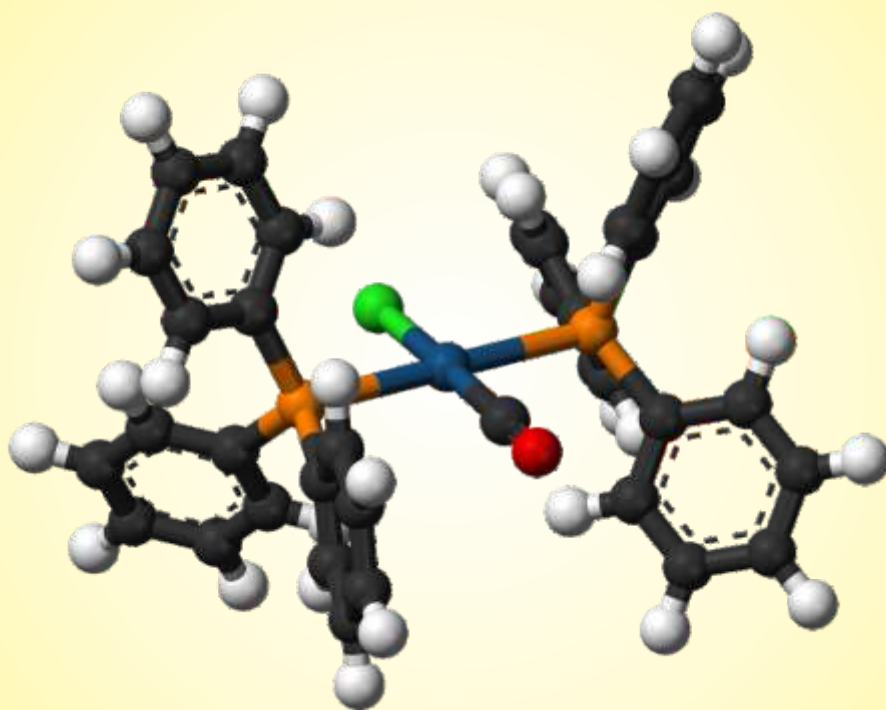


CHEMISTRY

IN SRI LANKA



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Institute of Chemistry Ceylon

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Chemistry in Sri Lanka

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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

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"Role of Chemistry for Sustainable Agriculture"

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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. 1200
Member	Rs. 1200
Associate	Rs. 900
Licentiate	Rs. 750
Technician	Rs. 500
Affiliate	Rs. 500
Membership for Life	Rs. 10000

Entrance Fee

All the grades	Rs. 500
Processing Fees*	Rs. 200
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 1500 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 May 2013.

- 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.

Facing the challenges in Food Science and Technology – some food for thought

Professor Siromi Samarasinghe

Department of Chemistry, University of Sri Jaywardenepura

The food industry can be described as one of the rapidly growing industries in Sri Lanka bringing valuable foreign exchange to the country. Higher output in processed foods has resulted not only in the expansion of the export market but also in the expansion of the domestic market due to the increased activity in tourism and trade extending to the North and the East of the country.

With the rapid expansion of the food industry and the changing life styles in the 21st century, new areas in food science have come to the forefront. Graduates seeking employment as food scientists, food analysts, managers of food laboratories and executives in food industries need to have a comprehensive knowledge of current practices followed in the industry such as food regulations, quality assurance, laboratory accreditation, concepts of HACCP and GMP among others, together with a sound knowledge of the fundamentals of food chemistry and principles of food processing. A good understanding on the safe use of food additives, effect of pesticides and environmental contaminants in food as well as an awareness of the changes brought about during food processing and manufacture are desirable.

Food safety is an issue which has to be given priority in the food processing industry. Sri Lanka being a tropical country, there is a high risk of food deterioration and spoilage. There have been many incidents of food poisoning in the country. A sound knowledge of food microbiology is essential for those employed in food manufacturing and catering establishments. Qualified personnel are needed to monitor, control and advice the hotel trade.

Fast foods and processed foods have become a way of life for certain sections of the urban population today. Busy housewives resort to convenience foods in preference to the laborious traditional cooking methods of the past. Modern technology together with the use of food additives offer the consumer many convenient options. However, the safety of such products, nutritional value and overall quality have to be considered.

While highlighting the importance of the food processing industry in national development one has also to consider its importance at an international level. With the expansion of the food industry which attracts buyers internationally, the processed food industries need to have internationally recognized safety standards. Testing laboratories are required to generate internationally acceptable test results through accreditation. Therefore, a high level of competency needs to be maintained in analytical laboratories and failure to do so may have a detrimental effect on international trade.

Food scientists and technologists need to be aware of the present Food Act, how food regulations affect the industry, about the safety of raw materials, specifications for food ingredients, safety limits for permitted food additives, and standards for categories of major food products. An in depth knowledge of the regulations for labeling and regulations for safety of packaging material are also important.

It is my opinion that at present, there is a lack of knowledgeable personnel employed in the food industry to deal with the numerous challenges faced by the food industry in Sri Lanka.

The education and training available in Sri Lanka for graduates seeking a career in the food industry is confined to a few Universities and Institutions which offer postgraduate programmes and training courses. It is my view that the Universities which offer postgraduate courses tend to focus more on a particular aspect of food science and technology, for example, some programmes are biased towards agriculture while others are biased towards chemistry or nutrition, depending on their affiliation to a particular department or faculty at the inception of the course. The bias also reflects the strength of each department or faculty, and the field of specialization and /or the expertise of resource persons they employ. Thus the knowledge obtained through these programmes does not sufficiently bridge the existing gap between universities and industry. Bringing together the academics, industrialists and research scientists has been attempted at various forums through symposia, workshops and seminars, without much success, and the industry is not getting suitable employees to handle the demanding tasks at hand.

The Institute of Chemistry, through its Diploma in Laboratory Technology Course (DLTC) has produced technicians at the middle level. The programme is targeted at school leavers and unskilled middle level employees, rather than at graduates seeking employment as managers and executives in the industry.

It is timely therefore, for the Institute of Chemistry to consider initiating a suitable programme for Graduates and Graduate Chemists, aimed at bridging the existing gap between universities and industry. In this respect, a programme incorporating the key topics necessary to deal with the demands and challenges of the food industry would be most appropriate.

I strongly believe that such a programme, in addition to the courses offered by Universities and Institutions, will pave the way towards producing competent individuals who will be an asset to the country.

Graduateship Examinations in Chemistry, 2012

LEVEL 1 – AWARDS LIST

First prize and Nandawathie Jayaweera Memorial (Open) Scholarship	Ms. A V K Munasinghe
Second prize and Charles Jayaweera Memorial (Open) Scholarship	Ms. N M Kodippilige
Third Prize and Prof. R S Ramakrishna Memorial Scholarship	Ms. G O de Silva
Fourth Prize and Dr. Dilanjan and Ms. Gowrie Soysa Scholarship	Ms. L A Wijesekara & Mr. M S Muneer

MERIT BURSARIES *(in order of merit)*

Ms. R Jayawardena, Ms. H K C K Haloluwa, Ms. N S Hapuarachchi, Ms. A S N Kurian, Ms. R W L N Rajapakse

SUBJECT PRIZES

Graduate Chemist Alumni prize for General & Inorganic Chemistry	Ms. A V K Munasinghe
Emerine Fernando Memorial prize for Principles of Physical Chemistry	Ms. N M Kodippilige
Bennet prize for Mathematics for Biological Science Students	Ms. N M Kodippilige & Ms. A V K Munasinghe
Somawathie Mathew Memorial prize for Biology for Physical Science Students	Ms. S M Abdulla
Prof & Mrs S Sotheeswaran Prize for Principles of Organic Chemistry	Ms. A V K Munasinghe
Mr & Mrs J M Ranasinghe Banda for Application of Mathematics in Chemistry	Ms. A V K Munasinghe
Analog & Digital Electronics for Chemists	Ms. A V K Munasinghe
Fundamentals of Physics for Chemists	Ms. A V K Munasinghe

Level 2 - Awards List

1 st Prize & W.F. Peiris Memorial Trust Scholarship	Ms. N.U. Dharmarathne
2 nd Prize & Professor W Pearlyn D Perera Commemoration Trust Scholarship	Ms. K. M. Perera
3 rd Prize & Professor G.C.N. Jayasuriya Memorial Scholarship	Ms. D. M. K. C. Dissanayake
4 th Prize & Family Leelarathna Scholarship	Ms. P. P. D. Jayapala

MERIT BURSARIES *(in order of merit)*

Ms. J. A. Vanlangenberg, Mr. M. A. T. N. Karunarathne, Ms. R. S. G. Corea, Mr. T. B. Alahakoon, Mr. C. D. R. Pathirana, Ms. W. S. M. Fernando, Ms. W. A. I. U. Jayawickrama, Ms. F.A.N. Refaideen, Ms. A.M.G.A. Ranasinghe, Mr. N.M.C.M. Navarathna

SUBJECT PRIZES

Prof J.N. Oleap Fernando Prize for Physical Chemistry	Mr. S. H. Senevirathne
Prof Samitha P. Deraniyagala Prize for Inorganic Chemistry	Ms. D. M. K. C. Dissanayake
Prof Siromi Samarasinghe Prize for Organic Chemistry	Ms. D. M. K. C. Dissanayake
Yogarane and Family Prize for Analytical Chemistry	Ms. K. M. Perera
Jayantha Welihinda Prize for Biochemistry I	Ms. R. S. G. Corea & Ms. P. P. D. Jayapala

Graduate Chemists Welfare Fund

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

- To provide partial assistance towards international travel of those proceeding abroad for PG degrees (once a life time)
- To provide partial assistance towards registration fees in respect of IChemC/CCS events such as International Conferences (Preference for those presenting papers)
- To provide assistance towards registration fees for IChemC/CCS training seminars etc.
- To provide partial assistance towards activities of the Alumni Association.

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

Professor Stanley Wijesundera Oration

Evidence based nutrition – a Biochemist's perspective

Professor Sunethra Atukorala

Senior Professor of Biochemistry, Faculty of Medicine, University of Colombo

Members of the family of the late Professor Stanley Wijesundera, President and members of the Council of the Institute of Chemistry, distinguished Past Presidents, distinguished invitees, I am indeed honoured and privileged to be invited to deliver an oration in memory of Prof. Stanley Wijesundera, a former Vice Chancellor and a distinguished scientist. I wish to express my sincere thanks to the current President, Past President and the Council of the Institute of Chemistry for the honour bestowed upon me by inviting me to deliver this lecture. In the first part of this lecture, I will attempt to highlight only some of his key achievements, as they are too numerous to mention. In the second part of this lecture my research in Nutritional Biochemistry that is of practical importance will be summarized.

Professor Wijesundera was born in 1923 and hails from Ampitiya, a village in the Kandy district. He had his school education at Trinity College, Kandy and at Dharmaraja College, Kandy. He obtained a B.Sc Special Degree in Chemistry, from the University of Ceylon in 1946 and was also awarded the B.Sc (1st Class Honours) degree from the University of London in 1947. After graduation he joined the University of Ceylon in 1948 and was awarded a fellowship to pursue postgraduate studies at the University of Oxford. As a requirement for commencing postgraduate research, he completed a research degree in Biochemistry in 1952 and was also awarded a B.Sc degree from the University of Oxford. This work resulted in publications in two prestigious journals, the *Biochemical Journal* (1) and the *Journal of Physiology* (2). His doctoral research on: "Elucidation of metabolic pathways in microorganisms" commenced in 1952 and he was awarded D.Phil (Oxon) in 1954 for his research on: "Methionine and related compounds in the metabolism of microorganisms". His research on suppression of methionine synthesis in *E. coli* by methionine, the end product of the synthetic pathway, was the first demonstration of feedback inhibition and this work was published in the *Journal of General Microbiology* (3). His doctoral research also included the role of vitamin B6 and glycine in methionine synthesis (4).

Dr. Wijesundera married Anoja Wijewardene and

they have two sons and two daughters who have also excelled in their chosen careers and serve the country with dedication. He was a devout Buddhist and served as the Chief Basnayake Nilame of the Kelaniya Raja Maha Vihare.

After completing doctoral studies he returned to Sri Lanka and served in the Department of Biochemistry, Faculty of Medicine University of Ceylon, Peradeniya and later in the Faculty of Medicine University of Ceylon, Colombo. He was an outstanding academic with excellent communication and writing skills. Dr. Wijesundera was actively involved in developing the course content for M.Sc course in Biochemistry in 1973, one of the first postgraduate courses to be conducted in the University of Colombo. My association with Professor Wijesundera dates back to early 1970's when I joined the Department of Biochemistry as an Assistant Lecturer. He was the supervisor for my research project for the Master's degree. The training received in scientific writing and laboratory work was of immense benefit in pursuing my doctoral research in the UK.

He was appointed Professor of Biochemistry, Faculty of Medicine, University of Colombo in 1978 and held this position until 1987. He was appointed the first Vice Chancellor of the University of Colombo in 1978 and served in this position until 1987. He continued to serve the University of Colombo until his tragic death on 8th March 1989. He also served as the Chairman of the Association of Commonwealth Universities in 1983 and was the recipient of the Symon's award in 1985 for his contribution to the advancement of higher education in Sri Lanka. He was actively involved in promoting education in Chemistry and served as the first Chairman of the Graduateship Board of Examiners of the Institute of Chemistry. He was the President of the Chemical Society of Ceylon (IChem) in 1966 and Fellow of the Institute of Chemistry. In recognition of his outstanding contribution towards advancement of science he was elected a Fellow of the National Academy of Sciences of Sri Lanka in 1977 and the General President of the Sri Lanka Association for the Advancement of Science (SLAAS) in 1984.

His vision for the future is illustrated in the theme during his Presidency of SLAAS: ***“Strategies for science – towards the 21st century”***. In his SLAAS General President's address he stated that: *“Human potential is most vital for the economic development of a country. the provision of and maintenance of the basic needs of housing, health, education, nutrition and sanitation are of the utmost importance in the process of building up a vibrant and healthy nation. Preventable diseases which now constitute 40% of hospital admissions must be cut down. A highly oriented programme of health and nutrition education and the provision of health care services with adequate medical and para-medical services are of the utmost concern”* (5). It is important to note that these recommendation are relevant even today.

His contribution to the higher education sector specially to University of Colombo was most significant and the Institute of Computer Technology, Chemistry Building, Administration Building and the Law Faculty are some examples of developments that have occurred during his tenure as the Vice Chancellor. He also took steps to initiate the establishment of the Institute of Biochemistry, Molecular Biology and Biotechnology (IBMBB). In recognition of his immense contribution to the advancement of science education and higher education he was conferred the Degree of Doctor of Science (*Honoris Causa*) posthumously by the University of Colombo in December 1990. The road linking Bauddhaloka Mawatha to Reid Avenue, bordering the Colombo University was named “Stanley Wijesundera Mawatha” in his honour, serving as a constant reminder of this eminent academic.

Importance of evidence based nutrition

In accordance with Prof. Wijesundera's vision for Sri Lanka, my research highlighting the role of Biochemistry in “Evidence based nutrition” will be presented. Nutrition related disorders and diseases (NRDs) account for a large proportion of the burden of ill health, disease and mortality. Scientific evidence is needed to increase validity, utility and cost effectiveness of public health interventions and nutrition interventions in clinical practice. Research in Nutritional Biochemistry provides insight into aetiology of nutrition related disorders, biological changes due to nutrient deficiency, excess or imbalance and also the effectiveness of nutrition interventions. Laboratory research in Nutritional Biochemistry, specially research on micronutrient deficiency was

limited in Sri Lanka until the 1970's. Micronutrient deficiency is commonly referred to as “Hidden hunger” and its consequences were described by Dr. K C Gautam, Deputy Executive Director, UNICEF in 2004 as follows; *“Hidden hunger due to micronutrient deficiency does not produce hunger as we know it. You might not feel it in the belly, but it strikes at the core of your health and vitality. It remains widespread, posing devastating threats to health, education, economic growth and to human dignity in developing countries”*.

Micronutrient deficiency – Hidden hunger

Studies on micronutrient deficiency among pregnant and lactating mothers, primary school children, adolescent girls, women of child bearing age and older women will be presented. In addition, studies on new cardiovascular risk factors and assessment of body fat and educational intervention to reduce risk of cardiovascular disease will also be described.

Anaemia and iron deficiency in pregnancy and lactation

Iron deficiency is the commonest nutritional deficiency in the world and is the commonest cause of anaemia. The World Health Organization (2000) estimated that more than 700 million people have iron deficiency anaemia, while more than two billion worldwide suffer from iron deficiency without being anaemic (WHO, 2000). In national surveys, anaemia has been used as a proxy for iron deficiency (6). As a high prevalence of anaemia has been reported among pregnant women in the plantation sector, a study was carried out to determine whether micronutrient deficiency is a problem among pregnant plantation workers (at 14-24 weeks of gestation) in five regions in the plantation sector during the period 1989-91. Haemoglobin (Hb) concentration and iron, vitamin A and zinc status was assessed in all women (n=309) during early and late pregnancy and re-assessed in a randomly selected sub-sample of (n=108) at 20-36 weeks after delivery (7). Serum ferritin concentration was identified as a more sensitive indicator of iron status than the markers used earlier and an ELISA assay was developed in our laboratory for estimating serum ferritin concentration. Serum vitamin A concentration was measured by HPLC and serum zinc concentration was measured by flame atomic absorption spectroscopy. A high prevalence (58.5 %) of anaemia (Hb <110 g/L) and low iron status (serum ferritin < 20 g/L) was noted among 62 % of plantation workers during pregnancy and there was no reduction in the

prevalence of anaemia or improvement in iron status following delivery. Zinc deficiency (Serum zinc <8 mol/L) and low vitamin A status (Serum vitamin A <20 g/dl) was also noted in more than 40 % of pregnant mothers, while there was a significant improvement in serum zinc and vitamin A concentrations among mothers after delivery.

Interventions to control anaemia in pregnancy have been a component of routine antenatal care for several decades and mothers were given combined iron-folate supplements (FeSO₄ containing 60 mg Fe + 250 g folic acid) and one course of anthelmintic therapy after the first trimester of pregnancy, but there was no scientific evidence that these interventions were effective. We evaluated the effectiveness of delivery of interventions against anaemia in a field setting in this population. There was no significant effect of variation of dose or dose frequency on change in Hb or iron status, but a significant increase in haemoglobin was noted when the duration of supplementation during pregnancy was more than 17 weeks, but there was no significant increase in iron stores (Figure 1).

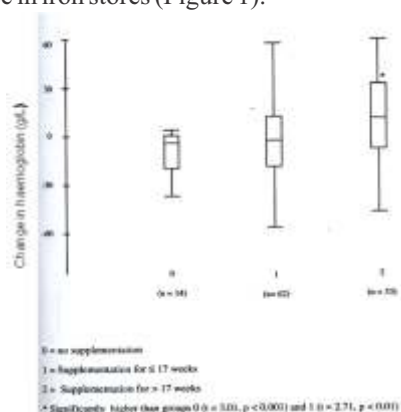


Figure 1: Effect of duration of iron-folate supplementation on change in haemoglobin levels during pregnancy

Anthelmintic therapy (AHT) in addition to iron-folate supplements not only significantly increased Hb but also significantly improved iron status in this population (Figure 2).

Multiple regression analysis revealed a significant association of Hb concentration in late pregnancy (Hb2) with Hb1 ($p=0.000$), duration of iron-folate supplementation ($p=0.032$) and receipt of AHT ($p=0.0001$). Further, log transformed serum ferritin concentration in late pregnancy was significantly associated with serum ferritin concentration in early pregnancy and AHT. Thus AHT in addition to iron-folate supplements significantly improved Hb and iron status in this population. These findings were used in

developing the national strategy for prevention and control of anaemia in pregnancy (Ministry of Health, 1994). This was the first study which demonstrated evidence for benefit of AHT after the first trimester of pregnancy among populations with poor living conditions and low personal hygiene (8). Following publication of these results, AHT was included in the antenatal care programme of other countries and significant benefit was reported.

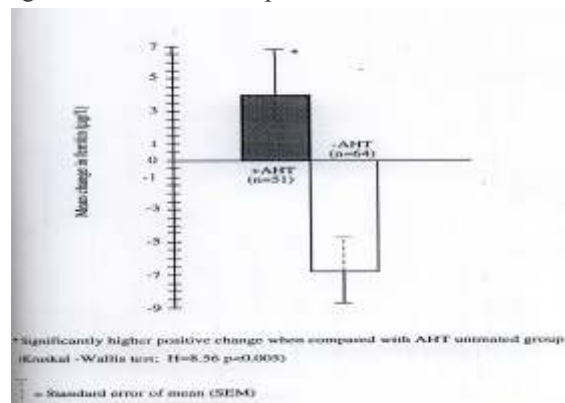


Figure 2: Change in serum ferritin in iron-folate supplemented mothers with or without AHT

Iron deficiency and infection – a study on primary school children

Both iron deficiency and respiratory tract infections affect children of low socioeconomic status specially in urban areas. Iron deficiency leads to decreased resistance to infection. We carried out a randomized controlled double blind study to determine whether iron supplementation during infection improves iron status and reduces incidence of upper respiratory tract infections (URTI) among primary school children. Children in the age group 5-10 y ($n=363$) with, or without recurrent URTI were selected for the study and within each group the children were randomly assigned on a 3:1 basis to receive either iron (60 mg/d) or placebo for a period of eight weeks and the iron and inflammatory status and morbidity were assessed. The iron status was assessed by measuring serum ferritin (by IRMA). As serum ferritin concentration increases in infection or inflammation, serum soluble transferrin receptor: sTfR, a new marker of iron deficiency, which increases in iron deficiency and is not affected by infection or inflammation was also measured by an ELISA technique. C-reactive protein (turbidimetry) and 1-acid glycoprotein (radial immunodiffusion) were measured as biomarkers of inflammation. Morbidity was assessed by recording the number of episodes of infection and the duration of URTI episodes. The number of days of school

absenteeism was obtained using an interviewer-administered questionnaire.

The prevalence of anaemia at baseline was similar in children with URTI (54.7 %) and in healthy children (50.5 %). Iron supplementation resulted in a significant reduction in the prevalence of anaemia and a significant improvement ($p<0.005$) in iron status in both children with URTI and healthy children. Further, iron supplementation resulted in a significant reduction in mean duration of URTI episodes/child ($p<0.0005$) and the mean number of hospital visits/child when compared with those given placebo.

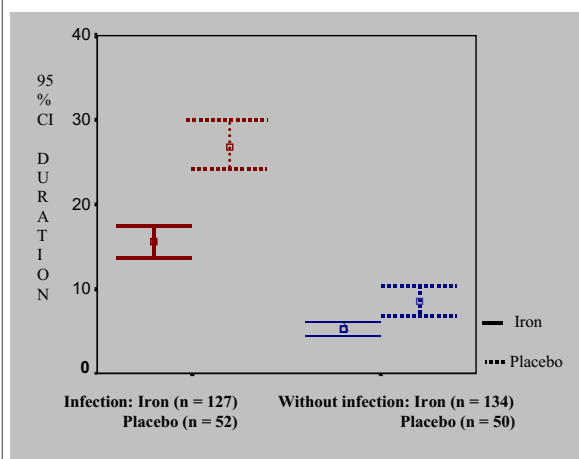


Figure 4: Effects of supplementation (iron vs. placebo) on duration of URTI episodes

It is also important to note that there was a significant decrease ($p<0.005$) in school absenteeism (5d/mo) when compared with the preceding two months in iron supplemented children than in the placebo group. Antibiotic treatment cannot solely account for reduction in morbidity as it was similar in iron and placebo groups. Thus iron supplementation significantly reduced morbidity in children with recurrent URTI (9).

Adolescent girls, women of childbearing age and older women

Nutritional status of adolescent girls and non-pregnant women of childbearing age has received little attention and nutrition interventions are provided only during pregnancy and for a short period after delivery. But interventions during pregnancy cannot correct pre-existing deficits (7). It is essential to improve the micronutrient status of adolescent girls and women of childbearing age before they enter pregnancy.

Anaemia and iron and vitamin A deficiency

To determine whether micronutrient deficiency is

a problem among adolescent girls in Sri Lanka, we assessed the iron and vitamin A status of 915 post-menarchial adolescent school girls in the age group 13-19 years belonging to low socioeconomic groups in the Colombo municipal area (11 schools, $n=562$) and in the Kaduwela MOH area ($n=353$). The prevalence of anaemia (Hb <120 g/L) was similar among urban (18.7 %) and rural (17.3 %) school girls, but the percentage of girls having low iron status (serum ferritin <20 ug/L) was significantly higher ($p<0.01$) in the urban area (55.3 %) than in rural area (44.1 %). Low vitamin A status (serum vitamin A <20 ug/L) was noted among 22.2 % of urban girls and 19.2 % of rural girls (10).

Nutrition education is likely to improve their micronutrient status. However, scientific evidence for effectiveness of nutrition education in improving iron and vitamin A status of adolescent girls is limited. We evaluated the effectiveness of a nutrition education package in improving iron and vitamin A status of adolescent school girls and also assessed the effectiveness of unsupervised daily iron supplementation in improving iron status when preceded by nutrition education. The intervention groups (education and daily unsupervised iron supplementation or education and placebo) were compared with a control group of school girls of similar socioeconomic status (without any intervention during the study period). We developed a low cost nutrition education package to improve iron and vitamin A status (11) which was delivered through lecture discussions, interactive group discussions using young adults (school leavers) as educators, focusing on messages which have special appeal to adolescents (Figure 5).



Figure 5: Educational messages

There was a significant reduction in the prevalence of anaemia in intervention groups when compared with

control groups with a greater reduction in the group given education and supplementation than the group given education alone (Figure 6).

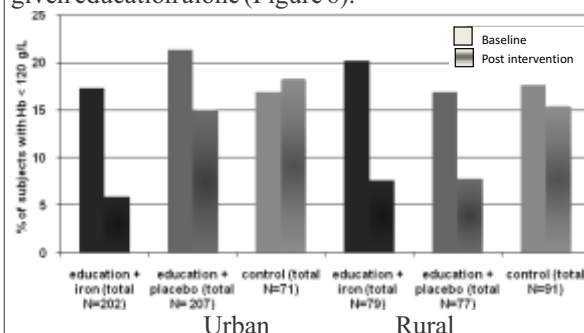


Figure 6: Effect of education + iron supplementation vs. placebo on prevalence of anaemia

Our study showed that a simple low cost education package was effective in increasing knowledge, increasing compliance with iron supplementation and reducing the prevalence of anaemia and improving iron (11) and vitamin A status of adolescent school girls (12). Education together with supplementation caused a greater improvement in iron status than education alone. Effect of education though small has greater long term benefit. The effect was more sustainable in rural area as rural school girls had more desirable attitudes than urban girls and home gardens were available. Further, urban girls had poor living conditions and more social pressures of community living and require greater reinforcement. It is necessary to carry out further studies among urban adolescent school girls, school dropouts and young women.

Folic acid and vitamin B12 deficiency

Recent attention has focused on folic acid as its deficiency is associated with anaemia, neural tube defects in newborn, increased plasma homocysteine and cardiovascular risk and increased risk of cancer (13). Studies on folate status are limited in Sri Lanka. We carried out a study on low income urban adolescent girls (n= 277) and young women (n=275) in the Colombo municipal area to determine whether folic acid deficiency is a problem in this population and to assess the importance of folic acid and vitamin B12 deficiency in the aetiology of anaemia. Both school girls and school dropouts were studied to determine whether school dropouts are at a greater risk of folic acid and iron deficiency than school going adolescents. In addition a group of clinically healthy older women (age: 30 -50 y, n=115) were also studied.

Serum folic acid concentration was measured by competitive protein binding radioisotopic assay and

serum ferritin concentration was measured by an immunoradiometric assay. Although the prevalence of anaemia in this population was 12.9 %, low iron status (serum ferritin <20 ng/L) and folate status (serum folate <3 ng/ml) were noted in 46.8 % and 43.6 % of subjects respectively, while low vitamin B12 status (serum vitamin B12 <150 pg/ml) was noted in <5 % of subjects. It is important to note that the prevalence of anaemia was significantly higher ($p<0.05$) among adolescent school dropouts than in school girls. In this population, depleted iron stores (serum ferritin <12 ng/L) and folate status (serum folate <3 ng/ml) were g/L and low serum folic acid (Serum folic acid <3 ng/ml) were significantly associated with anaemia (14). The prevalence of iron, folate and vitamin B12 status was compared among adolescent girls, young women and older women (Figure 7). In this population, both adolescent girls and young women had a lower iron status (assessed by serum ferritin) than older women, while the serum folate concentration was lowest in adolescent girls, slightly higher in young women and highest in older women (15). In contrast, older women had a significantly lower vitamin B12 concentration than adolescent girls and young women.

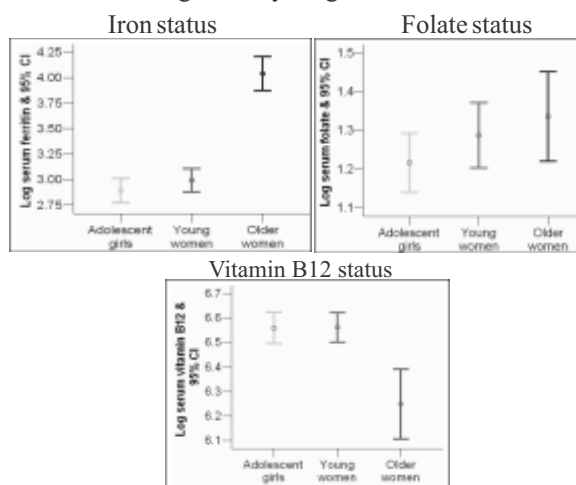


Figure 7: Iron, folate and vitamin B12 status of adolescent girls, young women and older women

Low serum folate was significantly associated with hyperhomocystinaemia, a risk factor for cardiovascular disease in all age groups.

Nutrition and cardiovascular disease

Multiple factors contribute to the aetiology of cardiovascular disease (CVD) and many of these factors are related to poor dietary habits and life style. The established modifiable diet related risk factors include diabetes, hypertension, hypercholesterolaemia

and obesity. In addition, hyperhomocystinaemia, oxidative stress and chronic inflammation are some new modifiable risk factors.

Folate deficiency, hyperhomocystinaemia and inflammation

High plasma homocysteine (hyperhomocystinaemia) is a new risk factor for CVD. Accumulation of homocysteine in cells is prevented by its reconversion to methionine by reactions which require methyl tetrahydrofolate and vitamin B12, or its metabolism via a pyridoxal phosphate dependent reaction. Deficiencies of folate, vitamin B12, or pyridoxal phosphate, or defects in enzymes catalyzing these reactions lead to accumulation of homocysteine which generates reactive oxygen species during its auto-oxidation. These reactive oxygen species cause lipid peroxidation and endothelial injury and promote atherogenesis and thrombosis respectively, thus increasing risk of cardiovascular disease.

We carried out a study among women with or without coronary artery disease (CAD), to determine a possible association of serum folate and plasma total homocysteine (tHcy) with CAD and also to assess the biochemical markers of inflammation (high sensitivity C reactive protein (hsCRP) and soluble intercellular adhesion molecule-1 (sICAM-1). An educational package was developed with the focus on improving food folate intake and nutritional practices to reduce plasma tHcy and conventional CAD risk factors and its effectiveness was assessed in a case control study.

The study population comprised of women in the age group 30 – 59 years, who were patients with CAD (n=105) enrolled in the cardiac rehabilitation programme, Institute of Cardiology, National Hospital, Sri Lanka and healthy controls (n=117), randomly selected from low income groups in the Colombo municipal area. Their socioeconomic status and dietary habits and folate intake was assessed using interviewer-administered questionnaires. Folate index was computed as a proxy for food folate intake. The laboratory measurements included serum ferritin and folic acid by radioisotopic methods and plasma total homocysteine by enzyme immunoassay and serum lipid profiles and blood glucose. Serum hsCRP was measured by immunoturbidimetry and sICAM-1 by an enzyme linked immunoassay (ELISA).

Plasma homocysteine, hsCRP and sICAM-1 were significantly higher in women with CAD when compared with healthy age matched controls (16). Logistic regression analysis revealed that in addition to conventional risk factors (hypertension, diabetes and

family history), a significant association between markers of inflammation (hsCRP and sICAM-1), plasma homocysteine and CAD was noted.

Both qualitative and quantitative research was used to develop a nutrition education package and education was carried out by lecture discussions, interactive group discussions using flip charts, posters and handouts as educational material. Educational messages focused on: increasing intake of folate-rich foods, improving culinary practices to reduce loss of folate, decreasing portion size, decreasing intake of total and saturated fat, avoiding empty calories and fasting or Nutrition counselling significantly increased intake of folate-rich foods, decreased intake of high-fat foods, decreased waist circumference, body mass index and serum triglyceride concentration.

Increasing folate intake



Suggested meal patterns



Figure 8: Educational messages

Assessment of obesity

Prevalence of overweight and obesity is increasing in many South Asian countries including Sri Lanka (WHO, 2000). Body Mass Index: BMI [weight (kg)/height² (m²)] is commonly used as a proxy for obesity, but BMI cannot distinguish between fat mass (linked to chronic disease) and muscle mass (18). Also, the usefulness of global cutoffs for BMI is limited as South Asians have a higher percentage fat mass for a given body weight or BMI than Caucasians (19).

Several methods are used to measure the body fat mass. These include Isotope Ratio Mass Spectrometry (IRMS) or Fourier Transform Infrared Spectrometry (FTIR), Bioimpedance analysis (BIA) and skinfold calipers (Figure 8). Stable isotopic techniques are currently used as the gold standard. In these methods, total body water is measured by isotope dilution using D₂O and the deuterium enrichment was determined using IRMS or FTIR and the percentage fat mass is calculated.

We carried out a study to determine the percentage

fat mass in 130 randomly selected adolescent school dropouts (15-19 y) from an urban and a rural area using FTIR. Saliva samples were used for assessment of Deuterium enrichment and the samples were collected according to IAEA guidelines. Deuterium enrichment in saliva was measured by FTIR and the total body water, fat free mass (FFM) and the percentage fat mass (%FM) were calculated using the following equations:

$$\text{FM (kg)} = \text{weight (kg)} - \text{FFM (kg)}$$

$$\% \text{ FM} = \text{FM (kg)} * 100 / \text{weight (kg)}$$

The percentage fat mass in our study population is given in figure 10 and a cutoff value of 30 % or above was considered to indicate excess body fat.



Figure 9: Equipment used to determine fat mass

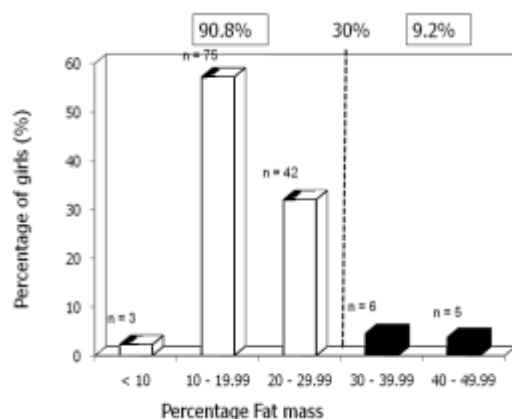


Figure 10: Distribution of percentage fat mass among adolescent girls

Measurement of skin fold thickness is considered to be the most cost effective and feasible field tool for assessing body fat. Skinfold thickness (Biceps, triceps, subscapular and suprailiac skin fold thickness) is measured using Harpenden calipers and the % fat mass is calculated using prediction equations. These equations are population specific (19) and the available equations are based on studies in Caucasians and unsuitable for Sri Lankan adolescent girls. We developed equations to predict percentage fat mass (%FM) using skinfold thickness measurements with

Deuterium dilution as reference and the equation that was developed are given below (20):

Model	$\% \text{FM} = 9.701 - (0.460) * \text{age} + (0.640) * \text{SFT-Triceps} + (0.583) * \text{SFT-Suprailiac}$
R	0.845
R ²	0.714

Future research needs

The data presented suggest that Chemists and Biochemists have a major role to play in providing scientific evidence to strengthen public health nutrition policy, identify changes in the spectrum of nutritionally related diseases (NRDs), recommend dietary patterns to protect against chronic diseases and evaluate health claims for traditional and designer foods.

“The purpose of Chemistry (Biochemistry) is not to make gold, but to study the fundamental sciences & turn them against disease. Not gold but Medicine is the purpose of Chemistry”

Paracelsus von Hohenheim (1493-1541)

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Chemistry of $[\text{IrX}(\text{CO})(\text{dppe})]$ complexes, where $\text{X} = \text{Cl}, \text{Br}, \text{I}, \text{H}$ or CN

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The oxidative addition of H_2 to d^8 square planar complexes has played an important role in homogeneous hydrogenation and hydroformylation catalysis.¹ This reaction has been extensively studied for systems such as Vaska's complex, $[\text{IrCl}(\text{CO})(\text{PPh}_3)_2]$, and is generally thought to proceed *via* concerted H_2 addition and leads to *cis* dihydride products.² Studies of H_2 oxidative addition to a series of $[\text{IrX}(\text{CO})(\text{dppe})]$ complexes, where X is $\text{Cl}, \text{Br}, \text{I}, \text{H}$ or CN , were carried out by Eisenberg.³ The results of these and other studies are now discussed.

Oxidative addition of H_2 to square planar 16-electron complexes

The oxidative addition of H_2 to square planar complexes where the metal is in the +1 oxidation state have been found to be facile when compared with the activation of other S-bonds,⁴ even though the H-H S-bond energy is relatively high ($105 \text{ kcal mol}^{-1}$). In 1984, a reaction sequence for the theoretical oxidative addition of H_2 to the metal complex $[\text{RhCl}(\text{PPh}_3)_3]$ was proposed by Hoffmann et al.⁵:

- 1) The H_2 molecule was found to approach the metal centre in an h^1 -coordination manner (Figure 1a).
- 2) The H-H orientation rapidly changes (swings around) to allow an h^2 -interaction with the metal centre, which is associated with a gain in stability (Figure 1b).
- 3) The elongation of H-H bond length (Figure 1c) yields the dihydride species with almost no change in M-H distance (Figure 1d).⁶

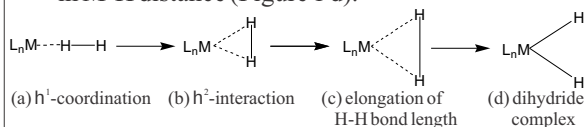


Figure 1: Schematic reaction pathway leading to H_2 oxidative addition by a transition metal centre.⁶

Oxidative addition of hydrogen to $[\text{IrX}(\text{CO})(\text{dppe})]$ complexes: analysis of electronic and steric factors, where $\text{X} = \text{Cl}, \text{Br}, \text{I}, \text{H}$ or CN

The mechanism of the oxidative addition of hydrogen to $[\text{IrX}(\text{CO})(\text{dppe})]$ complexes involves the concerted *cis*-addition of hydrogen to the metal centre to form an octahedral product complex with *cis* hydride ligands.³ For these complexes, the addition of hydrogen can occur *via* two possible pathways, **a** and

b, as shown in Figure 2. In pathway **a**, the H_2 ligand approaches the square planar complex with the molecular axis of H_2 parallel to the PIrCO axis. The concerted addition along pathway **a** takes place with concomitant bending of the *trans* PIrCO arrangement, so that one hydride ligand of the product becomes *trans* to the CO ligand, with the other becoming *trans* to the phosphine ligand. Pathway **b** corresponds to and approach of H_2 where its molecular axis is parallel to PIrX axis, and the addition proceeds with bending of the PIrX arrangement.

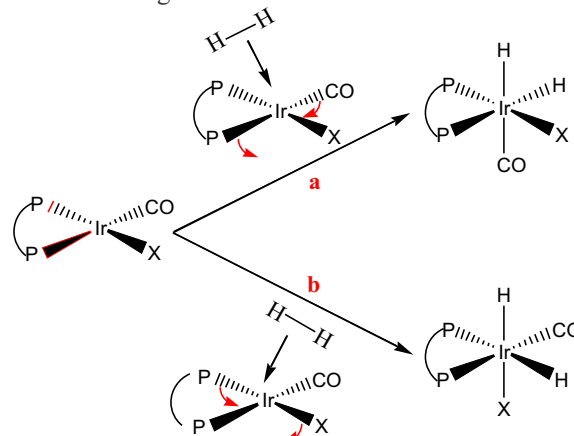


Figure 2: Orientations of H_2 addition as studied by Eisenberg³ for reactions involving $[\text{IrX}(\text{CO})(\text{dppe})]$ complexes.

Oxidative addition of H_2 to $[\text{IrCl}(\text{CO})(\text{dppe})]$

It has been found experimentally that $[\text{IrCl}(\text{CO})(\text{dppe})]$ reacts with hydrogen to give an initial product **A**, as shown in Figure 3. This reaction was found to proceed with a stereo selectivity of more than 99% and the reaction goes on to completion rapidly. This initial stereo selectivity indicates that the activation barrier for **pathway i** is lower than that for **pathway ii**. After a period of hours, the second product **B**, as depicted in Figure 3, is seen and ultimately becomes favoured over the initial product **A** by a factor of more than ten. This indicates that the product of **pathway ii** is thermodynamically more stable than the product of **pathway i**.

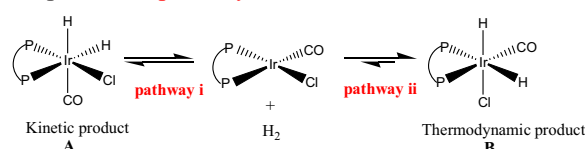


Figure 3: Stereochemistry obtained within the

reaction of $[\text{IrCl}(\text{CO})(\text{dppe})]$ and H_2 .

Eisenberg et al.³ then expanded the range of reactions by preparing the analogous complexes, $[\text{IrX}(\text{CO})(\text{dppe})]$, where $\text{X} = \text{Br}, \text{I}, \text{H}$ or CN . In each case, the initial H_2 addition reaction led to the formation of type **A** products (Figure 3).

Moreover, similar stereo selectivity, favouring initial hydrogen addition over the PIrCO axis, was also observed by Longato and Bresadola⁷ for an analogous complex with a carborane cluster ligand as the X ligand. In this case, no subsequent isomerisation was observed, indicating that the initial kinetic product is also the most stable thermodynamic product. This situation was proposed to arise due to the steric congestion imposed by the carborane cluster (formation of other isomer would require carborane to be *cis* to both arms of the phosphine ligand).

According to these data, the addition of hydrogen to the $[\text{IrX}(\text{CO})(\text{dppe})]$ system, where $\text{X} = \text{Cl}, \text{Br}, \text{I}, \text{H}$ or CN , is not affected by the steric demand of ligand X , indicating that the electronic properties of the X and CO ligands must be responsible for the orientation of the hydrogen addition process.

Eisenberg³ also stated that the orbital interactions could have accounted for electronic control. The metal complex does not remain planar as the reaction progresses: as the H_2 molecule approaches the ligands bend back (in order to occupy the *cis* position in the product complex) and this change the orbital interactions. It follows, that there are three principal orbital interactions, as illustrated in Figure 4, when dihydrogen approaches a square planar d^8 metal centre:

1) S bond formation

Donation from the bonding orbital of H_2 , (H_2), into the empty p_z or p_x - d_{z^2} orbital on the metal (Figure 4a).

2) Back donation

Back donation from the filled metal d_{xz} or d_{yz} into the antibonding orbital of H_2 , $\text{S}^*(\text{H}_2)$ (Figure 4b).

3) Repulsive interaction

4-electron repulsion between the filled $\text{s}(\text{H}_2)$ orbital and the filled metal d_{z^2} orbital (Figure 4c).

The third interaction, a repulsive interaction, does not contribute to bond formation but does contribute to the activation energy of the process. Hückel calculations showed that the most important interaction is the 4-electron repulsion, and the ligands which can withdraw electrons from the d_{z^2} orbital when bent in the transition state lower this repulsion.⁸

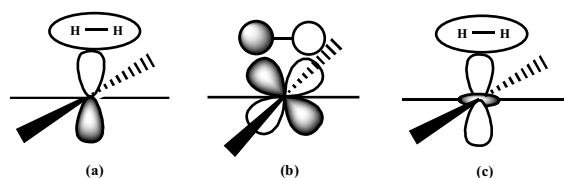


Figure 4: Three principal orbital interactions between H_2 and a square planar d^8 metal centre: (a) S bond formation (b) back donation (c) repulsive interaction.

The carbonyl ligand is a very good π -acid and will be able to reduce the 4-electron repulsion, and lower the activation energy barrier of the addition reaction, as drawn in Figure 5.

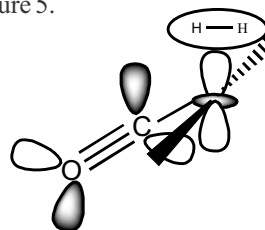


Figure 5: The π -acidity of the carbonyl ligand lowers the 4-electron repulsion in the transition state.

Factors affecting stereo selectivity of H_2 addition to $[\text{IrCl}(\text{CO})(\text{dppe})]$ - *ab initio* studies

Sargent and co-workers⁹ investigations into the addition of hydrogen to $[\text{IrCl}(\text{CO})(\text{dppe})]$, using *cis* PH_3 ligands in the computational model, provided additional theoretical confirmation that, while addition over the PIrCl axis leads to the most stable thermodynamic isomer, addition over the PIrCO axis proceeds *via* the most stable transition state. This behaviour is due to the interaction between the ligands in the plane of hydrogen addition and regions of charge density around the metal centre. As the square planar complex evolves to the six coordinate state, the two ligands on the axis of addition move past regions of high charge density due to the metal lone pair electrons, which are a source of repulsion; electron withdrawing ligands are able to minimise this repulsion, and therefore stabilise the corresponding transition state.

Similar computational studies were performed on the *trans* phosphine systems by Sargent.¹⁰ Once again the phosphine ligands are replaced by PH_3 . These calculations showed, in contrast to experimental observation, that addition across the P-Ir-P proceeded *via* the more stable transition state. Using PMe_3 as a more realistic model reversed this prediction. This illustrated the importance of accurately representing the phosphine ligands in these type of studies. In the previous calculations on the *cis* phosphine complexes,

the importance of correctly representing the phosphines was not highlighted, because any effects due to phosphine ligands were cancelled out.

Based on the reaction coordinate calculations of Sargent,¹⁰ hydrogen addition over the PIRP axis would be observed in complexes with sufficiently p-accepting phosphines, and it would be predicted that complexes of the type $[\text{IrCl}(\text{CO})\{\text{P}(\text{OR})_3\}_2]$ might exhibit this behaviour. They did not investigate this through *ab initio* calculations, however, Crabtree¹¹ did test this prediction experimentally.

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The World is described today as a Global Village. Modern developments in the society triggered by intense communication systems, increased travel by air, land and water, improved production technologies, and the desire of humans to migrate and settle in new environments brought together a variety of cultures, and especially the food habits resulting in increased movements of food across the globe. These events opened the way for the developing countries to seek economic benefits through global trade, exporting their produce to developed countries, and the newly emerging societies that opens consumer markets to make available to customers a variety of foods from all over the globe. The movement of food and the consumption of food at locations in the opposite sides of the globe brought in new issues of delivery of quality agricultural produce and foods protected from chemical and microbiological contaminants along the food chain – farm to fork. The new challenges emerging from globalization created a need to accept global standards, and to ensure maintenance of global standards in trade, especially with respect to safety of food.

The convergence of the cultures did not result in a blanket situation of everybody accepting everything, but a case of accepting only what is for the betterment of mankind. The World Trade Organization, with more and more countries becoming signatories to it, created three important agreements to handle fair trade globally, of which food is an important component¹. The first, General Agreements on Tariffs and Trade (GATT) deals with the goods. The second, General Agreement in Trade on Services (GATS) deals with the services and the third, Agreement of Trade Related Aspects of Intellectual Property Rights (TRIPS) looks after issues related to protecting the rights associated with inherent and new knowledge generated by humans.

GATS deals with the services through four models namely cross-border, consumption abroad, commercial presence of suppliers in countries where service is provided and presence of natural persons (human beings) in providing service.

TRIPS addresses the issues associated with copy rights & related rights, trademarks, geographic indicators, industrial designs, patents, layout-design of integrated circuits, protection of undisclosed information and control of anti-competitive practices. The WTO also has mechanisms to handle trade disputes arising among countries in application of above three agreements and transparent reviews on trade policies.

What is more relevant to the discussion today is GATT, which has important bearings on the world trade of goods and I wish to deal more specifically on the agricultural produce and their health implications. The discussions of WTO on GATT in the area of global food trade led to two agreements associated with food trade, with a view to protect the interests and rights of the food exporting and importing countries. The first agreement, “Sanitary and Phytosanitary Measures Agreement (SPS)” sets out the basic rules of food safety, and plant and animal health standards. It allows countries to establish their own food standards based on sound science, with the view of their application only to the extent necessary to protect human, plant and animal health. It discourages the use of health associated reasons to create barriers against trade. The member countries are encouraged under these schemes to use international standards, guidelines and recommendations. It also allows setting of higher standards by individual countries based on scientific assessment of risks appropriate to the situations and applied consistently.

The second, the agreement addressing “Technical Barriers to Trade (TBT)”, which was originally set to regulate sanitary and phytosanitary measures, contains a much far reaching approach by extending to technical requirements associated with food contaminants and labeling, essentially moving into the area of food testing.

Implementation of SPS and TBT agreements requires food regulations acceptable across the globe, food testing systems generating equivalent results, and certification of goods and services in common lines so that they become applicable equally everywhere. The seller and the buyer, or the exporter and the importer

thus need the intervention of a third party, acceptable to both sides, following rigid sets of guidelines globally to ensure that the produce and services meet the requirements established under TBT and SPS. The responsibility of meeting these challenges ended up in the hands of food testing laboratories and product and service certification bodies.

ACCREDITATION

Accreditation is a procedure by which an authoritative body gives formal recognition that a body or person is competent to carry out specific tasks (inspection, certification, testing).

Accreditation of the testing laboratories and certification bodies thus becomes a significant component in global trade in ensuring food safety. The uniformity expected in global trade was thus achieved through establishing a network of international standards associated with all aspects of accreditation, by the International Organization for Standards (ISO). This series is designated as the 17-thousand series which include the following international standards specifying requirements for each of the aspects used currently.

ISO/IEC 17025:2005 - Competence of testing and calibration laboratories²

ISO/IEC 17021:2011 - Operation of bodies performing audit and certification of management systems

ISO/IEC 17020:2012 - Operation of bodies performing inspections

ISO/IEC 17024:2003 - Operation of bodies performing certification of persons

ISO Guide 65:1996 - Bodies operating product certification systems

These standards and guidelines are used today to accredit the laboratories and certification bodies, strengthen the competency and uniformity of human resource engaged in testing, inspection, auditing and certification associated with food production and trade. The national accrediting bodies serve as a part of international system through links to International Laboratory Accreditation Co-operation (ILAC) and International Accreditation Forum (IAF), and various regional links such as European Cooperation for Accreditation (EA), Pacific Accreditation Co-operation (PAC), and Asian Pacific Laboratory Accreditation (APLAC). Linkages with these organizations through Mutual Recognition Agreements (MRA) make the decisions of national

accreditation bodies acceptable to each other internationally. The acceptances are based on scientific assessments of each other to ensure uniformity in application of standards.

Developing a laboratory to seek accreditation requires a series of activities taking much time³. The laboratories need to be purposefully built addressing separation of functions aimed at prevention of cross contaminations. The basic activities needed in establishing a laboratory put into a time scale is given in table 1.

A major constraint in operating a testing laboratory is the identification of persons willing to make a longtime commitment to technical activities. The qualifications and services of key staff members in a laboratory seeking accreditation are given in table 2. An accredited testing laboratory is an ever changing set up where much self-improvement through experience is needed to meet changing challenges of accreditation. High level of staff competency is essential to maintain good standing of a laboratory proven through participating in proficiency testing programs by maintaining satisfactory z-scores below ± 2.0 .

The activities in an accredited laboratory aim at linking the test results to the international system through a series of activities. This includes continuous maintenance of calibration status of equipment through a calibration laboratory maintaining accreditation along with appropriate mutual recognition agreements so that all results generated through use of equipment gets linked to the international system of measurements. The laboratories are expected to use only validated test methods, with evidence by the laboratory to generate accurate results under the conditions of operation of the laboratory. The competency of the analysts becomes very important in generation of reliable results. The closest point for a laboratory towards accreditation is the success in generating proficiency testing results within Z score of ± 2 on regular basis. Strict adherence to instructions in controlled documents and providing adequate evidence through proper records to prove that the analysts are maintaining required level of practice is much examined during assessment of laboratories for accreditation. The desire of the laboratory to continuously improve using customer feedback, self-examination of the operation of management system, and technical evaluation of the test results are mostly viewed features to understand competency of the staff.

The costs of maintaining a laboratory including the above features are given in table 3.

Table 1 – Time required for establishing a testing laboratory

No	Activity	Duration in months
1	Construction of a building or renovation of an existing building to meet environment control needs and aseptic conditions	3-6
2	Preparation of documents related to the quality management system	4-10
3	Purchase of equipment	3-6
4	Training abroad of staff on laboratory skills	0.5 - 1
5	On-the-job practice / training of staff	6
6	Operation of the laboratory with the quality management system established to achieve the work standard required to seek accreditation with proper work records	12
7	Processing of application for accreditation	3
8	Time for clearance of non-conformities after the initial assessment of the laboratory by the accrediting body	3
	Total duration with overlapping functions	30 - 36

Table 2 - Human Resource needs and their skills for a testing laboratory

Job titles	Qualifications	Job descriptions
Technical manager	(a) Bachelors' degree in the subject area with relevant postgraduate degree together with 5 years of work experience or equivalent qualifications reflecting competency	1) Administration of laboratory 2) Decision making on all technical matters 3) Interpretation of test results 4) Ability to provide guidance to the industry when required 5) Serve in national committees addressing food safety issues 6) Staff improvement activities
Quality manager	Bachelors' degree in Science with training on laboratory quality management	1) Maintaining quality management system 2) Arranging audits 3) Arranging management review meetings
Analysts	Bachelors' degree in the subject area	1) Testing 2) Preparation of analytical reagents or media 3) Managing equipment 4) Record keeping 5) Supervision of house keeping 6) Assisting technical manager in procurement
Attendants	Education up to year 10 with aptitude and liking for laboratory work	1) Moving heavy equipment and test cultures 2) Cleaning of laboratory and equipment 3) Assisting analysts
Help staff	Reading and writing knowledge preferably in English with work commitment	1) Moving documents inside and outside laboratory 2) Assisting in photocopying and filing 3) Helping in general maintenance work 4) Handling transfer of samples between laboratory and receipt room / stores

Table 3 – Generalized Operational costs for a medium scale testing laboratory

No.	Item	Cost US\$
1	Annual accreditation fee (By a foreign body)	10,000
2	Proficiency testing fee	1,000
3	Purchase of microbiological media	5,000
4	Depreciation on equipment and calibration	7,000
	Depreciation of the building and maintenance	10,000
5	Services (electricity, Water, gas, communication)	20,000
6	Staff emoluments (Highly variable)	30,000
7	Training and re-training	10,000
	Total annual expenditure	93,000

The need to maintain world trade at a satisfactory level serving the developmental necessities of all countries have compelled the developed countries to assist less developed countries to develop laboratories that could meet the challenges associated with technical barriers to trade (TBT). This generally takes the form of all costs in establishing a laboratory except construction of the building. Once an accredited laboratory is established, the major challenge faced by less developed countries is the maintenance of the laboratory at the required level through generation of adequate funds. This could be achieved through maintaining workload of at least 1000 samples annually. In view of the maintenance limitations that may arise, the laboratories planning to seek accreditation are advised to prepare a business plan based on a SLOT analysis identifying mechanisms to generate adequate income for efficient performance. The key factors that have led to failure of sustainability of testing laboratories are:

- a) Low funding – national economies not expanding & low industrial output
- b) Poor human skills – national education system remains stagnant
- c) High dependence on foreign sources for consumables, literature, knowledge, accreditation *etc.*

- d) Poor attitudes – Inadequate experience, competitiveness and low discipline

Global trade requires maintenance of accredited testing laboratories in food producing and processing countries for export, to eliminate using technical barriers to trade and raising of Phyto-sanitary and sanitary issues by importers. Food analysis meeting international standards contributes much to economic development of countries through export earnings.

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Innovations in Food Chemistry-Food Science for a Healthy Life: Now and Beyond

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Food science is a branch of applied sciences used to describe the application of scientific principles to create and maintain a wholesome food supply. Food scientists all over the globe study the fundamental phenomena involving basic sciences like chemistry, biology, statistics/mathematics, nutrition, physics and sensory sciences to develop a abundant, safe and nutritious food supply to everyone on this planet. Such a holistic integration of disciplines makes Food science a highly interdisciplinary applied science. Activities that are directly linked to these research efforts in the industrial and consumer level includes the development of new food products, design of processes to produce these foods, choice of packaging materials, shelf-life studies, sensory evaluation of the product with panels or potential consumers, as well as microbiological and chemical testing.

Various sub-disciplines within the food science like food safety (study of cause, prevention and communication dealing with food borne illness), food

microbiology (positive and negative interactions of microbes on food and human health), food preservation (study of quality maintenance and degradation), food engineering (unit operations and industrial operation in food manufacturing, distribution and storage), product development (invention of new food formulations and recipes), food chemistry (the molecular composition of food and the involvement of these molecules in chemical reactions), food packaging (packaging techniques as means of preserving food from farm to fork), molecular nutrition and nutrigenomics (the beneficial health aspects of various food components and their mechanism of action/interaction with the cell) help the food industry to cater the complete need of every consumer by providing safe and nutritious food-supply all through the year. Such a sustainable supply of food products, both fresh and processed is a result of the gross efforts of scientists, marketing professional and industrialists with a common vision to improve the lifestyle of the

consumers with healthy and convenient food.

Food Chemistry - Understanding role of Structure function relationships

The understanding of the interactions of the various components of the food system has helped the food industry to develop technologies to extend the shelf life and overall acceptability of the product. Food chemistry and biochemistry is one of the most fundamental aspects of food science to answer the myriad of questions to develop successful combinations of ingredients to develop a product that is rich in nutrients, economical and shelf stable. This branch of food science helps to understand the 3 main components of food namely carbohydrates, proteins and lipids along with other minor components like vitamins, minerals and phytochemicals and how these interact with one another to affect the physio-chemical, sensory and nutritional properties of the food system. Understanding of the structure of these biomolecules has been the key in unraveling their functionality and their interactions with other components.

Protein interactions: Proteins are not only one of the major components of the nutritional molecules but are also one the major molecules affecting the sensory properties of the food. Proteins interact with a number of molecules owing to the presence of both basic and acidic and neutral functional groups. Protein-flavor and protein-lipid interactions are one of the primary interactions that directly affect the texture, mouth-feel and flavor of a food-system directly. Examples of such interactions include milk and dairy products that contain considerable amount of protein and where fats dictate the overall flavor. The thermal and chemical stability of the dairy products are hence directly related to the way protein and fats are dispersed and the chemical moieties that are capable of interacting under different set of conditions. Pasteurization of milk and other dairy products for instance is one of the many processes that takes advantage of the understanding of the structure-function relationship of protein and lipid interaction in milk. Flavored yogurts are another class of food-systems that provide classic model for studying the interaction of proteins with other flavor compounds. Yogurt that primarily contains milk proteins, fats and probiotics is mainly bland making it an ideal system for the addition of variety of flavors. Various flavoring agents like vanilla, strawberry, banana, cherries, blue berries etc are incorporated into yogurt to increase their palatability and consumer

reach. Such improvements in flavors, apart from increasing the sales of the product, also have improved the choice of the consumer from fun-foods to food for health. Baking, fermentation, Enzymatic hydrolysis are some of the process that lead to an improvement in flavor, color and texture mainly because they exploit the such interactions of various components of food systems with proteins because of the production of flavorful compounds from these reactions.

Hydrocolloid interaction: A hydrocolloid is defined as a colloid system wherein the colloid particles are hydrophilic polymers dispersed in water. A hydrocolloid has colloid particles spread throughout water, and depending on the quantity of water available that can take place in different states, e.g., gel or sol (liquid). Hydrocolloids can be either irreversible (single-state) or reversible. For example, agar, a reversible hydrocolloid of seaweed extract, can exist in a gel and sol state, and alternate between states with the addition or elimination of heat. Many hydrocolloids are derived from natural sources. For example, agar-agar and carrageenan are extracted from seaweed, gelatin is produced by hydrolysis of proteins of bovine and fish origins, and pectin is extracted from citrus peel and apple pomace. Gelatin desserts like jelly or Jell-O are made from gelatin powder, another effective hydrocolloid. Hydrocolloids are employed in food mainly to influence texture or viscosity (e.g., a sauce). Hydrocolloid-based medical dressings are used for skin and wound treatment. Other main hydrocolloids are xanthan gum, gum arabic, guar gum, locust bean gum, cellulose derivatives as carboxymethyl cellulose, alginate and starch. The various chemical moieties and functional groups present in these hydrocolloids affect the kind of interaction like electrostatic interaction, Vander wall's forces, entropic forces or steric forces with each other or either with water molecules. Depending upon the food system and the various components present in the food system the choice of hydrocolloid is made. This scientific choice is made possible because of the knowledge of the various structures of the molecules and their interaction which avoids testing of all choices through random experimentation.

Antimicrobial compounds interactions: The use of antimicrobials in food system dates back to the ages of Louis Pasteur. Such compounds have been used in the food system for preventing the growth of harmful bacteria or to kill them. Study of their mechanisms of action has helped scientists to construct analogues, better understand microbial susceptibility to design

better drug candidates and to understand their efficacy in a food matrix. For instance depending on the type of functional groups present on the antimicrobial its interaction with various compounds may vary ranging from electrostatic interaction, vanderwalls force, hydrophobic interaction etc. For example some salts like quaternary ammonium salts that carry a net positive charge could be more effective against microbes that have a cell membranes or enveloped viruses as they can electrostatically interact with the membrane and disrupt it leading to cell death. On the other hand these salts could be quite ineffective in treating on enveloped viruses or endospores or mycobacterium that lacks a true cell membrane.

Delivery systems: Not all interactions within a food system are favorable. Adverse interaction within a food system not only affect the functionality of the components involved but also lead to undesirable texture, flavor and nutrient loss. One of the ways to avoid such undesirable interaction is to package or to encapsulate one of the interacting components inside a food compatible matrix like liposomes or nanoparticles. Liposomal delivery/packaging of compounds includes entrapment of the target molecule into a phospholipid bilayer membrane. These liposomal vesicles are formed when phospholipids are hydrated and mostly take vesicular conformation in order to minimize the surface tension of the system. These vesicles are typically capable of delivering lipophilic compounds.

Another delivery system that is capable of delivering lipophilic actives at very high concentration unlike liposome that can deliver these compounds only at low concentration is nanoparticle delivery systems. Nanoparticle delivery systems includes particles of sizes ranging from few nanometers to few hundred nanometers made from a wide range of materials like polymers (PLGA), metals (silver and gold), elements (carbon) to specific compounds. However very few of these are compatible with biological systems and even fewer with food systems. One such delivery system is PLGA (polylactic glycolic acid) nanoparticle system. These nanoparticles are capable of delivering the compounds at very efficient and controllable rates owing to their very small sizes and ease of manipulation by varying the pH and the ratio of lactic acid to glycolic acid.

Both liposomal and nano delivery systems apart from being compatible with the food matrix are also bio compatible and biodegradable. Once inside the body these particles are digested to their respective

monomeric units (fatty acids and phosphoric acid in case of liposomes and lactic/glycolic acid in case of nanoparticles) and excreted out safely. There has been no significant bioaccumulation of these particles inside the human body. Such positive results along with their efficacy to deliver and protect individual food component extend their uses for flavor masking, flavor extension, reduced volatilization and oxidation and increase their bioavailability. Such an extended literature and information on exploitation of these systems are results of laborious studies involving the relationship between their structure and function through various physio-chemical experiments.

Food microbiology – Understanding the role of microbes in food systems

Studies on interactions of all these components over the years have resulted in improved functionalities and more delicious, shelf-stable food products. However apart from the chemical interactions, biological interactions (i.e between living organisms and food) play a vital role in determining the safety, palatability and suitability of food product to a consumer. Food microbiology involves studying the interactions of beneficial as well as harmful microbes with the food systems. Food safety is a primary concern of any consumer and is no less important than basic need 'FOOD and WATER' itself. Studies pertaining to food borne pathogens involve Pathogenic bacteria, viruses and toxins produced by microorganisms which are all possible contaminants of food. Food safety addresses to eliminate these pathogens through food processing and from better understanding of their invasive behaviors. Apart from processing, microorganisms and their products can also be used to combat these pathogenic microbes. Probiotic bacteria, including those that produce bacteriocins, can kill and inhibit pathogens. Alternatively, purified bacteriocins such as nisin can be added directly to food products. Finally, bacteriophages, viruses that only infect bacteria, can be used to kill bacterial pathogens. Thorough preparation of food, including proper cooking, eliminates most bacteria and viruses. However, toxins produced by contaminants may not be heat-labile, and some are not eliminated by cooking. Elimination or screening of such heat resistant toxins and pathogens is major focus of food safety professionals across the world.

Safety of minimally processed and ready to eat foods like salads and fresh vegetables and fruits has gained extraordinary importance in recent times

because of the extreme vulnerability of these products to be vehicles of food borne pathogens. Molecular biology techniques like PCR (polymerase chain reaction), PFGE (pulse field gel electrophoresis), and blotting techniques are regularly used to study the plant pathogen interactions to better eliminate colonization of fresh produce by these microbes. Safe harvesting and packaging techniques are being advocated to all fresh produce industries to minimize the chances of outbreaks in these minimally processed foods.

Food microbiology also deals with understanding the role of microbes in improving the flavor of food and in the development of new foods through fermentation. Fermentation and use of microbes is also a primary way to administer beneficial microbes like lactobacillus species, bifidobacteria and yeasts to consumers. These beneficial microbes called probiotics apart from having functional roles in the food system play a significant role in the general well being of the human body. Food molecular biology has been extensively used to study and understand the functionality of these probiotics in the human body in order to administer them through food to improve the health of consumers. Such an understanding of the close interconnectedness of food, health and diseases has led the modern food industry to focus its aim on developing foods just for nutritive balance but also with curative effects.

Molecular Nutrition – Understanding the role of food in health and disease

Molecular nutrition along with food microbiology is a nascent and rapidly developing branch of food science that involves studying the functions of various food components for their effect at the cellular and organism level through the understanding of their structures. Modern lifestyle has fed this branch of food science and nutrition through innumerable metabolic diseases like cancer, cardiovascular disorders, diabetes, obesity etc which all could be partially (to completely) addressed through diet. This very close relationship between diet, lifestyle and disease is the focus of all nutritionists. Awareness of this inter relationship of diet and health among consumers has made the food industries to invest more on studying and understanding these interactions and to come up with solutions to these diseases through diet.

Cancer and diet: Cancer is the second leading cause of death among Americans and involves multiple organs, expensive medications, painful

treatment regimes and sometimes surgery. In spite of all the painful efforts put by the patients the prognosis of cancer is still mysterious and has not been clearly understood by the scientific community. There is mounting evidence that suggests that cancer development involves multiple mutations giving rise to clone of cells that has lost the ability to self regulate and whose self renewal genes have been turned on permanently. Such a clone of cells often called cancer stem cells are believed to be causative agents for the cancer to grow into multiple lineage tumors as the disease advances. One of the main reasons for increase in the incidence of cancer has been attributed to altered lifestyle including change in diet patterns. Also there are evidences to support that cancer could very well be mitigated through some of the food components like isoflavones etc. Extensive research on such food components has led scientists explore various molecules for anticancer activity and probable pharmaceutical roles. One such study involved peptide isolated from rice bran through enzymatic hydrolysis that possessed anti-proliferative activity against different types of cancer cells in vitro including breast, colon, liver, and lung cancer cells. Such a peptide and peptide fractions were obtained through an optimized enzymatic hydrolysis protocol of rice bran followed by ultrafiltration of the hydrolysates to separate the peptide fractions according to their sizes. The potent fraction was subjected to IEC and reverse phase HPLC to yield the potent pure peptide which was characterised using amino acid analysis and mass spectroscopy. This pentapeptide possess multiple anti cancer activity and has been tested on breast, colon, lung, liver cancer cell lines in dose dependent way. More specific examples of isolation of food components with anti cancer activity are found in literature and are gaining prime importance for further studies in exploiting their beneficial effects at a pharmaceutical level.

Cardiovascular diseases and diet: It is a well known fact that cardiovascular health could be well managed through a healthy lifestyle and diet. Modern scientific evidence points in no different direction than the known fact. Several classes of compounds including flavanoids, phytosterols, sito sterols have been found effective in improving cardiovascular health. The main mechanism of action through which they exhibit their beneficial effect is thought to involve reduction in cholesterol and low density lipoprotein levels. Other pathways involve reduction in inflammation that leads to arteriosclerosis and build up

of plaques in the arteries. Their effect in more than one path way is one of the main reason for their efficacy. The same reason leads to involvement of several groups that needs to work in parallel to understand their roles and increases the time and investment required for bringing these molecules as potential drug candidates.

Oxidative stress and diet: The etiology of many major diseases like cancer, coronary heart diseases, degenerative diseases still remains unclear however one of the common features seen in these diseases include oxidative stress related damages in the cells involved. Oxidative stress is not only one of the features of most diseases but also one of the main causes of age related complications seen in individuals. Food has long been thought curative of most of the age related complications and modern science has been able to rationalize the same with its myriad of powerful antioxidant systems. Fresh vegetables and fruits are excellent sources of natural antioxidants and some of the fruits loaded with such benefits have been termed as superfruits. Vitamin E, daidzein, saponin, bioactive peptides, fermented products etc. work as antioxidants and prevent free radicals (peroxides) accumulation in the body Other anti oxidant systems found in foods include lycopene, lutein and other carotenoids. Common food sources of the moleaules include tomatoes, spinach, carrots and fresh fruits.

Nutraceuticals – Integration of science and need

With impending evidence between diet and health and awareness of the same among public had led to the development of a special category of foods called nutraceuticals. Nutraceuticals are foods with either disease curative/preventive foods and are essentially an amalgam of nutrient turned with pharmaceutical properties. The very difference between a nutraceutical and a drug lies in the fact that nutraceutical being a food system or its components is much more dilute when compared to a very pure and concentrated compound that could be used as drug. This very reason affects the efficacy of both the products with drugs targeted towards a very specific condition while nutraceuticals promote a generalized well being of particular organ or a function and hence have varied roles in the bodies.

Nutraceuticals compounds present in foods include carotenoids like lycopene, lutein, guar gum, borage oil, sesame seeds. These nutraceuticals have varied functionality ranging from antioxidant properties that can reduce the risk of diseases like skin

cancer, stroke, artherosclerosis to promoting gut health and immune system. Brightly colored, yellow, orange and dark green vegetables and fruits such as kale, tomatoes, watermelon, red-pink, grapefruit, guava, and sweet potato provide carotenes and other plant pigment and are rich sources of nutraceutical compounds. Isolation of these compounds and utilizing the same in special food products has been a key development in the food industry in the recent times.

Apart from plants, animals also serve as sources of nutraceutical compounds and examples of the same includes glucosamine from shellfish tissue, and chondroitin which relieve arthritis and joint pain, to rebuild the cartilage and thicken the joint fluid that cushions and protects joints. Omega-3-Fatty acids from Fish (Tuna, Salmon, Sardines, Mackerel and Catfish), Conjugated Linoleic acid from Beef, Lamb and dairy products help to boost immunity, reduce cardiac myocyte hypertrophy and hypertension. L-Carnitine from Beef, Chicken and Eggs. has shown hepatic and cardiovascular antioxidant properties and improvement in insulin resistance in type II diabetic patients. Chitin and chitosan from the hard exoskeleton of shrimps, crabs, lobsters, and insects have been proved to reduce hypercholesterolemia.

Also probiotics formulations have recently been studied for their health effects and have been proved beneficial for a number of complications including cancer, irritable bowl syndrome, skin problems etc. For instance Lentinan, a glyco-protein extracted from shiitake mushroom (*Lentinula edodes*) has shown anti-cancer effect through host defense immune systems (Nakano et al 2009). Krestin, a protein-bound polysaccharide from cultured mycelia of *Coriolus versicolor* has been studied for its antitumor action and has been shown to have preventive effect on chemical carcinogen-induced, radiation-induced, and spontaneously developed carcinogenesis. Apart from yeasts and fungi, Lactic Acid Bacteria and bifidobacteria like *Lactobacillus gasseri* or *Bifidobacterium infantis* produce mannitol, sorbitol (polyols) and trehalose that are fermented to short-chain fatty acids (mainly butyrate) by colon microbes and may prevent colon cancer (Hugenholtz et al 2002). Trehalose is therapeutic against Creutzfeld-Jakob disease (degenerative neurological disorder) (Hugenholtz and Smid 2002). They also produce exopolysaccharides that are prebiotic, immunostimulatory, antitumoral and cholesterol-lowering activity and ω -3-fatty acids, isoflavones and

phytosterols (Awaisheh et al 2005) with cholesterol lowering ability.

Incorporation of these nutraceuticals into food systems with targeted benefits led to the evolution of functional foods which are foods that have specific health claims and aims to improve a specific functionality in an individual. Examples of such foods include oat and oat meal products that have beta-glucan and are effective against lowering the blood cholesterol to promote cardio vascular health, bread mixes to manage diabetes, orange juice with added calcium and vitamin D for bone health, yogurt drink with probiotics that can promote gut health and lower blood cholesterol etc. These functional foods are recent trends in the food industry and are rapidly growing area of any grocery store and market. The very future of these products lie in exploring and understanding the mechanism of their action and ways and tools to manipulate and improve the same.

Nutrigenomics and genetic engineering – Future of food science

Nutrigenomics and genetic engineering are tools that are used to study the effects of these nutrients at genetic level and to decipher the cellular pathways that they act upon to exert their benefits. Genetic engineering allows us to manipulate these systems to produce these components outside their natural source and also to tinker with their efficacies to improve their performance. For example developing tomato germplasm with enhanced fruit tissue-specific (antioxidant) carotenoid content, evaluating the effects of variety, maturity and growing environment on lycopene content in watermelon, Seeking genes and triggering mechanisms to increase lycopene biosynthesis in tomatoes are also research that are led by advances in genetic engineering. Nutrigenomics helps us to evaluate the bioavailability of carotenoids and their relative response in plasma tissue and to determine the roles of micronutrients and phytochemicals in maintaining health and reducing cancer present in these fruits. Nutrigenomics also maps the genes affected by these food nutrients and genes involved in metabolism of these nutrients hence allowing us to see how an individual might react to particular food. When put together they aim in revolutionizing the complete way a consumer looks at foods that he needs to eat by tailoring a food for the individual's need to cater his DNA.

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NATURAL TOXINS IN THE ENVIRONMENT AND HUMAN HEALTH IMPLICATIONS

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“All substances are poisons; there is none which is not a poison. The right dose differentiates a poison from a remedy.” Paracelsus (1493–1541).

The word “**poison**” generally describes any harmful substance, even in very small quantities, it can be deadly or harmful to living organisms.

A “**toxin**” is essentially a “**poison**” that is produced naturally by a living organism, usually by fungi, such as mushrooms and moulds, a cyanobacteria or blue green algae in a water body, a microalgae in the marine environment or any other living organism. In this context, venoms produced by snakes, spiders etc are excluded.

A poison can enter human body, usually by three principal routes; by inhalation, by ingestion or by dermal contact; however, ingestion either through the consumption of food or drinking water is the most common route of exposure.

Toxicity is generally expressed as LD₅₀ on a test subject, “**Lethal Dose 50**” will terminate 50% of the test animals, the usual test subject is the mouse, but depending upon the situation, other animals can and have been used, including primates, but such studies are very costly. It is apparent that the lower the LD₅₀ value, the more the potency of a toxin. In general, animal testing are conducted under strict ethical and experimental guidelines, but these guidelines vary from country to country.

Some Toxicity Values (intraperitoneal on mouse)

Toxin	Source	LD ₅₀ µg/kg
Botulinum toxin-A	<i>Clostridium botulinum</i>	0.00003
Saxitoxin	<i>Anabaena circinalis</i>	10
Microcystin LR	<i>Microcystis aeruginosa</i>	50

Toxins Derived from Fungi - Micotoxins such as Aflatoxins and Ochratoxins are toxic metabolites produced by a variety of fungi species of the families *Penicillium* and *Aspergillus* (1). Cereals such as corn, wheat, barley and rice, stored under damp conditions can promote mould growth and could harbour these toxin producing micro organisms. Additionally, other produce such as peanuts, beans dried fruits may also get contaminated with these toxins (2). There are other structural variants of these two toxin classes, the structures of the most important congeners are shown in figure 1. Aflatoxins have been implicated in human health disorders including hepatocellular carcinoma, aflatoxicosis and chronic hepatitis. Fatalities from acute toxicity of these toxins are rare, however, aflatoxin B1 is considered as a human carcinogen by the International Agency for Research on Cancer (IARC). Number of epidemiological studies done in Asia and Africa also supports this finding with a positive correlation between dietary aflatoxin intake and Liver Cell Cancer in these regions.

Mushroom Poisonings - Several very potent toxins are found in mushrooms, especially in the Genus *Amanita*. These mushrooms are known to produce several cyclic peptides; amatoxins (or amanitins) are the sole agent responsible for mushroom poisoning in humans (3). They tightly bind to RNA polymerase II, thereby decreasing the mRNA content progressively (4), thus inhibiting protein synthesis, the target organs are usually the liver and the kidney. In fatal cases, the damage to the liver is such that liver transplant seems to be the only treatable option, but success is not always guaranteed. Most of the mushroom poisonings are due to the consumption of misidentified mushrooms involving an amateur or a recent immigrant who misidentifies a toxic mushroom for an edible variety. The intraperitoneal LD₅₀ (i.p on mouse) for amatoxins, depending upon the isomer, varies from 300 – 700 mg/Kg. However, each individual mushroom is known to contain milligram quantities of the toxin, therefore, a meal is always fatal. Several fatalities have been reported from all over the world and recently from Canberra, Australia.

Marine microalgae - Microalgae are primary producers in the marine environment and some of these organisms produce secondary metabolites that are toxic to humans and other organisms. These toxins are structurally and functionally diverse and can get biotransformed and biomagnified in the marine food chain. Risks to humans consuming contaminated seafood can be considerable and significant numbers of people around the world are poisoned annually, but many incidents may go unreported due to complex diagnosis involved. These marine micro organisms such as dinoflagellates and diatoms that produce toxins are present in all parts of the world and survive in all climates but some of the species are limited to the tropics. However, due to expanding global trade, unsuspecting seafood from a tropical area, contaminated with a toxin can find its way into any market around the world.

Ciguatera Poisoning - Ciguatoxins (CTX) are a family of polycyclic, hydroxylated, polyether compounds which are lyphophilic and also heat stable. CTX originates from the dinoflagellate, *Gambierdiscus toxicus* as gambiertoxin which gets biotransformed in the food web to ciguatera toxin (5). It is mostly associated with reef fishes, such as Coral Trout (*Plectropomus spp.*), Barracuda (*Sphyræna jello*) and Red Bass (*Lutjanus bohar*) and many other such reef fishes. Depending upon the location where it is found, there are several CTX congeners, Pacific cigiatoxins,

Carebian ciguatoxins and Indian cigiatoxins. These have some modifications in the polyether ladder. Quite a few global ciguatera hot spots have been identified and commercial fishing is banned from these areas. However, catches through local and recreational fishing can still make it into the table. Due to the heat stability, cooking does not destroy the toxin. P-CTX-1 is the most toxic isomer known today, with an I.P. LD₅₀ of 0.25 µg/kg on mice, it is a very potent toxin. Ciguatera toxins binds to the voltage gated sodium channel (5) and interrupts the neuro transmissions. It is estimated that on average, about 50 000 Ciguatera poisonings are reported annually but many may go unreported or misdiagnosed.

Paralytic Shellfish Toxins - Several marine micro algae produce saxitoxin (STX), a neurotoxic guanidinium alkaloid which was originally isolated from the clam *Saxidomus giganteus* (6). With an intraperitoneal LD₅₀ value of 10 µg/kg on mice, it is a very potent neurotoxin. Saxitoxin binds to the voltage gated sodium channel and prevents neurotransmissions, causing respiratory paralysis (7). There are several structural variants of STX, but these are toxic to a lesser degree.

Other marine toxins - Palytoxin (8), one of the largest non peptidic organic compounds found in nature, with a molecular weight of about 2600, was originally isolated from a soft coral species, genus *Palythoa*, but it is now known that palytoxin is also produced by other species such as dinoflagellates. The toxin is reported in seafood such as mackerel, parrotfish and in crabs. It targets membrane Na/K –ATPase and converts it to non-selective cationic pore, thus disrupting the cellular Na/K balance (8). The intraperitoneal LD₅₀ on mice is 0.015 µg/kg, indicating it is a very potent toxin. However, the toxicity varies depending upon the route of exposure.

Tetradotoxin (6) or puffer fish toxin acts in a similar way to saxitoxin, binding to the voltage gated sodium channel. It is estimated that annually 50 deaths are reported from Japan due to puffer fish poisoning (9).

Domoic acid (6) mimics the effect of glutamic acid in neurotransmissions, thus affecting the central nervous system, leading to seizures and permanent memory loss. Known as Amnesic Shellfish Poisoning (ASP), it can be life-threatening and is characterised by both gastrointestinal and neurological disorders. Seafoods affected are mainly shellfish such as mussels but it could also affect certain fish species.

Freshwater Toxins - Cyanobacteria are an integral part of many ecosystems and have existed nearly three billion years. Some are useful nitrogen fixers and fertilize agricultural land throughout the world, especially rice paddies (10). A small group of genera, however, produce toxins and pose a threat to human and animal health through drinking water exposure, but exposure through food chain is an emerging public health concern.

Two notable toxins, the cyclic peptide microcystin and the guanidinium alkaloid cylindrospermopsin dominate the freshwater toxins. The organisms that produce these toxins are cosmopolitan and infests many water bodies around the world. Saxitoxins, which are usually associated with seafood are also produced by cyanobacteria and also pose a threat through drinking water exposure.

Microcystin toxicology - Microcystins are cyclic heptapeptides (11), produced mainly by *Microcystis* sp. Over 70 different microcystins have been characterized, with most of the structural variations originating from substitution of different amino acids in the positions 2 and 4 (X and Y in Figure 5). Microcystin-LR is the most common and also the most toxic isomer with LD₅₀ (I.P. on mice) being 50 µg/kg body weight. Microcystins are very potent phosphatase inhibitors and structural studies indicate the binding is covalent in nature (12). Phosphatases along with protein kinases control many cellular functions

through phosphorylation and de-phosphorylation at specific sites. At any given moment there is a subtle balance between the two processes. Over 30% of cellular proteins are subjected to phosphorylation at one or more residues. When phosphatases are inhibited by the action of microcystins, it leads to hyperphosphorylation, rendering many cellular processes inoperative.

Cylindrospermopsin Toxicology - Cylindrospermopsin (CYN) is a guanidinium alkaloid that came into public attention in early 1980s due to a mass poisoning event reported from the East coast of Queensland, Australia. *Cylindrospermopsis raciborskii* is the major organism responsible for the production of CYN, but several other cyanobacteria are also known to produce this toxin. One interesting feature of *Cylindrospermopsis raciborskii* blooms are that they do not usually appear as surface scums but are dispersed through the upper layers of water bodies (13) which makes the hazard they pose less visible.

When compared to microcystin, CYN is a slow acting toxin, maximum toxicity being realized after about 5 days. Acute intraperitoneal (IP) LD₅₀ on mice is 0.2 mg/kg body weight. Acute oral LD₅₀ is 6 mg/kg (14). Mechanism of toxicity involves inhibition of protein synthesis (15) and depletion of cellular glutathione (16) levels. It appears that there are other mechanisms causing hepatocyte necrosis. There are three known congeners of cylindrospermopsin as

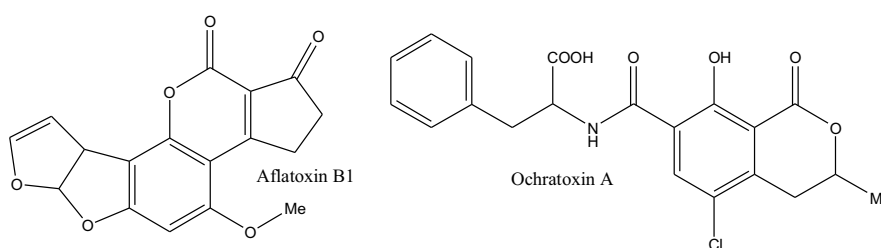


Figure 1: The structure of aflatoxin B1 and ochratoxin A

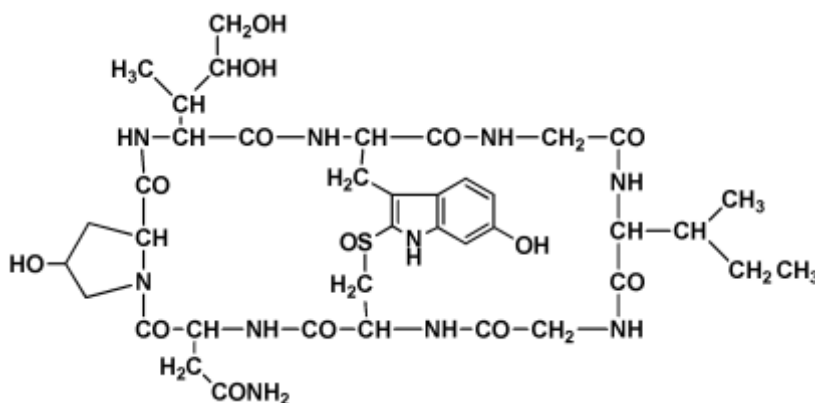


Figure 2: a-Amanitin, a bicyclic octapeptide from the fungi *Amanita phalloides*

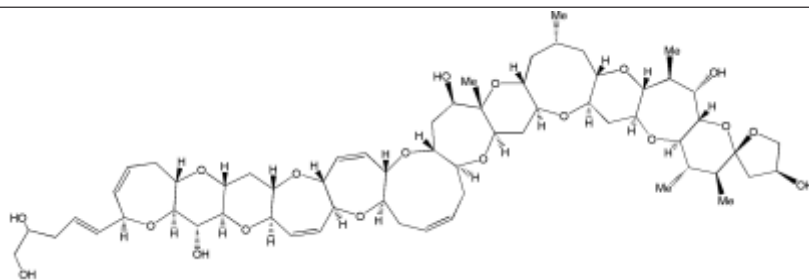


Figure 3. The structure of P-CTX-1, the most toxic Ciguatoxin

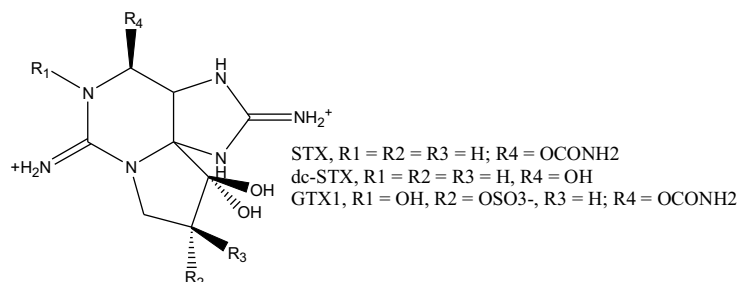


Figure 4: The structure of STX and some derivatives

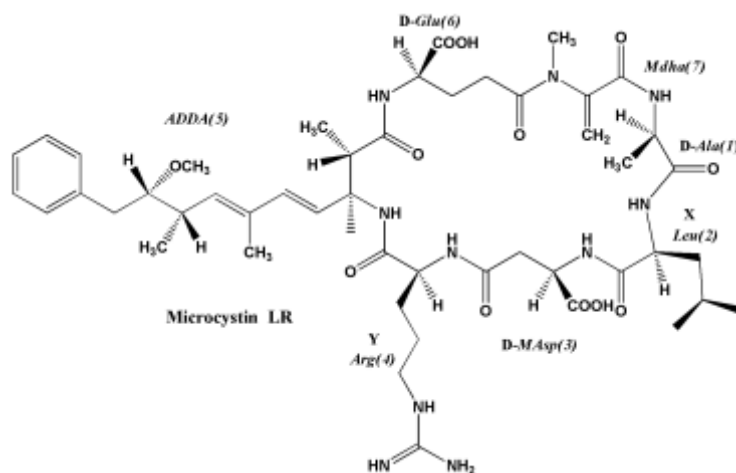


Figure 5: The structure of cyclic heptapeptide microcystin LR

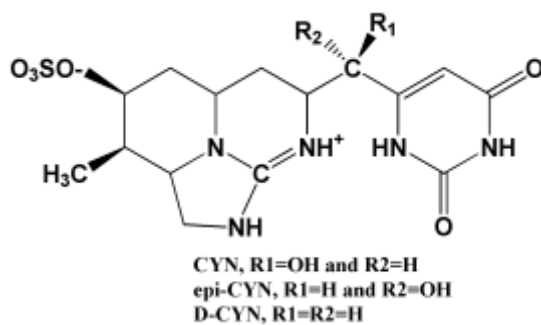


Figure 6: The structure of CYN isomers

depicted by the figure 6. Due to the presence of the uracil moiety, these compounds can bind to DNA and have demonstrated genotoxicity (17, 18). *In vitro* experiments have shown that all three isomers of CYN are toxic (19). However, contrary to *in vitro* studies, recent *in vivo* experiments conducted in our laboratories have shown that D-CYN is non toxic, when compared to CYN dosed mice with unremarkable tissue histology (20). This research is ongoing and may

shed some light to understand the mechanism of toxicity of these compounds.

Other freshwater toxins - In recent years, non peptide amino acids such as BMAA have received worldwide attention (21). BMAA (b-methyl amino L-alanine) is a mild neurotoxin. Whether accidental incorporation of this amino acid into proteins and disrupt the tertiary structure is yet to be established. The presence of this toxin in cyanobacteria needs close scrutiny.

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Cover Page

The cover page gives a 3D (stick and ball) representation of a Vaska's Complex (http://en.wikipedia.org/wiki/Vaska's_complex) of the general formula $[\text{IrX}(\text{CO})(\text{PPh}_3)_2]$ where $\text{X} = \text{Cl}, \text{Br}, \text{I}$. These complexes have been used to study the oxidative addition of H_2 in square planar complexes. These reactions play an important role in homogenous hydrogenation and hydroformylation catalysis. (pages 13 - 15)

42nd Annual Sessions of the Institute of Chemistry Ceylon 2013

Theme:

Role of Chemistry for Sustainable Agriculture

Date: June, 2013

CALL FOR ABSTRACTS AND EXTENDED ABSTRACTS

Last Date for receiving abstracts and extended abstracts is 15th February 2013

AWARDS 2013

The following awards will be presented at the Annual Sessions 2013 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 2013

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

Ninth Convocation Awards & Prizes 2012

First Class Honours (8)

Mr. P U A I Fernando, Ms. H C Weeraratna, Ms. L P Egodawatta, Ms. Maheeka Y Abeywardana, Mr. R Sanjeevan, Mr. S D Gunasinghe, Ms. Maheeshi Y Abeywardana, Mr. AS Ghouse

Second Class Honours (Upper Division) (22)

Ms. D Kaluthantri, Mr. H R C Chinthana, Ms. M C D Cooray, Ms. W D A R Costa, Ms. M N T Dayarathne, Ms. N H P De Silva, Ms. A R M Dias, Mr. M A N Dias, Ms. M L C Dulanthika, Ms. R S Hewawasam, Ms. M D C D Jayawardana, Mr. U L D I Kalana, Ms. O T Liyanage, Mr. J A D I Niranga, Ms. L A P Obeysekara, Ms. K A P S S Perera, Ms. W D M C Perera, Mr. K M S Samindra, Ms. D M C N K Senanayake, Mr. R D Senevirathne, Mr. K A V S Siriwardena, Ms. G H T C Kaushalya

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Pass (18)

Mr. K D Y Karannagoda, Ms. R P U De Silva, Mr. B P Ranasinghe, Ms. P L Liyanapathirana, Ms. W G C Kavinga, Ms. D G V P Samarajeewa, Ms. V R Wickramasinghe, Ms. J Rathini, Ms. N Swarna, Ms. S Laavanyaa, Ms. T D Abesuriya, Mr. C S Gunarathne, Mr. H G P A Indeera, Ms. S Vinuja, Ms. B D H Tharangika, Ms. H M E Chathurika, Ms. L Y U T Panangala, Ms. W G C M Premaratne

GRADUATESHIP (OVERALL) AWARDS

First	Shireen Jayasuriya Memorial Gold Medal	Mr. P U A I Fernando
Second	Graduateship Silver Jubilee Commemoration Award	Ms. H C Weeraratna
Third	Graduate Chemist (25 th Batch passing out) Silver Jubilee Commemoration Award	Ms. L P Egodawatta

AWARDS FOR OVERALL EXCELLENCE IN ALL LEVELS OF STUDY (THEORY)

Prof. J.K.P Ariyaratne Memorial Award for Overall Excellence in Inorganic Chemistry	Mr. P U A I Fernando
Professor Leslie Gunatilake Award for Overall Excellence in Organic Chemistry	Ms. L P Egodawatta
Haniffa Award for the Overall Excellence in Physical Chemistry	Ms. H C Weeraratna
Prof. Saman & Asoka Patiratne Award for Overall Excellence Analytical Chemistry	Ms. W D M C Perera

LEVEL 3 & 4 OVERALL (THEORY) AWARDS

First	Royal Society of Chemistry (Sri Lanka) Section Award	Mr. P U A I Fernando
Second	Professor and Mrs. H.W Dias Award	Mr. R Sanjeevan
Third		Ms. L P Egodawatta

BEST PERFORMER AWARDS FOR OVERALL EXCELLENCE IN CHEMISTRY PRACTICALS

Professor R.S Ramakrishna Memorial Award	Ms. Maheeka Y Abeywardana
Mr & Mrs Sivarajah and Family Award	Ms. R S Hewawasam
B A Jayasinghe Memorial Award & College of Chemical Sciences Award	Ms. M N T Dayarathne, Ms. H C Weeraratna, Ms. Maheeshi Y Abeywardana & Ms. M C D Cooray
Good Performer Awards	Mr. E M M S Ekanayake, Mr. P U A I Fernando, Ms. M D C D Jayawardana

CHAMIKARA WIJESINGHE ALL ROUNDER AWARDS

First : Mr. P U A I Fernando	Second : Mr. H R C Chinthana	Honorable mention: Mr. R Sanjeevan
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PRIZES FOR INDIVIDUAL COURSES

P Rohan K Fernando Prize for Special Topics in Chemistry	Ms. L A P Obeysekara
MicroChem Laboratories Pvt (Ltd) Prize for Environmental Chemistry	Ms. L. A. P. Obeysekara
W R O Fernando Memorial Prize for Energetics and Kinetics	Mr. R Sanjeevan
Mr. & Mrs. N I N S Nadarasa Prize for Special Topics in Organic Chemistry	Mr. R Sanjeevan
Professor Eugene De Silva Prize for Industrial Chemistry and Technology	Mr. R. Sanjeevan
Prize for Information Technology	Mr. H R Chinthana

(PTO)

Egodawatte G Somapala Prize for Food Chemistry and Technology

Mr. S D Gunasinghe, Ms. N H P D Silva and Ms. L P Egodawatte

Dr. Lakshman Ponnampereuma Memorial Prize for Special Topics in Inorganic Chemistry

Ms. L P Egodawatte

Denzil and Christobel Fernando Commemoration Prize for Agro industries

Mr. K A V S Siriwardena

Pincock Prize for Photochemistry

Mr. P U A I Fernando

Mr and Mrs. H S Dias Memorial Prize for Geochemistry

Mr. P U A I Fernando

Professor A P De Silva Prize for Chemical Sensors

Ms. H C Weeraratna

Dharmarathne Wasala Prize for Computational Chemistry

Ms. H C Weeraratna

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Mr. A S Ghouse

Mr. A M Jayasekara Atthanayaka & Mrs. Kusum Aththanayaka Family Prize for Separational Techniques

Mr. A. S. Ghouse, Ms. I. U. K. Gunnepana, Ms. R. S. Hewawasam & Ms. M. G. A. S. Silva

Diploma in Laboratory Technology in Chemistry

38th Batch (2010/12)

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Merit Pass (in order of merit) (13)

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Ordinary Pass (in order of merit) (17)

Ms. M N F Fasrina, Ms. T M N Jayasundera, Mr. T R Weerakoon, Mr. M N N Ahmed, Mr. R M R K Rathnayaka, Mr. M I M Ifham, Mr. J W Singhapura, Ms. U U K A L Perera, Ms. M Yamunadevi, Mr. A A C Pramod, Ms. M N F Minha, Mr. R W M R N R Wanigasekara, Mr. E W Wanigasekara, Ms. W A M A Perera, Ms. S A S Praboda, Ms. S S Samarawickrama, Mr. R L Warnapura

DLTC Overall Prize List-2012**First Prize****G C N Jayasuriya Award for the Best Performance**

Ms. M Y D Perera

Second Prize

Ms. R S de Fonseka

Third Prize

Mr. B M A B Jayathilaka

Mr P R K Fernando's prize for Industrial and Food Chemistry

Ms. M Y D Perera

P. D. Luckmal De Zoysa Memorial Prize for Clinical Laboratory Technology

Ms. R S de Fonseka

Call for Nominations for Institute of Chemistry Gold Medal 2013

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 2013 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 2013
- 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 42nd Annual Sessions. **Nominations should be forwarded to reach the Hony. Secretary, IChemC not later than 31st March 2013.**

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 (second edition)	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	Dr S P Deraniyagala & Dr M D P De Costa	Rs.75/-
15	Some Important Aspects of Polymer Characterization	Dr L Karunanayake	Rs.75/-
16	Hard & Soft Acids & Bases	Prof (Mrs) Janitha A Liyanage	Rs.65/-
17	Chemistry of Metallocenes	Dr Sarath D Perera	Rs.65/-
18	Lasers	Dr 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	Dr L Karunanayake	Rs.75/-
25	*NMR Spectroscopy	Dr (Mrs) D T U Abeyunga	Rs.65/-
26	Mosquito Coils and Consumer	Ms D K Galpoththage	Rs.100/-
27	Atomic Absorption Spectrometry	Dr K A S Pathiratne	Rs.100/-
28	Iron Management on Biological Systems	Dr (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/-

* - Second Edition /new print published on popular demand

CCS Publications

01	Functional Group Analysis in Organic Chemistry	Prof AAL Gunatilake	Rs. 175/-
02	Zinc Metalloproteins	Prof (Ms) R D Wijsekera	Rs. 175/-

General Publications

- ★ **Chemist & The Environment** (Rs.300/-)
- ★ **Infrastructure Support Services for Industrial Development** (Rs.200/-)
- ★ **Chemical Industries in Sri Lanka – Part II** (Members: Rs. 200/-, Non-members: Rs.275/-)
- ★ **Proceedings of the Workshop on the Technological aspects of the Production & Processing of Essential oils in Sri Lanka** (Rs.100/-)
- ★ **Proceedings of the Training Seminar on Towards a Cleaner Industrial Environment in the New Millennium** (Rs150/-)
- ★ **A-Level Chemistry Facts, Patterns & Principles by Dr. Seetha I Rodrigo** (Rs.1500/-)
- ★ **Proceedings of the Prof R S Ramakrishna Memorial Training Seminar on Modern Analytical Methods**(Rs.200/-)
- ★ **Historical Accounts of the Educational Activities (1972 - 2004)** (Rs.350/-)
- ★ **Proceedings of the Training Seminar cum Workshop on Sampling, Statistics and Standardization in Chemical Analysis and Environmental Management** (Rs.150/-)
- ★ **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	11
FRSC	05
CChem, MRSC	10
MRSC	20
AMRSC	08
Affiliate /Under Graduate.	06
Total Membership as at July 2012	60

2. Committee of Management

The following were elected to the Committee at the 51st Annual General Meeting held on 27th July 2012.

Chairman	- Dr. M P Deeyamulla
Vice Chairman	- Mr. W J P D Jayalath
Chairman Elect	- Mr. I M S Herath
Hony. Secretary	- Dr. Positha Premaratne
Hony. Treasurer	- Prof. W S Fernando

Committee Members - Prof. Sudantha Liyanage
Mr. W A P Silva
Mr. S Perasiriyan
Mr. R M G B Rajanayake
Mr. Sulith Liyanage

3. Committee Meetings

There were 12 Committee Meetings held during the period, July 2011 to July 2012. The venue of these meetings was the office of the Royal Society of Chemistry SL Section at the S L A A S Headquarters. These meetings were held to discuss the R S C SL Section's, new plans and strategies with regard to organizing the activities for the year 2011/2012 and thereafter.

4. Activities

4.1 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 Graduate ship Examination in Chemistry Part II Theory Examination

(d) Contributions for the International Conference

4.2 All - Island Inter School Chemistry Essay Competition.

4.3 IYC Challenge project at Eastern Province.

4.4 Inter - University Chemistry Competition.

4.5 Teacher training program.

4.6 Advanced Level chemistry seminar.

4.7 Donation of teaching and learning resources for Chemical Society of selected University.

4.8 Book donation program.

4.9 Popular Lectures.

4.10 Industrial Visit.

4.11 Writing Monographs by few committee members.

4.12 Newton A. Dias Weerasinha Memorial Scholarship 2011/2012

4.13 Popularisation of Chemical Science and Teacher training programme and book donation programme at Trincomalee.

5. Web Site

The members are reminded of the web site of our Section, the address of which is as follows:-

www.rsc.org/Membership/Networking/InternationalSections/SriLanka/index.asp.

Dr. Positha Premaratne
Hony Secretary

Professor Stanley Wijesundera Memorial Oration on 14th September



Prof. Sunethra Athukorala being awarded the gold medal for the Professor Stanley Wijesundera Memorial Oration by Dr. S Mohanadas, President of the Institute of Chemistry Ceylon.



Guests and invitees



Prof. Athukorala delivering the oration.



Fifth Professorial Oration by Professor K A S Pathiratne and Unveiling of Photographs of two Distinguished Service Awardees on 25th October at Adamantane House



Prof. K A S Pathiratne



Guests and invitees



Prof. K A S Pathiratne delivering the professorial oration.



Unveiling of Photographs of two Distinguished Service Awardees

Prof. Sujatha Hewage

Prof. W S Fernando