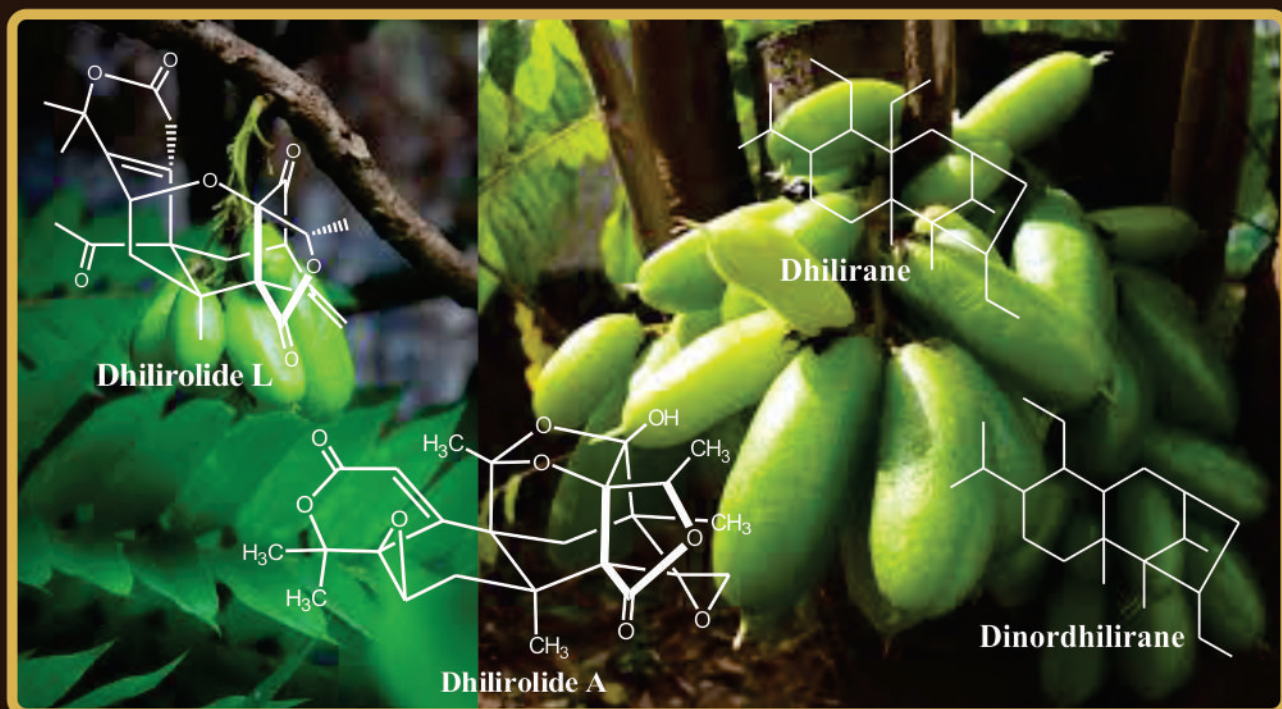


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YEARS
1941-2016

CHEMISTRY

IN SRI LANKA



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Institute of Chemistry Ceylon
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Chemistry in Sri Lanka

ISSN 1012 - 8999

The Tri-Annual Publication of the Institute of Chemistry Ceylon

Founded in 1971, Incorporated by Act of Parliament No. 15 of 1972

Successor to the Chemical Society of Ceylon, founded on 25th January 1941

Vol. 33 No. 3

September 2016

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Theme for the year -

Role of Chemists for a Better Tomorrow

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Outline of our Institute

The Institute of Chemistry Ceylon is a professional body and a learned society founded in 1971 and incorporated by act of Parliament No. 15 of 1972. It is the successor to the Chemical Society of Ceylon which was founded in 1941. Over 50 years of existence in Sri Lanka makes it the oldest scientific body in the country.

The Institute has been established for the general advancement of the science and practice of Chemistry and for the enhancement of the status of the profession of Chemistry in Sri Lanka. The Institute represents all branches of the profession and its membership is accepted by the government of Sri Lanka (by establishment circular 234 of 9-3-77) for purposes of recruitment and promotion of chemists.

Corporate Membership

Full membership is referred to as corporate membership and consists of two grades: **Fellow (F.I.Chem.C.)** and **Member (M.I.Chem.C.)**

Application for non-corporate membership is entertained for four grades: **Associate (former Graduate) (A.I.Chem.C.)**, **Licentiate (L.I.Chem.C.)**, **Technician (Tech.I.Chem.C.)** and **Affiliate Member**.

Revision of Membership Regulation

All Special Degree Chemists can now apply directly to obtain **Associate (Graduate) Membership**. Three year B. Sc. Graduates (with an acceptable standard of Chemistry) can

- directly become **Licentiate**
- obtain corporate membership in a lesser number of years.

Tech.I.Chem.C.

Those who have passed the DLTC examination or LTCC examination or have obtained equivalent qualification and are engaged in the practice of Chemistry (or chemical sciences) acceptable to the Council are entitled to the designation Tech.I.Chem.C.

Members/Fellows are entitled to the designation of **Chartered Chemist (C.Chem.)** on establishment of a high level of competence and professionalism in the practice of chemistry and showing their commitment to maintain their expertise.

All corporate members (Members / Fellows) are entitled to vote and become Council/ Committee members whether Chartered Chemists or not.

Membership Applications

Any application for admission to the appropriate class of membership or for transfer should be made on the prescribed form available from the Institute Office.

Current Subscription Rates

Fees should be paid on 1st of July every year and will be in respect of the year commencing from 1st July to 30th June

Fellow	Rs. 1500
Member	Rs. 1500
Associate	Rs. 1200
Licentiate	Rs. 1000
Technician	Rs. 500
Affiliate	Rs. 1000
Membership for Life	Rs. 15000

Entrance Fee

All the grades	Rs. 1000
Processing Fees*	Rs. 500
Processing Fee for Chartered Chemist designation	Rs. 1000
Institutional Members	Rs. 2500

*per application for admission/transfer to any grade

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CHEMISTRY IN SRI LANKA

Chemistry in Sri Lanka is a tri-annual publication of the Institute of Chemistry Ceylon and is published in January, May and September of each year. It is circulated among the members of the Institute of Chemistry and students of the Graduateship/DLTC course and libraries. The publication has a wide circulation and more than 1000 copies are published. Award winning lectures, abstracts of communications to be presented at the annual sessions, review papers, activities of the institute, membership news are some of the items included in the magazine.

The editor invites from the membership the following items for publication in the next issue of the Chemistry in Sri Lanka which is due to be released in January 2017.

- Personal news of the members
 - Brief articles of topical interests
 - Forthcoming conferences, seminars and workshops
 - Latest text books and monographs of interest to chemists
- All publications will be subjected to approval of the 'Editorial and Publicity Committee' and the Council of the Institute of Chemistry Ceylon.*

Further, prospective career opportunities for chemists, could be advertised in Chemistry in Sri Lanka at a nominal payment. The editor welcomes from the members suggestions for improvement of the publication.

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Chemistry of the Cover

A novel class of highly rearranged meroterpenoids, “Dhilirolides” has been isolated from the pathogenic fungi, *penicillium purpurogenum*, isolated from the infected fruits of *Averrhoa bilimbi* (Biling in Sinhalese).

(refer pages 13-17)

Role of Chemists for a Better Tomorrow

Dr. Poshitha Premarathne, *C.Chem., F.I.Chem.C.*

President-Elect, Institute of Chemistry Ceylon



The world we live in faces serious unprecedented changes continually. These changes impact on the rising population world over and are compounded by realities of climate changes, our fragile environment and our ever depleting natural resources.

This in mind therefore there is a vital role that the chemical sciences will have to play over the coming decades in addressing the global challenges faced by our human society and other terrestrial and marine fauna and flora.

It would be the profound duty of an enthusiastic, innovative and motivated scientific community to undertake these challenges to face the future. Thus emerges the all important role the chemical scientists have to strive towards bringing a better tomorrow for us all.

A large amount of observations and views have been gathered from scientific findings over decades and I wish to highlight a few key areas of enormous challenges that lay ahead for the scientific fraternity to solve. Challenges relating to and opportunities for chemical scientists are in sectors such as water, air, soil, energy, food, human health and medicine among many others.

With population growth there is a greater demand on water supply. Be it for domestic use, agriculture or industry. Poor quality drinking water damages human health. Chemical sciences alongside engineering should play a role in sustainable management and distribution of clean, good quality water as a priority. This could be achieved from many avenues, such as adopting, principles of green chemistry, integrated pollution prevention and controlling industrial manufacture, in order to reduce waste, energy and water usage.

Increasing anthropogenic emissions, mainly due to human activities are affecting air quality and are contributing to climate change and human health. Chemical science has an important role to play in understanding the chemistry of the atmosphere and the

impact of these emissions and devise methodologies to prevent further changes.

A secure, sustainable energy supply is as essential (as is good quality water), for almost every aspect of our lives and it has to be achieved without causing adverse environmental impact. Current fossil fuel usage in the petroleum industry suggests that it is unsustainable and is associated with it the production of greenhouse gases, which depletes the protective ozone layer. More efficient use of fossil fuels and their by – products is needed, however not at the expense of tarnishing the atmosphere. Solar energy – as imparted by the Sun has been seen to provide the earth with over 100,000 TW of energy, which is abundantly more than the global annual fossil fuel consumption rate. Harnessing this free sustainable clean energy for heating and electricity generation is an area for development and application for chemical sciences.

At a time when the world population is on the rise there will be a concomitant rise in demand for food and potable water. Limited land for agriculture and water availability is a constraint facing food production for a growing population. Therefore a sustainable increase in agricultural productivity has to be practiced. Various sub sections of agriculture, such as soil science, plant science, pest and weed control, irrigation, aquaculture, livestock management, effective farming etc are challenging areas, thus creating opportunities for chemical sciences. Chemists can play an important role to provide a secure, nutritious, safe and affordable food supply as well.

Towards a better tomorrow, Chemical sciences can and will play a leading role, as in improving and maintaining accessible health, disease prevention, hygiene and infection, diagnostics, drugs and therapies, prosthetics, personalized medicines, traditional medication, targeted drug delivery systems *etc.*

A renowned pharmacologist - Sir James Black once stated that, “Science is a gradual progression that requires building on the work of others”.

This is an ongoing process and there are many scientists and technologists already engaged in development work in keeping with the theme “Role of Chemist for a better tomorrow”. As new challenges are emerging, so are the opportunities created for Chemists.

Message from the President



I thought of making use of the opportunity given to me to write this article to comment on the Council theme for 2016/2017; that is **“Role of Chemists for a better tomorrow”**, a theme that encompasses a wide area related to chemists and society at large and also to outline, in brief, some of the main issues confronting the Institute of Chemistry Ceylon (ICChemC).

Role of Chemists and Allied Professions

Chemistry as a subject and Chemists as a profession are closely linked and need to be given due recognition in society. ICChemC has a major role in taking this message forward. It is an accepted fact that Chemistry is a central science, that Chemistry is everywhere; it is part of any sphere of life, be it agriculture, industry or even the household. However, the public perception of this subject (the image as it were) is not in keeping with the contribution made by those practicing the profession where chemistry plays a major role.

One of the most important functions of the new Council would be to take the message based on the theme to the next level through adequate publicity, to create an awareness amongst the public regarding the role of chemists in matters such as quality, quality assurance of consumer products including their safety *etc.* The Chartered Chemist could play a decisive role in such matters given the authority (empowerment as it were) to assure the public through an appropriate certification process of all consumer products. The award of the **Chartered Chemist (CChem)** designation recognises the experienced practising chemist who has demonstrated an in-depth knowledge of chemistry, significant personal achievements based upon chemistry, professionalism in the workplace and a commitment in maintaining technical expertise throughout the professional development.

The word CHEMICAL drives a sense of fear (dangerous/unsafe) in many ordinary people; it is a myth that we need to break by a concerted effort at providing necessary education, informally perhaps using the powerful media, electronic, print and now, the

social media as well. We need to highlight the fact that two of the most important chemicals are water and oxygen /air (there will be no life without them, right?). Carbohydrates, Vitamins, Proteins *etc* are all associated closely with chemistry and life itself. The fact that we are eating and breathing chemicals is taken for granted by the general public and is therefore, not appreciated. Be it pharmaceuticals/drugs, plastics, petroleum, food technology or any other industry, the chemist plays a key role in research and related activities in the development of such industries.

A great degree of responsibility lies with our membership; we need to wake up and generate sufficient publicity among the masses so as to enable us to establish a powerful arm in the national arena, a body that could exercise its authority thorough an assurance board of chartered chemists. We need to address national issues by writing appropriate articles to the daily newspapers, organize TV interviews to address the public on matters of national importance (the question of kidney diseases, use of agro chemicals *etc*); the chemists have to come to the fore and be counted. There must be regular exchange of ideas and debate of national interest relevant to us at ICChemC. We cannot afford to wait for "things to happen"; rather we should "make things happen". It is time for some positive action or shall I say, reaction (perhaps with a catalyst) for action to take place. We need to identify and motivate the members to come forward in this endeavour which would benefit both the profession as well the general public.

Space Constraints at ICChemC – Land at Malabe

With the increase in demand and popularity of the two main education programmes on offer, GIC and DLTC, we have an acute shortage of space to carry out all our academic programme and other student and staff activities. We are very happy to report that the UDA land (80 perches at Malabe) has been approved and that we would be in a position to start the building project immediately taking all aspects of our space requirement into consideration. No doubt, it is a gigantic task. May I, therefore, appeal to all of you to assist us in this very important endeavor. Council would give top priority for this activity immediately.

The way forward – support of all

Finally, I wish to make an appeal to all our staff,

members, parents, students, the Alumni, and all well wishers to extend your fullest support in carrying forward the objectives of the CCS and the IChemC. Certainly, we would welcome your moral and financial support for the future. (especially when our new building project comes into operation). Many plans are

in the pipeline and I hope and pray that all of you would help us to achieve these.

M.R.M Haniffa
President/IChemC

~*~

Forty Fifth Annual Sessions and Seventy Fifth Anniversary Celebrations 2016

Presidential Address

K R Dayananda, *Grad.Chem., F.I.ChemC, C.Chem., M.Phill.*
Immediate Past President, Institute of Chemistry Ceylon



In my address, I wish to take you through the last 75 years of the history of the Institute; as you know we are celebrating the 75th anniversary, commencing with the Chemical Society of Ceylon, the predecessor to the Institute of Chemistry Ceylon. We are also holding the 45th Annual Sessions of the Institute of Chemistry Ceylon today, having recorded many remarkable achievements in its long journey.

The Chemical Society of Ceylon was formed in 1941, in the middle of the World War II, a result of a determined group of great chemists led by Dr. N G Baptist. It is reported that the first meeting of the Chemical Society was held in June 1941, exactly 75 years ago. Professor Kandiah, the first President of the newly formed Chemical Society had the great ability to muster the academic colleagues in the chemistry department in this endeavor. The first meeting of the chemical society had 36 members who came from sub disciplines of chemistry, representing academics, and representatives of the research sector in the country. To mention the names of some of our forefathers, Dr N G Baptist, Professor A Kandiah, Mr. H Balfour, Dr. R Child, Mr. D A Bruce, Mr. N R Chanmugam, Dr. L Fonseka, Dr. A W R Joachim, Dr A A Hoover and Dr. R Child, and a few more, all chemists, of high caliber.

It is to the credit of the Chemical Society of Ceylon, the chemists who took the next bold step of getting all scientists in Ceylon, under one umbrella by

setting up the Ceylon Association for the Advancement of Sciences in 1943, currently known as the Sri Lanka Association for the Advancement of Science (SLAAS). The Honourable Minister of Finance and Planning, Mr. Ronie De Mel in 1986 recognizing the role of the Chemical Society of Ceylon at the inauguration of the Annual Sessions remarked that “one would normally expect the SLAAS to be the parent body bringing into being specialized Institutes in the various sciences; it is apparent that Sri Lankan Chemists can produce a chicken before an egg”. The Institute of Chemistry Ceylon has two annual memorial awards for research, Kandiah Memorial award and Devanathan Memorial Silver award recognizing the contributions made by the two distinguished Presidents of the Chemical Society of Ceylon. Many chemists in the universities and research institutions, some of whom are in the audience today, are recipients of these awards for their excellence in chemical research in the respective areas. I am sure that there are others in this audience who are much more familiar with the contributions made by the Past Presidents of the Chemical Society of Ceylon, for the benefit of all of us, the chemists. Among them are our Chief Guest Professor E R Jansz and the two distinguished scientists, Dr. R O B Wijesekara and Mr. T Kandasamy, who are not in the audience today, have done enormous amount of work as Presidents to record the history of the development of Sri Lankan chemistry through the Chemical Society of Ceylon and the Institute of Chemistry Ceylon. Mr. Kandasamy is presently in Canada but has sent his greetings today, and I am sure that he is with us in heart and mind.

During the decade, 1950 to 1960, the Chemical Society of Ceylon worked very hard for the development of chemical industry in Sri Lanka. At the

same time paved the way for the formation of the Sri Lanka section of the Royal Society of Chemistry (RSC), UK. I am glad to record here that Sri Lanka Section of RSC is playing a very supportive role with our institute from the time of its inception, and our Graduateship qualification is highly recognized by the RSC. RSC has granted accreditation to us since 1991 and recommend our qualification is in par with the Special Degree in Chemistry, awarded to graduates by any of the Universities for the purpose of enrolling for postgraduate studies, and in recruitment for employment, with greater respect outside Sri Lanka than in Sri Lanka. However, I am of the firm opinion that hundreds of students learning chemistry under the Adamantane roof today, possess the strength to prove their worth when they step into the society, armed with their qualifications. It has been the case so far and it would be the same or better in time to come.

In the year 1971, under the leadership of Dr. M A V. Devanathan, the last President of the Chemical Society of Ceylon, and his capable young secretary Dr. E R Jansz, who had just returned with his PhD degree from Canada, laid the foundation for the transformation of the Chemical Society of Ceylon to the Institute of Chemistry Ceylon through an Act presented to the Parliament by the member of the Parliament from Beliaththa, Mr. Mahinda Rajapaksa. Finally, the Act was approved on 15th April 1972, adding to the celebration of the traditional Sri Lankan new year. This Act was one of the last legislation to be enacted by “Her Majesty’s Parliament” before Ceylon became the Democratic Socialist Republic of Sri Lanka on 22nd May 1972. With State recognition through the Act of Parliament, the Institute of Chemistry Ceylon geared up her activities with increased vigour to serve the Sri Lankan chemical education sector and the chemical industry. In the following years, Dr. Jansz continued to be the secretary till 1974 under the presidencies of Dr. Senthe Shanmuganathan and Mr. E B Dissanayake respectively, providing much needed fuel to make the engines work efficiently. It is reported that the Council meetings were held at the Ceylon Institute of Scientific and Industrial Research (Currently ITI) library. The secretaries were responsible in addition to normal functions, to serve as the Editor, to handle the International relations, while engaged in laying the foundation for the educational activities.

In 1973, the then President Dr. Senthe Shanmuganathan, with Dr. Jansz, Professor Ramakrishna and several other chemists completed the groundwork for setting up of the first Laboratory

Technicians Training Course (LTTC) of the Institute of Chemistry, meeting a long felt dire need to strengthen the chemistry knowledge and the skills of the technicians serving the universities and the industries. Dr. Senthe Shanmuganathan was the first coordinator of the programme and Dr. Jansz, Professor Ramakrishna and Mr. Dissanayake playing leading roles. The responsibility of coordinating the programme continued to be with eminent and committed chemists, Dr. Senthe Shanmuganathan, Dr. E R Jansz, Dr. J N O Fernando, Dr. P M Jayatissa, Dr. M Coomaraswamy, Mr. M Thevendra, Mr. K Sivarajah and present Coordinator Mr. E. G. Somapala, who I believe has held this position for the longest period, and made notable structural changes to the course to suit the current needs of the industry and the medical laboratory sector, during the last two to three decades. Since 1985, the Institute has recognized the importance of the laboratory technicians by way of adding a new grade of membership category, the Technician Membership.

We are proud that our Institute is the only such institute producing graduates at a minimum cost, compared to other institutions in Sri Lanka. This point was well explained during the last presidential address at the SLAAS by its President Professor Deepal Mathew. As one of the alumni of the LTTC and the GIC, I must emphasize that uplifting of professional standards of chemical education initiated in the era of 1970s had made remarkable impact and I am proud to say our Graduate Chemists and Technicians shine equally well with other Chemistry graduates in many countries including USA, UK, Canada and Australia. While we as alumni are much proud to see the progress made by the Institute through the formal educational programmes, Diploma in Laboratory Technology in Chemistry (DLTC) and GIC initiated in 1970s, the senior chemists whom I mentioned earlier, also made the maximum effort to place our products in respectable positions in the industry and among the academia, in addition to imparting the knowledge to us as teachers. As the President of the Institute, I bow down my head to all of them.

I must place in record today, the SLAAS gave their willing hands to us in providing the office space and facilities for our activities continuously from 1971, till we moved to our own Adamantane House in 2005.

I should say during the early 1990 and 2000, the Institute made huge strides to have our own building to house our academic programmes, which was the dire need of the time as the two educational programmes

were so demanding, and improved facilities under one roof were needed to strengthen the two educational programmes, instead of having lectures, practical and library facilities provided in different locations. We are fortunate today that we were able to secure a land and built the Adamantane House due to the untiring efforts of two chemists. The land deal was successfully completed by Professor Upali Samarajeewa in 1999. Then Professor Tuley de Silva under the guidance of Professor J N O Fernando, established the College of Chemical Sciences (CCS) as the dedicated education arm of the Institute of Chemistry Ceylon, in 2002, a much felt need since 1990. Untiring efforts of Mr. Mevan Pieris, one of our another dynamic past President took the leadership in the building committee to complete the present Adamantane House where we are today. The newly constructed building was opened by Dr RO B Wijesekara in 2005.

Initiatives taken by Professor J N O Fernando in 1980s allowed school children to take part at the annual quiz competitions- interschool as well as the Australian Chemistry Quiz. I must place on record the commitment of one of our past presidents, Mr. N I N S Nadarasa who has dedicated his retired life from the Department of Government Analyst, for the chemistry quiz programme along with several other engagements at the Institute. I trust his inspirational, constructive ideas will continue in the future. We are indeed fortunate to have with us persons of his caliber at the Institute.

Year 2015 dealt us with the biggest blow faced by the Institute, when we had to bear the loss of our leader, Professor J N O Fernando who was the pillar of strength behind the success of the educational programmes of the Institute. The vacuum created by the demise of Professor Fernando at an unexpected moment, on 2nd March 2015, is not easily filled. Personally, I feel a great sense of loss in my current position as president, as he is the one who groomed me to take up this responsibility.

We dedicated the last issue of our journal “Chemistry in Sri Lanka”, containing 20 articles to the late Professor Fernando as a tribute. It is the first time that a full journal issue was dedicated to the name of a person for his creativeness and contribution to the education. The journal was presented to Mrs. Mandrupa Fernando, who was the force behind Professor Fernando; her presence in many of our functions is very much appreciated. The first death anniversary of Professor Fernando was celebrated with several religious activities, and “Professor J N O

Fernando Fund” was established to take forward his wishes to the future.

I have taken a few leaves from the life of my guru and wish to place couple of his principles before this august audience.

- Never use the word cannot, when you are expected to do good.
- Your opposition may be very strong, may come out with many reasons, if what is said by them are against your principles, stand firm by your principles.

It is heartening to see the long expected fruits of the Institute of Chemistry Ceylon ripening to feed the future chemists. Our graduates who have obtained doctoral and Masters' degrees from foreign universities are returning to serve the motherland, armed with their new qualifications and widened experiences. It is time for them to be a part of the team responsible for taking forward the institute to higher levels of professionalism. We have with us more than 50 such persons serving the academia at the Universities and the Institute of Chemistry Ceylon, and in various scientific administrative positions. The young postgraduate qualification holders should be glad that we have with us a large number of senior academics and industrialists with much experience to guide young academics.

Professor Samitha Deraniyagala accepted our invitation to serve as the Rector of the CCS even though he has lots of commitments elsewhere in other capacities; the Council felt that he was the one who could take over the position previously occupied by our great leader late Professor J N O Fernando. I wish to thank him for his commitment shown during the year and a half, despite all other responsibilities he has. Furthermore, Mr M R M Haniffa, the Dean and the President elect, my successor (who will be taking up duties as President in July) is a live wire who not only looked after his normal duties at the CCS as the Dean but also assisted me in many ways and made my work a pleasant one as the President. Professor M D P De Costa who has now spent over four decades at the Institute contributed to the success of the many activities of the Institute. Actually speaking as the President, I have not tried anything extraordinary but tried my best to maintain the high standards set by the Institute over the years. In this regard, I must confess that I am happy to have done my best during the past year.

A land from “Science Park” in Malabe is offered to

us, by the UDA on our request, but there are delays in this regard due to the procedures that have to be followed. I am hopeful that this land would be made available soon. Plans are already underway for a complete academic complex, a well-structured campus of our own.

At present we are a fully-fledged accredited academic institution to award the equivalent of a BSc special degree in chemistry, accredited by the Royal Society of Chemistry of the United Kingdom, which is of international standing. However, we are also working on accreditation from the national system for the betterment of our graduates with improved prospects of employment in the public sector.

Our ambition is not only to arm our students with a high level of chemistry knowledge, but also the cultural values, professional norms, and moral standings so that they may become better professional chemists ready to

contribute to the national wellbeing through teamwork. We selected this year's theme "Ethics, values and responsibilities of chemists for national development" with our long term aims and objectives in mind.

Finally, I wish to highlight an important message for the general membership and the members at the head table regarding the status of chemists.

As chemists, we also should acquire the necessary legal authority to ensure the quality of products entering the market; that is, to prevent the production of substandard, unsafe and adulterated products. The body of chemists (**Chartered Chemist - CChem**) can play a dominant role in this regard so that the consumers are safeguarded. Chemists are the silent workers and the hidden hands behind most of these developments; unfortunately, they are not given due recognition nor are they honoured appropriately.

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Chief Guest's Address

Emeritus Professor E. R. Jansz, *BSc (Hons), F. I.Chem.C., FNASSL, PhD, DSc (Honoris Causa)*

Past President, Institute of Chemistry Ceylon

Former Director, Ceylon Institute of Scientific and Industrial Research



Ladies and Gentlemen,

It was with mixed feelings that I accepted this invitation. Firstly, I was happy as both the President, IChemC and one of the Joint Secretaries were my postgraduate students and also from the GIC. I was surprised too, as this was the very first time I was invited to be the Chief Guest at any event of this Institute, despite being a senior member for some decades. Then when I heard that Dr. Senthe Shanmuganathan may be asked to be the Guest of Honour at this same event I felt that it might be inappropriate as Dr. Senthe was much more senior to me and a much better speaker. Further, as my speaking voice has been affected by an affliction, I was reluctant at first to accept the invitation. However I decided to give it my best effort as I have something to contribute as a scientist, especially in view of the questions besetting the Institute at this time.

One of the questions is whether to continue the GIC as a professional qualification or to redesign it as a B.Sc. in Chemistry. The latter would need recognition

by the UGC or a Ministry of Education, which incidentally can be given or for that matter taken away, the latter more easily, in my opinion. The main issue here is the course content for recognition. This has to be looked into in a holistic manner.

The present GIC has a good basic structure. (Shown below)

1. Credit courses and GPA
2. Basic courses in allied disciplines – Physics, Maths, Biology
3. Fundamentals of Chemistry Level 1,2
4. Level 3, 4 in Chemistry
5. Levels 3, 4 in Applied Chemistry with options.

The problem may lie in

- a) Pruning unnecessary areas
- b) Filling Gaps

This is the field of experienced scientists and also young post graduates coming from abroad.

My opinion is that it is better for the GIC to remain as a professional qualification for the following reasons.

1. It is recognized in the private sector and in many universities and it is also recognized abroad.
2. A B.Sc. may be equivalent to one that is given by

smaller institutes that now exist in Sri Lanka.

3. We can continue to give technicians' courses as stand-alone courses as before, which may be more difficult if we are to offer a mainly B.Sc. Chemistry course.
4. The course unit system at present need not undergo any drastic changes.

And now, to change the topic;

Your theme seminar this year is on "Ethics, Values and Responsibility of Chemists in National Development". This is a vast topic and is scheduled to be covered in half a day. Ethics and code of conduct are of course a long felt need for any development.

I will confine myself to an area with within I am conversant, that is food and nutrition. In the media you find articles which I find confusing for example Vitamin and Mineral content of fruits. There is no reference given to the amount to be consumed and the percentage Recommended Daily Allowance (RDA). The consumer is therefore being misled not only by the writer but also by the print media. There is a Right To Information (RTI) but it is the right to information that does not puzzle the reader. The articles must quote the qualifications, the writer must have in the field if it comes from his/her work. If it is, for example, from a website, the site must be quoted. This is all a matter of ethics.

Another case is CKDu (Chronic Kidney Disease of uncertain aetiology). It is now known that it is simply caused by solubles in the soil, leached by water. The solution given is to provide pure water.

The problem of ethics comes in when studies on this problem of farmers of the fatal kidney disease give rise to large amounts of funds for research, over some

years. Much of the research was focused but there was also "carpet bagging" according to a very authoritative source in a major newspaper, which has gone unchallenged. This "carpet bagging" refers to research done to further personal needs of ambition and the solution to the major problem is secondary. This is a problem of ethics. The kidney disease afflicts farmers providing a staple food.

In both cases quoted, the breach of ethics would affect National Development as we need healthy people in a healthy nation. This is just a few of the cases but I should not go on.

Once again I thank the President, members of the Council for inviting me and you, ladies and gentlemen for tolerating me!

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Graduate Chemists Welfare Fund

This fund has been established with effect from 1-1-2012. The principal benefits towards CCS Graduate Chemists would be,

- I. To provide partial assistance towards international travel of those proceeding abroad for PG degrees (once a life time). Assistance for
Active Graduate Chemists : Rs. 60,000 Passive Graduate Chemists: Rs. 30,000
- ii. To provide partial assistance towards registration fees in respect of IChemC /CCS events such as international Conferences.
- iii. To provide assistance towards registration fees for IChemC /CCS training seminars etc.
- iv. To provide partial assistance towards activities of the Alumni Association.

Note : Depending on the demand, Graduate Chemists who maintain positive contact and participate in IChemC/Alumni activities will get preference for the above mentioned assistance scheme.

Distinguished Service Award - 2016

Emeritus Professor Upali Samarajeewa, *C.Chem., F.I.Chem.C.*



Emeritus Professor Upali Samarajeewa obtained a Bachelors' degree in Chemistry (1970), and a PhD in Microbiology (1975) from the University of Peradeniya. At present, he is the President of the Institute of Food Science & Technology, Sri Lanka.

He has served 5 years as a research officer at the Coconut Research Institute. In 1981 he joined the faculty of Agriculture, University of Peradeniya and retired as a Senior Professor in 2012. Professor Samarajeewa was the founder Head of the Department of Food Science & Technology at the University of Peradeniya.

During his tenure at the University of Peradeniya he has carried out research in many disciplines such as aflatoxins, histamine in fish, polycyclic hydrocarbons in foods. He has an impressive research record with over 75 publications in internationally refereed journals and over 125 communications at conferences and meetings. He has contributed for about 15 chapters in books and reports at the international level.

Professor Samarajeewa's association with the Institute can be traced back to 1970 where he was a participant at the first Annual Session of the Institute of Chemistry Ceylon held in 1970 at the then CISIR. He has been a member of the Institute since 1981, a Council member on many occasions during the period from 1985 to 2001, the Vice President on three occasions and the President during the period 1998/1999. During his presidency, he successfully negotiated to secure the land where Admantane House is now located. The plan for the building was also proposed during his tenure and it is a fitting tribute for the Institute of Chemistry Ceylon to confer the distinguished service award at this ceremony. During his tenure as the President he has organised several workshops and conferences on Food safety, Ethics in Chemistry, Global food trade and accreditation of laboratories.

Professor Samarajeewa was the recipient of the Institute of Chemistry Ceylon Gold medal for his research on "Coconut Products", the General Research Committee Award of the SLAAS for the most Outstanding Research Contribution to Sri Lankan

Science for research on "Aflatoxins", the National Award for Agriculture Research from the Council for Agricultural Research Policy and Ministry of Agriculture for "Investigations on deposition, formation and control of polycyclic aromatic hydrocarbons in coconut kernel products during processing in relation to food safety", and two merit awards for research from the National Science Foundation.

In addition to his contributions to the Institute of Chemistry he has been an active member of the SLAAS where he was the General President in 2000. He was the Founder Chairman of the Council, Sri Lanka Institute of Food Science and Technology in 2011 and was the General President of this institute in 2014/2015. He was a Council member of the Nutrition Society. He was a Senior Fulbright Scholar where he served as the Adjunct Professor in the Food Science & Human Nutrition Department, University of Florida.

He has served in 23 countries as an International Consultant for United Nations Industrial Development Organization, World Bank, and Asian Development Bank in the fields of chemical and microbiological laboratory accreditation, food safety, and curriculum development in Food Science and Technology. He was a member of the Editorial Board of Food Microbiology published by the Academic Press Inc. (London) Ltd. England and a founder member of Afro-Asian Federation of Food Science and Technology Institution, CFTRI, India.

In recognition and appreciation of his long and dedicated services to the progress of the Institute of Chemistry Ceylon, Emeritus Professor Upali Samarajeewa was awarded the "Distinguished Service Award" at the 45th Annual Sessions of the Institute of Chemistry Ceylon in 2016.

Distinguished Service Award - 2016

Deshabandu Emeritus Professor Kuruneruge Tuley Dayananda De Silva

D.Sc. (Hon.C), Ph.D. (Manch), M.Sc. (Manch), B.Pharm. (Lond), B.Sc. (Cey), C.Chem., F.I.Chem.C.



Professor Tuley De Silva is currently serving as the Chancellor of the Wayamba University of Sri Lanka and the Research and Development

Consultant on Herbal Healthcare Products at the Link Natural Products (Pvt) Ltd.

Professor Tuley De Silva obtained a B.Sc. Honours in Chemistry from the University of Ceylon (1960) and B.Pharm from the School of Pharmacy of the University of London, UK. He obtained his M.Sc. by Research (1969) and PhD (1971) from the University of Manchester, UK. After obtaining his PhD, he joined the Vidyodaya University, currently known as the University of Sri Jayewardenepura and was appointed Professor of Chemistry in 1976. He served as the Head of the Department of Chemistry and the Dean of the Faculty of Applied Sciences. Professor Tuley De Silva has many publications in peer reviewed journals and presentations at International conferences. Considering his dedicated service to the University, he was awarded with "Professor Emeritus" in 2012.

He was a visiting Professor at the University of Maryland, USA and the Pharmaceutical University of Shenyang, China. He served as the special technical adviser of the Chemical Industry Section of the United Nations Industrial Development Organization (UNIDO), Vienna, Austria and former consultant of International Center for Science and High Technology, Trieste, Italy. He was the former Director of the Bandaranaike Ayurveda Research Center. He was the President of the Sri Lanka Association for the Advancement of Science and the Pharmaceutical Society of Sri Lanka.

In recognition of his commendable service to the Nation, the Government of Sri Lanka honoured him with the title of "Deshabandu". In recognition of his dedicated service to the University education, to research and industrial development, and to international services, Professor De Silva was awarded with the D.Sc. (*Honoris Causa*) by the University of Sri Jayewardenepura.

Professor Tuley De Silva contributed to the

development of the Institute of Chemistry Ceylon as a member of the Council for over 10 years. He was a member of the other committees of the Institute such as Admission and Ethical Practices Committee, House, Finance and Membership Committee, Board of Trustees, Committee for the History of the Institute, Education and Publicity Committee, Royal Australian Quiz Committee, Awards Committee, Building Project Committee, Committee of Training Seminars and Workshops and Academic Board of the College of Chemical Sciences. Professor Tuley De Silva served as the Vice President of the Institute in 1998/1999, the President Elect in 1999/2000, and as the President for two consecutive Council years in 2000/2001 and 2001/2002. The Diamond Jubilee celebration of the Chemical Society of Ceylon, the predecessor of the Institute of Chemistry Ceylon was held under his leadership in 2001. As the President, Professor Tuley De Silva played a major role in establishing the College of Chemical Sciences, the educational arm of the Institute. During his presidency in 2002, under the theme "Integrated Chemical Education to meet emerging challenges in the New Millennium", Chem-Tech 2002 exhibition on Science and Technology was held. Professor Tuley De Silva introduced Training Seminar and Workshops to the Institute, and they are being continued to date by the Institute and the College.

In recognition of the services rendered towards the activities of the Institute in an honorary capacity, Deshabandu Professor Tuley De Silva was awarded the "Distinguished Service Award" at the 45th Annual Sessions of the Institute of Chemistry Ceylon in 2016.

Dr. C L de Silva Gold Medal Award

Awarded for an outstanding research contribution in any branch of Chemical Sciences and/ or the use of such research for National Development during the last five (5) years in Sri Lanka. Credit will be given for the utilization of local raw materials, and where the contribution has already resulted in;

- (i) a publication in a Citation Indexed Journal or
- (ii) Registering a Patent or
- (iii) where the contribution has already resulted in a positive impact in the development and innovation in the industry.

Dr. C L De Silva Gold Medal Award 2016



Professor E Dilip de Silva is a retired Senior Professor and he held the Chair of Organic Chemistry at the University of Colombo. He received his BSc Special Degree in Chemistry with Honours from the University of Colombo in 1975. He earned his PhD degree in Organic Chemistry from the University of Hawaii at Manoa, USA in 1982. He won awards for Excellence in Research and as an Outstanding Teaching Assistant at the Department of Chemistry, University of Hawaii at Manoa, USA from 1979 to 1980. Professor de Silva has been a Senior Lecturer in the University of Colombo and later an Associate Professor in the Open University of Sri Lanka until he was appointed to the Chair of Organic Chemistry at the University of Colombo in 1997. Professor de Silva has also served as a visiting Assistant Professor in Chemistry, University of British Columbia, Canada, visiting Scholar in the Department of Medicinal Chemistry, University of Utah, Salt Lake City, USA and visiting Academic in the Department of Chemistry, University of Canterbury, Christchurch, New Zealand. He was awarded the “Professor P P G L Siriwardene Memorial Gold Medal” by the Institute of Chemistry Ceylon in 2007. Professor de Silva has also been the recipient of the General Research Committee (GRC) Research Award from the Sri Lanka Association for the Advancement of Science. He also spent his sabbatical leave at the College of Chemical Sciences as a Visiting Professor in Chemistry. He was the recipient of Presidential Research Awards for several years. He has a large number of publications in peer reviewed international journals to his credit.

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Exploring plant associated fungi of Sri Lanka for biologically active metabolites

Professor E D de Silva

Department of Chemistry, University of Colombo, Colombo 03

Fungi:

Fungi are a fascinating group of heterotrophic eukaryotic organisms that belong to the kingdom Fungi. Most fungi are composed of microscopic filaments called hyphae that exhibit apical growth and branch out to form a network called the mycelium. Fungi show cryptic lifestyles and become visible only when they produce familiar fruiting bodies known as mushrooms. Fungi are known to perform a number of beneficial ecological roles, such as breakdown of organic matter and nutrient recycling in the environment. They may be free-living or form mutualistic or parasitic relationships with plants and animals and at times may cause extensive damage and losses to agriculture and forestry, and also bring about human and animal diseases due to parasitic infestations.

Since ancient times humans have exploited fungi in a variety of ways, for example, in the brewing

industry (to make wine, beer and sake), in bread making, in specialized cheese production, and large scale production of citric acid by fermentation etc. However, it was the monumental discovery of the antibiotic penicillin from *Penicillium notatum* by Sir Alexander Fleming in the late 1920's that really brought to light one of the most important virtues of the fungi, namely their remarkable ability to bio synthesize a plethora of varied natural products with unusual structural features and remarkable biological activities. The wide spectrum of biologically active fungal metabolites isolated and characterized since then is epitomized by the well-known mycotoxins such as ergotamine, amatoxins and aflatoxins and a variety of pharmacologically active drugs such as the cephalosporins, fusidic acid, the statins (mevastatin and lovastatin), griseofulvin and the immunosuppressant cyclosporine, to name a few.

About 100,000 fungal species have been formally

classified by taxonomists but estimates suggest that there may be over 5 million species making the fungi a formidable resource for the discovery of novel secondary metabolites useful to humans. Until, recent times, the fungi of Sri Lanka have remained almost completely uninvestigated in this respect. Sri Lanka is known to have an exceptionally high degree of biodiversity and endemism among its fauna and flora. Although the degree of endemism among the fungal species of Sri Lanka is unknown considering the unique and numerous climatic conditions of the island one expects it to be high. Considering the above facts, we have recently initiated a program to investigate plant-associated fungi, both mutualistic and parasitic, for the presence of biologically active natural products that may prove to be useful as medicinal and agricultural agents.

Endophytic fungi

Endophytic fungi reside in the internal tissues of healthy plants without causing any apparent symptoms of disease or negative effects on their hosts. It has been firmly established that they are prolific producers of secondary metabolites and are an outstanding source of biologically active compounds with potential medicinal and agricultural applications. Although, they are widespread on Earth virtually inhabiting all plant species in all types of environments, only a very small percentage of endophytic fungi of the world have been investigated with respect to their secondary metabolite producing capacity and associated biological activities. Therefore, further research is essential to realize their full potential. We have recently launched a program to explore the endophytic fungi from unique ecological niches of Sri Lanka with the objective of isolating bioactive and novel metabolites that may prove to be useful in the development of new antimicrobial drugs which are urgently needed to treat drug resistant bacterial infections. Our hypothesis is that endophytic fungi from unique settings are likely to develop unique biosynthetic abilities leading to the production of unique biologically active metabolites that could be developed as antimicrobial agents. We have concentrated our efforts on endophytic fungi occupying endemic and endangered plants, plants from varied environments such as arid zones, aquatic and mangrove settings and grasses and sedges.

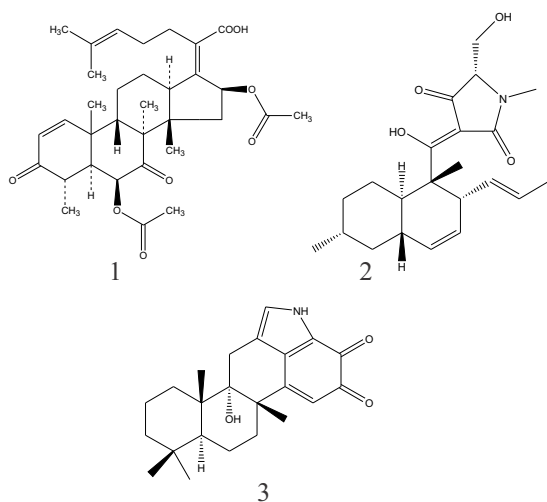
In our initial effort we investigated the endophytic fungi associated with *Anoectochilus setaceus* (Vernacular name: Wanaraja) collected from a tropical rain forest setting in the Kanneliya Forest Reserve. *A.*

setaceus is an endemic medicinal orchid used to treat snake bite poisoning and is facing a high risk of extinction in the wild. Among the endophytic fungi isolated from the surface sterilized plant material, the EtOAc extract of the endophyte *Xylaria* sp. showed promising antibacterial activities against Gram-positive *B. subtilis* and MRSA. Large scale culturing of this fungus followed by extraction and bioassay guided fractionation led to the isolation and characterization, mainly by high-field NMR spectroscopy, of the nortriterpenoid helvolic acid (**1**) as the principal antimicrobial compound (MIC: *B. subtilis* 2 µg mL⁻¹ and MRSA 4 µg mL⁻¹).¹

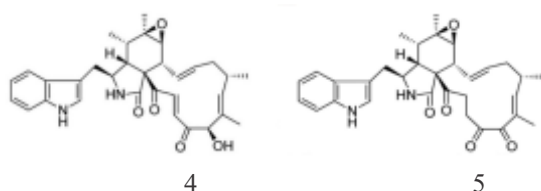
The cactus *Opuntia dillenii* is an invasive plant thriving in the environmentally harsh South-Eastern arid zone of Sri Lanka. It is hypothesized that the endophytic fungal population may assist the host overcome the biotic and abiotic stresses by producing biologically active metabolites. Our investigations led to the isolation of eight endophytic fungi from cladodes and flowers of *O. dillenii*, out of which seven showed selective antimicrobial activities against the tested microorganisms. Large scale culturing of *Fusarium* sp. which showed the most promising biological activity, led to the isolation and characterization of the tetramic acid derivative, equisetin (**2**) with MIC values of 8 µg mL⁻¹ against *B. subtilis* and 16 µg mL⁻¹ against *S. aureus* and MRSA.

Calamus thwaitesii Becc. (Veval in Sinhalese) is a rattan, belonging to the family Palmae (Arecaceae) distributed in the Western Ghats of India and Sri Lanka. Due to overexploitation for furniture industry *C. thwaitesii* is rapidly decreasing and in Sri Lanka it is listed as a vulnerable species, facing a high risk of extinction in the wild. From leaves and stem of *C. thwaitesii* collected from Udugampola, we isolated 21 morphologically distinct fungi belonging to 13 genera proving it to be a rich source of endophytic fungi. Out of these, seven extracts showed antibacterial activity and one extract showed antifungal activity at 300 µg/disc concentration. Large scale culturing of the endophyte *mycoleptodiscus* sp. which showed antibacterial activity even at 50 µg/disc concentration led to the isolation of a relatively rare alkaloid mycoleptodiscin B (**3**) responsible for the antibacterial activity. Mycoleptodiscin B showed strong selective antibacterial activities against Gram-positive *B. subtilis* and *S. aureus* with MIC values of 0.5 and 1 µg mL⁻¹, respectively. Mycoleptodiscin B, together with mycoleptodiscin A, has previously been isolated from the *Mycoleptodiscus* species endophytic in *Desmotes*

incomparabilis collected in Panama. In that study mycoleptodiscin B is reported to possess moderate cytotoxic effects against four cancer cell lines. This is the first report of the antimicrobial activities of mycoleptodiscin B.

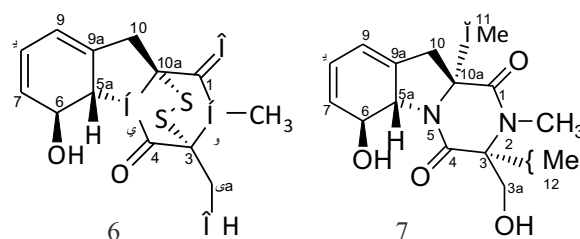


Aquatic plants or hydrophytes are highly adapted to their environment with unique morphological and physiological features and these features are likely to make the aquatic plants unique habitats for the growth of potentially distinctive endophytic fungi. *Nymphaea nouchali* (Nil Manel in Sinhalese) is a vulnerable aquatic plant native to Sri Lanka found in the inland fresh water bodies and has not been previously investigated with respect to its endophytic fungi. Our investigations led to the isolation and identification of 20 distinct Endophytic fungi belonging to 12 genera with *chaetomium globosum* exhibiting the most potent antimicrobial activity. Further investigations of this fungus led to the isolation of two known cytochalasans, chaetoglobosin A (4) and chaetoglobosin C (5). Chaetoglobosin A showed good antimicrobial activities against Gram-positive bacteria (MIC 16 $\mu\text{g mL}^{-1}$ *B. Subtilis*; 32 $\mu\text{g mL}^{-1}$ MRSA).

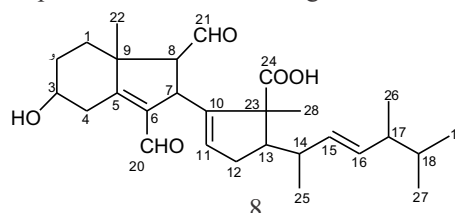


Mangrove habitat has several unique environmental features and endophytes from mangrove plants are an established source for biologically active natural products. We have isolated nine endophytic fungi from mangrove-associate plant *Premna serratifolia* collected from 'Kadol kale' mangrove forest in Negombo and the endophyte

Hypocrea virens exhibited the best antibacterial activity. Bioassay guided fractionation of its crude extract led to the isolation of the known metabolite Gliotoxin (6) (MIC 0.13 $\mu\text{g mL}^{-1}$ against *B. subtilis*) and the related bisdethiobis(methylthio)gliotoxin (7) which was less active.



The most promising result of our investigations originated from the endophytic fungus *Rhizoctonia solani* isolated from tubers of the medicinal weed plant *Cyperus rotundus*. This investigation culminated in the isolation of solanioic acid (8), a highly degraded and rearranged steroid with a novel carbon skeleton. The structure of this compound was elucidated by chemical transformations, and extensive NMR spectroscopic analyses and confirmed by X-ray analysis. Solanioic acid showed potent antimicrobial activities (MICs 1 $\mu\text{g mL}^{-1}$ against *B.subtilis*, *S. aureus* and MRSA) and represent a new antimicrobial scaffold for the development of antibacterial drugs.



Considering the potential for the commercialization of this compound as a topical antibacterial agent we have filled a Sri Lanka patent application to protect the Intellectual Property Rights to this molecule.

Plant Pathogenic Fungi

Unlike their cryptic counterparts, the endophytic fungi which exist symptomless in the host, pathogenic fungi have received much more prominence and attention by the scientific community due to their detrimental effects on plant life, especially the devastating effects on crops of economic importance. Our work on the pathogen *penicillium purpurogenum*, isolated from the infected fruits of *Averrhoa bilimbi* (Biling in Sinhalese) represent the pioneering and the only study done in Sri Lanka on the chemistry of a phytopathogen. This investigation was remarkably

successful and led to the isolation and characterization of 14 highly functionalized novel natural products which among them exhibited 04 new carbon skeletons (Figure 1).

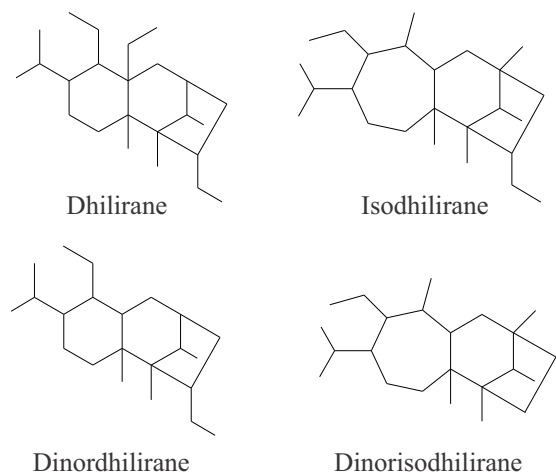


Figure 1: New carbon skeletons exhibited by the dhilirolides

We have named these metabolites which belong to a novel class of highly rearranged meroterpenoids as “Dhilirolides” based on the Sinhala name “Dhilira” for fungi to reflect their fungal origin. In a labelling study using doubly ^{13}C -labelled acetate done in Sri Lanka, we also have elucidated the biosynthetic pathway to these fascinating compounds, dhilirolide A to dhilirolide N. Some representative dhilirolide structures are shown in Figure 2. Although the crude extracts of *P. purpurogenum* showed reasonable antibacterial activity none of the isolated compounds showed promising antibacterial activity (inactive at or below 64 ng/disc concentration).

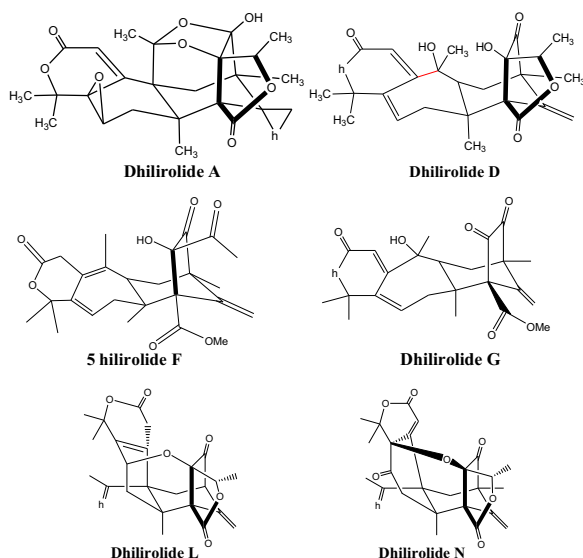


Figure 2: Some representative dhilirolides

However, in a series of various bioassays done to detect any useful bioactivities of dhilirolides at the University of British Columbia, Canada, Dhilirolide L (Figure 2) showed significant feeding inhibition and sub-lethal developmental disruption at low concentrations in the cabbage looper *Trichoplusia ni*, an important agricultural pest.

Conclusion:

Our pioneering work on the chemistry of plant-associated fungi has been highly productive. Among the 22 compounds included in this report, 15 are new to science and embrace 5 new natural product carbon skeletons. Some of them have shown potent bioactivities and may be useful as lead compounds in the development of new pharmaceuticals and insecticides useful in agriculture. Furthermore, these findings are consistent with our hypothesis that plant-associated fungi from unique ecological settings of Sri Lanka may harbor fungi with unique biosynthetic pathways leading to novel natural products. We are confident of more success in this area of research and hope to continue this area of research with enthusiasm.

Acknowledgements:

The work on the endophytic fungi was mainly done by Dr. Pamoda Ratnaweera and Mr. Ranga Dissanayake as a part of their graduate studies. Professor Raymond Andersen of the University of The British Columbia (UBC), Canada has been a long time collaborator and provided all facilities for NMR spectral determinations. I would also like to acknowledge the valuable contributions made by Dr. David Williams and Dr. Ryan Centko of UBC towards these studies. Research was funded by the NSF grant RG/2012/NRB/01 and HETC grant UWU/O-ST/N3.

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Kandiah Memorial Awards - 2016

Three Kandiah Memorial Awards are made annually to commemorate Professor A Kandiah, the first President of the Chemical Society of Ceylon. Professor Kandiah served in the University of Ceylon from 1933 and was the Professor of Chemistry at the University of Ceylon from 1934 until his death in 1951.

The Kandiah Memorial Awards for Basic Chemistry and Applied Chemistry are awarded for the best research contribution in Chemistry carried out by a postgraduate student registered at a Higher Education Institute and for work carried out in Sri Lanka with the exception of special analysis (less than 20% of findings) that cannot be done in the country.

- The Kandiah Award for Basic Chemistry is made for research predominantly in Basic Chemistry (Organic, Inorganic, Physical & Analytical).
- The Kandiah Award for Applied Chemistry is made annually for research in related areas such as polymer, food, biochemistry, biotechnology etc. where interdisciplinary research is involved, provided that chemistry has a central role & comprises at least 50% of the content.
- The Kandiah Memorial Graduateship Award is awarded to the best piece of research in the chemical sciences carried out by a Graduate Chemist of the Institute of Chemistry Ceylon registered with a Higher Educational Institute for a postgraduate degree.

Kandiah Memorial Award for Basic Chemistry - 2016



Ms. Nisansala Swarnamali Bopage obtained a B. Sc. Degree with First Class Honours from The Open University of Sri Lanka in 2008. She was awarded a research assistantship by the Link Natural Products (pvt) Ltd to carry out her post graduate research. She obtained her Master of Philosophy Degree from The Open University of Sri Lanka in 2015. Her research project titled "Investigation of some medicinal plants and plant preparation used in wound healing in indigenous medicine" was supervised by the Senior Professors G M Kamal B Gunaherath, Department of Chemistry, The Open University of Sri Lanka, S Chandrani Wijeyaratne, Department of Botany, University of Sri Jayewardanapura, A M Abeysekera, Department of Chemistry, University of Sri Jayewardanapura, and Dr. K Hector Jayawardena, Department of Zoology, The Open University of Sri Lanka. Her research was focused on the extraction and bioassay guided fractionation of some medicinal plants and medicinal oils with the view of isolating and characterizing wound healing active constituents. She has handled both human and animal adherent epithelial cells to develop the wound healing assay using plant extracts. She has authored nine local and international conference abstracts and one journal publication.

She is a Member of the Institute of Chemistry Ceylon, the Sri Lanka Association for the Advancement of Science and the Young Scientist Forum of National Science and Technology Commission. Currently she works as a temporary demonstrator at the Department of Chemistry, The Open University of Sri Lanka.

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Investigation on wound healing activity of bark of *Ficus racemosa* and "Seetodaka" oil using Scratch Wound Assay (SWA)

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Introduction

Plants and plant preparations have been used to enhance wound healing process from ancient times although it is a natural process. *Ficus racemosa* is a plant used in the indigenous system of medicine for wound healing while "Seetodaka" oil is reputed for fresh wound management. It is reported that stem bark and root extracts of *F. racemosa* have been evaluated for the wound healing activity on animal models. Although the wound healing activity of potential drugs have been investigated employing *in-vivo* methods and human trials, currently *in-vitro* methods based on cell cultures are being practiced. The scratch wound assay (SWA) has been established as a simple and relatively inexpensive tool to study unidirectional cell migration.

The present study was designed to identify the potential wound healing active substances from *F. racemosa* and "Seetodaka" oil using SWA over Baby Hamster Kidney 21 (BHK 21) and Madin-Darby Canine Kidney (MDCK) (ATCC, USA) cell cultures. Cell cultures were maintained at 37 °C in a 5% CO₂ humidified incubator and the assay was performed according to Liang *et al.* A scratch (wound) was performed on monolayer of cells along the vertical axis of each well under the microscope in 12 well plates.

Dimethyl sulphoxide (DMSO) was used as the carrier for the sample. Two negative controls, 1% DMSO in culture media and 100% culture media, and the positive control asiaticoside (25 M) were used in this experiment. The percentage wound closure was calculated. Images at each stage were photographed. All the experiments were carried out in three replicates and three measurements were taken for each wound.

Extraction and Scratch Wound Assay Directed Fractionation of *F. racemosa*

Dried plant material (500 g) was sequentially extracted with hexanes, dichloromethane (DCM), ethyl acetate (EtOAc), and methanol (MeOH) in a Soxhlet apparatus and were evaporated at 40 °C to obtain the respective extracts and were subjected to SWA (Table 1).

The hexanes and DCM extracts showed a significant wound healing effect in both cell lines at 24 h (Table 1, Fig. 1 and Fig. 2A). Hence SWA guided fractionation of these two extracts was undertaken to locate and identify the active constituents.

The DCM extract of *F. racemosa* (1.0 g) was chromatographed over a column of silica gel to give 18 fractions DF₁–DF₁₈. Among these, fraction DF₇ showed

the highest activity while fractions DF₄, DF₈–DF₁₂, DF₁₄, DF₁₇, and DF₁₈ (> 65 %) also showed enhanced activity (**Table 2**, **Fig. 2B**). Fractionation of DF₇ yielded a single compound which was identified as lupeol (**1**) (2.9 mg) (m. p. 213–215 °C) (lit. 215 °C) by spectroscopic data and comparison with an authentic sample. Fractions DF₄, DF₇, and DF₈ also contained lupeol in varying amounts. Fraction DF₉ contained one major compound which was different to **1**. Chromatographic purification of this fraction yielded β -sitosterol (**2**) (3.4 mg) (m. p. 139–140 °C), (lit. 140 °C) which was identified by spectroscopic data and comparison with an authentic sample. Fractions DF₁₀–DF₁₂ also contained β -sitosterol in varying amounts. Hence, it is inferred that lupeol and β -sitosterol are responsible for the wound healing activity of DCM extract of *F. racemosa*.

Table 1: Weights and SWA results of the different extracts of *F. racemosa*

Sample ^a	Weight of extract (g)	% Closure of the wound at $t = 24$ h ^b	
		BHK	MDCK
Hexane extract	9.32	91.0 (0.4)	84.9 (0.1)
DCM extract	1.35	78.1 (0.9)	75.8 (0.1)
EtOAc extract	1.25	8.8 (0.8)	6.5 (0.1)
MeOH extract	1.21	14.3 (2.6)	7.4 (0.1)
1% DMSO (Control 1)		15.5 (1.2)	4.4 (0.9)
100% DMEM (Control 2)		16.5 (1.1)	4.9 (0.1)

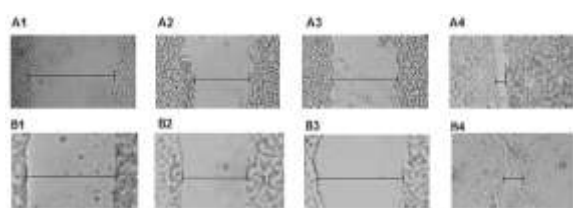


Figure 1. Images of the scratch wound assay of dichloromethane extract of *F. racemosa* on (A) BHK cells, A1- control at $t = 0$ h, A2- control at $t = 24$ h, A3- DCM extract at $t = 0$ h, A4- DCM extract at $t = 24$ h; (B) MDCK cells, B1- control at $t = 0$ h, B2- control at $t = 24$ h, B3- DCM extract at $t = 0$ h, B4- DCM extract at $t = 24$ h

Column chromatographic fractionation of the hexanes extract yielded 11 fractions (HF₁–HF₁₁) of which fraction HF₄ showed the highest activity (>90%) (**Table 3**, **Fig. 2C**). Fractionation of HF₄ guided by SWA afforded **1** as the active constituent. Fractions HF₂, HF₃, HF₅, and HF₆ also showed the presence of **1** in varying amounts revealing that **1** is responsible for the wound healing activity of hexanes extract of *F. racemosa*. HF₆, a sub-fraction of HF₂ constituted of one major compound, showed a considerable wound healing activity only at 48 h; 74 % on BHK cells and 72

% on MDCK cells. Purification of this fraction yielded a white crystalline compound, which was identified as lupeol acetate (**3**) (29.0 mg), (m. p. 216–217 °C) (lit. 218 °C) and confirmed by chemical conversion of lupeol (**1**) into its acetate (**3**).

Table 2: Percentage wound closure at 24 h of column fractions of DCM extract.

Fraction / Sample ^a	Weight (mg)	% Closure of the wound at 24 h ^b	
		BHK	MDCK
DF ₁	10.6	48.4 (1.3)	42.4 (0.4)
DF ₂	10.8	63.6 (0.5)	57.3 (1.1)
DF ₃	39.3	56.0 (0.7)	53.2 (1.1)
DF ₄	5.2	73.4 (0.5)	65.0 (0.9)
DF ₅	2.8	60.3 (0.5)	56.8 (2.5)
DF ₆	3.7	31.4 (1.2)	31.9 (3.2)
DF ₇	21.7	92.1 (0.1)	92.0 (0.2)
DF ₈	20.9	72.9 (0.9)	74.9 (0.7)
DF ₉	39.0	76.6 (0.1)	76.3 (0.5)
DF ₁₀	3.5	69.2 (0.2)	67.2 (0.3)
DF ₁₁	45.0	69.1 (0.2)	65.2 (0.3)
DF ₁₂	28.0	67.2 (0.2)	65.5 (0.3)
DF ₁₃	501.3	52.3 (0.2)	56.8 (1.0)
DF ₁₄	75.0	65.8(2.1)	65.7 (1.0)
DF ₁₅	60.0	46.2 (1.2)	45.5 (0.1)
DF ₁₆	55.2	55.2 (0.2)	52.3 (0.2)
DF ₁₇	91.1	68.4 (0.1)	65.0 (0.1)
DF ₁₈	50.7	65.1 (0.1)	65.5 (0.5)
1% DMSO (Control 1)	-	13.4 (1.5)	6.6 (0.1)
100% DMEM (Control 2)	-	11.6 (0.5)	6.6 (0.1)

^aSample concentration at a 50 mg dm⁻³

^bThe mean value follows the standard error of mean within the parentheses.

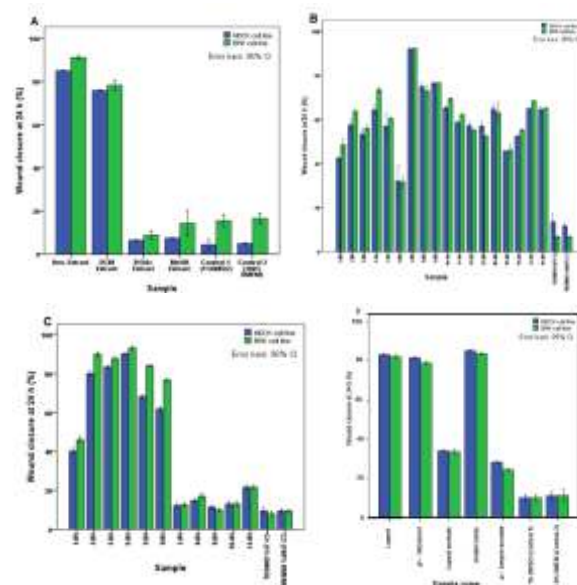


Figure 2. Percentage wound closure in the presence of extracts, fractions, and isolated compounds of *F. racemosa*. (A) Different solvent extracts (B) Column fractions of DCM extract (C) Column fractions of hexanes extract (D) Isolated compounds and the positive control, asiaticoside. (Bars represent the mean and 95% CI of nine measurements in the three replicates).

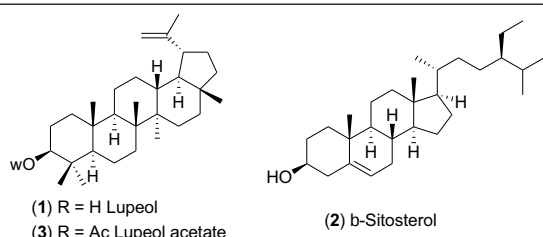


Table 3: Percentage wound closure at 24 h of hexanes extract of *F. racemosa*.

Sample ^a	Weight of Fraction (mg)	% Closure of the wound at <i>t</i> = 24 h	
		BHK	MDCK
HF ₁	233.8	45.9 (0.7)	40.1 (0.8)
HF ₂	1314.8	90.0 (0.4)	80.0 (0.6)
HF ₃	19.7	87.6 (0.5)	83.3 (0.3)
HF ₄	5.1	93.1 (0.4)	90.2 (0.2)
HF ₅	20.5	84.1 (0.2)	68.2 (0.4)
HF ₆	8.8	76.6 (0.6)	65.7 (0.4)
HF ₇	103.6	12.7 (0.4)	12.1 (0.6)
HF ₈	157.7	17.0 (0.7)	14.8 (0.2)
HF ₉	94.5	10.0 (0.3)	11.4 (0.5)
HF ₁₀	289.3	13.0 (0.5)	13.0 (0.5)
HF ₁₁	31.5	21.5 (0.6)	21.5 (0.6)
Control 1 (1% DMSO)		9.4 (0.8)	7.9 (0.6)
Control 2 (100% DMEM)		9.4 (0.4)	9.4 (0.4)

^aSample concentration at a 50 mg dm⁻³

^bThe mean value follows the standard error of mean within the parentheses.

It is apparent that, **1** and **2** are responsible for the wound healing activity of *F. racemosa* and their activities are comparable with that of the positive control, asiaticoside on both cell lines at 24 h (**Fig. 2D**). Optimum concentrations of **1**, **2** and asiaticoside required for the maximum wound healing activity at 24 h were determined by carrying out the SWA at different concentrations (10–50 μ M) against both cell lines and were found to be 30 μ M, 35 μ M and 25 μ M, respectively (**Fig. 3**).

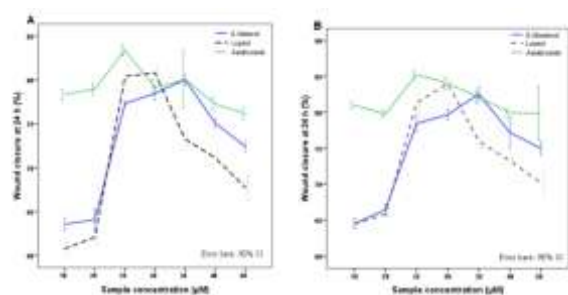


Figure 3. Percentage wound closure in the presence of varying concentrations lupeol (**1**), β -sitosterol (**2**) and asiaticoside (positive control) at 24 h: (A) BHK cell line, (B) MDCK cell line. (Error bars represent the mean $\pm$ S.E.M. 95% CI of nine measurements in the three experiments).

The delayed activity of **3** prompted us to

investigate whether it acts as a pro-drug and undergoes hydrolysis in the vicinity of the wound to produce **1**. SWA was carried out in the presence of **3** and calculated the healing percentage at different times (0 h, 24 h, 36 h, and 48 h) (**Fig. 4**). Assay media were extracted with EtOAc and compared on TLC with authentic **3** and **1** (**Fig. 5**). The SWA results of both types of cells showed that wound healing activity in the presence of **3** has increased with time (**Fig. 4**). Comparative TLC examination revealed that, **3** has been hydrolyzed to give **1** in the presence of cells, acts as a pro-drug in the vicinity of cells by undergoing hydrolysis into lupeol (**Fig. 5**).

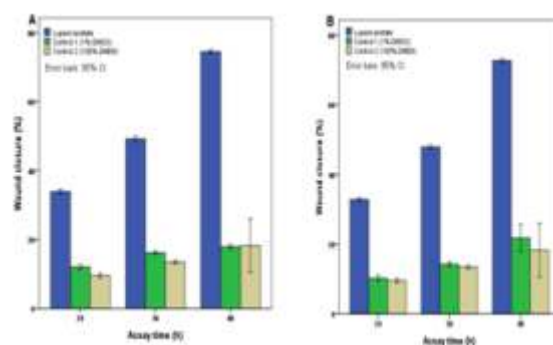
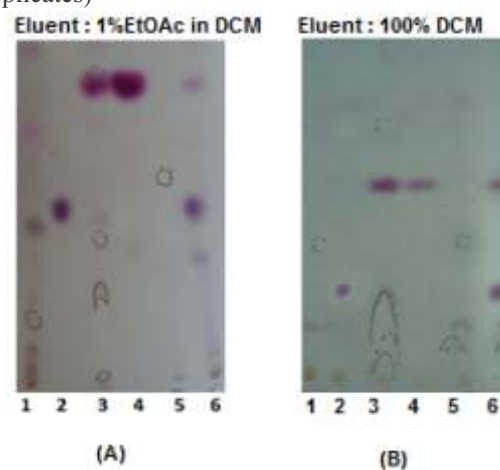


Figure 4. Variation of percentage wound closure in the presence of lupeol acetate (**3**) with time. (A) BHK cell line. (B) MDCK cell line. (Error bars represent the mean and 95% CI of nine measurements in the three replicates)



Track 1 - EtOAc extract of wells containing DMEM without cells
Track 2 - Authentic sample of **1**
Track 3 - EtOAc extract of wells containing DMEM and **3** at 48 h without cells
Track 4 - Authentic sample of **3**
Track 5 - EtOAc extract of wells containing DMEM with cells
Track 6 - EtOAc extract of wells containing DMEM and **3** with cells at 48 h

Figure 5. Thin Layer Chromatographic comparison of the EtOAc extracts showing hydrolysis of lupeol acetate during scratch wound assay (SWA). (A) BHK cells. (B) MDCK cells. Spray reagent: Anisaldehyde spray reagent.

In order to understand possible Structure Activity Relationships (SAR), SWA was carried out with lupeol (1), betulinic acid (5), betulin (6) and lupenone (7). Because lupeol acetate (3) has not shown wound healing activity at 24 h, and was active only when hydrolyzed to lupeol, it was evident that 3-OH is an essential structural feature in the lupane skeleton for the wound healing activity.

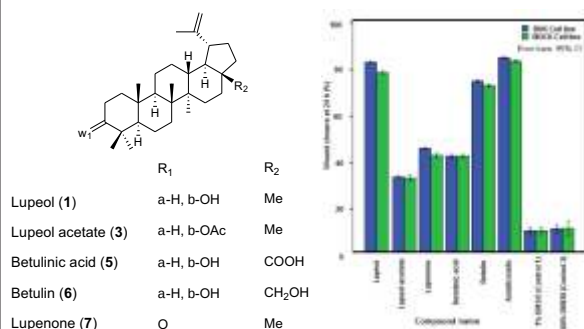


Figure 6. Percentage wound closure of the compounds in the SAR assay. Bars represent the mean $\pm$ S.E.M. of nine measurements in the three experiments.

Compounds 1, 5 and 6 contain OH group at C-3. Among them, only 1 and 6 has shown significantly high wound healing activity (Fig. 6) while 7 in which 3-OH is absent has not shown a significant activity. Even though 3-OH is present in 5, it has not shown significant activity. The only difference between 1 and 5 is the derivatization of C-28 methyl group into a carboxylic acid group thereby increasing the hydrophilicity at C-28. Thus the foregoing evidence leads to the conclusion that 3-OH is an essential feature in the lupane skeleton for its wound healing activity, while increase of the hydrophilic nature at C-28 may be detrimental to its activity.

Investigation of “Seetodaka” oil

“Seetodaka” oil is traditionally prepared by boiling a mixture of aqueous extracts of, rhizome of *Curcuma longa*, leaves of *Azadirachta indica* and roots of *Asparagus racemosus* with coconut milk. Oil (4.475 g, 5.0 mL) was dissolved in 80% aqueous MeOH and partitioned with hexanes. The aqueous MeOH fraction was diluted up to 50% aqueous MeOH solution and partitioned successively with DCM and EtOAc. All extracts were subjected to SWA at 100 mg dm⁻³ and antibacterial assay at 500 μ g per disc against *Bacillus subtilis* and *Pseudomonas aeruginosa* (Amoxicillin 25 g per disc was served as the positive control). While a significant wound healing activity was shown by the hexanes fraction over both cell lines (Table 4) a

significant antibacterial activity was shown by 80% aq. MeOH extract and EtOAc fraction of the oil.

Table 4: SWA results of fractions of “Seetodaka” oil.

Sample ^a	Weight (g)	% Closure of the wound at t = 24 h ^b	
		BHK	MDCK
80% Aq. MeOH extract	2.21	60.4 (0.3)	68.6 (0.4)
Hexane fraction	1.02	78.1 (0.2)	70.1 (0.3)
CH ₂ Cl ₂ fraction	0.75	16.6 (0.2)	15.6(0.1)
EtOAc fraction	0.25	24.0 (0.1)	20.2 (0.5)
50% Aq. MeOH fraction	0.12	25.0 (0.4)	22.1 (0.1)
Control 1 (1% DMSO)		12.2 (0.1)	10.6 (0.2)
Control 2 (100% DMEM)		10.6 (0.2)	10.6 (0.3)

^aSample concentration at a 100 mg dm⁻³

^bThe mean values are given followed by the standard error of the mean in parenthesis

Each constituent plant material of “Seetodaka” oil was extracted using MeOH, and then the MeOH extract was fractionated by solvent-solvent partitioning as described earlier, and were subjected to SWA and antibacterial assay. MeOH extract and the hexanes fraction of *A. racemosus* were found to be significantly active on SWA, and the EtOAc fraction of the *C. longa* was found to be moderately active although the MeOH extract was inactive on SWA over both cells.

It was observed, that hexanes fractions of both oil and *A. racemosus* contain β -sitosterol (2) as one of the major constituent by TLC. Since it was already found that 2 is active on SWA, the observed activity of these fractions may be due to the presences of 2.

MeOH extract and EtOAc fraction of *A. indica* have shown significant antibacterial activity (Inhibition zone diameter (IZD):10.0 cm and 12.0 cm, respectively) [positive control (Amoxicillin 25 μ g) IZD: 11.5 cm]. The antibacterial active constituents in *A. indica* may be accelerating the wound healing process by reduction of bacterial contaminations.

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Kandiah Memorial Graduateship Award 2015



Ms. Dharushana Thanabalasingam, a Graduate Chemist was awarded the “Kandiah Memorial Graduateship Award - 2016” in recognition of her research on “Chemistry and bioactivity of secondary metabolites produced by an endophytic fungus *Nigrospora oryzae* from a popular medicinal plant *Coccinia grandis*”.

Ms. D. Thanabalasingam obtained the Graduateship in Chemistry in 2011 and Bachelor of Science in Agriculture specializing in Biotechnology from Wayamba University of Sri Lanka in 2013. She completed her Master of Philosophy Degree from the Post Graduate Institute of Science, University of Peradeniya in 2016 under the supervision of Professors N S Kumara and L Jayasinghe. She has published her MPhil research findings in the international journal, Natural Product Communications. She currently works as a Research Assistant in Natural Products project at the National Institute of Fundamental Studies, Kandy.

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Chemistry and bioactivity of secondary metabolites produced by an endophytic fungus *Nigrospora oryzae* from a popular medicinal plant *Coccinia grandis*

D Thanabalasingam

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Fungi play an important role in our lives and some fungi, such as mushrooms, have been used by humans as food from time immemorial. The amazing discovery of the antibiotic penicillin from the fungus *Penicillium notatum* by Alexander Fleming in 1929, saved thousands of lives during the Second World War and led scientists worldwide to study microorganisms as a novel source of new drugs that could benefit human beings. Several important antibiotics such as penicillin, cyclosporine and cholesterol lowering statins are of fungal origin. Endophytes are microorganisms that live in the intercellular spaces of stems, petioles, roots and leaves of plants causing no discernible manifestation of their presence and have typically remained unnoticed. Endophytic fungi have been a source of many novel classes of bioactive compounds. Some endophytic fungi have the ability to produce the same compounds that are produced by their host plant. Camptothecin, huperzine A, podophyllotoxin, taxol, vinblastine and vincristine are some examples of such compounds. The objective of the present study is to investigate the chemistry and bioactivity of secondary metabolites produced by the endophytes from a popular medicinal

plant *Coccinia grandis* (local name: Kowakka).

Coccinia grandis of the family Cucurbitaceae is a popular medicinal plant used in Sri Lanka and India for the treatment of diabetes. The leaves of this plant are consumed raw as salad. Various parts of the plant are used for the treatment of healing wounds, ulcers, jaundice, stomachache, antipyretic, antiastringent, hypoglycemic, hypolipidemic, antioxidant and hepatitis. Several pharmacological activities including α -amylase, analgesic, anthelmintic, antibacterial, anticancer, antidyslipidemic, antifungal, anti-inflammatory, antimalarial, antioxidant, antipyretic, antitussive, antiulcer, hepatoprotective, hypoglycemic and mutagenic activity of *C. grandis* have been described in a review. This report describes the isolation of an endophytic fungus from the leaves of *C. grandis*, identification of the fungal species as *Nigrospora oryzae*, and the isolation of phenazine-1-carboxylic acid (**1**) and phenazine-1-carboxamide (**2**) as fermentation products. Compound **2** showed antifungal activity against plant pathogen *Cladosporium cladosporioides*. It is important to note that this is the first report of the isolation of phenazine

derivative from a fungal source.

Phenazines comprise of a large group of nitrogen-containing heterocyclic compounds. Over 100 biologically active phenazine derivatives have been reported from natural sources, mainly from species of *Pseudomonas* and *Streptomyces*. They have a broad spectrum of antibiotic activity. Phenazine-1-carboxylic acid (**1**) produced by *Pseudomonas* sp. is a strong antifungal compound having a broad range of activity. It is one of the simple molecules of the phenazine family and is also known as tubermycin B, since it is active against *Mycobacterium tuberculosis*. Phenazine producing bacteria such as *Pseudomonas* sp. are part of microcolonies (biofilms) and play an important role in the rhizosphere and soil ecosystems. These bacteria compete for colonization sites on the roots of agricultural crops and protect the plants from pathogenic fungi and bacteria.

Fresh leaves of the *C. grandis* were collected from the Central Province of Sri Lanka in February, 2014. Leaves were rinsed in running water. After triple sterilization of leaves with ethanol, 5% NaOCl and distilled water, a segment of a leaf was placed on potato dextrose agar (PDA) media in a petri-dish (90 mm) and incubated at room temperature. Emerging fungi were isolated after 4 days and sub cultured to obtain a pure culture of endophytic fungus. The fungus was identified as *N. oryzae* by sequence analysis of the ITS region of the rDNA gene. DNA was extracted using Promega, Wizard Genomic DNA Purification kit (A1120) and amplification of the ITS region was carried out using the universal eukaryotic primers of ITS1 and ITS4. These experiments were performed by the GeneTech Institute, Sri Lanka. BLAST search indicated that the sequence of the ITS region had 100% similarity to that of *N. oryzae* CEQCA-M1190 (GenBank Accession No. KC771472.1). Photographic evidence of the leaves of *C. grandis* and *N. oryzae* strain (IFS/D/EF1/2014) are deposited at the National Institute of Fundamental Studies.

Large scale culturing of the fungus was carried out by inoculating *N. oryzae* culture grown on PDA medium to 1 L conical flasks (x 20) containing 400 mL of PDB medium, which were allowed to stand at room temperature for 10 days and then incubated while shaking every other day on a laboratory shaker. The medium was filtered after four weeks and the filtrate was partitioned with EtOAc/H₂O. Concentration of the EtOAc layer on a rotary evaporator furnished EtOAc extract (6.25 g). The residual mycelium was crushed and extracted with EtOAc to give EtOAc extract (7.33

g). TLC analysis indicated that the EtOAc extract from the PDB medium exhibited the same pattern of spots as that from the mycelium. Hence, the two EtOAc extracts were combined.

The combined EtOAc extract was screened for antioxidant activity assayed by DPPH (2,2'-diphenyl-1-picrylhydrazine) radical scavenging ability, antifungal activity against *C. cladosporioides* by the TLC bioautography method, phytotoxicity against *Lactuca sativa* seed germination, brine shrimp toxicity against *Artemia salina* and α -amylase enzyme inhibitory activity. Significant activities were observed for antifungal activity, antioxidant activity (IC₅₀ 462 ppm), brine shrimp toxicity (IC₅₀ 190 ppm) and phytotoxicity (shoot inhibition at IC₅₀ 653 ppm and root inhibition at IC₅₀ 339 ppm).

The combined EtOAc extracts (13.6 g) was chromatographed over silica gel (*n*-hexane-CH₂Cl₂-MeOH), Sephadex LH-20 (MeOH) and PTLC to give compounds **1** (100 mg) and **2** (2.0 g). Purity of **1** and **2** were checked by HPLC (H₂O-MeOH (1:4), UV detection at 254 nm). Compounds **1** and **2** were identified as phenazine-1-carboxylic acid and phenazine-1-carboxamide, respectively (Fig. 1) by comparison of their spectral data (¹HNMR, ¹³CNMR and FABMS) with those reported.

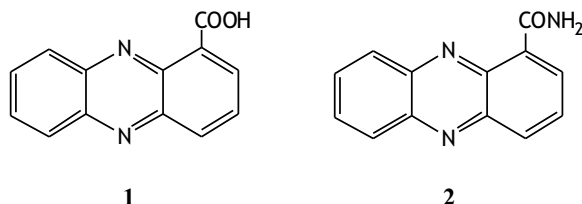


Figure 1: Structures of Compounds **1** and **2**

Phenazine-1-carboxylic acid (**1**): light yellow solid; ¹HNMR (500MHz, CDCl₃): δ 7.96-8.04 (2H, *m*, H-7, H-8), 8.05 (1H, *dd*, 8.7, 7.1 Hz, H-3), 8.29 (1H, *dd*, 8.5, 1.5 Hz, H-6), 8.36 (1H, *dd*, 8.4, 1.7 Hz, H-9), 8.54 (1H, *dd*, 8.7, 1.4 Hz, H-4), 8.99 (1H, *dd*, 7.1, 1.4 Hz, H-2); ¹³CNMR (125MHz, CDCl₃): δ 124.9 (C-1), 128.0 (C-6), 130.1 (C-9), 130.3 (C-3), 131.7 (C-8), 133.2 (C-7), 135.1 (C-4), 137.4 (C-2), 139.8 (C-9a), 140.1 (C-10a), 143.4 (C-4a), 144.1 (C-5a), 165.9 (COOH); FABMS *m/z*: 225 [M+H]⁺.

Phenazine-1-carboxamide (**2**): yellow solid; ¹HNMR (500MHz, CDCl₃): δ 6.38 (1H, *bs*, CONH₂), 7.84-7.95 (2H, *m*, H-7, H-8), 7.98 (1H, *dd*, 7.2, 7.1 Hz, H-3), 8.24 (1H, *m*, H-6), 8.29 (1H, *m*, H-9), 8.43 (1H, *dd*, 7.2, 1.4 Hz, H-4), 9.02 (1H, *dd*, 7.1, 1.3 Hz, H-2), 10.63 (1H, *bs*, CONH₂); ¹³CNMR (125 MHz, CDCl₃): δ 128.9 (C-1), 129.1 (C-6), 129.8 (C-9), 129.9 (C-3), 131.1 (C-8), 131.7 (C-7), 134.3 (C-4), 136.0 (C-2), 140.8 (C-9a), 141.5 (C-10a), 143.2 (C-4a), 143.5 (C-5a), 166.6 (CONH₂); FABMS *m/z*: 224 [M+H]⁺.

Compound **2** was obtained as the major metabolite (1.0 g/4 L). Compounds **1** and **2** were subjected to the antifungal bioassay against *C. cladosporioides* by the TLC bioautography method. Only compound **2** strongly inhibited the growth of *C. cladosporioides*. The minimum quantity of compound **2** required to inhibit the growth of *C. cladosporioides* on a TLC plate was found to be 4 µg/spot. Compound **2** showed toxicity towards brine shrimp lethality assay at IC₅₀ 98 ppm. Further the compound **1** and **2** showed phytotoxicity towards root inhibition at IC₅₀ 121 ppm and IC₅₀ 99 ppm, respectively. Compounds **1** and **2** did not show significant activity towards antioxidant and α-amylase bioassays.

Antifungal activity of compound **2** was determined as follows. Test solutions were prepared by dissolving 1 mg of compound **2** in 1 mL of MeOH. Solutions of 2, 4, 8, 16, 32, 64, 128 and 256 µL were spotted using a micropipette on TLC plate (10 x 20 cm, Merck Art. 1.05554.0007). Plate was air dried overnight and sprayed with *C. cladosporioides* in Czapek-Dox nutrient solution and kept in a moist chamber at room temperature for 36 hours. In this experiment the spores germinate as black zones and antifungal compounds appear as white zones on the TLC plate. Benlate was used as the positive control.

The endophytic fungus *N. oryzae* was isolated from *C. grandis* for the first time. The study further indicated that the fungus produced two phenazine type secondary metabolites, phenazine-1-carboxylic acid (**1**) and phenazine-1-carboxamide (**2**) when fermented in PDB medium. Compound **2** was obtained as the major metabolite (1.0 g/4 L). This is the first report of the isolation of phenazine derivatives from a fungal source. Thus far, bacteria have been the only known source of natural phenazines. In addition, compound **2** was found to be active against the plant pathogenic fungus *C. cladosporioides*. Further large scale production of compound **2** by fermentation of this *N. oryzae* strain can be used as a starting material for the synthesis of useful phenazine derivatives. It would be interesting to further investigate other parts, in particular roots and fruits of *C. grandis* as a possible source of endophytic fungi which produce environmentally friendly fungicides that may be useful for the protection of agricultural crops.

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Kandiah Memorial Award for Applied Chemistry - 2016



Ms. A G Achala W Alakolanga obtained a B.Sc. Special Degree from the University of Peradeniya in 2008. She obtained a Master of Philosophy degree in Chemical Sciences from the University of Peradeniya in 2015. Her research work was focused on natural metabolites from underutilized fruits as potential anti-oxidants, defensive agents against pests, fungi and other pathogens and also inhibitors and catalysts in enzymatic reactions under the supervision of Professor N S Kumar and Professor Lalith Jayasinghe. She has published two full articles in indexed journals, one conference paper and four conference abstracts from this study.

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Studies on the chemistry and bioactivity of *Flacourtia inermis* fruits

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Research in natural product chemistry deals with finding and studying novel metabolites that have the potential to be used as leads for pharmaceutical, nutraceutical, agrochemical or other products that may also be of economical interest. There are many sources of bioactive metabolites that are yet to be explored for their biological and economic potential. These include common edible fruits which, if not harvested, marketed and consumed, are often discarded.

Flacourtia inermis Roxb. (Lovi) (Flacourtiaceae) is a moderate sized tree cultivated in Sri Lanka for its fruits known as *Lovi*. Fruits are dark red when ripe with a sweet, sour and astringent taste. Fruits are grown in home gardens and the excess crop is wasted. This study was carried out in an attempt to evaluate the economic potential of the fruit crop, because most of the harvest is

unused and wasted every season. Research was focused on studying important biological activities of the fruit metabolites and also profiling the chemical composition using LC-MS/MS analysis. Study about this fruit was useful as a means of value addition to an underutilized fruit crop.

Extracts of *F. inermis* fruits were fractionated using chromatographic techniques and subjected to several bioassays in order to assess the nutritional and pharmacological value of these fruits and fruit extracts. For the study, ripe, healthy fruits were used and extracted using sequential solvent extraction techniques. Fruits collected were cleaned and examined for either diseases or microbial attacks because these may alter the chemical profile by changing the chemical nature and/or by contamination

with microbial metabolites. Ultrasound sonication at room temperature and partition were employed because fruits mostly contain thermolabile chemical compounds. Extraction at relatively low temperature is important in such situations to successfully extract the chemical compounds, although the yield may be low.

Fruits were blended and squeezed to separate juice and residue. The residue was subjected to ultrasound sonication using hexane, ethyl acetate (EtOAc) and methanol. Juice was partitioned with hexane, EtOAc and n-butanol. All the extracts were analyzed by Thin Layer Chromatography (TLC). Hexane extracts and EtOAc extracts from both juice and residue were combined as they showed the same TLC patterns, then evaporated using a rotary evaporator at low temperatures and subjected to bioassays. The total polyphenol content and anthocyanin content of fresh fruits were determined. According to these results, anthocyanins contribute approximately 10% of the total phenol content and this value was high compared to those reported for other berry type fruits.

EtOAc, methanol and n-butanol extracts of fruits were subjected to the following assays to assess bioactivities; DPPH (2,2'-diphenylpicrylhydrazyl) radical scavenging assay, brine shrimp lethality assay (cytotoxicity), lettuce seeds germination assay (phytotoxicity) and TLC bioautography with *Cladosporium cladosporioides* (antifungal activity). The same plant extracts were subjected to α -amylase inhibition assay against porcine pancreatic α -amylase enzyme using starch as the substrate and dinitrosalicylic acid as the indicator; lipase inhibition assay against *Candida rugosa* lipase enzyme using *p*-nitrophenylbutyrate as the substrate and α -glucosidase inhibition bioassay against *Saccharomyces cerevisiae* α -glucosidase using *p*-nitrophenyl- α -D-glucopyranoside as the substrate. Results on enzyme inhibition bioassays revealed significant activities against α -amylase, α -glucosidase and lipase enzymes.

The total polyphenol content of *F. inermis* fruits was determined as 1.28 g/100 g of fresh fruits by the Folin-Ciocalteu method using gallic acid as the standard and anthocyanin content was determined to be 0.107 g/100 g of fruits as cyanidin-3-glucoside equivalents, using a pH differential method.

Polyphenols and flavonoids are among the natural active antidiabetic agents. These compounds have been reported to exert various biological effects, including inhibition of carbohydrate hydrolyzing enzyme such as α -amylase and α -glucosidase enzymes. Polyphenolic compounds are able to inhibit the activities of digestive

enzymes due to their ability to bind with proteins. The inhibitory activities of plant phytochemicals, including polyphenols, against carbohydrate hydrolyzing enzymes contribute to the lowering of postprandial hyperglycemia which is useful in the management of diabetes. Polyphenolic compounds present in *F. inermis* fruit extracts are likely to have caused the inhibition of carbohydrate hydrolyzing enzymes observed during the current study.

Antioxidant activity against 2,2'-diphenylpicrylhydroxyl radical, antifungal activity against *C. cladosporioides*, cytotoxicity against nauplii of *A. salina* and phytotoxicity against *L. sativa* were tested for each extract. Activities exhibited by extracts were compared with positive controls. IC₅₀ values were calculated for dose-response relationships wherever possible. The EtOAc extract exhibited comparatively high antioxidant activity than other extracts. Previous studies have shown the presence of antioxidant compounds in the fruits of *F. inermis*. Polyphenolic compounds including anthocyanins and chlorogenic acids are the antioxidant compounds reported from these fruits.

There was no observable antifungal activity against selected plant pathogens in any of the extracts. The n-butanol extract showed a comparatively high cytotoxicity against brine shrimp larvae. Some phenolic compounds and essential oils are cytotoxic against brine shrimp larvae. High levels of phenolic acids in *F. inermis* extracts may account for high cytotoxic activity. Brine Shrimp lethality assay is considered to be a useful tool for preliminary assessment of toxicity. Therefore, results given above indicate that extracts from the fruits of *F. inermis* contain metabolites with potential cytotoxic activity.

The EtOAc extract was subjected to activity guided fractionation to isolate active compounds. First, the separation was carried out using normal phase gravity column chromatography using Hexane:EtOAc: MeOH and Hexane:CH₂Cl₂:MeOH solvent systems. Further purifications were carried out using size exclusion chromatography with Sephadex LH-20 and HPLC. This separation isolated one pure compound with remarkable α -amylase, α -glucosidase and lipase enzyme inhibition properties and it was identified as *S*-malic acid; $[\alpha]_D$ -1.8 (c 0.38, H₂O) with ¹H NMR and ¹³C NMR spectral data.

Malic acid showed high antioxidant activity and high activity for inhibition of α -glucosidase, α -amylase enzymes and lipase enzymes. These findings suggest that malic acid is responsible for the antioxidant

activity as well as the inhibitory activities of *F. inermis* fruit extracts against α -glucosidase, α -amylase and lipase enzymes.

Liquid Chromatography- Mass Spectroscopy or LC-MS/MS is a relatively novel tool in profiling chemical composition in fast and effective manner. The principle of LC-MS/MS is based on the fragmentation of charged ions and the detection of the resulting fragments. Thus it has a much higher selectivity and sensitivity than LC-MS and makes it possible to elucidate metabolite structures. During this study, LC-MS/MS analysis has been used to identify chemical compounds present in *F. inermis*.

Methanol extracts of fresh fruits were subjected to LC-MS/MS analysis and data were analyzed using “Bruker Daltanics” data analysis software. Presence of different compounds can be identified from their base peaks at different retention times and can be confirmed by analyzing their mass fragmentation patterns. LC-MS/MS analysis of the methanol extract of *F. inermis* fruits revealed the presence of many chlorogenic acids derivatives including monocaffeoylquinic acids (*Mr* 354), dicaffeoylquinic acids (*Mr* 516), feruloylquinic acid (*Mr* 368), methylcaffeoylquinates (*Mr* 368), caffeoylshikimates (*Mr* 336), flavanoids and flavanoid-glycosides. CGAs were first identified from their base peaks [M-H]⁻ at different retention times. Then MS² and MS³ fragments were identified at each retention time. In general, CGAs and their derivatives can be identified in an all tandem mass spectrum EIC (extracted ion chromatogram) by their unique fragments at m/z 173 and m/z 191.

Analysis revealed a large array of Chlorogenic acids (CGA) present in *F. inermis* fruits. The term CGA is used to describe one important group of antioxidants, which are soluble esters formed by phenolic hydroxycinnamates with quinic acid, shikimic acid and their methylated/acylated derivatives. Some common hydroxycinnamates are *cis* and *trans* isomers of ferulic acid, *cis* and *trans* isomers of caffeic acid, *cis* and *trans* isomers of *p*-coumaric acid. CGAs can be divided into various groups depending on the identity, number, and position of the acyl moiety with the most common groups being *p*-coumaroylquinic acids, caffeoylquinic acids (CQAs), feruloylquinic acids (FQAs), caffeoylshikimic acids (CSA) and dicaffeoylquinic acids.

Five caffeoylquinic acids were identified and assigned using the hierarchical keys previously developed as the 3-*O*-caffeoylquinic acid, *cis*-3-*O*-caffeoylquinic acid, 4-*O*-caffeoylquinic acid, 5-*O*-

caffeoylquinic acid and *cis* 5-*O*-caffeoylquinic acid. Three detected dicaffeoylquinic acids were identified using the hierarchical keys previously developed as 3, 4-di-*O*-caffeoylquinic acid, 3,5-di-*O*-caffeoylquinic acid and 4, 5-di-*O*-caffeoylquinic acid. Other than that, one 3-feruloylquinic acid, methyl caffeoylquinates, caffeoyl-shikimates, flavonoids and flavonoid-glycosides including quercetin, kaempferol and their glycosides were identified.

The presence of *S*-malic acid, a valuable combination of antioxidants, polyphenolic compounds including anthocyanins, chlorogenic acids and flavanoids indicated that *F. inermis* fruit, an under exploited fruit crop in Sri Lanka, have the potential to be used in health foods and in nutritional supplements.

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Professor M U S Sultanbawa Award for Research in Chemistry

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Prof. M U S Sultanbawa Award for Research in Chemistry- 2016



Dr. (Mrs.) Chayanika Padumadasa is currently a Senior Lecturer in the Department of Chemistry, Faculty of Applied Sciences, University of Sri Jayewardenepura. She obtained a B.Sc. Special Degree in Chemistry with a First Class Honours from the University of Colombo in 2001. In 2003, she won the Newton Abraham Scholarship to further her studies at the University of Oxford. After obtaining the Doctoral Degree from the University of Oxford in 2008, she returned to Sri Lanka. After a brief stint at the Open University of Sri Lanka, she settled in at her current position at the University of Sri Jayewardenepura from 2010. Currently, she is carrying out post-doctoral research at the Natural Product Center, School of Natural Resources and the Environment, College of Agriculture and Life Sciences, University of Arizona on a Fulbright Fellowship. Dr. (Mrs.) Chayanika Padumadasa's research areas include host-guest chemistry, organic synthesis and natural products chemistry.

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Megastigmanes from Leaves of *Artocarpus heterophyllus* Lam.

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Introduction

Artocarpus heterophyllus which belongs to the family Moraceae is a common tree in Sri Lanka. Medicinal properties of *A. heterophyllus* are well documented. In Sri Lankan traditional medicine the water extract of *A. heterophyllus* senescent leaves is used to reduce blood sugar levels. *Artocarpus heterophyllus* is a rich source of secondary metabolites such as flavonoids, stilbenes, triterpenes, chalcones, xanthone and sterols. Most of the compounds that have been reported to date have been isolated from the root, wood and twigs. The chemistry of the leaves of *A. heterophyllus* has not been fully explored. Here we report two megastigmane derivatives isolated from the senescent leaves of *A. heterophyllus*.

Materials and methods

Extraction

Water extract obtained from refluxing crushed *A. heterophyllus* senescent leaves (orange coloured) collected from Colombo district was concentrated under *vacuum*. Excess ethanol was added to precipitate the high molecular weight polysaccharides. After filtration the filtrate was concentrated under *vacuum*, extracted with ethyl acetate and solvent was removed under *vacuum* to produce a sticky solid (EA/W).

Fractionation

The sticky solid (EA/W) was chromatographed on Sephadex LH-20 eluting with five different solvent systems. Fraction 1 was eluted with dichloromethane/

hexane 4:1 and fractions 2, 3, 4 and 5 were eluted with dichloromethane/acetone 3:2, dichloromethane/acetone 1:4, dichloromethane/methanol 1:1 and methanol, respectively. All fractions were collected separately and were subjected for *in vivo* hypoglycemic activity studies, which revealed fractions 3 and 4 to be the most active. These two fractions had similar thin layer chromatographic profiles and were combined for compound isolation. Combined fraction was chromatographed on MCI gel column chromatography to produce 17 fractions (M1 – M17). Fraction M3 was chromatographed on silica using a gradient elution starting with 100% dichloromethane and gradually increasing the methanol concentration to 100%. A total of 130 fractions were collected. These fractions were combined based on their thin layer chromatographic profiles to produce 11 fractions (M3S1 – M3S11). M3S2 fraction was subjected to normal phase recycling preparative HPLC (ethyl acetate: hexane, 70: 30, 4 mL/min) to produce compound (**1**) in the pure form as a white solid. This was characterized by ¹H NMR, ¹³C NMR, IR and UV-visible spectroscopy, FAB and HR-FAB mass spectrometry in positive ion mode.

¹H NMR (CD₃OD) 500 MHz δ: 0.81 (3H, H-12A, 12B, 12C), 0.85 (3H, H-13A, 13B, 13C), 1.08 (3H, H-11A, 11B, 11C), 1.47 (1H, H-2B), 1.71 (1H, H-2A), 2.10 (1H, H-5), 2.12 (1H, H-6), 2.26 (3H, H-10A, 10B, 10C), 3.57 (1H, H-4), 3.84 (1H, H-3), 6.06 (1H, H-8), 6.74 (1H, H-7).

¹³C NMR (CD₃OD) 125 MHz δ: 17.4 (C-13), 24.0 (C-11), 26.8 (C-10), 31.3 (C-5), 32.5 (C-12, CH₃), 34.6 (C-1), 41.8 (C-2), 52.0 (C-6), 72.1 (C-3), 74.7 (C-4), 134.1 (C-8), 152.3 (C-7), 200.9 (C-9).

M3S5 fraction was subjected to normal phase recycling preparative HPLC (ethyl acetate: hexane, 70: 30, 4 mL/min) and the fraction corresponding to the highest intense peak was collected. This was subjected to preparative thin layer chromatography with ethyl acetate: hexane (7: 3) as the solvent system. The band with R_f 0.4 was scrapped and stirred in methanol overnight and filtered. Filtrate was concentrated under *vacuum* at 45 °C. This was then purified by size exclusion recycling preparative HPLC (methanol, 4 mL/min) to produce compound (**2**) in the pure form as a white solid. This was then characterized by ¹H NMR, ¹³C NMR, IR and UV-visible spectroscopy, FAB and HR-FAB mass spectrometry in positive ion mode.

¹H NMR (CD₃OD) 600 MHz: δ 6.13 (1H, m, H-4), 5.64 (1H, H-7), 5.60 (1H, H-8), 4.25 (1H, H-9), 4.17 (1H, H-13A), 4.12 (1H, H-13B), 2.64 (1H, H-6),

2.49 (1H, H-2B), 2.10 (1H, 2A), 1.23 (3H, H-10A, 10B, 10C), 1.02 (3H, H-11A, 11B, 11C), 0.98 (3H, H-12A, 12B, 12C)

¹³C NMR (CD₃OD) 175 MHz δ 23.7 (C-10, CH₃), 27.3 (C-13, CH₃), 27.8 (C-12, CH₃), 37.2 (C-1, C), 49.2 (C-2, CH₂), 52.1 (C-6, CH), 64.1 (C-11, CH₃), 68.8 (C-9, CH), 122.3 (C-4, CH), 127.4 (C-8, CH), 140.1 (C-7, CH), 168.3 (C-5, C), 202.0 (C-3, C)

Results and Discussion

The EA/W fraction was subjected to repeated column chromatography over Sephadex LH-20, MCI gel, preparative TLC and preparative HPLC to yield compounds (**1**) and (**2**) in the pure form as white solids.

The molecular formula of compound (**1**) was determined as C₁₃H₂₃O₃ by HR-FAB mass spectrometry with the pseudo molecular ion [M+H]⁺ peak observed at *m/z* 227.1640 (calculated for C₁₃H₂₃O₃, 226.1569). The ¹³C NMR spectrum revealed 13 carbon signals in accordance with the molecular formula. These included the signals of four CH₃ carbons (C-10, C-11, C-12 and C-13), six CH carbons (C-3, C-4, C-5, C-6, C-7 and C-8) and one CH₂ carbon (C-2). The remaining carbon signals in the ¹³C NMR spectrum are due to the conjugated keto carbonyl carbon (C-9) and the quaternary carbon (C-1). Of the six CH carbons two are olefinic and are observed at 134.1 (C-8) and 152.3 (C-7). The other CH carbons are sp³ carbons of which two are deshielded due to attachment of hydroxyl groups (C-4 and C-3). These assignments were confirmed by DEPT ¹³C NMR spectrum of compound (**1**). The ¹H NMR spectrum of compound (**1**) showed 12 hydrogen peaks. The four methyl signals were observed at _H 0.81 (3H, s), 0.85 (3H, d, J = 6.5 Hz), 1.08 (3H, s) and 2.26 (3H, s). The spectrum showed two olefinic proton signals at _H 6.06 (d, J = 15 Hz) and 6.74 (dd, J = 15 Hz) and according to the coupling constants these are trans to each other. The spectrum also showed two oxymethine proton signals at _H 3.57 (H-4) and 3.84 (H-3). The ¹H-¹H COSY spectrum of compound (**1**) showed all the important ¹H-¹H couplings. 1-D and 2-D NMR spectra confirmed compound (**1**) as 3,4-dihydroxy-7-ene-megastigman-9-one (Figure 1).

The molecular formula of compound (**2**) was determined as C₂₉H₂₆O₈ by HR-FAB mass spectrometry with the pseudo molecular ion [M+H]⁺ peak observed at *m/z* 225.1450 (calculated for C₂₉H₂₇O₈, 224.1412). The ¹³C NMR spectrum of compound (**2**) revealed 13 carbon signals in accordance with the molecular formula. These included the signals of three CH₃ carbons (C-10, C-11 and C-12), five CH carbons (C-4,

C-6, C-7, C-8 and C-9) and two CH₂ carbons (C-2 and C-13). The remaining two carbon signals in the ¹³C NMR spectrum were assigned to the conjugated keto carbonyl carbon (C-3) and the quaternary carbon (C-1). Of the five CH carbons the olefinic carbons appeared at 122.3 (C-4), 127.4 (C-8), 140.1 (C-7) and 168.3 (C-5). The remaining CH carbon is a sp³ carbon and is deshielded due to the attachment of the hydroxyl group. These assignments were confirmed by DEPT ¹³C NMR spectrum of compound (2). The ¹H NMR spectrum of compound (2) showed 11 hydrogen peaks. The three methyl signals were observed at δ 0.98 (H-12), 1.02 (H-11) and 1.23 (H-10). The spectrum showed three olefinic proton signals at δ 6.13 (H-4), 5.64 (H-7) and 5.60 (H-8) and according to the coupling constants both C=C are in trans configuration. The ¹H-¹H COSY spectrum of compound (2) showed all the important ¹H-¹H couplings. 1-D and 2-D NMR spectra confirmed compound (2) as 9,13-dihydroxy-4,7-diene-megastigman-3-one (Figure 1).

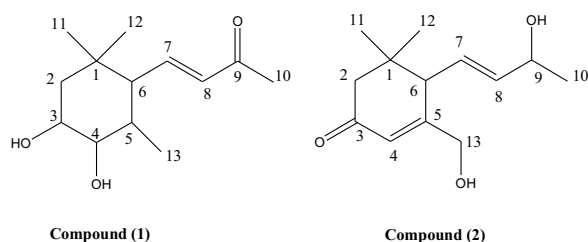


Figure 1. Structures of the megastigmane derivatives

Conclusion

Two megastigmane derivatives have been successfully isolated from ethyl acetate fraction of water extract of senescent leaves of *A. heterophyllum* upon extensive chromatography. They have been characterized by 1-D and 2-D NMR, IR and UV spectroscopy and HR-FAB mass spectrometry. The compounds have been previously reported, however, they have not been reported from *A. heterophyllum* species.

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2. Lin, C-N. and Lu, C. M., Heterophyllol, a phenolic compound with novel skeleton from *Artocarpus heterophyllum*, *Tetrahedron letters*, (1993), 34, 8249-8250.
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Call for Nominations for Institute of Chemistry Gold Medal 2017 by 31st March (Under Revised Rules)

This Gold Medal was the very first of such awards to be donated to the Institute and was made possible through a generous donation made by **Mascons Ltd** in memory of their founder, **Mr A Subramaniam** in 1978/79. It recognised contributions made to National Development through research and development involving Chemical Sciences. The Gold Medal Fund was supplemented recently through a further contribution from Mascons Ltd. This criteria governing the award were changed in 2011 since there were no applicants since 2007 in order to enable the award to be made to a mid-career Chemist in recognition of honorary services to the Institute.

Nominations are now being invited for the 2017 Award from amongst **Corporate Members** of the Institute who have fulfilled the following minimum criteria;

- Nominees should be not more than 55 years of age and should have been Corporate members of the Institute for at least 10 years on 1st of June 2017
- Nominees should have made significant contributions towards the activities of the Institute through yeoman services in an honorary capacity during the period of membership. These activities could include holding office, membership in committees, coordination of events such as workshops, social events etc.

Nominations could be made by any **corporate member** of the Institute and should include the consent of the nominee and details of the contributions made by the nominee in accordance with the above guidelines. The Award will be presented at the 46th Annual Sessions. **Nominations should be forwarded to reach the Hony. Secretary, Institute of Chemistry Ceylon not later than 31st March 2017.**

45TH ANNUAL SESSIONS OF THE INSTITUTE OF CHEMISTRY CEYLON



Mr. K R Dayananda delivering the Presidential Address



Prof. E R Jansz, Chief Guest delivering his address



Mr. D C Dissanayake, Guest of Honour delivering his address



Prof. (Ms.) S Ekanayake receives the Professor M U S Sultanbawa Award



Ms. A G A W Alakolange receives the Kandiah Memorial Award for Applied Chemistry



Ms. N S Bopage receives the Kandiah Memorial Award for Basic Chemistry



Ms. D Thanabalasingam receives the Kandiah Memorial Graduateship Award



Prof. Tuley de Silva receives the Distinguished Service Award



Prof. Upali Samarajeewa receives the Distinguished Service Award



Prof. E D de Silva delivering the Dr. C L De Silva Gold Medal Award Lecture



Winners of the All Island Interschool Chemistry Quiz Competition 2015/16 - Vincent Girls' High School (National School), Batticaloa

Theme Seminar on
**“ETHICS, VALUES AND RESPONSIBILITIES OF CHEMISTS
 IN NATIONAL DEVELOPMENT”**

16th June 2016

Venue: SLFI, Colombo 07.



Keynote Speaker,
Mr. Mevan Pieris



Prof Ajith
Abeysekara



Prof Vijaya Kumar



Prof Veranja
Karunaratne



Mr. Rizvi Zaheed



section of participants



Panel discussion

Annual Dinner & Induction of New President, Mr. M R M Haniffa



Mrs. Mandrupa
Fernando, Chief Guest



Mr. M R M Haniffa was ceremonially inducted as
the new President by presenting him the
President's Medal.



section of participants



section of participants

Theme Seminar on
**“ETHICS, VALUES AND RESPONSIBILITIES OF CHEMISTS
IN NATIONAL DEVELOPMENT”**

16th June 2016

Venue: Sri Lanka Foundation Institute, Independence Square, Colombo 07.

Keynote Address

**An overview of Ethics, Values and Responsibilities of chemists in a rapidly
changing world**

Mevan Pieris, *F.I.Chem.C., C.Chem.*

Former President, Institute of Chemistry Ceylon

Former President, Plastics & Rubber Institute.

Ladies and Gentlemen, at the very outset let me thank the President & the Council of the Institute of Chemistry Ceylon, for inviting me to deliver the keynote address at this year's theme seminar, titled “An overview of ethics, values and responsibilities of chemists in a rapidly changing world”.

The human mind is both rational and irrational in thinking capability. Humans have all kinds of beliefs and all beliefs are what the mind accepts as real. Some of our beliefs are valuable to us and are deeply cherished and get embedded in our minds as values which serve us as a pair of lenses through which we see the rest of the world before us. Based on the values attitudes result, and that's how the mind reacts towards other things. Therefore, what is expected of chemists is a favourable reaction towards other things and the general environment. It is the attitudes that generate responsibilities and conduct of chemists.

Ethics could be considered to be the principles which govern good conduct, whereas morals are the principles on which judgments of right and wrong are based. Therefore morals and ethics are closely interwoven and are often inter-changeable. The main difference is that morals are abstract, subjective and often personal or religion based, whereas ethics are more practical and believed to be shared principles that promote fairness in social and business transactions. For instance sexual misbehavior is considered to be a breakdown of morals, whereas plagiarism is unethical conduct. Ethics define how to live in a morally accepted manner. Since ethics serve as guidelines towards right & wrong living, individuals in a society are expected to follow such principles. Therefore ethics can be considered to be a code of conduct.

A thousand years before Gautam Buddha, God's voice was heard by Moses on top of mount Sinai as ten

commandments to be obeyed by man. Of them four, could be considered to serve as the core of the commandments that fashion the generally accepted ethics of good conduct towards fellow mortals. They are, Thou shalt not Kill; Thou shalt not commit adultery; Thou shalt not steal; Thou shalt not covet thy neighbour's wife nor anything that is thy neighbour's. The five precepts of Buddhism lays a basic code of ethics and at least three of them seem to convey the same ethics as handed over to Moses by God. They are, abstaining from harming living beings (Thou shalt not kill), stealing (Thou shalt not steal), sexual misconduct (Thou shalt not commit adultery), lying, and intoxication. Chemists must not only be governed by strict professional codes of conduct imposed on them by various internationally recognized chemical societies, but must surely be bound by the generally accepted principles of good conduct. If one were to impose the relevance of these God's commandments or Buddhist precepts to the practice of the discipline of chemistry, one would expect chemists not to synthesize toxic life threatening chemicals ; they are expected not to sexually abuse colleagues in work places and not to steal professional information from fellow chemists (plagiarism). Plagiarism is also a form of lying to others. As per Buddhist precept of abstaining from intoxication it seems unethical for chemists to participate in distillation activities of alcohol as a beverage. Protecting the internal and external environments is considered to be ethical in practically every society.

Responsibility refers to answerability, and a variety of responsibilities can be recognized. A chemist is answerable to others for what he does as an individual (individual responsibility) or as a member of a professional community or as representing an

organization and such responsibility is referred to as corporate responsibility. A chemist is also responsible for his actions or omissions of actions as well. Action responsibility, and the consequences that are already known due to such actions (retrospective responsibility) and possible future consequences (prospective responsibility). What is referred to as care responsibility requires the chemist to take care of others as much as a parent would take care of the children. Therefore, a chemist has an obligation by society that the chemical knowledge imparted by him must be for the good of man.

Table 1 - Types and Levels of responsibilities

Types	Levels
Individual, Corporate, Action, Retrospective, Prospective, Care	Co-worker, Superior, Organization, Professional community, clients, students, spouses, Society, Nation, Environment

It could well be that the bad consequences of a chemist's actions were unintentional, unforeseen and unavoidable. If so, the chemist has done nothing immoral but yet must be held responsible for the consequences. Holding a chemist responsible to humanity for the consequences of their actions is fully justified (Joachim Schummer: 2012).

There are three conditions said to define a moral system. The main condition is the welfare of humanity. Secondly, the existence of moral standards (norms) and obligations which when followed the welfare of humanity is met, and thirdly all norms and obligations must be applicable equally to everyone, when judging their actions. Based on such a moral premise carrying welfare of humanity as the central tenant, it is possible to recognize at least three ideals corresponding to different aspects of the scientific process in which chemists participate. Firstly, the ideal which ensures integrity of the research process, which is the ideal of the habit of truth. This is the ideal that prevents laboratory results being fabricated. Secondly, the ideal of open communication that recognizes science to be a contributor to public knowledge and requires open communication. It requires the chemist to describe experimental procedures completely so that another could reproduce the results. This second ideal becomes difficult when organizational commercial priorities are an issue. Thirdly, the ideal of shared fate that expects service to others and humanity should take preference over self interest in selecting careers and research problems.

Table 2 - Conditions of a moral system and Professional Ideals⁽³⁾

Conditions of a moral system	Ideals of Professionalism
1. Welfare of humanity	1. Integrity & habit of truth
2. Moral standards and obligations	2. Open communication
3. Equal application of moral standards to all	3. Service to others takes priority.

Ladies and gentlemen, chemistry is well known to be the central science and the contribution chemistry has made is all around us. It is only too well known that chemistry has made a major contribution to the improvement of quality of life that has greatly increased the life expectancy of man. The creative capability of chemistry has provided an enormous array of chemicals and materials that has helped man to derive greater satisfaction in every conceivable avenue of life but not without its ill effects.

Since 1930 the global production of chemicals has increased enormously and is still growing to meet man's requirement in a world where population keeps increasing. The chemical industry of the world is undoubtedly the biggest, accounting for billions of US dollars worth of chemical shipments alone, per annum. Chemical and allied industries embrace a wide range of manufacturing activities such as, petrochemicals, plastics and rubbers, fibres, paints, fertilizers, pharmaceuticals, herbicides & pesticides, dyestuffs, industrial chemicals, detergents, soaps, disinfectants, explosives, cosmetics, polishes, toiletries and food. The 21st century depends on all of them. Some chemicals bring great benefits to society such as in health care, but other chemicals such as pesticides are harmful to people and animals and long term ill effects are yet unknown. Such an expanse of chemical industries has already damaged the environment and continues to do so. Hazardous chemicals have contaminated almost all environments. At the centre of it all is chemistry, and the chemist is faced with a moral and ethical dilemma.

During the first world war, the Germans were faced with a severe shortage of nitrogen fertilizer and food production was severely affected.

Fritz Haber a Jew, was called upon by the German government to solve the problem and quite ingeniously he produced ammonia, using the freely available nitrogen in the air by the well known Haber process. This was a remarkable chemical synthesis that revolutionized the capability of agriculture using ammonium fertilizers. It was undoubtedly an ethically strong contribution that provided more food for the

people. However, this same man Haber when called upon by the German Nation to come up with a chemical weapon that could neutralize the superior gun power of the enemy, recommended chlorine to be used in shells to kill vast numbers of enemy in their trenches. Haber heeded the call of the nation and the responsibility by the nation drove him to contribute towards this atrocity. Such immoral and unethical conduct of Haber was viewed with utter contempt by his peace loving wife Clara Immerwahr, the first German lady PhD in chemistry, who committed suicide by shooting herself in the head with her husband's pistol in disapproval of her husband's criminal conduct. Here then we have one of the finest examples in history of ethical feelings of chemists at the two extremities of an ethical continuum. On the one hand helping mankind to live a healthy life and on the other hand knowingly contributing to the destruction of life. Clara's action is also a great example of the need to make personal sacrifices when standing up to immoral and unethical behavior of fellow chemists that one may encounter in one's professional career, raising its ugly head in various forms. The first world war experienced nations using chemical weapons. Chlorine, phosgene and mustard gas were among the chemicals used. Nearly 100,000 people died. Since then, chemical weapons are thought to have killed at least a million persons globally. By the 1980s, 25 countries were developing chemical weapons. After many years of discussions and with 189 countries representing 98% of the global population consenting, the Organization for the Prohibition of Chemical Weapons (OPCW) was established in 1997.



Figure 1: Photograph of Haber and wife Clara

Ladies and gentlemen, the greatest creative capability of chemists has been the ability to synthesize new substances which have changed the material world we live in. Changing the material content of the world forces us to consider the implications of such changes, as they could be both beneficial and harmful to life on earth. Therefore, the synthesis of new materials is

undoubtedly an area of moral and ethical concern. During the past century chemical synthesis has been the most important and most challenging activity of chemists. Chemical firms depend greatly on the capability of the researcher to come up with newer and better chemicals of practical significance. Therefore, the chemist in organizations who are responsible to their superiors may at times encounter value conflicts between them and the organization. It is in such moments that ethical principles carried by the chemist gets tested and principle centred decisions have to be made which may even result in resignations.

It has been reported that there are more than 3 million chemists in the world and around 570,000 research papers are presented per year, and of them 50% are concerned in fundamental chemical synthesis, 25% in applied synthesis, and the balance 25% deal with other areas such as elaborating on classifications, identifying structural peculiarities etc. The chemist who conducts basic chemical synthesis is responsible to the community of chemists as a whole, as by developing the capacity of synthetic chemistry and chemicals it could even promote the growth of applied chemical research.

Ladies and gentlemen, the production of new materials changes the existing mix of materials in the world. Every new synthesis undoubtedly improves our knowledge. Yet for all, the new material also produces a large content of the unknown referred to by certain authors as non-knowledge (Schummer: 2012). The non-knowledge refers to the quantum of undetermined properties of the new substance and its possible reactions with already existing materials in the world. There is a well known saying, “the more we know, the more we do not know”. The introduction of new substances into the environment increases its chemical complexity and incomprehensibility. Therefore moral and ethical issues surface when the synthesis is responsible for any harm to the environment. One school of thought is that the inventor should be held responsible, even if the actual introduction of the material to the environment was done by someone else. A chemist may try to defend himself that he was unable to visualize the possible harmful effects at the time of the synthesis which tantamount to a knowledge argument. Yet for all, the chemist is expected to understand the probability of harmful effects a new material could cause. A chemist could also argue that his creation was not meant to harm and that amounts to an intention argument and such arguments may go as far as even to say that greater good was expected than

bad out of the research. Such an argument is best illustrated by the work of Alfred Nobel who discovered dynamite.



“My dynamite will sooner lead to peace than a thousand world conventions. As soon as men will find that in one instant, whole armies can be utterly destroyed, they surely will abide by golden peace”.

Figure 2: Alfred Nobel

Nitroglycerine had been invented as a powerful unpredictable explosive by Ascario Sobrero, an Italian chemist by reacting glycerine and a combination of sulphuric and nitric acid. Alfred Nobel who emerged from a family that was dabbling in explosives, scaled up the production of this dangerous material and in the process experienced several explosions and one of them took his brother's life. In 1864 he mixed kieselguhr with the liquid nitroglycerine and was able to make a much safer paste that enabled its conversion to rods. He patented this material in 1867 as dynamite.

Alfred Nobel invented the terribly destructive dynamite for commercial use as an explosive but with the full knowledge of its capacity to destroy human life. Yet for all he justifies such wicked intentions by saying that such lethal power of dynamite was expected to end the war faster and thereby prevent more deaths that would have otherwise resulted if the war had prolonged. He tries to gain respectability by linking a noble ideal of saving more. In the world we live in, even the memory of such persons of destructive contributions is perpetuated at the highest possible level of recognition, possibly in consideration of the legacy left behind by them for a more noble purpose. Perhaps, similar intentions guided them that dropped two hydrogen bombs on Hiroshima and Nagasaki in August 1945 with devastating consequences, and the loss of more than a hundred thousand lives, to put an end to Japanese aggression. Only the actual or probable consequences of one's action play a role in moral judgments, regardless of the intentions. It is utterly unacceptable to judge actions only according to good intentions regardless of bad consequences. Good intentions to be considered favourably must necessarily have a good moral premise.

Pure research carried out to contribute to the general pool of knowledge would have only a single good intention of enlarging the scope of knowledge. Since, the contribution to knowledge is generally

accompanied by a greater contribution to non-knowledge, producing new substances simply because they did not exist previously is morally questionable. The synthetic chemist may like to think that their actions are morally neutral from a purely scientific point of view. However, it seems justified to hold the synthetic chemist responsible for any harmful effects the new material may cause.

Chemists also produce new materials useful to man. Some new materials could be useful to a certain group but harmful to others. Every synthesis of a harmful or lethal substance is morally wrong. Therefore chemists involved in developing chemical weapons are violating norms of general morality. Neither the commercial interests of the business owners nor the obligations an employee has towards his employer can change the moral obligations the chemist must have towards humanity. In another scenario the public and the government may consider chemical weapons a necessity in the interest of the nation at times of war. A chemist may feel patriotic and may like to synthesize such chemical weapons, but it is morally wrong to do so as it serves only the nation and not humanity as a whole.

“Every synthesis of a new substance with the intention to harm or kill people is morally wrong”.

A new synthesis raises issues concerning risks and responsibilities. In carrying out the synthesis for the first time the chemist deals with the unknown. History has shown that a first synthesis could be dangerous and even explosive. Therefore, considering the safety of others in the laboratory it would be prudent to do the first synthesis with a small quantity. After the first synthesis risks can arise due to subsequent availability of large quantities of the material outside the laboratory. Risks can arise due to future use of large quantities of the substance, or due to the manufacturing process of such large quantities or by the dissemination of the method of synthesis in scientific journals. The chemist is ethically bound to prove that the synthesizing procedure is safe before the substance is released. An additional problem results due to possible impurities. The usual types of risks are, explosions, toxicity and environmental pollution.

The case of Agent Orange is an interesting but horrendous example that helps to explain the risks mentioned.

In 1941, a scientist by the name of Robert Pokorny working for a company that was making agricultural pesticides published the synthesis of 2,4,5

trichlorophenoxy acetic acid known as 2,4,5 T. Four years later, American Chemical Paint company patented 2,4,5 T as a weed killer, together with several other weed killers among which was 2,4 D as well (US patent 2390941, 1945). Dow Chemicals began in 1950, large scale production of the herbicide 2,4,5 T. During large scale production a very small amount of the highly toxic 2,3,7,8 tetrachlorodibenzo-beta-dioxin (TCDD) had formed as an impurity, due to a side reaction.

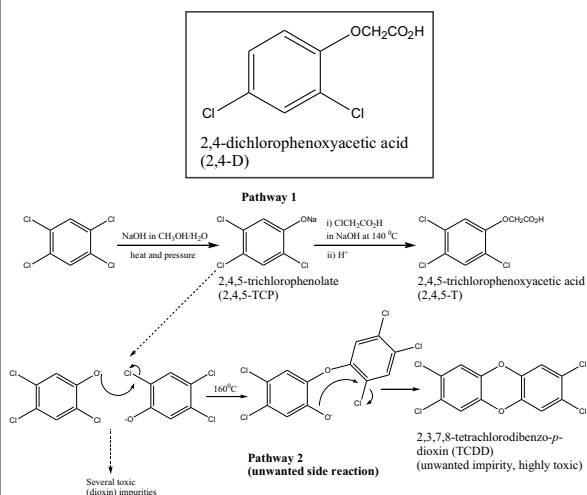


Figure 3: Chemical pathways in the synthesis of herbicide 2,4,5 trichlorophenoxy acetic acid.⁽⁴⁾

In the synthesis of the herbicide 1,2,4,5 tetrachlorobenzene was reacted with NaOH at high temperature to form sodium 2,4,5 trichlorophenoxide, which thereafter reacted with chloroethanoic acid at 140 °C to produce 2,4,5 trichlorophenoxy acetic acid (2,4,5 T). However in large scale bulk manufacturing, the temperature controls were not precise as in the laboratory, and at around 160 °C due to a side reaction involving the dimerization of the 2,4,5 trichlorophenolate by a nucleophilic substitution reaction, a small amount of the poisonous 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD) resulted, of the order of parts per million. Ladies and gentlemen one of the saddest stories in the history of chemistry is in the use of this material.

In the Vietnam war the United States of America waged against the North Vietnamese Vietcong guerilla fighters, as much as 45 million litres of a powerful mixture of herbicides known as Agent Orange, consisting of a 50 : 50 mixture of 2,4,5T and 2,4 D, were sprayed from air on 4.5 million acres of tropical forest to defoliate the trees, as it was providing a canopy under which the Vietcong troops were hiding. Such

indiscriminate use of massive amounts of chemicals, over a period of eleven years from 1961 to 1972, violating all norms of decent, moral and ethical conduct, was unheard of before, and was catastrophic, causing immense damage to the natural environment and the Vietnamese people.

The massive amounts of the herbicide was manufactured by seven of the most powerful chemical organizations of America, which heeded the call of the US military and Government. The chemists' responsibility had now shifted dramatically in the cause of patriotism, in the cause of aggression rather than defense of its own national territory. A chemical that had been synthesized for an entirely peaceful purpose of producing more food was now diverted in massive quantities for an entirely different purpose calculated to destroy the natural environment for a military objective. The use of Agent Orange, so called due to the orange coloured stripe the chemical barrels carried, caused havoc among the Vietnamese people.



Figure 4: Some images of people who suffered from Agent Orange

Serious health issues ranging from tumours, birth defects, miscarriages, rashes, cancers, and various

psychological problems were recorded. It is reported that as many as 400,000 people were killed or maimed on account of the use of Agent Orange and Vietnam has claimed that half a million were born with serious birth defects and 2 million suffered from cancer and other illnesses. In such a deadly situation, quite definitely the chemical firms have to be held responsible for supplying a highly dangerous destructive chemical for a use in such large quantities for a purpose for which it was not synthesized. In such a situation it is unreasonable to hold the first synthesizer of the chemical responsible for such a calamity.

Ladies and gentlemen extensive research carried out has shown both 2,4,5 T and 2,4 D type of herbicides in its pure form are harmless and safe to be used as an effective herbicide and that the unanticipated by-product TCDD was responsible for the serious health issues. Agent Orange was contaminated with the Dioxin on the average up to only 1.91 ppm. An obvious question that surfaces is whether the chemical companies used a higher temperature above 140 °C to increase the rate of production and if so whether they were unmindful of the formation of a by-product or were aware of the formation of the toxic by-product but were ignorant of its gravity at such small amounts of ppm. Whatever may be the truth, the undisputed fact is that the chemical factories exceeded the required temperature of 140 °C and are not only responsible for their unethical and immoral conduct of supplying chemicals for war, but are accountable for the misery caused to so many. The arm of the law descended on the chemical companies and compensation was paid to millions of war victims. The upper limit of dioxin was fixed at 1ppm and thereafter in 1979 it was reduced further in the US to 0.1 ppm and to 0.01 ppm in UK. At this point Dow chemicals ceased to make this herbicide.

Glyphosate or N- (phosphonomethyl) glycine is a widely used broad spectrum herbicide which is mainly absorbed through the leaves of weeds. Monsanto which makes this chemical has also genetically modified certain crops such as Soya bean to be tolerant to glyphosate. However in march 2015, the World Health Organization internal agency for research on cancer, classified this chemical as “probably carcinogenic in humans” (category 2A). The harmful effect of this herbicide is only probable and all do not agree. Yet for all, the Sri Lankan government has deemed it fit to ban the use of this chemical in agriculture forcing tea and other agricultural plantations to go in search of newer methods of controlling the weeds.

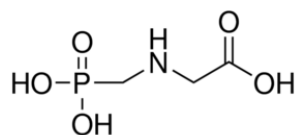


Figure 5: Chemical structure of Glyphosate or N-(phosphonomethyl) glycine

Ladies and gentlemen, herbicides which cause death to plants is viewed as a poison by society. Such chemicals are now carefully tested by the Environmental Protection Agency (EPA) before allowed to be used. The toxicity of chemicals can be tested by determining the LD₅₀ value, which is the lethal dose in mg per kg of the tested population of animals such as rabbits. Two important questions that arise are, firstly, whether it is immoral and unethical to take away the lives of innocent animals in doing tests in spite of certain religions being strongly against killing any animals. Secondly, how relevant are such test results done on animals where humans are concerned.

Table 3: Comparison of oral LD₅₀ values of common herbicides and consumer goods

Herbicides	LD ₅₀	Common consumer chemicals	LD ₅₀
Paraquat (Gramaxone)	100	Nicotine	09
Triclopyr	630	caffeine	192
Pendimethalin (Procol)	1050	Tylenol	352
Atraine	3090	10% household ammonia	350
Glyphosate (Roundup)	4900	Codeine	427
Imazaquin (image)	> 5000	Table salt	3000

The lower the LD₅₀ value the more toxic is the chemical. It is seen from the table that herbicides which are highly toxic to plants are very much less toxic than many household chemicals freely in use. Herbicides do not bind in the human system and are excreted in urine. Therefore a lethal concentration of the herbicide does not accumulate in humans. However, even if it be non-lethal, chemicals could create other health problems.

Ever since the ground breaking contribution of Haber towards the first synthetic chemical fertilizer, the contribution of chemists in the field of agriculture has been tremendous. Although initially synthetic fertilizers played a critical role in food production, and in health and well being of people, its application in large amounts has had a negative effect on the environment (Townsend et al : 2003). Adverse effects of synthetic fertilizers are often ignored by the manufacturers and users of such fertilizers despite far reaching harm. Often only the nitrogen, phosphorus, and potassium content of a fertilizer mix is shown on

the package with three numbers such as 15 – 5- 10 to indicate such a content. In this instance it adds up to 30%, but the rest of the 70% is unknown. It could be any industrial or domestic waste material as it hasn't to be disclosed. In a study carried out by the California Public interest research group, 29 fertiliser brands from 12 States were tested for 22 toxic metals such as aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, uranium, and zinc, and all 29 brands were found to carry all 22 toxic chemicals and many of them were found to exceed levels of concern. Of these metals nine metals such as arsenic and lead are suspected to cause cancer and 10 metals such as lead, mercury and cadmium are persistent bio accumulative toxins (PBTs). They persist for a long time in the environment and can accumulate in tissues of plants, animals and humans, thereby increasing the long term health risks even at low exposures. Pb, Hg and Cd can also cause cancer, birth defects and reproductive problems. Cadmium and lead are highly persistent and can affect the soil quality. Barium is said to cause kidney and lung damage. These toxic chemicals can accumulate in soils and enter streams and wells. It has been also reported that some plant varieties are more likely to absorb non-nutrient toxic substances from the soil. Fruits and grain can absorb lead, lettuce and corn can absorb cadmium from the soil. This means that our food supply is at risk of contamination by toxic chemicals that threatens health. So what then is the responsibility of the chemist in a situation such as this. Chemists have to display the care responsibility expected of a professional community. They have to scientifically evaluate the quality of fertilizers and the environmental damage caused and find solutions to the problems of a chemical nature. Therefore, there is now an additional responsibility on the chemist to disentangle society from the web of chemicals woven by the chemists themselves.

The chemists have altered nature's nitrogen cycle drastically contributing to a significant global change. The amount of reactive nitrogen generated by humans keeps increasing greatly. About 50% of synthetic nitrogen fertilizer ever to be used on earth has been applied in the last 15 years thereby the nitrogen content in waterways has increased significantly. The nitrates in water reduce the quality of water. It increases algal growth, depletes the oxygen in water and affects aquatic life. Medical studies seem to suggest that certain urinary and kidney disorders are due to

excessive nitrate in drinking water. Certain bacteria are able to convert the nitrate ion to the dangerous nitrite ion which can bind with the hemoglobin thereby removing its capability to capture and transport oxygen. This problem could be severe as such bacteria are known to exist in the alkaline stomach conditions of little babies. Therefore nitrate contaminated water should not be used to prepare milk for babies. In a world of increasing water pollution by various chemicals, there is now a huge responsibility weighing on the heads of chemists, to find better ways and means of purifying water.

Ladies and gentlemen, man's destruction of the forest cover that provided nature's green and the destructive contribution of the chemical industry threatens the very existence of us all on this planet. Sustainable development demands strongly that the environment be taken care of, and there is a moral and ethical responsibility resting on the chemists to rectify the position. The concept of green chemistry has recognized several principles that a chemist should consider as an ethical responsibility in maintaining a cleaner and greener environment. Chemists should improve the 'chemical process mass intensity' which expresses the ratio of the mass of all materials used (water, organic solvents, materials and reagents, process aids etc.) to the mass of the active ingredient produced in a chemical process. A chemist must also be concerned with what is known as the "atom economy" which raises the question, what are the atoms that end up in the final product and what are the atoms which are wasted in the chemical reaction? These first two principles draw the attention of the chemist to the concept of wastage of materials. It is better to prevent wastage than clean up wastage. The use of catalysts which are regenerated help to minimize wastage. The Japanese quality guru Taguchi stated that wastage is a crime against society. It is also desired that less hazardous chemicals be used and synthetic methods generate substances having little or no toxicity to human health and the environment. It is now known that toxicity and resulting hazards could relate to all materials in the reacting vessel and not to the reactants only. Some of the chemicals produced like certain drugs and agricultural chemicals are deliberately designed to be toxic to living organisms. The unknown ill effects cause concern. There is a moral responsibility to develop safer chemicals. Minimizing toxicity and simultaneously preserving the functional efficiency is a challenge for the chemist and requires good knowledge of chemistry, toxicity and of the environment. Hazards

could flow from the molecular design itself and such intrinsic hazards of elements and molecules flowing from its design need to be evaluated and managed as part of a systems based strategy. The time is right for chemists to work in cooperation with toxicologists in a multidisciplinary manner. The mechanisms of toxicology are much better understood today and a clearer understanding of such pathways will undoubtedly provide the chemist the sunshine of a new dawn. It is also necessary that auxiliary chemicals such as solvents be rendered unnecessary by the discovery of newer methods. At times, more than 50% of the reaction system is made of solvents and such materials also pose safety concerns as they are volatile, flammable, and explosive and could be neurotoxic as well. Chemists should also be concerned with energy consumption and the impact on the environment. Synthetic methods as far as possible should be conducted under ambient conditions. Very often the energy consumption to the chemist is irrelevant. Green chemistry also encourages the use of renewable materials. So far economic growth has been supported mainly by exhaustible fossil fuels, coal, oil and natural gas. Nature is said to have a capacity of producing about 170 bn tons of plant bio mass annually of which currently only about 3.5% are consumed to meet human needs. It has been estimated that about 40 bn tons of biomass are needed per annum to generate a total bio based economy. The challenge is to develop low energy, non toxic pathways of converting biomass into useful chemicals in a manner that does not generate more carbon than being removed from the air. Ideally the carbon sent in must greatly exceed carbon sent out so that global warming gases in the atmosphere will decrease. Over the past decade significant progress has been made in developing chemicals such as bio ethanol, biodiesel etc. There is also a high emphasis to design for degradation and that means designing chemical products to breakdown fast after the function has been served, so that products will not stagnate in the environment. Degradation can be promoted by biodegradation, hydrolysis and photolysis.

In an overview of this nature at least a passing reference must be made to terrible accidents that have occurred in chemical plants causing misery to the people in the environment. In the interest of time, it would suffice if reference is made only to the explosion which took place in 1984 at the Union Carbide pesticide plant located in Bhopal, India, which was manufacturing carbamate pesticides using highly toxic methyl isocyanates as an intermediate chemical. The

explosion of the tank carrying the dangerous methyl isocyanate was due to cooling water seeping into the tank due to poor maintenance of the plant and triggering off an exothermic reaction between the isocyanate and water that resulted in the explosion. Over 500,000 people were exposed to the toxic isocyanate. The responsibility and accountability of this terrible incident must rest with the maintenance engineers of the plant, rather than with the first synthesizer of the pesticides.

Ladies and gentlemen, in view of the seriousness of the harmful effects of chemicals, ethical codes of conduct have been formulated by world's leading professional bodies such as the American Chemical Society and the Royal Society of Chemistry so as to serve as guidelines to the professional chemists who remain scattered in a variety of locations such as in industry, university, research laboratories and government and other corporations. The American Chemical Society has identified nine key responsibilities that demand good conduct of chemists.

Chemical Professionals' Code of conduct, ACS, 2012

1. Responsibility to the Public

To serve the public interest & safety and advance the knowledge of science. They should be actively concerned with the health & safety of co-workers, consumers & the community. **Public comments on scientific matters should be made with care and accuracy without unsubstantiated, exaggerated or premature statements.**

2. Responsibility to the Science of Chemistry

Should seek to **advance chemical science, understand the limitations of their knowledge and respect the truth.** They should ensure that their scientific contributions and those of their collaborators are thorough, accurate, and unbiased in design, implementation and presentation.

3. Responsibility to the Profession

Should strive to **remain current with developments** in their field, share ideas & information, keep accurate & complete laboratory records, **maintain integrity in all conduct and publications** and give due credit to the contributions of others. Conflicts of interest and scientific misconduct such as fabrication, falsification and plagiarism are incompatible with this code.

4. Responsibility to Employer

Promote and **protect legitimate interests of the employer**, perform work honestly, competently,

comply with safety policies and procedures, fulfill obligations, and safeguard proprietary and confidential business information.

5. Responsibility to Employees

Should respect the professionalism of their subordinates and have concern for their well being without bias. Employers should **provide them with a safe, congenial working environment, fair compensation, opportunities for advancement and properly acknowledge their scientific contributions.**

6. Responsibility to Students

Should regard the tutelage of students as a trust conferred by society for the promotion of the students' learning, professional development and safety. **Each student should be treated fairly, respectfully, and without exploitation.**

7. Responsibility to Colleagues

Should treat colleagues with respect, encourage them, learn with them, share ideas honestly, and give credit for their contributions. Should avoid bias based on race, gender, age, religion, ethnicity, nationality, sexual orientation, gender identity, presence of disabilities, educational background or other personal attributes. They should show consistent respect to colleagues regardless of the level of their formal education and whether they are from industry, government or academia, or other scientific and engineering disciplines.

8. Responsibility to Clients

Should serve clients faithfully and incorruptibly, **respect confidentiality, advise honestly, and charge fairly.**

9. Responsibility to Environment

Should strive to do their work in ways that are safe for both the environment and for the health of all who may be affected. They have a responsibility to understand the health, safety, and environmental impacts of their work to recognize the constraints of limited resources and to **develop sustainable products and processes that protect the health, safety, and prosperity of future generations.**

Of the nine responsibilities two are concerned with responsibility towards science of chemistry itself and towards themselves as professionals. In the main what is expected of chemists as professionals is to be truthful and admit their limitations, and avoid falsification of results and plagiarism and ensure thoroughness of their scientific work and publications. Three core responsibilities are focused on the context of work and refer to colleagues, employer and employee. These are

organizational internal responsibilities of an interpersonal nature. Three other core responsibilities relate to those whom the chemist may be called upon to serve in one way or other. They are the clients, students and the general public. The ninth responsibility is the all important responsibility by the environment, linked to sustainable growth. What is expected of the chemist is detailed in the above table.

Ladies and gentlemen we live as imperfect men in an imperfect world, born to live and die. So many have lived and gone before us and in an uncertain world what is certain is that we all will disappear one day and what is uncertain is how that will happen. Yet for all we have a responsibility by others yet to be born on this planet and what we do must not be detrimental to what is needed to sustain life. With hind sight it is fair to state that in spite of the harm contributions of chemists have caused, over the past hundred years the life expectancy of people have doubled due to the creative power of the chemists, and the quality of life of an expanding population has also improved greatly. The world today is better fed and better dressed as never before, thanks to the chemist. The world of creativity of the chemist is now a world of creativity of scientists. If chemists were able to achieve much in the past as a singular profession, their future success will greatly depend on their ability to team up with related other fields of science. That indeed I see as the greatest responsibility and challenge of the chemists in this century. The unconquered unconquerable spirit of the chemist and other scientists shall surely be the golden thread of hope that could meet all challenges ahead of us.

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Conference on
**“Environmental Challenges for Sustainable Development:
 Role of Chemists”**

August 18-19, 2016

Venue: Sri Lanka Exhibition and Convention Centre (SLECC), Colombo.



section of participants



Chief Guest:
Hon. Patali Champika
Ranawaka



Dr. A M Mubarak



Prof. K R R Mahanama



Mr. V Vikram



Prof. O A Illeperuma



Chief Guest's procession



section of participants



section of participants

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Honorary Minister's Address

Environmental Challenges for Sustainable Development

Hon. Patali Champika Ranawaka

Minister of Megapolis and Western Development

I am honoured to be here as the Minister of Megapolis and Western Development, but I am more honoured to be here as a person who handled the portfolios of Environment, Energy, Research and Technology, which I believe is more relevant to you members and the well wishers of the Institute of Chemistry Ceylon, and also as a person who believes that knowledge in sciences and advancements in technology are essential for the development of our nation.

I often quote Albert Einstein “Knowledge is important, but innovative thinking is more important” and our own Kumaratunga Munidasa, “The nations that does not produce new, will not emerge”.

I must congratulate the Institute of Chemistry Ceylon for your long standing contribution for 75 years in various ways for the development of Sri Lanka and I believe the theme “**The role of the chemists in sustainable development, with specific relevance to environmental challenges**” is timely and highly relevant. However, I am trying to see the chemistry between the chemists, “Chemistry”: the science that you have a command in, and the Megapolis development, which I am handling now with a range of professionals. This at the very outset maybe seen as 'less obvious'.

Megapolis is often seen as an event or an affair at a large scale dealing with physical developments such as buildings, infrastructure and people; Scaled in volume, scaled in investments and scaled in terms of impacts. It deals with planning, engineering, economics, social wellbeing, investment promotion, construction management, and many more.

The general perception that we (the general public) have of chemists is often limited to a laboratory of small scale, and a few busy people engaged with experiments in them. Is this perception inevitable due to the nature of the subject? Or is this a result of the level of

involvement and presence of chemists in the developmental activities in this country? I would suggest this is something that we should think about at this 75th anniversary of the Institute of chemists!

Even though the physical developments that we are aiming at are large in scale, we shall not forget that they all are concepts built upon the thoughts of individuals. Therefore, the sustainability of the developments depends upon the right chemistry of the individuals and their thoughts. They all are emerging from the forces combined by efforts. The forces are conflicting and not necessarily complementary always. The sustainability of the developments depends upon the balancing of the forces that we got to deal with. Ultimately, they all are masses built with molecules. However, noble our thoughts can be and however good our efforts could be, it is the right combination of molecules and their inter-relations that assures the long term sustainability of our physical developments.

'Sustainability' is more an overarching principle that we got to think about in the building, operating, as well as disposing our physical masses. Right chemistry matters in all stages in our developments: I would like to conceptualize this, relating to how it is shown in Hindu philosophy, which we Buddhists as well as the believers in others faiths can also relate to with our own versions. The order of the Brahma: the building, of not at all as supreme as 'Creation'. The order of the Vishnu: the existence, if not as scared as 'Ruling' and the order of Shiva: the disposal, if not to 'Destroy'. At the first instance we need to be sustainable in planning, designing and construction. We shall be truly 'creative' in all aspects, following the order of the Brahma. However the challenge that we face is meeting the emerging demand, while being sensitive to universal order.

Throughout the evolution of the human civilization, we have been converting energy into mass

and *vice-a-versa*. As we all know these conversions are not easy two way process. When the forward processes are economical and attractive, their backward processes are costly and cause negative externalities.

In a simplest example, the amount of energy embodied in the materials that we use, throughout the processes of their production, if not accounted for, then we may not be sustainable. The types of chemical compositions that formulated them and the effects that such compositions will have upon the users and the environments that we live in along with the technologies that we use, may decide how sustainable we could be.

Each step that we move forward, in these processes, can be reversed only with huge costs and immeasurable damages. If suitable compositions will not fall in place our works will not be 'Creations', rather they may become silent volcanoes, the courses of destruction.

The recent situations where our work got questioned are the use of Asbestos, corals for lime and use of Glyphosate in agriculture. I need not go into details as you chemists are well aware of these hard experiences.

In the second phase we shall be mindful and sustainable in our own existence: the operations and maintenance and all our activities, infusing love and care for the entire universe, non less than what is gifted by 'Vishnu'.

It is clear that the state of our affairs may soon place us before testing. To give you a few examples, we can find comfort with modern lifestyles, sophisticated infrastructure and state of art technology. However, we all know that we all find these comforts imposing a huge cost on the earth that we live in. It is calculated, the present modes of transportation consumes trillions of liters of petroleum based fuels a day. They emit gasses that cause heat, environmental pollution and discomfort.

The amount of water that is consumed within the city of Colombo alone is more than a few hundred million liters a day. When we develop in to a Megapolis, this will be doubled. The type of apparatus, the materials and methodologies that we use are critical in that sense.

We can maintain clean and green surroundings for the sake of visual comfort, just to please our eyes. We can use most economical and fast result generating methods masking with catchy terms such as 'efficiency' and 'productivity'. However, the chemistry of the materials and the methods that we use has implications

those go beyond visual comforts. They may not be visible to the naked eye.

In the third phase, not only in creation and maintenance, we need to be sustainable also in disposing what we produce. As a result of developments we produce waste, and this waste, either from our day to day operations or periodically from construction and demolition. The problem is the way that we destroy what we produce is more destroying than what 'Shiva' said to have destroyed.

To give you an example, the city of Colombo today produces nearly 80 metric tons of solid waste. When we develop into a Megapolis, this maybe doubled in volume. It is the chemistry of this garbage that the challenge that we have faced today. We have been looking for methods of disposal. Although it's not the responsibility of the Ministry of Megapolis and Western Development, as a shared responsibility that we have in the present government of Sri Lanka, we have called for proposals for projects to dispose solid waste in Colombo. The proposals that we receive show that the main challenge that proposes face is not the quantity of the waste or the locations where they are, but the material composition of the waste that we produce, which needs scientific investigation on an above what is already known to the parties experienced in solid waste management.

We have a mountain of solid waste in Bloumendhal area in Colombo, which I would call a historic landscape of a decaying city, rather than a dump of solid waste. We are looking for a capable party to remove this dump and transform this valuable land into an attractive landscape and a useful activity setting.

The challenge that we have is the chemical composition and the non obvious organic and non organic chemical reactions prolonged as a result of decay and decomposition. These are not readily evident on the surface of this dump, but likely to be disastrous, if exposed. This is where you chemists will have to make your presence and can raise your voice in the creation, existence and disposal. We need you to join hands with professionals to move forward in realizing our dream of Western Megapolis irrespective of what this term Megapolis means. We intend to make the Western Megapolis be the booster of the economy of the entire nation, assuring that the other areas of the island too will have the benefits of developments.

I shall propagate this impact all over the island. We need to be creative, in its true sense, with no harm to anyone. We need to be mindful of our existence with

true love and care, without imposing additional costs on this earth and we need to dispose without being destructive.

This understanding and the right mix of expertise will make us sustainable. Therefore at this occasion, I invite you chemists to contribute your ideas, your

inputs and your expertise for a better future in Sri Lanka.

Once again, I thank the Institute of Chemistry Ceylon for inviting me to address you at this occasion and I wish the 75th anniversary and conference be a success!

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We are happy to announce that the following services will be provided by the College of Chemical Sciences (CCS), the educational arm of **Institute of Chemistry Ceylon**.

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Dr. C Udawatte, Senior Lecturer

Dr. U K Jayasundara, Senior Lecturer

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An Appreciation

Mrs. Yogarane Mahesan *FRSC (UK); FRACI (Aus); C. Chem, F.I.Chem.C*



The sudden death of Mrs. Yogarane Mahesan, retired Government Analyst and a Past President of the Institute of Chemistry Ceylon came as a shock to members of the Institute of Chemistry Ceylon (IChemC) and to all her close associates, relations and friends. She was visiting her son in the USA and, passed away soon after her arrival in Sri Lanka. The President, the Council and members of IChemC wish to express our deepest sympathies to her family members at this time of grief and great sorrow.

Mrs Mahesan had a distinguished career before retirement and was also quite active thereafter. She participated in many of the IChemC activities whenever she was in Sri Lanka. She was a very cheerful person with a perpetual smile. She was a close associate of the late Emeritus Professor J N O Fernando.

As a Fellow of the Institute of Chemistry Ceylon (F.I.Chem.C.) and a Chartered Chemist, she was the first lady to enter the Government Analyst's Department in the year 1964. She had a distinguished record of service at the Government Analyst's Department from 1964-1999 and was the first lady to become the Government Analyst in 1992.

In 1981-1982, Mrs. Mahesan participated in the International Seminar in Chemistry at the University of Uppsala, Sweden. She also participated in the Food Sanitation Administration Experts' Programme held under the Japan Food Hygiene Association (in 1988) and in the International Seminar on narcotic Drugs conducted by the Food and Drug Administration of USA (in 1993).

In 1995, Zonta Club of Colombo had adjudged her

as the Woman of Achievement in the field of Science, Technology and Telecommunication.

On retirement, Mrs Mahesan served as Chairman of Mantai Salt Ltd., successor to Lanka Salt Cooperation.

Mrs. Mahesan was a member of the IChemC since 1971 and has been an elected Council Member from 1991-2006.

She had actively participated in seminars, workshops and exhibitions organized by the Institute of Chemistry Ceylon. She highlighted some aspects of the work of the Government Analyst's Department at these events conducted by the Institute of Chemistry Ceylon.

She became the President of the IChemC in 1994, after holding the position of Vice President in 1993. In addition she had served as a member in various committees at the IChemC including the Awards Committee (1991-1995), Admission and Ethical practices committee (1998-2006) and Buildings Project Committee (2000-2004). She was the Chairperson of the Board of Trustees (2005-2006) and the College of Past Presidents (2005-2006). She was actively involved in translating the All Island Chemistry Quiz paper, National Australian Chemistry Quiz papers and other documents into Tamil medium.

The idea of awarding the distinguished service award by the Institute was mooted by Mrs. Mahesan and was implemented for the first time in the year 1995. Considering her tremendous services to the IChemC, she was herself the recipient of the prestigious distinguished service award in 2006.

On behalf of the IChemC, I wish to place on record our appreciation of the long and dedicated service rendered to the IChemC by the late Mrs Y Mahesan.

May her soul rest in peace.

An Appreciation

late Mr Thambipillay Kandasamy

Bsc (Cey); MSc (Lond); DIC; FRSC; F.I.Chem.C.; C.Chem.



The members of the IChemC were deeply saddened to learn about the death of Mr T Kandasamy, coming as it did on the heels of the demise of Mrs Y. Mahesan, another past President of the Institute of Chemistry Ceylon (IChemC). Mr T Kandasamy was one of the distinguished past Presidents of the IChemC.

Late Mr Kandasamy was one of the pioneers/founding fathers of the Chemical Society Ceylon [established in 1941], predecessor to the IChemC. He retired as Government Analyst way back in 1986 and also served as President of IChemC in 1979. His dedicated and committed services to the IChemC was recognized when he was presented with the distinguished service award in 1999.

He made a huge contribution to the IChemC, silently and unobtrusively, a rare feature in this day and age. What he and his contemporaries did then to establish the Graduateship Programme in Chemistry (GIC) is beyond comparison; those were hard days but they left no stone unturned in association with the late Professor J N O Fernando to bring the IChemC to what it is today.

Mr. Kandasamy obtained his BSc (Chemistry Special) from the University of Ceylon in 1950 and the MSc from the Imperial College of Science and Technology (UK) in the field of Food and Drugs. He also held the Mastership in Chemical Analysis from the Royal Society of Chemistry (RSC), UK. He was a Fellow and Chartered Chemist of both the RSC and the IChemC.

Having joined the Government Analyst's department in 1951, he rose to the top position of Government Analyst before retiring in 1986. He was

actively involved in many Food Control activities, having served as a member of the Food Advisory Committee in the Ministry of Health for over 40 years.

He was a UN National Consultant in Chemical Analysis from 1997 – 1998. He was responsible for setting up a new, fully equipped Food Laboratory at Anuradhapura and in upgrading the similar facility at Kalutara. He also worked as a UN National Consultant at the National Building Research Organization from 1988- 1992 in the Pollution Control Laboratory and the Landslide Hazard Project.

He took an active part in the work of the Sri Lanka Standard Institution (SLSI), serving in many committees connected with Quality and Standards.

He played a significant and active role in developing the Chemical Society of Ceylon and the IChemC, its successor. Here too he served in many committees, including the Admissions and Ethical Practices Committee and, as its Chairman at one time. He was a long standing Council Member of the IChemC, was its Vice President in 1978 and then, became its President in 1979. He was instrumental in writing the 40 year History of the Chemical Society of Ceylon and the IChemC.

Mr Kandasamy was a visiting lecturer for the MSc programme in Analytical Chemistry, University of Colombo, from the time of its commencement till 2006. He was also the coordinator for the Environmental Chemistry Unit of this course till 2006. He was involved in the drafting of the syllabus for the Food Science and Technology unit in the GIC programme at the IChemC.

There will be much more to write about the late Mr Kandasamy; time and space does not allow me to do so. We are greatly indebted to the late Mr Kandasamy for his dedicated and committed, loyal services to the IChemC that has brought the IChemC to its present prestigious position in Sri Lanka and abroad.

He was living with his children in Canada at the time of his demise. On behalf of the Council, Staff and members of the IChemC, I would like to extend our heartfelt condolences and deepest sympathies to his children in Canada

May his soul rest in peace

46th Annual Sessions of the Institute of Chemistry Ceylon 2017

Theme:
Role of Chemists for a Better Tomorrow

Date: June, 2017

CALL FOR ABSTRACTS AND EXTENDED ABSTRACTS

Last Date for receiving abstracts and extended abstracts is 31st January 2017

AWARDS 2017

The following awards will be presented at the Annual Sessions 2017 of the Institute of Chemistry Ceylon.

- **Dr. C L de Silva Gold Medal Award**

Awarded for an outstanding research contribution in any branch of Chemical Sciences and/ or the use of such research for National Development during the last five (5) years in Sri Lanka. Credit will be given for the utilization of local raw materials, and where the contribution has already resulted in (i) a publication in a Citation Indexed Journal or (ii) Registering a Patent or (iii) where the contribution has already resulted in a positive impact in the development and innovation in the industry.

- **INSTITUTE OF CHEMISTRY SILVER MEDALS**

Devanathan Memorial Award

Awarded for an exceptional research contribution of an original nature in the field of Physical Chemistry and/or related areas, such as Physical-Inorganic, Physical-Organic and Biophysical Chemistry.

Chandrasena Memorial Award

Awarded for an exceptional research contribution of an original nature in the field of Organic Chemistry and/or related areas such as Biochemistry, Pharmacognosy, Molecular Biology and Bioactivity studies.

Ramakrishna Memorial Award

Awarded for an exceptional research contribution of an original nature in the field of Inorganic and/or Analytical Chemistry and/or related areas such as Bio-inorganic Chemistry or Bio-analytical Chemistry.

- **INSTITUTE OF CHEMISTRY BRONZE MEDALS**

Kandiah Memorial Awards

Awarded for the best research contribution in Chemistry carried out by a postgraduate student registered for a postgraduate degree by either course work or/ and research at a Higher Educational Institute in Sri Lanka and for work carried out in Sri Lanka, with the exception of special analysis that cannot be done in the country. Such results should be less than 20% of the findings from the work. Sandwich programs carried out partially abroad do not qualify for the award.

Kandiah Award for Basic Chemistry

For research predominately in basic Chemistry (Organic, Inorganic, Physical, and Analytical).

Kandiah Award for Applied Chemistry

For research in Chemistry related areas such as polymer, food, biochemistry, biotechnology, where interdisciplinary research is involved and provided that chemistry has a central role and comprises at least 50% of the content.

Kandiah Memorial Graduateship Award

For the best piece of research in the Chemical Sciences carried out by a Graduate Chemist of the College of Chemical Sciences/Institute Chemistry Ceylon registered with a Higher Education Institute for a Post Graduate Degree.

- **Professor M. U. S. Sultanbawa Award for Research in Chemistry**

Awarded for the best research paper presented at the Annual Sessions of the Institute of Chemistry Ceylon, for work carried out and completed in Sri Lanka.

Closing date for receiving applications/nominations for the above awards: 28th February 2017

Further information could be obtained from the Registrar, Institute of Chemistry Ceylon or www.ichemc.edu.lk

PUBLICATIONS OF THE INSTITUTE OF CHEMISTRY CEYLON

Monograph	Title	Author	Price
01	Textile Fibers	Mr T Rajasekeram	Rs.50/-
02	Principles of Food Preservation	Prof U Samarajeewa	Rs.75/-
03	Biotechnology	Prof C P D W Mathew	Rs.75/-
04	Recombinant DNA Technology	Prof J Welihinda	Rs.75/-
05	*Natural Toxins in Foodstuffs	Prof E R Jansz & Ms A S Perera	Rs.50/-
06	Fat Soluble Vitamins	Prof E R Jansz & Ms S Malavidana	Rs.50/-
07	Nucleic Acid and Protein Synthesis	Prof J Welihinda	Rs.75/-
08	Extraction of Energy from Food	Prof J Welihinda	Rs.50/-
09	Corrosion of Materials	Dr A M M Amirudeen	Rs.75/-
10	Vitamin C-Have all its mysteries been Unravalled ?	Prof E R Jansz & Ms S T C Mahavithanage	Rs.75/-
11	*Environmental Organic Chemistry	Prof S Sotheeswaran	Rs.150/- (US \$3)
12	Enzyme Kinetics and Catalysis	Prof (Mrs) S A Deraniyagala	Rs.100/-
13	Insecticides	Prof (Mrs) Sukumal Wimalasena	Rs.95/-
14	Organotransition Metal Catalysts	Prof S P Deraniyagala & Prof M D P De Costa	Rs.75/-
15	Some Important Aspects of Polymer Characterization	Prof L Karunanayake	Rs.75/-
16	*Hard & Soft Acids & Bases	Prof (Mrs) Janitha A Liyanage	Rs.65/-
17	Chemistry of Metallocenes	Prof Sarath D Perera	Rs.65/-
18	Lasers	Prof P P M Jayaweera	Rs.65/-
19	*Life and Metals	Prof (Mrs) Janitha A Liyanage	Rs.75/-
21	*Silicones	Prof Sudantha Liyanage	Rs.65/-
22	*Pericyclic Reactions: Theory and Applications	Dr M D P De Costa	Rs.65/-
23	Inorganic NMR Spectroscopy	Prof K S D Perera	Rs.65/-
24	Industrial Polymers	Prof L Karunanayake	Rs.75/-
25	*NMR Spectroscopy	Dr (Mrs) D T U Abeytunga	Rs.65/-
26	Mosquito Coils and Consumer	Ms D K Galpoththage	Rs.100/-
27	*Atomic Absorption Spectrometry	Prof K A S Pathiratne	Rs.100/-
28	Iron Management on Biological Systems	Prof (Ms) R D Wijsekera	Rs.100/-
29	Nutritional Antioxidants	Prof. (Mrs) Sukumal Wimalasena	Rs.100/-
30	*f-Block Elements	Prof Sudantha Liyanage	Rs.65/-
31	*Scientific Measurements and Calculations	Prof (Mrs) S A Deraniyagala	Rs. 80/-
32	Applications of Organometallic compounds in Organic Synthesis	Dr. Chayanika Padumadasa	Rs. 60/-
33	Organosulfur Compounds in Nature	Prof. S Sotheeswaran	Rs. 200/-

* - Second Edition /new print published on popular demand

CCS Publications

01	Functional Group Analysis in Organic Chemistry	Prof A A L Gunatilake & Prof S Sotheeswaran	Rs. 175/-
02	Zinc Metalloproteins	Prof (Ms) R D Wijsekera	Rs. 175/-
03	Conformational Analysis and Reactivity of Organic Molecules	Prof S Sotheeswaran & Dr. (Ms) H I C de Silva	Rs. 175/-
04	Marine Organic Chemistry	Prof S Sotheeswaran	Rs. 175



General Publications

- ★ **Historical Accounts of the Educational Activities (1972 - 2004)** (Rs.350/-)
- ★ **Polymer Industries of Sri Lanka** (Rs. 200/-)
- ★ **Industry & Environment** (Rs. 200/-)
- ★ **Herbal Medicine Phytopharmaceuticals and Other Natural Products: Trends and Advances** (Rs. 500/-)
- ★ **Chemistry in Sri Lanka** (Rs. 150/-)





RSC NEWS

THE ROYAL SOCIETY OF CHEMISTRY SRI LANKA SECTION

1. Membership

According to the records sent to us from the parent body, a breakdown of the membership is as follows:-

Category	Number
CChem, FRSC	08
FRSC	02
Chem, MRSC	08
MRSC	26
AMRSC	12
Affiliate /Under Graduate.	<u>10</u>
Total Membership as at July 2016	<u>66</u>

2. Committee of Management

The following were elected to the Committee at the 55th Annual General Meeting held in July 2016.

Hony. Chairman - Mr S Perasiriyana
Hony. Secretary - Dr W G Piyal Ariyananda
Hony. Treasurer - Mr. I M S Herath

Committee Members -

Mr. R M G B Rajanayake
Prof. Sudantha Liyanage
Dr. Poshitha Premarathne
Dr. M Sirimuthu
Dr. P Iyngaran
Mr. Sulith Liyanage
Mr. Wasantha Samarakoon
Mr. Viraj Jayalath

Co opted Members

Dr. M.K. Deeyamulla
Prof. W S Fernando
Mr. T M Kumara

3 Activities

3.1 Contributions to Activities of the Institute of Chemistry Ceylon

- (a) Full page advertisement of "Chemistry in Sri Lanka".
- (b) Contribution for the Interschool Chemistry Quiz
- (c) Award for the Best Performance at the Graduateship Examination in Chemistry Levels 3/4 Theory Examination
- (d) Have an exhibition stall in CHEMEX 2017 – Chemistry Exhibition Planned to be held in January 2017

3.2 All - Island Inter School Chemistry Essay Competition.

3.3 Inter University Chemistry Essay Competition

3.4 Book donation programme

3.5 A/L Teacher training workshop

3.6 Advanced Level Chemistry Seminar

3.7 Industrial Visit for B.Sc. Special degree students, M.Sc. students and RSC Members

3.8 Collaboration with SLAAS E-2 workshop and seminars

3.9 Supporting Chemical Societies of Universities in Sri Lanka

Dr Piyal Ariyananda
Hony Secretary

**After
A/L**

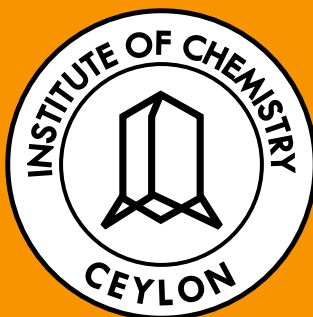
Graduateship Programme in Chemistry 2017/2020

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- 👍 Programme will commence in **January, 2017**.
- 👍 Classes during week-days
- 👍 Classes during week-ends to facilitate employed/University undergraduates/those otherwise occupied.
- 👍 Those sat the GCE A/L Exam 2016 could also apply immediately for provisional registration & benefit from the reduced fees.
- 👍 Internationally accredited by RSC (UK)
- 👍 BSc students (in their 3rd year at University) can join our programme in October 2017 and become Graduate Chemists by 2019. They are exempted from the first two years.
- 👍 Application forms with prospectus & other information available free of charge from address below OR download from our website.
- 👍 Over 1170 Graduate Chemists produced from 1979 to 2015 (over 37 years)

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**College of Chemical Sciences
Institute of Chemistry Ceylon**

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