saw the MYCN Logo Competition shared by her friend. As she has always loved to design and create things, the competition instantly caught her attention. She firmly believes that the combination of Science and Arts could make Science more visually appealing which would help attract, deliver and communicate Science to a wider group of audience, especially the youth.

“A logo is a branding that is strong enough to capture audience.” Ms Hayati hopes that her small effort could help bring more people into this field. She hopes that MYCN will fluorish and be able to connect more people to Chemistry.

Once again, congratulations Ms Noor Hayati binti Mohd Sidik for being the winner of the MYCN Logo Competition.

Report prepared by,
ChM Dr Yvonne Choo Shuen Lann
23 Nov 2020

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ICS-IKM's First Webinar on New Opportunities amid Covid-19: Digitalisation, 5G and Rubber Industry

ICS-IKM is an abbreviation for the Industrial Chemistry Section of the Malaysian Institute of Chemistry. This section is currently chaired by ChM Dr Yvonne Choo Shuen Lann and co-chaired by Assoc. Prof. ChM Dr. Juan Joon Ching. On Nov 20th, 2020, ICS-IKM successfully organised its first webinar on New Opportunities amid COVID-19: Digitalisation, 5G and Rubber Industry. This webinar is the first of a series of webinars by ICS-IKM. The idea is to bring together two very different industries to see if it could initiate thought-provoking discussions which could potentially lead to new collaborations. This webinar was made possible by the Malaysian Institute of Chemistry (IKM) in collaboration with International Medical University (School of Pharmacy), Tunku Abdul Rahman University College (Faculty of Applied Science), Xiamen University Malaysia (School of Energy and Chemical Engineering) and Malaysian Young Chemists Network (MYCN) as fellow co-organisers.

As the COVID-19 pandemic strikes, industries worldwide faced unprecedented challenges that they may not be well prepared for. Countries worldwide went into lockdown for months with many businesses impacted and lots of employees ended up working remotely from home. On a flip side, manufacturing industries such as

the rubber glove, health supplies and remote work/learning platforms, to name a few, have been thriving due to a huge increase in demand. To get a glimpse of what new opportunities these rising industries could offer/share, ICS-IKM brought together a rubber industry representative – Pn Siti Hawa Sulong, the Director of Economy, Licensing and Enforcement Division of Malaysian Rubber Board (MRB) and a digitalisation representative – Mr Hans Chang, Manager of Channels and Alliances of Alibaba Cloud Malaysia to discuss on the matter and to expose webinar attendees with inputs that they could potentially implement in their respective industries moving forward. MRB is the custodian of the rubber industry in Malaysia. Its main objective is to assist in the development and modernisation of the Malaysian rubber industry in all aspects from cultivation of the rubber tree, the extraction and

processing of its raw rubber, the manufacture of rubber products and the marketing of rubber and rubber products. MRB has also established G-TACR (Global Testing and Consultancy for Rubber) – a one stop centre for rubber testing and consultancy. Alibaba Cloud, on the other hand, is the global leader in cloud computing and artificial intelligence, providing services to thousands of enterprises, developers, and government organisations in more than 200 countries and regions. Committed to the success of its customers, Alibaba Cloud provides reliable and secure cloud computing and data processing capabilities as a part of its online solutions. The webinar has attracted around 60 participants from various backgrounds ranging from chemists, engineers, consultants from pharmaceutical, oleo, rubber glove manufacturing, agriculture, oil and gas industries to academics from local and private institutions in Malaysia. Dr Vasudeva Rao Avupati (IMU) was the emcee while ChM Dr Yvonne Choo (IKM, XMUM) was the moderator of the webinar. In the first half of the webinar, both speakers delivered their 25 minutes presentations – Pn Siti Hawa gave a talk on "Digitalisation Tools for the Rubber Industry – Exploring Some Possible and Workable Means to Ensure Business as Usual in The New Norms of COVID-19 Pandemic" while Mr Hans gave a talk on "Alibaba Cloud and IR4.0". In the second half of the webinar, two other MRB experts were invited to join in the Q&A Forum Discussion – Dr Roland Ngeow, senior research officer from the Elastomer Technology and Innovation Unit of MRB and En Md Zaid Ahmad, Head of Information Technology Unit of MRB. Some take home messages from the webinar were to stay ahead by implementing forward-thinking strategies, to ensure that one is well equipped with the right skill sets and sufficient preparations as well as to go forth with digital transformation of industries. These are things that would come in handly at difficult times like the covid pandemic!

Feel free to drop us an email (icsikm1@gmail.com):

1. If your company/industry would like to be involved in our ICS-IKM webinar series
2. If you are an IKM member and would like to be actively involved in our section activities
3. If you would like to be added to the email loop for our future webinars

Do stay tune via IKM website and IKM Facebook page for more details of our upcoming webinars.

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Dr Vasudeva Rao Avupati (IMU)

Once again, thank you to all the organising committee members, organising institutions, speakers, panel members and participants for making this a successful first webinar.

Report prepared by,
ChM Dr Yvonne Choo Shuen Lann
23 Nov 2020

IKM Pahang Branch Online Symposium 2021 :

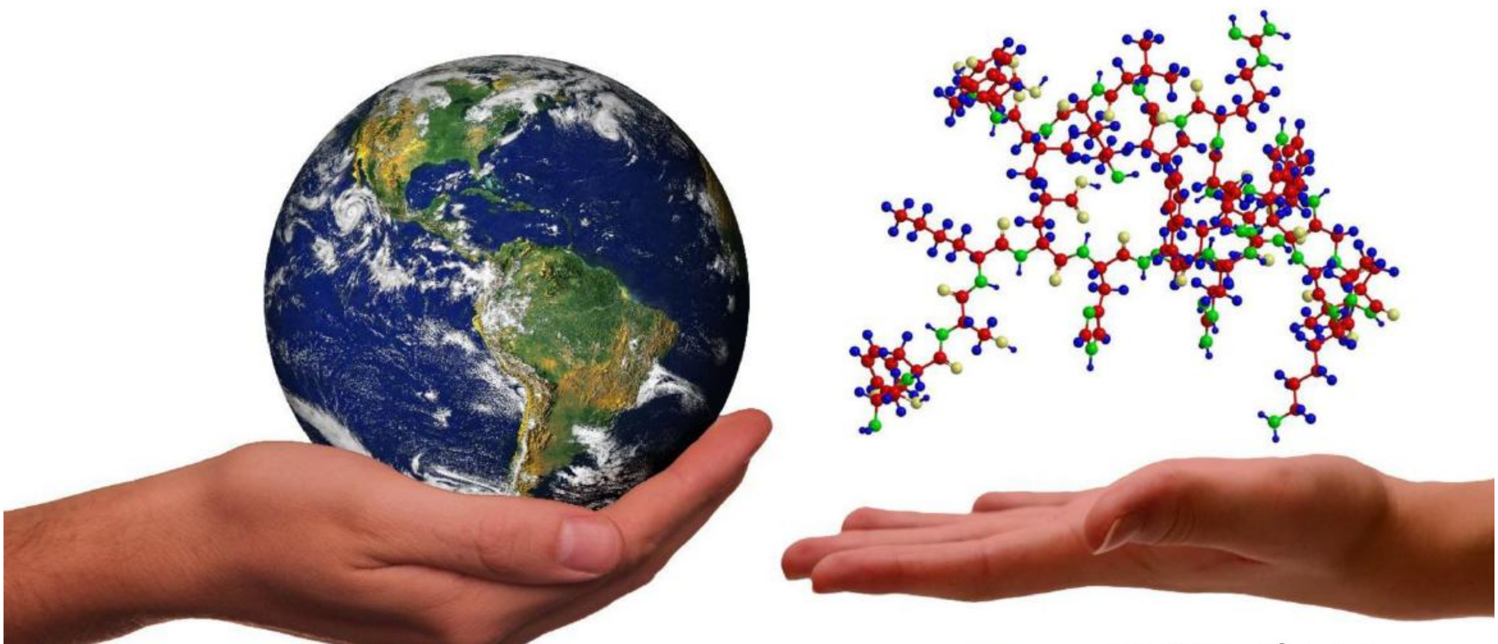
Chemistry For Sustainable World

Join now

Abstract deadline: 15th Nov 2020

16th January 2021

All accepted papers will be published in Malaysian Journal of Chemistry (SCOPUS Indexed)



Co Organisers:

https://ikmpbsymp.wixsite.com/home

ikmpb.sympo@gmail.com

thermo scientific

Free eBook on Ion Chromatography

Thermo Fisher Scientific is committed to ensuring that our Thermo Scientific™ Dionex™ ion chromatography (IC) systems continue to be future-ready, helping laboratory professionals be more productive, be safer with less chemical handling and maximize their resources.

To commemorate the significance of this 45 years anniversary, we have a new eBook on IC authored by Joachim Weiss, PhD, Technical Director for Dionex Products at Thermo Fisher Scientific, an international expert in analytical chemistry.

Dr. Joachim Weiss, Technical Director for Dionex Products at Thermo Fisher Scientific

"I have developed an eBook, Basics of Ion Chromatography, for analytical chemists who are looking for an up-to-date introduction to ion chromatography, providing an overview on the major topics related to this expanding and increasingly important field of science," said Dr. Weiss. "Separation methods, stationary phases, and detection principles offered by Thermo Fisher Scientific as well as the most important application areas are covered. The eBook is not limited to methods for analyzing inorganic anions and cations only, lab professionals will also find a compact description on modern carbohydrate and amino acid analyses as well as high-resolution separations of oligonucleotides and proteins."

Scan the QR Code or visit **thermofisher.com/BasicsIC-eBook** to download:

Let Us Continue To Advance IC Science For Future Impact

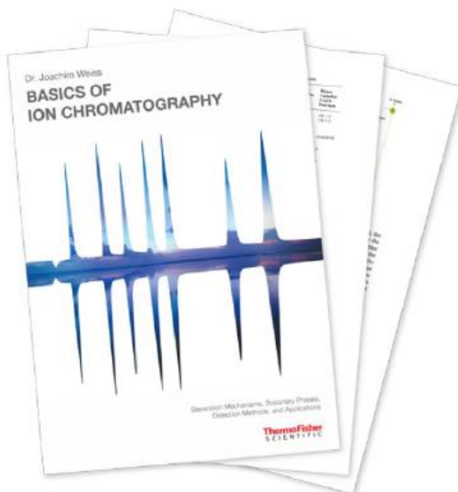
Virtual Global Ion Chromatography Symposium

The Thermo Fisher Scientific virtual Global Ion Chromatography Symposium attended by participants globally across Asia Pacific, EMEA and Americas is now available as on-demand.

Day 1 of the 3-day virtual symposium kicked off with a plenary lecture by Dr. Joachim Weiss on 45 years of ion chromatography and its impact on industries. Attend the on-demand virtual symposium to:

- View presentations by fellow international scientists
- Listen to forums on IC and its applications addressed by a panel of IC experts such as Professor Paul Haddad, Emeritus Distinguished Professor at the University of Tasmania and other fellow Laboratory Professionals
- Access resources to see how IC can be applied in laboratories

Register for this inaugural virtual Ion Chromatography Symposium on-demand at **thermofisher.com/icsymposium**

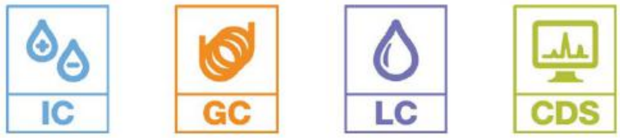


ThermoFisher
SCIENTIFIC

The Evolution of Chromatography: Our journey of innovation - Past, Present & Future

As we look forward to 2021, we are at the cusp of a new decade, one that could offer much opportunities to create new innovations that will drive unprecedented progress for the scientific community around the world.

Thermo Fisher Scientific is offering laboratory professionals in Malaysia an exciting opportunity to co-create the laboratory of the future where capabilities in chromatography, "smart" technologies and connectivity converge, empowering you to achieve your goals.



In order to know where we can go in the future, let us review the past innovations and breakthroughs in chromatography from Thermo Fisher Scientific, and appreciate their contributions to science over the years.

You are invited!

Thermo Fisher Scientific is inviting laboratory professionals in Asia Pacific to a unique challenge and rewards event. From now to 31st December 2020, tell us:

- Your biggest pain point in the laboratory
- And if you were to build a chromatography solution to solve that pain point, what would it be?

If your submission is among one of the best recommendations, we will share it on web feature -- "The Evolution of Chromatography". We will also reward you with an exclusive limited-edition gift.

If your submission is not selected for the web feature, fret not! We will also reward the first 100 entries with special gifts*.

** Subject to terms and conditions which can be viewed on the website.*

To view interactive timeline and to participate in our challenge, please visit **thermofisher.com/chrom-evolution**

New Liquid Chromatography-Mass Spectrometry Workstream Offers Comprehensive Solution for Toxicology

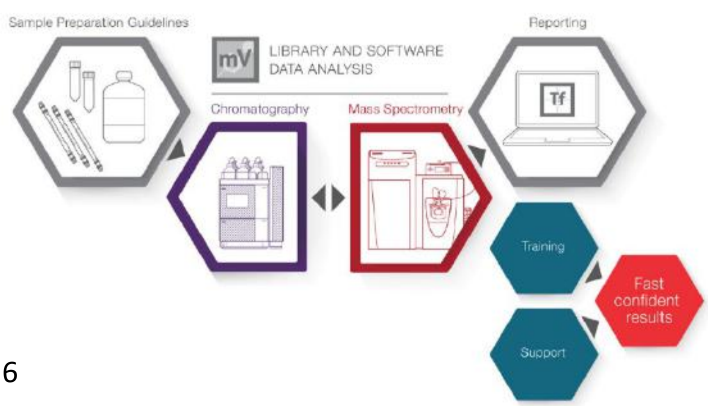
The new Thermo Scientific™ Tox Explorer™ Collection offers a comprehensive LC-MS workstream for toxicology assays.

Clinical research, forensic and anti-doping toxicology laboratories facing the challenges of analyzing increasing numbers of analytes in biological matrices, can now easily and rapidly optimize their liquid chromatography-mass spectrometry (LC-MS) methods for targeted screening and quantification.

Particularly important for toxicology laboratories which must ensure they carry out reliable, reproducible and sensitive analyses with a quick turnaround, using numerous instruments and software to ensure thorough sample screening. The Tox Explorer Collection provides a robust, consistent, all-in-one LC-MS workstream, with an extensive library of analytes to allow for high-performance, targeted analyte screening on a daily basis.

The Tox Explorer Collection consists of:

- Proven and tested methods enabling toxicology laboratories to achieve accurate, high-resolution data, regardless of analyte type, matrix complexities or user expertise, and
- A comprehensive library of analytes, allowing for faster identification and targeted screening assays with 1,500 compounds confirmed in a single analysis.



Portable XRF For Environmental Analysis – Olympus Vanta™

OLYMPUS
Your Vision, Our Future

Water Pollution

Water Pollution is a serious problem in developing countries, it causes severe impacts on the ecosystem, agriculture, environment and even public health. The cost for polluted water treatment is very high and in some instances, the polluted water are untreatable and not suitable for consumption.

Challenges on Water Pollution.

Many studies published today reveals that 40% of major river in Malaysia is polluted. Industrial discharge is one of the major source of pollution and it requires a tedious process to identify the correct culprit. Large amount of manpower is required to conduct water sampling followed by sending the samples to laboratory for analysis.

The cost involved to analyze the water samples also pose as one of the main challenges. Lab Analysis on heavy elements in water is very costly and hence leading to a high operational cost to monitor the river pollution .

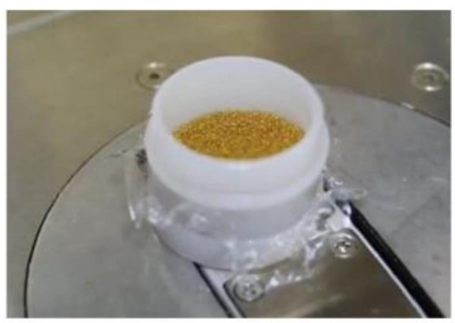
- ✓ Compatible with the requirements of US EPA 6200; EPA TCLP HAZMAT; ISO/DIS 13196; US EPA, NIOSH, and OSHA.
- ✓ Fully functional in temperatures ranging from 14 °F to 122 °F (-10 °C to 50 °C)*. Passed 4-foot drop test (MIL-STD-810G). IP54 rated.
- ✓ Optional wireless connectivity enables real-time data uploads and downloads, via the Olympus Scientific Cloud. Build in GPS.
- ✓ THREE (**3**) years warranty on hardware faulty.

How To Monitor the River Pollution:

Our Collaboration with National Taiwan University has successfully developed a method, with the use of the Olympus Portable XRF coupled with a special resin, we were able to perform a 'Cost Effective' monitoring on the water pollution from an Area to another Area. The method provided quantitative results that correlated with the laboratory results allowing the enforcer to determine the source of the pollution. This technology allows a more forensic approach to site assessment, eliminating high cost from higher frequency of sampling to monitor the pollution.

Shih, P. K., Chiang L. C., Lin, S. C., Chang T. S., Hsu, W. C. (2019). Application of Time-Lapse Ion Exchange Resin Sachets (TIERS) for Detecting Illegal Effluent Discharge in Mixed Industrial and Agricultural Areas, Taiwan. *Sustainability* 2019, *11*(11), 3129

Resin will absorb the heavy element in water



Resin was dried and direct measure by using XRF.

The Vanta portable XRF comes with dedicated modes and methods to test for Lead and heavy metals like Cd, Hg, Ti, Cr, As etc in Soil, Dust, Water, Wood, Ceramics etc.

Vincent Lee
Senior Executive, Product
Scientific Solutions Business Division (ANI)
Olympus Singapore

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crest

Gas Chromatography-Mass Spectrometry (GC-MS) for Food Safety Analysis

In order to protect consumers and the environment, monitoring the food supply to ensure levels of chemical residues and contaminants are compliant with statutory levels set by regulatory bodies is imperative.

Because regulations differ in different parts of the world, analytical food testing laboratories and food manufacturers must first navigate the complexity of regulatory frameworks before considering the analysis.

Detecting and quantifying many thousands of residues and contaminants from different chemical classes at potentially extremely low levels in diverse food commodities and products is very challenging.

This challenge is further complicated when we consider the following:

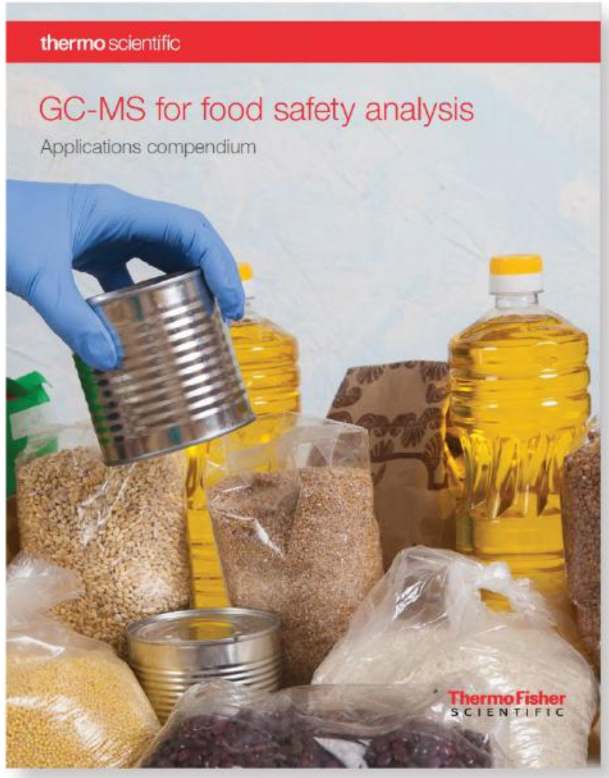
- Food products are traded in complex global supply chains, for which details of the history of products, such as cultivation, treatment, storage and processing, are often unknown
- The use of pesticides to protect crops from pests during cultivation, storage and transport will often leave detectable residues in food, while persistent organic pollutants (POPs) in the soil, water or in the air can contaminate crops
- Chemicals in food packaging materials can leach into the food

In this 149-page applications compendium, Thermo Fisher Scientific focuses on gas chromatographic solutions applicable to testing laboratories involved in food-related analyses.

Among the application notes in this compendium are:

- Rapid qualitative and quantitative analysis of residual solvents in food packaging by static headspace coupled to GC-FID/MS
- Simple and cost-effective determination of acrylamide in food products and coffee using gas chromatography mass spectrometry
- Ultra low level quantification of pesticides in baby foods using an advanced triple quadrupole GC-MS/MS system

Visit **thermofisher.com/GCMS-Foodcompendium** to download your copy of GC-MS for Food Safety Analysis - Applications Compendium.




Contents

Next page 3

Knowledge Exchange

Thermo Fisher Scientific, the world leader in serving science, is sharing knowledge with chemists, researchers, scientists and other laboratory professionals in Malaysia through virtual conferences and webinars. Check out these opportunities to connect, learn and exchange knowledge with experts worldwide!

2020 has been an unprecedented year and it is even more imperative for laboratory professionals to access online learning. Please check out the resources that Thermo Fisher Scientific has specially developed with international experts for you.

Ask the Expert on-demand webinars include:

Technology

- Simple to the CORE – The new Thermo Scientific Vanquish Core HPLC system
- Perform like a PRO, fast ICP-OES analysis with iCAP PRO Series ICP-OES
- Column Selection and Troubleshooting in Ion Chromatography
- Automated online µSPE clean-up to improve efficiency, robustness and productivity in LC- and GC-MS/MS analysis of pesticide residues
- Concepts for Application of New Instrument and Software Features for the Transfer of EP and USP Methods in HPLC
- Looking for the Right Technique for Your Trace Elemental Analysis?

Applications

- Isotope Fingerprints for Environmental Investigations
- Rapid and Reliable Environmental Wet Chemical Analysis
- Updating your Peptide Mapping and Glycan Analysis for Therapeutic Proteins
- Advances in Column Technology and Universal Separation Platform for Analysis of Monoclonal Antibodies (mAbs)

Scan the QR Code or visit **thermofisher.com/asktheexpert** to register:

One of the first online global event was the virtual LCMS Conference – an exclusive event on state-of-the-art mass spectrometry with a focus on Orbitrap technology and beyond.

We invite you to attend the on-demand virtual LCMS Conference which has a plenary presentation by Professor Alexander Makarov on "Designing the Smallest Ever Orbitrap Mass Spectrometer for New HRAM Applications".

You will learn and gain valuable insights from mass spectrometry experts about Orbitrap mass spectrometry technology and the applications it enables.

Register at **thermofisher.com/vlcms**

For laboratory professionals in the pharmaceutical industry, Thermo Fisher Scientific has developed a virtual learning series with thought leaders from across the world meeting to discuss and explore current and future trends in QbD and PAT and their impact on the laboratory of the future and its connection to manufacturing.

Register at **thermofisher.com/pharma4-0**

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- Welding & Joining Technology for Non-Welding Personnel Course
- Steel Technology for Non-Technical Personnel Course
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IMM Competency Certificate holders are recognised as possessing supplementary knowledge in materials technology and engineering and are better placed for employment, career advancement and usually enjoy higher remunerations.

For information on training and competency assessments contact IMM Secretariat.

www.iomm.org.my | +6018 911 3480 | secretariat@iomm.org.my | Institute of Materials, Malaysia

New Tenants at Wisma IKM

IKM Council welcomes new tenants at ground floor of Wisma IKM, Taman Tun Dr Ismail, Kuala Lumpur. Baba Ho Liao restaurant offers original baba nyonya cuisine meanwhile MeatCartel BBQ offers smoked meat.

Malaysian Journal of Chemistry (MJChem)

MJChem is a double-blind peer reviewed journal published by the Malaysian Institute of Chemistry (Institut Kimia Malaysia)
E-ISSN: 2550-1658

Scope

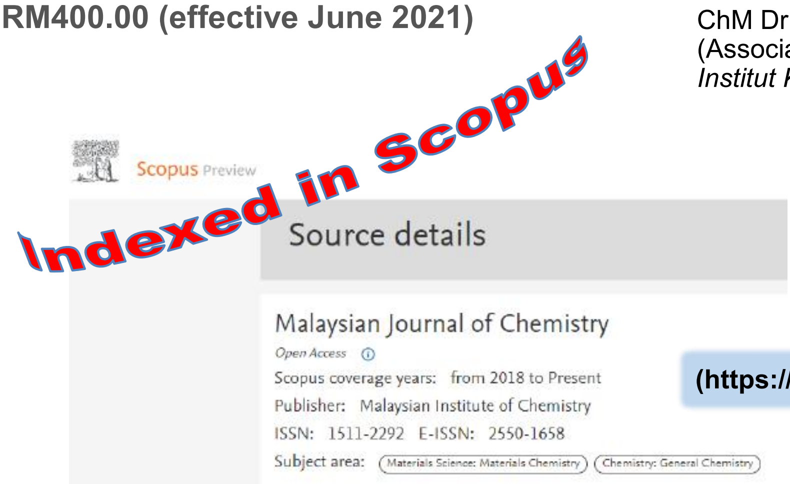
The Journal publishes articles on the following categories:
(i) Research Articles
(ii) Short Communications
(iii) Research Perspectives and
(iv) Reviews.

Article contributions including but not limited to, the following topics will be considered for publication:

- Analytical chemistry (Characterization and analysis)
- Inorganic chemistry (Organometallic chemistry)
- Materials chemistry (Solids, liquids, polymers)
- Nuclear chemistry (Radioactivity, nuclear properties and processes, such as nuclear transmutation)
- Organic chemistry (Structure, properties, composition, mechanisms and reactions of organic compounds)
- Physical chemistry (Chemical thermodynamics, chemical kinetics, electrochemistry, statistical mechanics, spectroscopy and more recently astrochemistry)
- Theoretical chemistry (Quantum mechanics, quantum chemistry, computational chemistry, computer programs)
- Nanotechnology
- Bioinorganic Chemistry
- Catalysts

Journal Website and Article Submission Information:
https://ikm.org.my/ojs/index.php/MJChem

Article publishing charges:
RM400.00 (effective June 2021)



(https://www2.scopus.com/sourceid/21100874945)

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Farah Liyana binti Mohd Rodin *L/3020/8974/21*
Farah Nabilah binti Shahbudin *L/3034/9021/21*
Hazim Ahmad bin Thajudeen *L/3022/8981/21*
Jocephine anak Jonip *L3005/8931/21*
Khor Hui Wen *L/3006/8934/21*
Lee Yi Xia *L/3011/8946/21*

New Licentiates (LMIC)
Mira Hazira binti Zaid *L/3023/8983/21*
Mohamad Ashiqeen bin Anwar Ali *L/3037/9025/21*
Mohamad Azuan bin Mohd Ashri *L/3021/8975/21*
Mohammad Ashraf bin Ahmad Suhairi *L/3024/8985/21*
Mohd Nornaim bin A. Razak *L/3015/8959/21*
Muhammad Ashraf bin Mohd Kahar *L/3028/9012/21*
Muhammad Khairi bin Abdul Rashid *L/3009/8944/21*
Muhammad Zulfadli bin Zamri *L/3004/8928/21*
Noor Atikah binti Momen *L/3038/9026/21*
Nor Fateha binti Azuan *L/3029/9014/21*
Nur Alia Qistina binti Muhamad Mahyuddin *L/3036/9023/21*
Nur Amira Aqila binti Abd Razak *L/3033/9020/21*
Nur Asyiqin binti Samsukamal *L/3018/8963/21*
Nur Atirah Sakinah binti Mohammad Ali *L/3031/9017/21*
Nurul Nabilah binti Ishak *L/3032/9019/21*
Rabiatul Adawiah bt Mohamad Nasruddin *L/3035/9022/21*
Siti Aishah binti Ishak *L/3008/8941/21*
Siti Sarah binti Zainal Abidin *L/3030/9016/21*
Sonja Sheena Jacob *L/3025/8988/21*
Soo Chan Wai *L/3026/8991/21*
Syafiran bin Imran *L/3012/8949/21*
Tan Khai Chen *L/3014/8958/21*
Tang Kar Huey *L/3027/9001/21*
Tang Xin Ting *L/3019/8968/21*
Wan Mohd Hilmey bin W. Mohd Arifin *L/3013/8953/21*
Zuraini binti Ilias *L/3001/8897/21*

Upgrade to Member (MMIC)
Amir Firdaus bin Shuhaimi *M/5561/5788/10/20*
Boo Wei Ping *M/5572/7052/15/20*
Chew Chee Siu *M/5570/7843/17/20*
Fathin binti Karudin *M/5560/7852/17/20*
Fatim Neni Heryatie Binti Anwar *M/5566/7969/18/20*
Foo Zhi Ling *M/5569/8738/20/20*
Jagath Retchahan a/l Sivalingam *M/5559/7832/17/20*
Low Yun Yee, Dr. *M/5567/6807/14/20*
Mazrina binti Sari Hasan *M/5562/7096/15/20*
Mohd Safuan bin Che Baharom *M/5563/6448/13/20*
Nur Hajjar binti Kamaruddin *M/5564/5316/08/20*
Nurul Atikah binti Mohd Amin *M/5568/8527/19/20*
Suhaila binti Johari *M/5565/6439/13/20*
Yap Poh Siew *M/5571/7453/16/20*

Upgrade to Fellow (FMIC)
Chin Teen Teen, Dr. *F/0126/2772/97/20*

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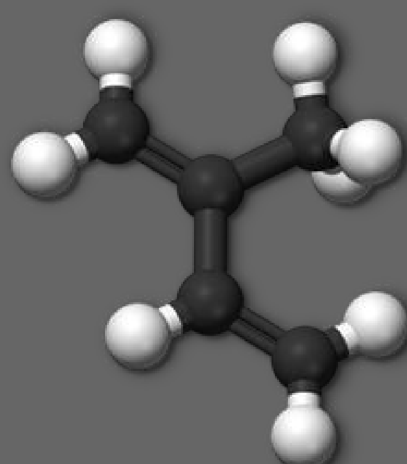

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